TWENTY-FOURTH ILLINOIS CUSTOM SPRAY OPERATORS TRAINING SCHOOL

SUMMARIES OF PRESENTATIONS
JANUARY 26 & 27, 1972
URBANA, ILLINOIS

Cooperative Extension Service
University of Illinois at Urbana-Champaign
College of Agriculture
in cooperation with the
Illinois Natural History Survey

This training school is presented specifically for commercial applicators of agricultural chemicals by the University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service, and Illinois Natural History Survey, but is open to all persons involved in the handling of agricultural chemicals. The school promotes the proper, timely, and wise use of agricultural chemicals. We gratefully acknowledge the assistance of officers of the Illinois Association of Aerial Applicators and the Agricultural Spraying Association in planning the program. Abstracts in this manual bring to you the latest research information, but do not constitute positive recommendation unless so stated. Statements made herein are the responsibility of either the speaker or the institution he represents. *Reproduction and publication are permitted only with the approval of each author.*

TWENTY-FOURTH ILLINOIS
CUSTOM SPRAY OPERATORS TRAINING SCHOOL

January 26 and 27, 1972
Illini Union Building
University of Illinois at Urbana-Champaign

Sponsors: Cooperative Extension Service, University of Illinois at Urbana-Champaign College of Agriculture, Illinois Natural History Survey, Illinois Aerial Applicators Association, and Illinois Ground Operators Association.

Special Events, Tuesday, January 25

A Special Meeting for Applicators

RAMADA INN, Fourth Floor Banquet Room

10:00 a.m.	Federal Legislation	*H.B. Petty*
10:10	Revisions of Custom Applicators Law	*R.G. Anderson and J.C. Hogancamp*
11:00	Liability	*C.A. Bock*
11:20	Aerial Application Pattern Measurements, 1971	*B.J. Butler*
11:40	Lunch	
2:00 p.m.	Business Meetings of Assocations Illinois Aerial Applicators Association Illinois Ground Applicators Association	

Get-Acquainted Time

7:30-9:30 p.m. Illini Union Building--General Lounge, Second Floor

If you are in town, come over and say hello, register, and visit with the speakers who will be on the program for the next two days.

FORMAL PROGRAM

Illini Union Building, Illini Room

WEDNESDAY MORNING, JANUARY 26, 1972
WELDON WADLEIGH, PRESIDING

8:30 a.m.	Movie: "Norman Borlaug--Revolutionary!"	
9:10	Disease Developments of Current Importance	*M.C. Shurtleff*
	Marihuana Control.	*E.L. Knake*
	Agriculture, Pesticides, and the Future.	*O.G. Bentley*
	Insecticide Residues in Milk	*S. Moore, III*
	Herbicide Incorporation During Tillage	*B.J. Butler*
10:30	Coffee	

HAROLD BRINKMEIER, PRESIDING

10:50	Fall Panicum Control	*R.E. Doersch*
	Alternate Methods for the Control of European Corn Borers	*E.C. Berry*
	Crop-Herbicide Rotations	*F.W. Slife*
	New Insecticide Developments on the Drawing Board.	*G.M. Booth*
	Management and Problems with No-Tillage Systems.	*G.B. Triplett*
12:15 p.m.	Lunch	

JOSEPH ANDERSON, PRESIDING

1:30	Quackgrass Control	*R.E. Doersch*
	Fungicide Seed Treatment Research.	*T.H. Bowyer*
	Insect Situation, 1971	*T.A. Cooley* *D.E. Kuhlman* *R. Randell*
	Crop and Weed Desiccation.	*R.J. Fink*
	Weed Control in Soybeans	*M.D. McGlamery*
	Rootworm Control Demonstrations--A Four-Year Summary.	*H.B. Petty*
3:05	Coffee	

CLARENCE STATON, PRESIDING

3:25 Herbicides and Liquid Plant Nutrient Combinations
Compatability . . . .*M.D. McGlamery*
Handling and Applying . . . . *R.A. Lemler*

Soil Insect Control Demonstrations, 1970-71 . . . .*D.E. Kuhlman*

The Search for New Sources of Resistance to
Southern Corn Leaf Blight . . . .*S.M. Lim*

Garden Symphylan Control, 1971. . . . .*R.E. Sechriest*

Insecticide Residues in Soybeans. . . . .*H.B. Petty*

Illinois Pesticide Accident Report. . . . .*R. Randell*

5:10 Adjourn

THURSDAY MORNING, JANUARY 27, 1972
DAVE MYATT, PRESIDING

8:50 a.m. New Insecticides and Their Place in Illinois
Agriculture . . . .*R. Randell*

Southern Corn Leaf Blight in 1971 and
Overwintering Studies . . . .*E.E. Burns*

Smartweed Control in Corn and Soybeans. . . . .*M.D. McGlamery*

Practical Aspects of Insect Control with
Bacillus thuringiensis. . . . .*R. Randell*

Cereal Leaf Beetle and Japanese Beetle
Quarantines . . . . *R.G. Anderson*

Sorghum Insect Pests. . . . . *J.G. Thomas*

10:25 Coffee

PAUL CURTIS, PRESIDING

10:45 Weed Control in Grain Sorghum . . . .*G. Kapusta*

Aquatic Weed Control. . . . .*R.C. Hiltibran*

Barn and Livestock Fly Control. . . . . *S. Moore, III*

Weed Control in No-Tillage Systems. . . . . *G.B. Triplett*

Weed Control in Corn. . . . .*E.L. Knake*

New Herbicides. . . . .*F.W. Slife*

12:30 Adjourn

CONTENTS

SUBJECT INDEX

PLANT DISEASE CONTROL

POLLUTION

WEED CONTROL

WHO'S WHO

*Anderson, J.E., Shell Chemical Company, Oak Brook, Illinois
Anderson, R.G., Superintendent, Division of Plant Industry, Illinois Department of Agriculture, Springfield
*Anderson, V.C., President, Illinois Ground Sprayers Association, Anderson Farm Service, Inc., Newark
Bentley, O.G., Dean of College of Agriculture
Berry, E.C., Research Entomologist, USDA, European Corn Borer Laboratory, Ankeny, Iowa
*Brinkmeier, H.A., Senior Extension Adviser in Agriculture, Carroll County
Bock, C.A., Assistant Professor of Agricultural Law
Booth, G.M., Assistant Entomologist, Illinois Natural History Survey and Assistant Professor of Entomology
Bowyer, T.H., Graduate Extension Assistant in Plant Pathology
*Burns, E.E., Instructor, Plant Pathology
*Butler, B.J., Professor of Agricultural Engineering
Cooley, T.A., Assistant Specialist in Extension Entomology and Assistant Specialist, Illinois Natural History Survey
*Craig, W.R., Agriculture Instructor, Lincoln Land Community College, Springfield, Illinois
*Curtis, P.C., Lead Instructor in Agricultural Department, Parkland Junior College, Champaign, Illinois
Doersch, R.E., Associate Professor, Extension Weed Control, Department of Agronomy, University of Wisconsin, Madison, Wisconsin
Fink, R.J., Associate Professor, Department of Agriculture, Western Illinois University, Macomb
*Hiltibran, R.C., Biochemist, Illinois Natural History Survey and Associate Professor of Agronomy
*Hogancamp, J.C., Weed and Herbicide Adviser, Illinois Department of Agriculture, Springfield
*Hopen, H.J., Associate Professor of Vegetable Crops and Head of Division of Vegetable Crops
Kapusta, G., Department of Plant Industry, Southern Illinois University, Carbondale
*Keeper, M., Van Horn Sales, Decatur, Illinois
*Knake, E.L., Professor of Agronomy
*Kuhlman, D.E., Assistant Professor of Agricultural Entomology, Extension Entomologist, Illinois Natural History Survey
*Lemler, R.A., Kaiser Agricultural Chemicals, Sullivan, Illinois
Lim, S.M., Assistant Professor of Plant Pathology
*McGlamery, M.D., Associate Professor of Agronomy (on leave)
*Moore, S., III, Professor of Agricultural Entomology, Entomologist, Illinois Natural History Survey
*Myatt, H.D., Extension Adviser in Agriculture, Tazewell County
*Obst, A.H., Extension Adviser in Agriculture, Monroe County
*Petty, H.B., Professor of Agricultural Entomology, Entomologist, Illinois Natural History Survey; and Chairman, Sprayers School Committee
*Rachesky, S.R., Area Adviser, Pesticides, Chicago
*Randell, R., Assistant Professor of Agricultural Entomology, Extension Entomologist, Illinois Natural History Survey
*Scott, W.O., Professor of Agronomy
Sechriest, R.E., Associate Entomologist, Illinois Natural History Survey, and Assistant Professor of Agricultural Entomology
*Shurtleff, M.C., Professor of Plant Pathology
*Siemens, J.C., Associate Professor of Agricultural Engineering
*Slife, F.W., Professor of Agronomy
*Staton, C., President, Staton Aerial Service, Inc., Steward, Illinois
Thomas, J.G., Extension Entomologist, Texas A & M University, College Station, Texas
Triplett, G.B., Professor, Department of Agronomy, OARDC, Wooster, Ohio
*Turgeon, A.J., Assistant Professor of Turf Management
Wadleigh, W.W., Stauffer Chemical Company, Omaha, Nebraska
*Woodis, R.A., Communications Specialist and Assistant Professor in Agricultural Communications

*Also members of planning committee.

1972 URBAN PESTICIDE DEALERS AND APPLICATORS CLINICS

The following series of meetings is an expansion of the clinics held in past years for the small package or home and garden pesticide dealers. This year's series of clinics will be geared to these same dealers, but also will have topics of interest to custom applicators who apply pesticides to trees, shrubs, and lawn areas. The examination for the Custom Applicators and Custom Operators Licenses will be given at the close of the meetings. Registration will be from 9:30 to 10:00 a.m. Adjournment will be about 3:00 p.m.

Date	City	Location
March 6	Champaign	Ramada Inn Rt. 45
March 7	Elgin	Blue Moon Restaurant Bus. Rt. 20 W
March 8	Rockford	Holiday Inn Rt. 51 S
March 9	Moline	Deere and Co. Administrative Center John Deere Road
March 10	LaSalle	Holiday Inn I-80 and Rt. 51
March 13	Homewood	Dixie Governor Motel 175 St. and Governor's Highway
March 14	Pekin	County Extension Office 116 S. Capital
March 15	Marion	Holiday Inn I-57 and Rt. 13
March 16	Edwardsville	Flaming Pit Rt. 159 S
March 17	Springfield	Heritage House Rt. 66 S

Advance registration is necessary for the meetings at Homewood, Elgin, Moline, and Edwardsville. Contact by mail or phone: William Whiteside, Cook County Extension Adviser, 6657 South St., Tinley Park, if you plan to attend the Clinic at Homewood. Contact Philip Farris, Kane County Extension Adviser, Box 589, Randall Road, St. Charles, for the Elgin Clinic; J.E. Kenney, Rock Island County Extension Adviser, 1188 Coaltown Road, East Moline, for the Moline Clinic; and Wayne Siefert, Area Adviser, 132 N. Kansas, Edwardsville, for the Clinic at Edwardsville.

1972 PESTICIDE DEALERS AND APPLICATORS CLINICS

Sponsored by the College of Agriculture, University of Illinois, Illinois Natural History Survey, and the State Department of Agriculture, Division of Plant Industries

As a pesticide dealer or applicator, you are invited to attend one of the area agricultural chemical clinics. The discussions will include the current situation and the why and how of control for weeds, diseases, and insects affecting field crops, as well as the proper use of application equipment. The examination for the Custom Spray Operators License will be given at the end of the meeting.

We look forward to seeing you at the meeting and discussing problems of mutual interest. The following are the dates and locations for the clinics:

Date	City	Location
February 14	Champaign	Ramada Inn
February 15	Jacksonville	Black Hawk Restaurant
February 16	Edwardsville	Flaming Pit Restaurant
February 17	Marion	Holiday Inn
February 18	Effingham	Ramada Inn
February 21	Bloomington	Williams Towne Hall Restaurant
February 22	Quincy	Holiday Inn
February 23	Galesburg	Sheraton Inn
February 24	Sterling	Emerald Hills Country Club
February 25	Joliet	Rossi Autumn Acres Restaurant

A registration of $3 per person will be charged to cover the cost of the reference packet and other incidental expenses. A copy of the *1972 Custom Spray Operators Training School* manual will be included in this packet.

The program for the clinics is shown on the next page.

PROGRAM

9:30-9:55	Registration, Coffee, and Get-Acquainted	
9:55-10:00	Welcome.	*Extension Service*
10:00-10:30	Insect Situation and New Developments in Stored Grain Insect Control	*Steve Moore*
10:30-11:05	Corn Insect Control.	*Pete Petty*
11:05-11:20	Seed Treatments for Small Grains	*Mal Shurtleff or Ed Burns*
11:20-12:00	Weed Control in Corn and Soybeans.	*Ellery Knake*
12:00 noon-1:00 p.m.	Lunch	
1:00-1:20	Calibration of Spray Equipment	*John Siemens*
1:20-1:50	Recent Developments on Diseases of Corn and Soybeans, Including Corn Blight.	*Mal Shurtleff or Ed Burns*
1:50-2:00	The Illinois Custom Spray Operators Licensing Law.	*Juett Hogancamp*
2:00-3:00	Do's and Don'ts for Applying Pesticides	
	Application Aspects.	*John Siemens*
	Herbicide Aspects.	*Ellery Knake*
	Fungicide Aspects.	*Mal Shurtleff or Ed Burns*
	Insecticide Aspects.	*Pete Petty*
3:00-4:00	Examination for Custom Spray Applicators and Operators License will be given by Mr. Juett Hogancamp of the State Department of Agriculture	

Prepared by the Pesticide Dealers and Applicators Committee of the College of Agriculture, University of Illinois, Illinois Natural History Survey, and the State Department of Agriculture, Division of Plant Industries: E.E. Burns and M.C. Shurtleff, Department of Plant Pathology; J.C. Siemens, Department of Agricultural Engineering; Juett Hogancamp, State Department of Agriculture, Springfield; E.L. Knake, Department of Agronomy; Steve Moore and H.B. Petty, Department of Agricultural Entomology.

ILLINOIS INSECT, WEED, AND PLANT DISEASE SURVEY BULLETIN FOR 1972

Attendance at the Custom Spray Operators Training School does not provide automatic subscription to this weekly Survey Bulletin. Purchase of the Training School Manual does not provide subscription. This has been misunderstood many times in the past and we regret these misunderstandings.

To avoid future misunderstandings, we suggest you send your check for $3 directly to:

Insect Survey Bulletin
118 Mumford Hall
Urbana, Illinois 61801

Make your check payable to the University of Illinois. This is the subscription for this weekly bulletin.

If you were a subscriber in 1971, you will also receive a special notice through the mail. Please do not pay twice.

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TEAR OUT AND MAIL

Enclosed is a check/money order for $3.

Send *Insect, Weed, and Plant Disease Survey Bulletin for 1972* to

(Print name and correct mailing address):

Make checks payable to the University of Illinois.

PENDING FEDERAL LEGISLATION ON PESTICIDES

H. B. Petty

House Bill 10729 has been passed by the House of Representatives and very soon may appear as a Senate Bill. Numerous changes and amendments can be expected.

The main parts of the bill drastically change the Federal Insecticide, Fungicide, and Rodenticide Act from a labeling law into a comprehensive regulatory statute, and the U.S. Environmental Protection Agency is responsible for its administration rather than the USDA. It establishes a coordinated federal-state administrative system to carry out the new program. This bill lists the rules and regulations on registration requirements and other pertinent matters. There is a five-year automatic expiration date on each registration unless renewal is requested.

Of particular interest to Illinois are the following:

There will be two classes of pesticides.

1. A pesticide will be registered for *general use* if its registered use or uses will not cause substantial adverse effects on the environment. General-use pesticides can be used by everyone.

2. A pesticide will be listed for *restricted use* if its registered use or uses will cause substantial adverse effects on the environment, including injury to the operator. Restricted-use pesticides will be restricted to use by those who have a certified pesticide applicator's license.

A pesticide may be for general use with one formulation but restricted for a different formulation.

"Substantial adverse effects" means any injury to man, or any substantial adverse effects on environmental values, taking into account the public interest, including benefits from the use of pesticides.

There will be two classes of certified pesticide applicators:

1. Those with *commercial* licenses will be for hire.

2. Those with *private* licenses will be able to apply pesticides on their own property, property rented by them, or as exchange labor.

How the homeowner and home gardener will be affected will be determined by the interpretation of injury to the operator and substantial effect. It is possible that very few pesticides would be listed for general use, but equally, it is possible that many may be. As an example: How will chlordane for foundation sprays and termite control be listed? It is possible that the homeowner would be required to have a private applicator's license to spray the foundation of his home for ant control.

The interpretation of general- and restricted-use pesticides is all-important. If the general use is a very limited list, then many licenses for private applicators may be required. How this will affect our present custom applicators remains to be seen. There is a distinct possibility that it will increase their business. But if many holders of private applicators licenses decide to obtain commercial applicators licenses to apply pesticides for 10 to 15 neighbors, business for the applicator who depends on application as a part of his income may be decreased.

MAJOR CHANGES TO THE ILLINOIS CUSTOM APPLICATION OF PESTICIDES ACT

Juett C. Hogancamp

The 77th Illinois General Assembly enacted a number of amendments to the Illinois Custom Application of Pesticides Act to become effective on January 1, 1972.

A license known as a *Pesticide Applicator's License* will be issued to a person who owns or operates a custom application business that applies pesticides to the property of another outside a structure.

A license known as a *Pesticide Operator's License* will be issued to a person who is employed or directly supervised by a Pesticide Applicator, and who in turn supervises or operates pesticide applicating equipment, including recommending controls, handling, mixing, and applying pesticides outside a structure, and the disposal of waste excess material and containers.

The annual license fee for a Pesticide Applicator is $25. The annual license fee for a Pesticide Operator is $10. No bond is required for the Pesticide Operator's License. For each Pesticide Applicator's License issued, a $3,000 performance bond with a surety or bonding company is required. A deposit of cash or other collateral security indicating the financial responsibility of the applicant may be deposited in lieu of bond.

All licenses will expire annually on December 31.

Two new licenses to be issued are the *Public Applicator's License* and the *Public Operator's License*. The Public Applicator's License will be issued to a public employee who exercises direct control over the recommending, selecting, use, and application of pesticides by a federal or state agency, municipal corporation, or other governmental agency. A Public Operator's License will be issued to a public employee who operates an engine or motor-driven applicating equipment or device used by a federal or state agency, municipal corporation, or other governmental agency to apply pesticides.

No person shall act as a pesticide applicator, pesticide operator, or public applicator or operator without the respective license. The public applicator or operator's license will be valid only while duties are being carried out as a public employee.

The Director of Agriculture may issue a license without examination to a nonresident who is licensed in another state that has requirements substantially similar to those of this act, provided that the state of original license affords the same or similar privilege to Illinois license holders.

DOWNY MILDEWS OF CORN AND SORGHUM

M. C. Shurtleff, E. E. Burns

Two important downy mildews of corn and sorghum, caused by *Sclerophthora (Sclerospora) macrospora* and *S. sorghi*, are known in the United States. *Sclerospora graminicola*, causing a disease called "green ear," occurs sporadically on corn, sorghum, and various other grasses throughout the world but is of little economic importance in the Midwest.

At least six other species of downy mildew fungi attack corn or sorghum in other parts of the world but are still unknown in this country. These mildews vary in nature of occurrence and severity of damage.

CRAZY TOP (Sclerophthora macrospora)

This downy mildew disease, commonly called crazy top, is widespread but sporadic over the Midwest and most temperate or warm-temperate climates wherever corn and sorghums are grown. It is seldom prevalent enough to cause much damage, although losses of 60 percent or more have been reported in parts of some Illinois fields. The disease occurs only where soil becomes flooded or water-logged sometime between germination of the corn or sorghum kernels and when seedlings are 6 to 10 inches tall.

Symptoms

The symptoms on corn and sorghum vary greatly with time of infection and host colonization. Instead of growing a normal tassel or head, the floral parts continue growing to form a bushy mass of small leaves. The corn tassel or sorghum head is completely deformed. Corn ear formation may also be checked, causing ear shoots to be numerous, elongated, and barren. In severely infected plants no sorghum heads and corn ears or tassels are formed; stunting is pronounced; leaves are narrow, strap-like, leathery, and twisted; suckering (tillering) is excessive.

Disease Cycle

The mildew fungus produces large numbers of yellowish, thick-walled resting spores (oospores) within infected corn and sorghum tissues. The oospores germinate in saturated soil to form sporangia (conidia), which in turn produce numbers of zoospores. The latter spores swim about in water for an hour or longer before settling down, penetrating corn or sorghum tissues, and initiating infection. Saturation of the soil for 24 to 48 hours is needed for infection to occur. A soil temperature range of about 53° to 82° F. is favorable for infection. How long the oospores can remain alive in soil or within infected host tissues is unknown.

Although transmission of the fungus by seed has been demonstrated, it is not considered important in the dissemination of the downy mildew fungus.

Besides attacking corn and sorghum, *Sclerophthora macrospora* infects sudangrass, broomcorn, Johnsongrass, small grains (wheat, oats, barley, and rye), millet, bluestem, bromegrass, canarygrass, crabgrass, green foxtail, lovegrass, mannagrass, redtop, witchgrass, and barnyardgrass. The mildew fungus probably survives in tissues of these grasses in the absence of corn and sorghum.

Control

Where feasible, provide adequate soil drainage or avoid planting in low wet spots.

Little is known about the relative resistance of inbred lines and hybrids of corn or sorghum.

Seed treatment is *not* effective.

SORGHUM DOWNY MILDEW (Sclerospora sorghi)

This downy mildew is unknown in Illinois, but has caused severe damage to both corn and sorghum in Texas, Mississippi, Oklahoma, Arkansas, Alabama, Georgia, Louisiana, New Mexico, Kansas, and Tennessee. The disease appears to be spreading north, east, and west in the United States. Most sudangrass, sorghum-sudangrass hybrids, and broomcorn are susceptible as are shattercane and Johnsongrass. Grain sorghums are less susceptible, although some hybrids are highly susceptible to the foliar phase of the disease.

Symptoms

Young, systemically infected corn and sorghum plants are yellow and stunted with occasional green- and white-striped leaves. Such plants are usually sterile and do not produce grain. Older or more tolerant plants may show symptoms of systemic infection but have partial to normal grain production. Long, narrow, white or yellowish stripes develop on some corn and sorghum lines. Such leaves may shred and wither prematurely, releasing large numbers of thick-walled, pale yellow-orange spores (oospores) that carry the fungus from one year to the next. Leaves of infected plants are narrower, stiffer, and more erect than those of healthy plants.

In cool, damp weather a white downy growth may appear on the lower leaf surface of young infected plants. This white growth is composed of delicate sporangiophores that bear large numbers of spores (conidia). The conidia are easily airborne to other corn and sorghum leaves where infection occurs, resulting in stippled, speckled or mottled areas. These new lesions may produce another generation of sporangiophores and conidia within four to seven days. This foliar cycle is repeated as long as cool (below 68° F.), humid weather prevails and leaf tissues are susceptible.

Disease Cycle

Oospores produced in shredded leaves may survive up to six or eight years in soil or infected crop residues. When conditions are favorable, the oospores germinate and systemically infect young corn and sorghum seedlings. Conidia produced on the leaf surface of such infected plants result in foliar infection. The foliar cycle of conidia from diseased to healthy leaves may be repeated several times or more during a cool, wet growing season. Plants infected in the foliar cycle may become systemically diseased, resulting in white- and yellow-striped leaves and partial to complete sterility.

Control

Grow resistant corn and sorghum hybrids and varieties. Many forage-type sorghums and sorghum-sudangrass hybrids are highly susceptible and should be avoided where the disease is present.

Rotate corn and sorghum or other hosts with soybeans, forage legumes, or small grains.

Plow-down stubble cleanly.

Since the downy mildew fungus can be carried with seed, sow *only* healthy corn and sorghum seed from disease-free fields or areas.

DOWNY MILDEW OF SOYBEANS

M. C. Shurtleff, E. E. Burns

Downy mildew, caused by the fungus *Peronospora manshurica*, was widespread over much of Illinois in 1971, but no serious damage occurred. In an "average" year approximately half of the soybean fields in the state show evidence of this disease.

SYMPTOMS

Small, indefinite, yellowish-green areas appear on the upper leaf surface about mid-season. Later, these spots enlarge and turn yellow to grayish-brown or dark brown with yellowish-green margins. Downy mildew can be easily distinguished from other soybean diseases by tufts of grayish mold (conidiophores) that develop in humid weather on the lower surface of infected leaves. As the spots age and the weather dries, the conidiophores wither and drop off, leaving a brown spot similar to that on the upper leaf surface.

Microscopic spores (conidia) produced on the conidiophores serve to spread the downy mildew infection to other leaves and soybean plants throughout the growing season as long as moisture and temperature conditions are favorable. Severely infected leaves wither and fall early.

The *Peronospora* fungus grows within the developing pods and may form a whitish, crusty growth on the seed. This growth is composed of thick-walled resting spores (oospores). Oospores are also produced in infected leaf tissues. The fungus overwinters on seed and in infected foliage as oospores. Planting such crusty seed sometimes results in systemic infection in which the first and second pairs of leaves to form are pale yellow to yellowish-white. These leaves can produce enough conidia to infect the new crop of soybeans.

CONTROL

Sow certified disease-free seed of adapted and recommended varieties.

Clean-plow in the fall or early spring to turn under *all* soybean debris.

No recommended variety is resistant to all 26 races of the mildew fungus, but Chippewa, Clark, Harosoy, Lindarin, and Shelby show less infection in the field than Hawkeye. A source of resistance to all known races of the fungus has been found, and resistant varieties are being developed.

BACTERIAL LEAF DISEASES OF SORGHUM

M. C. Shurtleff, E. E. Burns

Bacterial leaf diseases are widespread during warm, moist weather wherever sorghums are grown. The causal bacteria are believed to overwinter on seed, in infected sorghum debris in the soil, and sometimes on volunteer overwintering plants. Spread of the bacteria is by wind, rain, and insects. Infection occurs through natural openings in the sorghum leaf.

Bacterial leaf diseases seldom produce serious losses, although yields may be reduced and grain may be of inferior quality. Good sorghum-growing weather (hot and dry) inhibits bacterial leaf blights. During rainy periods, the bacteria may spread rapidly from lower to upper leaves, from plant to plant, and from field to field. High levels of infection may destroy considerable leaf surface.

The three bacterial diseases of sorghum are known as bacterial stripe, bacterial streak, and bacterial spot. The most common and important of these is bacterial stripe.

Disease (Cause)	*Symptoms*
Bacterial stripe *(Pseudomonas andropogoni)*	Long, narrow, somewhat irregular stripes, usually red at first, appear on lower leaves. Stripes may be up to 9 inches long and tend to be confined between leaf veins. Ends of stripes are blunt or extended into long, jagged points. Color is *continuous* throughout stripe. Abundant bacterial slime (which dries to a crust or thin scales) occurs on stripes, unless washed off by rain. Color of stripe varies with sorghum type and variety--brownish-red, dark purplish-red, light brick red, or light to dark brown.
Bacterial streak *(Xanthomonas holcicola)*	Narrow, water-soaked translucent streaks about 1/8 inch wide and 1 to 6 inches long occur from seedlings to mature plants. At first, no color is visible except in light yellow, bead-like drops of exudate on young streaks. Later streaks are red throughout. Parts of streaks may broaden into long oval spots with tan centers and narrow red margins. Considerable portion of leaf may be covered with long, irregular, red-brown streaks. In advanced stage, yellow drops of bacterial exudate may dry to form thin white or cream-colored scales.
Bacterial spot *(Pseudomonas syringae)*	Circular to irregularly elliptical spots--1/25 to 1/3 inch in diameter. At first, dark green and water-soaked, but turn red in a few hours. Later become dry with tan centers, usually surrounded by a red border. Small lesions may be red throughout with tiny, somewhat sunken centers. Overlapping spots may girdle and kill whole leaf.

CONTROL

Cleanly plow down infected sorghum debris before planting.

Sow certified, disease-free seed of well-adapted, resistant varieties.

Rotate sorghum, sudangrass, broomcorn, or corn with soybeans and forage legumes.

Keep down susceptible weedgrasses such as Johnsongrass.

GOSS'S BACTERIAL WILT OF CORN

M. C. Shurtleff, E. E. Burns

Goss's bacterial wilt is apparently a new disease of corn, and is caused by *Corynebacterium nebraskense*. It has been observed infecting corn in a number of central Nebraska counties for several years, and was found in western Iowa in 1971. Reports of its presence in Illinois in 1971 are apparently untrue. (Goss's wilt was confused with Stewart's disease or bacterial wilt caused by *Xanthomonas stewartii.)* All types of corn are infected by Goss's wilt and leaf stripes may form in sorghum. Corn seedlings are more susceptible than older plants. A few heavily infected fields have sustained losses of 10 to 30 percent.

SYMPTOMS

Discrete water-soaked spots develop along the leaf veins on corn seedlings or on older plants. Early infection may result in seedling blight; later infection in stunting or various degrees of leaf blight. The leaf blight phase appears first as light-green to yellow streaks with irregular margins and later as long, necrotic lesions. Some lesions may have a shiny appearance produced by bacterial ooze that has dried on the leaf surface. Later, entire leaves wither and die. When cut across, systemically infected plants may show discolored vascular bundles. Water-soaking, dry rot, pith shredding, and root rot may also occur. Wilt symptoms are more prevalent in early infections.

DISEASE CYCLE

The causal bacterium overwinters in infected corn debris on the soil surface and in infected kernels. Infection of leaves, roots, and stems may occur following wounding or may take place directly.

CONTROL

Plow down infected corn debris cleanly and deeply.

Rotate corn and sorghum with soybeans, small grains, or forage legumes.

Plant only seed from disease-free fields.

Differences in resistance between corn inbreds and hybrids are known, and the best sources of resistance are being put into commercial corn hybrids as rapidly as possible.

PHYSODERMA BROWN SPOT OF CORN

M. C. Shurtleff, T. H. Bowyer

A serious, localized outbreak of brown spot, Physoderma disease *(Physoderma maydis)*, occurred in southeastern Illinois in 1971. Normally, serious losses from this disease are limited to low bottomlands in warm, moist areas of the South Atlantic and Gulf Coast states and lower Mississippi Valley.

SYMPTOMS

Numbers of small, round to oblong or irregular, yellowish spots develop on the leaf, leaf sheath, and sometimes on the outer ear husks and tassels. The lesions may merge and occur as bands across the leaf. Infected tissues soon turn chocolate-brown to reddish-brown and form large irregular blotches. Cells of infected tissues disintegrate to form "brown blisters" containing large numbers of dusty, dark-brown sporangia. Individual sporangia are the size of a pinhead. Corn stalks infected at the nodes under the leaf sheaths are girdled and easily broken over by the wind. In 1971, a number of corn fields were severely lodged (80 percent or more) in southern Illinois because of Physoderma brown spot.

DISEASE CYCLE

The thick-walled brown sporangia overwinter in infected corn debris or in soil. Wind, insects, splashing water, and man carry the sporangia to growing corn plants. When water is present, such as in the whorl or behind the leaf sheath, and temperatures are relatively high (73°-86° F.), a sporangium "germinates" to release 20 to 50 swimming spores (zoospores). The zoospores move in water for one to two hours before penetrating young corn tissues. Infection occurs in a diurnal cycle, which results in alternating bands of infected and healthy leaf tissue. A new generation of sporangia may form every 16 to 20 days.

CONTROL

Clean plow-down of corn debris before planting and rotation with any other crop may be beneficial. Research in 1920 showed that shredding before plow-down helped prevent surfacing of infected debris during cultivation the following season.

Development of resistant hybrids and varieties appears to offer the best control. A number of corn hybrids will be tested in southern Illinois in 1972 for resistance to Physoderma brown spot.

MARIHUANA CONTROL

E. L. Knake

Marihuana, or wild hemp, is now classified as a noxious weed in Illinois. This means it is unlawful to have it growing on your farm. Not only is marihuana considered a menace to our society, especially for some of our young people, it may also encourage undesirable trespassing on your land. Learn to recognize marihuana, and also how to get rid of it. You will be doing yourself and society a favor.

IDENTIFICATION

Marihuana is an annual plant that grows only from seed each year. In Illinois, the seed begins to germinate in April. New plants may also start from seed, germinating later in the season.

Although marihuana is well adapted to fertile soils, it is not usually found in cultivated crops such as corn and soybeans. Watch for it along fences, railroads, roadsides, ditch banks, and other noncrop areas.

Each leaf on the marihuana plant is made up of an odd number of leaflets--five, seven, nine, or eleven. The usual number is seven. The leaflets have a palmate arrangement. They join together at the base, somewhat like the fingers on your hand. Each leaflet is long and narrow, with notched or sawtoothed edges.

The stems are somewhat grooved, with branches coming out just above the leaves. Crowded plants may not have any lower branches. Widely spaced plants may be rather bushy. The plants can grow to ten feet or more in height. They feel rather rough and coarse and are sometimes confused with giant ragweed (horseweed). Giant ragweed leaves, however, have three main lobes and are not divided into the long narrow leaflets with notched edges, as are marihuana leaves. The cinquefoil leaves resemble those of marihuana, but cinquefoil is a much smaller plant with small flowers that have yellow petals.

Marihuana plants are of two kinds, male and female. The male plants have small, greenish-yellow flowers at the top. After producing pollen, the male plants wither and die. The flowers of the female plants are not quite as conspicuous; but after pollination, the female plants become bushy, produce seed, and may remain green and vigorous until frost.

Marihuana was raised as a fiber crop in Illinois during World War II, but was also present before that time. It may be found in many parts of Illinois, but is most prevalent in the northern two-thirds of the state.

CONTROL

Most farmers realize their moral obligation to control marihuana plants and to remove this temptation from the environment.

Control measures should be aimed at preventing seed production. Pulling and hoeing are effective for a few plants or for small patches of them. Mowing is effective if the area is accessible.

Another way to discourage the growth of marihuana is to cultivate the area and grow row crops. Establishment of a good, vigorous, competitive stand of desirable grasses or legumes also discourages marihuana.

Spraying provides a simple, low-cost, and very effective means of control. For best results, spray in May or June while the plants are relatively small--twelve inches high or less. If new plants grow or regrowth of treated plants occurs, spray again as needed.

The most economical spray is 2,4-D. It should be used when plants are small. Silvex is similar to 2,4-D, and has also provided good control.

Using about one quart of 2,4-D or silvex with 50 gallons of water for each acre to be sprayed and thoroughly wetting the plants is usually adequate. For older plants, the amount of 2,4-D and water may be increased. But be certain to spray before the marihuana plants produce seed.

Precautions should be taken with 2,4-D or silvex to prevent injury to nearby susceptible plants. In such areas, amitrole-T at the rate of one gallon per acre mixed with 50 gallons of water would present less risk of injury to nearby plants. This application has been extremely effective. However, do not spray amitrole-T on desirable grasses. Such spraying may kill these grasses. If you are too busy with field work during June, consider hiring someone to do the spraying.

Next fall, seed smooth bromegrass or other desirable grass in fencerows and on other noncrop land. Such competitive cover will discourage the growth of marihuana as well as other weeds. This cover will also provide good wildlife cover and will protect the area from erosion. Such seeding is simple to do and low in cost. It provides permanent control, with little follow-up needed in future years.

If a few weeds or some marihuana happens to come through the brome for a year or two while the grass is becoming established, 2,4-D or silvex can still be used without killing the grass. Do not use amitrole-T on the grass.

By controlling marihuana, you will be improving the quality of our environment.

AGRICULTURE, PESTICIDES, AND THE FUTURE

O. G. Bentley

The University of Illinois College of Agriculture is happy to co-sponsor the 24th Illinois Custom Spray Operators Training School with the Illinois Natural History Survey. Your continued support of this school--for nearly a quarter of a century--encourages our staff to present a program worthwhile to you. You have always been welcome, and we encourage your cooperation as we work together to solve agricultural problems.

I am certain that those of you attending this school share the concerns of our agricultural scientists about the quality of the environment and the pollution of resources used in the production of plant and animal products. I hope you will join with us in viewing the environmental problem as a much broader, all-encompassing problem that touches the lives of people in urban as well as in rural America.

The deterioration of the environment is brought on largely by the impact of increased population and the demand for goods to sustain the standard of living that has typified America. The relationship between agriculture and the demand for goods illustrates how closely related agriculture is to the central issues of environment on both a national and global scale.

Many of us in the College and throughout the nation are especially concerned about the impact of science and technology on the environment. And we are concerned about the posture we as educators and scientists should take in viewing environmental problems.

Dr. Philip Handler, president of the National Academy of Sciences, has a point of view that I can personally subscribe to. In a 1970 W.O. Atwater Memorial Lecture he said:

> The current overly emotional worldwide awakening to the undesirable side effects of some facets of our technological civilization has led to diminution in public support of the scientific endeavor. Whether this derives from simple know-nothing anti-intellectualism, informed repugnance, or simple ignorance, the effect is the same--demands for a moratorium in the pace of the scientific endeavor, reduction in support for the education of tomorrow's scientists.
>
> I could not disagree more violently. For all of our difficulties, the fact remains that the technology science makes possible is the principal tool this civilization has fashioned to alleviate the condition of man. If life is to be better tomorrow than it was yesterday, we shall require more and better science-based technology rather than less. If we retreat from scientific research today, if we fail to educate a large, diversified corps of scientists, some capable of working at the disciplinary frontiers, others trained and motivated to function in multi-disciplinary teams gathered to address

> one of the multitudinous societal problems, we shall also fail to construct a platform for the technology of tomorrow, and our great-grandchildren will not thank us.

Peter F. Drucker, economist and writer, has pointed out some philosophical shortcomings resulting in three major misunderstandings that he believes inhibit the results of most present advocates of the environment.

The first misunderstanding is that they think one can live in a riskless universe--that one can somehow deprive human action of risk. He says:

> The real challenge in the environmental situation is to think through what risks to afford and what risks are not permissible and where to draw the line, and what price to pay for what degree of insurance. That is taboo and anathema to the mood of today. Yet the whole history of the human race proves that one always pays a price and that the decision is how much to pay. One takes risks, and the crucial decision is what risks are intelligent and prudent risks. The moment you want to be riskless, you are endangered and you are vulnerable to the wrong catastrophes.

The second misunderstanding Drucker cites is the notion that one way or another, profits can pay the costs of managing the environment. "Yet we have known for a long time there is no such thing as profit anyhow; that's an accounting delusion. There are only the costs of the past and the costs of the future."

The final misunderstanding is that "it is 'greed' that explains the environmental crisis." Drucker disagrees, saying, "It is largely the desire not to see two out of three children die before they reach age five; to have enough to eat for the poor, and to have access to job and opportunity. The environment is a problem of success."

Drucker then summed up what appeared to be the challenge to government, scientists, and educators by saying that perhaps the greatest single problem we face is that we are unwilling, as a nation, to set priorities in the attack on pollution of the environment.

I see Drucker's challenge as a realistic challenge to those of us here today who are concerned about maintenance of the quality of the environment and the conservation of renewable resources for future generations, on the one hand, and the growing need to preserve an efficient and productive agriculture for posterity on the other hand.

Specifically, this school deals with pesticides, and I think each of us must continue to critically examine our use of all pesticides. Such use is probably not all good, but neither is it all bad. If we are to help feed others, then we must grow food not only for the least production costs, but also for the least cost to our environment.

In some cases our concern for the environment may increase production costs and may result in use of pest-control programs that are less than perfect. But we must realize that our first objective is neither simply controlling pests nor decreasing use of pesticides. Our first objective must be to act in the best way for humanity. We must weigh the facts, set priorities, and make decisions for the good of everybody and everything.

We know that pesticide use in the past has presented some problems. You will hear a discussion on an insecticide residue problem in milk and hear about a problem with soybeans. These are problems that we have been able to correct or are correcting. Later in the program you will hear a discussion of pesticide accidents, and we hope to decrease these.

Shortly you will hear of attempts to synthesize chemicals that will quickly break down in the system of warm-blooded animals and be excreted rather than stored in body fats. The new insecticides will be much less toxic to animals, including man, but they will be just as effective for controlling insects as the ones now in use.

As we look to the future, we hope also to increase the use of nonchemical pest-control methods. But as far as the realistic scientists can see at present, pesticides are still a part of our future, and we must continue our studies along these lines.

Because of the pesticide furor, new laws will be passed restricting pesticide use. The Illinois Custom Applicator's Licensing Law is an example. New changes are listed in this school's manual and federal laws are outlined.

It appears that the proposed federal law, while restricting pesticide use, may benefit the custom applicator of pesticides. Now is the time to gain all the knowledge possible. Your services may be more in demand in your community than at any time in the past. More than ever, each community needs knowledgeable people working on pest-control problems.

The problems we face in pest control are complicated, and the situations are always changing. I am certain each of you will keep informed, and I encourage you to consult your county Extension advisers and our staff here at the university for help and guidance when you need it.

Again, we welcome you here today. We hope we can continue to serve you and join with you in the important job of setting priorities as we work toward more effective pest-control programs in the future.

INSECTICIDE RESIDUES IN MILK

Steve Moore III

This report is not based on controlled detailed research, but rather on a gross field investigation of a problem situation having many variables. During the last two years in Illinois, 27 dairymen were found to be producing milk with illegal amounts of chlorinated hydrocarbon insecticide residues (this number still represents only a fraction of 1 percent of the total dairy herds in Illinois).

It is expected that additional herds, but in lessening numbers, will be found producing milk with illegal residues of the chlorinated hydrocarbon insecticides for at least another four to six years.

PURPOSE OF THIS STUDY

The purpose was to determine the source of chlorinated hydrocarbon insecticide contamination for dairy cows. This information is needed in order to help dairymen avoid or recover from a chlorinated hydrocarbon insecticide residue problem in their milk supply.

METHOD

Twelve dairy farms with a dieldrin milk residue ranging from low, to medium, to high were selected from a total of 40 herds surveyed. They were Grade B dairy herds located in an intensive grain-producing area in the northwest section. They did not represent a cross-section of Illinois dairy herds.

On March 16 and 17, 1971, samples of all the feed (including concentrates and roughages), a sample of well water, a composite milk sample, and a soil sample from every field on each of the 12 farms were obtained for insecticide analysis. Cropping history, insecticide usage history, and cattle management practices were obtained for each farm for the preceding ten years.

Robert Lahne, Stephenson County extension adviser in agriculture, Stanley Smith, area extension adviser in dairy, and Benjamin Greiner, Ogle County assistant extension adviser in agriculture, circulated the questionnaire to the cooperating farmers and helped obtain the samples. W.N. Bruce, entomologist with the Illinois Natural History Survey, analyzed the samples by electron capture detection with liquid gas chromotography for the presence of aldrin, dieldrin, heptachlor, heptachlor epoxide, DDT, and DDE.

DISCUSSION AND RESULTS

Residues of aldrin and dieldrin were significant in the milk and in many of the other materials sampled on the 12 farms studied. This was to be expected since 6 of the 12 dairymen reported using aldrin as a corn soil treatment within the last ten years.

Residues of heptachlor, heptachlor epoxide, DDT, and DDE were found only at trace levels. Five of the dairymen reported using a heptachlor seed treatment (an insignificant amount), and none reported using DDT during the last ten years.

A definite correlation was found between the overall dieldrin soil residue on each farm and the level of dieldrin present in the milk (Table 1). Significant amounts of dieldrin milk residues occurred even on Farms 8 through 12, where no aldrin was used in the last ten years. There is some indication from the data that dairy cattle on a farm having a history of aldrin soil treatments within the previous six to seven years will produce milk with dieldrin residues near or above the legal level.

Table 1. Aldrin Plus Dieldrin Residues Found in Milk and Soil on 12 Illinois Dairy Farms, March 16 and 17, 1971

Farm No.	In milk fat, p.p.m. Feb. 2	March 17	Sept. 24	In soil, avg. for all fields, p.p.m. March 17	No. of years farmer reported using aldrin on farm in last 10 years	Year farmer reported last applying aldrin
1	.5560	.3360	.3561	.3859	8	1968
2[a]	.5294	.2740	.2773	.2183	5	1967
3	.4343	.2940	.1894	.3558	2	1966
4[a]	.4037	.2300	.2561	.3153	5	1966
5	.2786	.2800	.2757	.3515	5	1968
6	.3333	.2800	.2348	.1344	0[b]	...
7	.1864	.1900	.0833	.0219	4	1964
8	.1823	.2071	.0833	.0566	0	...
9	.1784	.1571	.0788	.0047	0	...
10	.1608	.1243	.0492	.0009	0	...
11	.1512	.0929	.0492	.0020	0	...
12	.1314	.1000	.0492	.0010	0	...

a/ Drylot operation.
b/ History of insecticide usage available only from 1966 to date.

All the samples of hay and oat straw showed significant levels of dieldrin residues (Table 2).

Roasted soybeans being fed to cattle on Farms 6 and 7 had exceedingly high dieldrin residues. Significant dieldrin residues were also present in the roasted soybeans from Farm 3, while only trace levels of dieldrin occurred in the roasted soybeans from Farm 8. The two samples of soybean meal obtained from Farms 1 and 12 showed only trace levels of dieldrin.

Corn silage, commercial feed concentrates and protein supplements, and the water on all 12 farms showed only trace amounts of dieldrin (Table 3). There was no apparent correlation between the dieldrin soil residue and the dieldrin residue in the silage.

Table 2. Aldrin Plus Dieldrin Residues Found in Hay, Oat Straw, and Soybeans on 12 Illinois Dairy Farms, March 16 and 17, 1971

Farm No.	In milk fat, p.p.m.	In hay, p.p.m.	In oat straw, p.p.m.	In soybean feed, p.p.m.
1	.3360	.0373	.0208	.0062[a/]
2[b/]	.2740	.0401	.0303	...
3	.2940	.0213	.0221	.0133[c/]
4[b/]	.2300	.0313	.0332	...
5	.2800	.0206	.0223	...
6	.2800	.0393	.0510	.0444[c/]
7	.1900	.0256	.0230	.0458[c/]
8	.2071	.0203	.0184	.0081[c/]
9	.1571	.0129	.0150	...
10	.1243	.0159	.0170	...
11	.0929	.0155	.0197[d/]	...
12	.1000	.0160	.0117	.0064[a/]

a/ Soybean meal, purchased.
b/ Drylot operation.
c/ Roasted soybeans, purchased.
d/ Purchased.

Table 3. Aldrin Plus Dieldrin Residues Found in Corn Silage, Corn Soil, Concentrate Feeds, and Water on 12 Illinois Dairy Farms, March 16 and 17, 1971

Farm No.	In corn silage, p.p.m.	In corn soil, p.p.m.	In concentrate feed[a/], p.p.m.	In commercial protein supplement, p.p.m.	In water, p.p.m.
1	.0098	.4507	.0024	.0030	< .0005
2[b/]	.0047	.3590	.0011	.0037	< .0005
3	.0061	.2583	.0007	...	< .0005
4[b/]	...	...	.0009	< .0005	< .0005
5	...	...	.0008	.0037	< .0005
6	...	...	.0038	...	< .0005
7	.0028	.0095	.0051	...	< .0005
8	...	...	.0009	.0016	< .0005
9	.0032	.0008	.0017[c/]	...	< .0005
10	.0038	.0006	.0010	.0038	< .0005
11	.0014	.0027	< .0005	< .0005	< .0005
12	.0021	.0013	.0009	.0052	< .0005

a/ Made from home-grown corn and oats plus commercial protein supplement and minerals.
b/ Drylot operation.
c/ Commercial concentrate feed.

Cattle can absorb dieldrin directly through their skin. The amount of dieldrin absorbed by cattle lying on contaminated soil or consuming dieldrin-contaminated soil is currently not predictable.

There was no good correlation between the dieldrin soil residues and the dieldrin residues in hay and oat straw (Table 4). It was impossible on any of the farms, including those where no aldrin had been used for at least ten years, to produce hay or oat straw with less than a 0.01 p.p.m. dieldrin residue. The waxy coating on hay and straw could readily absorb dieldrin.

Table 4. Aldrin Plus Dieldrin Residues Found in Hay, Oat Straw, and Soil on 12 Illinois Dairy Farms, March 16 and 17, 1971

Farm No.	In hay, p.p.m.	In hay soil, p.p.m.	In oat straw, p.p.m.	In oat soil, p.p.m.
1	.0373	.3531	.0208	.2730
2[a/]	.0401	.2271	.0303	.1700
3	.0213	.6551	.0221	.3003
4[a/]	.0313	.4223	.0332	.3762
5	.0206	.2115	.0223	.0422
6	.0393	.0864	.0510	.3144
7	.0256	.0287	.0230	.0314
8	.0203	.0151	.0184	.0142
9	.0129	< .0005	.0150	< .0005
10	.0159	.0006	.0170	< .0005
11	.0155	.0013	.0197[b/]	...
12	.0160	.0044	.0117	< .0005

a/ Drylot operation.
b/ Purchased, no field history.

Dieldrin residue was higher at the soil surface than in a 6-inch-deep composite core sample in permanent pastures on six farms (Table 5). Aldrin had never been

Table 5. Aldrin Plus Dieldrin Residues in the Soil of Permanent Pastures at the Surface and in 6-Inch-Deep Core Samples on 6 Illinois Dairy Farms, 1971

Farm No.	In 6-inch-deep composite core sample, March 17, p.p.m.	In surface sample, May 25, p.p.m.
3	.0251	.0397
5	.0173	.0277
7	.0009	.0081
8	.0046	.0104
10	< .0005	.0065
12	< .0005	.0109

applied to this land, and no soil erosion from adjacent fields had occurred at the sampling sites. This would indicate that soil particles contaminated with dieldrin were transported by the wind to these fields.

SUGGESTIONS TO DAIRYMEN TO AVOID PRODUCING MILK WITH UNSAFE DIELDRIN OR HEPTACHLOR EPOXIDE MILK RESIDUES

1. It is now illegal in Illinois for you to apply or store for agricultural purposes on your farm the chlorinated hydrocarbon insecticides aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, and lindane.
2. Do not pasture cattle on land that received an aldrin or heptachlor treatment within the last six years. Consider a drylot operation for all of your cattle, especially if you are experiencing a residue problem.
3. If you have used aldrin or heptachlor within the last six years, grow your corn on this land. Do not graze your cattle in stubble field.
4. Avoid growing hay or soybeans for feed, or oats if straw is to be used for bedding, on land receiving an aldrin or heptachlor treatment within the last six years.
5. When purchasing feeds, especially roasted soybeans, be sure the soybeans have not been grown on a farm with a history of aldrin or heptachlor usage. The same precaution is suggested for hay, haylage, or oat straw.
6. Corn or oats purchased as grain should be safe to feed regardless of the source of supply.

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INCORPORATION OF SURFACE-APPLIED PESTICIDES

B. J. Butler, J. C. Siemens

Preemergence herbicides are sometimes called "wet weather insurance." It is in the wet years when weeds grow best and cultivation is delayed that preemergence herbicides do the most good. When it is dry for a few weeks after planting, preemergence herbicides may not be very effective, but weeds are usually not as serious because cultivation can be timely. It could also be said that if the weather could be predicted, "preemergence insurance" would not be needed in the dry years.

However, with the increases that have taken place in farm sizes and with labor per farm staying about constant, timely cultivation is difficult to achieve even in the dry years. Some preemergence herbicides perform better and give more consistent results when incorporated into the soil, especially in the dry years. The question often asked is, "What tool should be used for incorporating herbicides?"

The common tools being used for incorporating pesticides are the tandem disk harrow and the field cultivator. During the last several years, studies have been made at the University of Illinois on the tools used for incorporating chemicals and on the differences in weed control obtained as a result of incorporation. The tools studied include the tandem disk harrow, the field cultivator, and the mulch treader. If you are unfamiliar with the mulch treader, visualize a tandem disk harrow with the disk gangs replaced by backward-mounted rotary hoe sections. Some of the results of these studies are included in this report.

It should be mentioned that few tools used for incorporating pesticides were designed specifically for the purpose. The incorporating tool should provide good vertical incorporation, but horizontal incorporation uniformity is probably even more important. Poor pest control can result from areas with low rates, and high concentrations can cause increased residual life of the pesticide in the soil.

TESTS WITH FLUORESCENT GRANULES

Granules coated with fluorescent powder were used to examine the incorporating ability of the three implements. A heavy application of the granules was made to a smooth, level, well-tilled soil surface before incorporating with each tool. After the granules were incorporated, vertical cross-sections of the soil were taken into a darkroom and photographed under fluorescent light. By projecting the slide-mounted photographs, the distribution of the granules in the soil was determined. Hundreds of such samples were analyzed to determine both the vertical and horizontal incorporation of the granules.

Observations Common to All Incorporation Tools

1. Soil should be loose and dry enough to prevent the granular pesticide from sticking to large clods, because when this is the case the pesticide remains on the surface with the clods.

2. A wet or sticky layer of soil under the surface prevents proper incorporation.

3. Incorporation is not as good in the tractor wheel tracks as elsewhere.

4. Large clods hinder uniform incorporation and result in concentrations of the pesticide.

Tandem Disk Harrow

The studies indicate that the tandem disk harrow is a satisfactory incorporating tool--better than either the field cultivator or the mulch treader.

As shown in Table 1, the disk harrow incorporated most of the surface-applied granules in the upper 3 inches of soil when operated 5 inches deep. Horizontally, across the soil, the incorporation was not uniform. For example, if 10 pounds per acre was the desired application rate, Table 2 shows that two passes with the disk harrow gave a range from 6 pounds (60 percent) to 16 pounds (160 percent) per acre.

Table 1. Vertical Incorporation of Surface-Applied Granules

	Percent of total granules found at each depth				
	Tandem disk harrow		Field cultivator		Mulch treader
Soil layer	Single pass	Cross-disked	Single pass	Cross-tilled	Single pass
Surface to 1" depth	36	23	13	11	33
1"-2" depth	32	24	25	21	31
2"-3" depth	21	27	30	31	25
3"-4" depth	9	20	23	27	9
4"-5" depth	2	6	9	10	2
	100	100	100	100	100

Table 2. Horizontal Incorporation of Surface-Applied Granules

	Range below and above ideal (100% uniform distribution)		
	Tandem disk harrow	Field cultivator	Mulch treader
	(percent of ideal distribution)		
Single pass	35 to 199	24 to 240	28 to 236
Incorporated two directions	60 to 160	36 to 204	...
Average	48 to 180	30 to 222	...

Other observations from the incorporation tests of the disk harrow are:

1. Incorporation with the disk improved with faster speeds and larger gang angles.

2. A second disking moved the granules deeper and increased both the vertical and horizontal uniformity considerably.

3. Disking twice in the same direction was just as good as cross-disking the second time.

4. The disk incorporates pesticides as deep as the operating depth, but relatively uniform incorporation occurs only to a depth of about 1-1/2 inches less than the operating depth.

5. Disking deeper than 4 inches may result in diluting the chemical and its effect.

Field Cultivator

The field cultivator was tested using both sweep and point-type shovels over a range of speeds. A second pass also helped with this tool, but incorporation was not as good as with the disk in either case. Although the sweeps did a slightly better job of incorporation than the points and higher speeds helped, there still were zones in the soil that had few or no granules. This was especially true behind the shanks of the last row of shovels because the shovel tips tended to bring fresh untreated soil to the surface and leave it there. Concentrations tended to appear at the midpoints between the shovels in the rear row. Two passes helped break up the concentrations, but zones with few or no granules were still present. Leveling the soil behind the field cultivator would probably help obtain uniformity.

The field cultivator shows up better than it should in the vertical incorporation results given in Table 1. This is due to the uneven surface left by the field cultivator and the way samples were taken for determining the distribution of the granules in the soil. Since the samples were horizontal across the top, the uneven surface resulted in a low number of granules being recorded for the top inch. Otherwise, the table shows no startling differences between the field cultivator and the disk harrow.

Horizontal incorporation with the field cultivator was far from uniform, giving rates of application that ranged from well below half the recommended rate to more than double. For example, assuming 10 pounds per acre as the ideal rate, Table 2 shows that two passes with the field cultivator gave horizontal incorporation rates ranging from 3.6 pounds (36 percent of the ideal) to 20.4 pounds (204 percent) per acre.

Mulch Treader

The mulch treader was tested at several gang angles and speeds. Using the mulch treader to make two passes in a friable soil requires considerable power and results in a very finely textured seedbed susceptible to crusting and erosion. It was felt that not many farmers would wish to use it twice, and hence it was not checked except with one pass.

The treader did a better job of incorporating at speeds of 5 miles per hour or higher with gang angles of 16.5 degrees or more. Although some concentrations of chemicals occurred at all speeds and gang angles tested, they were most severe at the lower speeds and gang angles. The concentrations occurred on the same spacing as the treader tines at low speeds and gang angles, but were more randomly located when speeds and gang angles increased. Some tendency to concentrate granules at the center of the swath was present at all speeds.

With the treader operated at a 5-inch depth, 80 to 90 percent of the granules were incorporated in the top 3 inches of soil at all speeds and gang angles. The treader did as good a job of vertical incorporation as the disk harrow, but was little better than the field cultivator in obtaining good distribution horizontally.

WEED CONTROL OBTAINED WITH DIFFERENT INCORPORATION METHODS

The performance of Treflan and Amiben was determined in 1970 and 1971 with six different methods of incorporation. Plots were 140 feet long and 20 feet wide. Each incorporation treatment was replicated three times, and two herbicide application rates were used.

All plots were moldboard-plowed and disked. Then the herbicide and the first part of the incorporation treatment were applied in one operation. The second part of the incorporation treatment, if the treatment consisted of two parts, was applied one week later, and all plots were planted to soybeans.

In 1970 several rains occurred during the 4-week period after the herbicides were applied. In 1971 the amount of rain during this period was quite low.

The results of this herbicide performance study are given in Table 3.

Treflan Incorporation

As shown in Table 3, the ability of Treflan to control foxtail and pigweed was increased when incorporated into the soil. Weed control was best when Treflan was incorporated twice with the disk harrow (treatment 4), or twice with the field cultivator (treatment 3). Even the drag harrow helped in 1970 but not in 1971.

Little difference in the performance of Treflan was obtained between 1970 and 1971, except that incorporation was not as beneficial in 1971.

Amiben Incorporation

The manufacturer does not recommend that Amiben be incorporated into the soil before planting. In 1970 when rains followed shortly after treatment, incorporation did not improve the performance of Amiben (see Table 3). In fact, incorporating Amiben in 1970 resulted in slight soybean injury. Soybean injury in 1970 was noted in treatments 3, 4, and 6, which were the treatments using the disk harrow and field cultivator. No soybean injury due to Amiben was found in the check, drag harrow, or mulch treader treatments.

In 1971 when very little rain occurred during the 4 weeks after treatment, incorporation increased the weed control performance of Amiben without soybean injury (Table 3).

SUMMARY OF RESULTS

These tests tend to verify field reports, which indicate that most herbicides, when incorporation is needed, give better results when incorporated with a more aggressive tool than a drag, spike-tooth harrow, or rotary hoe. The disk harrow alone or the disk harrow with field cultivator is the most satisfactory tool. The tools, especially the field cultivator, should not be run too deeply as poor distribution and dilution can result.

Chemicals not normally recommended for incorporation may benefit from it when rainfall is limited after application.

Table 3. Weed Control Ratings for Different Soybean Herbicide Incorporation Methods

(Ratings were taken one month after applying herbicide. Herbicide and first part of incorporation treatment were applied in one operation.)

Herbicide	Treflan				Amiben			
Rate, lb. per acre	2/3		1		2		3	
Year	1970	1971	1970	1971	1970	1971	1970	1971
Incorporation treatment	Foxtail and pigweed control ratings (0-100)[a/]							
1. Check, not incorporated	73	83	67	88	98	61	100	77
2. Drag harrow	87	83	90	86	92	64	97	78
3. Disk--field-cultivate	89	92	92	97	91	94	93	100
4. Disk (twice)	100	89	100	95	98	92	100	98
5. Mulch treader	86	84	92	86	94	74	95	90
6. Field-cultivate (twice)	94	94	94	95	98	90	98	95

a/ Control ratings: 0 = no effect, 100 = all plants killed.

FALL PANICUM CONTROL

R. E. Doersch

Fall panicum (*Panicum dichotomiflorum*) is the most common of many closely related Panicum species which are often collectively considered late-season grasses. Fall panicum has been a serious annual grass problem throughout the Corn Belt.

Initial reports indicated that fall panicum generally germinated later than most annual weeds. However, as infestations became more widespread and with greater experience, it was apparent that fall panicum could germinate as early as late April or May. It is a poor competitor with other weeds but grows vigorously in the absence of other weed competition. Possibly its initial classification as a late-season grass was related to the fact that it did not appear until other weeds had been removed by postemergence herbicide treatment. Under such circumstances it has been noted to germinate as late as June or July.

In the seedling stage, fall panicum is difficult to distinguish from foxtails. However, as panicums mature they branch profusely and set roots wherever a node touches the soil surface. Eventually plants become intertwined into a solid mat. In dense infestations, plants grow somewhat more erect. At maturity large bushy seedheads are produced, which have given rise to local names like "ticklegrass" and "tumbleweed."

Why the increase in fall panicum in cornfields during the past several years? One of the major reasons probably is the extensive use and dependence upon atrazine for weed control in corn. Atrazine has worked modern weed control miracles for many corn producers, but it also has some shortcomings. The tolerance of fall panicum to atrazine was not recognized until a major portion of the more susceptible weed competition had been removed. Secondly, farmers have become so dependent upon chemical weed control that many hesitate to cultivate even when tolerant weed species appear. The relative noncompetitive appearance of initial seedlings of fall panicum left most farmers unconcerned. However, fall panicum increased in incidence and intensity. And it soon became apparent that fall panicum could cause serious yield reductions and harvest difficulties. Although fall panicum is not nearly as tolerant of shade as are foxtails, the greater shading of narrower corn rows has diminished the threat of fall panicum only slightly. Earlier corn planting and the use of short-stalked varieties have increased the incidence of fall panicum.

Several herbicides for the control of fall panicum are now available. Lasso and Sutan or combinations of these herbicides with AAtrex have provided effective fall panicum control in Wisconsin trials. Princep and the Princep/AAtrex combination have shown some activity but have not provided the most effective fall panicum control. Several experimental herbicides or herbicide combinations show promise for the future. Bladex, Bladex/Lasso, and Princep/Lasso have demonstrated substantial control of fall panicum. Basamaize appears intermediate between Lasso and Ramrod in its ability to control fall panicum.

Results of a 1971 fall panicum control trial at the University of Wisconsin Lancaster Experimental Farm are provided in the table on the next page. This trial

Fall Panicum Control in Corn, Lancaster, Wisconsin

Herbicide	Product rate	Percent control 6/22	Percent control 7/15	Corn yield[a/] (bu./A.)
AAtrex 80W	1-1/2 lb.	20	8	43.8 i
AAtrex 80W	3 lb.	55	15	47.6 hi
Outfox	1-1/5 gal.	47	17	43.2 i
Outfox	2-2/5 gal.	71	32	62.2 ef
Princep 80W	1-1/2 lb.	73	15	60.3 fg
Princep 80W	3 lb.	81	38	66.7 def
Bladex 80W	1-1/2 lb.	77	32	59.7 fg
Bladex 80W	3 lb.	90	72	74.0 cd
AAtrex/Outfox	1-1/2 lb. + 1-1/5 gal.	71	25	53.3 gh
AAtrex/Princep	1-1/2 lb. + 1-1/2 lb.	76	37	62.6 ef
AAtrex/Bladex	1-1/2 lb. + 1-1/2 lb.	84	48	71.8 d
Princep/Outfox	1-1/2 lb. + 1-1/5 gal.	82	40	66.4 def
Princep/Bladex	1-1/2 lb. + 1-1/2 lb.	89	67	70.5 de
AAtrex/Ramrod	1-1/2 lb. + 4-1/2 lb.	89	58	70.5 de
AAtrex/Basamaize	1-1/2 lb. + 3 qt.	92	80	81.3 bc
AAtrex/Lasso	1-1/2 lb. + 1-1/2 qt.	97	94	83.2 b
Princep/Lasso	1-1/2 lb. + 1-1/2 qt.	96	94	94.6 a
Bladex/Lasso	1-1/2 lb. + 1-1/2 qt.	97	96	88.6 ab
Outfox/Lasso	1-1/5 lb. + 1-1/2 qt.	98	94	87.6 ab
Control	...	0	0	23.8 j

a/ Entries with the same letter are not significantly different at 5-percent level.

was located on a Fayette silt loam soil containing approximately 2 percent of organic matter and heavily infested with fall panicum. Corn was planted in 30-inch rows at 22,200 plants per acre on May 10. All herbicides were applied preemergence. Rainfall was below normal but well distributed throughout the growing season.

The proper selection of present and future herbicides will do an effective job of fall panicum control. However, with many cornfields in an advanced stage of fall panicum infestation, several years of effective treatment with panicum control herbicides are required. Also, the wise corn producer will utilize a rotary hoe and cultivator in conjunction with proven herbicides for most effective fall panicum control.

ALTERNATE METHODS FOR THE CONTROL OF EUROPEAN CORN BORERS

E. C. Berry

FOAM APPLICATIONS OF INSECTICIDES

In the search to find alternate methods for insect control, consideration must be given not only to finding effective insecticides but also to finding the most effective method of applying these materials. Thus the development of new equipment or techniques for more accurate deposition of insecticides on the target area has the potential benefit of improving insect control as well as reducing possible pollution.

Traditionally, first-generation European corn borer larvae have been controlled by placing a small quantity of insecticide in the whorl of the corn plant at the correct time. Likewise, second-generation borers can be controlled by placing a small amount of insecticide in the region of the primary ear. At present, insecticides are applied as sprays or granules and only a small portion of the toxicant hits the target area. More accurate placement of the insecticide for borer control may be obtained by applying the insecticide in the form of foam. Investigations were therefore conducted to compare sprays, granules, and foam applications of DDT and *Bacillus thuringiensis* for corn borer control.

Procedures

Field experiments were conducted to study the effect of type of foam nozzle, formulation of insecticide, and type of insecticide on first- and second-generation corn borer control. All materials were applied with a conventional high-clearance machine. Foam formulations were applied with a trifluid nozzle designed and built to generate foam. Insecticides mixed with water, a liquid foaming agent (Spret®, 7.5 ounces per acre), and air were combined in the nozzle and forced through a meshed material to produce foam.

Results and Discussion

Data presented in Table 1 represent a comparison of three formulations of DDT applied for first- and second-generation corn borer control. Foam formulations of DDT were as effective as granules for first- and second-generation borers. Foam applications were more effective than spray formulations for second-generation control.

Table 2 presents the effect of rate of DDT applied as a foam for borer control. Foam applications of DDT at 0.5 pound per acre were as effective as applications at 1 pound per acre for first-generation borer control. For second-generation borer control, increasing the rate of DDT from 0.5 pound per acre to 1 pound per acre significantly increased the level of control.

Paper prepared in cooperation with the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa.

Table 1. Effect of Method of Applying DDT at 1 Pound Active Ingredient per Acre for European Corn Borer Control

Treatment	Cavities per 20 plants	
	First generation	Second generation
Foam	8.3	17.7
Spray	8.9	24.6
Granules	7.0	17.5
Untreated	21.3	42.3

Table 2. Effect of Rate of DDT Applied as Foam for European Corn Borer Control

Treatment	Cavities per 20 plants	
	First generation	Second generation
1.0 lb./acre	8.3	17.7
.5 lb./acre	8.0	22.5

It was evident that foam produced in combination with DDT as an emulsifiable concentrate gave better control than DDT as a wettable powder for both first- and second-generation corn borers (Table 3). The foam produced with the wettable powder appeared to have a drier consistency than foam produced with the emulsifiable concentrate. The wet foam tended to run down the leaves into the corn whorls and leaf axils, whereas the dry foam tended to adhere to the top leaves.

Table 3. Effect of Insecticide Formulation of Foam Application for European Corn Borer Control

Treatment	Cavities per 20 plants	
	First generation	Second generation
DDT, EC	5.7	16.7
WP	10.6	23.4

Data presented in Table 4 are from an experiment designed to determine the effect of the method of applying *Bacillus thuringiensis* in three formulations for corn borer control. Foam formulations gave approximately the same level of control as did granules for both first- and second-generation borers. Foam treatments controlled both generations significantly better than spray formulations.

Foam applications of *Bacillus thuringiensis* at one-half the rate (1 pound of spore powder per acre) produced approximately the same level of control as did 2 pounds of spore powder per acre (Table 5).

Data presented in Table 6 are from an experiment comparing the effectiveness of two types of distribution nozzles. A distributor that produced a large stream of foam was compared with one that produced three smaller streams. There were no detectable differences between the two types of distributors.

Table 4. Effect of Method of Applying Bacillus thuringiensis at 2 Pounds of Spore Powder per Acre for European Corn Borer Control

Treatment	Cavities per 20 plants: First generation	Cavities per 20 plants: Second generation
Foam	5.0	14.3
Spray	10.3	33.5
Granules	7.3	19.5
Untreated	21.3	42.3

Table 5. Effect of Rate of Bacillus thuringiensis Applied as Foam on European Corn Borer Control

Treatment	Cavities per 20 plants: First generation	Cavities per 20 plants: Second generation
1 lb./acre	5.8	19.3
2 lb./acre	5.0	14.3

Table 6. Effect of Distribution Nozzle on Foam Application of DDT on European Corn Borer Control

Treatment	Cavities per 20 plants: First generation	Cavities per 20 plants: Second generation
1 stream of foam	7.6	18.9
3 streams of foam	8.7	21.3

Conclusions

These results indicate that foam formulations of insecticides are equal to or better than conventional methods of applications. By utilizing this technique, it may be possible to deposit most of the pesticide on the target area, thereby improving insect control as well as reducing possible pollution.

SEX PHEROMONE STUDIES

In recent years entomologists have discovered that insects communicate with each other by means of a chemical communication system. The chemical messengers used by the insects are called pheromones; and it has been said that the pheromones are among the most biologically potent substances known to man. In our studies of the sex life of the European corn borer, we have found that the female moth emits minute quantities of a sex pheromone which Dr. J.A. Klun has identified and synthesized in our laboratory. The chemical is *cis*-11-tetradecenyl acetate (*cis*-11-tda). This substance is used by the female corn borer moth to attract and sexually stimulate her mate. In field tests we have found that insect traps baited with one-tenth of a millionth of an ounce of the synthetic sex pheromone will attract male borers for as long as 48 hours. We are currently investigating the potential application of the attractant in borer population surveys and timing of crop protection chemical applications. Research in this area has only recently been initiated, and it is premature to speculate on the usefulness of the synthetic lure in monitoring of borer populations in the field; nonetheless we are pursuing this research with great interest.

In the course of our research we have also discovered certain synthetic chemicals similar to *cis*-11-tda that disrupt successful communication between the female borer and her mate. These chemicals, called sex attraction inhibitors, are surprisingly potent; for example, four virgin female borer moths placed in the vicinity of a few millionths of an ounce of inhibitor are incapable of attracting mates. Through additional research we are hoping that such inhibitors may be of utility in suppression of borer mating in the field.

CROP-HERBICIDE ROTATIONS

F. W. Slife

In 1965 we initiated a long-time experiment which is still going on to study the effects of cropping systems and herbicides on weed species, soil, and the economies of weed control.

The crops grown in the rotation are corn, soybeans, and wheat. Each replication consists of 9 major plots: continuous corn, continuous soybeans, and continuous wheat; corn, soybeans, wheat grown in rotation; and a rotation of corn, corn, soybeans. Each of the major plots is further divided into three segments. One of these segments receives the same herbicide treatment year after year, another segment receives a different herbicide treatment each year, and the third segment receives only good cultural practices. The subplots then are designed to evaluate using a continuous chemical versus changing the herbicide treatment each year, and both of these practices can be adequately compared with the segment where only good cultural practices are used. The herbicide used continuously on corn is atrazine, the continuous soybean treatment is amiben, and the continuous wheat treatment is Banvel-D. Yields of crops and weeds and the degree of weed control are measured each year and observations made of any symptoms of herbicide injury on crops or of symptoms of residue from the previous year's treatments.

From samples obtained at the beginning of the experiment in 1965, we determined the kinds of weeds that were present in the experimental area and the numbers of seeds from each species. At the end of six years, the soil was again sampled according to the procedure used in 1965, giving us a comparison of the effect of the various treatments on the amount of weed seeds in the soil.

Following is a summary of the results from the first six years of this experiment:

1. Corn yields have been increased about 10 to 12 percent each year where either the continuous herbicide or the rotational herbicide is compared with the cultivated check.

2. Soybean yields have been increased over 20 percent each year where the herbicide treatment is compared with the cultivated check.

3. Wheat yields have neither been increased or decreased by the herbicide treatment because the annual weeds present in the wheat area do not grow vigorously until the winter wheat is removed.

4. Where atrazine has been used on the same corn plots for six years:

    a. Weed control has been outstanding.

    b. The broadleaf species have greatly decreased but annual grasses have increased.

    c. No detectable soil residues were found, with oats as a test plant.

5. Where amiben has been used on the same soybean plots for six years:

   a. The total weed population has decreased.

   b. No soil residue was found, with millet as a test crop.

6. Where Banvel-D has been used for six years:

   a. On the same wheat plots, the broadleaf species have decreased and the grass weeds have increased.

   b. No soil residue could be detected, with buckwheat as a test crop.

7. The drop in weed seed content of the soil was greatest where a different herbicide was used each year on corn or soybeans rather than one herbicide year after year.

8. A greater benefit was realized from the chemical treatments on soybeans than on corn, but for both crops the yield increase more than compensated for the cost of treatment.

NEW INSECTICIDE DEVELOPMENTS ON THE DRAWING BOARD

G. M. Booth

One of the earliest chemicals used to control insects was a tea made from powdered tobacco to destroy plant lice. Chrysanthemum flowers, containing pyrethrins, were used to control fleas and lice about 1800, and ground roots of the derris plant were used against leaf-eating caterpillars as early as 1848. About 1865 the first insecticide, Paris green, was used to control the Colorado potato beetle. During the next few decades more than 100 insecticides and acaricides became commercial items; annual sales in the United States now exceed $200 million. Insecticides have become an indispensable adjunct of modern agriculture, providing unblemished fruits and vegetables and often materially increasing crop yields. Through such innovations as seed treatments, soil fumigations, and animal systemics, insecticides have become an integral part of mechanized crop production.

During 1970, nearly a billion pounds of some 900 registered pesticides were applied throughout the United States for pest management programs. This large quantity of pesticides is aimed primarily at about 2,000 pest species of plants and animals. Not unexpectedly, however, residues of some of these compounds have permeated our global aquatic and terrestrial ecosystems and have threatened non-target organisms. The lethal effects of these materials may be jeopardizing the quality of our environment (*1*, *2*), as the public is becoming more and more aware.

The problems that result from the indiscriminate and over-enthusiastic application of pesticides, have basically been grouped into three broad categories (*3*): the lack of appropriate pesticides selectivity between pest and man and his domestic animals, between pest and wildlife, and between destructive and beneficial insects; the selection of resistant strains or races by continued use of a pesticide so that the pesticide ultimately loses much of its usefulness; and the lack of environmental degradability for certain persistent pesticides so that these accumulate in soil and within plant and animal tissues where they are subject to ecological magnification by food-chain organisms.

It is not realistic to visualize that it will be possible in the near future to feed and clothe the world's expanding population and to preserve, let alone improve, the present standards of health and hygiene without the continuing and large-scale use of pesticides. A recent symposium on integrated pest control examined the potential for improving the use and design of synthetic organic chemicals, especially for agricultural purposes. These improvements were summarized as follows: employing pesticides only when necessary for the control of pest populations which are producing injury beyond the economic threshold; establishing conditions for pesticide use based on minimal dosages and optimal formulations, timing, methods, and sites of application; and developing new pesticides and methods of application which are truly selective for the target organism and which are appropriately biodegradable so as to minimize environmental contamination. It is the writer's belief that such improvements in pesticides and in their use will be essential to the successful application of the integrated control concept in pest management programs.

This same point of view is essentially shared by J.W. Wright (*4*), Chief of the Vector Biology and Control Program of the World Health Organization program:

> Taking all points of view into consideration, it would appear that the only practicable and effective solution to vector control today is the systematic development, evaluation, and testing of new compounds, relating these to the ecology of the vector to be controlled and using techniques and equipment that will bring about the minimum contamination of the environment and the greatest degree of safety to man and animal compatible with effective control.

A rational approach to the development of selective insecticides would be to begin with a toxic molecule and modify it by using structure-activity relationships so as to optimize the insecticidal activity and minimize the toxicity to mammals and other organisms which are beneficial to man. This makes much more sense than the sometimes more common approach of simply randomly synthesizing biologically active compounds. By using theoretical models rather than approaching the synthesis of insecticides blindly, new candidate pesticides might be developed that could not be obtained simply by intuition (*5*, *6*).

For example, the mode of action of carbamate and organophosphorus insecticides is essentially known to occur by inhibition of an enzyme known as acetylcholinesterase. This enzyme is responsible in mammalian systems and in some invertebrates for transmission of nerve impulses in the central nervous system of the organism. By subtle modifications of the parent toxic molecule, one can "build-in" selectivity for the benefit of man, domestic animals, wildlife, and beneficial insects. The most obvious example of low toxicity to mammals and high insecticidal activity on insects is that of the insecticide malathion. This compound has been shown to have low toxicity to mammals, primarily because of the high rate of carboxyesterase detoxication of both malathion and its activation product, malaoxon, by the mammalian liver. Insects, for the most part, lack this enzyme that detoxifies the parent molecule. This principle of selectivity can undoubtedly be applied to many other molecules.

Hence, the selectivity of insecticides may be carried out by carefully tailoring the molecules so that an infinite number or types of selectivity may be achieved. The number of carbamate and organophosphorus compounds with insecticidal action is incredibly large. Therefore, it is highly probable that a very selective, persistent, and yet biodegradable analog of the already existing toxic molecules could be synthesized in the immediate future.

SELECTIVITY OF CARBAMATES

Carbamates are esters of *N*-methyl or *N,N*-dimethyl carbamic acid and a variety of phenols and heterocyclic enols. As cited above, these compounds are inhibitors of acetylcholinesterase. The reason they inhibit this enzyme is because they have a close spatial similarity to the natural substrate, acetylcholine; they may also have a direct stimulating effect on acetylcholine receptors.

The carbamates are essentially the most selective of all the insecticides, both in their differential toxicity to insects and vertebrates and in their specific action among the arthropods. One of the most interesting features of this specificity is the difference in toxicity of some of these carbamates to insects and mammals. For example, prostigmine (a quaternary ammonium salt) is extremely toxic to mammals and is virtually inactive as a contact insecticide to many pest insects, even though it is a very active inhibitor (I_{50}=2 x 10^{-8}M) of both insect and mammalian cholinesterase. This suggests that the insects apparently have an impenetrable barrier to quaternary amines which is not present in mammalian systems. It has been determined, for instance, that insect nervous tissues, particularly the axons, are surrounded by an ionic barrier which will not allow these quaternized structures to penetrate the nerve membrane. The theory has been further substantiated by showing that uncharged carbon isosteres such as *m*-isopropylphenyl and *m*-tert-butylphenyl *N*-methylcarbamates are toxic to both insects and mammals. These facts suggest that there are a number of differences in the physiological and biochemical systems of insects and mammals which would in fact be worth pursuing in order to develop a selective insecticide that would be active on insects and not on mammals.

CARBOFURAN ANALOGS

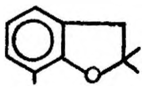
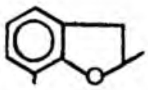
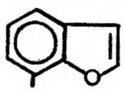
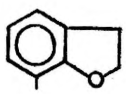
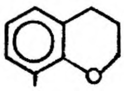
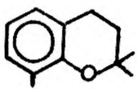
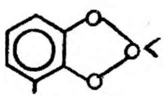
Carbofuran is a broad-spectrum insecticide. It is very effective in controlling many insects, including most subterranean insect pests of agricultural crops. The USDA has labeled it for use on corn, and it is a candidate to replace aldrin and heptachlor, now used on approximately 2.7 million acres in Illinois. Carbofuran may be widely used in agriculture in the next 5 to 10 years. However, there are some obvious disadvantages associated with this very potent insecticide. It is essentially equitoxic to both mammalian species and insect species, with LD_{50} values of about 4 mg./kg. Therefore, with the financial support of the Rockefeller Foundation for the past two years, the Illinois Natural History Survey and University of Illinois and other laboratories in the United States have sought to develop new pesticides from carbofuran and other existing potent insecticides. There is no question that carbofuran is one of the most effective of all the carbamate insecticides that has yet been developed. This compound represents a spatial analog of *o*-isopropoxyphenyl methylcarbamate (propoxur). The fusion of the isopropoxy moiety into the benzofuran ring enhances affinity for acetylcholinesterases and decreases the *in vitro* detoxification in insects, as shown by the comparative synergistic ratio values of 7 for propoxur and 2.8 for carbofuran (*7*). Research during the past two years has, in fact, shown that modifications of the parent carbofuran molecule enhance affinity for insect acetylcholinesterase and decrease the affinity for mammalian cholinesterase; this is shown by several key analogs which have been analyzed in our laboratory at the Natural History Survey (Table 1). For example, the related 2,3-dihydro-2-methyl-7-benzofuranyl methylcarbamate (the second compound from the top) is of lower affinity to acetylcholinesterase, probably because of lower van der Waals interaction, but it is highly insect specific, having less than 1/10 the toxicity of carbofuran for the rat.

These carbofuran analogs are currently being investigated on a wide variety of agricultural pests and through a model ecosystem to determine how appropriate they might be as replacements for the less desirable DDT molecule which persists in the environment.

OTHER CARBAMATE INSECTICIDES

As has already been stated, the reason that malathion is safe for mammals is because of the presence of an esterase that can be degraded rapidly, whereas in insects this enzyme is apparently either absent or has a very low activity. The Riverside Lab at the University of California, under the direction of T.R. Fukuto (*8*), has been searching for carbamate derivatives whose metabolic degradation in insects would be different from that in mammals. For example, it has been shown that insects have an enzyme that can hydrolyze amido groups. Fukuto and his coworkers took one of the very active carbamates, *m*-isopropylphenyl methylcarbamate,

Table 1. Toxicity Data of Carbofuran and Selected Analogs for Rats or Mice, House Flies, and Mosquitoes

R-O-C(=O)-NHCH$_3$ R=	Rat LD_{50} (mg./kg.)	Female housefly LD_{50} (µg./g.)	LC_{50} *Culex fatigens* (p.p.m.)
	4 to 11	4.6(.1)[a/]	.054
	43	5.5(.205)	.19
	10 to 20[b/]	28(1.6)	...
	30[b/]	125(.875)	...
	20[b/]	>500(.43)	...
	3 to 4	35(.2)	.046
	80	4.2(.45)	.2

a/ Pretreated for 1 hour with 50 µg. of piperonyl butoxide per female.
b/ Treated on female mice.

which is highly toxic to both insects and mammals, and formed derivatives of it. A dimethoxy thionophosphororyl group was put on the nitrogen and the biological activity of the compound examined. The reasoning was that in mammalian systems the O-C bond would be broken, leaving two non-toxic fragments, whereas in insects the P-N bond would be broken, generating the original toxic carbamate. It was hoped that the latter reaction would take place rapidly in insects and that the former would take place rapidly in mammals. In fact, the results of toxicity tests showed this. The LD_{50} factor for mice increased from 18 mg./kg. to 760, and the LD_{50} for resistant house flies dropped from >100 mg./g. to 30.

DDT AND DDT ANALOGS

Since the advent of DDT there has been a substantial increase in the use of pesticides to control a variety of public health and agricultural pests. The use of such compounds has brought great social and economic gains to many countries of the world, including the United States. However, the original unreserved optimism has been somewhat tempered by the almost unbelievable magnification of DDT in our aquatic ecosystems, as well as the emergence of resistance.

For almost 20 years man has sought the development of new insecticides for the control of insect vectors of human diseases, as well as suppressing pests of agriculture. None of these materials to date has equalled or excelled the combined properties of the DDT molecule--that is, high stability, safety to humans and higher animals, and low cost insecticidal effectiveness. DDT, however, is not without its problems. Its very low water solubility (0.002 p.p.m.) and high lipid solubility (about 100,000 p.p.m.) have resulted in its accumulation in the fatty tissues of animals and progressive accumulation and concentration in organisms of the food chain. For these reasons it has become necessary to provide replacements for DDT in a number of eradication and suppression programs since the risk of contaminating our water resources is too high.

Under the direction of Dr. Robert L. Metcalf and his group at the University of Illinois Entomology Department, in cooperation with the Illinois Natural History Survey, many persistent and yet biodegradable analogs of DDT have been developed which, by the very nature of their substituents, apparently do not accumulate in aquatic systems. Literally dozens of analogs of methoxychlor and DDT have been synthesized in these laboratories. The most promising of these analogs are shown in Table 2, together with toxicity data. All of these compounds are highly insecticidal, have low toxicity for mammals, and should readily undergo biodegradation. These compounds, even though the exact mode of their action is not known, offer potential substitutes for DDT in the near future.

Table 2. Toxicity of Some DDT Analogs for Mosquitoes and Mice[a/]

Compound number	R_1 [b/]	R_2 [b/]	LC_{50} for *C. fatigens* larvae (p.p.m.)	LC_{50} for *Anopheles albimanus* larvae (p.p.m.)	Oral LD_{50} for mouse (mg./kg.)
1 (DDT)	Cl	Cl	.07	.015	200
2	CH_3	OC_2H_5	.13	.11	1,000
3	CH_3S	OCH_3	.11	.044	1,000
4	C_2H_5O	OC_3H_7	.036	.12	75-100
5	C_2H_5O	OC_2H_5	.04	.086	300-325
6	CH_3S	CH_3S	.21	>1.0	1,000
7	CH_3O	OC_4H_9	.18	.01	500
8	CH_3	CH_3	.081	.17	750
9	CH_3O	OCH_3	.067	.18	1,000

a/ Metcalf *et al.* (5).
b/ R_1 and R_2 represent the p,p' substituents on the parent DDT molecule.

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MANAGEMENT AND PROBLEMS WITH NO-TILLAGE SYSTEMS

G. B. Triplett, Jr.

Good managers strive to create a good environment for crop growth. What comprises a good environment for crops is relatively well defined for conventional tillage systems. Adoption of a no-tillage system of crop production is a radical change of practices so that a technique used in conventional tillage cannot be adopted without modification. With no-tillage, some crop-management practices will have to be reevaluated, while others may be used with little or no modification. Not all the facts have been sorted out to date, but some notes on the state of the art are listed below.

WEED CONTROL

Weed control is absolutely essential for any successful crop-production system, including no-tillage. The herbicides substitute for mechanical techniques in removing weeds present and keeping new weed plants from becoming established. This means a broad-spectrum herbicide, probably a combination of materials with residual effects, must be used.

With a spray-plant-harvest system of crop culture, the herbicide is the sole means for weed control. Some systems intermediate between no-tillage and conventional tillage exist in which some mechanical means of weed control is possible. Rolling cultivators will function in crop residues, and disking prior to planting helps destroy weeds present on the site.

PLANTING

The role of the planter in any corn production method is to open the soil, deposit the corn seeds in the soil at the proper depth, and cover the seeds. Any device that will perform these functions can be used satisfactorily. In systems where plant residues are left on the soil surface, coulters are desirable to cut through the residue and loosen the soil. Satisfactory planters are available that have either shoe or disk openers for the seeds. Press wheels are often used to cover the seeds, although some covering disks are also used.

Problems with no-till planting include: driving too fast so the planter leaves the seeds in an open trench, improper adjustment of equipment, and depth bands riding on mulch and keeping the seeds out of the soil.

FERTILIZER APPLICATION

With plowdown applications of nutrients impossible in a no-tillage crop-management system, alternate means of providing nutrients for the crop become necessary. We have found that surface-applied phosphorus accumulates near the soil surface. There is some movement of potassium, and nitrogen is seemingly freely mobile. Many no-tillage planters can be equipped to apply fertilizer in a band.

Research results to date indicate that availability of surface-applied nutrients is not greatly different from that of the same amount of nutrients plowed down. Mulch cover keeps the soil surface moist, and the surface-applied nutrients are available to roots growing near the soil surface. Band applications of nutrients are more efficient than surface or plowdown applications for either system.

Crop nutritional requirements can be met in no-tillage management systems. The nitrogen can be applied on the soil surface in dry or liquid form; sprayed-on liquid nitrogen also can double as a carrier for herbicides. Phosphorus and potassium may be applied either in a band or broadcast, with assurance that they will be available to the crop. If greatest efficiency of minimum nutrient application is desirable, fertilizer should be banded near the seed.

INSECTS AND OTHER PESTS

Most of the pests of corn grown in clean-tilled soil can be at least as bad, if not worse, in corn grown without tillage. A whole range of seed and pests of young plants are present in meadows, and the habitat of these organisms is not disturbed with tillage. Wireworms, billbugs, and seed maggots have given us problems, to name a few, and some damage can be expected in most seasons. Corn rootworms can give trouble in fields planted to continuous corn.

Above-ground insects can be worse in no-tillage. Cutworms cause some damage during most seasons and slugs have been serious pests during some years. The mulch cover on no-tillage fields provides a good place for the female moth of the armyworm to lay eggs. During years of heavy moth flights, we have had damage from armyworms, a pest that usually migrates from grassed areas.

Non-insect pests include mice, which are usually found in old meadows and can eat most of the corn seeds planted in the vicinity of their runs.

Control of these pests is complicated in that insecticides cannot be incorporated. Entomologists working on the problem have been getting satisfactory control of most insects with several of the currently available insecticides. An insecticide should probably be used when no-tillage corn is planted, and the field watched carefully so that problems can be treated before they develop to serious proportions. Slugs remain as the most serious pest without a good means of control, although some non-labelled materials are at least partially satisfactory. For a more detailed treatment of this subject, see the article by Dr. G.J. Musick on page 112 of the proceedings of the *1971 Illinois Custom Spray Operators Training School*.

SOILS

Conventional tillage (based on plowing) has been used on all soils where row crops are grown because it has been the only satisfactory method of crop production available. Comparisons of tillage systems on a variety of soils show that no-tillage may be better than conventional tillage on some soils and not as good on others. There is no reason this should not be the case; we have not had the techniques which permitted us to find these differences in the past. A few soil characteristics that may influence tillage response on different soil types are becoming apparent. This is an area that needs more research.

DRAINAGE

No-tillage performs relatively better on well-drained soils than on poorly drained soils, and drainage is probably the largest single factor to consider in selecting tillage systems for different soil types. We have seen excellent corn stands in tilled areas on soils with perched water tables when an adjacent strip planted with no-tillage had no plants at all. Apparently, loosening the soil kept the seeds from being killed by water-logging during a rainy period. Tillage helps to warm soils in the spring, promoting more rapid crop emergence.

In trials conducted over a period of years, no-tillage corn yields have averaged higher than yields from conventional corn on well-drained soils. On poorly drained soils no-tillage corn yields have been lower than or only equal to yields from conventional corn, even with the best management known at the time, including adequate weed control. This means that no-tillage may have less use on poorly drained soils.

MULCH COVER

The amount of residue on the soil surface is important in the production of no-tillage corn on some soils but not on others. Light-colored (low organic matter content) silt loam soils (or others low in clay content) that do not shrink and swell have averaged about 1/2 bushel more corn for each percent of mulch cover present in August, equaling yields on conventionally tilled soils when mulch cover was 45 to 55 percent. This means that no-tillage corn can have either a much poorer yield or a much better yield than conventionally tilled corn, depending on the amount of mulch cover. The most important contribution of the mulch seems to be improved water relations. In years with adequate rainfall, the effect of mulch is nearly eliminated. Corn yields in these soils are also improved by cultivation (if the soil is plowed or has a low amount of mulch cover) even if weeds are not a problem.

On high organic matter soils that may shrink and swell and do not respond to cultivation beyond weed control, mulch cover has not improved crop yields. In fact, many soils of this type are poorly drained, and mulch cover may depress temperatures in the spring, resulting in slower early corn growth. We have not been able to show that mulch improves moisture greatly during the growing season on these soils.

TEXTURE

Texture of soils does not seem as important in the response to tillage systems as its influence on other factors. Thus internal drainage may be slow on a soil high in clay content, and the soil may be less well adapted to no-tillage than a soil with a silt loam texture that is also well drained. We have found a poorly drained soil (because of a high water table) with a sandy loam texture that did not respond favorably to no-tillage. A few soils high in clay content may be relatively well drained and soils of this nature may have mechanical problems, for example, difficulty with proper planter function, associated with texture.

WHERE TO USE NO-TILLAGE

No-tillage may solve some problems and create others. Certainly, with the present state of the art, no-tillage is not adapted under some conditions and plowing will be a better choice. No-tillage may have an advantage over conventional tillage under some circumstances on almost all soils.

Erosion Control

Planting corn in undisturbed soil with mulch cover from crop residues, manure, or a cover crop can reduce the hazard of both wind and water erosion. In some studies on water erosion we have seen 50 times as much soil movement, during a severe storm, on conventional tillage as from no-tillage. Wind movement of soil particles is reduced several-fold by mulch cover.

This means that farmers in hilly areas can reevaluate land-use potentials. Many soils that have a great erosion hazard because of slope or texture can be highly productive if managed properly. No-tillage allows use of these soils for row crops while limiting the erosion.

Time

Much less time and labor are required during the planting season to establish an acre of corn with no-tillage than with conventional tillage, especially if plowing is delayed until planting time. Exact time and labor requirements will depend on the size of equipment used, but may require 1/2 hour or less for no-tillage and nearly 2 hours per acre for conventional tillage.

If fall or winter plowing is delayed or is an unacceptable practice because of erosion hazard, time savings become important for farmers handling large acreages. Time savings may accrue at harvest on untilled soil because of better flotation after rains.

Planting Date

Some soils that do not respond to no-tillage also need to be fall-plowed for best results. These soils are poorly drained, plastic in the spring, but highly productive when managed properly. If fall or winter tillage is not possible and plowing is delayed until planting time, we expect yield losses from delayed planting and poor emergence. This seems more critical as planting is delayed past early May.

No-tillage under these conditions, while not as good as fall plowing, is better than spring plowing on the same planting date. Add the possibility of more days suitable for planting than would be possible following plowing, and no-tillage looks promising as an alternative to spring plowing. Corn yields have been better with no-tillage on poorly drained soils following some crops other than corn, so this factor could be considered in the selection of tillage systems.

Yields

Corn yields have been more variable with no-tillage than with conventional tillage. In some cases no-tillage is an outstanding practice, while in other situations it should not be used.

When no-tillage yields are compared with yields from conventional tillage, with weed control and stand satisfactory for both systems, the score to date for no-tillage seems to be:

--Better on well-drained soils with adequate mulch cover (a good place for manure)

--Poorest on well-drained soils with surface sealing problems and no mulch cover

--Poor on poorly drained soil with continuous no-tillage corn, but almost equal if the soil was plowed the previous year

--Essentially equal on poorly drained soils following some crop other than corn

--Better than plowing at planting time on poorly drained soils

No-tillage and Crops Other Than Corn

Most of the work with no-tillage has been with corn, primarily because of the availability of herbicides. Weed control is essential for production of any crop, and herbicide systems are most dependable for corn.

Some soybeans are grown with no-tillage as a second crop following wheat. Research on no-tillage has been conducted with a variety of crops, and the major stumbling block for use of no-tillage seems to be availability of satisfactory herbicides.

FARMER ACCEPTANCE OF NO-TILLAGE

No-tillage is a practice that offers the hill farmer a chance to increase his grain acreage with a decrease in erosion hazard, and hilly areas have the greatest acceptance of no-tillage. In Kentucky during 1971, an estimated 16 percent of the corn acreage was planted with no-tillage. The acreage of no-tillage in Ohio during 1971 was about 5 percent of the total, but was as much as 50 percent of the total in some of the counties in hilly areas. The practice has grown phenomenally where it solves problems, and very little in areas where, because of soils or other conditions, it may not be as well adapted. Significant penetration into the corn belt proper will wait until no-tillage will solve some major problem or give a definite advantage over conventional tillage methods. Acceptance may be better after exact relations between drainage, soil type, previous crop, and tillage have been defined.

QUACKGRASS CONTROL

R. E. Doersch

Quackgrass (*Agropyron repens*) is an extremely aggressive perennial grass which spreads by rhizomes and seed production. It was introduced from Europe in the mid-1700's and has become widely distributed across northeastern and north-central United States and southern Canada. It occurs in continuous infestations in Michigan, Minnesota, and Wisconsin but tends more toward scattered patches in Illinois and Indiana. Quackgrass thrives in cool, moist spring climates. In warmer, less humid areas, quackgrass rhizomes are less likely to survive because of higher soil temperatures and greater moisture stress during the growing season.

Quackgrass is cross-pollinated and thus exhibits considerable morphological variation. Individual clones may vary markedly in color, hairiness, height, and seedhead size. However, leaves are usually about 1/4 inch wide, with a restriction that resembles an M or W about three-fourths of the way up the blade. The base of each leaf possesses small claw-like hooks (auricles) which clasp the stem.

Quackgrass rhizomes are the underground food-storage organ of the quackgrass plant. They are white, fleshy, and smooth except at the nodes, where they are covered with small scales. They have very sharp growing points which penetrate potatoes and other tuberous vegetables. Quackgrass has a remarkable capacity to produce rhizomes. In a Pennsylvania study, individual quackgrass nodes were planted in late fall. By May 27 of the following spring, these initial plantings had each produced from two to five rhizomes averaging almost 10 inches in length. By June 5, each rhizome had grown an additional 10 inches. And by June 20, rhizomes had lengthened a further 13 inches (23 inches in 24 days), and nodes were beginning to produce new quackgrass plants (topgrowth). On June 27, rhizomes had lengthened another 3 inches and most new plants were beginning to send out rhizomes of their own. By September 9 (less than 12 months after planting), the single quackgrass node had spread throughout an area 10 feet, 10 inches in diameter. The total length of rhizomes produced was over 458 feet, and the dry weight of rhizomes represented 62 percent of the plant's total dry weight. The rhizomes had also produced 206 above-ground shoots which produced 15 seedheads.

Quackgrass-control procedures must be aimed at depletion of the plant's vast storehouse of food reserves in its rhizomes. Repeated tillage whenever topgrowth is 2 to 3 inches tall will eventually kill quackgrass. Late-summer and fall tillage with a spring-tooth implement brings rhizomes to the surface where they dry out and die in dry weather. However, if rainfall follows tillage the rhizomes rejuvenate and resume growth. Temperatures below 20° F. also kill exposed rhizomes. So tillage just prior to freeze-up and leaving the soil surface rough overwinter to enhance frost penetration also aid in quackgrass control. In most old quackgrass sods, rhizomes have relatively short internodes and are located in the upper 2 to 3 inches of soil. With increased tillage, rhizomes grow as much as 6 inches deep and produce longer internodes. Rhizomes with longer internodes can produce new quackgrass shoots from greater soil depths. Quackgrass rhizomes are most obvious when being dragged from one field to another on tillage equipment, but quackgrass seeds are frequently overlooked as a means of quackgrass spread. Seeds are spread in feed grains, hay, manure, crop seeds, etc. Quackgrass seed is the most common contaminant in small-grain seed planted in Wisconsin.

Repeated tillage under dry conditions can eventually eliminate quackgrass, but this process requires a year of fallow. The use of herbicides enables one to eliminate quackgrass while producing a crop. And the benefits of quackgrass elimination are apparent for years to follow. But the herbicide application must be appropriately applied for maximum effectiveness and return.

AAtrex is by far the most effective and widely used herbicide for quackgrass control. It is absorbed through both the leaves and roots and kills quackgrass by interrupting the plant's ability to utilize sunlight to manufacture food. The quackgrass plant remains alive, using its supply of food reserves in the rhizomes as a source of energy. When the stored reserves are depleted, the quackgrass plant dies. This process usually takes six to eight weeks, so early AAtrex application prior to corn planting is important.

Virtually all research trials have demonstrated that the time of AAtrex application for quackgrass control is more important than the rate of application. Over ten years ago, Buchholtz showed that 8 pounds per acre of active atrazine applied after planting failed to control quackgrass as well as 2 to 4 pounds per acre applied in fall or early spring prior to plowing in preparation for corn planting. Preplow treatment places the atrazine in contact with more quackgrass rhizomes and allows greater time for quackgrass kill prior to corn planting. And yet most farmers fail to distinguish between AAtrex applied for annual weed control and AAtrex applied for quackgrass control. Most of them still apply AAtrex after corn planting for quackgrass control. AAtrex applied after corn planting may occasionally provide reasonable control of light quackgrass infestations on sandy soils when followed by heavy rainfall to leach the herbicide downward. But even under ideal circumstances, corn suffers from quackgrass competition until midseason when the treatment finally shows its full effect. Even AAtrex applied several weeks before planting and incorporated during seedbed preparation provides better quackgrass control than treatment after corn planting. The most effective quackgrass control is obtained by applying 5 pounds per acre of AAtrex 80W prior to plowing or 2-1/2 pounds per acre prior to plowing followed by 2-1/2 pounds per acre after corn planting. The split application will control quackgrass as well as many annual weeds.

Dowpon applied as a preplow treatment can also be used for effective quackgrass control. This herbicide works approximately the same way as atrazine except that its residue dissipates more rapidly. Usually not all quackgrass rhizomes are killed by a single Dowpon application of 5 to 10 pounds per acre. A follow-up treatment of AAtrex after corn planting generally improves the effectiveness of the Dowpon treatment. Spring preplow treatment with Amitrol T or Cytrol has also been used to control quackgrass in the past. However, the use of these products on food and feed crops has recently been cancelled.

Herbicide research suggests several future possibilities for quackgrass control in field crops. Kerb has looked promising for the control of quackgrass in alfalfa and other small-seeded legumes, but it also kills other perennial grasses like orchardgrass, bromegrass, and timothy, which might be planted in association with the legume. Another experimental product that shows substantial promise for quackgrass control is MON 0468. This herbicide is very easily translocated by quackgrass but dissipates rapidly in the soil, permitting any crop to be planted within a relatively short time after treatment. Both Kerb and MON 0468 are still in a developmental stage and several years away from commercial use.

Quackgrass Control in Rotation, 2-Year Average Yields, Lancaster, Wisconsin

Herbicide treatment to corn		Culti-	Corn	Oat	Forage yield	
Preplow	Preemergence	vations	yield	yield	Alfalfa	Quackgrass
			(bu./A.)	(bu./A.)	(T./A.)	
AAtrex 80W	AAtrex 80W	..	118.2	66.8	1.27	.04
AAtrex 80W	...	2	121.4	80.0	1.54	.01
...	AAtrex 80W	..	95.4	65.7	1.14	.40
...	...	2	101.5	64.4	1.33	.26
Dowpon	AAtrex 80W	..	108.4	75.8	1.44	.16
Amitrol T	AAtrex 80W	..	99.0	68.2	1.39	.32

All preplow herbicides applied in spring. Preplow and preemergence AAtrex 80W rate = 2-1/2 lb./A. Dowpon rate = 5 lb./A. Amitrol T rate = 1 gal./A.

FUNGICIDE SEED TREATMENT RESEARCH

T. H. Bowyer

Over the years, fungicides as seed treatments have saved U.S. small grain farmers over $16 billion. In the past, more than a hundred registered and unregistered seed-treatment fungicides have been studied by plant pathologists. More than thirty-five were tested at the University of Illinois at Urbana-Champaign. E.D. Hansing, Kansas State University at Manhattan, found that treating wheat seed increases seedling stands from zero to 20 percent. In laboratory tests, 92 percent of the seed in each of three groups of certified seed germinated without seed treatment. Untreated seeds from the same lots tested *in the field* germinated at the rate of 75, 85, and 65 percent. When treated, all field-tested seeds germinated at a rate of nearly 85 percent.

Research by R.V. Clark of the Canadian Department of Agriculture at Ottawa in Ontario Province indicates that seed treatment of clean, certified oat seed is not necessary for increased yields. Data from his experiments over a three-year period showed that an increase in yield over the check occurred 6 times, while in 9 cases a decrease was measured. Other evidence has shown that a decrease in yield usually does not occur until there is more than a 50-percent reduction in stand or seedling emergence. Clark's yield data were taken from 100 seeds planted in rows 12 inches apart. Not all researchers would agree with the validity of the data accumulated from such an experiment.

Research at the Urbana-Champaign Campus of the University of Illinois last year was restricted to determining the effects of thirty-seven nonmercurial fungicides, applied to 2 wheat varieties having 3 seed conditions (certified, certified-artificially inoculated, and naturally infected "scabby" seed), on seed germination, tillering, and tiller height. All of these data were collected at the South Farm on the Urbana-Champaign Campus. This year, seed-treatment tests have been made at Carbondale, Belleville, and Urbana--using certified, Arthur wheat seed.

The Belleville and Carbondale plots will test:

Treatment	Rate (oz./bu.)
1. Captan 80	1
2. Captan + HCB (40:10)	2
3. Captan + Maneb (30:30)	4
4. Captan + Maneb (37.5:37.5)	2
5. Captan + Maneb + HCB (20:20:20)	3
6. Dithane M - 45 (Manzate 200)	1
7. Thiram	1
8. Vitavax	2
9. Vitavax + Thiram (37.5:37.5)	1
10. Vitavax + Maneb (37.5:37.5)	1

The Urbana experiment will test:

Treatment	Rate (oz./bu.)
1. Captan + HCB (40:10)	2
2. Captan + HCB (40:40)	1
3. Captan + Maneb + HCB (20:20:20)	3
4. Vitavax	2

Along with germination counts, yields will be measured. Information from these and other tests will be used to update the listing of seed-treatment fungicides found in the UI's Report on Plant Diseases No. 1001.

INSECT SITUATION, 1971

T. A. Cooley, D. E. Kuhlman, Roscoe Randell

HIGHLIGHTS

Insect activity in field crops during 1971 varied somewhat from that of previous years. Wireworms, flea beetles, grasshoppers, and fall armyworms increased in activity. A greater acreage of grain sorghum resulted in more problems on that crop with corn leaf aphid, corn earworm, and sorghum midge. Spider mites were a problem in both corn and soybean fields. Populations of seed corn beetles and armyworms were less than in 1970.

Information in the tables in this report summarizes data sent in by county Extension advisers in agriculture. These advisers averaged 1,006 inquiries during 1971 about insect pests, of which 677 were about pests related to agriculture and 329 concerned home and garden insects. The most common insect pest problems reported by Extension advisers are listed below in decreasing order of importance:

1. Corn rootworms
2. Grasshoppers
3. Corn borers
4. Wireworms
5. Corn leaf aphids
6. Cutworms
7. Bagworms
8. Alfalfa weevils
9. Spiders
10. Roaches
11. Spider mites
12. Fall armyworms
13. Flies
14. Armyworms
15. Vegetable insects
16. Termites
17. Flea beetles
18. Sod webworms
19. White grubs
20. Cereal insects

Field crop acreage treated in 1971 was similar to the acreage treated in 1970. Approximately 6,809,905 acres of field crops were treated, with an estimated savings to farmers of $23,092,825 over and above treatment cost (Table 1). The percentage of acres treated by aerial or ground applicators or by individual farmers is given in Tables 2 and 3.

CORN INSECTS

Corn soil insects. The major use of insecticides in Illinois in 1971 was for controlling corn soil insects. Approximately 60 percent of the total corn acreage in Illinois was treated with an insecticide, saving farmers an estimated $21,179,278 above treatment costs. Approximately 3,420,000 acres were treated with organic phosphate and carbamate insecticides, primarily continuous-corn acreage, in the northern one-third of Illinois (Table 4).

Resistant western and northern corn rootworms. In 1972 moderate to severe damage by rootworms will be most common in fields planted to corn for two or more consecutive years in the area north and west of a line from Fort Madison, Iowa, to Peoria to Elgin (Figure 1). Light to moderate damage may occur in the remaining area south

Table 1. Acres of Field Crops Treated With Insecticides and Estimated Profit From Treatments, Illinois, 1971

Crop and insect	Acres treated	Estimated profit[a]
Corn		
Armyworms	8,271	12,439
Corn rootworm adults	29,645	118,580
Corn leaf aphids	28,150	140,750
Cutworms	57,387	344,322
European corn borers	95,546	143,219
Grasshoppers	64,810	64,810
Soil insects	6,142,039	21,179,278[b]
Fall armyworms	21,485	53,313
TOTAL	6,447,354	22,056,711
Soybeans		
Grasshoppers	67,964	202,892
Spider mites	14,285	21,428
TOTAL	82,249	235,320
Wheat		
Armyworms	38,159	152,636
Sorghum		
Webworm, corn earworm, etc.	24,353	36,520
Clover and alfalfa		
Alfalfa webworms	870	5,220
Alfalfa weevils	71,231	284,924
Clover leaf weevils	684	1,026
Grasshoppers	71,303	106,955
Meadow spittlebugs	798	1,596
Pea aphids	812	1,624
Potato leafhoppers	5,023	10,046
Variegated cutworms	960	1,920
TOTAL	151,681	413,311
Fence rows, ditch banks, roadsides, reserve acreage, etc.		
Grasshoppers	66,109	198,327
1970 TOTAL	7,368,101	$27,501,930
1971 TOTAL	6,809,905	$23,092,825

a/ Over and above treatment costs.
b/ Based on yield increase from use of rootworm insecticides.

Table 2. Percent of Total Field Crops Treated by Commercial and Private Applicators in Illinois, 1958 Through 1971

Year	Percent of total acreage treated		
	Airplane application	Ground application	
		Commercial	Individual
1958	3.0	19.5	77.5[a/]
1959	2.6	14.5	82.9
1960	5.6	11.9	82.5
1961	7.4	12.0	80.6
1962	9.9	12.3	77.8
1963	9.2	18.8	72.0
1964	10.1	8.4	81.5
1965	4.9	10.4	84.3
1966	5.8	13.8	80.4
1967	5.5	14.7	79.8
1968	7.1	13.4	79.5
1969	5.3	15.2	79.5
1970	4.5	16.0	79.5
1971	5.5	13.9	80.6

a/ First year in which soil insecticides were included in these calculations.

Table 3. Number of Acres Treated, by Method, for Certain Insects in Illinois, 1971

Insect	Airplane application	Ground application	
		Commercial	Individual
Clover and alfalfa insects	38,674	11,674	26,102
Corn soil insects	161,365	776,548	5,204,126
European corn borer	66,350	50,355	16,182
Grasshoppers	44,677	71,954	153,555
Corn leaf aphids	10,025	12,385	5,740
Sorghum insects	15,209	9,144	12,523
Armyworms	34,590	5,516	5,262
TOTAL	370,890	937,576	5,423,490

Table 4. Number of Corn Acres Treated With Different Types of Soil Insecticides, 1964 Through 1971

Year	Chlorinated hydrocarbons	Organic phosphates and carbamates
1964	4,009,303	81,822
1965	4,544,432	189,352
1966	5,116,605	326,592
1967	5,601,572	602,721
1968	5,170,726	1,091,143
1969	4,517,931	1,990,138
1970	3,844,740	2,765,547
1971	2,723,119	3,418,920

to a line from St. Louis to Champaign. Farmers in the northern one-third of Illinois who have experienced serious rootworm damage in past years and who have continuous corn should continue a rootworm control program. In 1971 the overall adult corn rootworm population in August was similar to that of 1970. This determines the potential threat for 1972. Twenty-six percent of the fields in the northern one-third of Illinois averaged 1 or more beetles per plant. Potentially, egg-laying should be greatest in these and late-silking fields, which attract large numbers of female beetles. Although the overall damage may be moderate in 1972, we expect to see some fields severely damaged by rootworms. Crop rotation and the use of rootworm insecticides may reduce the potential for damage in 1972.

The highest adult rootworm populations in 1971, among 32 counties surveyed, occurred in Boone and McDonough Counties, averaging almost 2 adults per plant (Figure 1). Adult populations declined slightly in the northwest section of Illinois, were highest in northeastern Illinois, and increased slightly in the west, central, and eastern sections. The populations were extremely low in the southern one-third of Illinois. (See report on the 1971 adult rootworm survey by Kuhlman and Cooley elsewhere in this book.)

The larval populations in some fields in 1971 were the highest we have seen in four years. Rootworm egg hatch was about 10 days later than in 1970, and newly hatched larvae were not observed until mid-June.

Western corn rootworms (WCR). Adult WCR's were found for the first time in Macon, DeWitt, Sangamon, Morgan, Christian, Menard, and Shelby Counties in 1971. The WCR has how been positively identified in 54 counties in the northern one-half of Illinois since first found in Rock Island County in 1964. Rootworm population pressures, formerly great in the western counties of Mercer and Rock Island along the Mississippi River, have decreased. The WCR is gradually displacing the northern corn rootworm (NCR) in the northwest, northeast, and western sections. The increase in abundance of the WCR has been one of displacement of the NCR rather than additive since overall combined populations have actually been declining. The WCR adults seek late-maturing fields to feed and lay their eggs. Damage is common in second-year corn.

Northern corn rootworms (NCR). This species is present throughout Illinois, but economic infestations are confined primarily to the northern one-half of the state. In general, damage by NCR's will be most common in third-year corn or more in the area north and west of a line from Fort Madison, Iowa, to Peoria to Elgin (see Figure 1).

In 1971 the highest adult NCR populations were in the northeastern section of Illinois. NCR populations increased over those in 1970 in the northeast, west, central, and eastern sections and declined slightly in the northwest.

All NCR's in the northern one-half of Illinois should be considered resistant to the chlorinated hydrocarbons.

Seed-corn beetles. Damage to corn in 1971 by the reddish-brown slender seed-corn beetle and the slightly larger striped seed-corn beetle was relatively light. Again, as during the past two years, the beetles were very abundant. Although germination and plant growth were delayed by below-normal soil temperatures, a relatively dry seedbed at planting time may have been responsible for averting damage. We normally associate seed-corn beetle damage with cool, wet soil.

Garden symphylans. This non-insect pest occurs in most fields in Illinois, but populations are usually non-economic. However, a few fields of corn were damaged in

1971. The fields damaged by this pest are generally very high in organic matter in the form of animal manures or legumes.

Garden symphylans feed on the root systems of corn, which greatly reduces plant vigor and growth or may kill plants. They are not restricted to any particular soil level, being found from the surface to a depth of 4 feet or more. Symphylans are often found in high numbers in localized areas with a corresponding type of damage.

The garden symphylan has a complex life history. At birth newly hatched larvae have 6 pairs of legs and 6 antennal segments. Fully grown individuals have 12 pairs of legs.

The organic phosphate and carbamate insecticides applied in a 7-inch band at planting time have given practical control in research conducted by Dr. Ralph Sechriest. However, Dyfonate is the only material specifically labeled for this pest.

Black cutworms. This insect caused severe damage in a few cornfields in Illinois this year. Most reports of damage were in bottomland areas in western Illinois, but the range extended to other sections as well. An estimated 51,851 acres of corn were replanted because of cutworm injury, and 57,387 acres received emergency control treatments (Table 1).

About half of the damaged fields for which cutworm complaints were received had been treated with a row or broadcast application of aldrin or heptachlor at planting time. Emergency control measures used by farmers in 1971 included a carbaryl-molasses spray and a carbaryl-apple pomace bait. Excellent cutworm control was obtained where a carbaryl-apple pomace bait was used in field trials. Varied cutworm control was obtained by farmers using the carbaryl-molasses spray. In some instances, several days passed before control was evident. Where the soil surface was dry or crusted, the worms were not attracted to the soil surface and did not come in contact with the toxicant. Where the soil surface was moist, the cutworms fed on or near the surface and were killed.

Black cutworms must be considered a potential problem in 1972. It is impossible to forecast the severity of a problem more than a week or two in advance. A wet, cool spring is most favorable for cutworm development. Therefore, frequent observations for damage should be made, particularly in fields with low, wet spots. Check for cut, wilting, or missing corn plants. Emergency treatments will be based on number and size of worms present and the size of corn. Corn that is cut off above the growing point will usually recover, but plants cut off below the growing point, or heart, are killed. In evaluating damage, take this possible regrowth factor into consideration before disking up a field for replanting. The black cutworm probably does not overwinter extensively in Illinois, so severe infestations may be the result of moths migrating from southern states in the spring and depositing eggs in fields.

European corn borers. First-brood populations in 1971 were generally low (Tables 5 and 6) and damage minor. Although the 1970 overwintering populations were fairly low (state average of 85 borers per 100 plants), corn planting was earlier than usual and thus a situation was provided in which infestations and survival of first-generation borers might have been great. Fortunately this did not occur. Instead there were large acreages of early-planted corn in 1971. These provided the moths with many places to deposit eggs. The first generation was, therefore, scattered over a large area with most fields having light to non-economic infestations. Only a few fields required chemical control. But many fields did have some borers, and this added up to a big supply of moths to lay eggs in late-planted corn during late July and August.

Table 5. First- and Second-Generation Corn Borer Populations[a/]

	July 1966	Oct. 1966	July 1967	Oct. 1967	July 1968	Oct. 1968	July 1969	Oct. 1969	July 1970	Oct. 1970	July 1971	Oct. 1971
Northwest												
Ogle*	3	58	13	52	0	100	8	85	0	59	6	207
Whiteside*	5	167	22	26	3	177	0	42	0	81	6	253
Bureau	9	129	17	113	1	150	6	198	2	62	2	49
Mercer*	30	109	16	76	3	217	4	331	0	42	8	164
Average	12	116	17	67	2	161	5	164	1	61	5	168
Northeast												
Boone*	6	66	16	12	0	156	24	48	0	72	1	73
DeKalb*	1	21	1	13	1	113	5	73	3	52	5	102
LaSalle	2	88	4	87	5	304	5	97	0	62	2	93
Average	3	58	7	37	2	191	11	73	1	62	2	89
East												
Kankakee*	0	56	1	41	1	94	0	66	0	53	0	204
Iroquois*	0	42	2	21	1	321	1	69	0	17	0	123
Livingston	0	84	13	65	5	540	2	140	0	36	0	117
Champaign*	0	8	0	7	0	80	0	12	0	9	0	34
Average	0	48	4	34	2	259	1	72	0	29	0	120
Central												
McLean*	6	103	4	82	0	267	1	46	0	24	3	65
Logan	3	28	1	30	0	41	0	13	0	3	1	60
Average	5	66	3	56	0	154	1	30	0	14	2	62
West												
Knox*	4	232	14	136	11	158	11	183	0	85	11	63
McDonough*	2	153	9	93	7	191	2	199	5	131	16	100
Average	3	193	12	115	9	246	7	191	5	108	13	82
West-Southwest												
Christian	1	15	2	74	0	158	0	44	0	30	0	64
Sangamon	0	15	0	16	0	84	2	7	0	16	5	57
Macoupin	9	84	2	53	3	177	0	339	8	117	4	92
Greene	11	167	14	147	7	236	2	311	3	93	2	116
Average	5	70	5	73	3	164	1	175	4	64	3	82
OVERALL AVERAGE	5	86	8	60	3	195	4	121	1	55	3	107

a/ Asterisks indicate an 11-county comparison (see Table 6).

Table 6. Average First- and Second-Generation Corn Borer Populations (11-County Comparison)[a/]

Year	First generation	Second generation
1961	3	82
1962	10	139
1963	14	126
1964	7	122
1965	3	42
1966	5	92
1967	9	51
1968	3	183
1969	5	105
1970	1	57
1971	5	126

a/ Starred counties, Table 5.

Second-generation corn borer populations were higher in 1971 than in 1970. The state average was 130 borers per 100 stalks of corn (Table 7). Overwintering populations are highest in the northwest, west, and southern sections of Illinois (Figure 2). With favorable weather these overwintering populations are high enough to present a first-brood problem to early-planted corn in 1972. The evidence of infection by disease organisms among overwintering borers is low in the northern one-half of Illinois, but increases in the southern sections. If corn borers are subjected to extremes in temperature, most of the diseased borers will die from the added stress. The damage potential (Figure 2) in 1972 is non-economic to light for those districts with an average of 0 to 100 borers per 100 plants; light to moderate for 100 to 250 borers per 100 plants; and moderate to severe with 250 borers and over.

Corn leaf aphids. Populations were low in 1971 as in 1970 and 1969. Control measures were necessary in only occasional fields. An estimated 28,150 acres were treated in 1971. In mid-July enough aphids were present in the whorls to indicate the possibility of a serious problem. But before aphid numbers could build to damaging proportions, 80 percent of the corn was beyond the critical late-whorl and early-tassel stage. As the corn tassels emerged, aphid numbers declined and numerous predators helped to keep populations in check.

Spider mites. Extended periods of dry weather were responsible for a buildup of 2-spotted spider mite populations in central and west-central areas. Mites could be found on the undersides of lower leaves of corn plants along the margins of many fields. Damaged leaves turned yellow or brown. An occasional field was infested throughout and required treatment. Timely rains prevented damage by killing the mites and allowed plants to recover.

Southwestern corn borers. These insects are present in 15 counties in the southern section of Illinois (Figure 3). Since first found in Illinois in 1963, the northward movement has been relatively slow, probably because of the inability of the larval stage to survive our winters. None were found in additional counties in 1970 or 1971. Five of 10 fields in Pulaski-Alexander Counties were infested with the southwestern corn borer, with an average of 3.6 borers per 100 stalks. The overall infestation was less than in 1969 and 1970. Early planting very likely averted higher infestations, since damage is usually confined to late-planted corn.

Table 7. Corn Borer Fall Population Surveys in 36 Counties, 1961 Through 1971 (County Averages Expressed in Borers per 100 Stalks of Corn)

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Northwest											
Jo Daviess	46	98	70	146	17	69	39	295	112	111	116
Winnebago	51	114	214	93	28	54	34	213	71	169	224
Ogle	49	95	121	96	18	58	52	100	85	59	207
Whiteside	131	29	178	306	69	167	26	177	42	81	253
Bureau	97	135	370	179	74	129	113	150	198	62	49
Mercer	111	428	287	275	49	109	76	217	331	42	164
Average	81	150	207	183	43	98	57	192	139	87	169
Northeast											
Boone	47	70	88	34	11	66	12	156	48	72	73
Lake	12	13	15	59	10	33	11	158	65	83	98
DeKalb	126	81	160	132	31	21	13	113	73	52	102
DuPage	34	53	58	45	11	33	30	70	71	79	25
Will	76	101	119	78	16	38	37	87	99	21	136
LaSalle	127	66	258	163	46	88	87	304	97	62	93
Average	70	64	116	90	21	47	32	148	75	62	89
East											
Kankakee	133	152	52	79	28	56	41	94	66	53	204
Iroquois	109	198	85	191	61	42	21	321	69	17	123
Livingston	59	81	83	163	32	84	65	540	140	36	117
Vermilion	14	42	14	11	17	16	11	195	92	50	68
Champaign	5	10	14	9	10	8	7	80	12	9	34
Average	64	97	50	91	30	41	29	246	76	33	109
Central											
Peoria	121	237	110	106	66	708	191	285	267	53	80
Woodford	122	131	210	154	81	493	125	288	64	43	61
McLean	49	88	65	43	45	103	82	267	46	24	65
Logan	18	23	47	30	10	28	30	41	13	3	60
Macon	12	23	14	17	6	5	23	52	28	11	68
Average	64	100	89	70	42	267	90	187	84	27	67
West											
Henderson	117	174	150	223	106	285	115	287	367	50	193
Knox	53	190	194	56	45	232	136	300	183	85	63
Hancock	35	142	206	102	89	171	109	99	205	213	166
McDonough	48	192	144	123	98	153	93	191	199	131	100
Adams	62	129	118	179	73	502	98	169	269	209	52
Brown-Cass	41	67	88	117	84	148	58	349	184	93	73
Average	59	149	150	133	83	249	102	233	235	130	108
West-Southwest											
Sangamon	13	20	10	12	8	15	16	84	7	16	57
Christian	21	24	15	15	23	15	74	158	44	30	64
Madison	77	150	56	30	126	90	107	425	447	270	233
Average	37	65	27	19	52	40	66	222	166	105	118
Southwest											
St. Clair	13	89	108	46	98	96	110	357	444	58	365
Average	13	89	108	46	98	96	110	357	444	58	365
East-Southeast											
Moultrie	6	30	23	4	13	22	66	172	54	11	42
Clark	12	20	21	16	151	74	8	189	207	63	37
Jasper	53	102	25	24	40	44	59	196	118	95	388
Lawrence	8	44	22	28	62	48	15	199	172	53	51
Average	20	49	23	18	67	47	37	189	138	56	130
AVERAGE, ABOVE 36 COUNTIES	59	101	106	95	49	120	61	205	139	71	120
AVERAGE, ALL COUNTIES SURVEYED	56	99	98	100	57	112	57	211	170	85	130

Wireworms. A sudden upsurge in the number of corn fields damaged by wireworms occurred in 1971. The greatest number of reports of damage came from the southern one-half of Illinois. They involved a variety of rotations, but were most common in fields that were in wheat in 1969. This insect lives as a larva in the soil for two to six years. A wireworm problem in 1971 quite likely means there will also be one in the same field in 1972; so plan accordingly.

We had several reports of wireworm control failures where row treatments of aldrin, heptachlor, and chlordane were used. Emergency control measures of this insect are not reliable. If damage is just beginning, and replanting not yet indicated, a cultivator application with Thimet or Dyfonate may be helpful. Another possibility is to straddle the rows and replant, leaving the old stand. Later, the poorer of the two stands can be eliminated by cultivation.

SOYBEAN INSECTS

Grasshoppers. Populations were very high in 1971. An estimated 67,964 acres of soybeans were treated to prevent damage. Grasshoppers may present some problems in 1972 in the central section where fall counts indicated several counties with threatening populations (Figure 4). A hot, dry June in 1972 during the period of egg hatch will favor the survival of hoppers.

Spider mites. Damage by the two-spotted spider mite was widespread in 1971, and persisted in some areas throughout the summer. This species is commonly present in fencerows, and along roadsides, ditchbanks, etc., and increases in abundance as well as distribution during extended dry periods. An estimated 14,285 acres were treated in 1971. Damage is usually most severe along field margins. Soybean fields adjacent to clover fields are the most likely to be attacked, but the mites may also migrate from grassy fencerows and ditchbanks. The mites appear as small black specks on the undersides of the leaves and produce webbing.

SMALL-GRAIN INSECTS

Cereal leaf beetles. These insects continue to spread rapidly in Illinois and have now been found in 57 counties. In 1971 the cereal leaf beetle was detected for the first time in 27 counties (Figure 5). From 1965, when first detected in Illinois, through 1970 it had been found and identified in 30 counties in the east-central section of Illinois.

Damage to oats, wheat, and corn by the larval and adult stage is expected to be minor within Illinois during 1972. Surveys will be conducted by regulatory officials in 1972 to detect the spread of the insect. Quarantines have been imposed on all or parts of the counties designated in Figure 5 to prevent the spread of the cereal leaf beetle.

True armyworms. An occasional small-grain field in south-central sections had enough armyworms to warrant control measures. Overall, however, armyworm numbers were low. An estimated 38,159 acres were treated for control in 1971. This species does not overwinter successfully in Illinois, but migrates from the south and southwest on the prevailing spring winds. True armyworms survive best in a cool, wet spring.

Hessian fly. Populations were again low in 1971. The late-summer survey indicated an average of 2 flaxseeds per 100 tillers, which is relatively low (Table 8). The average number of flaxseeds per 100 tillers is given for the counties surveyed in

Figure 6. Lawrence and Morgan Counties had the highest counts. The ten-year state average is 5.2 puparia per 100 tillers. A number of fields of fall-seeded wheat in south-central Illinois were observed with hessian fly damage in late October and early November. The varieties involved were susceptible to damage and seeded prior to the fly-free date. There is also some indication that a supplementary generation of hessian fly developed and infested a few wheat fields planted after the recommended seeding date for susceptible varieties.

Table 8. Hessian Fly Populations, by Sections, July 1961 Through 1971

	Flaxseeds per 100 tillers										
	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
West	1.5	10.8	7.5	2.2	2.0	7.2	2.5	1.0	1.0	.4	0
Central	2.0	3.3	4.0	1.6	0	2.1	1.0	0	1.0	.8	0
East	1.5	5.2	3.0	0	2.0	0	.5	0	0	0	...
West-southwest	21.2	24.1	10.5	1.9	1.1	15.9	3.7	.18	1.0	3.1	2.3
East-southeast	3.8	12.4	2.5	4.2	.4	25.6	4.2	4.3	3.0	1.2	5.5
Southwest	7.7	11.9	1.2	10.1	3.7	8.8	2.8	4.2	3.0	6.2	1.2
Southeast	33.6	10.9	3.0	1.0	.8	22.6	13.0	2.0	2.0	4.4	1.2
State average	8.0	11.2	4.8	3.4	1.5	14.4	5.3	1.9	2.0	3.3	2.0

CLOVER AND ALFALFA INSECTS

Alfalfa weevils. Damage to alfalfa by this insect was again pronounced, being moderate to severe in the southern one-third of Illinois. Weevil development was slowed by cool spring temperatures, and damaging levels came in late April. Some populations in central Illinois were high enough to warrant treatment, but the high infestations were late and coincided with cutting of the first crop. In the northern one-half of Illinois, alfalfa weevil infestations were low and non-economic. C.E. White, Illinois Natural History Survey Entomologist, reports that an average of 5.4 percent of the alfalfa weevil larvae were parasitized by a parasitic wasp, *Bathyplectes curculionis*, during April 20-21 and the figure increased to 39.9 percent during May 9-12 in the southern one-half of Illinois. These wasp parasites helped check weevil populations, requiring less insecticide for control. A nematode, *Hexamermis arvalis*, was also found, for the first time, parasitizing alfalfa weevil larvae in Champaign County.

In 1972 we can expect moderate to severe damage south of a line from Watseka to Hardin and light to moderate damage in some fields north of this line (Figure 7). Each alfalfa field will have to be examined and evaluated on an individual basis.

SORGHUM INSECTS

With a sharp increase in grain sorghum acreage in 1971, particularly in southern Illinois, there was reason to be concerned about insect damage. Fortunately the insect damage to grain sorghum was, for the most part, non-economic. Many fields were heavily infested with corn leaf aphids. These infestations apparently did not cause any economic losses. *Greenbugs* were observed in relatively few fields and were not a problem. *Sorghum midges* caused some concern; but again, damage was relatively minor. *Corn earworms* and *sorghum webworms* were found feeding in many fields, ranging in size from newly hatched to fully grown. The corn earworm caused the most damage of any of the sorghum insects, but infestations rarely warranted control measures. There were about 24,353 acres treated in 1971 for various sorghum insects. Following is a brief report on some of the sorghum insects encountered in 1971.

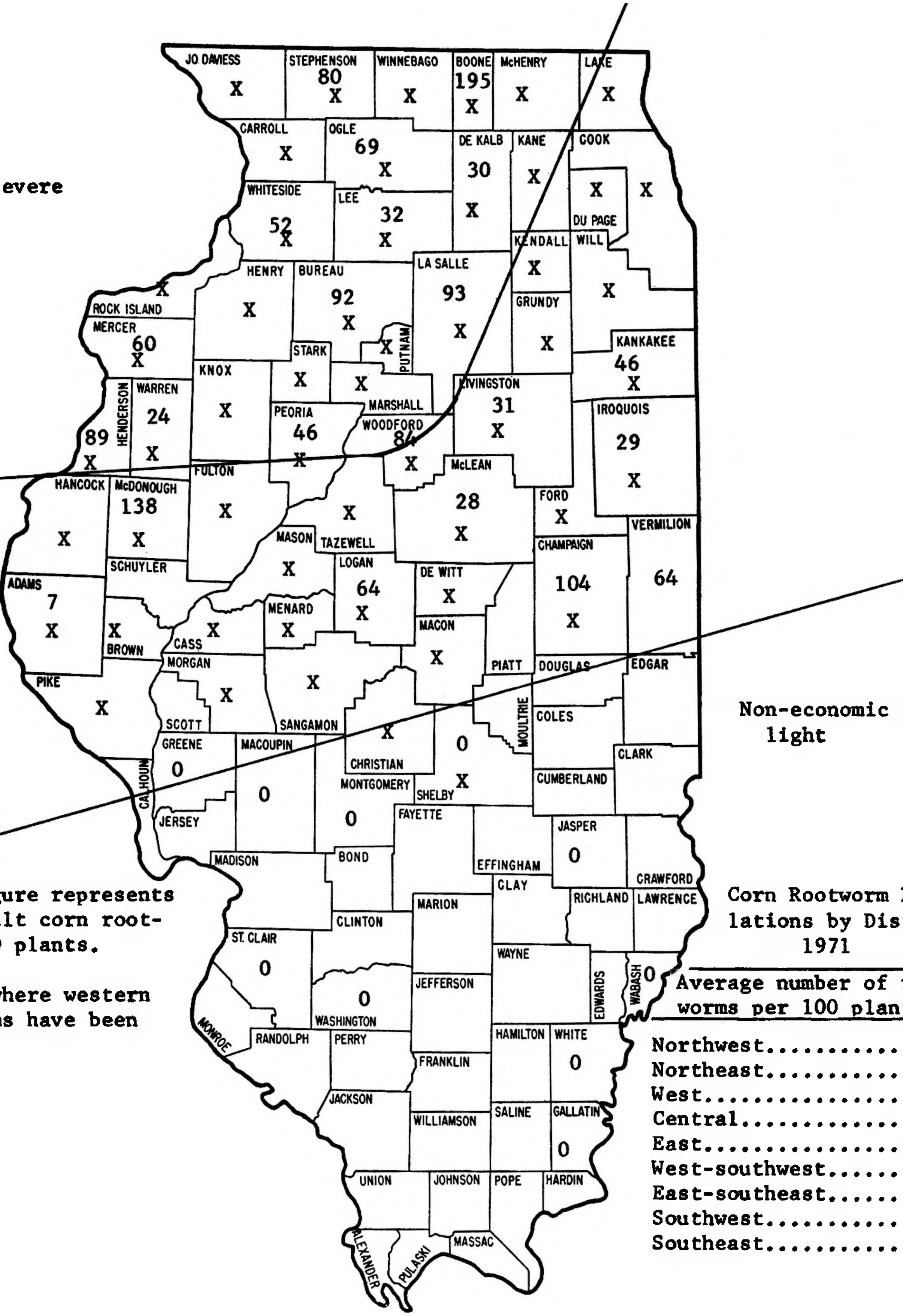
Aphids. Three species of aphids were present on grain sorghum this year. *Corn leaf aphids* were extremely abundant in the whorls of many fields of grain sorghum. It is not known how much, if any, damage they caused. In most fields the aphids disappeared as the heads began to emerge from the root. An abundance of lady beetles and other predators also kept corn leaf aphid populations in check. *Greenbugs* were present in a few sorghum fields in southern Illinois but numbers were light; this aphid feeds on the undersides of sorghum leaves, whereas the corn leaf aphid feeds in the plant whorl. *Potato aphids* were observed feeding on lower leaves but populations were light.

Sorghum webworms. These are very destructive pests at times, particularly on late-planted sorghum. The insect overwinters in the fully grown larval stage. Johnsongrass is an important host plant. Populations were light in most sorghum fields in 1971. The caterpillar causing the damage is about 1/2 inch long when fully grown, somewhat flattened, and covered with spines and hair. The body is greenish with four, reddish-brown longitudinal stripes. Ripening kernels are eaten out, leaving only a shell. Small larvae feed inside the grain and larger worms feed externally. Early planting is helpful as a control measure. Little damage is done because webworm populations are low when the sorghum is heading.

Outbreaks are most likely to occur when large acreages of sorghum do not mature and are left standing in the field, thus providing a suitable host for late generations and favorable winter hibernating quarters.

Sorghum midges. Damage to a few fields of sorghum by midges was observed in southern Illinois, but the overall incidence of midge damage was fairly low. Injury is caused by tiny maggots feeding inside the seed. In severe infestations, the heads appear blasted or blighted and produce little or no grain. The greatest incidence of midge damage occurred in the southern two tiers of counties, with late plantings having the highest infestations. The adult midge is an orange-colored gnat about 1/12 inch long. The flies deposit their eggs in the spikelet or seed husk of the plant shortly after the heads emerge. Sorghum heads are most susceptible to midge egg-laying from one day before bloom to four days after the first bloom appears. Early plantings are less subject to midge damage and are usually the most practical means of control.

Fall armyworms. An estimated 21,485 acres of field corn were treated in 1971. Many late-maturing fields of sorghum and corn in southern sections were damaged by these dark-brown to dull-green, smooth-skinned worms feeding in the whorl. Early planting is the best means to avoid damage since the moths select late-planted fields in which to deposit their eggs.



Moderate to severe

Light to moderate

Non-economic to light

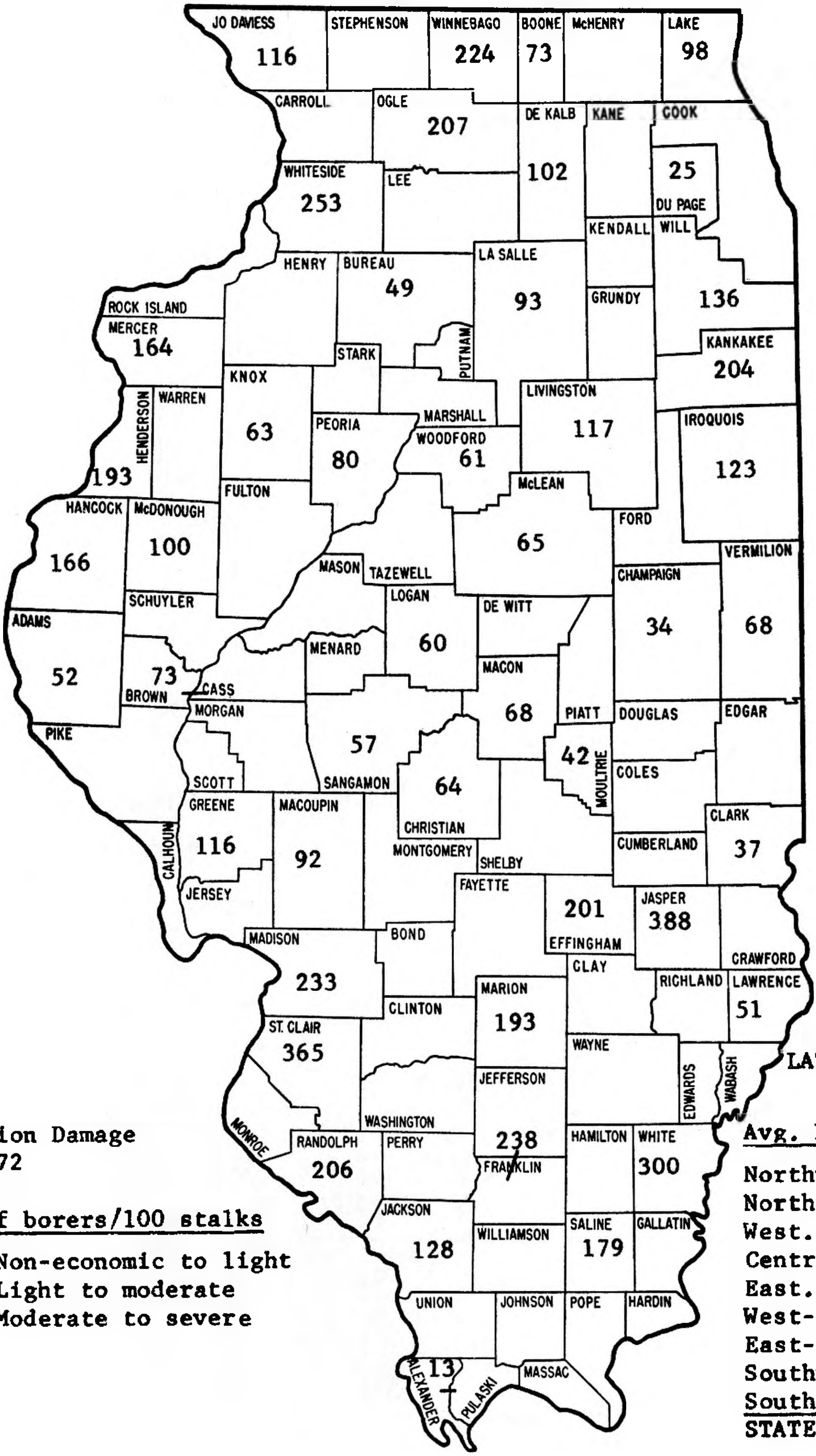
Numerical Figure represents number of adult corn rootworms per 100 plants.

X Counties where western corn rootworms have been found.

Corn Rootworm Populations by District, 1971

Average number of rootworms per 100 plants	
Northwest...........	64
Northeast...........	106
West................	64
Central.............	55
East................	55
West-southwest......	0
East-southeast......	0
Southwest...........	0
Southeast...........	0

Figure 1. Western and Northern Corn Rootworms Prospects for 1972.



CORN BORER POPULATIONS BY DISTRICT, FALL, 1971

Avg. No. borers/100 stalks	
Northwest.........	169
Northeast..........	89
West..............	108
Central............	67
East..............	109
West-southwest....	112
East-southeast....	135
Southwest.........	178
Southeast.........	239
STATE	128

irst-generation Damage
otential, 1972

vg. number of borers/100 stalks

-100........Non-economic to light
00-250.....Light to moderate
50 and over.Moderate to severe

Figure 2. European Corn Borer Prospects, 1972.

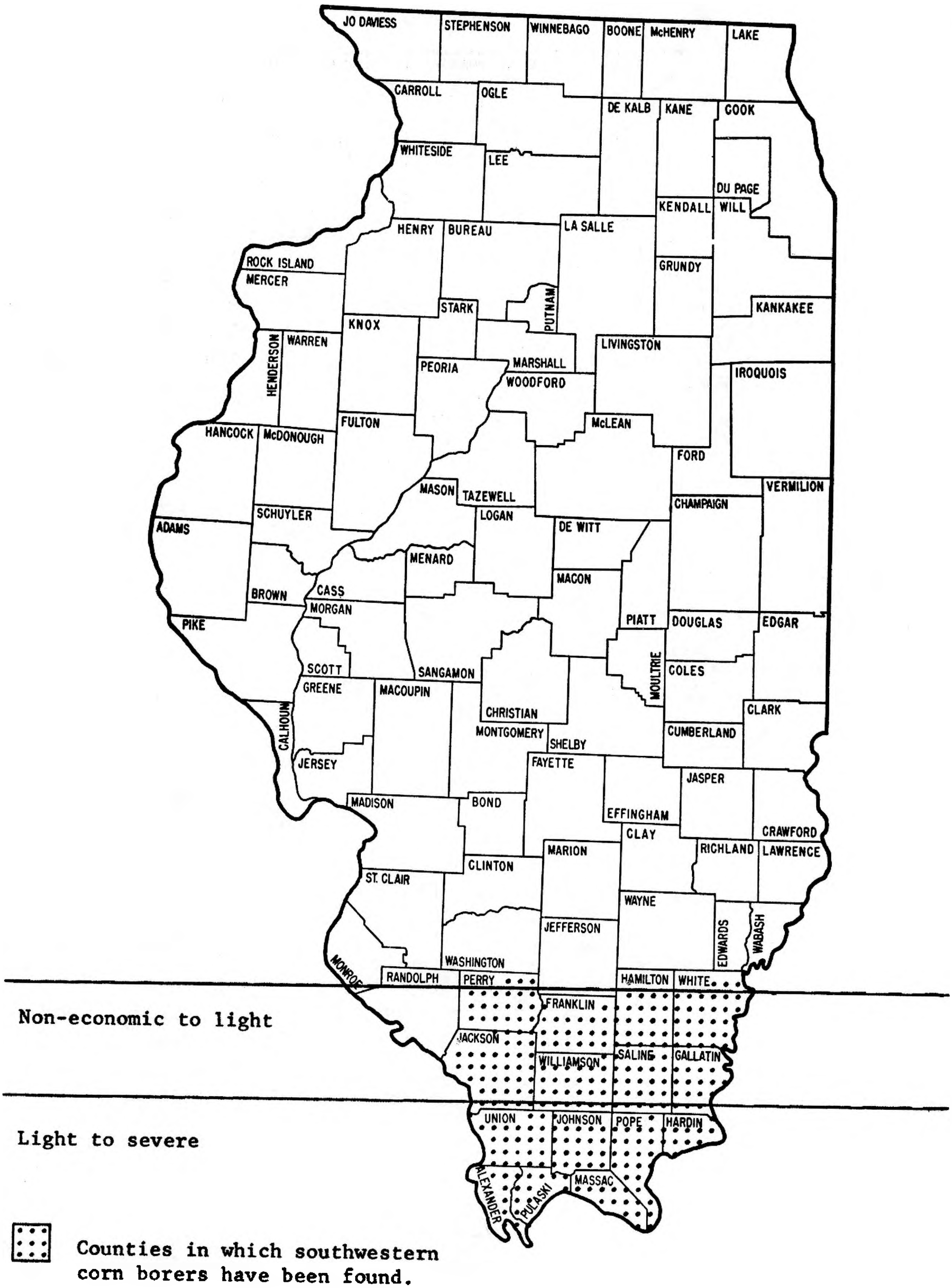
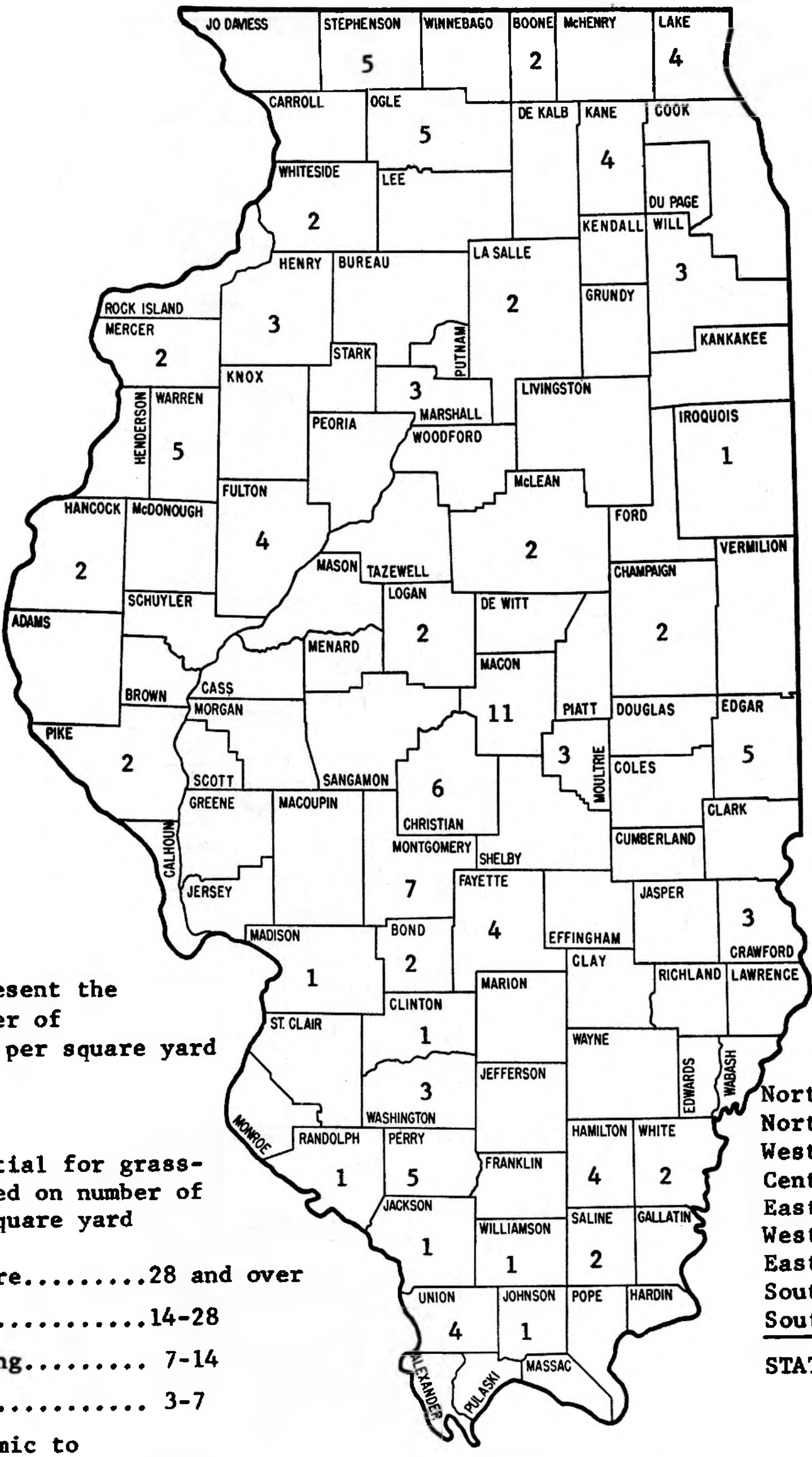


Figure 3. Southwestern Corn Borer Prospects for 1972.



igures represent the
verage number of
rasshoppers per square yard

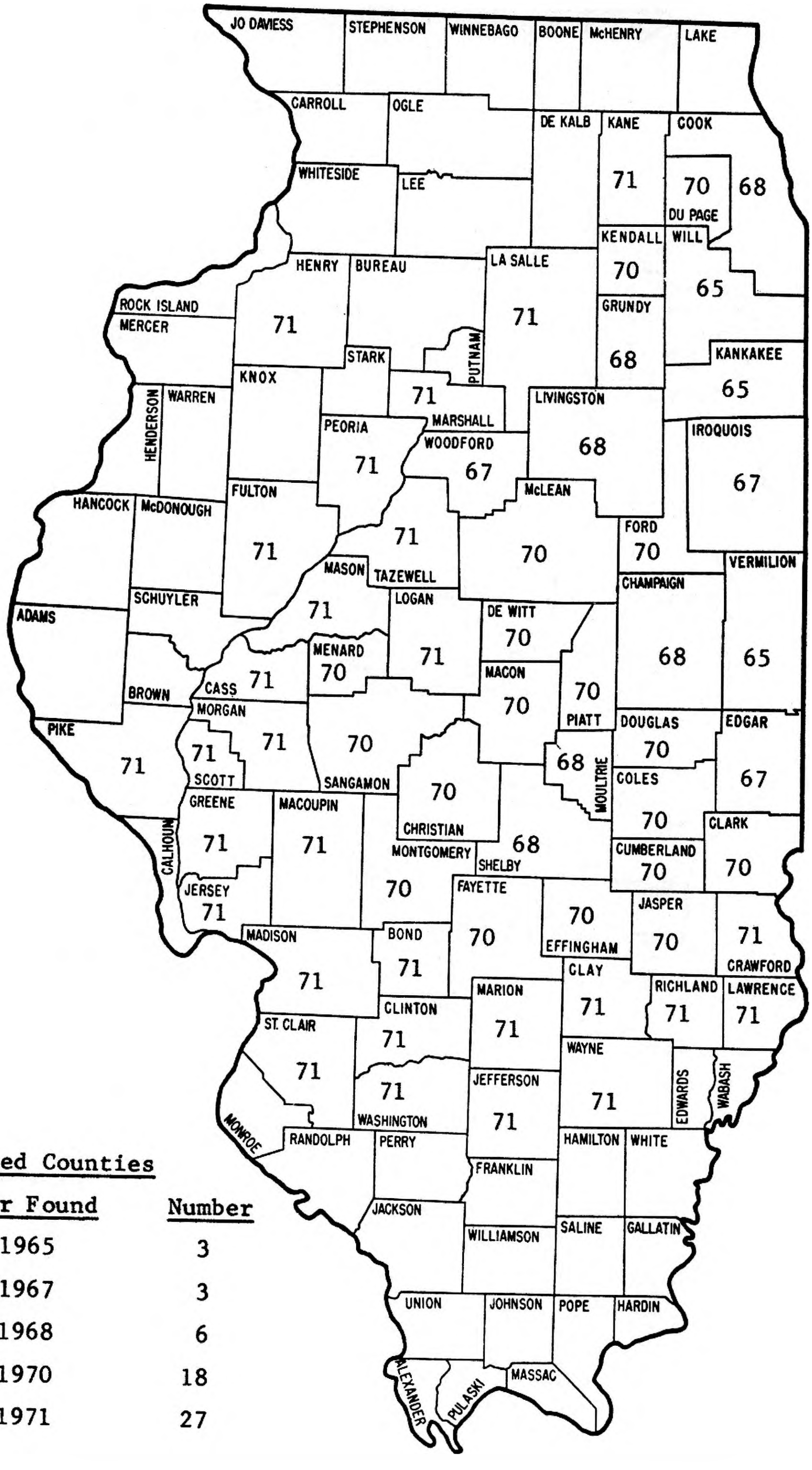
amage potential for grass-
oppers, based on number of
dults per square yard

Very severe.........28 and over
Severe..............14-28
Threatening......... 7-14
Light............... 3-7
Non-economic to
light............. 0-3

GRASSHOPPER POPULATIONS BY DISTRICT, 1971

Northwest..........	3.4
Northeast..........	2.9
West	3.8
Central............	4.4
East...............	1.5
West-southwest.....	3.5
East-southeast.....	3.9
Southwest..........	2.1
Southeast..........	2.8
STATE	3.5

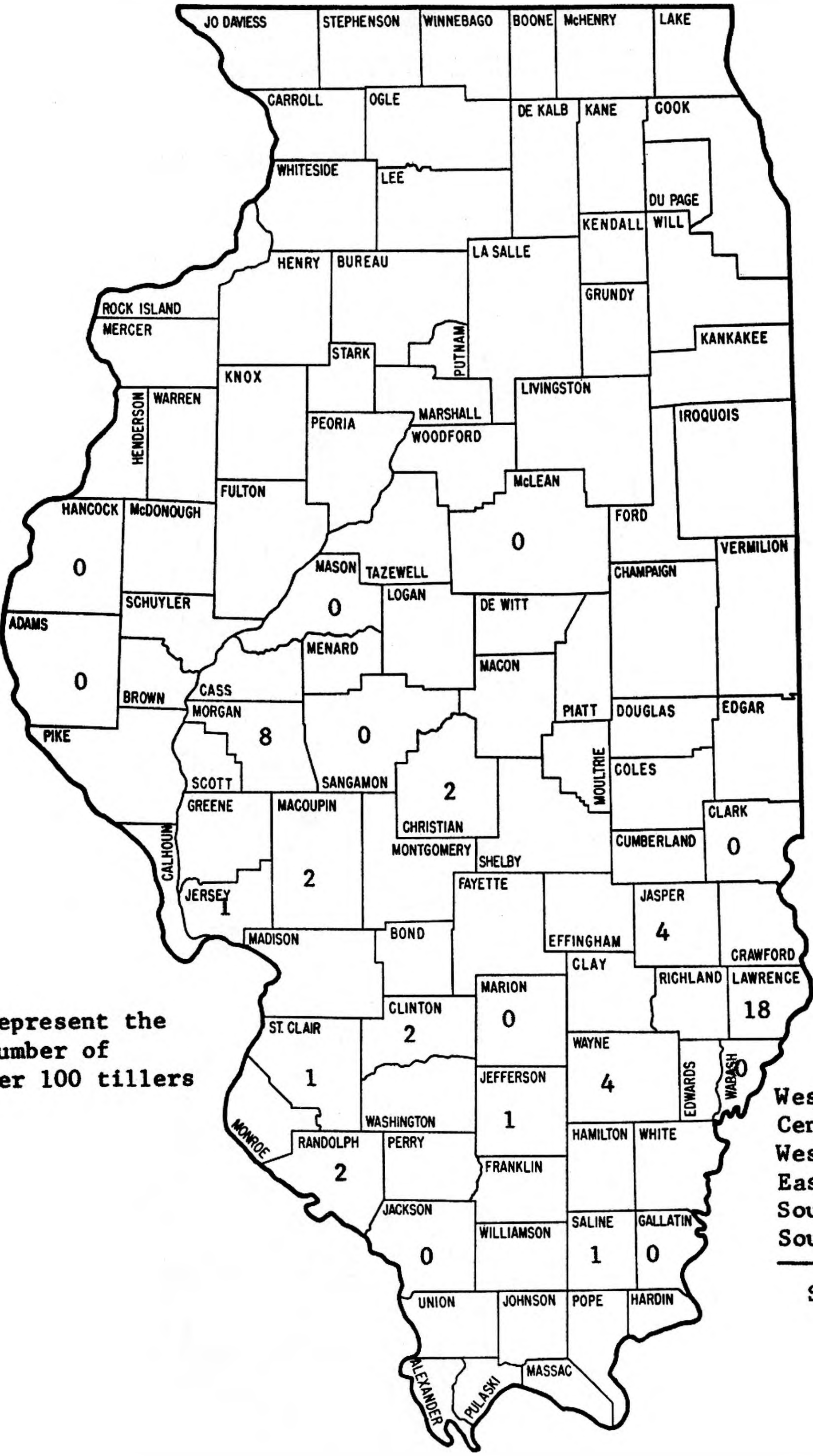
Figure 4. Grasshoppers Prospects for 1972.



Infested Counties

Year Found	Number
1965	3
1967	3
1968	6
1970	18
1971	27

Figure 5. Cereal Leaf Beetle Distribution, 1971.



Figures represent the average number of puparia per 100 tillers

HESSIAN FLY POPULATIONS BY DISTRICT, 1971

West	0
Central	0
West-southwest	2
East-southeast	6
Southwest	1
Southeast	1
STATE	2

Figure 6. Hessian Fly Population, Summer, 1971.

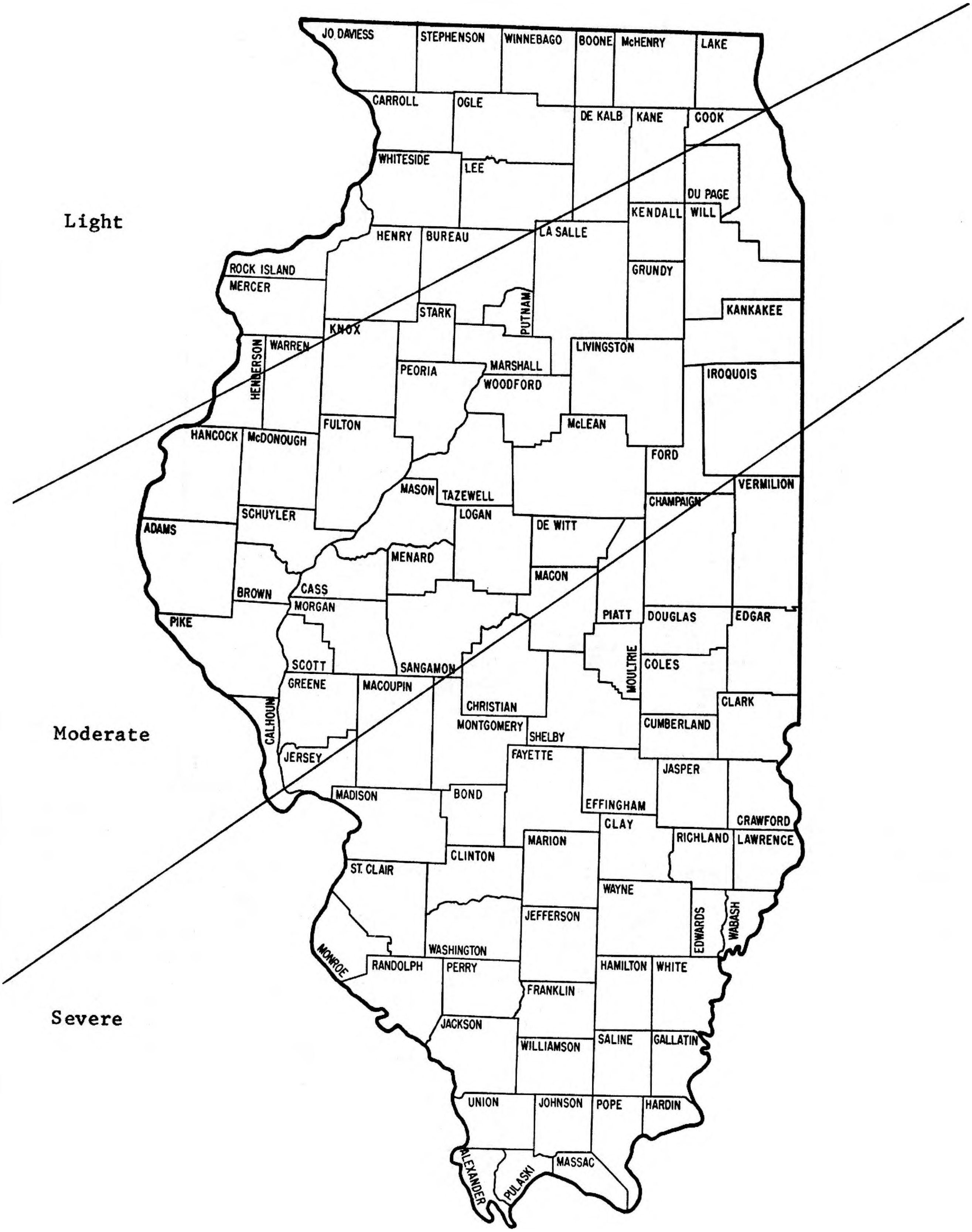
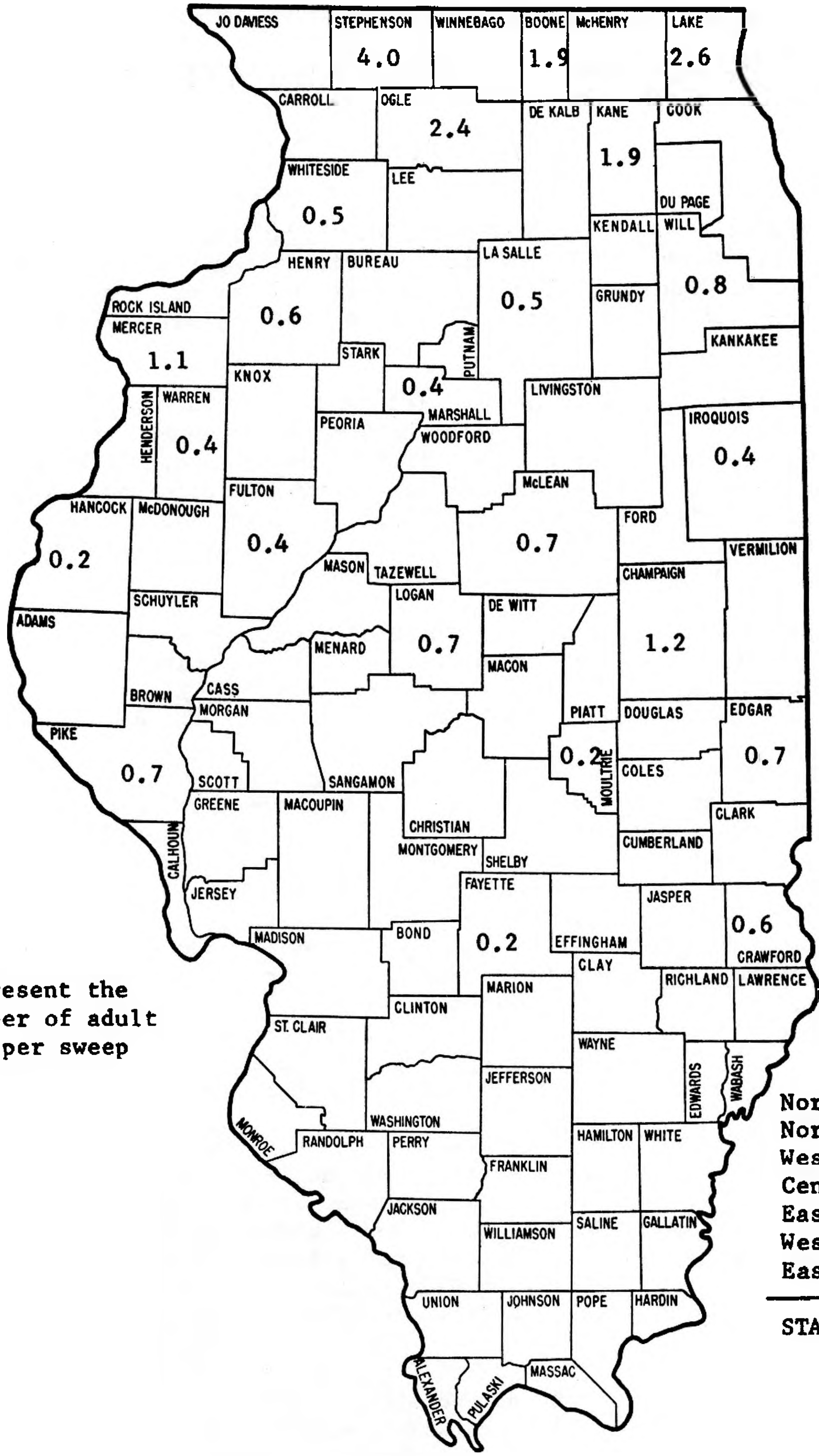


Figure 7. Alfalfa Weevil Prospects, 1972.



gures represent the
verage number of adult
pittlebugs per sweep

SPITTLEBUG POPULATION BY DISTRICTS, 1971

Northwest	1.7
Northeast	1.5
West..............	0.3
Central...........	0.6
East..............	0.8
West-southwest....	0.7
East-southeast....	0.4
STATE	1.0

Figure 8. Meadow Spittlebug Prospects, 1972.

CROP AND WEED DESICCATION

R. J. Fink

An interesting and relatively recent agricultural practice is the use of chemical harvesting aids for preharvest drying and for defoliating standing crops and weeds. Earlier harvesting of crops may reduce preharvest and harvest losses that result from stalk breakage, ear or head drop, shattering, birds, hail, wind, and other causes.

Preharvest chemicals are applied for defoliation or desiccation. A defoliant causes the early formation of an abscission layer between the stem and the leaf; a desiccant is essentially a contact herbicide. Both types of materials have value in certain cases but must be applied with precise timing in order not to kill the plant before physiological maturity. Under the limited growing season of the north-central states, these chemicals have had limited success, but they are of considerable value in the southern and western states, especially on cotton.

Legume seed crops are well suited for preharvest treatment with desiccants. Small-seeded legumes are commonly mowed, windrowed, and then combined using a pick-up attachment. Varying amounts of seed are lost in this way. Chemical curing and direct harvest of such fields can reduce losses under many circumstances.

Chemical drying of grain sorghum might offer an advantage when certain weeds and sorghum sucker growth are a problem. This would reduce the amount of high-moisture material going through the combine that might further increase moisture content of the grain. Over the past few years, sodium chlorate has been used on grain sorghum as a drying agent to speed harvest. A tolerance for use of sodium chlorate is necessary before it can maintain registration, and apparently manufacturers have decided that the establishment of a tolerance will not be economical. In view of this, the Environmental Protection Agency recently discontinued the registration of sodium chlorate as a drying agent on grain sorghum and rice. Nitrogen solution at a rate of 60 pounds per acre also gives a desirable drying effect. Liquid nitrogen, however, as a drying agent on grain sorghum, does not appear as a registered practice in the EPA "Summary of Agricultural Pesticide Chemical Uses."

Chemical drying may be profitable for weedy soybeans. Desiccants should not be used to hasten maturity because of the adverse effect on seed, size, and yield. Recent work conducted by Caviness and Johnson in Arkansas determined the effect of paraquat applied to soybeans at maturity, 7 days, 17 days, and 25 days before maturity. Yield, seed size, and oil and protein content were not affected by application of paraquat at maturity or 7 days before maturity. Significant reductions in yield, oil content of seeds, seed quality, and seed size occurred when application was at 17 or 25 days before maturity.

The only pesticide fully registered as a desiccant on soybeans is paraquat (1,1'--dimethyl--4,4'--bipyridinium salt) which was federally cleared and registered for use as a "soybean harvest aid" in 1970. The label clearance referred to use of paraquat for desiccating weeds at normal soybean maturity to facilitate combine harvest. The label states as follows: "SOYBEAN HARVEST AID--Apply 1/2 to 1 pt. per acre on Broadleaf Weeds and Grasses. Use high rate on Cocklebur. Add 1 qt. non-ionic surfactant per 100 gals. spray. AERIAL APPLICATION--2 to 5 gals. spray per acre. GROUND APPLICATION--20 to 40 gals. spray per acre. Apply when soybean plants are mature, i.e., beans are fully developed, at least 1/2 of leaves have dropped, and leaves left on plants are turning yellow. Immature soybeans will be injured. Do not pasture livestock within 15 days of treatment. Remove livestock from treated fields at least 30 days before slaughter."

The advantages to the use of a desiccant on weedy soybean fields are mainly a more efficient harvest with less yield loss. In 1970 a study was conducted on the Western Illinois University Farm with the following data being taken after treatment:

	Paraquat per acre	
	None	*1/4 lb.*
Yield, bushels per acre	28	28
Percent inert matter	5.2	2.9
Soybean moisture, percent	11.9	11.1
Harvest loss, bushels per acre	3	2
Time to harvest 300 ft. by 10 ft., minutes	7.2	4.5

Most effective desiccation occurred on broadleaf weeds such as pigweeds *(Amaranthus spp.)* jimsonweed *(Datura stramonium)*, and smartweeds *(Polygonum spp.)*. Annual weed grasses such as foxtails *(Setaria spp.)* were readily desiccated, but due to the high stem to leaf ratio, little improvement in harvest efficiency was realized where grasses were dominant.

In determining whether the use of a desiccant will be profitable, the grower must compare the advantages of harvesting early and the advantages of waiting for a killing frost. In some cases, such as when a grower may want to follow soybeans with wheat, the use of a desiccant may be practical. Soybeans would have to be mature two to three weeks before a killing frost to benefit from a desiccant. If a frost is due soon, it might be wise to wait rather than make a chemical investment of $1.75 to $3.50 per acre. It is evident that growers should not use a desiccant to hasten maturity of soybeans.

WEED CONTROL IN SOYBEANS

Marshal McGlamery

It is extremely important that soybeans have good weed control during the first three to five weeks. Soybeans usually compete well with the weeds that begin growth later. Weeds reduce yield, quality, and harvesting efficiency and increase production costs.

The most common annual weeds in soybeans are foxtails, pigweeds, smartweeds, and velvetleaf. Other annual weeds that are problems in soybeans are cockleburs, jimsonweeds, and ragweeds. Perennial weeds sometimes found in soybean fields are yellow nutsedge, johnsongrass, quackgrass, and milkweed. Most perennial weeds are difficult to control in soybeans. However, there are herbicides for control of nutsedge and johnsongrass seedlings in soybeans.

Soybean weed control should be an integrated program of cultural, mechanical, and chemical control. Cultural control practices involving optimum row spacing, plant population, and planting date are very helpful in aiding the soybeans to better compete with the crop. The rotation of crops and herbicides is often helpful to prevent certain weed species from becoming dominant. Many broadleaved weeds are easier to control in corn than in soybeans, while some monocots such as nutsedge and johnsongrass seedlings are easier to control in soybeans.

Mechanical weed control with rotary hoes and row cultivators is still very popular. Good mechanical weed control can greatly improve the weed control when herbicide performance has been imperfect. Use the rotary hoe after weed seeds have germinated but before the weeds have emerged. The rotary hoe should be weighted enough to penetrate and should be operated at a speed of 8 to 12 miles per hour for maximum weed control. Row cultivators should be properly adjusted to avoid excessive ridging yet to move adequate soil into the row to smother small weeds.

Preemergence herbicides are used on about 75 percent of the soybeans in Illinois. Preemergence herbicide selection should be based on the weed species likely to be present, the soil type, the equipment available, and the management system.

PREPLANT HERBICIDES

Treflan (trifluralin) incorporated into the soil before planting controls annual grasses, pigweed, and lambsquarters. It also controls wild cane and johnsongrass seedlings. Treflan can be applied up to 10 weeks before planting. It needs incorporation after application. *Planavin* (nitralin) controls the same weeds as Treflan, but it is not suited to soils of over 3 percent organic matter.

Vernam (vernolate) controls annual grasses and pigweed as well as nutsedge when incorporated into the soil. Vernam sometimes injures soybeans, but this early injury seldom reduces yield. Granular formulations of Vernam are sometimes applied preemergence, but have been quite variable in their weed control.

PREEMERGENCE HERBICIDES

Amiben (chloramben) is one of the most popular herbicides for soybean weed control, because it controls some of the broadleaf weeds that many other herbicides miss. It is ineffective on morningglory and seldom controls jimsonweed and cockleburs. Soybeans are sometimes injured by Amiben, but damage is not usually very severe.

Lasso (alachlor) usually controls annual grasses and pigweed. It also provides some control of yellow nutsedge, especially when applied preplant incorporated.

Lorox (linuron) controls many annual grass and broadleaf weeds. The margin of selectivity between dependable weed control and crop damage is rather narrow. Careful rate selection based on the soil and accurate, uniform application will help reduce the possibility of injury. It is best adapted to medium-textured soils of less than 3 percent organic matter, such as occur in southern Illinois.

Preforan (fluorodiphen) controls annual grasses plus pigweed and smartweed. In 1971 the granular formulation did not perform nearly as well as the liquid formulation.

PREEMERGENCE HERBICIDE MIXTURES

Lasso plus Lorox (alachlor plus linuron) has provided good weed control on soils of medium texture with less than 3 percent organic matter. Lasso improves grass control and crop tolerance, while Lorox improves the broadleaf weed control. Select rates accurately for the soil to maximize weed control and crop tolerance.

Chloro-IPC plus Lasso (chlorpropham plus alachlor) can be tank-mixed to improve the smartweed control of Lasso.

Solo (naptalam plus chlorpropham) sometimes gives satisfactory weed control, but has often been quite erratic. Soybean injury sometimes occurs.

Shamrox (DCPA plus linuron) is a mixture of Dacthal and Lorox for use on soils of 1 to 3 percent organic matter. Weed control with it has been erratic on soils of higher organic matter.

Amilon (chloramben plus linuron) and *Noraben* (norea plus chloramben) are mixtures of herbicides best suited to soils of 1 to 3 percent organic matter. Amiben (chloramben) alone has performed as well or better on soils of higher organic matter.

Dyanap (naptalam plus dinoseb) is a packaged mixture of "dinitro" plus Alanap and can be applied preemergence or up to early postemergence. The latter application needs to be applied before the first true leaves of the soybeans open to expose the terminal bud.

Premerge plus Lasso (dinoseb plus alachlor) and *Premerge plus Amiben* (dinoseb plus chloramben) tank mixes are cleared for preemergence and early postemergence applications. Rates of the "dinitro" must be adjusted to temperatures for the postemergence use. The early postemergence application must be applied before the first true leaves of the soybeans open to expose the terminal bud.

Treflan plus Lorox (trifluralin plus linuron) and *Treflan plus Chloro-IPC* (chlorpropham) are cleared for use as split or sequential treatments at preplant and preemergence applications. Some farmers also use a sequential treatment of *Treflan plus Amiben*, but it is not officially cleared.

Ramrod (propachlor) and *Londax* (propachlor plus linuron) are cleared only for seed beans to be used for planting and not for soybeans to be used for food, feed, or oil purposes.

POSTEMERGENCE HERBICIDES

Tenoran (chloroxuron) can be used to control some broadleaf weeds at an early post-emergence stage. Weeds must be less than 2 inches tall. Annual grasses must be controlled with a preplant or preemergence herbicide. The use of a surfactant (Adjuvan-T) or nonphytotoxic oil improves the control. Soybeans need to have the first trifoliolate leaves to minimize soybean injury. Control with Tenoran has been somewhat erratic, and soybeans usually show some injury, but this injury does not usually reduce yield.

Butoxone SB and *Butyrac 175* (2,4-DB) can be used for emergency cocklebur control. It can be applied as a directed spray when soybeans are at least 8 inches tall and cockleburs are 3 inches tall, if this height difference occurs. It can be broadcast from 10 days prior to bloom to midbloom. More soybean injury is to be expected from the topical application.

Choose a weed control program which fits the soil, weed problem, management system, and available equipment. If preemergence herbicides fail to control early weeds because of lack of rainfall, do not wait to rotary-hoe the soybeans. The rotary-hoeing will help keep small weeds in check and will not affect the herbicide.

ROOTWORM CONTROL DEMONSTRATIONS: A FOUR-YEAR SUMMARY

H. B. Petty, D. E. Kuhlman

This report is a summary of corn rootworm control for 1971 as well as for the period 1968-1971.

1971 DEMONSTRATIONS

Seven field tests were conducted during 1971 in cooperation with the county Extension advisers and cooperators listed below. Our sincere appreciation is extended to these people for their cooperation in conducting these demonstration plots.

County	Cooperator	Extension adviser
Boone	Clyde Curtis, Calendonia	Wallace Reynolds, Belvidere
Bureau	Robert Gutschall, Wyanet	John Ellis, Princeton
Carroll	Evan Queckboerner, Chadwick	Harold Brinkmeier, Mt. Carroll
Henderson	George "Jack" Brokaw, Biggsville	Curt Eisenmayer, Stronghurst
McHenry	Robert Stoxen, Harvard	Louis Engelbrecht, Woodstock
Ogle	Craig Brattrud, Baileyville	Stan Eden, Ogle
Woodford	Eugene Hangartner, Roanoke	W.M. Sager, Eureka

Methods

The insecticides used in these tests were aldrin 20G; chlordane as Belt-Plus 33-1/3G; Bux; Dasanit 15G; diazinon 14G; Dyfonate 20G; prophos as Mocap 10G; phorate as Thimet 15G; and carbofuran as Furadan 10G. All treatments were applied in a 7-inch band ahead of the press wheel except for aldrin which was applied in the furrow. Plots were 8 to 12 rows in width. Stand counts were made on 1/40th of an acre for each treatment. Treatments were evaluated by taking larval counts, root ratings, pounds of pull, and yield data. Larvae per plant were counted with a minimum of 5 samples per treatment; root ratings were made on 10 plants per plot, using a scale of 1 = no damage and 5 = severe damage; and pounds of pull necessary to remove a plant from the soil was measured with a recording dynamometer. Yield records were obtained by mechanical harvesting, with the exception of one field.

Results

Satisfactory corn rootworm control was obtained with Bux, carbofuran, Dasanit, Dyfonate, phorate, and prophos in 1971. Aldrin and Belt-Plus gave no control. With larval control as the criterion, diazinon was less effective than the other organic phosphates and carbamates; carbofuran at 3/4 pound per acre gave the highest control of all materials evaluated, 77.7 percent. Carbofuran was also the best where root ratings, pounds of pull, and yield were used for evaluation (Table 1).

Table 1. Summary of Results From Seven Corn Rootworm Control Demonstrations in 1971

Treatment	Lb. per acre	Larvae per plant	Pct. control	Root rating	Lb. pull	Pct. yield savings
carbofuran (Furadan)	.8	6.5	77.7	1.7	265	11.4
	1.0	6.7	76.9	1.8	263	13.4
Bux	1.0	10.0	65.7	2.2	235	7.9
phorate (Thimet)	1.0	11.0	62.2	2.0	245	10.4
Dyfonate	1.0	14.8	49.1	2.0	245	9.8
Dasanit	1.0	14.7	49.5	2.1	228	11.2
prophos (Mocap)[a/]	1.0	15.4	47.1	2.1	239	9.4
diazinon	1.5	18.5	36.4	2.5	226	7.0
chlordane (Belt-Plus)	2.0	30.5	0	3.4	160	3.7
Aldrin[a/]	1.0	31.6	0	3.1	181	0
Untreated	...	29.1	...	3.3	170	...

a/ Six fields.

Carbofuran gave an 11.4 percent yield savings over the untreated test at 0.75 pound per acre and 13.4 percent savings at 1.0 pound.

Larvae in untreated plots averaged 109.2 per plant in Boone County, 21.7 in Bureau; 5.8 in Henderson; 10.5 in Woodford; 7.3 in Carroll; 31.5 in McHenry; and 18.6 in Ogle. The Boone County field infestation was very severe, and the infestations in the other counties were considered moderate to severe. Severe lodging was noted in all fields except the Woodford County plot.

ROOTWORM CONTROL DEMONSTRATIONS, 1968-1971

There are no new insecticides ready for the rootworm market in the next few years. We are therefore summarizing four years of demonstrations with the thought that our extensive series of demonstrations will be greatly reduced.

Methods

All materials were applied with farm equipment at planting as a 7-inch band ahead of the press wheel. A.C., Free-Flo, Gandy, International, John Deere, and Noble applicators were used. All equipment was calibrated prior to planting, usually all materials were weighed in and out, and the amounts applied per acre were calculated. Rates were based on 40-inch rows and adjusted for various row spacings.

Farmers, dealers, salesmen, and other interested people counted worms per plant, rated roots for damage, and helped pull the plants. With a few exceptions the plots were machine-harvested as they averaged from 4 to 16 rows in width for the field length. Treatments were not replicated within fields, and fields were regarded as replicates. Insecticides were all to be applied at 1.0 pound per acre, but the rate varied by as much as 20 percent. In 1970 and 1971 we attempted to decrease the rate of carbofuran to 3/4 pound per acre and increase diazinon to

1 to 1-1/2 pounds per acre. Aldrin, heptachlor, and chlordane results are averaged and listed as chlorinated hydrocarbons. Aldrin and heptachlor were applied at 1.0 pound per acre and chlordane at 2.0. They were usually applied in the planter shoe but sometimes as a 7-inch band in the soil surface (control was unsatisfactory either way).

Results

There was little effect on plant population per acre (Table 2). Rootworm populations expressed as larvae per plant did show differences, with carbofuran most effective. Root ratings, pounds of pull, and yields gave a similar indication.

When we convert field results to percent of effectiveness (Table 3), we find the same trends; carbofuran is rated as number 1 for rootworms, Bux, phorate, Dyfonate, and Dasanit are next in order. Prophos to be sold as Mocap and Jolt is next in line.

We recommend prophos this year because of its performance in 1971. In past years our use of this material in demonstrations has been erratic, and in many cases it was not put in plots for various reasons, mainly supply. In some cases application rates were very low. In 1971, it was applied in a manner comparable with other materials.

Diazinon, a potential rootworm control insecticide, has given very erratic results in Illinois. In some fields it was very satisfactory, while in other fields it resembled the untreated. For this reason we have not recommended it even though the average results are not too inferior. With the advent of resistance, all chlorinated hydrocarbons have had little value.

Complete records for all insecticides were taken for only 11 fields (Table 4). Results are similar to those in Table 1.

Conclusions

Based on field results, we have recommended 1.0 pound of carbofuran per acre in fields where very severe rootworm infestations are expected (see the *1972 Suggested Insecticide Guides, Insect Control on Field Crops*, later in this book). If infestations are expected to be light to severe, then 3/4 pound of carbofuran or 1.0 pound of Bux, Dasanit, Dyfonate, phorate, or prophos per acre will provide good root protection. For cautions in use of these materials, see the *1972 Suggested Insecticide Guides*.

Table 2. Summary of Results From 23 Corn Rootworm Control Demonstrations With Five or More Rootworms per Plant, 1968-1971

Treatment	Lb. per acre	No. of fields	Plants per acre	Larvae per plant	Root rating	Lb. pull	Bu. per acre
Untreated	...	23	21,559 ab	18.2 a	3.7[1/] a	169[2/] a	111.8 a
carbofuran	.75-1.1	23	21,630 ab	2.8 d	1.8 c	276 b	125.6 b
Bux	.8-1.2	23	21,116 b	5.5 c	2.3 b	251 b	120.5 b
phorate	.7-1.1	23	21,752 ab	5.4 bc	2.5 b	235 b	121.7 b
Dyfonate	.8-1.2	23	21,497 ab	7.4 bc	2.4 b	246 b	122.7 b
Dasanit	.7-1.1	23	22,031 a	7.3 bc	2.4 b	231 b	122.6 b
Untreated	...	20	21,463 a	19.4 a	3.8[3/] a	167[4/] a	112.3 a
diazinon	.8-1.5	20	21,952 a	11.2 ab	2.9 b	205 a	120.3 b
Untreated	...	13	21,334 a	23.4 a	3.8 a	175[5/] a	115.8 a
prophos	.6-1.1	13	21,392 ab	11.0 b	2.8 b	229 b	123.5 b
Untreated	...	20	21,580 a	19.1 a	3.6[6/] a	169[2/] a	111.8 a
Chlorinated hydrocarbons	.9-1.2	20	21,336 a	18.7 a	3.7 a	182 a	110.2 a

1/ Nineteen fields only in this group.
2/ Twelve fields only in this group.
3/ Seventeen fields only in this group.
4/ Ten fields only in this group.
5/ Seven fields only in this group.
6/ Sixteen fields only in this group.

Averages followed by the same letter are not significantly different.

Table 3. Comparison of Results From Corn Rootworm Control Demonstration Fields With Five or More Rootworms per Plant, 1968-1971

Treatment	Plants per acre over untreated	Pct. control	Pct. reduction in root damage	Pct. increase in lb. pull	Pct. savings in yield
carbofuran	71	84.6	70.4	63.3	12.3
Bux	-514	69.8	51.9	48.5	7.8
phorate	193	70.3	44.4	39.1	8.9
Dyfonate	-62	59.3	48.2	45.6	9.7
Dasanit	472	59.9	48.2	36.7	9.7
diazinon	489	42.3	32.1	22.8	7.1
prophos	58	52.9	35.7	30.9	6.6
Chlorinated hydrocarbons	-244	2.1	-3.8	7.7	-1.4

Table 4. Summary of Results From 11 Corn Rootworm Control Demonstrations With Five or More Rootworms per Plant, 1968-1971

Treatment	Plants per acre	Larvae per plant	Root rating	Lb. pull (7 fields only)	Bu. per acre
None	21,084a	25.6ab	3.6a	175a	115.1a
carbofuran	21,260a	4.5e	1.6d	271c	132.2b
Bux	21,295a	8.7d	2.2c	242bc	126.9b
phorate	21,895a	8.3d	2.4c	240bc	128.0b
Dasanit	21,597a	11.3d	2.3c	226abc	129.7b
Dyfonate	21,370a	11.1cd	2.3c	238bc	128.8b
prophos	21,455a	12.4cd	2.6bc	229abc	123.8b
diazinon	21,661a	15.4bc	2.9b	212ab	125.9b
Chlorinated hydrocarbons	21,198a	27.5a	3.7a	170a	113.0a

Averages followed by the same letter are not significantly different.

MIXING HERBICIDES AND LIQUID FERTILIZERS

Marshal McGlamery

There is considerable interest in mixing herbicides and liquid fertilizers. This saves time, labor, and money and reduces the number of trips across the field.

Are mixtures of herbicides and liquid fertilizers legal? Supposedly, if the label does not state how the pesticide can be applied in combination with a liquid fertilizer, such a mixture should not be used.

Are such mixtures practical? Distribution requirements for fertilizers are not as exacting as for herbicides. Some fertilizers should be mixed with the soil (incorporated) while some herbicides do not perform well when incorporated. Compromising one requirement may limit the usefulness and safety of the mixture.

What are some of the problems with tank-mixing? One of the biggest problems is failure of components to remain uniformly dispersed (physical incompatibility). Some of the causes are inadequate agitation, insufficient spray volume, or lack of a stable emulsifier. Wettable powder (WP) and water-dispersible liquid (WDL) formulations require good agitation to keep them dispersed. Mechanical, hydraulic jet, or sparger agitation is better than by-pass agitation.

Some emulsifiable concentrate (EC) formulations may contain emulsifiers that are not stable in salty solutions such as liquid fertilizers. Some manufacturers have special pesticidal formulations (fertilizer grade) for liquid fertilizer application. Other manufacturers specify that you check emulsion stability and, if needed, that you add a compatibility agent, which is a heavy-duty emulsifier. These compatibility agents are usually added at the rate of 1 to 3 pints per 100 gallons of spray volume.

Mixing procedures can make a difference between a satisfactory mix and a "gunky" mess. Always partially fill the tank before adding the pesticide. Wettable powders should be mixed with water to form a slurry before they are added to liquid fertilizers, unless you have an inductor system. Emulsifiable concentrates should be preemulsified in water before they are added to a liquid fertilizer. Wettable powders should be added before emulsifiable concentrates. If there is a compatibility agent to be added, add it before the pesticide.

CHECKING COMPATIBILITY

It is best to check compatibility before mixing tankfuls. First, determine the spray volume to be used per acre. This will depend upon the analysis of the liquid fertilizer and the amount of nutrients desired. Determine the rate of the herbicide to be applied in volume or weight of product. Then convert quarts and pounds of product per acre to amounts per pint of spray. Milliliters (ml) and grams (g) are very useful units when working with small amounts. One pint is 473 milliliters and one pound is 454 grams. Thus 1 pound per 25 gallons = 2.2 grams per pint, and 1 quart per 25 gallons = 4.7 milliliters per pint. If gram scales and pipettes are not available, approximations can be made with measuring spoons. One teaspoon is approximately 5 milliliters of liquid. Wettable powders differ in density, but one level teaspoon of wettable powder is approximately 2 to 3 grams. Thus if 1 quart of EC and 1 pound of WP were to be added to 25 gallons of liquid fertilizer, there would be approximately 1 teaspoon of each component per pint of liquid fertilizer.

TESTING PROCEDURE

1. Calculate spray volume and volume or weight of pesticide per acre. Then convert to amount per pint.

2. Place 1 pint of liquid fertilizer in each of two quart jars, one marked "A" and the other "N."

3. Add 1/3 teaspoon (3 pints per 100 gallons) of compatibility agent to jar "A."

4. Add the proper amount of each pesticide to each jar in the proper sequence.

5. Close the jars and shake or invert to thoroughly mix.

6. Observe the mixtures at once and again after 30 minutes.

Comparing jar "N" with jar "A" will determine the value of adding a compatibility agent. If materials remain suspended in jar "N" or if they are easily resuspended, mixing is a possibility with good agitation. If they separate, precipitate, or form "gunk," check jar "A" to see if a compatibility agent will solve the problem. If so, you may want to repeat the test to determine the optimum amount of compatibility agent.

SOIL INSECT CONTROL DEMONSTRATIONS, 1970-1971

D. E. Kuhlman, H. B. Petty

During 1971 we continued field tests to evaluate the effectiveness of several corn soil insecticides in controlling wireworms and white grubs. County Extension advisers and their cooperators in 26 counties assisted by conducting corn insect control demonstrations. We wish to acknowledge those persons listed below for their wholehearted support, enthusiasm, and work in establishing the plots and conducting the tests.

County	Cooperator	Extension adviser
Adams	Ed "Bud" Niekamp, Camp Point	Ron Dedert, Quincy
Boone	Maxwell Newport, Poplar Grove and K-B Farms, Inc., Belvidere	Wallace Reynolds, Belvidere
Clark	Joe Welsh, Marshall	Charles Orcutt, Marshall, and Larry Casey, Jasper County Extension Adviser, Newton
Coles	Robert C. Hawkins, Oakland	Louis Christen, Charleston
Fayette	Ivan and Willard Strullmeyer Loogootee	Joe Faggetti, Vandalia
Ford	James Malone & Sons, Kempton	James Neuschwander, Melvin
Gallatin	J.E. Logsdon III, Shawneetown	Earl Lutz, Ridgway
Hancock	Roger Wegehenkel, Hamilton	Ray Rendleman, Carthage
Henderson	Frank Yaley, Media Dwain Gipe, Media	Curt Eisenmayer, Stronghurst
Henry	Lowell Bjorling, Altona	Hugh Ross, Cambridge
Kane	James Foley, St. Charles	Phil Farris, St. Charles
Knox	John Robson, Wataga	Don Teel, Galesburg
Livingston	Wilbur Birge, Manville	Paul Wilson, Pontiac
Macon	Charles Stoutenborough, Maroa	Warren Myers, Decatur
Menard	Elmer Behrends, Petersburg	Elmer Rankin, Petersburg
Monroe	Victor Schrader, Waterloo	Arlin Obst, Waterloo
Montgomery	Tom Justison, Butler	Bill Brink, Hillsboro
Morgan	Charles Finch, Jacksonville	George Trull, Jacksonville
Ogle	Leonard Bauman, Polo	Stan Eden, Oregon
Perry	Vernon Caupert, Cutter	Charles R. Howell, Pinckneyville
Pike	Perry Metcalf, Barry	Harry Wright, Jr., Pittsfield
Sangamon	Phil Simpson, Dawson	Denver Corn, Springfield
Tazewell	John Phillips, Green Valley	H. David Myatt, Pekin
Vermilion	Richard Fourez, Ellis	Ken Bolen, Danville
Wayne	Fred Taylor, Geff	Bob Schmerbauch, Fairfield
Will	Earl Meisinger, Lemont	George Young, Joliet

METHODS

Soil insect control demonstrations were conducted in 28 fields of corn throughout Illinois in 1971. In 5 fields the corn followed soybeans, in 17 it followed corn, and in 6 it followed clover or sod. Five of the fields had light to moderate wireworm infestations, and one had a severe white grub infestation. Thirteen fields were planted between April 20 and April 30, and 15 from May 1 to May 17.

The soil insecticides used in the tests were: aldrin 20G; chlordane (Belt 33-1/3G); chlordane (Belt-Plus 33-1/3G); Bux 10G; Dasanit 15G; diazinon 14G; Dyfonate 10G and 20G; carbofuran (Furadan 10G); prophos (Mocap 10G); and phorate (Thimet 15G). Planter-box seed treatments of diazinon 33 percent dust and a 3-way seed treater containing captan 33.5 percent, lindane 16.6 percent, and diazinon 11 percent were included in all the tests. All insecticides were applied at the rate of 1.0 pound active ingredient (a.i.) per acre based on 40-inch row spacing except chlordane and diazinon which were applied at 2.0 and 1.4 pounds a.i. per acre. All insecticides were applied at planting time in a 7-inch band ahead of the press wheel except aldrin which was applied in the furrow behind the planter shoe.

Each insecticide treatment plot was generally 8 to 12 rows wide with 15 to 20 treatments per field. Criteria for evaluating the different insecticide treatments included plant populations, insect counts where applicable, and yields. Wireworm and white grub controls were evaluated by removing sections of soil in the corn row 2 feet long, 8 inches wide, and 6 inches deep at three or more locations for each treatment. The soil was sifted by hand to determine the number of wireworms and grubs present. Yields were taken in 16 fields by picker-sheller or by hand-harvesting 200 to 250 linear feet of row per treatment.

Wireworm populations varied from 1.7 to 9.3 larvae per 10 linear feet of row in fields evaluated in Livingston, Ogle, Kane, Perry, and Tazewell Counties. These infestations were considered as being light to moderate. The wireworm infestation of 9.3 larvae per foot of row in Perry County caused a reduction in plant stand in the untreated plots, whereas little if any reduction occurred in the other fields. Plant populations were taken in all fields during early June shortly after plant emergence was complete. White grub populations in Sangamon County were very high, averaging 21.9 per 10 linear feet of row in the untreated plots.

RESULTS

Wireworm Control

The data indicate that the organic phosphate, carbamate, and chlorinated hydrocarbon insecticides gave relatively poor control of wireworms in 1971. These results are comparable to those obtained in 1970 in similar tests.

Of the organic phosphate insecticides applied in a 7-inch band, phorate (Thimet) and Dyfonate gave some suppression of wireworm populations, whereas Dasanit, diazinon, and prophos (Mocap) were relatively ineffective (Table 1). Phorate gave 43 percent control, and Dyfonate 20G gave 37.8 percent control of wireworms at 1.0 pound a.i. per acre. Using a 10G formulation of Dyfonate at 1.0 pound a.i. per acre, wireworm control was 70.7 percent in five field tests. The superior wireworm control obtained with Dyfonate 10G over Dyfonate 20G cannot be readily explained. The increased wireworm control with Dyfonate 10G may be due to more thorough coverage with the 10 percent granules as contrasted to a lesser amount of material being applied with the 20 percent formulation. However, these results are for only one year, and additional field tests will need to be conducted. When phorate was increased to 1.7 pounds a.i. per acre, wireworm control increased to 70.6 percent. This higher rate does not have label clearance.

Overall wireworm control for 1970 and 1971 was 36.1 percent with phorate in 14 fields and 26.4 percent for Dyfonate 20G in 14 fields. Dasanit, diazinon, and prophos gave 7.7 to 8.1 percent control of wireworms for 1970-1971. In fields more heavily infested with wireworms (averaging over 4 wireworms per 10 linear feet of row), phorate and Dyfonate were the most effective of the organic phosphate insecticides (Table 1).

The chlorinated hydrocarbon insecticides gave varying degrees of wireworm control in 1971. Belt-Plus gave 37.7 percent control of wireworms, and aldrin gave 26.9 percent. In a limited number of field comparisons, Belt gave 82.9 percent control.

The carbamates, Bux and Furadan, were generally the least effective in wireworm control of all insecticides tested (Table 1).

The planter-box insecticide seed treatments, if effective, could provide a low-cost method of preventing wireworm damage. In 1971, the diazinon seed treatment (1.3 ounces of actual diazinon per bushel of seed) gave 48.2 percent control, whereas the 3-way seed treatment (0.33 ounce of actual diazinon and 0.5 ounce of actual lindane) gave no apparent control. Over a two-year period, the diazinon seed treatment has given 26.6 percent control in 15 fields (Table 1).

In summary, Dyfonate, phorate, and the diazinon planter-box seed treatment gave slight suppression of wireworms in 1970 and 1971 field tests. In most fields, large wireworms were not controlled, whereas some control of smaller wireworms was obtained. The degree of control achieved in these tests would probably be unsatisfactory in heavily infested fields.

Plant Populations

The overall differences in plant populations between plots treated with insecticides and the untreated plots were not significant (Table 2). Slight reductions in number of plants per acre, ranging from 0.9 to 1.9 percent occurred in plots treated with Bux, prophos, Dyfonate, diazinon seed treatment and the 3-way seed treatment. The average stand reduction of 1.1 percent with the diazinon seed-treater for the two-year period with a hypothetical plant population of 20,000 per acre would be 220 plants. This reduction had no significant effect on yield (Table 4).

White Grub Control

The control of white grubs with the organic phosphate insecticides, Dasanit, diazinon, Dyfonate, phorate, and prophos, was relatively good (Table 3). Aldrin at 1.3 pounds a.i. gave 74.1 percent control when applied in the furrow with the seed, but no control when applied as a 7-inch band. Furadan gave 44.3 percent control in 8 comparisons.

Yields

Corn yields for various insecticide treatments are given in Table 4. There were no significant differences in yield between treatments. In fields with known wireworm infestations, all insecticide treatments gave slight yield increases over the untreated plots.

In 12 fields without an apparent insect problem, the yield response varied from a 0.8 percent decrease with aldrin and Belt-Plus to a 3.0 percent increase with Furadan. These results indicate that the use of a soil insecticide is not warranted in fields where soil insect problems such as wireworms, grubs, or rootworms are not present. Unfortunately in many instances we are unable to identify those fields where the use of a soil insecticide is economically justified.

European Corn Borer Control

Tests conducted in the summer of 1971 indicate that planting-time treatments of Furadan applied at 1.0 pound a.i. per acre do not give good control of first-generation European corn borers (Tables 5 and 6). At higher, but illegal, rates of 2.0 and 3.0 pounds a.i. per acre, Furadan does suppress corn borer populations. The corn borer populations in these fields were generally light. Measurable differences in control may possibly occur with higher population pressure of corn borers.

DISCUSSION

The wireworm-control data for the chlorinated hydrocarbons (primarily aldrin) in this report vary considerably from those reported by J.H. Bigger, Entomologist Emeritus, Illinois Natural History Survey, in previous editions of the Illinois Custom Spray Operators Training School book. In a 10-year summary for the period 1954-1963, Bigger obtained 77.7 percent control of wireworms; 79.8 percent control of white grubs, and 84.5 percent control of corn rootworms with aldrin. The apparent ineffectiveness of aldrin in controlling wireworms in 1970-1971 field tests may be due to a build-up in resistance to the chlorinated hydrocarbons by this insect. This has not been confirmed in Illinois, but considering the extensive corn acreage treated with aldrin and heptachlor since 1954, it would be highly probable that changes in wireworm susceptibility to these materials have occurred. In the case of corn rootworms, seed-corn beetles, and seed-corn maggots, resistance of these insects to the chlorinated hydrocarbons in Illinois has been confirmed.

Bigger also reported an average savings of 5.8 percent in corn plant populations and a 6.7 percent yield savings per acre where aldrin was used as a soil insecticide during 1954-1963. Again, results of the 1970-1971 field tests indicate little if any savings in plant populations or yield due to the use of aldrin. The data of Bigger are suggestive that the chlorinated hydrocarbons such as aldrin and heptachlor were effective during 1954-1963 in controlling seed-infesting insects such as the seed-corn beetles, seed-corn maggot, and wireworms.

In summary, the current widespread use of chlorinated hydrocarbon soil insecticides in Illinois does not appear to be economically justified. In the northern one-third of Illinois, the use of organic phosphate or carbamate insecticides for corn rootworm control in continuous corn will be necessary in many fields, on the basis of surveys of adult rootworm populations. The probability of a soil insect problem occurring in rotations of corn following soybeans and corn after small grains is much less than with corn after sod or clover. A planter-box seed treatment with diazinon will suffice in most of the above rotations except for rootworm control in continuous corn and white grub and wireworm control in corn after sod.

Table 1. Summary of Wireworm Control, County Demonstration Plots, Illinois, 1970-1971

				Average percent wireworm control a/		
					1970-1971	
Insecticide	Formulation	Placement	Lb. actual per acre	1971 All fields	All fields	Only heavily b/ infested fields
Aldrin	20G	Furrow	1.0	26.9 (5)	37.5 (12)	33.1 (6)
Bux	10G	7" band	1.0	18.5 (5)	c/	10.5 (2)
carbofuran (Furadan)	10G	7" band	1.0	13.3 (5)	0 (15)	0 (8)
chlordane (Belt)	33-1/3G	7" band	2.0	82.9 (2)	45.6 (3)	40.4 (2)
chlordane (Belt-Plus)	33-1/3G	7" band	2.0	37.7 (5)	c/	28.3 (2)
Dasanit	15G	7" band	1.0	12.0 (5)	8.0 (14)	12.6 (7)
diazinon	14G	7" band	1.4	33.0 (5)	7.7 (15)	11.7 (8)
Dyfonate	10G	7" band	1.0	70.7 (5)	c/	70.7 (2)
phorate (Thimet)	15G	7" band	1.0	43.1 (5)	36.1 (14)	39.7 (8)
	15G	7" band	1.7	70.6 (3)	76.5 (4)	...
prophos (Mocap)	10G	7" band	1.0	22.2 (4)	8.1 (7)	9.6 (4)
diazinon seed treater	33% dust	On seed	4 oz./bu.	48.2 (5)	26.6 (15)	18.8 (8)
3-way seed treater	d/	On seed	3 oz./bu.	0 (5)	0 (12)	0 (7)

a/ Number of field comparisons indicated in parenthesis.
b/ Fields where wireworm populations averaged 4 or more per 10 linear feet of row in untreated plots.
c/ Tested only in 1971.
d/ 33.5 percent captan, 11 percent diazinon, 16.6 percent lindane.

Table 2. Summary of Corn Plant Populations Using Various Soil Insecticides, County Demonstration Plots, Illinois, 1970-1971

Insecticide	Lb. actual per acre	Average percent variation from untreated[a/] 1971	1970-1971
Aldrin 20G	1.0	+2.2 (28)	+2.1 (33)
carbofuran (Furadan 10G)	1.0	+1.5 (29)	+1.9 (38)
chlordane (Belt-Plus 33-1/3G)	2.0	+1.1 (29)	...
chlordane (Bux 10G)	1.0	-1.7 (29)	...
Dasanit 15G	1.0	+2.4 (29)	+2.4 (37)
diazinon 14G	1.4	+0.2 (29)	+ .1 (37)
Dyfonate 10G	1.0	-1.1 (18)	...
Dyfonate 20G	1.0	- .2 (28)	- .7 (37)
phorate (Thimet 15G)	1.0	+2.9 (29)	+1.6 (37)
prophos (Mocap 10G)	1.0	-1.4 (24)	- .3 (27)
diazinon seed treater[b/]	4 oz./bu.	-1.9 (22)	-1.1 (41)
3-way seed treater[c/]	3 oz./bu.	- .9 (23)	- .4 (36)

a/ Number of fields in parenthesis.
b/ 33 percent diazinon.
c/ 33.5 percent captan, 11 percent diazinon, 16.6 percent lindane.

Table 3. Summary of White Grub Control, County Demonstration Plots, Illinois, 1970-1971

Insecticide	Lb. actual per acre	Placement	Number of comparisons	Percent control
Aldrin 20G	1.3	furrow	3	74.1
Aldrin 20G	1.2	7" band	3	0
carbofuran (Furadan 10G)	1.2	7" band	8	44.3
chlordane (Belt-Plus 33-1/3G)	3.5	furrow	2	54.3
Dasanit 15G	1.1	7" band	5	75.5
diazinon 14G	1.1	7" band	5	75.4
Dyfonate 20G	1.1	7" band	7	71.3
phorate (Thimet 15G)	1.2	7" band	6	77.5
prophos (Mocap 10G)	1.0	7" band	2	63.3

Table 4. Effect of Soil Insecticides on Corn Yields, County Demonstration Plots, Illinois, 1970-1971

Insecticide	Placement	Lb. actual per acre	Percent difference in yield between treated and untreated[a/]		
			Fields with wireworms infestation	Fields with no apparent insect problem	All fields
Aldrin 20G	Furrow	1.0	+5.9 (7)	.8 (12)	+1.7 (19)
Bux 10G	7" band	1.0	+4.6 (4)[b/]	+1.0 (12)	+1.9 (16)
carbofuran (Furadan 10G)	7" band	1.0	+3.3 (7)	+3.0 (12)	+3.1 (19)
chlordane (Belt Plus 33-1/3G)	7" band	2.0	+3.2 (4)[b/]	.8 (12)	.2 (16)
Dasanit 15G	7" band	1.0	.7 (7)	.2 (12)	.4 (19)
diazinon 14G	7" band	1.0	+2.8 (7)	.7 (12)	+1.5 (19)
Dyfonate 10G	7" band	1.0	+1.6 (4)[b/]	+1.1 (8)	+1.3 (12)
Dyfonate 20G	7" band	1.0	+2.6 (6)	+1.6 (12)	+1.9 (18)
phorate (Thimet 15G)	7" band	1.0	+3.6 (7)	+2.3 (12)	+2.8 (19)
prophos (Mocap)	7" band	1.0	+1.4 (5)	+ .2 (12)	+ .5 (17)
diazinon seed treater	On seed	4 oz./bu.	+2.3 (7)	+1.5 (12)	+1.8 (19)
3-way seed treater	On seed	3 oz./bu.	+3.2 (7)	- .6 (12)	+ .8 (19)

a/ Number of fields indicated in parenthesis.
b/ Tested only in 1971.

Table 5. Effect of Soil Insecticides on First-Generation European Corn Borer Populations, Illinois, 1971

Insecticide	Lb. actual per acre	Number of fields	Total plants dissected	Percent plants infested	Borers per 100 plants[a/]
carbofuran (Furadan 10G)	1.0	4	110	14.5	14.5
	2.0	4	80	1.3	1.3
	3.0	2	50	0	0
chlordane (Belt Plus 33-1/3G)	2.0	4	80	13.8	13.8
Bux 10G	1.0	4	80	12.5	13.8
Dasanit 15G	1.0	4	80	10.0	11.3
diazinon 14G	1.4	4	80	13.8	15.0
Dyfonate 20G	1.0	4	80	10.0	10.0
Mocap 10G	1.0	4	80	11.3	12.5
Thimet 15G	1.0	4	80	15.0	16.3
Seed treatments	...	4	160	9.4	10.6
Untreated	...	4	190	13.2	16.8

a/ Evaluated July 20 and 21.

Table 6. Effect of Planting Time Treatments of Furadan on First-Generation European Corn Borers, Illinois, 1971

Insecticide	Lb. actual per acre	Percent plants with whorl feeding	Borers per 100 plants	Cavities per 100 plants
carbofuran (Furadan)	1.0	8.4 (7)[a/]	14.5 (4)	24.7 (3)
	2.0	8.7 (7)	1.3 (4)	12.7 (3)
	3.0	6.5 (2)	0 (2)	12.0 (1)
No treatment	...	10.8 (7)	16.8 (4)	27.8 (3)

a/ Number of different fields in parenthesis.

THE SEARCH FOR NEW SOURCES OF RESISTANCE TO SOUTHERN CORN LEAF BLIGHT

S. M. Lim, A. L. Hooker, D. R. Smith, J. G. Kinsey, M. D. Musson

The unexpected outbreak of southern corn leaf blight in 1970 caused by a new race of *Helminthosporium maydis* (race T) brought worldwide attention to the dangers of monocytoplasmic background in hybrid corn production. Our objective is to explore all the available nucleargenic and cytoplasmic resources that could control the southern corn leaf blight. The pathogen was first studied to better understand the problems of breeding resistance into corn.

THE PATHOGEN

Prior to the growing season of 1970 we first identified two races, T and O, of *H. maydis* (the causal fungus of southern corn leaf blight) by differential pathogenicity on corn seedlings and pathotoxin production. The two races are morphologically similar, however race T shows selective pathogenicity to different types of corn cytoplasm while race O does not. Corn with normal cytoplasm (N) is resistant to race T, and corn with Texas male-sterile cytoplasm *(cms-T)* is susceptible.

Race T produces a pathotoxin that is specific to normal (resistant) and to *cms-T* cytoplasm (susceptible), but race O produces a toxin that is nonspecific to both types of cytoplasm. The genetic analysis of ascospore progeny obtained from the cross between race T and race O indicates that both the production of the host-specific pathotoxin and the selective pathogenicity of race T are monogenic in inheritance. The amount of pathotoxin produced and the severity of pathogenicity are polygenic in inheritance.

In addition to T and O, other races of *H. maydis* with specific pathogenicity to other types of cytoplasm may appear in the future. The genetic variation of *H. maydis* has not been studied extensively.

DISEASE RESISTANCE IN CORN

Resistance to race O is due to nuclear-gene inheritance, and is expressed both qualitatively and quantitatively. Qualitative inheritance is characterized by lesion types; quantitative inheritance, by the number of lesions or by the percentage of the leaf area that becomes infected. Qualitative resistance, expressed by the formation of small and circular chlorotic lesions, has been studied in Nigeria. This resistance is apparently conditioned by two, linked, recessive genes. These results have been confirmed in other crosses studied by Dr. Hooker's group.* Many inbred lines and varieties of corn are resistant to race O in terms of quantitative measurement--the number of lesions, percentage of infection, and sporulation on infected leaves.

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* The authors.

Resistance to race T is both cytoplasmic and nuclear. Normal cytoplasm and many sources of male-sterile cytoplasm were tested against race T at Urbana in 1970. Twenty-six sources of male-sterile cytoplasm were found to be resistant, and seed stocks were released to the seed industry. Other sources have been evaluated in 1971 and are resistant. The resistance in corn to race O and race T is positively correlated. The resistance in *cms-T* cytoplasm is partial, probably coming from the same nuclear genes that provide resistance to race O. However, nuclear-genic resistance does not completely suppress the cytoplasmic susceptibility in *cms-T* corn.

Attempts are being made to locate the sources of resistance that function in *cms-T* cytoplasm against race T. This process continues.

GARDEN SYMPHYLAN CONTROL, 1971

R. E. Sechriest

Garden symphylans are generally distributed throughout Illinois and feed on the roots of plants all season in hay fields, flower beds, greenhouses, gardens, lawns, and various cultivated crops. We have observed economic problems in the northern two-thirds of the state and strongly suspect that economic problems may be found anywhere in the state. Field experiments have been conducted for the last three years to find a method of economic control. During 1971, one series of planting-time applications was made, and an emergency control situation was attempted.

PLANTING-TIME TREATMENTS

Treatments were applied in a 7-inch band over the planted row of corn and lightly incorporated into the soil with a Gandy RoWheel. All experiments contained three randomized replicates and were located in western Rock Island County near Illinois City. The 1971 yields and those of the previous two years are shown in Table 1.

Table 1. Three-Year Summary of Yields of Planting-Time Garden Symphylan Experiment

Treatment	Lb. per acre	1969 Broadcast	1969 Band	1970 Band	1971 Band
Dyfonate 20G	1	...	164a	136ax	118a
	2	168a	...	...	...
	4	163a	...	...	...
Phorate 15G (Thimet)	1	...	...	148a	109a
	2	...	...	144a	...
Prophos (Mocap 10G)	1	...	158ax	...	104
	2	160a	...	150a	...
Bux 10G	1	...	...	135ax	111a
	2	...	...	145a	112a
Carbofuran 10G (Furadan)	1	...	157ax	...	114a
	2	154ax	169a	...	...
	4	169a	...	...	...
Dasanit 15G	1	...	...	...	106
Untreated	..	143 x	144 x	117 x	92 x

Note: Means followed by same letter are not significantly different at the 5% level.

Broadcast treatments provide quick, long-lasting control but involve high dosage rates. Band treatments generally provide enough control to suppress the symphylan populations below economic levels and yield a good harvest. Dyfonate has been our standard and has provided good control as a band treatment for three years. Control by phorate (Thimet) was good at applications of both 1 and 2 pounds per acre. Mocap may result in better control when 2 pounds are used, especially when the symphylan populations are heavy, as they were during 1969 and 1970. Results with Bux were similar to those with Mocap. Carbofuran (Furadan) was not considered very acceptable with heavy populations after the 1969 experiment, but with a light population during 1971 carbofuran provided good results. Dasanit has not been outstanding for planting-time symphylan control, but provides some suppression.

EMERGENCY BASAL TREATMENT

Seven insecticides were selected and applied as a 7-inch band over the row of corn plants on June 7, 1971. The granular treatments were incorporated by cultivation immediately after application. Each treatment was replicated three times, and each replicate was 4 rows wide and 300 feet long (approximately 1/4 acre total). The plots were harvested on September 21.

All treated plots yielded approximately twice as much shelled No. 2 corn as the untreated plots (Table 2). No meaningful differences between the treatments are apparent, but the untreated is obviously different from all treatments. The moisture of the corn from untreated plots was much higher than that from treated plots, similar to results on moisture obtained during 1969 planting-time treatments. The continued season-long feeding on the corn roots by these animals seriously slows development and maturity of corn plants.

Table 2. Yield and Moisture Content of Shelled No. 2 Corn From the Emergency Field Experiment Against Garden Symphylans, Argenta, Illinois, 1971

Treatment	Lb. active ingredient per acre	Percent moisture	Bu. per acre
Dyfonate 20G	1	32	118.6
Phorate (Thimet 15G)	1	32	115.0
Dasanit 15G	1	30	121.6
Bux 10G	1	31	124.9
NC-6897 2.5G	3/4	30	125.7
Dursban 10G	1-1/2	30	125.9
Prophos (Mocap 10G)	1	30	122.9
Untreated	...	36	58.8

SUMMARY

The phosphate and carbamate soil insecticides now on the market do suppress garden symphylans in cultivated crops. Treatments work best when applied at planting time, but basal treatments also provide good control.

INSECTICIDE RESIDUES IN SOYBEANS

H. B. Petty, W. N. Bruce

This is only a progress report of our 1971 soybean pesticide-residue survey. We have not had time to recheck questionable results, nor have we had an opportunity to recheck with the farmers to see if they understood the field-history questionnaire.

We have included as untreated any fields where aldrin had not been used. In several fields heptachlor had been used, but this was disregarded as it should not affect the presence of dieldrin in the beans. Nevertheless soybeans grown on fields where heptachlor has been used almost always seem to have a slightly higher dieldrin content than expected. It may be that some subtle change of which we are not aware takes place.

Aldrin as used in cornfields changes to dieldrin in the soil. As such it persists in soils for many years, but decreases annually until it is near zero at the end of the twelfth year. Rate of decrease varies with the amount of cultivation, soil, and soil type, etc. When oil crops, particularly soybeans, follow corn where aldrin has been used, dieldrin can be found in the crop. Studies in Illinois were made in 1965, 1966, and 1967; it was decided to survey the Illinois soybean crop in 1971 because of the steady decrease in the use of aldrin during the past four years.

The Illinois Crop Reporting Service, Robert Moats, Director, conducts a study of soybean practices based on a randomized selection of fields. Since Crop Reporting Service enumerators visit the growers, they took collection jars and insecticide-use questionnaires to each cooperator. They collected bean samples at harvest and took them to the county Extension adviser, who notified us or brought the beans to our laboratory.

The soybeans were analyzed in the laboratory of the Illinois Natural History Survey by Mrs. George Wilson. These tests are accurate to about 0.005 p.p.m. It has been suggested by many chemists that residues under 0.01 p.p.m. be considered a practical zero.

Based on research work reported in previous years *(1)* and the history of use in each field, dieldrin content in the soil could be computed (Table 1). Studies have shown a relationship between soil content and residues in beans *(2, 3)*. Monitoring surveys of soybeans in Illinois in 1965, 1966, and 1967 confirmed this relationship of use and dieldrin content in soybeans in actual practice *(4, 5, 6, 7)*.

It will be noted that beans from untreated fields have small amounts of dieldrin in them. This can be a result of dust-carried dieldrin residues blowing from treated fields onto the soybeans or at least into the fields *(8)*. Soil erosion by water from one field to another is also possible.

When comparing the four-year results, we find that the 1971 dieldrin content in soybeans from untreated fields is similar to that of the period 1965, 1966, and 1967 (Table 2). It will also be noted that the content in beans from treated fields is somewhat higher than in those three years. The overall average thus is slightly over 0.01 p.p.m. in the soybeans in Illinois.

As expected, there is a correlation between the calculated soil residues based on field history and the content of dieldrin in soybeans (Table 3). However, it appears that the residue in the beans is greater when compared with the calculated higher soil residues in 1971 than it was in an average for the period 1965 to 1967.

It will be noted that the percent of fields in the various ranges of dieldrin residues in soybeans, although higher than the average for 1965, 1966, and 1967 tends to parallel the results obtained in 1967 alone (Table 4).

One of the 85 fields had 0.075 p.p.m. of dieldrin in the beans. This obviously is too high. No health problem is involved, but certainly a legal problem is.

We call your attention to the fact that the results of 1971 are not final. We are still analyzing samples and rechecking results. A final report will be issued later.

However, we can conclude from these results that soybean farmers in Illinois should be extremely careful about the use of aldrin and heptachlor in fields where soybeans are to be grown within the next one or two years. Based on these results soybeans probably should not be grown in 1972 in fields where aldrin or heptachlor were used in 1971. This statement might be questionable, but if aldrin or heptachlor was used in 1971 and one or more earlier years, then soybeans should certainly not be grown on those fields in 1972 (Table 5). In 1966 we did recommend that soybeans not be grown on a field where aldrin or heptachlor had been used for five or more consecutive years until one complete growing season had elapsed with no use of either soil insecticide. The 1971 data indicate that soybeans should not be grown for at least one full crop year after the 2 years use of aldrin or heptachlor. Under no conditions should these two insecticides be used directly on soybeans, either as a foliar or a soil insecticide.

These 1971 results are not cause for alarm as the dieldrin content in general is still at a very low level. However, the results do show a need for caution.

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Table 1. Theoretical Residues (Aldrin + Dieldrin) To Be Expected in Soil at Yearly Intervals after Aldrin Application (p.p.m. in soil in spring at yearly intervals after application of 1 pound per acre in top 6 inches of soil)

Years after application	Two-year half-life
0	.5
1	.13
2	.10
3	.07
4	.05
5	.035
6	.025
7	.018
8	.013
9	.009
10	.006

Table 2. Four-Year Study of Dieldrin Residue in Soybeans

	Residues[a/] in soybeans expressed in parts per million		
Year	Overall average	Average for untreated fields	Average for all known treated fields
1965	.0087	.0067	.0101
1966	.0078	.0043	.0119
1967	.0080	.0061	.0123
1971	.0112	.0063	.0167

a/ Not corrected.

Table 3. Aldrin-Dieldrin Residues in Beans From Treated and Untreated Fields, 1965-1967 and 1971

Calculated soil residues in p.p.m. based on lb. per acre applied					Residues in soybeans in p.p.m.	
	Average				Average	
Range	1965-1967		1971		1965-1967	1971
0	(119)	0	(43)	0	.0056	.0063
0-.2	(48)	.165	(17)	.099	.0103	.0101
.2-.4	(63)	.266	(19)	.267	.0128	.0197
.4-.6	(6)	.473	(2)	.417	.0192	.0450
.6-.8		0		...	...	...

( ) = Number of fields.

Table 4. Percent of Fields With Soybeans in Various Aldrin-Dieldrin Residue Ranges, 1965, 1966, 1967, 1971

Range of residues in soybeans in p.p.m.	Percent of fields in each residue range						
	1965	1966	1967		Ave.		1971
0-.01	67.8	72.5	58.5	(174)	67.4		58.8
.01-.02	31.1	20.6	29.2	(68)	26.4		24.7
.02-.03	1.1	6.9	10.8	(15)	5.8		9.4
.03-.04	0	0	1.5	(1)	.4		5.9
.04-.05	0	0	0	(0)	0		0
.05-.06	0	0	0	(0)	0		0
.06-.07	...	...	...	...	...		0
07-.08	...	...	...	...	...		1.2
TOTAL				(258)	100.0	(85)	100

( ) = Number of fields.

Table 5. Use of Aldrin on Corn in 1970 or Earlier Compared With Dieldrin Residue in Beans Grown in Field in 1971

Last years of use in combination with any prior year's use	Residue of dieldrin in soybeans in p.p.m.	
1970 only	(5)	.0121
1970 + earlier years	(16)	.0230
1969 + earlier years	(5)	.0133
1968 + earlier years	(9)	.0115

( ) = Number of fields.

ILLINOIS PESTICIDE ACCIDENT REPORT: A TEN-YEAR SUMMARY

Roscoe Randell, H. B. Petty

This report is a summary of ten years' data on pesticide accidents among children in Illinois. During the period of 1961 to 1970, approximately 121,270 children were taken to a doctor or hospital because the child ingested or was contaminated by a hazardous substance. All such cases of pesticide accidents involving children 12 years of age or under are reported to the Illinois Department of Public Health through one of the downstate poison control centers. Dr. Norman Rose, Bureau of Hazardous Substances or Poison Control, State Department of Public Health, and his successor, for the past year, Dr. Richard H. Suhs, supplied the data summarized here.

Where do pesticides as a group rank with other materials as a source of hazard?
Pesticides were involved in an average of 742 cases per year, ranging from 567 to 872 per year over the ten-year period (Table 1). This was 6.1 percent of the total cases. Individual years ranged from a high of 7.3 to a low of 5.2 percent (Table 2). Medicines of all kinds were involved in 60.8 percent of the cases.

Is there a seasonal fluctuation in the ingestion of hazardous substances?
The peak time for ingestion of medicines was in the winter months (Table 3); ingestion of household preparations was somewhat higher in the fall; both pesticides and paint were ingested more commonly from late spring until fall than at any other time.

Are certain pesticides more commonly ingested at one time of the year?
Rodent-bait ingestions were highest in November and December (Table 4). Ingestion of other baits was most common from May through August. Roach-poison ingestions were highest in the fall.

What major pests were the parents attempting to control?
Pesticides for rats, mice, ants, clothes moths, and roaches accounted for about 82 percent of all accidental ingestions (Table 5). Also, over one-half (58.6) of the ingestion cases involved the pesticide used as a bait.

What pesticides were most commonly involved in pesticide accident cases?
Anticoagulant rodent baits led the list with the arsenicals next in order. Naphthalene and PDB were next (Table 6).

What can parents do to reduce the risk of children getting into pesticides?
The answer to this question is the same as it was in 1961. It involves avoiding the use of baits to control rats, mice, ants, and roaches whenever possible. If they are used, keep them where small children cannot get into them. From 1961 to 1970 an average of 267 children in downstate Illinois ate baits containing a pesticide (Table 7).

Store moth balls in sealed or locked containers where children cannot get into them, thinking they are candy. Annually during the past ten years an average of 77 children ate moth balls.

An average of 58 children per year found the pesticides when they were improperly stored. There were 17 cases in which the cause was unknown.

Table 1. A Comparison of Illinois Population and Exposures to Hazardous Substances and Pesticides of Children 12 and Under in Illinois, 1961-1970

	1961	1962	1963	1964	1965
Hazardous substances exposure	7,898	9,953	11,901	12,750	14,187
Pesticide exposure	567	722	819	852	872

	1966	1967	1968	1969	1970
Hazardous substances exposure	13,727	14,585	13,209	12,429	10,631
Pesticide exposure	778	801	678	678	653

Table 2. Ingestion of Hazardous Materials by Illinois Children Under 12 Years of Age, as Reported to Illinois Poison-Control Centers, 1961-1970

	Percent of total										
Material	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Avg.
Medicine	56.4	57.2	56.2	59.3	64.8	66.7	63.7	62.9	62.7	59.0	60.8
Household preparations	16.4	16.6	16.3	15.0	13.0	12.5	11.8	11.4	11.7	12.7	13.5
Pesticides	7.2	7.3	6.9	6.7	6.1	5.7	5.5	5.2	5.4	6.1	6.1
Paints, etc.	5.3	4.9	6.3	5.0	5.2	4.3	4.3	3.9	4.8	5.9	4.8
Cosmetics	2.7	2.7	3.0	3.0	2.7	2.9	3.0	2.9	4.1	3.5	2.9
Miscellaneous	12.0	11.3	11.3	11.0	8.2	7.9	11.7	13.7	11.3	12.8	11.9

Table 3. Ingestion of Hazardous Materials by Children Under 12 Years of Age, As Reported to Illinois Poison-Control Centers, From Average Yearly Cases, 1961-1970

	Bimonthly averages						
Material	Jan.-Feb.	March-April	May-June	July-August	Sept.-Oct.	Nov.-Dec.	Total
Medicine	1,274	1,349	1,112	972	1,309	1,370	7,386
Household preparations	224	267	287	283	299	272	1,632
Pesticides	86	87	141	162	145	121	742
Paints, etc.	58	75	101	122	130	97	583
Cosmetics	56	64	60	52	62	63	357
Miscellaneous	...	...	...	...	...	...	1,427
					GRAND TOTAL		12,127

Table 4. Ingestion of Pesticides Intended for Control of Rodents, Ants, Moths, and Roaches by Children Under 12 Years of Age, as Reported to Downstate Illinois Poison-Control Centers, Average for 1961-1970

	Bimonthly total					
Pests	Jan.-Feb.	March-April	May-June	July-August	Sept.-Oct.	Nov.-Dec.
Rodents	24	21	29	23	28	38
Ants	4	6	25	37	15	4
Moths	11	11	16	14	14	13
Roaches	5	7	8	11	11	8

Table 5. Ingestion of Pesticides by Children Under 12 Years of Age, as Reported by Downstate Poison-Control Centers, Average for 1961-1970, Based on Pests to Be Controlled and Source of Pesticide

Pests	In use	From storage	Unknown	Total	Pct. of total	Pesticide obtained as bait	Pct. of total
Rodents	86	21	56	163	34.8	155	95.0
Ants	54	8	27	89	19.0	80	88.3
Moths	46	9	24	79	16.8	0	0
Roaches	28	10	14	52	11.1	32	61.1
Unspecified	7	8	18	33	7.0	2	6.1
Flies	5	5	6	16	3.4	4	25.0
Mosquitoes	2	4	3	9	1.9	0	0
Flower pests	1	3	2	6	1.3	0	0
Weeds	3	7	5	15	3.2	0	0
Others	2	3	2	7	1.5	2	28.6
TOTAL	234	78	157	469	100	275	...
PERCENT	49.9	16.6	33.5	...	100	...	58.6

Table 6. Cases of Pesticide Ingestion by Children Under 12 Years of Age, as Reported by Downstate Poison-Control Centers, 1961-1970

Pesticide	Number of cases										
	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	10-yr. total
Anticoagulant rodenticides	82	126	128	184	169	144	162	164	174	174	1,507
Arsenicals	102	65	110	145	117	134	110	108	125	68	1,084
Naphthalene and PDB	45	76	93	90	101	78	85	73	70	64	775
Unspecified	21	38	38	9	38	14	8	41	16	4	227
DDT	10	21	22	10	12	9	4	15	5	2	110
Lindane and BHC	11	10	11	11	13	11	12	8	6	8	106
Dieldrin	2	8	6	15	3	15	19	12	13	4	97
612 and Deet	11	7	9	11	4	6	14	6	13	2	83
2,4-D	7	11	4	7	3	9	12	10	6	11	80
Chlordane	11	12	8	9	7	9	9	0	5	9	79
Boric acid	1	3	0	5	11	7	16	15	10	10	78
Pyrethrins	3	8	0	2	16	12	13	5	9	6	74
Thallium sulfate	4	8	5	10	10	13	2	1	1	1	55
Strychnine	10	9	7	5	5	6	3	4	5	0	54
Sodium fluoride	10	8	7	4	8	3	3	0	6	4	53
Phosphorus paste	2	8	15	3	6	4	5	0	2	3	48
DDVP	4	12	2	2	1	2	3	11	2	6	45
Malathion	4	2	1	4	3	7	2	3	3	5	34
Fungicides	4	0	0	0	3	0	2	3	1	3	16
Diazinon	0	0	0	1	1	4	1	0	1	4	12
Rotenone	1	3	0	4	2	1	0	0	0	0	11
Methoxychlor	0	1	0	2	0	4	1	0	0	2	10

The following pesticides averaged less than one case per year: aldrin, Amiben, atrazine, Bidrin, camphor, carbaryl, cyanate, DDD, Dibrom, Dimite, Di-Syston, fumigants, Kepone, metaldehyde, nicotine, parathion, potassium, randox, ronnel, and toxaphene.

Table 7. Actual and Projected Cases of Pesticide Contamination or Ingestion by Illinois Children Under 12 Years of Age, by Source of or Reason for Exposure, as Reported to Downstate Illinois Poison-Control Centers, 1961-1970

Sources	1961	1962	1963	1964	1965	
Baits	214	246	302	366	322	
Moth balls	46	82	95	90	99	
Storage	68	57	45	65	45	
Disposal	11	16	5	17	9	
Unknown	16	72	61	16	61	
Total	355	473	509	554	536	
Sources	**1966**	**1967**	**1968**	**1969**	**1970**	**Yearly avg.**
Baits	275	271	266	206	204	267
Moth balls	80	85	73	66	54	77
Storage	29	63	57	92	60	58
Disposal	15	29	12	36	16	17
Unknown	96	43	35	47	70	52
Total	495	491	443	447	404	...

NEW INSECTICIDES AND THEIR PLACE IN ILLINOIS AGRICULTURE

Roscoe Randell

Names of new insecticides and a brief description of toxicity, use and basic manufacturer are contained in the *Check List of Insecticides*. Some of the insecticides discussed have been listed before, but either have received new use registration or are now suggested for additional uses in the circulars on insect control suggestions.

Methomyl (Lannate) is a carbamate labeled for control of worms in vegetable crops including tomatoes, cabbage and other cole crops, field and sweet corn, and just recently, potatoes. It is sold as 90-percent soluble powder. Lannate has also shown good control of plant bugs and leafhoppers.

Fundal and *Galecron* received label clearance for use on cabbage and other cole crops. Both of these formanidine compounds have been successfully used as miticides on apples. They give good control of cabbage worms, including cabbage looper in the egg stage and new hatching worms. Both insecticides are formulated as a 95- to 97-percent soluble powder and 4 EC. When aphids, thrips, or similar sucking insects are also a problem, another insecticide needs to be included.

Dimethoate (Cygon, De-Fend) is not a new insecticide but now has some new uses. This insecticide has been used successfully to control aphids in early-season sprays on fruit crops. It is also effective against aphids in vegetables, especially pea aphids. At the present time, it is the only insecticide suggested for tree borer control as a replacement for DDT. Bronze birch borers and flat-headed borers are effectively controlled with properly timed applications. It is sold either as 25-percent wettable powder, or 25-percent, 2-pound, or 2.67-pound liquid concentrate.

Biothion (Abate) is labeled for application to water areas for mosquito larval control. It is formulated in 4-pound liquid concentrate and granules.

Omite is an organic sulfur miticide formulated as 30-percent wettable powder. It is effective against all stages of leaf-feeding mites and does not harm predatory mites or insects. At the present time it is labeled for fruit crops only.

Prophos (Mocap, Jolt) is labeled and listed in our insect control suggestions for corn rootworm control. It will be formulated as 10- and 15-percent granules.

Rabon is the livestock insect control formulation of Gardona. It is marketed as a 50-percent wettable powder. It is effective as a residual barn spray alone or is also formulated in combination with dichlorvos and marketed as *Ravap*.

Imidan is a broad-spectrum insecticide labeled for use on alfalfa weevil and as a general insecticide on fruit. It is sold primarily as a 50-percent wettable powder.

Dursban is presently labeled for use in roach control by pest control operators. It is also labeled for control of sod webworm and chinchbugs by professional applicators only.

Bacillus thuringiensis (Biotrol, Dipel, Thuricide) is labeled and suggested for control of cabbage worms on cabbage and related crops. It is a bacterial agent that is effective when eaten by many leaf-feeding caterpillars.

SOUTHERN CORN LEAF BLIGHT IN 1971 AND STUDIES ON OVERWINTERING

E. E. Burns

The conditions necessary for an epidemic of any plant disease are: (1) widespread planting of uniformly susceptible plants, (2) a virulent and rapidly reproducing pathogen, (3) very favorable weather conditions for infection and reproduction by the pathogen, and (4) time for build-up of the disease. Southern corn leaf blight (SCLB), caused by *Helminthosporium maydis*, race T, was able to reduce 1970 Illinois average corn yields per acre by over 20 percent. The stage was set early in 1971 for a repeat of this drastic situation, but high yields in 1971 indicate that something prevented southern corn leaf blight from reaching its full potential.

RESEARCH ON OVERWINTERING

Viable spores of race T were recovered from infected corn leaves stored 12 inches above the soil surface in nylon mesh bags from December 7, 1970, until July 1, 1971. Race T did not survive burial in the soil beyond March, 1971. Spores of race O were not isolated from infected leaves stored either above or below the soil surface after one month of exposure to weather conditions at Agronomy South Farm, Urbana.

Tillage practices that left corn debris above the soil surface, such as chiselling and zero-tillage, favored the survival of race T (Table 1). Viable conidia of race T were obtained from corn debris left above the soil surface from harvest in 1970 until May 1, 1971, when planting was completed in tillage plots at Dixon Springs, Urbana, and Elwood.

Table 1. Relative Disease Potential for SCLB in 1971 Illinois Corn Determined by Effect of Tillage Practices on Overwintering of H. maydis, Race T[a]

Tillage treatment	Date		
	November, 1970	January, 1971	March, 1971
Fall plow	180[b]	66	.5
Fall partial shred	180	55	3.5
Fall chisel	180	36	6.5
Fall complete shred	180	8	3.0
Zero-till	180	38	9.0

a/ Numbers computed by adding cumulative disease ratings (severity times number of seedlings) on differentials for a given month and for all three tillage plot locations.

b/ Estimated maximum potential for SCLB under field conditions at harvest time, 1970.

Southern corn leaf blight appeared first on susceptible corn in zero-tillage plots and last on corn in plowed plots (Table 2).

Table 2. Disease Rating of SCLB in Tillage Plots at Agronomy South Farm Indicating Time of Primary Infection and Development of the Disease at Different Dates in 1971

Tillage treatment	Average disease rating of SCLB (Ullstrup scale) on naturally infected differentials in the field plots[a/] May 28	June 28	July 28
Fall plow	0	0	1.58
Spring plow	0	0	1.80
Fall chisel + spring disk[b/]	0	.5	2.00[c/]
Fall shred + spring disk	0	0	1.81
Zero till	0	.55	2.40[c/]

a/ Twenty randomly selected plants rated in each of 3 replicates. Differentials containing Tms or N cytoplasm planted April 21, 1971.
b/ Considerable debris left on soil surface.
c/ Many lesions were observed on the upper leaves of plants in treatments, but this information could not be recorded when rated with the Ullstrup scale.

Table 3. Survival of H. maydis in Corn Crib Storage

County (corn line)	Moisture content, percent	Percent of seed infected with *H. maydis*	Average yield loss, bu./acre[a/]	Other fungi[b/]
JoDaviess	22	18	-27	*Acremoniella* spp. (AC) *Cephalosporium acremonium* (CE)
Boone	20.9	2	-10	*Fusarium moniliforme* (FU)
Henry	?	76	-29	FU
Tazewell	?	34	-33	FU, CE, *Mucor* spp.
Champaign	?	8	-13	*Penicillium* spp. (PE) *Trichoderma* spp. (TR)
Adams	15	14	-17	*Nigrospora oryzae*
Montgomery	14	18	-33	FU, NI, and *Aspergillus glaucus* (AS)
White (Bojac 290W)	?	45	-20	AC
Jackson	17.7	24	-33	CE, TR, AS
Pope-Hardin	?	8	-28	AS, PE

a/ USDA Crop Reporting Service estimate for 1970 in Illinois.
b/ Seed were surface-sterilized with Clorox and rinsed twice with sterile, distilled water. Fifty seeds were planted on PDA, pH = 4.

Race T survived in corn cribs on ten widely scattered farms in Illinois (Table 3). Severe infections of susceptible corn near shelling operations at other locations provided additional evidence of survival. Although race T is carried on the seed (Tables 4 and 5), there is little chance that the disease is transmitted by seed to the next generation of corn.

Table 4. Effect of Seed Infection by H. maydis, Race T, on Seed Quality

Hybrid seed type[a/]	Primary root growth, mm.[b/]	Percent infected with *H. maydis*	Percent seed germination
PAG 15029 Tmsc	3.34	19	75
PAG 15029 N	8.79[c/]	0	98
388 Tmsc	3.34	.025	85
388 N	8.19[c/]	.002	99.9
OP3X Tmsc	11.27	0	99.9
OP3X N	11.37	0	99.0

a/ PAG 15029 Tmsc and N were from field-infected plants; 388 Tmsc and N were from corn inoculated artificially with *H. maydis*, race T, by A.L. Hooker; OP3X Tmsc and N were disease-free seed lots supplied by Dr. Hooker.
b/ Germination test of 400 seeds for each type. Growth was measured after 7 days storage in a germinator at 22° C. Seeds were surface-sterilized with Clorox before the germination test was started.
c/ t-Test, analysis of variance, indicated significant difference in primary root growth of Tmsc and N seedlings at 1 percent level.

Table 5. Seed Transmission Study Using Race T of H. maydis-Infected Seed Corn Planted in Field Soil in the Greenhouse

Seed type	Percent emergence	Percent infected with *H. maydis*	*H. maydis* isolated from seedling 2 weeks after planting
PAG 15029 Tmsc	85[a/]	19	0
PAG 15029 N	100	0	0
F2 field corn Tmsc	65	45	+
388 Tmsc	97	0.025	0
388 N	100	0.002	0
OP3X Tmsc	97	0	0

a/ Replicated three times with 20 seeds of each type in a replication.

Chlamydospores and mycelial fragments of race T in and on corn debris are known to survive the winter and provide an inoculum source the following season.

DEVELOPMENT OF SCLB IN 1971

About 50 percent of the Illinois corn in 1971 contained Texas male-sterile cytoplasm (Tmsc or cms-T), compared with about 85 percent in 1970. Thus there was approximately 35 percent less susceptible corn around in 1971. The proportion of resistant normal (N) cytoplasm corn in the southern states approached 90 percent, and this helped greatly to retard build-up in the south and also largely prevented spores from blowing up to the corn belt.

It was known that race T had survived the winter in many areas of the state either in corn debris or cribbed corn. The reproductive potential of this fungus is so great that the potential for rapid build-up was always present.

The first 1971 report of SCLB was released after identification of the spores of *H. maydis* on a sample of field corn from St. Clair County on May 19. The second sample with positive SCLB was on volunteer corn from Marion County, identified May 21. Numerous instances of infected volunteer corn appeared throughout Illinois in May. Corn debris was often associated with the volunteer corn, but some infected plants occurred in apparently clean-plowed fields.

Favorable weather including warm temperatures (Table 6), frequent rain, and cloudy days and considerable field observations provided for the detection of SCLB in nearly every Illinois county in the first two to three weeks of June. Knowing the potential of race T for spreading and developing, it appeared certain that the "blight" was on its way. However, close examination of weather data showed that the optimum conditions for blight did not persist during most of the season, and that even where conditions were favorable, the area was relatively limited to what were called "hot spots." Yields were probably reduced most where local weather conditions enhanced disease development.

Table 6. Effect of Temperature on Growth of H. maydis, Races O and T, in Culture[a/]

Temperature, °C	Mean radial growth, millimeters[b/] Race O	Race T
10	17.23	7.90
15	29.23	29.70
20	38.07	36.37
25	72.20	66.27
30	48.40	35.80
35	.13	.07

a/ Potato dextrose agar, in dark.
b/ Mean of 5 separate replicates with 3 plates per replicate.
Note: F-Test, analysis of variance, indicated significant differences in growth at the different temperatures at the 1 percent level. Least significant difference for race O is 11.04 mm. at 5 percent level and for race T it is 15.81 mm.

Spore-trap data. The build-up and spread of *H. maydis* spores were monitored with Kramer-Collins spore traps set up at Dixon Springs and Urbana. No massive wind-borne movements of conidia (asexual spores) were detected in 1971. The number of spores collected per month increased during late July and August (Figure 1). Local spread of the disease was presumed to occur in corn fields from overwintering sources at or near ground level.

Early planting a factor. The final condition for an epiphytotic is time. By planting early, most of the corn was beyond the danger of severe infection by the time the fungus had a chance to increase significantly.

The primary factor that held the fungus in check was the weather--very hot, very cool, or dry weather is detrimental to reproduction and infection by *Helminthosporium maydis*.

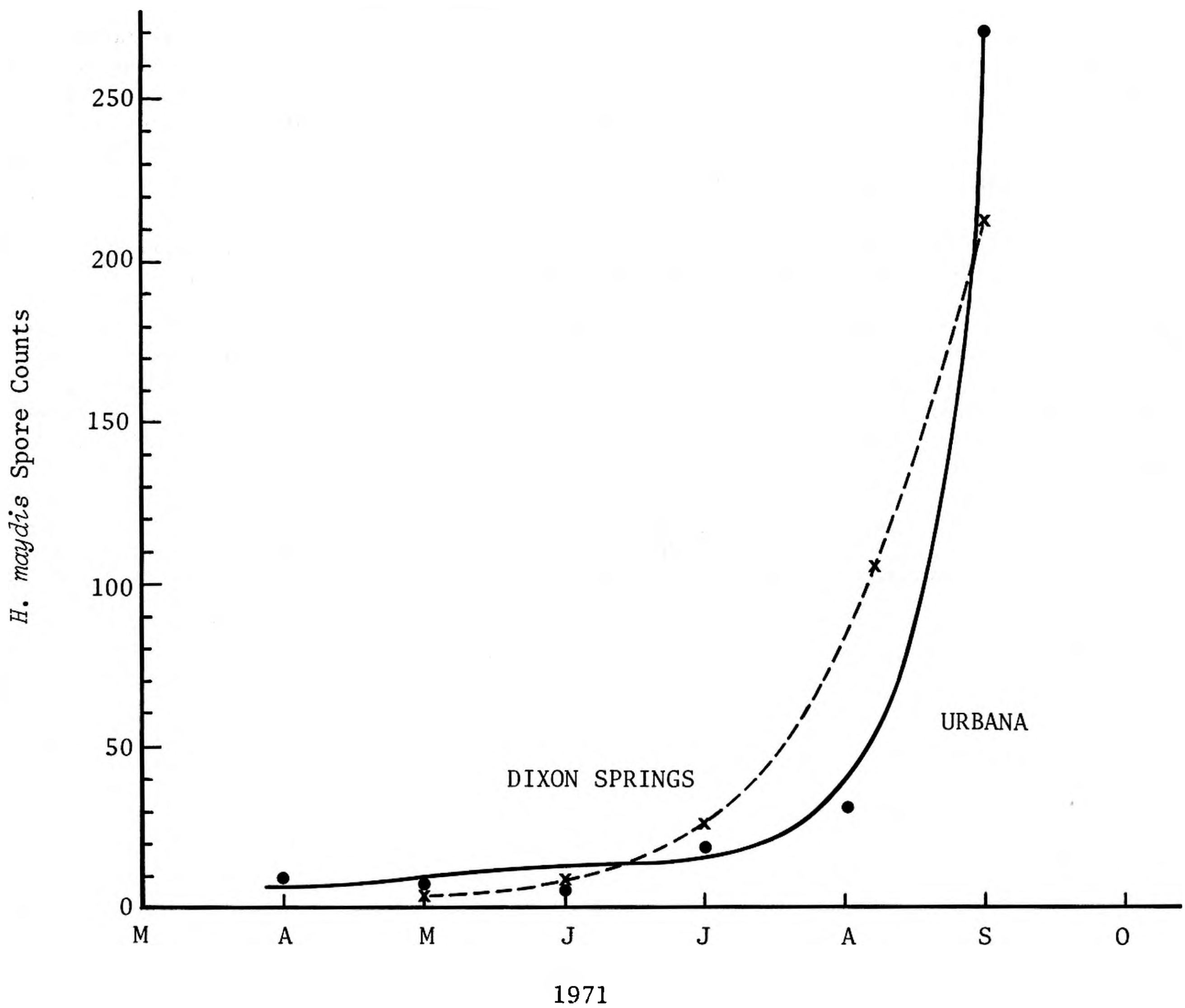


Figure 1. Total monthly spore counts Helminthosporium maydis, 1971.

SMARTWEED CONTROL

Marshal McGlamery

The two common annual smartweeds in Illinois corn and soybean fields are Pennsylvania smartweed (*Polygonum pennsylvanicum*) and ladysthumb smartweed (*P. persicaria*). Smartweeds are a greater problem in wet environments and in wet years. There is a dormancy in the seeds, so that they can remain viable in the soil for many years. Several herbicides can be used to control smartweeds.

AAtrex (atrazine) used either as a preplant, preemergence, or postemergence herbicide does a good job of controlling smartweed. It can be used at half rates in preemergence or preplant combinations and still control smartweed.

Lorox (linuron) can be used in combination with Ramrod (propachlor) or Lasso (alachlor) to control smartweeds. Corn tolerance to Lorox is not good, so rates must be adjusted very accurately. Londax is a packaged mixture of linuron and propachlor. Ramrod and Lasso alone will sometimes give some control of smartweed at the higher rates, but this control has been variable.

Banvel (dicamba) is better than 2,4-D on smartweed, but there have been many complaints about drift of Banvel injuring soybeans. Soybeans are very susceptible to Banvel, especially while blooming. Spray thickeners or foam applicators will help reduce this drift problem, but will probably not eliminate them. Smartweeds gain tolerance to 2,4-D as they get older, so if you plan on using 2,4-D to control smartweeds, then the 2,4-D should be applied early.

Smartweeds can be controlled in soybeans with Amiben, Chloro-IPC, Lorox, or Preforan. Many farmers have experienced variable control of smartweed with Amiben (chloramben) when they have used the low rates. Smartweed control is much better with the higher (3 pounds per acre) rate.

Lorox (linuron) effectively controls smartweed, but the rates must be adjusted to soil type and organic matter to minimize soybean injury. Some farmers prefer a mixture of Lasso (alachlor) plus Lorox to improve grass control and crop tolerance. Lorox is also cleared as a split application over Treflan (trifluralin).

Preforan (fluorodiphen) is a relatively new herbicide, which provides good control of smartweed in the liquid formulation. In 1971, the granular form did not perform as well as the liquid formulation.

Chloro-IPC (chlorpropham) is probably one of the best herbicides for controlling smartweed in soybeans, but a mixture with another herbicide is required to control most of the other weeds without injuring the soybeans. Chloro-IPC is cleared as a tank mix with Lasso and as a split application after Treflan.

Solo (naptalam plus chlorpropham) is a mixture of the old herbicide Alanap and Chloro-IPC. It has been somewhat variable in its control of grasses and has sometimes injured soybeans.

Let's outsmart smartweed and choose the correct herbicide for the job, which will give maximum control with minimum injury.

PRACTICAL ASPECTS OF INSECT CONTROL WITH *BACILLUS THURINGIENSIS*

Roscoe Randell

Biological control of insects has been a current topic in magazines and newspapers, especially with the increased interest in improving the quality of our environment. But controlling insects biologically has been going on for many years. The back cover of this manual relates an attempt to transmit parasites in orchards in 1871. Entomologists in the field have continually observed naturally occurring biological insect control. Examples of effective control by biological means include pea aphids in a clover field attacked by a naturally occurring disease organism, tomato hornworms fed upon internally by parasitic wasp larvae, and armyworm populations eliminated by both disease and tachinid fly larvae feeding internally.

Many people have defined biological control. It has been defined as the suppression of the reproductive potential of organisms such as insects, through the actions of other organisms. *Bacillus thuringiensis* is one such organism which has been formulated for use against some insects. It is not a new material as its history traces back to before many of the present-day insecticides were discovered. The earliest reported development of *B. thuringiensis* was in Japan about 1901. Even earlier, attempts were made to utilize insect disease organisms to control insects. Some of these early attempts included releasing fungus diseases of specific insects when a population was present. In Illinois, one such insect on which control was attempted by releasing fungus spores was the chinch bug before 1900. Work in recent years has also been concerned with bacterial and viral insect disease producers.

Interest in *B. thuringiensis* as an insect-control material was renewed about 20 years ago. At that time, it was discovered that the toxin or killing effect of it was not by the bacterial spores in it but rather by crystals present. These crystals were responsible for the paralysis occurring in caterpillars exposed to *B. thuringiensis*. These crystals are formed as bacterial spores increase. Therefore, number of spores applied is not the reliable method of evaluating control. Today, manufacturers and formulators of *B. thuringiensis* rate its effectiveness by a standard called International Units (IU) of potency rather than by spore counts as previously used.

Now let us move from the background situation of biological control and specifically *B. thuringiensis* to the present status of the material and the practical aspects of it as an insect-controlling material. What are the advantages, disadvantages, and future of such an insect-control method today?

Some of the advantages are: It is nontoxic to beneficial insects, including predator insects such as lady beetles or parasitic wasps and pollinating insects. It controls all sizes of caterpillars present. On approved crops such as cole crops and leafy vegetables, there are no time limitations between last application and harvest, and the formulations are exempt from tolerance requirements. The formulations are relatively nontoxic to the user, and there has been no reported phytotoxicity to treated crops.

There are some disadvantages. First, *B. thuringiensis* is effective only against some caterpillars, the larvae of butterflies and moths. If other insects are also present, then a chemical insecticide has to be included. It has been successfully tested on slightly more than 100 insect species, of which probably one-half or less are economic pests in Illinois. In order to be toxic to the insect, the material must be eaten, as it is not a contact poison.

At the present time, *B. thuringiensis* is being used by commercial vegetable growers for control of imported cabbage worm, diamondback moth, and cabbage looper feeding on cabbage and related cole crops. Results have been generally very good. It has been tested along with other insecticides for control of insects on ornamentals. It gave good control of bagworms in tests by Dr. J.E. Appleby at the Illinois Natural History Survey. Control of some leaf-feeding caterpillars on greenhouse crops by *B. thuringiensis* was successful in tests this past year. Pressurized spray cans containing *B. thuringiensis* and pyrethrin proved to be an easy and effective method to control cabbage worms by the homeowner. Results in this state and others have been disappointing with its control of corn earworm. Dr. R.H. Meyer, Illinois Natural History Entomologist, applied it to apples for codling moth control in 1958-1960 with excellent results, but applications had to be made every 4 to 5 days.

The future of *B. thuringiensis* usage in Illinois will depend on the number of additional economic insect pests it is tested on and its effectiveness in controlling them. Also, it will depend on whether it will be available in homeowner or small-package units to be used against insect pests of ornamentals and vegetable gardens as well as agricultural use.

With the recent increase in the toxicity or potency IU of present formulations, decreased cost, and consistent performance of applications, *B. thuringiensis* has advanced from a much-discussed idea to reality as another control to be used against certain insect pests.

CEREAL LEAF BEETLE AND JAPANESE BEETLE QUARANTINES

R. G. Anderson

The cereal leaf beetle, a very serious pest of small grains, is continuing its spread to the west. It was found the first time in Kankakee, Vermilion, and Will Counties in 1965 and has continued to spread west and southwest in Illinois until it reached the Mississippi River in 1971.

The feeding of both adults and larvae is responsible for the damage to oats, barley, wheat, and rye. The beetle has been known to feed on late-planted corn, but as yet has not caused any serious damage to the corn yield. The adult beetle is about 3/16 inch long. The wing covers and head are a metallic bluish-black. The legs and front segment of the thorax are reddish.

Malathion applied at the rate of 3 ounces liquid per acre to the host crops when the adults are present is the best control for this pest. A quarantine has been promulgated to prevent the artificial spread to noninfested areas. This quarantine area now includes 59 counties in Illinois.

The quarantine regulates the movement of wheat, oats, barley, rye, ear corn, and soybeans as well as grass and forage seed, hay, straw, sod, plant litter, and used harvesting machinery. The most recent regulated item is Austrian, red, and Scotch pine Christmas trees. Research people are continuing to improve the methods to make regulated commodities eligible for certification. If you should have a problem concerning certification, get in touch with one of our offices at Springfield or Glen Ellyn.

See attached map for regulated areas.

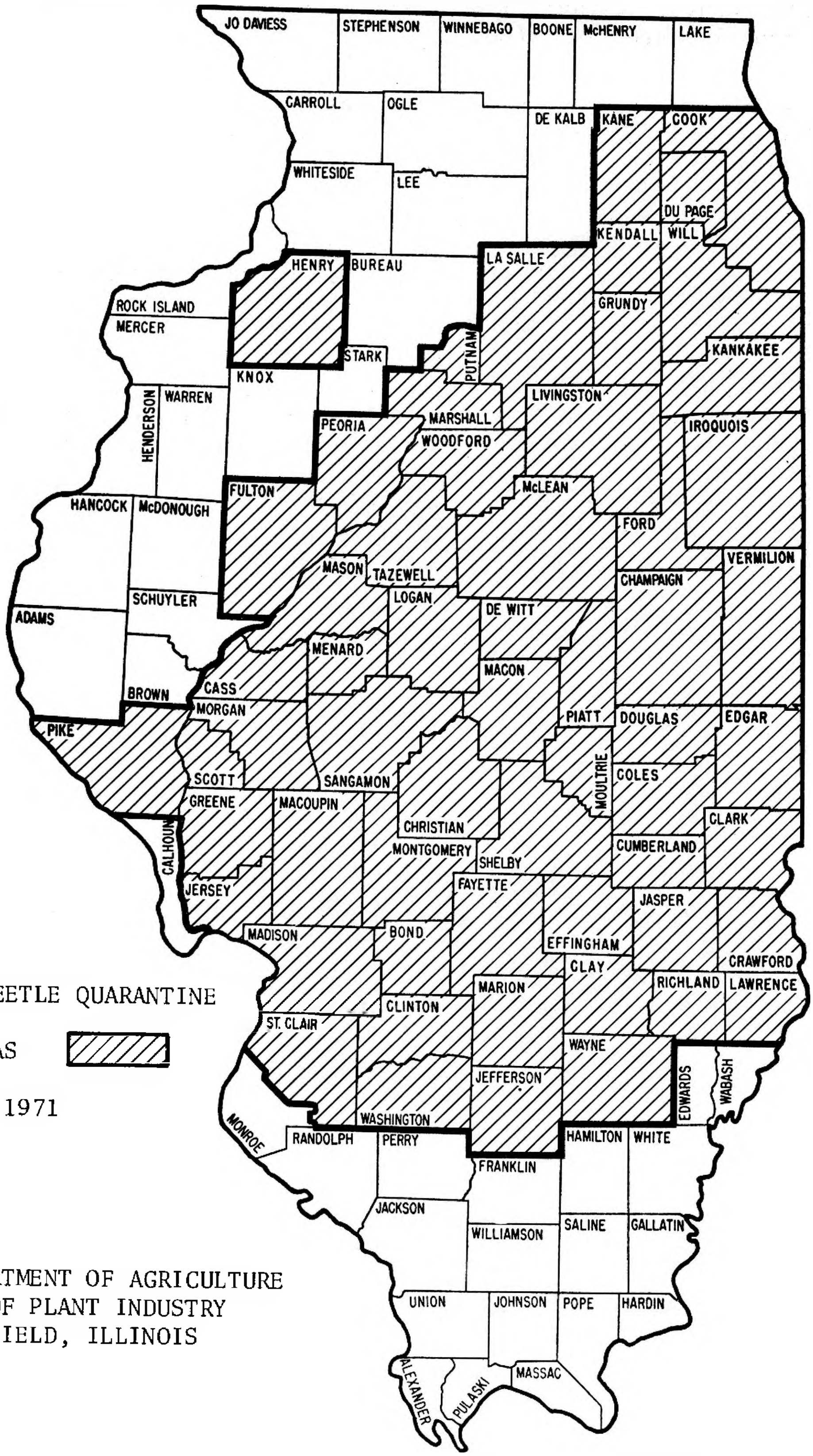
The Japanese beetle has been with us in Illinois since 1932 when infestations were found in Chicago and East St. Louis. This is one of our most serious agricultural pests. It feeds on over 250 varieties of plants and is especially destructive to corn, soybeans, sod, early-ripening varieties of fruit and berries, and most ornamental and shade trees.

We were able to do a very good job of control when we could use our most persistent chlorinated hydrocarbons, but since these can no longer be used we are using repeated applications of Sevin against the adults and chlordane granules to control the grubs on nonagricultural lands.

Here too we must make use of a quarantine, so we can control the artificial long-distance spread of the pest.

The regulated items include soil, plants with roots, sod, newly harvested grain, and used harvesting and earth-moving equipment. There are several methods of treating to make the above-mentioned things eligible for certification for movement. Contact either of our offices for details. Certain parts of the following counties are regulated:

Coles--in the Mattoon and Charleston areas.
Cook--Chicago and certain suburbs principally on the south side. A newly regulated area is on both sides of the Cook-DuPage County line, including part of the cities of Bensenville and Elmhurst.
Edgar--cities of Paris and Vermilion.
Fayette--Vandalia and rural area just to the west of town.
Iroquois--eastern part of the county and several sections near Gilman.
Kankakee--southeast corner of county.
LaSalle--city of Streator and rural area to the north of town.
Tazewell--cities of East Peoria and Creve Coeur.
Vermilion--cities of Hoopeston and Cheneyville and rural area between them.
Will--cities of Crete and Steger as well as several sections around them.
Madison and St. Clair--an area from Granite City to the south edge of East St. Louis.
Rock Island--a small area including all of the City of Silvis and parts of the cities of Carbon Cliff and East Moline.



CEREAL LEAF BEETLE QUARANTINE

REGULATED AREAS

JULY 13, 1971

ILLINOIS DEPARTMENT OF AGRICULTURE
DIVISION OF PLANT INDUSTRY
SPRINGFIELD, ILLINOIS

SORGHUM INSECT PROBLEMS IN TEXAS

J. G. Thomas

Texas grain sorghum production has been valued in excess of $300 million for the past six years, not including government payments. An additional 1.25 to 2.0 million acres of sorghum are grown in the state for grazing and hay production. Texas produces approximately 40 to 45 percent of the grain sorghum in the United States. In terms of producer income, grain sorghum ranks second to cotton in Texas. In fact, if government payments and cottonseed value are excluded, grain sorghum production value has exceeded lint value in four of the past eight years. Grain sorghum is an extremely important agricultural crop in Texas.

GRAIN SORGHUM PEST CONTROL IN TEXAS

In many respects grain sorghum has not been plagued with serious pest problems. Thus the profit margin has not been as inversely correlated with insecticide use practices as is the case with cotton in a number of Texas production areas. With continued emphasis on grain sorghum production, we must be aware that this situation may not continue as in the past.

Extensive efforts have been made in the areas of grain sorghum research and extension educational programs to avoid mistakes that have been made in cotton insect control programs. Although a number of the problems associated with cotton insect control were not foreseen, we should be wise enough to avoid the same pitfalls in developing and designing pest management programs for grain sorghum production.

There is clear evidence that resistance problems (Banks grass mite), multiple applications (corn leaf aphid, greenbug, and sorghum midge control), and total crop loss are not associated only with cotton production. We cannot afford to travel this same road in developing pest control strategies for grain sorghum production. In developing the 1972 recommendations for grain sorghum insect control, emphasis has been placed on determining specific economic threshold guidelines for each pest species. These guidelines are certainly no better than research and experience on which they are based. To be effective, they must be used by growers and other decision-makers with judgment and understanding.

MAJOR PESTS

The sorghum midge is recognized as the potentially most damaging pest of grain sorghum in Texas. Although it was first described in Texas in the late 1800's, it was not considered an economic pest until the mid-1950's. Extensive economic damage was not recorded until 1961, when it first appeared in damaging numbers in the Texas High Plains. Over 50 percent of the Texas grain sorghum acreage is grown in this area. The 1963 grain sorghum crop losses in the High Plains were estimated at $4 million to $7 million. Although losses have been reduced significantly in the past few years by early uniform planting in each production area, damage still occurs where weather or other factors result in extended planting periods.

The greenbug occurred for the first time in 1968, principally in the High Plains and Panhandle production areas. The pattern of occurrence of this pest was most striking. Populations began to develop in late June, and by July 20 to 25 over 2 million acres were heavily infested. Few fields could be found that did not support from 5,000 to 40,000 aphids per plant. Very little was known of the potential damage which could be caused by this insect, since no prior observations could be used for reference. Extensive treatment occurred, and in many instances applications were too late to prevent yield reductions. The impact of grower experience in 1968 has created serious problems in developing a sound approach to greenbug control since 1968. A review of insecticide use on grain sorghum for greenbug control clearly indicates the need for implementing control guidelines. Prior to 1968 the total grain sorghum acreage treated for insect control had never exceeded 1.5 million acres. Since 1968 treatment acreage has been approximately 4 million acres (Table 1).

Table 1. Estimated Acreage of Grain Sorghum Treated for Insect Control in Texas, 1960-1971

Year	Base acres treated	Aggregate acres treated
1960	not available	1,130,800 a/
1961	not available	444,600 a/
1962	not available	1,000,000 a/,b/
1963	not available	1,500,000 a/,b/
1964	not available	1,500,000 a/,b/
1965	not available	1,500,000 a/,b/
1966	not available	1,000,000 a/
1967	not available	1,200,000 a/
1968	3,367,542 c/,d/	4,073,518 c/,d/
1969	2,695,251 c/,d/	4,260,576 c/,d/
1970	2,565,122 c/,d/	3,962,342 c/,d/
1971 e/	2,623,642	3,873,642

a/ Cooperative Economic Insect Report.
b/ Principally for sorghum midge control.
c/ From county extension agents' reports.
d/ Principally for greenbug control.
e/ Data for Texas High Plains and Panhandle counties only.

OTHER PEST PROBLEMS

Although the sorghum midge and greenbug are the major grain sorghum pests in Texas, Banks grass mite and the soil pest complex (rootworms, seedcorn maggots, seedcorn beetles, and cutworms) are of real importance in somewhat more restricted areas of the state. Sporadic economic losses have resulted from infestations of sorghum webworms, fall armyworms, chinch bugs, stink bugs, false chinch bugs, stalk borers, etc. Use of insecticides for pest control must be based on economic pest thresholds and the absence of effective natural controls. Equally important in any pest control program is the selection of an effective insecticide, proper calibration to control rate of application, and selection of the method of application.

ECONOMIC THRESHOLDS

Our most serious challenge at this time is to work closely enough with growers so that they can gain proficiency and confidence in using economic threshold guidelines.

Current production economics, the threat of insecticide resistance, and secondary pest outbreaks dictate that insecticides be used only when needed to prevent economic loss. The indiscriminate use of chemicals for control can only result in the loss of these effective tools. The following damage threshold guidelines have proven effective in Texas.

Pest	*Control Guidelines*	
Sorghum midge	Damage occurs *only* at the time of spikelet anthesis or blooming. An average of 2 or more adult midges per head are required to cause economic damage.	
Greenbug	*Plant size*	*When to treat*
	Emergence of 6 inches in height	When visible damage is observed with greenbug colonies on plants. Early seedling mortality is a good thumb-rule.
	Larger plants to pre-boot	Before any entire leaves are killed.
	Pre-boot to hard-dough	When damage is sufficient to cause death of more than two normal-sized leaves.
Corn leaf aphid	Control seldom justified after seedling stage. Stand loss can occur if heavy populations migrate to seedling plants. Although rare, control in grain sorghum heads may be required to prevent the accumulation of honeydew which interferes with harvesting.	
Sorghum webworm	Applications justified when 10-25 percent of heads are infested with 5 or more larvae per head.	
Chinch bug	Severe stunting occurs from seedling emergence to booting. Economic damage occurs when 1 to 2 or more adults are found per 5 seedling plants up to 6 inches in height. On larger plants, initiate control when nymphs or adults are found on 75 percent of plants. Control on booting and larger plants is seldom satisfactory.	
Fall armyworm Corn earworm	Only on rare occasions do these two pests cause economic loss as whorl or head feeders. Larval counts averaging 2 or more per head are required for economic damage.	

1972 CONTROL RECOMMENDATIONS

The 1972 control recommendations for grain sorghum insects in Texas are presented on the following pages.

1972 Insect Control Recommendations for Grain Sorghum in Texas

Pest	Insecticides (listed alphabetically) Sprays (toxicant per gallon)	Spray concentrate	Days from last application Harvest	Grazing	Remarks
Wireworm Corn rootworm	A. Chlordane (8 lb.) B. Diazinon (14.3% G)	1 to 2 qt. 7 to 10 lb.	See remarks See remarks		Chlordane. Use as preplant broadcast soil application only. Spray or granular formulations at the same rate are equally effective. Diazinon. Use as granular, row band application at time of planting. Seed treatments with aldrin, dieldrin, heptachlor, or lindane are effective in controlling wireworms and light infestations of corn rootworms at planting time.
Sorghum midge	A. Carbaryl (Sevin) (80% WP)	1-1/2 to 2 lb.	21	0	Mainly a pest of late-blooming grain sorghum. Timing of applications is important in obtaining effective control. First application should be made when approximately 30 to 50 percent of the heads have just begun to bloom and 2 or more adult midges are present per head. Repeat the application 3-5 days later where economic adult populations persist. Economic damage occurs when adult midge numbers exceed an average of 2 per head. Disulfoton and carbophenothion. Do not apply more than twice per season.
	B. Carbophenothion (Trithion) (4 lb.)	1 pt.	21 See remarks	21	
	C. Diazinon (4 lb.)	1/2 pt.	7	0	
	D. Disulfoton (Di-Syston) (6 lb.)	1/3 to 2/3 pt.	7 See remarks	28	
	E. Ethion (4 lb.)	1/2 to 1 pt.	30 See remarks	30	
	F. Parathion (4 lb.)	1 pt.	12	12	

					Ethion. Do not apply more than 3 times per growing season. Do not substitute methyl parathion for parathion.
Sorghum webworm	A. Carbaryl (Sevin) (80% WP) B. Parathion (4 lb.) C. Toxaphene (6 lb.)	1-1/4 to 2-1/2 lb. 1/2 pt. 1/3 to 1/2 gal.	21 12 See remarks	0 12	Make applications when 10-25 percent of heads are infested with 5 or more larvae per head. Apply insecticides when worms are small. Toxaphene. 1/3 gallon. Do not apply within 28 days of harvest; 1/2 gallon, do not apply within 40 days of harvest. At either rate, apply only once after heads start to form; do not graze dairy animals or animals being finished for slaughter on treated fields; do not ensile treated forage. Do not substitute methyl parathion for parathion.
Greenbug	A. Carbophenothion (Trithion) (4 lb.) B. Demeton (Systox) (2 lb.) C. Diazinon (4 lb.) D. Disulfoton (Di-Syston) (6 lb.) (15% G) E. Malathion (5 lb.) F. Parathion (4 lb.) G. Phorate (Thimet) (15% G)	0.2 to 0.4 pt. 0.4 to 0.8 pt. 1/2 pt. 1/8 to 1/4 pt. 3-1/2 to 4 lb. 1/2 pt. 1/2 pt. 3-1/2 to 4 lb.	21 / See remarks 35 / See remarks 7 7 30 / See remarks 7 12 28	21 35 0 28 14 7 12 28	The need for insecticide applications is dependent on greenbug numbers, plant size, vigor and stage of growth, moisture conditions, and presence of parasites and predators. It is important to be able to distinguish between the greenbug and other aphids occurring in sorghums. The lower rates of Carbophenothion, Demeton, and Disulfoton have been effective in controlling economic infestations. Effective use of reduced rates is dependent on proper application timing. Reduced rates are designed to suppress greenbug populations

Greenbug (continued)

Guidelines for Determining Need for Greenbug Control

Plant Size	*When to Treat*
Emergence to about 6 inches	Visible damage with colonies of greenbug on plants.
Larger plants to pre-boot	Before any entire leaves are killed.
Pre-boot to hard-dough	When greenbug damage is sufficient to cause death of more than two, normal-sized leaves.

below injurious levels while providing maximum protection of beneficial species. Total elimination of greenbugs is not desirable. To conserve beneficial species, sub-economic greenbug populations must be maintained as a food source.
Carbophenothion. See remarks under sorghum midge.
Demeton. Apply only once per season.
Disulfoton. Do not apply foliar spray more than twice per crop season or granular application more than once per season. Granular formulation recommended as whorl application only.
Malathion. Recommended for ground application only.
Phorate. Recommended as whorl application only.
Do not substitute methyl parathion for parathion.

Corn leaf aphid	A. Carbophenothion (Trithion) (4 lb.)	1 pt.	21	21 See remarks	Heavy populations of corn leaf aphids sometimes cause stand loss in seedling or small grain sorghum. Larger sorghum can tolerate heavy populations without yield reductions. Although rare, control in grain sorghum heads may be required to prevent the accumulation of honeydew which interferes with harvesting. Demeton, disulfoton, malathion, and phorate. See restrictions under
	B. Demeton (Systox) (2 lb.)	1 pt.	35	35 See remarks	
	C. Diazinon (4 lb.)	1 pt.	7	0	
	D. Disulfoton (Di-Syston) (6 lb.)	1/3 to 2/3 pt.	7	28	
	(15% G)	2 to 3 lb.	30	14 See remarks	
	E. Malathion (5 lb.)	1-1/2 pt.	7	7 See remarks	

Corn leaf (continued) aphid	F. Parathion (4 lb.)	1/2 to 1 pt.	12	12	greenbugs above. Carbophenothion. See restrictions under sorghum midge.
	G. Phorate (Thimet) (15% G)	3-1/2 to 4 lb.	28	28	Do not substitute methyl parathion for parathion.
Yellow sugar-cane aphid	A. Demeton (Systox) (2 lb.)	1 pt.	35	35	This aphid is lemon yellow in color, covered with small spines and has two double rows of dark spots down the back. Feeding aphids secrete a toxin, and colonies of 5 to 10 per leaf can kill grain sorghum up to 18 inches in height. Treatment should begin at first sign of damage. Demeton. Apply only once per season. Do not substitute methyl parathion for parathion.
	B. Parathion (4 lb.)	1 pt.	12	12	
Chinch bug Flea beetle Stink bug	A. Carbaryl (Sevin) (80% WP)	1-1/2 to 2 lb.	21	0	Severe stunting by chinch bugs noted from time of seedling emergence to 18 inches high. Control not generally justified on larger sorghum. Apply controls when 1 to 2 or more adults are found per 5 plants on seedlings. Make at least 5 checks randomly in field. On 6-inch or taller plants, initiate control when nymphs or adults are on 75 percent of plants. Toxaphene. See restrictions listed under sorghum webworm. Do not substitute methyl parathion for parathion.
	B. Parathion (4 lb.)	1 pt.	12	12	
	C. Toxaphene + Parathion (6 lb. + 4 lb.)	1/3 gal. + 1 pt. or 1/2 gal. + 1/2 pt.	See remarks		

False chinch bug	A. Malathion (5 lb.)	1-1/4 to 1-1/2 pt.	7	7	Do not substitute methyl parathion for parathion.
	B. Parathion (4 lb.)	1/2 to 1 pt.	12	12	
Mites *(Oligonychus ssp.)*	A. Carbophenothion (Trithion) (4 lb.)	1 pt.	21	21 See remarks	Size and maturity of the plants will dictate the need for applications. Research has shown no yield increase or reduced lodging following treatments in the hard dough or later stages of plant growth. Erratic control with all recommended material has been experienced in some areas of Texas. Thorough application is required. Disulfoton and phorate. See restrictions above under greenbug. Ethion. See restrictions under sorghum midge; has been effective only in South Texas and Gulf Coast areas. Parathion. Two or more applications may be required. Sulfur. This is the only material which has been effective in the Trans-Pecos area of Texas. Thorough coverage is necessary. Carbophenothion. See restrictions under sorghum midge. Do not substitute methyl parathion for parathion.
	B. Diazinon (4 lb.)	1 pt.	7	0	
	C. Disulfoton (Di-Syston) (6 lb.)	2/3 pt.	7	28	
	(15% G)	3-1/2 to 4 lb.	30	14	
	D. Ethion (4 lb.)	1 pt.	30	30 See remarks	
	E. Parathion (4 lb.)	1/2 to 1 pt.	12	12	
	F. Phorate (Thimet) (15% G)	3-1/2 to 4 lb.	28	28	
	G. Sulfur (50% dust)	60 to 70 lb.	0	0 See remarks	

None of the above materials have provided consistent, satisfactory control in the Trans-Pecos area.

Sugarcane borer Southwestern corn borer	A. Carbaryl (Sevin) (80% WP) (20% G) B. Diazinon (4 lb.) C. Parathion (4 lb.)	 2 lb. 6.25 lb. 1 pt. 1 pt.	 21 0 7 12	 0 0 0 12	Fall stalk destruction reduces number of larvae overwintering in old stalks. This cultural practice is the most effective means of control. Early planted sorghum commonly escapes damage caused by larvae. Apply spray or granules when 25 percent of plants show feeding injury on foliage. Early detection of eggs or small larvae is important. Repeat application in 7 to 10 days. Two to 4 applications generally required. Direct application at upper 1/3 of plant and into whorl. Do not substitute methyl parathion for parathion.
Lesser cornstalk borer	A. Diazinon (4 lb.) (14.3% G) B. Parathion (4 lb.) (4% G)	1 to 2 pt. 7 to 8 lb. 1 pt. 25 lb.	See remarks See remarks See remarks See remarks		Apply spray or granules in a band 4-6 inches wide over seed furrow or seedling plants. Simultaneous with planting, apply just after seed drop and seed press wheel and in front of covering shovels, press wheel, or chain drag. Soil coverage is important. Do not substitute methyl parathion for parathion.
Fall armyworm Corn earworm	A. Carbaryl (Sevin) (80% WP) B. Toxaphene (6 lb.) C. Parathion (4 lb.)	 2 lb. 1 qt. 1 to 2 qt.	 21 See remarks 12	 0 12	Only on rare occasions do these two pests cause economic loss. Good control of corn earworm is difficult to achieve. Larval counts exceeding an average of 2 per head are required for economic damage. Toxaphene. Refer to use restrictions under sorghum webworm. Do not substitute methyl parathion for parathion.

WEED CONTROL IN GRAIN SORGHUM

George Kapusta

Weed control in grain sorghum closely parallels control in corn in that several of the same herbicides are used for both crops. Important use differences must be considered, however. Data are not available on sorghum acreage treated with herbicides or on which herbicide is used most commonly, but returns from a recent farmer questionnaire suggest that most of the 1971 acreage was treated with a herbicide, and that AAtrex was the most commonly used herbicide.

PREEMERGENCE

Ramrod at 6.0-7.5 pounds per acre will control most grass weeds and lambsquarter, pigweed, and ragweed. The higher rate should be used on soils with higher organic matter. Ramrod can be mixed with nonpressure nitrogen solutions and applied prior to crop emergence. Dairy animals and beef finishing for market should not graze or feed on forage or silage from treated fields.

Ramrod/atrazine combination is preferred to Ramrod alone where large-seeded broadleafs such as jimsonweed, cocklebur, smartweed, and velvetleaf are a problem. Ramrod/atrazine should be applied preemergence only, at a rate of 5 to 8 pounds per acre of the mixed product (4.5-5.2 pounds per acre of Ramrod + 1.5-1.8 pounds per acre of AAtrex 80W). The upper rates should be used on soils with over 3.0 percent of organic matter. Dairy animal feeding restrictions are the same as for Ramrod alone.

Milogard is a triazine herbicide similar to AAtrex in certain respects but can be applied preemergence to grain sorghum. Suggested rates are 2.5 to 3.0 pounds per acre although experienced growers on the lighter, low-organic-matter soils obtain good results with lower rates. Milogard should not be used on sandy soils. Corn can be planted safely 12 months after Milogard use but an 18-month waiting period is necessary for crops such as soybeans. It should not be applied postemergence on grain sorghum.

Herban at 2.0 to 3.0 pounds per acre preemergence provides good grass control. It also controls a relatively wide spectrum of broadleaf weeds.

Herban 21A is a mixture of Herban and AAtrex and provides better broadleaf weed control than Herban alone. Suggested use rates are Herban 2.5 pounds per acre and AAtrex 1.25 pounds per acre. Grain sorghum treated with this herbicide should not be grazed for 60 days after application.

Herban 21P is similar to Herban 21A except that Milogard is substituted for AAtrex at an equal rate. Herban 21A is the preferred treatment for Illinois.

POSTEMERGENCE

AAtrex is cleared for postemergence use only in Illinois. Oil (nonphytotoxic) should not be used in combination with AAtrex as sorghum injury may occur. The best time to spray is when sorghum is 1-1/2 to 4 inches tall and weeds are less than 2 inches high, although control of older weeds is often satisfactory. AAtrex rates of 2.5 to 3.0 pounds per acre are recommended, but experienced growers on low-organic-matter soils have used lower rates. Sorghum can be sprayed until just prior to boot stage, but weed control will be less satisfactory since weeds are larger. If AAtrex is applied to late-planted sorghum, greater carryover might occur since the period of breakdown has been reduced in contrast to applications on corn fields. Treated sorghum should not be fed or grazed for 60 days.

2,4-D is an effective, economical postemergence herbicide for broadleaf weed control in sorghum and can be applied when the crop is between 4 and 20 inches high. Drop nozzles should be used if the crop exceeds 10 inches in height. Rate recommendations are 4 to 6 ounces per acre of ester or 8 ounces per acre of the amine formulation. Preemergence applications of 2,4-D should not be made, as the crop may be injured.

RECENT DEVELOPMENTS IN AQUATIC WEED CONTROL

R. C. Hiltibran

New developments in aquatic plant control have been very slow due in part to the reorganization of the federal government and the creation of the Environmental Protection Agency and in part to the very cautious consideration of the aquatic herbicide registration requests. This past summer much of our efforts was directed to investigating the uptake of herbicides by plants and fishes, and the water and hydrosoil content of various herbicides, applied under various experimental conditions. The data are not yet available, but results of a previous investigation indicate that bluegill, aquatic plants, and hydrosoil rapidly remove diquat from water.

The combination of diquat and copper has been found to be very effective for the control of some aquatic plant species. The combinations we have used were made by calculating the amount of diquat necessary to treat the area desired, and then using one-half that volume and mixing with an equal volume of Cutrine, a triethanolamine complex of copper (Applied Biochemists & Associates, Mequon, Wisconsin), and applying the mixture under the water surface. We found that curlyleaf pondweed, *Potamogeton crispus*, in the test areas was eliminated at a rate of diquat of 0.25 ppmw. This combination will have to be investigated further on other species more difficult to control before we can suggest this combination on those species.

Granular Hydrothol-47 (Pennwalt Corporation) applied to a total pond at a rate of 100 pounds of the granular formulation per surface acre eliminated the stand of leafy pondweed, *P. foliosus*, and small pondweed, *P. pusillus*, within four days after application. Heavy rains in July resulted in an increase in water volume, and apparently the level of herbicides was reduced below the toxic level necessary for the control of sago pondweed, *P. pectinatus*. There was a reduction in the stand of filamentous algae. Chara, *Chara vulgaris*, was also present in the pond, but the stand was not adequate to obtain definitive data as to the effect of Hydrothol-47 on chara at this rate of application. No loss of fish occurred, but there should be approximately 4 acre-feet of water surface to reduce the potential toxic hazard to fishes. This rate of application of Hydrothol-47 has been very successful in Indiana in farm ponds containing from 4 to 6 acre-feet of water. With more than 6 acre-feet of water, 100 pounds of Hydrothol-47 may not be very effective.

BARN AND LIVESTOCK FLY CONTROL

Steve Moore III

CONTROL OF BARN FLIES

House flies and stable flies comprise the major complex of barn flies.

Sanitation. Eliminate fly-breeding material at frequent intervals, preferably once each week.

Barn Sprays. The results of the 1971 barn spray tests are given in Table 1. Results of field trials in the previous five years showed that the following insecticides used as barn sprays can be expected to perform as follows:

Insecticide[a/]	Weeks of satisfactory control
fenthion (Baytex) 1.5%	4 to 6
dimethoate (Cygon) 1.0%	3 to 4
Rabon 1.0%	2 to 4
Ravap 1.0% + 0.1%	2 to 4
diazinon 1.0%	2 to 3
ronnel (Korlan) 1.0%	1 to 2

a/ Insecticides have label approval and are commercially available. Remove animals from the barn before spraying the barn, and avoid contaminating feed and water troughs. Do not apply in conjunction with the feeding of phenothiazine or organo-phosphorus insecticides.

A higher percentage of failures due to fly resistance can be expected when diazinon or ronnel are used.

Barn sprays should be applied to runoff to the ceilings and walls of all buildings housing cattle. In addition, outside areas where flies congregate around windows, doors, along fences, and under feed bunks also should be sprayed.

Spray Baits. Spray baits serve as a supplement to good sanitation and barn spraying. Use 4 ounces of dichlorvos (Vapona, DDVP) 22% liquid concentrate or 2 ounces of naled (Dibrom) 37% liquid concentrate in one gallon of clear corn sirup and one-half gallon of warm water. Apply as a straight stream or wetted spray to the favorite fly-roosting areas but out of reach of the animals.

Space Sprays. Use space sprays as alternatives to barn sprays and spray baits for large drylot and large enclosed-housing operations. The mist blower can be mounted on a pickup truck or trailer and moved through the alleyways and lanes as the mist is blown over the pens and into the barns through doorways and windows. It may be applied with animals present, but avoid direct application to exposed feed and water. Do not apply in conjunction with animal or shelter treatments of organophosphate or carbamate insecticides.

The insecticides and rates suggested for mist blowers are as follows:

Insecticide	Amount per 100 gal. water	How to apply[1/]
Dichlorvos (DDVP) 22% liquid concentrate	2 gallons	Apply at 5 gallons of finished spray per acre
Naled (Dibrom) 37% liquid concentrate	1 gallon	Same as above

a/ Apply every 3 to 7 days.

CONTROL OF PASTURE FLIES

Face flies, horn flies, and stable flies comprise the major fly complex affecting pastured cattle in Illinois. A two-year study of the state-wide populations of these flies and their estimated effect on production was as follows:

Fly species	Percent production loss per fly per day	Number of flies per animal, May-Sept.	Percent production loss per animal
Face fly	.02	138.7	2.8
Horn fly	.70	8.5	6.0
Stable fly	.15	10.9	1.6
		Total	10.4

Cattle kept on drylot will not be bothered by either face flies or horn flies. In the summer of 1971, a study was conducted on the effectiveness of forced treatment of cattle with dust bags containing 3% crotoxyphos (Ciodrin) against the fly complex attacking pastured cattle in three different herds. Crotoxyphos in dust bags used as forced treatments on pastured cattle nearly eliminated horn flies but was erratic against face flies and stable flies (Table 2).

The greatest reduction of all three pasture flies occurred in herd 1 in the northern section. The cattle in this herd also received two to three times as much dust per day as cattle in herds 2 and 3 (Table 3).

The crotoxyphos dust bag treatments on all three herds reduced face flies by 26.2 percent, horn flies by 97.7 percent, and stable flies by 31.5 percent (Table 4).

Suggested Insecticides for Control of the Pasture Fly Complex in Illinois

For Dairy Cattle

Insecticide	How to apply	Results expected
Crotoxyphos (Ciodrin) 2.0% in oil	1 to 2 oz. per animal 2 to 4 times per week	Effective control of horn flies, face flies, and stable flies
Crotoxyphos 2.0% in water	Same as above	Same as above
Crotoxyphos 1.0% in water	1 to 2 pints per animal per week	Same as above
Dichlorvos (DDVP) 1.0% in oil	1 to 2 oz. per animal per day	Effective control of horn flies and some protection against stable flies
Pyrethrin 0.1% in oil + synergist 1.0%	Same as above	Same as above

For Beef Cattle

Insecticide	How to apply	Results expected
Crotoxyphos (Ciodrin) 2.0% in oil	1 to 2 ounces per animal 2 to 4 times per week from automatic sprayer	Effective control of face flies, horn flies, and stable flies
Crotoxyphos 1.0% in water	1 to 2 pints per animal per week	Same as above
Toxaphene 0.5% in water	1 to 2 quarts per animal every 3 weeks	Effective control of horn flies and some protection against stable flies
Toxaphene 5.0% in oil	From canvas or burlap back and face oiler	Effective control of horn flies and partial control of stable flies and face flies

Table 1. Results of Residual Barn Sprays With Fenthion, Rabon, and Dimethoate Against House Flies and Stable Flies in Illinois in 1971

Location and cooperator	Insecticide and dosage	Dates of appli-cation	Fly populations before treatment	Control rating: Days after treatment 1	7	14	21	28	35	42
Ogle County (John Leary)	fenthion 1.0%	6/20/71	Medium	Exc.	Good	Good	Fair	Fair		
	fenthion 1.5%	7/20/71	Abundant	Exc.	Exc.	Good	Good	Good	Good	Fair
Ogle County (Don Leary)	Rabon 1.0%	7/1/71	Medium	Exc.	Good	Good	Fair	Fair		
	Rabon 1.0%	8/9/71	Abundant	Exc.	Good	Fair	Fair	Poor		
St. Clair County (Wayne Meng)	fenthion 1.0%	5/29/71	Heavy	Exc.	Exc.	Good	Fair	Poor		
	fenthion 1.5%	6/29/71	Heavy	Exc.	Fair	Fair	Poor			
	fenthion 1.5%	7/20/71	Abundant	Good	Fair	Fair	Poor			
	dimethoate 1.0%	8/17/71	Heavy	Good	Fair	Fair	Poor			

Table 2. Number of Pasture Flies on Cattle Force-Treated With 3% Crotoxyphos From Dust Bags in Illinois in 1971

Location and herd No.	No. head tr.	No. days tr.	Date treatment started	Number of flies per animal											
				6/15-6/17			6/22-6/23			7/12-7/15			8/25-8/27		
				Face	Horn	Stable	Face	Horn	Stable	Face	Horn	Stable	Face	Horn	Stable
Northern section															
Herd 1 Treated	38	95	5/24	4.6	1.8	1.8	5.8	0	6.1	28.2	0	11.2	16.5	0	.8
Herd 1A Untr.	..	...	...	10.4	56.0	8.0	11.6	53.4	22.6	34.6	70.0	10.2	24.9	62.5	3.8
Central section															
Herd 2 Treated	36	98	5/19	29.5	7.4	2.4	...	...	...	11.8	1.2	2.4	15.1	0	4.8
Herd 2A Untr.	..	...	...	35.4	97.0	2.8	...	...	...	33.7	68.5	2.0	45.4	136.0	4.0
Southern section															
Herd 3 Treated	40	100	5/17	19.5	3.2	3.8	23.7	21.4	6.4	43.8	0	5.6	21.2	0	3.6
Herd 3A Untr.	..	...	...	15.8	302.0	1.5	23.3	460.0	9.8	36.5	90.0	4.2	26.1	156.0	2.5

Table 3. Reduction of Pasture Flies on Cattle Force-Treated With 3% Crotoxyphos From Dust Bags in Illinois in 1971.

Location and herd No.	Oz. dust per animal per day	Percent reduction of flies on treated animals											
		6/15-6/17			6/22-6/23			7/12-7/15			8/25-8/27		
		Face	Horn	Stable	Face	Horn	Stable	Face	Horn	Stable	Face	Horn	Stable
Northern Section													
Herd 1	.0914	55.8	96.8	77.5	50.0	100.0	73.0	18.5	100.0	0	33.7	100.0	78.9
Central Section													
Herd 2	.0334	16.7	92.4	14.3	...	...	...	65.0	98.2	0	66.7	100.0	0
Southern Section													
Herd 3	.0425	0	98.9	0	0	95.3	34.7	0	100.0	10.0	18.8	100.0	0

Table 4. Results of Pasture Fly Control on Cattle Force-Treated With 3% Crotoxyphos From Dust Bags in Illinois in 1971

Location and herd No.	Percent reduction of flies for entire rest period		
	Face	Horn	Stable
Northern Section			
Herd 1	32.4	99.3	55.4
Central Section			
Herd 2	50.7	97.1	0
Southern Section			
Herd 3	6.0	97.6	7.2
All herds	26.2	97.7	31.5

WEED CONTROL IN NO-TILLAGE SYSTEMS

G. B. Triplett, Jr.

One of the first uses of herbicides in field crops was to kill weeds escaping the plow, disk, or cultivator. Thus 2,4-D controlled ragweed and pigweed plants growing in the corn row but did not replace any tillage operation. Some herbicides developed more recently have made possible the substitution of herbicides for some or all of the tillage function of weed control. No-tillage, a spray-plant-harvest system, involves complete substitution of herbicides for tillage. Since weed control is essential for satisfactory crop production, the herbicide must assume, dependably, all the functions of tillage in controlling weeds. Successful adoption of no-tillage by farmers on nearly half a million acres of corn indicates that the system, including herbicides, can perform satisfactorily.

Several functions are required of herbicides used for no-tillage crop production. The herbicides must:

(1) Destroy vegetation present on the site,
(2) Prevent growth of weeds from seed present in the soil,
(3) Not injure the crop,
(4) Not injure succeeding crops.

Another requirement that the herbicide should compete economically with alternative practices could be included. No one herbicide known today will perform all these functions over a wide range of conditions, making herbicide combinations necessary. Further, vegetation and soils vary widely, and a satisfactory herbicide system for one set of conditions may be ineffective under other circumstances. This paper will discuss herbicide systems for no-tillage using the requirements noted above.

PLANTING CORN FOLLOWING MEADOW

No doubt very little corn follows a meadow crop in the central Corn Belt, but pasture and meadow crops are important in the rolling topography to the east and south of the Corn Belt where no-tillage is becoming an accepted practice. Usually a meadow is planted to corn after the legume stand is reduced and grasses dominate. A wide range of perennial species may be present in meadows.

Control of Perennial Grasses

Several herbicides or combinations may be used to kill perennial grasses. A listing of herbicides and an evaluation of their usefulness in controlling established perennials are shown in Table 1. All the satisfactory herbicides listed here except diuron are chlorotriazines.

Most cool-season forage grasses can be killed with a mixture of 2 pounds[1/] per acre of atrazine plus 1/4 to 1/2 pound of paraquat. This is quite a dependable system.

1/ All rates of herbicides throughout this paper are in pounds per acre of active ingredients.

Table 1. Rating of Herbicide Effectiveness in Controlling Perennial Grasses

Control with or without paraquat	No control or unsatisfactory control, even with paraquat
Atrazine	Alachlor
Gs 13529	Amiben
Simazine	Ametryne
Bladex[a/]	Linuron
Diuron[b/]	Prometryne
	Propazine

a/ Bladex alone did not give control at 8 pounds per acre in one experiment on orchardgrass.
b/ Rates of Diuron required for kill exceed crop safety requirements.

The atrazine rate represents the minimum amount necessary to give residual control. We have controlled perennial grasses with as little as 1/2 pound of paraquat plus 1/2 pound of atrazine, but with this mixture annual weeds became a problem. Paraquat alone usually will not kill meadow grasses.

Atrazine alone or combined with oil can be used to kill perennial grasses but requires higher rates than if combined with paraquat. A ranking of grass species based on their susceptibility to atrazine is given in Table 2. As low a rate as 2 pounds of atrazine alone might kill bluegrass for early spring applications to immature plants while 3 to 3-1/2 pounds could be required for control of orchardgrass sprayed on the same date. Higher rates of the herbicide are required as the season progresses and the grass matures. After heading, paraquat is almost essential for control of orchardgrass and tall fescue.

Mowing has influenced the rate of herbicide necessary for kill. Even after the grass heads, mowing reduces the rate of atrazine alone required for control to the level necessary in early spring. Thus 2 to 2-1/2 pounds of atrazine sprayed on the stubble of timothy or smooth bromegrass after removal of a meadow crop can give satisfactory control. This would be of interest to the farmer planting corn after an early meadow harvest.

Relatively large changes in herbicide rates for atrazine applied alone are required to move from the no-effect level to complete death. As the rate is reduced from that required for complete kill, scattered plants begin to survive. These barely stay alive, produce very little growth during the season, and do not compete significantly with the growing crop. Further reductions in herbicide rate allow more and more plants to survive with increasing vigor, allowing competition with the crop plants and a corresponding reduction in yield.

Table 2. Ranking of Grass Species According to Ease of Control With Atrazine

Kentucky bluegrass		No control of these species:
Reed canarygrass		
Timothy	More	Johnsongrass
Smooth bromegrass	herbicide	Bermudagrass
Quackgrass	needed	
Tall fescue		
Orchardgrass		

The opportunity to correct a poor spraying job exists with perennial grasses, even after the crop emerges. If the rate of herbicide was inadequate and the surviving grass is competing with the crop, another pound of atrazine plus a good surfactant will complete killing the grass without injury to the planted corn.

Control of Perennial Broadleaf Species

Atrazine and oil or atrazine and paraquat can effectively control perennial grasses but may fail to control many perennial broadleaf species. Alfalfa, dandelions, and dock can survive 3 to 4 pounds of atrazine and still compete with the corn crop. Applying 2,4-D, dicamba, or a combination will eradicate these and many of the other common broadleaf species. Paraquat interferes with the action of 2,4-D but not of dicamba if the two herbicides are applied in a tank mix. One possible reason for this is that the rapid defoliation by paraquat reduces entry of 2,4-D into the plant. Dicamba can be taken up through root absorption, and its effectiveness is not diminished by defoliating the plants. A mixture of atrazine, oil, and 2,4-D has given good results in our trials on meadow species, and there is little danger to the crop if the herbicides are applied preemergence. When vigorous stands of perennials are killed, 2 to 3 pounds of atrazine is usually adequate for control of annual weeds growing from seed.

PLANTING CORN FOLLOWING CLEAN-TILLED CROPS

Weed problems for no-tillage corn planted following a clean-tilled crop contrast sharply with those for corn planted in sod. Usually established perennials are a minor part of the weed population, and seedling perennials or small annuals present when herbicides are applied are relatively easy to control. The most important weed pressure comes from germinating weed seeds, which the residual herbicide must control. If the residual herbicide does not control all weed species present, those that escape can increase and create severe problems after a year or two of continuous cropping. An example of this is the rapid increase of fall panicum where corn is grown without tillage and atrazine is used as the residual herbicide.

Several herbicide systems have performed satisfactorily in our trials on continuous no-tillage corn. With no-tillage systems, weed seeds are not buried and other conditions differ, so performance of herbicide systems used for conventional tillage cannot be exactly transposed.

1. Simazine or simazine plus atrazine, 1:1

Paraquat at a rate of 1/8 to 1/4 pound should be added to control vegetation present at planting time; if fall panicum is the major weed problem, apply before the grass is more than 2 to 3 inches tall. Simazine at 2 pounds plus paraquat has given consistently satisfactory control of annual weeds including fall panicum for no-tillage corn over a period of nine years. These trials were on a silt loam soil low in organic matter, and the rates noted would need to be increased with higher organic matter or clay content of soil. The combination of simazine plus atrazine plus paraquat has performed satisfactorily over a period of five years on the same soil. Both combinations provide season-long control so the fields are relatively weed-free at harvest time, and the residual could cause problems if some sensitive crop follows the corn or if a cover crop is planted.

2. Simazine plus linuron, 1:1

In our trials this mixture has given good control of a wide range of annual species including fall panicum. Residual is shorter than the combination (1) and some weeds may become established late in the season. This mixture, however, would be less likely to cause injury to sensitive crops following the corn, and the linuron when mixed with a good surfactant has enough contact activity to destroy seedling weeds present at planting time. Paraquat should be included in the mixture if grass seedling weeds are 1 inch or taller. Linuron can cause corn injury if the rate is too high or seeds are planted too shallow, although we have not had trouble with 1 pound active.

3. Linuron plus alachlor, 1:2

This mixture has been relatively effective under heavy panicum pressure but does not have long enough residual to give consistent full-season control. This is our best combination for no-tillage soybeans, and the only one noted here that does not contain a triazine. Paraquat should be added if weeds are large when spray is applied.

4. Others

Several herbicide systems that show promise include simazine plus alachlor, atrazine plus alachlor, and atrazine plus linuron. Paraquat should be included to destroy emerged weed seedlings; panicum plants only a few days old can tolerate simazine or alachlor.

Almost every mixture listed above contains herbicides that will injure emerged corn plants. Thus the herbicides must be used preemergence or applied as a directed spray. In emerged corn, fall panicum is much more difficult to control than perennial grasses noted in the section on meadow crops, and the herbicide program should be carefully designed to eliminate annuals before the crop emergence.

Problem Weeds

Several weeds are not readily controlled with the materials listed above. As noted in Table 2, johnsongrass and bermudagrass cannot be controlled with herbicides currently available, and crops should not be planted with no-tillage where these are present in any quantity. Nutsedge usually has not emerged when the herbicide is applied and, if present, may create problems later in the season. Nutsedge can be controlled with a postemergence application of atrazine plus oil.

Several perennial broadleaf weeds may not be controlled by routine herbicide applications. These include Indian hemp (dogbane), milkweed, horsenettle, and ground cherry. Many of these are tolerant to the herbicides used or escape application because of late emergence, or both. Fortunately, most are not serious competitors with the crop, and a small infestation is not critical. Spot spraying with effective herbicides will be required for control of these weeds.

INTERMEDIATE TILLAGE SYSTEMS

Weed control may be simplified by use of some intermediate tillage systems rather than complete no-tillage. Disking and cultivation can augment the herbicides and can be used as a basis for satisfactory tillage systems. Disking before planting will destroy weeds present, reducing or eliminating the need for contact herbicides. Rolling cultivators will perform satisfactorily in crop residues to destroy seedling weeds between the crop rows. With the possibility of cultivating, full-season persistence of herbicides is not as important.

OTHER CROPS

The discussion on the preceding pages primarily concerns no-tillage corn production. Herbicide systems are best developed for corn, and most work has been done with this crop. Work has been reported with many other crops including cotton, grain sorghum, soybeans, sugarbeets, peanuts, wheat, direct-seeded tomatoes, potatoes, and alfalfa and other forage crops. Double-crop soybeans are planted with no-tillage on a commercial scale following small grain harvest, but work on most other crops is still in the experimental stage. In many cases, yields of crops have been satisfactory when weeds were controlled.

Tillage is not necessary for production of a satisfactory soybean crop. Yet there are no herbicides available to kill perennial grasses before planting soybeans, and control of many broadleaf species is difficult. Development of new herbicides or new techniques of weed control such as directed sprays will be necessary before no-tillage soybeans become practical. The same will be true of other crops.

Adoption of no-tillage crop-production systems requires development of new weed-control skills.

- --Herbicide mixtures are almost mandatory.
- --One herbicide system will not fit all conditions.
- --Herbicide performance in clean-tilled crops cannot be exactly transposed to no-tillage.
- --Backup procedures for herbicide malfunctions may be difficult or not well developed.

Satisfactory no-tillage crop production demands extensive knowledge of weeds and herbicides.

WEED CONTROL FOR CORN

E. L. Knake

With careful selection and use of herbicides, supplemented with timely cultivation, we can achieve good control of most of our major annual weeds in corn. We have good controls for both annual broadleaf and grass weeds and relatively good corn tolerance.

PREPLANT

Preplant has become popular in an attempt to get more operations performed before the busy planting season. For some preplant treatments incorporation is necessary, for others it is optional.

AAtrex may be applied within two weeks before planting. Usually, the closer to planting, the better. Preplant means broadcasting, but especially on the lighter soils, where relatively low rates are adequate, cost of broadcasting is considered reasonable. Mixing AAtrex with fluid fertilizer is popular in some areas. There is no urgency about incorporating AAtrex. If weather is dry, there may be some advantage to getting the herbicide into more moist soil to enhance absorption by weed seedlings. But incorporation of AAtrex should usually be relatively shallow to avoid excessive dilution.

Sutan may be applied preplant, alone or in combination with atrazine. The combination can improve control of grass weeds and reduce atrazine residue. A common rate has been 1/2 gallon (3 pounds active) of Sutan plus 1-1/4 pounds of AAtrex 80W per acre. However, rates up to 2/3 gallon of Sutan and 2 pounds of AAtrex 80W might be used. Application with fluid fertilizers is popular, but considerable care should be taken to make accurate and uniform applications to avoid injury. Sutan, alone or with atrazine, may be applied within two weeks before planting and should be incorporated immediately.

Lasso may be applied preplant, alone or in combination with atrazine. Incorporation is optional. For panicum control, surface application is preferable, but for nutsedge control, incorporation is desirable--especially if rainfall is light. Lasso may be applied within seven days before planting. Rates should be adjusted according to soils and weed species to be controlled. If Lasso is incorporated preplant, usually the rate should be slightly higher than for a preemergence treatment.

PREEMERGENCE

AAtrex applied at planting or shortly after continues to perform well. It controls most major annual broadleaf weeds and is usually quite good for smartweed control. Control of annual grass weeds is sometimes satisfactory with adequate rates. However, where control of foxtail is not as good as desired or where panicum is becoming a problem, combining a good grass killer with atrazine can be helpful.

Ramrod continues to be popular as a band-applied granule on soils with over 3 percent of organic matter. Supplementing Ramrod's grass control with an early postemergence application of 2,4-D provides one of the most effective and economical programs for corn.

Ramrod-atrazine has an excellent performance record with good crop tolerance, broad spectrum control, and reduced residue. Granules of this combination may be available for 1972. Because of the irritation from the Ramrod wettable powder and the amount of wettable powder and water needed for application, this combination has probably not gained as much acceptance as its performance would justify.

Lasso is adapted to a wide range of soils. The liquid formulation has some handling advantage over the more irritating Ramrod wettable powder. Control of annual grasses has been very good, and Lasso provides one of the best answers for panicum and nutsedge. Corn tolerance may be a little less with Lasso than with Ramrod. Initial control with Ramrod may be a little better than with Lasso under minimal rainfall conditions. But weed control with Lasso may be a little longer than with Ramrod. Although the tolerance problem is not considered serious, we suggest that growers check with their chemical dealers and seed companies to avoid the possibility of using Lasso on sensitive hybrids. Suggested preemergence rate is usually 2 to 3 pounds per acre (active ingredient, broadcast basis), depending on soil and weed species.

Lasso-atrazine performance has been similar to that of Ramrod-atrazine. Some growers and applicators prefer the Lasso liquid formulation to the Ramrod wettable powder.

Knoxweed continues to have some acceptance because it is available as granules, controls both broadleaf and grass weeds, and presents no residue problem. Although sometimes satisfactory, its record of consistent performance is not quite as good as that of some other materials, and crop injury occasionally occurs.

Londax is a combination of Lorox and Ramrod. It is available in both granular and wettable powder form. Weed control has often been relatively good, but with Lorox in the combination there is some risk of corn injury.

POSTEMERGENCE

AAtrex and oil continues to find some use, primarily in the northern part of the state. This treatment has generally given good control of broadleaf weeds, including smartweed. Under favorable conditions it may also control small grass weeds. Injury to corn sometimes occurs and has occasionally been severe. If AAtrex and oil is used, label precautions should be followed very carefully. Usually preplant or preemergence applications of AAtrex are preferred over postemergence use.

2,4-D continues to be an effective, low-cost treatment for broadleaf control. Some corn injury occurs each year, but the acreage with severe injury is usually not extensive. Although more costly, an alternative which can provide greater crop safety and better smartweed control is AAtrex preemergence or preplant.

Banvel usage continues each year on a limited acreage. Injury to nearby soybeans is not uncommon and appeared to have increased in Illinois in 1971. The extent of possible reduction in soybean yields will depend on the amount of Banvel contacting the bean plants and the time. If soybeans are affected when small, yield reductions may not be as great as from later applications. New types of spray nozzles and spray additives may reduce but not eliminate the problem of Banvel movement to nearby soybeans. Corn injury from Banvel has occasionally occurred. A major reason for using Banvel is to control smartweed. For this purpose, AAtrex preplant, preemergence, or possibly postemergence would be preferable. If Banvel is used, it appears best to apply it soon after smartweeds emerge and before or soon after nearby soybeans have emerged.

NEW HERBICIDE DEVELOPMENTS

F. W. Slife

A number of new herbicides are under evaluation or development. Many of these alone or in combination will be useful if they receive registration.

BAS 3512. This has considerable promise as a postemergence spray for corn and soybeans. Early indications are that it controls most or all of the problem annual broadleaf weeds found in corn and soybeans. It has little effect on annual grasses.

MON 0468. Exceptionally good perennial grass control has resulted when this material has been applied. Both johnsongrass and quackgrass appear to be sensitive. Although it has low selectivity for use in crops, it appears to have very short soil residue.

Bladex. This triazine herbicide received registration in December, 1971. Corn tolerance appears to be satisfactory for preemergence applications. Compared with AAtrex, Bladex may give slightly better control for annual grasses. Length of control and residual activity are less than with equal rates of atrazine.

Maloran is similar chemically to Lorox. However, compared with Lorox about 1-1/2 times as much Maloran seems to be required for similar performance. Both corn tolerance and soybean tolerance are limited. Primary adaptation would probably be on soils with less than 3 percent of organic matter. Maloran is being considered for corn but is likely to have more potential for soybeans, possibly in combinations.

Basamaize is a new herbicide which performs somewhat like Ramrod and Lasso. Tolerance of corn and soybeans appears to be relatively good. Basamaize provides good control of annual grass weeds and will probably be of interest in combinations.

Noraben is a combination of norea and Amiben. Norea is a substituted urea herbicide related to Lorox. Norea, under the name Herban, is used as a sorghum herbicide. Noraben seems to be similar in performance to Amiben, but weed control is sometimes slightly less than with Amiben.

Coriben is a new experimental combination of Amiben and atrazine. Corn tolerance should theoretically be better than with a full rate of Amiben alone, but the possibility of corn injury is not completely eliminated. Amiben might improve grass control.

Amilon is a combination of Amiben and Lorox. Theoretically, Lorox might offer some improvement in control of velvetleaf, jimsonweed, and cocklebur, and Amiben may strengthen grass control. Control of annual morningglory should not be expected. More field evaluation is needed.

Dynoram and *Premerge 21* are combinations of Amiben and "dinitro." The "dinitro" may improve control of cocklebur and annual morningglory and possibly jimsonweed and velvetleaf.

Naphthalic anhydride is a new experimental chemical used to treat crop seed and decrease herbicide injury to the crop. In field trials, this chemical has decreased malformation from some herbicides but sometimes seems to cause a little loss of vigor and color. If this principle can be successfully developed, it may allow more widespread use of some herbicides that now have limited use on certain crops because of limited tolerance.

Solo-Lasso. This tank-mix combination has been approved by several of our surrounding states and has a state label in those states.

ADULT NORTHERN AND WESTERN CORN ROOTWORM POPULATIONS IN ILLINOIS, 1967-1971

D. E. Kuhlman, T. A. Cooley

This report includes a summary of the abundance and distribution of adult northern and western corn rootworm populations for 1971 and the period 1967-1971. A random survey of 320 cornfields in 32 counties was conducted between July 26 and August 4, 1971, to assess rootworm abundance. Counts of adult western (WCR) and northern (NCR) corn rootworms were taken in ten randomly selected fields per county. Counts were taken on 20 plants in each field and included the beetles found in the silks plus those present on the remainder of the plant. In this report we have reported our findings as the "average number of adults per 100 plants."

As in previous years, the survey was conducted through the joint efforts of county Extension advisers and Extension entomologists. A special thanks is extended to the Extension advisers of the counties listed below for their assistance in securing the crop and soil insecticide history of the fields.

District	Counties
Northwest	Bureau, Lee, Mercer, Ogle, Stephenson, Whiteside
Northwest	Boone, DeKalb, LaSalle
West	Adams, Henderson, McDonough, Warren
Central	Logan, McLean, Peoria, Woodford
East	Champaign, Iroquois, Kankakee, Vermilion, Livingston
West-southwest	Greene, Macoupin, Montgomery
East-southeast	Shelby, Jasper
Southwest	St. Clair, Washington
Southeast	Gallatin, Wabash, White

ABUNDANCE OF ROOTWORMS

Corn rootworm populations in 1971 were generally as high as in 1970 or higher, based on a survey of 320 fields. The highest populations of adult WCR's and NCR's in 1971 occurred in the northeast district of Illinois with an average of 106 adults per 100 plants for 30 different fields (Table 1).

Boone County, in the northeast district, had the highest rootworm populations of all counties surveyed with an average of 195 adults per 100 plants in 1971. In previous years, the highest rootworm infestations have generally occurred in the counties in northwestern Illinois. However, populations in the northwest district declined from 122 adults per 100 plants in 1970 to 64 per 100 plants in 1971. Even though populations have been decreasing in this region since 1967, a great potential for economic damage still exists, particularly in fields of continuous corn. Adult rootworm numbers also increased in counties in the west, central, and eastern districts (Table 1) over levels found in 1970. In general, populations were higher in 1971 than in 1970 in all areas surveyed except in northwestern Illinois.

As a rule-of-thumb guide, fields of continuous corn in those districts with 0-100 adult rootworms per 100 plants would be expected to have light to moderate damage with an occasional field severely damaged; and those fields with over 100 beetles per 100 plants, moderate to severe damage, with many fields damaged.

How serious are rootworms in Illinois? This question can best be answered by examining the rootworm populations and observing trends that are occurring. With 26 percent of the fields in the northern one-third of Illinois averaging one or more adults per plant, a great potential for rootworm damage to a sizable corn acreage in 1972 still exists (Table 2). Through central Illinois, 18 percent of the fields averaged one or more adults per plant, while in southern Illinois adult NCR's were almost non-existent. The number of reports of corn rootworm damage is relatively low compared with the period 1965-1968. The primary factor for this is the extensive use of corn rootworm insecticides by farmers. However, damage is still observed each year in the untreated areas of county demonstration plots.

During 1971, the WCR was found for the first time in Menard, Macon, Sangamon, Morgan, DeWitt, Christian and Shelby Counties. Although the NCR is still the dominant species numerically, the WCR is gradually increasing not only in abundance but in distribution in Illinois. In 1971, the WCR constituted 50 percent or more of the corn rootworm population in Mercer, Stephenson, Boone, Adams, and Henderson Counties.

ROOTWORM POPULATIONS IN RELATION TO ROTATION AND INSECTICIDE USE

Based upon the bionomics of the NCR and WCR, the highest rootworm infestations are found in second-, third-, and fourth-year corn or more. In a survey of 88 fields in the northern one-half of Illinois in 1971, adult rootworm abundance was highly correlated with the type of crop rotation and soil insecticide being used (Table 3). Note that the highest populations occurred in fields of continuous corn that were either untreated or treated with chlorinated hydrocarbons. Adult rootworm numbers were significantly lower in those fields of continuous corn treated with organic phosphate or carbamate insecticides.

Crop Rotations

A survey of cropping practices for the years 1966 and 1968-1971 indicates that farm operators in the rootworm problem areas (northern one-third of Illinois) are continuing to grow a high percentage of continuous corn (Tables 4 and 5).

Insecticide Use

In 1971, corn soil insecticides were used on 63 percent of 147 farms surveyed (Table 6). The carbamate and organic phosphate insecticides were used on 34 percent of the farms, with the most extensive use occurring in the northwest, northeast, and west-central sections of Illinois. The use of chlorinated hydrocarbon insecticides by farmers continued to decline (Table 7). An estimate of corn acreage treated with the different groups of insecticides by district is shown in Table 8.

SUMMARY

1. In the primary rootworm problem area in the northern one-third of Illinois, WCR and NCR populations averaged one or more beetles per plant in 26 percent of the fields surveyed in 1971. This level is slightly higher than 1970 populations.

2. Adult NCR and WCR populations increased slightly in the west, central, and east districts.

3. The proportion of fields treated with organic phosphate and carbamate insecticide increased from 32 percent in 1970 to 34 percent in 1971. Total corn acreage treated with chlorinated hydrocarbons continued to decline.

Table 1. Adult Northern and Western Corn Rootworm Populations, Illinois, 1967-1971

District and County	Average number of adults per 100 plants[a]									
	1967		1968		1969		1970		1971	
	Total	Pct. WCR's	Total	Pct. WCR's	Total	Pct. WCR's	Total	Pct. WCR's	Total	Pct. WCR's
Northwest										
Bureau	79	0	...	...	...	...	42	24	92	7
Lee	...	...	149	3	98	6	35	11	33	12
Mercer	534	81	170	53	98	93	49	69	61	60
Ogle	202	0	446	3	208	8	211	13	69	30
Stephenson	151	0	99	55	182	54	316	62	80	82
Whiteside	71	0	39	72	111	15	78	58	52	40
Average	207	16	181	37	139	35	122	40	64	40
Northeast										
Boone	220	0	258	0	58	3	127	21	195	63
DeKalb	167	0	300	0	55	0	40	0	30	0
LaSalle	48	0	79	0	62	0	33	0	93	3
Average	145	0	212	0	58	1	67	7	106	39
West										
Adams	...	...	...	...	...	...	6	0	7	64
Henderson	...	...	80	42	94	89	7	43	89	73
McDonough	51	2	94	30	37	18	16	13	138	6
Warren	179	1	195	41	51	23	29	3	24	6
Average	115	2	135	38	60	43	15	15	64	31
Central										
Logan	220	0	...	...	...	...	11	0	64	11
McLean	132	0	122	0	121	0	53	0	28	2
Peoria	...	...	...	...	...	...	90	4	46	11
Woodford	...	...	...	...	...	...	36	3	85	5
Average	176	0	122	0	121	0	48	2	55	8
East										
Champaign	38	0	303	0	29	0	39	0	105	0
Iroquois	26	0	80	0	28	0	1	0	29	0
Kankakee	27	0	...	...	...	...	1	0	46	14
Livingston	103	0	92	0	8	0	10	0	31	0
Vermilion	...	...	...	...	...	...	...	...	64	0
Average	49	0	158	0	22	0	13	0	55	3
Southwest										
Greene	46	0	47	0	39	0	0	0	0	0
Macoupin	11	0	8	0	1	0	0	0	0	0
Montgomery	...	...	0	0	0	0	0	0	0	0
St. Clair	...	...	...	...	...	...	...	...	0	0
Washington	...	...	...	...	...	...	...	...	0	0
Average	29	0	18	0	13	0	0	0	0	0
Southeast										
Gallatin	...	...	18	0	28	0	61	0	0	0
Jasper	...	...	...	...	...	...	...	...	0	0
Shelby	2	0	5	0	36	0	0	0	0	0
Wabash	...	...	13	0	1	0	11	0	0	0
White	...	...	6	0	0	0	7	0	0	0
Average	2	0	11	0	16	0	20	0	0	0

a/ 10 fields surveyed at random in each county.

Table 2. Adult Northern and Western Corn Rootworm Population Trends, Illinois, 1967-1971

Region	Year	Number of fields surveyed	Percent of fields according to number of adults per plant <1	1-3	4+
Northern Illinois	1967	80	60	17	23
	1968	90	41	39	20
	1969	90	60	37	3
	1970	90	78	9	13
	1971	90	74	24	2
Central Illinois	1967	80	75	15	10
	1968	65	55	40	5
	1969	70	81	17	2
	1970	130	93	6	1
	1971	130	82	14	4
Southern Illinois	1967	40	95	5	0
	1968	70	96	4	0
	1969	70	94	2	4
	1970	70	99	0	1
	1971	100	100	0	0
State average	1967	200	73	14	13
	1968	225	62	29	9
	1969	230	77	20	3
	1970	290	90	5	5
	1971	320	85	13	2

Table 3. Adult Rootworm Populations in Relation to Crop Rotation and Soil Insecticide Treatment for 88 Fields, Northern Illinois, 1971

Years in Corn	Soil insecticide used: None	Organic phosphate or carbamate	Chlorinated hydrocarbon
	Average number of beetles per 100 plants[a/]		
First-year corn	16.3 (16)	51.4 (14)	19.6 (12)
Continuous corn (2 years or more)	221.9 (13)	74.3 (27)	240.8 (6)

a/ Number of fields in parenthesis.

Table 4. Percent of Fields in Continuous Corn, by Districts, Illinois, 1971

District	Number of fields	Percent of fields: One year in corn	Two years in corn	Three or more years in corn
Northwest	11	36	36	28
Northeast	16	25	31	44
West-central	45	51	9	40
East-central	16	69	19	12
Southwest	34	50	18	32
Southeast	25	52	20	28
	147	47	22	31

Table 5. Percent of Fields Planted to Continuous Corn[a/] in Illinois, 1966 and 1968-1971

District	1966	1968	1969	1970	1971
Northwest	82	87	53	74	64
Northeast	70	57	60	56	75
West-central	79	67	54	40	49
East-central	70	36	26	35	31
Southwest	45	33	57	47	50
Southeast	43	77	47	41	48

a/ Two consecutive years or more.

Table 6. Corn Soil Insecticide Use by District, Illinois, 1971

	Percent of fields by treatment						
	North-west	North-east	West-central	East-central	South-west	South-east	State avg.
None	9	31	27	75	44	36	37
Chlorinated hydrocarbons	9	19	23	12	51	59	29
Organic phosphates and carbamates	82	50	50	13	5	5	34

Table 7. Corn Soil Insecticide Use, Illinois, 1966, 1968-1971

	Percent of fields by treatment				
Treatment	1966	1968	1969	1970	1971
None	37	36	31	32	37
Chlorinated hydrocarbons	61	46	42	36	29
Organic phosphates and carbamates	2	18	27	32	34

Table 8. Estimated Corn Acres Treated With Different Soil Insecticides, Illinois, 1971[a/]

	Estimated acres by treatment		
District	Organic phosphates and carbamates	Chlorinated hydrocarbons	None
Northwest	1,422,502	158,249	158,249
Northeast	593,500	222,563	370,937
West-central	908,000	423,128	484,872
East-central	272,250	272,250	1,633,500
Southeast	82,650	843,030	728,973
Southwest	82,500	973,500	594,000
	3,361,402	2,892,720	3,970,531

a/ Based on a random survey of 147 fields.

CHEMICAL CONTROLS FOR TURFGRASS DISEASES

M. C. Shurtleff

Principal turfgrasses	Fungicide[a/]	Ounces per 1,000 sq. ft.[b/]	Normal season and interval of application (remarks)
	HELMINTHOSPORIUM DISEASES (a) Melting-out (*H. vagans*)		
	Materials listed below are effective against *all* Helminthosporium diseases:		
Kentucky bluegrass	Acti-dione-Thiram	2-4	April-June, Sept.-Oct.
Ryegrasses	Folpet (Phaltan) WP 50%	4-6	7-14 days
	(b) Helminthosporium leaf spot (*H. sorokinianum*)		
All turfgrasses	Captan WP 50%	4-6	June-August
	Thiram WP 75%	3-6	7-14 days
	Daconil 2787 WP 75%	4	
	(c) Zonate eyespot (*H. giganteum*)		
Bentgrasses	Ortho Lawn & Turf Fungicide	4-6	July-August
Bluegrasses	Dyrene WP 50%	4-8	7-14 days
Bermudagrass	Fore WP 80%	4-6	
Fescues	Zineb WP 75%	4-6	
Ryegrasses	Tersan LSR WP 80%	4-6	
	(d) Red leaf spot (*H. erythrospilum*)		
Bentgrasses	Manzate 200 WP 80%	4-6	April-August 7-14 days
	(e) Helminthosporium blight (*H. dictyoides*)		
Fescues			April-July
Ryegrasses			7-14 days
	(f) Brown blight (*H. siccans*)		
Ryegrasses			April-June
Fescues			7-14 days
	(g) Leaf blotch (*H. cynodontis*)		
Bermudagrass			April-June 7-14 days

(Footnotes at end of table)

Principal turfgrasses	Fungicide[a/]	Ounces per 1,000 sq. ft.[b/]	Normal season and interval of application (remarks)
	FUSARIUM BLIGHT *(F. roseum)*		
Bentgrasses	Tersan 1991 WP 50%	5-6	Bentgrasses and Fescues:
Bluegrasses, esp.	Mertect WP 60%	2	May-September
Merion and	Tersan LSR WP 80%	6-8	7-10 days
Windsor Kentucky	Fore WP 80%	6-8	Bluegrasses:
Fescues			July-August
Ryegrasses			7-10 days
	SCLEROTINIA DOLLAR SPOT *(S. homeocarpa)*		
All turfgrasses	Acti-dione-Thiram	2-4	May-October
	Daconil 2787 WP 75%	2-4	7-14 days
	Cadmium compound	See label	(Resistance to Cadmium
	Mertect WP 60%	2	compounds, Dyrene, and
	Thiram WP 75%	2-4	other fungicides has
	Tobaz WP 60%	2	been reported in certain
	Ortho Lawn & Turf Fungicide	4-6	areas.)
	Tersan 1991 WP 50%	1/2-1	
	Dyrene WP 50%	4-6	
	RHIZOCTONIA BROWN PATCH *(R. solani)*		
All turfgrasses	Dyrene WP 50%	4-6	June-September
	Daconil 2787 WP 75%	4	5-10 days
	Fore WP 80%	4-6	
	Tersan LSR WP 80%	4-6	
	Tersan 1991 WP 50%	1-4	
	Acti-dione-Thiram	3-4	
	Ortho Lawn & Turf Fungicide	4-6	
	Mertect WP 60%	2	
	Tobaz WP 60%	2	
	Manzate 200 WP 80%	4-6	
	LEAF SMUTS (a) Stripe smut (*Ustilago striiformis*)		
Bentgrasses	Tersan 1991 WP 50%	6-12	Early spring or late fall.
Bluegrasses, esp.	(when registered)		Drench in (50 gal./1,000
Merion Kentucky			sq. ft.) after application.
			(Follow fertility and irri-
	(b) Flag smut (*Urocystis agropyri*)		gation practices to produce
			optimum growth of turf-
Ryegrasses			grass.)

(Footnotes at end of table)

Principal turfgrasses	Fungicide[a]	Ounces per 1,000 sq. ft.[b]	Normal season and interval of application (remarks)
	RUSTS (LEAF AND STEM) *(Puccinia species)*		
All turfgrasses	Acti-dione-Thiram	2-4	July-September
	Tersan LSR WP 80%	2-4	7-10 days
	Fore WP 80%	2-4	
	Zineb WP 75%	2-4	
	Manzate 200 WP 80%	2-4	
	Thiram WP 75%	2-4	
	Ortho Lawn & Turf Fungicide	4-6	
	Daconil 2787 WP 75%	4	
	POWDERY MILDEW *(Erysiphe graminis)*		
Bluegrasses	Acti-dione-Thiram	2-4	June-October
Fescues	Karathane WD WP 22.5%	1/4-1/2	7-14 days
Bermudagrass	Tersan 1991 WP 50%	1-3	
	PYTHIUM BLIGHT, GREASE SPOT, SPOT BLIGHT *(P. aphanidermatum, P. irregulare, P. ultimum)*		
All turfgrasses	Koban WP 35%	3-6	June-September
	Tersan SP WP 65%	4	5-7 days (Apply fungicide in 10 gal. water/1,000 sq. ft.)
	SNOW MOLDS (a) Typhula blight[c] (*T. itoana, T. incarnata*) (b) Fusarium patch[d] (*F. nivale*)		
All turfgrasses	Tersan SP WP 65%	6-8	Late fall to mid-spring
	Ortho Lawn & Turf Fungicide	4-8	2-8 weeks
	FAIRY RINGS (*Marasmius oreades, Lepiota morgani, Agaricus campestris*, etc.)		
All turfgrasses	Methyl bromide or formaldehyde fumigation OR Drench rings with water, using root-feeder attachment on hose.	See label	(Soil temperature should be above 60° F. for fumigation.)

(Footnotes at end of table)

Principal turfgrasses	Fungicide[a]	Ounces per 1,000 sq. ft.[b]	Normal season and interval of application (remarks)
	ANTHRACNOSE *(Colletotrichum graminicola)*		
All turfgrasses	Fore WP 80%	4-6	June-November
	Tersan LSR WP 80%	4-6	7-10 days
	Manzate 200 WP 80%	4-6	
	Zineb WP 75%	4-6	
	SEED ROT, DAMPING-OFF, SEEDLING BLIGHTS (*Pythium* species, *Fusarium* species, *Rhizoctonia solani*, *Helminthosporium* spp., *Colletotrichum graminicola*)		
All turfgrasses	Captan or Thiram (50-75%)	See label	Treat seed before planting.
	Folpet (Phaltan) WP 50%	2-4	At early seedling emergence and 7-10 days later.
	Captan WP 50%	2-4	
	Dyrene WP 50%	2-4	
	Kromad	4-6	
	Daconil 2787 WP 75%	2-4	
	Zineb WP 75%	2-4	
	Thiram WP 75%	2-4	
	Ortho Lawn & Turf Fungicide	4	
	NEMATODES (many genera and species)		
All turfgrasses	All grasses except bentgrass: Mix 1-1/2 to 2 pints of Nemagon EC-2 or Fumazone 70E with 10-15 gal. water and drench 1,000 sq. ft. of turf. Water turf immediately to insure penetration of nematicide into soil and prevent toxic effects. Treat in spring or fall when soil temperature is above 60° F. Aerifying turf before application improves results. Do *not* apply chemical to newly seeded areas. Bentgrass: Use 1 pint of chemical; otherwise same as above.		
	SLIME MOLDS (*Physarum cinereum*, *Fuligo* species, etc.)		
All turfgrasses	Any fungicide mentioned above when disease is evident. OR Mow, rake, pole, or hose to remove when seen.		May-September

(Footnotes at end of table)

Principal turfgrasses	Fungicide[a/]	Ounces per 1,000 sq. ft.[b/]	Normal season and interval of application (remarks)
	ALGAE OR GREEN SCUM		
All turfgrasses	Thiram WP 75%	2-4	Apply when first seen; reapply as needed.
	Zineb WP 75%	2-4	
	Tersan LSR WP 80%	2-4	
	Fore WP 80%	2-4	
	Copper sulfate	1-2	
	MOSS		
All turfgrasses	Ferrous ammonium sulfate	16	Apply when first seen; reapply as needed.

NOTE: Causal fungus given in parentheses.

a/ Denotes either fungicide, coined name of the material, or representative trade names. Mention of a trade name does not constitute warranty of the product named and does not mean that the product is recommended to the exclusion of comparable products.

b/ Except where indicated, all materials should be applied in 3-5 gallons of water per 1,000 square feet. Use lower fungicide rates in *preventive* programs; higher rates for *curative* programs.

c/ Other fungicides that control Typhula blight but *not* Fusarium patch, include: Thiram WP 75% (8-10 oz./1,000 sq. ft.) and Cadmium compound (see label).

d/ Fungicides that control Fusarium patch but *not* Typhula blight, include: Tersan 1991 WP (3-8 oz./1,000 sq. ft.) and Mertect and Tobaz (see label).

WEED CONTROL IN TURF

A. J. Turgeon

The occurrence of weeds in turf may be an indication of some major deficiency in the turfgrass management program. Principal components of management include mowing, watering, and fertilization practices as well as the selection of proper turfgrass species and varieties for use in a specific combination of environmental conditions. Diseases and insect injury also provide sites for weed infestation; however, these factors may also be indications of poor growing conditions for turf. The most important means of maintaining a weed-free turf is through the provision of conditions which favor the development of a vigorous, healthy turf that is competitive with potential and existing weed invaders.

CULTURAL CONTROL

Proper mowing practices favor the development of a dense and uniform turfgrass sward. Important considerations include the height and frequency of mowing, evenness of the surface, and proper selection and maintenance of mowing equipment. The height of cut largely depends upon the specific turfgrasses present. Optimum cutting heights for turfgrasses found in the northern half of the United States are:

Kentucky bluegrass	1-1/2 to 2 inches
Red fescue	2 to 2-1/2 inches
Ryegrass	2 to 2-1/2 inches
Tall fescue	2-1/2 to 3 inches
Colonial bentgrass	1/2 to 1 inch
Creeping bentgrass	1/4 to 1/2 inch

Mowing too closely for long periods may produce conditions that encourage infestations of crabgrass, annual bluegrass, and a variety of broadleaved weeds. Frequency of mowing should be determined in accordance with the following rule of thumb--do not remove more than one-third of the total foliage at any one mowing. Obviously, mowing frequency is based on the vertical growth rate of the turf and the cutting height employed and is not simply a function of time. As climatic conditions change through the season, so does the required number of mowings per week or month.

The soil surface underlying the turf should be as even as possible to avoid scalping injury from mowing. Small convolutions of the surface may be corrected with light rolling in early spring. If large ridges and depressions exist, the sod should be lifted and the soil graded properly before replacement.

Mowers should be sharpened regularly to provide a clean cut of the turf. Dull cutting blades tend to tear the leaves, resulting in a shaggy appearance of the turf and a greater susceptibility to disease and other environmental stresses. Powered mowers should be checked for gas and oil leaks as these agents rapidly reduce turfgrass quality and allow weed invasion.

During drouth periods watering is essential for healthy growth of turfgrass; however, applications should be carefully controlled to moisten the soil to a depth of at least 6 inches without puddling. Frequent and light applications of water encourage shallow rooting and result in greater susceptibility of the turf to environmental stress. The specific frequency of watering should depend upon the wilting tendency of the turf. This can be determined by observing the turf for shiny purplish casts and foot-printing. The time between the last watering and the appearance of wilt provides a guide for the desired watering frequency during comparable weather conditions.

Fertilization is essential for optimum turfgrass vigor, and if performed correctly, it constitutes a most important tool for preventing weed invasion. As nitrogen is considered the most critical element for vegetative growth of turf, its specific rate and frequency of application should be geared to the particular species and varieties of turf in use and the environmental conditions under which they are maintained. Generally, Kentucky bluegrasses require 3 to 6 pounds of nitrogen per 1,000 square foot per year while red fescues should receive no more than 1 to 2 pounds yearly. A thin, chlorotic appearance of the turf and patches of white clover are good indicators of a nitrogen fertility deficit. Refer to extension circular 982 entitled "Keeping a Lawn" for a more detailed discussion of this subject.

The selection of a particular turfgrass species or variety often spells the difference between success and failure in maintaining a weed-free turf. As a rule, Kentucky bluegrasses are not suitable for use in shaded environments as indicated by the presence of ground ivy, yellow woodsorrel, yarrow, and other weeds. This is believed to be due, primarily, to the susceptibility of Kentucky bluegrasses to powdery mildew disease in shade. For this reason, red fescues are generally recommended for use in this situation. Other turfgrasses, such as bentgrass, are so susceptible to disease that a preventative fungicide-spray program is required to maintain healthy turf.

Additional factors associated with large weed populations in turf are soil compaction and poor soil drainage. Goosegrass and knotweed are good indicators of these conditions. Soil compaction may be alleviated by aerification with specialized equipment; however, it is generally recommended that heavy soils be amended by incorporating organic matter into the soil and, where possible, restricting traffic over the area. In some situations, underground tile should be installed and the surface contoured to facilitate drainage.

CHEMICAL CONTROL

Most turf weeds can be placed into one of three categories in terms of their susceptibility to herbicides: annual grasses, perennial grasses, and broadleaved weeds.

Annual grasses include crabgrass, goosegrass, foxtails, barnyard grass, panicums, and others. Control may be obtained with successive applications of DSMA or other organic arsenicals after these weeds have emerged. A single preemergence application of benefin, bensulide, DCPA, siduron, or terbutol, in spring, frequently provides season-long control. Results from recent research indicate that continued use of preemergence herbicides may cause deterioration of the turf. The persistent occurrence of these weeds should be cause for a detailed evaluation and improvement of cultural practices to increase the competitive ability of the existing turf. Also, with the exception of siduron, applications of preemergence herbicides preclude overseeding of the turf for at least two to five months, depending upon their persistence in the soil.

At present, there are no herbicides suitable for selective control of perennial grasses in turf. Quackgrass, nimblewill, tall fescue, bentgrass, and others should be mechanically removed from the turf or spot-treated with a nonselective herbicide such as dalapon or amitrole. The areas can then be seeded or replaced with sod once the herbicide residue disappears.

Herbicides for use on broadleaved weeds in turf include 2,4-D, silvex, mecoprop, dicamba, bromoxynil, and endothall. Generally, a combination of 2,4-D and silvex, mecoprop, or dicamba provides an effective broad-spectrum control for most broadleaved weeds. Herbicide applications to weeds in their early growth stage are generally more effective than applications to mature weeds. In addition, herbicides should be applied when the plants are actively growing for best results; however, mild temperatures of spring and fall are preferred to reduce the possibility of turf injury. Dicamba should be restricted to use in areas that are well beyond the root systems of desirable trees and shrubs. Taxus and juniper plants are particularly susceptible to injury from this herbicide. Bromoxynil is relatively safe for use on seedling turf infested with broadleaved weeds. It may provide good control of most weeds except purslane. Endothall may be used for control of some speedwell species that are resistant to the other herbicides. This material may cause temporary browning of the turf and should be used only on Kentucky bluegrasses. Several treatments are generally required for complete control.

IN CONCLUSION

The key to maintaining weed-free turf is proper management. A healthy, vigorous turf resists weed invasion by competition. Herbicides can be an important supplement to a turfgrass management program, but they should not be regarded as a substitute for proper mowing, watering, fertilization, and other practices that ensure the development and maintenance of quality turf.

Controlling Weeds in Noncrop Areas

Soil sterilization is the application of nonselective chemicals or nonselective rates of selective chemicals as a means of controlling all vegetation in an area. Soil sterilants may be used to control vegetation in noncrop areas such as parking lots, drive-in theaters, driveways, patios, and certain industrial sites.

Soil sterilants can be classified by their length of control. Those with little or no residual activity are the fumigants and the contact herbicides. Fumigants are volatile materials that can affect the viability of weed seeds as well as existing growth. Contact herbicides such as paraquat control only the existing vegetation which the spray contacts.

Amitrole, dalapon, 2,4-D, and DSMA give temporary control for four months or less. Semipermanent control is provided by some inorganic salts, such as sodium borate and sodium chlorate. Organic compounds that provide semipermanent control are the uracils (bromacil), phenylureas (monuron, diuron), and the s-triazines (atrazine, simazine, and prometone).

There are a variety of particular uses including (1) beneath asphalt pavement prior to the asphalt application, (2) along railroads, (3) around buildings as a means of preventing the growth of weeds that are unsightly or present a fire hazard, and (4) along fences to control weeds. However, it may be preferable to establish desirable, competitive vegetation along a fence in order to discourage weed growth and to provide protective soil and wildlife cover. Short-term herbicides, such as 2,4-D and dalapon, might be used for temporary control until desirable vegetation can be established.

PRECAUTIONS AND GENERAL PROCEDURES

Several precautions must be observed when using nonselective chemicals. You must know what weeds are to be controlled and must select the correct chemical for those particular problems. A survey of the area must be made, noting any desirable vegetation in the immediate or adjacent areas that could be affected by spray drift, chemical runoff, or leaching into the root zone.

Appropriate precautions should be taken to prevent damage to desirable plants. The risk of injury with some of these materials may be too great to allow their use in some areas. Be certain that you are familiar with the product, and are aware of the risks before using these materials. Some treatments should be made only by professional applicators.

The type of vegetation to be controlled will affect your decision in selecting a chemical. Perennial grasses can be controlled with dalapon, amitrole, or DSMA; woody perennials, with 2,4,5-T, silvex, or picloram. Deep-rooted vines such as bindweed can be controlled with fenac, 2,3,6-TBA, dicamba, or picloram.

Application time is very important. The best time to apply nonselective, soil-residual herbicides is early in the spring before herbaceous weeds have emerged. If vegetation is heavy, it may be necessary to remove existing vegetation or to add a contact or foliar herbicide to speed topkill. Mixing the herbicides with diesel fuel will also do this. After existing vegetation is under control, the rate can be reduced for maintenance applications in the future.

Adjust the application rates according to the soil types. Also, rates are often adjusted for the desired length of control. When a span of two or three years is desired, maintenance applications are better than an initial application that is too high.

HERBICIDES FOR NONCROPLAND

Inorganic Compounds

1. *Sodium chlorate*. It has both foliar and root activity. However, there is an extreme *fire hazard* with this compound. Fire retardants, such as calcium chloride or the borates, are often added to reduce the hazard. Sodium chlorate may also be toxic to livestock that seek its salty taste. The rates are 500 to 1,000 pounds per acre.

2. *Sodium borate (concentrated Borascu)*. This one has primarily root activity. Very high rates are required (1 to 2 tons per acre), so it is often used only as a granular carrier for organic compounds.

3. *Sodium arsenite*. This is a *highly toxic* compound; therefore, it is not usually recommended, especially since safer products are now available. Sodium arsenite is formulated as a 9.5-pounds-per-gallon liquid. The rates are 55 to 110 gallons per acre.

4. *Ammonium sulfamate (Ammate-X)*. It is formulated as soluble crystals for weed control on woody plants and herbaceous weeds. It is sometimes used for brush control where volatilization of phenoxy herbicides would be a hazard. Ammonium sulfamate is corrosive to metals. The rate is 60 pounds per acre.

Organic Compounds for Long-Term Control

1. *Bromacil (Hyvar-X)*. It has both foliar and soil activity, and is formulated as an 80-percent wettable powder (WP), a 50-percent wettable powder, and a 3-pounds-per-gallon liquid. The rates of active ingredient are 5 to 15 pounds per acre.

2. *Karbutylate (Tandex)*. This is a new soil sterilant, formulated as an 80-percent wettable powder and a 4-percent granule. It has a fairly broad spectrum of control. The rates are 5 to 30 pounds per acre of the 80-percent wettable powder.

3. *Simazine (Princep)*. This one is formulated as an 80-percent wettable powder and a 4-percent granule. It has little foliar activity, but has a longer residual control than atrazine. The rates are 5 to 40 pounds per acre of the 80-percent wettable powder.

4. *Atrazine (AAtrex).* It is an 80-percent wettable powder. Atratol 8P is 8-percent atrazine on a chlorate-borate granule. The rates are 5 to 40 pounds per acre of the 80-percent wettable powder.

5. *Prometone (Pramitol).* Available as a 2-pounds-per-gallon liquid and as a 5-percent pellet, it has more foliar activity than atrazine. The rates are 5 to 30 gallons per acre.

6. *Diuron (Karmex).* This is an 80-percent wettable powder. The rates are 10 to 40 pounds per acre. It is sometimes mixed with bromacil.

7. *Monuron (Telvar).* It is an 80-percent wettable powder that is more soluble than diuron. Monuron is usually used in drier climates; diuron, in the humid areas. The rates for Telvar are 10 to 40 pounds per acre.

8. *Dichlobenil (Casoron).* This is available as a 50-percent wettable powder, a 4-percent granule, and a 10-percent pellet. It is more commonly used for nursery weed control than for soil sterilization. The rates are 10 to 40 pounds per acre of the 50-percent wettable powder.

9. *Amizine.* It is a combination of amitrole and simazine, bringing together the foliar activity of amitrole with the residual activity of simazine. The suggested rate for general vegetation control is 20 pounds of Amizine in 100 gallons of water per acre.

10. *Urox.* This combination of monuron and TCA is available as a 22-percent pellet and a 3-pounds-per-gallon liquid. Urox combines the grass control of TCA with the residual control of monuron.

Many of the granular or pelleted materials are organic herbicides formulated on sodium borate or borate-chlorate granules. They can be applied dry, which is often convenient for spot treatment or application on small areas.

1. Chlorea is monuron on a chlorate-borate base.
2. Ureabor is 1.5-percent bromacil on sodium-borate pellets.
3. Vacate is 8-percent monuron on sodium borate.
4. Atratol 8P is 8-percent atrazine on a borate-chlorate base.
5. Pramitol 5P is prometone on a borate-chlorate pellet.
6. Benzabor is 2,3,6-TBA on a borate granule.

Organic Herbicides for Short-Term Control

1. *Amitrole.* It is available as Weedazol and Amino Triazole. Amitrole is a translocated herbicide that is especially effective on poison ivy and some strains of Canada thistle. It can provide control of some perennial grasses such as quackgrass. Amitrole is a 90-percent soluble powder, and is applied at a rate of 4 to 8 pounds per acre as a spray.

2. *Amitrole-T.* This is available in liquid form as Cytrol and Amitrol-T with 2 pounds per gallon of amitrole plus ammonium thiocyanate. Since amitrole-T is formulated as a liquid, it is sometimes considered more convenient to handle than amitrole. The rates are 1 to 3 gallons per acre.

3. *Dalapon (Dowpon, Basfapon).* It is a foliar-applied, translocated grass killer. Dalapon is available with TCA (Dowpon-C) for longer residual control. The rates are 10 to 15 pounds per acre of the 85-percent soluble powder. A wetting agent improves the control. Perennial grass may require more than one application.

4. *Sodium-TCA.* This one is a root-absorbed grass killer that remains in the soil longer than dalapon. It is a 90-percent soluble powder used at 50 to 150 pounds per acre.

5. *MSMA.* It is available as Ansar 170HC as an 8-pounds-per-gallon liquid without surfactant, or as Ansar 529HC or Daconate as a 6-pounds-per-gallon liquid with surfactant. MSMA is used for perennial grass control at 0.5 to 1.5 gallons per acre. More than one application may be necessary.

6. *DSMA.* There are two forms, Ansar DSMA Liquid or Ansar 8100. DSMA is frequently used for spot treatment of Johnsongrass. The rates are 3 to 9 pounds per acre of the soluble powder or 1 to 2 gallons per acre of the liquid.

7. *Paraquat.* It is a 2-pounds-per-gallon contact herbicide with little residual activity. The volume of water should be adjusted to the amount of vegetation. The rates are 1 to 3 quarts per acre. A surfactant is added at the time of application.

8. *Dinoseb ("dinitro").* This contact herbicide is often mixed with fuel oil. Dinoseb is *quite toxic*, and will stain clothes and the skin. Mix 1 to 2 quarts per 30 to 50 gallons of fuel oil with enough water to make a total volume of 100 gallons.

HERBICIDES FOR BROADLEAF WEED AND BRUSH CONTROL

1. *Dicamba (Banvel).* It is available as a 4-pounds-per-gallon formulation. Banvel presents a hazard to nearby soybeans, tomatoes, and desirable woody plants. The application rates are 1 to 4 quarts per acre.

2. *Picloram (Tordon).* This is a persistent, broadleaf herbicide. It is formulated as a liquid with 2,4-D as Tordon 212 and on a borate pellet as Tordon 22K and Borolin. Special care must be taken because of the long soil life and because of its mobility in the soil.

3. *2,3,6-TBA.* It is a benzoic acid herbicide available as Benzac 1281 and Trysben 200. This compound is used to control deep-rooted, perennial broadleaf weeds. It is formulated as a 2-pounds-per-gallon liquid, and is applied at 2 to 10 gallons per acre. Considerable precaution should be taken to avoid injury to nearby, desirable plants.

4. *Fenac.* This one is closely related to 2,3,6-TBA in terms of controlling deep-rooted, perennial broadleaf weeds. It is formulated as a 1.5-pounds-per-gallon liquid. The application rates are 2 to 15 gallons per acre.

5. *2,4-D.* This is a broadleaf herbicide with short persistence. Amine formulations present less hazard to nearby, sensitive plants than ester forms. The common formulation is as a 4-pounds-per-gallon liquid. Mixtures of 2,4-D and dalapon are often used for short-term control of both broadleaf and grass weeds.

6. *2,4,5-T.* It is similar to 2,4-D, but gives better control of some woody plants and has a longer soil life. Mixtures of 2,4-D and 2,4,5-T are commonly called "brushkiller." The common formulation is as a 4-pounds-per-gallon liquid. Current restrictions (1971) forbid the use of 2,4,5-T around homes or on lakes, ponds, and ditchbanks.

7. *Silvex.* This herbicide may be used for control of brush in a manner similar to 2,4,5-T. Silvex has had fewer restrictions on where it can be used.

8. *Fenuron (Dybar).* This is a 25-percent pellet for spot-treatment brush control by soil application.

9. *Urab.* It is a combination of fenuron-TCA, also used for brush control. It is formulated as 22-percent pellets and a 3-pounds-per-gallon liquid.

LONG-TERM RESIDUAL CONTROL

Spray Applications

Many of these chemicals are wettable powders and will require thorough agitation for spray application. The rates listed are for the different types of weeds to be controlled. Initial applications are often made at the high rate, with subsequent treatments at the lower rate.

Herbicide	Annuals	Rate of formulation per acre: Shallow perennials	Rate of formulation per acre: Deep perennials
Hyvar-X-WX (50 pct.)	5 to 10 lb.	10 to 20 lb.	20 to 40 lb.
Hyvar-X-L (3 lb./gal.)	1 to 2 gal.	2 to 4 gal.	4 to 8 gal.
Tandex (80 pct.)	4 to 8 lb.	3 to 16 lb.	16 to 30 lb.
Princep (80 pct.)	6 to 12.5 lb.	12.5 to 25 lb.	25 to 50 lb.
AAtrex (80 pct.)	6 to 12.5 lb.	12.5 to 25 lb.	25 to 50 lb.
Karmex (80 pct.)	8 to 20 lb.	20 to 40 lb.	20 to 60 lb.
Casoron (50 pct.)	8 to 12 lb.	12 to 25 lb.	25 to 40 lb.
Pramitol 25E (2 lb./gal.)	5 to 7.5 gal.	7.5 to 15 gal.	15 to 30 gal.
Urox 22 (22 pct.)	50 to 75 lb.	75 to 150 lb.	150 to 200 lb.
Sodium chlorate	300 to 500 lb.	500 to 750 lb.	750 to 1,300 lb.
Amizine	6 lb.	12 lb.	20 lb.

Granular or Pellet Application

Granulars are often more convenient for spot treatment and for small areas. Many granules are on a sodium chlorate-borate base.

Herbicide	No. of pounds per: 100 square feet	No. of pounds per: square rod
Concentrated Borascu	4 to 6	12 to 15
Sodium chlorate	1.5 to 3	4 to 6
Sodium chlorate-modified	2 to 4	6 to 10
Sodium chlorate-borate	3 to 4	8 to 10
Ureabor	2 to 4	6 to 9
Chlorea-3 (3 pct. monuron + borate-chlorate)	1 to 2	3 to 5
Vacate	1 to 2	3 to 5
Benzabor	0.5 to 0.5	1 to 2
Atratol 8P	0.5 to 1	2 to 3
Pramitol 5P	1 to 2	3 to 5
Tandex 4G	0.25 to 0.5	1 to 2
Hyvar-X-P	0.25	0.5 to 1
Casoron-10P	0.5 to 1	3 to 5

BROADLEAF WEEDS

These are often best controlled with foliar applications. Deep-rooted perennials can usually be controlled best when they are at the early bud to early bloom stage. The materials listed below can move through the air and damage nearby, desirable broadleaf plants. They are quite soluble and mobile in the soil, and can move into the soil and damage trees or other desirable shrubs and broadleaf plants.

Herbicide	Rate of formulation per acre: Annual and shallow perennials	Rate of formulation per acre: Deep-rooted perennials
2,4-D and/or 2,4,5-T	1 to 2 qt.	2 to 4 qt.
Silvex	1 to 2 qt.	2 to 4 qt.
Banvel (dicamba)	0.5 to 1 qt.	1 to 4 qt.
Tordon 212 (picloram + 2,4-D)	2 to 4 qt.	4 to 12 qt.
2,3,6-TBA	2 to 5 gal.	5 to 20 gal.
Fenac	2 to 5 gal.	10 to 15 gal.
Tritac (2,3,6-TBP)		10 to 20 gal.

UNDESIRABLE WOODY PLANTS

Most of the materials used to control such plants are applied to the foliage, but can be applied (1) as basal bark treatments if the trees are less than 3 inches in diameter or (2) as a frilled treatment if the trees are larger. The basal treatment can be applied during the dormant season in fuel oil. Foliar treatments are usually applied as soon as the brush or trees have leaves fully expanded.

Herbicide	Method of application	Rate of formulation
2,4-D and/or 2,4,5-T	Foliar or basal	2 to 4 qt./A.
Silvex	Foliar or basal	2 to 4 qt./A.
Tordon 212 (picloram + 2,4-D)	Foliar or basal	1 gal./A.
Banvel (4 lb./gal. dicamba)	Foliar	2 to 4 qt./A.
Ammate-X (ammonium sulfamate)	Foliar	60 lb./A.
Dybar (25 pct. fenuron)	Soil	0.25 to .50 lb./100 sq. ft.
Urab-22 (22 pct. fenuron-TCA)	Soil	0.5 to 1 lb./100 sq. ft.

WEEDY GRASS CONTROL

Weedy grass control is often best accomplished with the herbicides listed below. The use of a spreader-sticker (surfactant) often helps.

Herbicide	Rate of formulation per acre: Annuals	Rate of formulation per acre: Perennials
Dowpon	5 to 10 lb.	10 to 30 lb.
Sodium-TCA	20 to 50	100 to 150
Cytrol, Amitrol-T	1 gal.	2 to 3 gal.
Glytac (TCA ester)	2.5 gal.	5 gal.
Ansar 529HC	1 to 2 qt.	2 to 4 qt.
Daconate	2 to 3 qt.	3 to 5 qt.

CONTACT WEED CONTROL

Contact herbicides kill the plant tissue with which they come in contact. Thus, adequate spray volume is needed for full coverage. The use of a surfactant often helps the spray to spread on the plants.

Herbicide	Rate per acre
Paraquat.	.1 to 3 qt./A.
Fuel oil + dinoseb. . .	.50 gal. + 2 qt.
Herbicidal naphtha. . .	.30 to 50 gal.

COMMENTS

Availability, formulations, trade names, and federal clearance for the use of herbicides change from time to time. Always refer to the most recent product labels for precautions, directions for use and rates to use. Use herbicides with appropriate precautions to avoid injury to desirable vegetation, to protect the user, and to assure the safety of humans and animals. Store herbicides properly so that children and those who may not be responsible for their actions do not have access to them. Store herbicides only in the original, well-marked containers. Properly dispose of used herbicide containers and old herbicides.

There are both benefits and risks associated with the use of herbicides. Used properly, the benefits can far exceed the risks and the quality of our environment can be improved by controlling undesirable vegetation. Do not neglect the opportunities for using desirable vegetation to compete with and replace undesirable vegetation. For some areas, mechanical control may sometimes be quite practical and the most appropriate method.

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Effect of Dicamba on Soybeans

When dicamba (trade name, Banvel) is used to control weeds in corn fields, some of this material may move to nearby soybean fields and cause very noticeable effects on the plants. This question is often raised: *What will the effect be on the soybeans, particularly on the yield?*

This fact sheet is based primarily on research conducted during 1966 and 1967 by Dr. L.M. Wax, Mr. L.A. Knuth, and Dr. F.W. Slife, as well as on observations in the field and on many plants sent in for diagnosis.

Dicamba is 3,6-dichloro-*o*-anisic acid, and is usually formulated as a dimethylamine salt. It is commercially available in liquid form, with four pounds of active ingredient per gallon. Dicamba, like 2,4-D, may be classified as a translocated herbicide that affects the physiology, growth, and appearance of broadleaf plants, primarily. However, dicamba and 2,4-D are different chemically.

These two herbicides also differ in two other respects. Dicamba gives better control than 2,4-D of smartweed. However, dicamba presents a much greater hazard to nearby soybeans and other sensitive plants than 2,4-D. For that reason, the use of dicamba in Illinois has been discouraged, even though it has been cleared by the federal government and made available commercially.

The rate of dicamba used to control weeds in corn is 2 to 4 ounces of active ingredient per acre. It is sometimes mixed with 2,4-D amine. In the research conducted by Wax, Knuth, and Slife, dicamba was applied directly to soybeans at rates of 1/32 to 1 ounce of active ingredient per acre to simulate the movement of various amounts of dicamba into soybeans. Separate treatments with 2,4-D were also included in the study.

Table 1 compares the dicamba rates with the percentage of a 4-ounce application. In other words, the 1-ounce rate applied to soybeans would simulate 25 percent of a 4-ounce application to corn moving into nearby soybeans.

Table 1

Rate of direct application to soybeans	Approximate equivalent, percent of 4 ounces
1/32	3/4
1/16	1-1/2
1/8	3
1/4	6
1/2	12-1/2
1	25

MOVEMENT. Although the volatility of the amine formulation of 2,4-D is considered to be relatively low, the same is not necessarily true of dicamba formulated as an amine.

Fine spray particles may drift with the wind and carry the dicamba into soybeans. Even though wind is blowing away from the soybeans during application, dicamba symptoms can appear later on the plants. Apparently, vapor or very fine spray particles lingering in the air can move from a treated corn field on air currents some time after the application.

In research conducted in North Dakota, greenhouse flats of corn were sprayed with dicamba and placed outside. Untreated flats with soybeans were then placed downwind from the corn flats. The soybeans subsequently showed dicamba symptoms, suggesting that dicamba volatilized from the corn flats and moved to the soybean flats.

Special nozzles and certain thickening agents or other additives may decrease the number of fine spray particles. Even so, this would not completely solve the problem of vapor movement.

SYMPTOMS. The leaves of soybeans affected by dicamba become crinkled and cupped. The top leaf buds do not open normally and the new leaves do not expand normally, giving the field a yellowish cast. Symptoms from 2,4-D may appear as a ruffling of the leaves, somewhat similar to the crinkling, but 2,4-D usually gives more parallel veination or strapping and less cupping than dicamba.

Other agents that may produce somewhat similar symptoms to those produced by dicamba are soybean mosaic disease, Randox-T, TBA, and Tordon. Mosaic usually causes some crinkling or ruffling of leaves, but not the pronounced cupping or effect on leaf buds described previously; also, the field pattern is not likely to be as widespread and general as with dicamba. There is little or no use of Randox-T, TBA, or Tordon in Illinois. The growth regulator TIBA may cause a little puckering of leaves and some change in shape. When the recommended rates are used, these symptoms are not as pronounced as with dicamba.

A decrease in the number and size of the leaves in the tops of soybean plants may actually allow more light to enter the canopy, thus, encouraging pod set.

YIELDS. These are not always decreased as much as one might expect after looking at the rather pronounced symptoms. The extent of possible yield reductions will depend largely on the stage of development the soybeans are in when affected; also, on the amount of dicamba that reaches the soybeans.

In Illinois research, soybeans treated about three weeks after planting (prior to blooming when the third trifoliate leaf was open and expanding) sometimes showed apical buds that were injured or killed by relatively high rates of dicamba. When the apical buds were killed, however, branching in the cotyledon and unifoliate axils increased.

Dicamba was applied to some soybeans about six weeks after planting, when soybeans were blooming and were in the early eighth trifoliate stage. The flowers on the lower part of the plants were drying and the flower buds in the upper part were just opening. When treated at this stage with rates sufficient to damage or kill the apical bud, the plants did not produce sizable branches--just small branches with many small, malformed pods.

Dicamba can cause shorter plants, especially if the treatment is made when the plants are in the bloom stage. Dicamba usually does not reduce the stand significantly and usually does not increase lodging. Dicamba may delay maturity, especially if it is applied at the bloom stage.

Prebloom treatments, which increased branching, have resulted in more pods and more seed but in smaller beans. Plants treated in the bloom stage sometimes produced very few pods on the main stem above the point of treatment. The result was fewer but larger seeds per plant. Nevertheless, the increase in seed size was not sufficient to compensate for the smaller number of seeds.

Dicamba at the prebloom stage had little effect on the germination of harvested seed. Higher rates of dicamba at the bloom stage reduced germination markedly. Seedlings grown from the seed of plants treated in the bloom stage showed some leaf malformation, suggesting the possible presence of dicamba or some metabolites in the seed.

SUMMARY. Dicamba moving from treated corn fields to nearby soybeans can produce rather noticeable effects. The extent of the potential yield reduction will depend largely on when the dicamba treatment was made and on how much dicamba reached the soybeans. If dicamba moves into soybeans at the bloom stage, the chance of yield reduction is greater than if the dicamba movement is before the plants bloom. This may be part of the reason for the label recommendation that dicamba should be applied before corn is over three feet high. The greater the amount that reaches the beans, the greater the likelihood of yield reductions.

If dicamba is to be used, earlier treatments would be preferred to later ones. However, one of the major reasons for using dicamba is to control smartweed. Atrazine applied preplant, preemergence, or early postemergence usually provides excellent smartweed control and presents much less of a risk for injury to nearby soybeans.

For those who wish to estimate the possible reduction in soybean yield from dicamba prior to harvest, pod and bean counts per plant or for a given area can be made in affected and unaffected areas. More accurate yield checks can be made by making a comparison of the actual yields at harvest.

Some people have had the opinion that there is less risk of injury to corn from dicamba than from 2,4-D. However, there is occasional dicamba injury to corn. One of the reasons for fewer reports of such injury may be the smaller number of acres treated with dicamba than with 2,4-D.

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Table 2. Soybean Yield and Other Agronomic Characteristics as Influenced by Foliar Applications of Dicamba and 2,4-D, Urbana, Illinois, 1966-1967

Herbicide, time and rate of application (oz./A.)	Soybean yield (lb./A.)	Plant height (in.)	No. of plants/ft. of row	Lodging[a]	Maturity delay days	Wt./100 seeds (g.)	Seed quality[b]	Pct. germination	Pct. oil in seed	Pct. protein in seed
2,4-D prebloom										
0.	2,310	37	6.6	1.5	0	17.1	2.5	94	22.2	39.7
1/4.	2,420	36	6.9	1.7	0	19.9	2.7	96	21.9	39.4
1/2.	2,360	36	6.8	1.5	0	16.4	2.6	95	22.8	39.2
1.	2,240	36	7.1	1.7	2	16.5	2.6	95	22.1	39.1
2.	2,300	36	6.4	1.8	2	16.3	2.8	94	22.4	38.8
2,4-D bloom										
0.	2,470	36	7.0	1.6	0	17.5	2.5	97	21.8	39.7
1/4.	2,400	36	7.1	1.6	0	17.9	2.6	96	22.1	39.7
1/2.	2,320	35	6.9	1.5	1	18.1	2.8	95	21.9	39.9
1.	2,200	34	6.9	1.6	1	18.3	3.0	95	21.9	39.4
2.	2,190	34	6.4	1.8	2	17.7	3.0	94	22.1	40.2
Dicamba prebloom										
1/32[c].	2,180	29	5.8	1.0	0	15.1	2.4	95	22.6	38.2
1/16	2,030	30	6.4	1.5	0	15.8	2.6	97	21.9	39.0
1/8.	2,220	28	6.9	1.8	3	15.5	2.7	97	22.0	39.2
1/4.	2,100	28	7.5	1.9	3	15.1	2.6	97	22.3	39.3
1/2.	2,050	28	7.1	1.8	4	15.0	2.7	98	22.2	39.3
1[d]	1,940	28	7.5	1.4	2	15.1	2.9	97	22.3	39.8
Dicamba bloom										
1/32[c].	1,970	27	6.0	1.0	0	19.0	2.8	95	21.5	40.0
1/16	2,060	29	6.9	1.2	4	19.6	3.1	97	20.8	41.7
1/8.	1,900	27	6.8	1.2	5	19.9	3.4	97	20.5	42.3
1/4.	1,680	25	6.7	1.2	7	19.6	3.8	97	20.0	42.5
1/2.	1,180	20	6.7	1.3	14	17.3	3.9	79	19.4	44.0
1[d]	620	21	6.0	1.8	24	15.9	4.1	19	18.5	45.5
Bayes LSD .05 between herbicide-time main plots.	430	4	1.0	0.5	2	1.1	0.4	13		
Bayes LSD .05 between rate subplots within main plots	160	2	0.8	0.5	1	0.6	0.4	9		

[a] Lodging scored 1 (erect) to 5 (prostrate).
[b] Seed quality scored 1 (good) to 5 (poor).
[c] Data only in 1967.
[d] Data only in 1966.

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Weed Control in Sorghum

Grain sorghum is grown much like corn, but it is planted later than corn. Timely seedbed preparation, rotary-hoeing, and row cultivation are useful methods of mechanical weed control. Narrow rows and high plant populations also help to control weeds.

Sorghum weed problems will be similar to those in soybeans and corn. Three weeds which will be more difficult to control in sorghum will be fall panicum, wild cane (shattercane), and Johnson grass. The herbicides which are most effective for control of these weeds will injure sorghum to some degree.

Several herbicides are cleared for weed control in sorghum. Some are cleared especially for grain sorghum (milo), but these are not generally available in Illinois because of limited demand. The current interest in sorghum may create a demand for some of these herbicides. Herbicides for corn that can also be used on sorghum are Ramrod, Ramrod/atrazine, AAtrex, and 2,4-D.

PREEMERGENCE HERBICIDES--GRAIN SORGHUM

Ramrod (propachlor) is cleared for use on grain sorghum (milo) but not on forage sorghum. Grain sorghum *forage* should not be grazed or fed to dairy animals. Ramrod is better adapted to soils with organic matter over 3 percent, as length of control has been too short on the soils of lower organic matter content. However, the fact that sorghum is planted later than corn may permit Ramrod to perform better on the lower organic matter soils when sorghum is planted.

Ramrod is available as a 65% wettable powder (65W) and a 20% granule (20G). The broadcast rate is 6 to 7-1/2 pounds per acre of the 65W or 20 to 25 pounds per acre of the 20G (4 to 5 pounds per acre, active ingredient). Use proportionately less for band application. Ramrod controls most of the annual grasses and pigweed, but does not control many of the broadleaved weeds. Ramrod can be followed with a postemergence spray of 2,4-D or atrazine or can be tank-mixed with atrazine or propazine to control most of the annual broadleaved weeds. Ramrod/atrazine is also available as a packaged mix. See the Ramrod label for rates of the tank-mixtures of Ramrod with atrazine or propazine. If you use the mixtures with atrazine or propazine, be sure to check the label for rotational crops that can be planted.

Milogard (propazine) is a triazine herbicide much like atrazine, but it is cleared only for sorghum (grain or sweet) as a preplant or preemergence application. Propazine has a slightly longer soil persistence than atrazine and is also weaker on some of the grassy weeds. The rate for Milogard 80W is 2-1/2 to 4 pounds per acre (broadcast basis), depending on soil texture and organic matter. Do not use on sandy soils. Do not plant crops other than corn or sorghum for 18 months after application.

Herban (norea) is a substituted urea herbicide cleared on sorghum and soybeans. It is available as an 80% wettable powder formulation. Herban is weak on broadleaved weed control, so it is often combined with atrazine or propazine. These combinations can be tank-mixed (see Herban label for directions) or are available as packaged mixtures. Herban 21A is a 2:1 ratio of norea:atrazine, and Herban 21P is a 2:1 ratio of norea:propazine. Do not use Herban 21A or 21P on sandy soils. Do not use Herban 21A on soils of low organic matter. Herban 21A also has a 90-day grazing restriction after application.

POSTEMERGENCE HERBICIDES--GRAIN SORGHUM

2,4-D can be used to control many broadleaved weeds in sorghum. Sorghum is most tolerant to 2,4-D when it is 4 to 12 inches tall, although injury can occur at this stage. Sorghum tolerance to 2,4-D varies with stress conditions (moisture and temperature) as well as with stage of growth. Use extension nozzles (drops) to keep spray away from the whorl after sorghum is 8 inches tall. The rate of 2,4-D varies with formulation (ester or amine) and concentration (pounds per gallon, active ingredient), but is the same as for postemergence use on corn.

AAtrex (atrazine) is cleared in Illinois only by itself as a postemergence application with water (not with emulsifiable oil). It is cleared in some states as a preemergence application alone, and is cleared in combinations with Ramrod and Herban for preemergence use in Illinois. The rate of AAtrex depends upon soil texture and organic matter as well as formulation. AAtrex is available as an 80% wettable powder (80W) and a 4-pounds-per-gallon-of-water dispersible liquid (4L). Weed control is best if weeds are less than 1-1/2 inches tall; however, sorghum plants should be completely emerged.

FORAGE SORGHUM

Most herbicides cleared for use on grain sorghum (milo) are not cleared for use on forage sorghums. Many of the grain sorghum herbicides also carry grazing restrictions for the forage from grain sorghum. One of the best practices for weed control in forage sorghums is to narrow the row width and use a high plant population.

AAtrex (atrazine) is cleared for use on forage sorghums and sorghum-sudan hybrids as a postemergence application. The rates are the same as for grain sorghum.

2,4-D clearances are not at present specific as to type of sorghum.

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CHECK LIST OF INSECTICIDES

There are many insecticides listed in Circulars 897 (Commercial Vegetables), 898 (Livestock), 899 (Field Crops), and 900 (Homeowner) containing the current Illinois insecticide recommendations. The following list gives some information about these insecticides; we have also included other insecticides that have label approval but are not in the Illinois recommendations.

The insecticide names are listed at the left in capital letters. Usually these are the common names, but if they are trade names they are marked with an asterisk. Trade names and other identifying names follow the common names. The name of the basic manufacturer is listed after the trade name.

Toxicity ratings for each insecticide are listed below the name. An acute oral toxicity rating for each insecticide is given, also a dermal toxicity rating if known. Acute oral toxicity ratings are usually obtained by feeding white rats, acute dermal ratings by skin absorption tests on rats or rabbits. These figures are expressed as LD50. This means the size of the dose which is lethal to 50 percent of the test animals. LD50 is expressed in terms of milligrams of actual insecticide per kilogram of body weight of the test animal--mg./kg. Chronic oral toxicity (90 days plus) with the no-effect level in the diet is expressed in parts per million. When available, toxicity ratings of insecticides to fish and honeybees are also given. Those for bees can be interpreted readily as follows: (1) High--kills bees on contact and by residues; bees should be removed from area of application. (2) Moderate--kills bees if applied over them; limited damage with correct dosage, timing, and method of application. (3) Low--can be used around bees with few precautions and a minimum of injury.

To express toxicity in practical terms, the factor .003 times the LD50 value will give the ounces of actual insecticide required to be lethal to one of every two 187-pound men or other warm-blooded animals. As an example, the oral LD50 value for malathion is 1,200 mg./kg.; thus, if a group of men each weighing 187 pounds ate 3.6 ounces (1,200 times .003) of actual malathion per man, half of them would succumb. The dermal-toxicity-LD50 value of malathion is approximately 4,000 mg./kg. or for a 187-pound man, 12 ounces. If you check the list of insecticides, you will find some highly toxic chemicals with LD50 values from 1 to 10 mg./kg. For the average man, fatal doses of these would be in the range of .003 to .03 ounce.

By comparison, the oral LD50 value of aspirin is 1,200 mg./kg. or 3.6 ounces per 187-pound man, the equivalent of malathion. The oral LD50 value of ethyl alcohol is 4,500 mg./kg. If a group of 187-pound men each consumed somewhat more than 1 quart of 80 proof whiskey in 45 minutes they would not only be intoxicated, 50 percent of them might die.

It is important to remember that these toxicity ratings of each insecticide listed are approximate and pertain to white rats and sometimes rabbits. Such ratings do serve as a guide to compare the toxicity of insecticides as well as an indication of their comparative acute toxicity to other warm-blooded animals and man. Acute toxicity ratings expressed as LD50 are classified as to their relative danger when being used. An LD50 of 750 mg./kg. or higher is rated as low toxicity, LD50 ratings of 150-750 is moderate, 50-150 is moderately high, and 50 or less is very high.

The chemical group to which the insecticide belongs is given after the toxicity ratings. From this, you can determine which insecticides have similar chemical properties. A brief statement follows the chemical group name, describing in general terms the principal uses for the insecticide.

Remember, this is *not* a list of recommended insecticides, nor is it to be used in determining what insecticide to use to control a particular insect. This list is a quick insecticide reference to compare common chemical names to trade names, their toxicity ratings and general uses.

ABATE*--see biothion

ACARALATE*--see chloropropylate

AKTON* SD 9098 Shell

Acute oral--146
Acute dermal--177
Organic phosphate--Insecticide for lawn insects.

ALDRIN Shell

Acute oral--39-60
Acute dermal--98
Chronic oral--0.5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as a soil insecticide for corn soil insects and termites. Not suggested for use in Illinois.

ALLETHRIN Synthetic pyrethrin, Pynamin FMC, Benzol Products

Acute oral--680-1,000
Acute dermal--11,200
Chronic oral--5,000

Bee toxicity--Low

Botanical--Used in household aerosols and fly sprays as a quick knockdown.

ALUMINUM PHOSPHIDE Phostoxin Hollywood Termite Company

Fumigant--Used on stored products. Highly toxic when phosphine gas is formed.

APHOLATE Olin Mathieson

Acute oral--90
Acute dermal--50-200

Organic phosphate--Used as an experimental chemical sterilizing agent of insects.

* Trade name.

ARAMITE* — U.S. Rubber

Acute oral--3,900
Chronic oral--500

Fish toxicity--Moderate
Bee toxicity--Low

Sulfonate--Miticide limited to ornamentals and household. No clearance on fruit or vegetables, has carcinogenic properties.

AZINPHOSMETHYL — Guthion — Chemagro

Acute oral--11-13
Acute dermal--220
Chronic oral--5

Bee toxicity--High

Organic phosphate--Used on cotton, forage crops, ornamental crops, and tree fruit to control both insects and mites.

AZODRIN* — SD 9129 — Shell

Acute oral--21
Acute dermal--354
Chronic oral--1

Bee toxicity--High

Organic phosphate: Systemic insecticide for use on cotton and fruit crops upon label approval.

BACILLUS POPILLIAE

Bacterial--Nontoxic microbial insecticide. Applied to soil to infect Japanese beetle grubs with milky disease.

BACILLUS THURINGIENSIS — Thuricide, Dipel, Biotrol

Bee toxicity--Low

Bacterial--A nontoxic microbial insecticide used to control caterpillars on vegetable crops and forest trees.

BAYGON* — propoxur — Chemagro

Acute oral--95-104
Acute dermal--1,000+
Chronic oral--800

Carbamate--For use against mosquitoes, household insects, and certain lawn insects.

BAYTEX*--see fenthion

BENZENE HEXACHLORIDE — BHC, gammexane — Diamond Alkali, Hooker, Olin Mathieson, Stauffer

Acute oral--1,250
Chronic oral--10

Bee toxicity--High

Chlorinated hydrocarbon--Limited use; replaced by lindane.

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* Trade name.

BENZYL BENZOATE — Monsanto

Acute oral--500-5,000

Repellent--A repellent for chiggers, mosquitoes, and ticks on man.

BIDRIN* — Shell

Acute oral--22 — Bee toxicity--High
Acute dermal--225
Chronic oral--1

Organic phosphate--Systemic insecticide used for mimosa webworm control on honey locust. Recommended in many states as an injected systemic for elm bark beetle control but to be applied only by people especially trained to do the work.

BINAPACRYL — Morocide, Acricid — FMC

Acute oral--161 — Bee toxicity--Low
Acute dermal--1,350

Nitrophenol--A miticide for certain fruit crops.

BIOTHION — Abate — American Cyanamid

Acute oral--1,000-3,000
Acute dermal--1,024-1,782
Chronic oral--2

Organic phosphate--Used as a larvicide for mosquito control.

BIOTROL*--see Bacillus thuringiensis

BUX* — Ortho 5353 — Chevron

Acute oral--87
Acute dermal--400

Carbamate--Used for soil insect control in corn.

BUTOXY POLYPROPYLENE GLYCOL — Crag Fly Repellent — Union Carbide

Acute oral--9,100-11,200
Chronic oral--640

Repellent--Used in sprays for cattle against flies.

CARBARYL — Sevin — Union Carbide

Acute oral--500-850 — Fish toxicity--Very low
Acute dermal--4,000+ — Bee toxicity--High
Chronic oral--200

Carbamate--A general insecticide registered for control of many pests of field crops, vegetables, fruit, homeowner, and livestock.

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* Trade name.

CARBOFURAN | NIA 10242, Furadan | Niagara, FMC, Chemagro

Acute oral--8-11
Acute dermal--10,200

Carbamate--Systemic insecticide for corn soil insects and experimental use on alfalfa weevil.

CARBON DISULFIDE | Stauffer

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

CARBON TETRACHLORIDE | Allied, Diamond Alkali, Dow, FMC, Frontier, Stauffer

Acute oral--5,730-9,770
Acute dermal--5,070-8,780
Chronic vapor--10 ppm. (40 hr.)
Acute vapor--300 ppm. (1 hr.)

Fumigant--Used as safener in fumigant mixtures for stored grain insects.

CARBOPHENOTHION | Trithion, Garrathion | Stauffer

Acute oral--10-30 | Bee toxicity--Moderate
Acute dermal--27-54
Chronic oral--5

Organic phosphate--Insecticide with lasting residue with limited use on some fruits and vegetables. It is used chiefly as a miticide.

CHLORBENSIDE | Mitox | Chevron

Acute oral--3,000 | Bee toxicity--Low
Chronic oral--20

Organic sulfide--A miticide used on many fruit crops.

CHLORDANE | Octachlor, Octa-Klor, Belt | Velsicol

Acute oral--335-430 | Fish toxicity--Very high
Acute dermal--690-840 | Bee toxicity--High
Chronic oral--25+

Chlorinated hydrocarbon--A residual insecticide for control of ants and roaches and a soil insecticide for termites, lawn, and corn soil insects.

CHLOROBENZILATE | CIBA-Geigy

Acute oral--1,040-1,220 | Bee toxicity--Moderate
Acute dermal--5,000+

Chlorinated hydrocarbon--A comparatively safe miticide used in orchards and greenhouses.

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* Trade name.

CHLOROPICRIN | Picfume | Dow, Morton

Chronic vapor--0.1 ppm. (40 hr.)
Acute vapor--20 ppm. (1 hr.)

Fumigant--Used on stored products in ship holds.

CHLOROPROPYLATE | Acaralate | CIBA-Geigy

Acute oral--34,600 | Bee toxicity--Low
Acute dermal--10,200
Chronic oral--40

Chlorinated hydrocarbon--Miticide for fruit crops.

CHLORPYRIFOS | Dursban, Dowco 179 | Dow

Acute oral--97-276
Acute dermal--2,000

Organic phosphate--Used as a soil insecticide in corn and for mosquito control. Used by PCO's for roach control.

CIODRIN*--see crotoxyphos

CO-RAL*--see coumaphos

COUMAPHOS | Co-Ral | Chemagro

Acute oral--15-41 | Bee toxicity--Moderate
Acute dermal--860
Chronic oral--5

Organic phosphate--A systemic insecticide for beef cattle and poultry to control grubs, lice, and mites.

CROTOXYPHOS | Ciodrin, SD 4294 | Shell

Acute oral--125 | Bee toxicity--High
Acute dermal--385
Chronic oral--7

Organic phosphate--Used to control livestock insects, especially biting flies.

CRUFOMATE | Dowco 132, Ruelene | Dow

Acute oral--460-635
Acute dermal--2,000-4,000
Chronic oral--10-30

Organic phosphate--A systemic insecticide for controlling grubs and lice on beef cattle.

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* Trade name.

CYGON*--see dimethoate

CYTHION*--see malathion

DASANIT* Bayer 25141 Chemagro

Acute oral--2-11
Acute dermal--3-30

Organic phosphate--Insecticide and nematicide for soil insect control in corn and for onion maggot control.

DDD*--see TDE

DDT Allied, Diamond Alkali, CIBA-Geigy Lebanon, Montrose, Olin Mathieson, Stauffer

Acute oral--113-118
Acute dermal--2,510
Chronic oral--5

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Illegal for sale or use in Illinois except by permit.

DDVP*--see dichlorvos

DEET Off, Delphene, diethyltoluamide Hercules

Acute oral--1,950
Acute dermal--10,000

Repellent--Used for control of biting insects and chiggers on man. Applied directly to skin.

DE-FEND*--see dimethoate

DELNAV*--see dioxathion

DEMETON Systox Chemagro

Acute oral--2-6
Acute dermal--8-14
Chronic oral--1

Fish toxicity--Moderate
Bee toxicity--Low

Organic phosphate--A systemic miticide and aphicide for use in greenhouses, orchards, and on certain field crops.

DESSIN* Murphy, Union Carbide

Acute oral--100-155
Acute dermal--1,000

Carbonate--Miticide for fruit crops.

* Trade name.

DIAZINON | Spectracide | CIBA-Geigy

Acute oral--76-108
Acute dermal--455-900
Chronic oral--1

Fish toxicity--High
Bee toxicity--High

Organic phosphate--A general insecticide; can be used as a residual fly spray in barns, also to control insects in soil of cornfields, as well as insect pests of turf, vegetables, fruits and household.

DIBROM*--see naled

DIBUTYL PHTHALATE | DBP | Allied, Monsanto, Commercial Solvent

Acute oral--5,000-15,000

Repellent--For impregnating clothing to repel chiggers and mites.

DICHLORVOS | DDVP, Vapona | Shell

Acute oral--56-80
Acute dermal--75-107

Fish toxicity--Moderate
Bee toxicity--High

Organic phosphate--Short-lived residual insecticide for livestock, fly bait, greenhouses, and warehouses. Also impregnated in plastic resin strips.

DICOFOL | Kelthane | Rohm and Haas

Acute oral--1,000-1,100
Acute dermal--1,000-1,230
Chronic oral--20

Fish toxicity--High
Bee toxicity--Low

Chlorinated hydrocarbon--Miticide used on vegetables, fruit, and ornamentals.

DIELDRIN | Octalox | Shell

Acute oral--46
Acute dermal--60-90
Chronic oral--0.5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as a seed treatment insecticide and for control of specific fruit insects, lawn soil insects, termites and household insects.

DIMETHOATE | Cygon, De-Fend, Rogor, Roxion | American Cyanamid

Acute oral--215
Acute dermal--400-610
Chronic oral--5

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--A systemic insecticide for use on fruit, vegetable, and ornamental crops and residual fly spray inside of livestock barns.

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* Trade name.

DIMETHYL PHTHALATE | DMP | Monsanto, Allied

Acute oral--8,200
Acute dermal--4,000+

Repellent--General purpose mosquito repellent.

DIMETILAN* | SNIP | CIBA-Geigy

Acute oral--25-64
Acute dermal--600+
Chronic oral--400

Bee toxicity--Moderate

Carbamate--Insecticide impregnated on plastic foam bands for fly control in livestock buildings.

DINITRO COMPOUNDS | Elgetol 318, DNOC | Dow, FMC, Chem. Ins. Corp.

Acute oral--5-60
Acute dermal--150-600

Nitrophenol--Used primarily for controlling aphids, mites, and scale insects as dormant fruit spray.

DINOCAP | Karathane | Rohm and Haas

Acute oral--980-1,190
Acute dermal--4,700-9,400

Dinitro--A fungicide used for control of powdery mildew; also acts as a mite suppressant.

DIOXATHION | Delnav, Navadel | Hercules

Acute oral--23-43
Acute dermal--63-235
Chronic oral--4

Bee toxicity--Low

Organic phosphate--Miticide and insecticide used as an animal dip and spray.

DIPEL*--see Bacillus thuringiensis

DIPTEREX*--see trichlorfon

DISULFOTON | Di-Syston, dithiodemeton, thiodemeton | Chemagro

Acute oral--2-7
Acute dermal--6-15
Chronic oral--2

Bee toxicity--Moderate

Organic phosphate--A systemic insecticide to control aphids, leafhoppers, and flea beetles on certain vegetable crops. Also a soil insecticide for corn.

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* Trade name.

DI-SYSTON*--see disulfoton

DURSBAN*--see chlorphyrifos

DYFONATE* N2790 Stauffer

Acute oral--16
Acute dermal--319

Organic phosphate--Used for soil insect control in corn.

DYLOX*--see trichlorfon

ENDOSULFAN Thiodan, Malix FMC

Acute oral--18-43
Acute dermal--74-130
Chronic oral--30

Bee toxicity--Moderate

Chlorinated hydrocarbon--Used on some vegetable crops to control aphids, cabbage worms, and other caterpillars. Also used for peach borer control.

ENDRIN Shell, Velsicol

Acute oral--8-18
Acute dermal--15-18
Chronic oral--1

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Highly toxic residual insecticide used on some field crops and ornamentals.

ENTEX*--see fenthion

EPN DuPont

Acute oral--8-36
Acute dermal--25-230

Bee toxicity--High

Organic phosphate--Used for insect control on field crops.

ETHION Nialate FMC

Acute oral--27-65
Acute dermal--62-245
Chronic oral--3

Bee toxicity--Low

Organic phosphate--Used for onion maggot control, aphids and mite control in orchards.

ETHYLENE DIBROMIDE American Potash, Dow, FMC, Great Lakes, Michigan Chemical

Acute oral--117-146
Acute dermal--300
Chronic vapor--25 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

* Trade name.

ETHYLENE DICHLORIDE — Diamond Alkali, Dow, Olin Mathieson

Acute oral--770
Acute dermal--3,890
Chronic vapor--50 ppm. (40 hr.)
Acute vapor--1,000 ppm. (1 hr.)

Fumigant--Used on stored grains.

EUGENOL — Penick

Acute oral--500-5,000

Attractant--Used for attracting fruit flies.

FAMPHUR — Famphos, Warbex — American Cyanamid

Acute oral--35-62
Acute dermal--1,460-5,093
Chronic oral--1

Organic phosphate--A systemic insecticide used for controlling grubs in cattle.

FENTHION — Baytex, Entex, Tiguvon — Chemagro

Acute oral--215-245
Acute dermal--330
Chronic oral--2

Fish toxicity--Low
Bee toxicity--High

Organic phosphate--Residual fly spray for livestock barns. Used in mosquito control and for household insects.

FUNDAL*--see Galecron

FURADAN*--see carbofuran

GALECRON* — Fundal — CIBA-Geigy, Nor-Am

Acute oral--162-170
Acute dermal--225
Chronic oral--250

Formanidine--Miticide for fruit crops and an insecticide for cabbage worm control.

GARDONA* — SD 8447, Rabon — Shell

Acute oral--4,000-5,000
Acute dermal--5,000+

Organic phosphate--Used for earworm control on seed corn, also for control of livestock flies and fruit insects.

* Trade name.

GENITE — Allied

Acute oral--980
Acute dermal--940

Sulfonate--Miticide for fruit crops.

GERANIOL — Fritche

Attractant--Used as an attractant in traps for Japanese beetle.

GUTHION*--see azinphosmethyl

GYPLURE — USDA

Attractant--Used as an attractant for gypsy moths.

HEMPA — Distillation Products Industries

Acute oral LD 100--2,640

Organic phosphate--Used as an experimental chemical sterilizing agent of insects.

HEPTACHLOR — Velsicol

Acute oral--100-162
Acute dermal--195-250
Chronic oral--0.5-5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as a corn soil insecticide. Not suggested for use in Illinois.

HYDROCYANIC ACID — HCN — American Cyanamid

Acute oral--4
Chronic vapor--10 ppm. (40 hr.)
Acute vapor--40 ppm. (1 hr.)

Fumigant--Used on stored products, for rodent control and building fumigation.

IMIDAN* — R-1504, Prolate — Stauffer

Acute oral--147-216
Acute dermal--3,160

Organic phosphate--Insecticide for fruit insect control, and against alfalfa insects.

KARATHANE*--see dinocap

KELTHANE*--see dicofol

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* Trade name.

KEPONE* Allied

Acute oral--125
Acute dermal--2,000+

Chlorinated hydrocarbon--Used in baits to control ants, roaches, and certain other insects.

KORLAN*--see ronnel

LANNATE*--see methomyl

LEAD ARSENATE

Acute oral--1,050 Bee toxicity--High
Acute dermal--2,400+

Arsenical--Used to control certain chewing insects of fruit and ornamentals.

LETHANE 60* Rohm and Haas

Acute oral--250-500
Acute dermal--3,000

Thiocyanate--Used in household insecticide sprays.

LETHANE 384*

Acute oral--90
Acute dermal--250-500

Thiocyanate--Used in livestock fly sprays as a quick knockdown agent.

LINDANE gamma BHC Hooker

Acute oral--88-91 Fish toxicity--Very high
Acute dermal--900-1,000 Bee toxicity--High
Chronic oral--50

Chlorinated hydrocarbon--Used to control spittlebugs on certain crops and mite and louse control on certain livestock.

MALATHION Cythion American Cyanamid

Acute oral--1,000-1,375 Fish toxicity--High
Acute dermal--4,444+ Bee toxicity--High
Chronic oral--100-1,000

Organic phosphate--General use insecticide for homeowner insect control, for certain livestock insects and certain crop insects. Premium grade used for treating grain to be stored.

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* Trade name.

METALDEHYDE

Acute oral--1,000

Attractant--Used in combination with stomach poisons for snail and slug baits.

META-SYSTOX R*--see oxydemetonmethyl

METEPA | Metaphoxide, Methyl Aphoxide | American Cyanamid

Acute oral--93-277
Acute dermal--156-214

Organic phosphate--Used as an experimental chemical sterilizing agent of insects.

METHOMYL | 1179, Lannate | DuPont

Acute oral--17-24
Acute dermal--1,500
Chronic oral--100

Carbamate--Used for worm control on cabbage, tomatoes, sweet corn, and field corn.

METHOXYCHLOR | Marlate | DuPont, CIBA-Geigy

Acute oral--5,000
Acute dermal--6,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used in many homeowner fruit and vegetable spray or dust mixtures, for certain field crop insects, and Dutch elm disease control.

METHYL BROMIDE | Bromomethane | American Potash, Dow, Frontier, Great Lakes, Michigan Chemical

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

METHYL PARATHION | Metacide, Nitrox, Metron | American Potash, Monsanto, Shell, Stauffer, Velsicol

Acute oral--14-24
Acute dermal--67

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--It is closely related to parathion and is used primarily for insect control on cotton.

* Trade name.

METHYL TRITHION* — Stauffer

Acute oral--98-120 — Bee toxicity--High
Acute dermal--190-215

Organic phosphate--It is closely related to trithion or carbophenothion. It is a residual insecticide used in both insect and mite control on certain fruits and vegetables.

MEVINPHOS — Phosdrin — Shell

Acute oral--4-6 — Bee toxicity--High
Acute dermal--4-5
Chronic oral--0.8

Organic phosphate--A short-lived residual insecticide for control of insects on certain field and vegetable crops.

MGK-R11* — MGK

Acute oral--2,500
Acute dermal--2,000+

Repellent--Used in sprays for cattle against flies.

MGK-R326* — MGK

Acute oral--5,230-7,230
Acute dermal--9,400

Repellent--Used in sprays for cattle against flies.

MOCAP* — VC9104, Prophos — Mobil

Acute oral--62
Acute dermal--26

Phosphate--Residual chemical for control of soil insects and nematodes.

MORESTAN* — Chemagro

Acute oral--1,100-1,800 — Bee toxicity--Low
Acute dermal--2,000+
Chronic oral--50

Organic carbonate--Miticide to be used on apples prior to bloom.

MOROCIDE*--see binapacryl

NALED — Dibrom — Chevron

Acute oral--250 — Fish toxicity--High
Acute dermal--800 — Bee toxicity--High

Organic phosphate--A short-lived residual insecticide for use in greenhouses and for certain field crops. Also used in fly baits in livestock barns.

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* Trade name.

NEGUVON*--see trichlorfon

NICOTINE — Black Leaf 40, Nicotine Sulfate — Center Chemical, Inc.

Acute oral--83 — Bee toxicity--Low
Acute dermal--285

Heterocyclic botanical compound--Contact insecticide that is used to control aphids.

OMITE — Uniroyal

Acute oral--2,200 — Bee toxicity--Low

Sulfite--Miticide for use on fruit crops. Not harmful to predatory mites.

OXYDEMETONMETHYL — Meta-Systox R — Chemagro

Acute oral--65-75 — Bee toxicity--Moderate
Acute dermal--250
Chronic oral--10

Organic phosphate--A systemic insecticide for controlling aphids, mites, and other plant-sucking insects.

PARADICHLOROBENZENE — PDB, Paracide — Dow, Monsanto

Acute oral--1,000+

Fumigant--Used as fumigant to control fabric pests. Obsolete for peach borer control.

PARATHION — Alkron, Niran, Stathion, Thiophos — American Cyanamid, American Potash, Monsanto, Shell, Stauffer, Velsicol

Acute oral--4-13
Acute dermal--7-21 — Fish toxicity--High
Chronic oral--1 — Bee toxicity--High

Organic phosphate--A highly toxic insecticide to control a wide range of insects and mites on vegetable, fruit, and field crops.

PENTAC* — HRS-16 — Hooker

Acute oral--3,160 — Bee toxicity--Low
Acute dermal--3,160+

Chlorinated hydrocarbon--Miticide used on greenhouse floral crops and nursery stock.

PERTHANE* — Rohm and Haas

Acute oral--4,000+ — Fish toxicity--Very high
Chronic oral--500 — Bee toxicity--Moderate

Chlorinated hydrocarbon--Used in formulating household insecticides and also used on certain vegetable crops.

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* Trade name.

PHORATE — Thimet — American Cyanamid

Acute oral--1-3
Acute dermal--3-6

Bee toxicity--Moderate

Organic phosphate--A systemic insecticide for use on certain vegetable crops, field crops, and as a soil insecticide for corn.

PHOSALONE — Zolone — Rhodia

Acute oral--120

Organic phosphate--Used as a miticide and insecticide on fruit trees.

PHOSDRIN*--see mevinphos

PHOSPHAMIDON — Dimecron — Chevron

Acute oral--24
Acute dermal--107-143

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--A systemic insecticide for use on certain fruit and vegetable crops.

PHOSTOXIN*--see aluminum phosphide

PIPERONYL BUTOXIDE — Butocide — FMC

Acute oral--7,500+
Acute dermal--1,880
Chronic oral--1,000

Synergist--Commonly used with pyrethrum.

PLICTRAN — Dow

Acute oral--1,675

Tin--Miticide for use on fruit crops.

PROLATE--see Imidan

PYRETHRUM — pyrethrin I and II — FMC, Penick, MGK

Acute oral--820-1,870
Acute dermal--1,880+
Chronic oral--1,000

Fish toxicity--High
Bee toxicity--Low

Botanical--Used as a fly control insecticide in household and livestock sprays.

RABON*--see Gardona

RAVAP*--mixture of dichlorvos and Rabon.

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* Trade name.

RONNEL Korlan, Trolene, Viozene Dow

Acute oral--1,250-2,630
Acute dermal--5,000+
Chronic oral--10

Organic phosphate--Used in baits and sprays for fly control in livestock barns.

ROTENONE derris, cube FMC, Penick

Acute oral--50-75
Acute dermal--940+
Chronic oral--25

Fish toxicity--Very high
Bee toxicity--Low

Botanical--A contact poison used to control certain home garden insects and cattle grubs.

RUELENE*--see crufomate

SEVIN*--see carbaryl

SPECTRACIDE*--see diazinon

SULFOXIDE Sulfox-Cide Penick

Acute oral--2,000
Acute dermal--9,000+
Chronic oral--2,000

Synergist--Commonly used with pyrethrum.

SYSTOX*--see demeton

TDE DDD, Rhothane Allied, Rohm and Haas

Acute oral--4,000+
Acute dermal--4,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Used to control leaf rollers, tobacco hornworm, and tomato fruitworms.

TEDION*--see tetradifon

TEMIK* UC 21149, Aldicarb Union Carbide

Acute oral--5-10
Acute dermal--1,400

Carbamate--Experimental residual, systemic insecticide and miticide for possible use against mites and certain insects of fruits, vegetables, and ornamentals.

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* Trade name.

TETRADIFON Tedion Niagara, Phillips

Acute oral--14,700+
Acute dermal--10,000+

Bee toxicity--Low

Sulfonate--A miticide for fruit crops.

THANITE* Hercules

Acute oral--1,600
Acute dermal--6,000

Thiocyanate--It is added to household and livestock sprays to increase knockdown of flying insects.

THIMET*--see phorate

THIODAN*--see endosulfan

THURICIDE*--see Bacillus thuringiensis

TOXAPHENE chlorinated camphene Hercules

Acute oral--80-90
Acute dermal--780-1,075
Chronic oral--10

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used to control many insects of grain and forage crops, livestock, vegetable, and fruit crops. Used in backrubbers and as a sheep dip.

TRICHLORFON Dylox, Dipterex, Neguvon Chemagro

Acute oral--560-630
Acute dermal--2,000+

Fish toxicity--Very low
Bee toxicity--Low

Organic phosphate--Dipterex used in fly baits and Dylox as a spray for certain field crops, vegetable and ornamental insects.

TRITHION*--see carbophenothion

VAPONA*--see dichlorvos

ZECTRAN* Dowco 139 Dow

Acute oral--25-37
Acute dermal--1,500-2,500

Fish toxicity--Very low
Bee toxicity--High

Carbamate--Used for ornamentals and turf insect control, also for control of slugs.

* Trade name.

ZINOPHOS* Nemaphos, Nemafos American Cyanamid

Acute oral--9-16
Acute dermal--8-15
Chronic oral--5

Organic phosphate--A soil insecticide for control of garden symphylans and cabbage maggot.

ZOLONE*--see phosalone

* Trade name.

Prepared by entomologists of the Illinois Agricultural Extension Service and Illinois Natural History Survey. For additional copies, see your county extension adviser.

No. 1000

THE SAFE USE AND TOXICITY OF FUNGICIDES, BACTERICIDES, AND NEMATICIDES

Edward E. Burns and Malcolm C. Shurtleff[1/]

More than $200 million was spent on pesticides (insecticides, fungicides, nematicides, and herbicides) in the 1969 growing season. About 5 to 10 percent was spent for fungicides, representing a considerable cost to control plant diseases. But we also derive many benefits from the use of pesticides. For example: (1) Peach growers can expect $23 in return for every $1 invested in fungicides; (2) one farmer in the Corn Belt provides food for 100 other persons, and; (3) American housewives now spend only 17 percent of their family's disposable income to purchase food, the lowest of any country in the world. It is our responsibility, therefore, to understand and use all pesticides wisely.

The Food and Drug Administration (FDA) sets the maximum tolerances (residues in parts per million, or ppm) that a food may contain of a particular pesticide and be legally sold or transported in interstate commerce. The USDA registers the uses, rates, methods, and timing of application of chemicals on specific crops. These are indicated on currently registered package labels and in many pest control guides.

The major purposes of this leaflet are to describe proper methods for safe use of these materials by all persons concerned, and to consider the "toxicity" of disease control chemicals now being used in Illinois.

SELECTING A CHEMICAL TO CONTROL PLANT DISEASE

Part of the safe use of chemicals for disease control includes being able to answer the following questions regarding effectiveness and possible hazards:

- Has the causal fungus, bacterium or nematode been identified?
- Does it cause a serious plant disease?
- Can other control measures be used (such as a change in cultural practices, biological control, or the use of resistant varieties)?
- Where is the pathogen most active (greenhouse or field; plant parts affected)?
- How toxic to humans are the suggested chemicals?
- Will there be drift or possible side effects (such as injuring or killing nearby plants, bees, other beneficial insects, or wildlife)?
- Will the chemical leave a toxic residue?
- Are there any special health hazards to the applicator?

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THE CHEMICAL PACKAGE LABEL

Regardless of the chemical used, particular attention must be given to the package label. Look for: (1) warnings (POISON, DANGER, KEEP OUT OF REACH OF CHILDREN), (2) directions for use (dosage, time, and method of application), (3) crops to be treated, (4) contents of the package, (5) how to mix it, and (6) where and how to store or dispose of any left over material.

TOXICITY RATINGS FOR PLANT DISEASE CONTROL CHEMICALS

Certain terms need to be understood:

Pesticide--any substance or mixture of substances intended to prevent, destroy, repel or mitigate pests, including fungi, bacteria, nematodes, insects or weeds.

Toxicity--the inherent capacity of a substance to produce injury or death in animals or humans.

Hazard--likelihood that a chemical will cause harm when used as directed. It will depend upon the *toxicity* of the chemical and the length of time or form of *exposure* to the chemical. Reduction of either factor will, of course, reduce the hazard.

LD/50 (Lethal Dose)--the dosage or concentration of a chemical that will kill approximately 50 percent of the test animals in a certain length of time.

Acute oral LD/50--the dosage of chemical fed in one dose (in aqueous solution) necessary to kill 50 percent of the test animals. This is expressed as milligrams per kilogram (mg/kg) of body weight of the test amimal.

Dermal LD/50--the amount of chemical applied to the skin for a period of 24 hours able to cause death in 50 percent of the test animals, or when LD/50 is not available, the measurable skin reaction.

LC/50 (Lethal Concentration)--the air concentration that will kill 50 percent of the animals inhaling (breathing) the air mixture for 24 hours. It is normally expressed as parts per million (ppm). This test may also be applied to fish.

Phytotoxicity--the ability of a chemical to injure or kill the plant to which it is applied.

Information about chemical toxicity to humans has been obtained from accidental exposures to harmful levels of chemicals, from suicides, and indirectly from tests on mice, rats, guinea pigs, poultry, dogs, and monkeys. The results are affected by sex, diet, and general health of the test animal. Extrapolation of the chemical's possible effect on humans should be done with caution. Many people may be allergic to a chemical that is nontoxic to most persons.

Table 1 lists toxicity classes of fungicides, nematicides, insecticides, herbicides, and other pesticides. Note the special signals. These are required by law to be plainly visible on all package labels.

Table 1. Pesticide Toxicity Classes and the Amount of Substance Effective by Different Routes of Absorption[a]

Commonly used term (toxicity class or rating)	Routes of Absorption: LD/50-single oral dose, rats mg/kg	LD/50-single dermal dose, rabbits mg/kg	Probable lethal oral dose, man (signal word)
Extremely toxic (1)	1 or less[b]	20 or less	A taste, a grain[c] (POISON-DANGER)
Highly toxic (2)	1-50	20-200	A pinch, 1 teaspoon (POISON-DANGER)[c]
Moderately toxic (3)	50-500	200-1,000	1 teaspoon-2 tablespoons (WARNING)
Slightly toxic (4)	500-5,000	1,000-2,000	1 ounce- 1 pint (CAUTION)
Practically non-toxic (5)	5,000-15,000	2,000-20,000	1 pint- 1 quart (NONE)
Relatively harmless (6)	15,000+	20,000+	Greater than 1 quart (NONE)

a/ Modified after Bailey, J.B., and J.E. Swift. 1968. *Pesticide Information and Safety Manual.* University of California Press. Berkeley.
b/ Of the pure, undiluted compound.
c/ Any compound having the signal words POISON-DANGER must also have the skull and crossbones symbol on the package label.
Note: 1 kilogram (kg)=2.2 pounds (lb) 28.3 grams (gr)=1 ounce (oz.)
1000 milligram (mg)=1 gram (gm)

In Appendix I, plant disease control chemicals are listed on the basis of their toxicity. They can be checked against Table 1 for class and warning signals.

To translate the amount of LD/50 into the number of ounces that would be fatal to 50 percent of a group of men whose weight averaged 180 pounds, multiply the "mg/kg" by 0.003 to get ounces per 180 pounds.

Since LD/50 depends upon body weight, a child's body requires *less* chemical and a heavier adult requires *more* chemical to have a toxic effect. LD/50 also is proportional to the percent of active ingredient. A material only 50 percent active requires twice as much to produce a toxic effect as 100 percent pure material.

The lower the LD/50 value, the greater the toxicity. A common standard for comparison is aspirin, which has an LD/50 of 1,200 mg/kg and is considered slightly toxic.

SAFETY TIPS FOR SPECIFIC USES

Here are a few minimum precautions applicable to certain persons and situations. If you are a supervisor or foreman, you need to be thoroughly familiar with all of them.

General

When in doubt, consult an authority on problems of plant disease control.
Read the package label carefully, even the small print.
Plan ahead.
Check and calibrate your equipment.
Check gloves, masks, and other protective clothing for holes and cleanliness before each use.
Wash yourself, your clothing, and your equipment thoroughly after each application.
Keep others away from the treated area until it is safe to enter.
Cover or remove food, feed, and water containers in the vicinity.

Pilots (aerial application)

Plane engines should remain off while filling chemical tanks.
Do not fly through the drift of an application.
Wear the proper helmet and respirator.
Refuse to fly if the conditions are not "just right."
Do not spray or dust over the flagman.

Ground crew (aerial application)

Clean and cover hoppers when loading is complete.
Change clothing after washing aircraft and other contaminated equipment.
Keep a record of what is being applied in case of emergency.

Flagman (aerial application)

Avoid as much spray or dust as possible.
Wear protective garments.
Never turn your back on an approaching airplane.

Ground applicators

Have two people working together if highly toxic materials are being mixed in the field.
Stay out of the drift or drip line of sprayed trees.

Storage fumigators

Warn all persons in the area and post signs.
Aerate fumigated goods and spaces before handling or reentry.
Use proper detector equipment.

Greenhouse operators

Use the most effective but least toxic materials available.
Post warning signs.
Avoid contact with treated plants and other treated surfaces.
Label and keep separate equipment for fumigation and spraying.

Household and garden

For food gardens use nonpersistent materials.
Never deviate from package directions.
Keep materials out of the reach of children, irresponsible adults, and pets.

Keep aerosol sprays away from lighted fires and electrical outlets.
Cover bird baths, fish ponds, wells, and picnic tables during application to avoid contamination.

Cities and municipalities
Give advance notice and explanation of pesticide application through the press, radio or television.
Have a legitimate reason for spraying.

Mixing chemicals
Do not mix a "home brew" unless absolutely sure the chemicals are compatible. (See Report on Plant Disease 1004- Problems in Mixing Pesticides.)
Pour liquids, powders, and dusts slowly to avoid splashing and spilling.. Wear a mask especially when pouring dusts.
Be aware that some chemicals, when combined, have increased toxicity (potentiation).

Disposal of containers and materials
Rinse containers several times when empty. Pour on a gravel drive or on to a waste soil area away from wells.
Keep empty containers locked up and do not use for anything else until they are disposed of safely.
Do not puncture aerosol cans or place in fires.
Never burn bags or metal cans that can release fumes into the air. Bury them 18 inches below the soil in an isolated location.

For your own protection, keep a record of plant disease control chemicals used and the methods of handling.

ENTRY OF CHEMICALS INTO THE HUMAN BODY

Chemicals enter humans through (1) skin contact and absorption (dermal), (2) breathing the vapors, fumes, or dusts (inhalation), and (3) eating or drinking (oral). The contact hazard will depend upon the type of material and the method of application in actual use. Generally, powders and dusts are not as readily absorbed by the skin as are liquid preparations. Observe safe waiting periods after each application to avoid unnecessary contact with chemicals. Any chemical, if ingested in sufficient amounts, can be toxic enough to kill mammals.

EFFECTS OF DISEASE CONTROL CHEMICALS ON HUMANS

All persons using plant disease control chemicals should be familiar with the symptoms of poisoning and be alert to these symptoms in themselves and their co-workers both during and after application.
DO NOT DIAGNOSE YOURSELF. Check with a qualified physician at your nearest Poison Control Center. These symptoms are often produced during true illness and may not necessarily reflect poisoning. Not all pesticides produce all of the symptoms listed.

The following symptoms of poisoning may appear:
eyes watering excessively (lacrimation)
stomach cramps
dizziness (vertigo)
vomiting
excessive sweating
pupils of the eye reduced in size (miosis)
rapid heart beat (tachycardia)

muscle tremors or convulsions
extreme nervousness
mental confusion, lack of coordination
uncontrolled drooling or watering at the mouth (salivation)
severe burns of the skin
loss of ability to use muscles (paralysis)
difficulty in breathing (dyspnea)
unconsciousness (coma)

FIRST AID FOR CHEMICAL (PESTICIDE) POISONING

In all cases

1. Stop exposure to the poison.
2. Give artificial respiration if breathing has stopped or is labored.
3. Call a physician immediately and show him the container or label. If you do not have either, save a sample of the vomit.

Poison on skin

1. Drench skin and clothing with water.
2. Remove clothing.
3. Cleanse skin and hair with soap and water thoroughly and as quickly as possible.

Poison in eye

1. Hold the eyelid open, wash eye with a gentle stream of clean running water in large amounts.
2. Continue for 15 minutes or more.
3. Don't treat the eye with commercially available eye medicines that might aggravate the injury.

Inhaled poisons (dusts, vapors, gases)

1. If the victim is in an enclosed area, do not go in after him without proper respirator equipment.
2. Carry patient to fresh air immediately.
3. Loosen all tight-fitting clothing.
4. Open all doors and windows.
5. Prevent chilling (but do not overheat) and keep the person as quiet as possible.
6. If convulsing, protect victim from injury to himself.
7. Do not give alcohol in any form.

Swallowed poisons

1. Do NOT induce vomiting if:
   a. patient is unconscious or convulsing.
   b. patient has swallowed petroleum products (kerosene, gasoline, or lighter fluids).
   c. patient has swallowed corrosive poisons (acids or alkali).
   Note: For ACIDS- Have victim drink milk, water, or milk of magnesia (1 tablespoon to 1 cup).
   For ALKALI- Have victim drink milk or water; for patients 1-5 years old, 1-2 cups; for patients 5 years or older, up to 1 quart of liquid to dilute the poison.
2. If it is necessary to induce vomiting:
   a. get the victim to a hospital *first*, if possible where they have the proper stomach-pumping equipment.
   b. otherwise, place your finger at the back of the victim's mouth or use an emetic (2 tablespoons of salt in a glass of warm water).

Chemical burns of the skin

1. Wash the area with large amounts of water.
2. Remove contaminated clothing.
3. Cover the area immediately with clean, loosely fitting clothing.
4. Avoid the use of ointments, greases, powders or other drugs on the burned area.
5. Treat for shock by keeping the patient flat with his feet slightly raised. Keep him warm. Give reassurance until a physician arrives.

There are many antidotes for chemical poisoning available. They can be prescribed *only by a doctor*. Clean water or milk can be extremely valuable until specific antidotes are given.

APPENDIX I

Fungicides and other plant disease control chemicals are listed with their LD/50's, potential skin reaction of humans, and potential lethal dose for an average 180-pound man. Refer to Table 1 for a comparison of toxicity classes. This list does not constitute a recommendation of any chemical by the University of Illinois. LD/50's and potential hazard information were supplied by chemical companies that manufacture the products.

Chemical (grouped on the basis of LD/50)	LD/50 (rats), acute oral, mg/kg	Potential skin reaction	Potential lethal dose for 180-lb. man
Less than 100			
Chloropicrin (tear gas, Larvicide, Picfume, Tri-clor)	...	Severe	0.1 ppm in air
Cyclohexamide (Acti-dione)	1.8-2.5	Severe	0.05-.075 oz.
Dexon	60	Mild	.18 oz.
Dinitrocresol (Elgetol)	30-60	Severe	0.09-.195 oz.
Mercury, Organic (PMA, TAG, Puratized, Morsodren, Liquiphene)	30	Severe	0.09 oz.
100-500			
Dibromochloropropane (DBCP, Fumazone, Nemagon)	172	Severe to mild	1 ppm in air
Dichloropropenes (Telone, D-D, Vidden-D, Nemafume)	250	Severe	1 ppm in air
DMTT (Mylone, Soil Fumigant M)	500	Light to none	1.5 oz.
Ethylene dibromide (EDB, Soil-Fume, Dow-Fume W40, W85.)	146	Severe	0.438 oz.
Methyl bromide (Dowfume, Panobrome, Brozone, Trizone, Picride)	...	Severe	2,000 ppm in air
Mercury, Inorganic (Mercuric chloride, Corrosive sublimate)	100-210	Severe	0.3-.63 oz.
MIT (Vorlex Soil Fumigant, Vorlex 201)	305	Severe	0.915 oz.
Nabam (Dithana D-14, A 40, Parzate)	395	Mild	0.2 oz.
PCNB (Terraclor, Sanasol)	200-12,000	Mild	0.6-36 oz.

500-5,000			
Bacticin	4,600	Mild	14 oz.
Chloranil (Spergon)	4,000	Mild	12 oz.
Copper, fixed	3,000-6,000	...	9-18 oz.
Dichlone (Phygon)	1,300-2,250	Mild	3.9-6.8 oz.
Diphenyl (Phenyl benzene)	3,280	...	9.84 oz.
Dodine (Cyprex)	750-1,550	Mild	2.5-4 oz.
Dyrene	2,710	Mild	8.13 oz.
Formaldehyde	800	Mild	2.4 oz.
Glyodin	3,170-5,770	...	9-17.3 oz.
Karathane	980	Mild to light	2.94 oz.
Plantvax (Oxyxarboxin, DCMOD)	2,000	...	6 oz.
SMDC (Vapam Soil Fumigant, VPM)	800	Severe	2.4 oz.
Terrazole or Koban	2,000	...	6 oz.
Thiram (TMTD, Arasan, Thiuram, Thylate)	780	Severe	2.3 oz.
Vitavax (Corboxin, DMOC)	3,200	...	9.6 oz.
Ziram (Zerlate, Ziram Fungicide, Karbam White, Z-C spray or dust)	1,400	Severe	4.2 oz.
5,000-15,000			
Benomyl (Benlate, duPont 1991)	9,590	Light to none	28.8 oz.
Botran (DCNA)	4,000-10,000	Light	12 oz.
Captan (Orthocide)	9,000-15,000	Light to none	32 oz.
Chloroneb (Demosan)	11,000	...	33 oz.
Copper (bordeaux mixture, blue vitrol with hydrated lime)	...	Mild	50-500 mg/kg
Copper-8-quinolinolate (wood preservative)	...	None	very large amts.
Copper-zinc-chromate complex (Miller 658)	6,160	Light	18.5 oz.
Daconil 2787 (Termil, Exotherm)	10,000	Mild	30 oz.
Difolatan	6,200	Severe to mild	18.6 oz.
Ferbam (Fermate Ferbam Fungicide, Carbamate, Karbam black)	17,000	Mild	51 oz.
Folpet (Phaltan, Fungitrol)	10,000	Mild	30 oz.
Household bleach (Clorox, Purex, Saniclor)	...	Severe to mild	...
Lime-sulfur	...	Mild	...
Maneb	6,750-7,500	Mild	20-22 oz.
Parnon (EL241)	...	Mild	...
Polyram	6,400	...	19.2 oz.
Streptomycin (Agrinycin, Agri-strep, Phytomycin)	9,000	Allergic?	27 oz.
Zineb (Dithane Z-78, Parzate C)	5,200	Mild	16 oz.

THE TOXICITY OF HERBICIDES

Toxicity is the capacity of a substance to produce injury. The toxic action of greatest concern is the lethal dosage (LD). This action can be immediate (acute) or it can be accumulative (chronic). Results of tests with animals show that toxicity of a given substance varies with species, age, sex, and nutritional status of the animal and also with the route of administration (internal--stomach, lungs; or external--dermal).

Before companies are granted clearances, they are required to do several types of toxological tests on their compounds. They conduct mutagenic and teratogenic tests by progeny and litter testing. They also conduct acute, subacute, and chronic toxicity tests. One of the most useful expressions of acute lethal toxicity is the LD_{50}. LD_{50} represents the average lethal dosage (LD) per unit of body weight required to kill one-half (50 percent) of a large test population. Toxicity must, of necessity, be tested on animals rather than people. This creates some question when the results are applied to humans.

The usual test animals are white rats, but mice, rabbits, and dogs are sometimes used. The most common LD_{50} expression represents the acute oral toxicity, that is, the single internal dosage necessary to kill one-half of the test animals. The acute oral toxicity has limitations because it represents only the immediate toxicity of an internal dosage and not the chronic, accumulative effects of any skin absorption or irritation. Few herbicides, however, are absorbed rapidly through the skin, and most herbicides do not accumulate in the body to a toxic level. Some, however, such as Ramrod, do cause skin irritation.

LD_{50} values are expressed in terms of milligram of chemical per kilogram of body weight (mg/kg). Some conversion factors to convert common terms are:

1 ounce = 28.38 grams = 28,380 milligrams
1 kilogram = 1,000 grams = 2.2 pounds
mg/kg x 0.0016 = ounces/hundredweight or $\frac{mg/kg}{625}$ = ounces/hundredweight
mg/kg x 0.0030 = ounces/180 pounds

Therefore an LD_{50} of 1,000 mg/kg would be 3 ounces of material per 180 pounds of body weight, while LD_{50} values of 100 and 10 would be 0.30 and 0.03 ounce per 180 pounds respectively. Since toxicities depend on body weight, it would take only one-third of this amount to be lethal to a 60-pound child and five times as much to kill a 900-pound animal.

The LD_{50} values are expressed on the basis of active ingredient. If a commercial material is only 50 percent active ingredient, it would take two parts of the material to make one part of the active ingredient. In some cases chemicals mixed with the active ingredient (adjuvants) for formulating a pesticide may cause the toxicity to differ from that of the active ingredient alone. For example, the LD_{50} of 2,4-D acid is 320 mg/kg, while that of the ester formulations is 500 to 600.

The persistence of herbicides is an important factor in herbicide toxicity. A relatively toxic material that is not easily broken down is potentially more hazardous than one that decomposes rapidly after application. Soil persistence of herbicides is discussed in Agronomy Fact No. W-22a.

Sodium arsenite is one of the most toxic herbicides. It is a relatively old material that has been quite effective as a sterilant. It would be advisable, especially around the house, to use more recent, less toxic materials wherever possible. Sodium arsenite has caused more deaths than any other herbicide.

Pesticides must be handled and stored carefully. Pesticides should be stored only in properly labeled original containers. They should be kept where children cannot reach them. Empty containers should be destroyed or disposed of where children and animals cannot find them. Though the LD_{50} of some herbicides indicates a relatively low toxicity, it is well to form the habit of handling *all* pesticides carefully.

Proper precautions should be taken where livestock graze treated areas or are fed crops from treated areas. Although a certain herbicide may not be very toxic to animals, some residue may occur in the meat or milk. Treated pastures should not be grazed by dairy animals for seven days after they have been treated with 2,4-D. Questions associated with 2,4-D toxicity in forage or food crops are discussed in Fact Sheet W-23.

The acute oral LD_{50} values for the active ingredient of some common herbicides are given in Table 1. Remember: *The lower the LD_{50} value, the greater the toxicity.* A common standard for comparison is aspirin, which has an LD_{50} of 750 mg/kg or table salt which has 3,320.

The toxicity ratings for the various LD_{50} values are as follows:

Rating	*LD_{50}*	*Probable lethal dose for man*
Highly toxic	1-50	A few drops to 1 teaspoon
Moderately toxic	50-500	1 teaspoon to 2 tablespoons
Slightly toxic	500-5,000	1 ounce to 1 pint
Practically nontoxic	5,000-15,000	1 pint to 1 quart
Relatively harmless	15,000+	1 quart +

Table 1. Herbicides Classed as Highly (1-50) or Moderately (50-500) Toxic

Name		Acute Oral LD_{50}	
Common[1/]	Trade	Mg/Kg	Oz/180-lb. man
1-50			
sodium arsenite	Many	10-50	.03-.50
PCP	Penta, others	27-80	.08-.24
PMA	Many	30	.09
dinoseb (dinitro)	Preemerge Sinox	30-40	.09-.12
endothall	Endothal Aquathol Hydrothol	51-206[2/]	.15-.62
50-500			
allyl alcohol		64	.19
paraquat	Paraquat	150	.45
bromozynil	Brominal Buctril	190	.57
SD-15418	Bladex	334	1.04
2,4-D	Many	300-1,000[2/]	0.9-3.0
diquat	Diquat	400	1.20
2,4-DB	Butyrac Butozone	300-1,000[2/]	0.9-3.0
2,4,5-T[3/]	Many	300-1,000[2/]	0.9-3.0

1/ Common Name = name approved by Weed Science Society of America.
2/ Varies with formulation; i.e. acid, amine, ester, salt.
3/ Usage has been restricted (1970).

Table 2. Toxicity of Herbicides

Name			Chemical class	Acute oral LD_{50}	Skin irritation 2/	Use 3/
Common 1/	Trade	Producer				
alachlor	Lasso	Monsanto	acetanilide	1,200		Fc
amitrole	Amizol Cytrol Amitrol-T	Amchem American Cyanamid	triazole	2,500		Br, Fr, Ss
AMA	Many	Cleary, Vineland	organic arsenical	600		Tf
AMS	Ammate-X	DuPont	inorganic	3,900	M	Br, Fr
atrazine	AAtrex	Geigy	triazine	3,080		Fc, Ss, Vg
bandane	Many	Velsicol	chlorinated hydrocarbon	575		Tf
BAS-2903	Basamaize	BASF	acetanilide	1,500	M	Fc
benefin	Balan	Elanco	nitroaniline	10,000+		Fc, Vg
bensulide	Betasan Prefar, PreSan	Stauffer	sulfonamide	770		Vg, Tf
bromacil	Hyvar-X	DuPont	uracil	5,200	M	Ss
bromoxynil	Brominal Buctril	Amchem Rhodia	benzonitrile	190*	M	Fc, Tf
butylate	Sutan	Stauffer	thiocarbamate	4,660		Fc, Vg
cacodylic acid	Phytar 560 Silvisar 510	Ansul	organic arsenical	830		Ns
calcium arsenate	Many	Many	inorganic arsenical	35*	M	Tf
CDDA (allidochlor)	Randox	Monsanto	acetamide	750	M	Fc, Vg

Table 2, continued

Name			Chemical class	Acute oral LD_{50}	Skin irritation 2/	Use 3/
Common 1/	Trade	Producer				
CDEC (sulfallate)	Vegadex	Monsanto	thiocarbamate	850	M	Vg
chloramben	Amiben Vegiben	Amchem	benzoic acid	3,500		Fc, Vg
chlorbromuron (C-6313)	Maloran	CIBA	phenylurea	4,287		Fc
chloroxuron	Tenoran	CIBA	phenylurea	3,700		Fc, Fr, Vg
chlorpropham (CIPC)	Chloro-IPC	PPG Industry	phenylcarbamate	5,000		Fc, Fr, Vg
dalapon	Dowpon	Dow	aliphatic acid	7,570	M	Fc, Fr, Ss, Vg
DCPA (chlorthal)	Dacthal	Diamond Shamrock	terephthalic acid	3,000+		Fc, Fr, Tf, Vg
dicamba	Banvel	Velsicol	benzoic acid	1,028		Br, Fc, Tf
dichlobenil	Casoron	Thompson Hayward	benzonitrile	3,160		Ag, Fc, Fr, Ss
dinoseb (DNBP) "dinitro"	Preemerge Sinox PE Dow General	Dow	dinitrophenol	5-60**	M	Fc, Vg
diphenamid	Dymid Enide	Elanco Tuco	phenylamide	970		Fc, Fr, Vg
diquat	Diquat	Chevron	pyridilium	400*	S	Aq
diuron	Karmex	DuPont	phenylurea	3,400		Fr, Vg, Ss
DSMA	Many	Ansul	organic arsenical	1,800		Fr, Ss, Tf
endothall	Endothal Aquathol Hydrothol	Pennwalt	phthalic acid	125-200*	S	Aq, Vg

Table 2, continued

Name: Common[1/]	Name: Trade	Name: Producer	Chemical class	Acute oral LD_{50}	Skin irri-tation[2/]	Use[3/]
EPTC	Knoxweed[1/] Eptam	Stauffer	thiocarbamate	1,652		Fc, Vg
fenac (chlorfenac)	Fenac	Amchem	phenylacetic acid	1,780		Aq, Fr, Ss
fenuron	Dybar	DuPont	phenylurea	6,400	M	Br, Ss
fenuron-TCA	Urab	General Chemical	phenylurea	4,000	M	Br, Ss
fluorodifen (C-6989)	Preforan	CIBA	diphenyl ether	10,000		Fc
HCA	HCA	General Chemical	chloro-acetone	1,290	M	Ss
linuron	Londax[1/], Lorox	DuPont	phenylurea	1,500	M	Fc, Vg
MCPA, MCPB	Many	Rhodia, Amchem	phenoxy acid	650-700		Fc, Vg
mecoprop (MCPP)	Mecopex Mecopar	Morton, Rhodia	phenoxy acid	930		Tf
metobromuron	Patoran	CIBA	phenylurea	3,000+	M	Vg
monuron	Telvar	DuPont	phenylurea	3,600	M	Vg
MSMA	Daconate Ansar 529, 170	Diamond Shamrock	organic arsenical	1,800		Fr, Ss, Tf
naptalam (NPA)	Alanap, Solo[1/]	Uniroyal	phthalic acid	1,770		Fc, Vg
nitralin	Planavin	Shell	nitroaniline	2,000+		Fc, Vg
nitrofen	TOK	Rohm & Haas	diphenyl ether	1,470	M	Vg
norea	Noraben[1/], Herban	Hercules	phenylurea	1,470	M	Fc

Table 2, continued

Name: Common[1]	Name: Trade	Name: Producer	Chemical class	Acute oral LD_{50}	Skin irritation [2]	Use[3]
paraquat	Gramoxone Paraquat	Chevron	pyridilium	150*	M	Fc, Ns, Ss, Vg
pebulate	Tillam	Stauffer	thiocarbamate	1,120		Vg
picloram	Tordon	Dow	picolinic acid	8,200		Br, Ss
PMA	Many	Many	phenyl mercuric	40**	S	Br, Sc, Tf
prometone	Pramitol	Geigy	triazine	2,980		Ss
prometryne	Caparol Primaze[1]	Geigy	triazine	3,750		Fc
propachlor	Ramrod	Monsanto	acetanilide	1,200	M	Fc, Vg
pyrazon	Pyramin	BASF	pyridazone	3,000	M	Vg
S-6115	Outfox	Gulf	triazine	1,200		Fc
SD-15418	Bladex	Shell	triazine	334		Fc
sesone	Sesone	Amchem	phenoxy compound	1,230		Fr
siduron	Tupersan	DuPont	phenylurea	5,000+	M	Tf
silvex	Many		phenoxy acid	650		Aq, Br, Tf
simazine	Princep	Geigy	triazine	5,000+		Fc, Fr, Ss, Vg
sodium arsenite	Many	Many	inorganic arsenical	10-50**		Ss
sodium borate	Borascu & others	Many	inorganic	2,000	M	Ss
sodium chlorate	Many	Many	inorganic	1.350	M	Ss

Name			Chemical class	Acute oral LD_{50}	Skin irritation 2/	Use 3/
Common 1/	Trade	Producer				
terbacil	Sinbar	DuPont	uracil	5,000+		Fr
terbutol	Azak	Hercules	methylcarbamate	15,000+		Tf
trifluralin	Treflan	Elanco	nitroaniline	3,700		Fc, Vg
vernolate	Vernam	Stauffer	thiocarbamate	1,780		Fc
2,3,6-TBA	Benzac Trysben	DuPont Amchem	benzoic acid	750		Ss
2,4-D	Many	Many	phenoxy acid	300-1,000		Br, Fc, Tf, Vg
2,4-DB 3/	Butyrac Butoxone	Amchem Rhodia	phenoxy acid	300-1,000		Fc
2,4,5-T 4/	Many	Many	phenoxy acid	300-1,000		Br

1/ Common name approved by Weed Science Society of America

2/ Skin irritation:
**highly toxic
*moderately toxic
M = mild skin irritant
S = severe skin irritant

3/ Use:
Aq = aquatic
Br = brush
Fc = field crops
Fr = fruits
Ns = non selective
Ss = soil sterilant
Tf = turf
Vg = vegetables

4/ Usage restricted (1970).

M.D. McGlamery and
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PESTICIDES FOR MINIMIZING FISH AND WILDLIFE LOSSES

It is impossible to use strong toxins out-of-doors at any time or place in Illinois without endangering some populations of fish and wildlife. Therefore, the following comments should in no way be construed as acceptance or approval by wildlife conservationists of the widescale use of chemical sprays to control pest populations. From an ecological standpoint there is no "good" time or place to add strong toxins to the environment, especially on a broad scale. The more durable or persistent the chemical, the greater the danger. Consequently when applying pesticides use precautionary measures.

Follow the recommendations given below to help reduce mortality of fish and wildlife when pesticides are used.

1. Restrict the application of agricultural pesticides to agricultural fields where possible.

2. Follow all general and specific safety recommendations of the manufacturer and of state cooperative Extension workers.

3. Treat only when necessary, using the pesticide least toxic to nontarget organisms that will still do the job.

4. Apply the least amount of pesticide(s) that will give effective control.

5. Make every effort to keep toxic materials on the target field and to avoid excessive drift. Do not spray when the wind velocity exceeds 5 to 10 m.p.h.

6. Do not apply pesticides directly to water (ponds, streams, rivers, or lakes) unless the label recommends the material for specific use in controlling a pest species found in water.

7. Avoid spraying the immediate watershed of a lake or pond with chemicals highly toxic to fish. Keep treated animals from going into fish-bearing waters or other water supplies until the spray has dried.

8. Do not treat ditches and channels that drain directly into farm ponds and other waters with chemicals toxic to fish or to warm-blooded animals that may drink the water.

9. Do not store or mix pesticides or liquid fertilizers where accidental spilling or release will drain directly into ditches and streams.

10. Do not use streams, ponds, or water-filled ditches for washing spray equipment or for the disposal of left-over pesticides or liquid fertilizers, particularly anhydrous ammonia.

11. Follow the U.S. Forest Service practice of delineating the infected areas to be treated and then mark off buffer zones bordering lakes, streams, and ponds. There should be a strip of grass at least 50 feet wide around the edge of a farm pond to reduce rapid runoff from the watershed.

12. Do not leave puddles of pesticides on hard surfaces--roads, concrete around buildings, and such. Desirable animals may drink them, or the pesticides may drain into water courses through prepared drainage systems.

13. Do not throw empty pesticide containers into water or leave them where they may be attractive to desirable animal species. Dispose of containers only in an approved manner. Burn paper bags or containers and avoid breathing in the smoke. Bury empty glass or metal containers.

14. Use granules instead of sprays or dusts whenever possible to prevent undesirable drift.

15. Use ground machinery for application near critical wildlife and aquatic areas. This equipment makes it easier to confine the chemicals to specific target areas.

16. Do not spray areas harboring dense populations of wildlife.

17. If at all possible, no direct applications or excessive drift of toxic materials should be permitted in wooded areas, because these areas usually contain the greatest abundance and variety of wildlife.

18. If possible, avoid treating habitats other than row crops or plowed fields between April 1 and June 1, and between September 1 and November 1. If treatment of other habitat is essential, use the chemical least toxic to wildlife.

19. In areas frequented by waterfowl and shorebirds, avoid treatments between October 1 and January 1, between March 1 and April 30, and at any time the area is being frequented by waterfowl. (In several areas in Illinois one or more species of waterfowl or shorebirds will be present from about October 1 through May.)

20. When using treated seed, do not leave spilled seed exposed. See that the seed is all well covered and not readily available to birds and mammals.

21. Disk soil insecticides in immediately upon application, both to avoid wasting insecticide and to prevent wildlife losses.

22. Use the most-selective insecticides at minimum dosage rates and avoid the large-scale use of persistent pesticides (chlorinated hydrocarbons) that are known to concentrate in living organisms.

23. Use the information in the checklist of insecticides or the attached table for the LD50 or LC50 values. Select those insecticides that will do the job but be less toxic to warm-blooded animals, including wildlife.

SOME CHARACTERISTICS OF ANIMAL POPULATIONS IN ILLINOIS, ONES HELPFUL IN UNDERSTANDING THE WILDLIFE-PESTICIDE PROBLEM

First of all, it should be emphasized that we know little about the overall effects of *any* pesticide on *any* population of wild vertebrate animals. Certain general facts have been established, however. A considerable amount of data is available on the acute toxicity of various compounds to a variety of species in captivity. Also, a limited number of studies have been made on the rate of recovery of a population following one or more applications of a pesticide to an area. In populations of wild vertebrates some pesticides may produce great mortality both directly and indirectly through the food chain. It has been shown that persistent chemicals such as the chlorinated hydrocarbons are concentrated from the bottom of the food chain to the top so that animals at the top often accumulate heavy dosages of the toxin. As a result, whole populations may lose their reproductive capacity. Accumulations of pesticides through the food chain may already have reduced the reproductive capacity of the bald eagle, duck hawk, and other raptor populations both in Europe and North America, as well as certain species of fishes and fish-eating birds such as loons and cormorants.

While these discussions refer to all wild vertebrates in general, most of the remarks and examples will refer to birds. Because of their migratory and highly mobile nature, a greater number of birds are susceptible to poisoning from a single application of pesticides than are mammals.

Certain ecological principles should be obvious to everyone. The simpler the habitat, the fewer organisms it supports, both in terms of the numbers of organisms and the variety of organisms. Conversely, the more complex the habitat, the greater the number and variety of organisms. For example, in summer, bare plowed ground usually supports only about 3 to 5 native species of birds with only about 1 bird for every 2 acres. At the other extreme is forest, which supports about 80 to 85 nesting species of birds with about 5 to 8 birds per acre. Of the agricultural habitats in Illinois, corn and soybean fields have the poorest bird populations, essentially the same as plowed bare ground; wheat fields are only slightly better, but oat fields have conspicuously higher bird populations. Grasslands and hayfields are very rich bird habitats with 40 to 70 native species in summer and 3 to 5 birds per acre. The shrub borders and hedges at the edges of cultivated fields have some of the densest populations of birds of any Illinois habitat. Marshlands also have high populations and many species. In Illinois, the prairie-grassland and marsh-dwelling species are the ones in greatest danger of extermination.

Regrettably, the effects of pesticides applied to a wheat field do not stop at the borders of the wheat field because animals, especially birds, from adjacent fields may pass through the poisoned wheat field or even forage at its boundaries. A study made in Illinois in 1964 indicated that in a single breeding season two successive populations of birds were killed in a hayfield from the effects of one application of 1/4 pound of dieldrin on a nearby wheatfield. The hayfield was not sprayed, but the birds there died. A third population of birds that moved into the hayfield within a month of the spray date was unable to produce fertile eggs.

Populations of birds shift greatly from season to season. Between April 15 and June 10, and again between September 1 and November 15, the bird populations in all parts of Illinois reach their greatest heights. Over 200 species are present in the state, and the numbers are many times the normal breeding population. Many of these species are highly insectivorous. After October 1, more and more waterfowl appear in the wetlands of the state. The songbird populations penetrate every habitat, but are most abundant where there is some woody vegetation. Populations of songbird migrants in open field habitats probably reach their peak in late March to mid-May and in October and early November. Fortunately most of the migrants do not spend time in plowed fields, or corn or bean fields, i.e., bare fields. An exception is the golden plover which passes through the state by the thousands in April and May; these birds regularly feed on bare fields and grasslands and concentrate particularly around rain pools.

In Illinois, bird populations reach their lowest levels in the northern third of the state in the winter (Jan. 1 - March 1), but in the southern third of the state winter populations are even higher than the summer populations in practically all habitats.

SOME USEFUL FACTS ABOUT PESTICIDES AND FISH MORTALITY

There are many causes of fish kills in ponds and streams including insecticides, herbicides, liquid fertilizers, barnyard wash, and numerous other factors which affect the supply of oxygen. Specifically some insecticides are much less toxic to fish than others. Proper selection and use of insecticides will reduce potential danger. We urge extreme care and caution in applying any insecticide near streams and ponds. Remember that even if only a very short section of a stream or dredge ditch becomes toxic, fish and other animals may be killed for many miles as the toxic slug flows downstream. When fish kill occurs, examine all possible causes, including pesticides.

The enclosed table may be of some help to you in answering questions about insecticides and fish kill. We compiled this information from several sources. In using this information, consider the stability of the compound, its tendency to store in fat, method and rate of use, affinity for soil particles, and solubility, as well as exact toxicity.

In the table, LC50 means the amount of pesticide in parts per billion needed to kill 50 percent of the test fish in a 24-hour period in the aquarium. This information applies to kill immediately after exposure and not to continued exposure at lower levels of concentration. Low levels of some pesticides may be stored in fat over a period of weeks. Theoretically this stored material could cause fish mortality if the fat was suddenly used up under stress and the pesticides were thrown all at once into the fish's system.

LD50 is the number of milligrams (0.001 gram) needed per kilogram (1,000 grams) or 2.2 pounds of body weight to kill 50 percent of selected healthy laboratory test animals, usually white rats. Both oral and dermal toxicities are included in the table.

The LC50 and the rate per acre-foot of water is based on laboratory tests on 2-inch bluegills exposed to that concentration for 24 hours at a water temperature of 75° F. When exposed for 96 hours the concentration required to reach the LC50 was much lower. Toxicity varies greatly with fish species, chemical, and formulation of the chemical. The LC50 for naled (Dibrom) to rainbow trout was 70 p.p.b. and for bluegill, 220 p.p.b.; for trichlorfon (Dylox) it was 28,000 p.p.b. for trout and 5,600 p.p.b. for bluegill. Thus this table serves only as a guide. Bluegills, popular Illinois fish species, were used as a guide rather than trout.

Insecticides, Their Common Agricultural Rates, Extent of Use, LD50 to White Rats and Other Animals, 24-Hour LC50 to Bluegills, and the Calculated 24-Hour LC50 in Pounds of Toxicant per Water Acre 3 Feet Deep

Insecticide	Approximate LD50, mg./kg. Oral	Dermal	Common agr. rate, (lb./A.)	LC50, p.p.b.	Use in Illinois	Lb. toxicant per ft.-acre for blue-gill LC50	Comments apply only to fish kill
Toxaphene a/	85	925	1.5	7	Moderate	.02	Extremely toxic to fish. Do not use in the vicinity of streams or ponds.
DDT a/	115	2,510	...	7 d/	None	.02	
Azinphosmethyl (Guthion) b/	12	220	.5	8?	Moderate	.02+	
Aldrin a/	49	98	1.0 to 1.5	10	Heavy e/	.03	
Phorare (Thimet) b/	1	3	1.0	10	Heavy	.03	
Rotenone	75	940+	...	24	None	.06	
Methoxychlor a/	5,000	6,000+	1.5	31	Light	.08	
Heptachlor a/	131	230	1.0 to 1.5	35	Moderate e/	.09	
Diazinon b/	92	680	1.0	54	Moderate	.15	Highly toxic to fish. Use great caution if applied in the immediate vicinity of streams and ponds.
Parathion	12	14	.25 to .5	56	Light	.15	
Lindane a/	89	950	...	61	None	.16	
Malathion b/	1,200	4,000+	1.0	120	Moderate	.32	Moderately toxic to fish. Use cautiously around streams and ponds. Avoid direct application of agricultural sprays to water insofar as fish are concerned.
Demeton (Systox) b/	5	11	...	195	None	.53	
Naled (Dibrom) b/	250	800	.75	220	Light	.59	
Carbofuran (Furadan)	5	885	.75-1.0	240 f/	Moderate	.60	
Carbaryl (Sevin) c/	675	4,000+	1.0 to 2.0	3,400	Heavy	9.2	Least toxic to fish. Reasonably safe to use around ponds or streams insofar as fish are concerned.
Trichlorfon (Dylox)	595	2,000+	1.0	5,600	None	15.1	
Methyl parathion b/	19	67	.25- .5	8,500	Light	23.0	
Dimethoate (Cygon) b/	215	505	.5	28,000	Light	75.6	

a/ Chlorinated hydrocarbons, aldrin (as dieldrin), DDT, dieldrin, and heptachlor (heptachlor epoxide) are stored in fat and persist as residues. Methoxychlor is less readily stored, and its toxicity is lower than many others. Toxaphene does not tend to store and is rapidly excreted.

b/ Organic phosphates are usually not readily stored and break down in water. Some are highly toxic to warm-blooded animals.

c/ This carbamate is more residual than many phosphates but is relatively non-toxic to fish and wildlife.

d/ Lower than some studies show.

e/ Used as soil treatments; adheres readily to soil particles.

f/ Four-day exposure for LC50.

POISON CONTROL CENTERS IN ILLINOIS

DOWNSTATE

HOSPITAL AND LOCATION	*TELEPHONE*
Copley Memorial Hospital Lincoln & Weston Avenues Aurora	896-3911
St. Joseph Mercy Hospital 1325 N. Highland Aurora	859-2222
Memorial Hospital 4501 N. Park Drive Belleville	233-7750 Ext. 250, 251, 252, 253
Highland Hospital 1625 S. State St. Belvidere	547-5441
MacNeal Memorial Hospital 3249 S. Oak Park Ave. Berwyn	484-2211 Ext. 311
Mennonite Hospital 807 N. Main Bloomington	828-5241 Ext. 312
St. Joseph Hospital 2200 E. Washington Bloomington	662-3311 Ext. 352
St. Mary's Hospital 2020 Cedar St. Cairo	734-2400 Ext. 42, 33
Graham Hospital Association 210 W. Walnut St. Canton	647-5240 Ext. 248 Night Ext. 230
Doctors Memorial Hospital 404 W. Main St. Carbondale	457-4101 Ext. 341
Memorial Hospital End of S. Adams Carthage	357-3131 Ext. 57

HOSPITAL AND LOCATION	*TELEPHONE*
St. Mary's Hospital 400 N. Pleasant Ave. Centralia	532-6731
Burnham City Hospital 407 S. 4th Champaign	337-2533
USAF Hospital Chanute Air Force Base (Limited for treatment of military personnel and families, except for indicated civilian emergencies)	495-3134
Memorial Hospital 1900 State St. Chester	826-4581
Lake View Memorial Hospital 812 N. Logan Ave. Danville	443-5221
St. Elizabeth Hospital 600 Sager Ave. Danville	442-6300
Decatur Memorial Hospital 2300 N. Edward St. Decatur	877-8121 Ext. 676
St. Mary's Hospital 1800 E. Lake Shore Drive Decatur	429-2966 Ext. 640
Holy Family Hospital 100 N. River Road Des Plaines	297-1800 Ext. 856
Christian Welfare Hospital 1509 Illinois Ave. East St. Louis	874-7076 Ext. 232, 216

HOSPITAL AND LOCATION	*TELEPHONE*
St. Mary's Hospital	
129 N. 8th St.	274-1900
East St. Louis	Ext. 204
St. Anthony's Memorial Hospital	
503 N. Maple	342-2121
Effingham	Ext. 211
St. Joseph's Hospital	
277 Jefferson Ave.	741-5400
Elgin	Ext. 65, 69
Sherman Hospital	
934 Center St.	742-9800
Elgin	Ext. 682
Memorial Hospital of DuPage County	
315 Schiller St.	833-1400
Elmhurst	Ext. 550, 551
Community Hospital	869-5400
2040 Brown Ave.	Ext. 54
Evanston	Night Ext. 58
Evanston Hospital	
2650 Ridge Ave.	492-6460
Evanston	
St. Francis Hospital	
355 Ridge Ave.	492-2440
Evanston	
Little Company of Mary Hospital	
2800 W. 95th St.	442-6200
Evergreen Park	
Fairbury Hospital	
519 S. Fifth St.	692-2346
Fairbury	Ext. 248
Freeport Memorial Hospital	
420 S. Harlen	233-4131
Freeport	Ext. 228
The Galena Hospital District	
Summit St.	777-1340
Galena	
Galesburg Cottage Hospital	
674 N. Seminary St.	343-4121
Galesburg	Ext. 356, 336

HOSPITAL AND LOCATION	*TELEPHONE*
St. Mary's Hospital	
239 S. Cherry St.	343-3161
Galesburg	Ext. 210
St. Elizabeth Hospital	
2100 Madison Ave.	876-2020
Granite City	Ext. 224
Ingalls Memorial Hospital	
15510 Page Ave.	333-2300
Harvey	Ext. 787
St. Joseph Hospital	
1515 Main St.	654-2171
Highland	Ext. 297, 298
Highland Park Hospital Foundation	
718 Glenview Ave.	432-8000
Highland Park	
Hinsdale San. & Hospital	
120 N. Oak St.	323-2100
Hinsdale	Ext. 336
Hoopeston Comm. Memorial Hospital	
701 E. Orange	283-5531
Hoopeston	
Passavant Memorial Area Hospital	
1600 W. Walnut St.	245-9541
Jacksonville	
St. Joseph's Hospital	
333 N. Madison St.	725-7133
Joliet	Ext. 679, 680
Silver Cross Hospital	
600 Walnut St.	729-7563
Joliet	
Riverside Hospital	
350 N. Wall St.	933-1671
Kankakee	Ext. 606, 614
St. Mary's Hospital	
150 S. Fifth Ave.	939-4111
Kankakee	Ext. 735
Kewanee Public Hospital	
719 Elliott St.	853-3361
Kewanee	Ext. 219

HOSPITAL AND LOCATION	TELEPHONE
Lake Forest Hospital	
660 Westmoreland Road	234-5600
Lake Forest	Ext. 608
St. Mary's Hospital	
1015 O'Conor Ave.	223-0607
LaSalle	
Condell Memorial Hospital	
Cleveland & Stewart Avenues	362-2900
Libertyville	Ext. 325, 326
Abraham Lincoln Memorial Hospital	
315 Eighth St.	732-2161
Lincoln	Ext. 346, 365, 335
McHenry Hospital	
3516 W. Waukegan Road	385-2200
McHenry	Ext. 614
McDonough District Hospital	
525 E. Grant St.	833-4101
Macomb	Ext. 433
Memorial Hosp. Dist. of Coles County	
2101 Champaign Ave.	234-8881
Mattoon	Ext. 43
	Night Ext. 29
Loyola University Hospital	
2160 S. First Ave.	531-3000
Maywood	
Westlake Hospital	
1225 Superior St.	681-3000
Melrose Park	Ext. 226
Mendota Community Hospital	
Memorial Drive	539-7461
Mendota	Ext. 221
Moline Public Hospital	
635 Tenth Ave.	762-3651
Moline	Ext. 232
Community Memorial Hospital	
1000 W. Harlem Ave.	734-3141
Monmouth	Ext. 224
Wabash General Hospital	
1418 College Drive	262-4121
Mt. Carmel	Ext. 231

HOSPITAL AND LOCATION	TELEPHONE
Good Samaritan Hospital	
605 N. 12th St.	242-4600
Mt. Vernon	
Edward Hospital	
S. Washington St.	355-0450
Naperville	Ext. 326
Brokaw Hospital	
Franklin & Virginia Avenues	829-7685
Normal	Ext. 274
Christ Community Hospital	425-8000
4440 W. 95th St.	Ext. 659
Oak Lawn	Night Ext. 660
West Suburban Hospital	
518 N. Austin Blvd.	383-6200
Oak Park	Ext. 6747
Richland Memorial Hospital	
800 E. Locust St.	395-2131
Olney	Ext. 226
Ryburn Memorial Hospital	
701 Clinton St.	433-3100
Ottawa	Ext. 48
Lutheran General Hospital	696-2210
1775 Dempster St.	Ext. 1462
Park Ridge	Night Ext. 1463
Pekin Memorial Hospital	
14th & Court	347-1151
Pekin	Ext. 241
Methodist Hospital	685-6511
221 N.E. Glen Oak Ave.	Ext. 250
Peoria	Night Ext. 360
Proctor Community Hospital	691-4702
5409 N. Knoxville	Ext. 791, 792, 793
Peoria	
St. Francis Hospital	
530 N.E. Glen Oak Ave.	674-2943
Peoria	
People Hospital	
925 West St.	223-3300
Peru	Ext. 53, 55

HOSPITAL AND LOCATION	TELEPHONE
Illini Community Hospital 640 W. Washington Pittsfield	285-2115 Ext. 238 Night Ext. 213
Perry Memorial Hospital 530 Park Ave. East Princeton	875-2811 Ext. 311
Blessing Hospital 1005 Broadway Quincy	223-5811 Ext. 255
St. Mary's Hospital 1415 Vermont St. Quincy	223-1200 Ext. 275
Rockford Memorial Hospital 2400 N. Rockton Ave. Rockford	968-6861 Ext. 441
St. Anthony's Hospital 5666 E. State St. Rockford	226-2041
Swedish-American Hospital 1316 Charles St. Rockford	968-6898 Ext. 603
St. Anthony's Hospital 767 30th St. Rock Island	788-7631 Ext. 725 Night Ext. 772
Delnor Hospital 975 N. Fifth Ave. St. Charles	584-3300 Ext. 229
USAF Medical Center Scott Air Force Base	256-7363

HOSPITAL AND LOCATION	TELEPHONE
Memorial Hospital First & Miller Streets Springfield	528-2041 Ext. 333
St. John's Hospital 701 E. Mason St. Springfield	544-6451 Ext. 375
St. Mary's Hospital 111 E. Spring St. Streator	673-2311 Exts. 221 & 343
Carle Foundation Hospital 611 W. Park Urbana	337-3311
Mercy Hospital 1400 W. Park Urbana	337-2131
St. Therese Hospital 2615 W. Washington St. Waukegan	688-6470 688-6471
Victory Memorial Hospital 1324 N. Sheridan Rd. Waukegan	688-4181 688-4182
Memorial Hospital for McHenry County 527 W. South St. Woodstock	338-2500 Ext. 232 Night Ext. 277
Zion-Benton Hospital Shiloh Blvd. Zion	872-4561 Ext. 240

CHICAGO POISON CONTROL CENTERS

Master Chicago Center for information, treatment, reference on poisoning:

Rush-Presbyterian-St. Lukes Medical Center
1753 W. Congress Parkway 942-5969

Chicago Centers for treatment only:

Children's Memorial Hospital 2300 Children's Plaza	348-4040 Ext. 338
Cook County Hospital 1825 W. Harrison Ave.	633-6542
Mercy Hospital 2510 Martin Luther King Drive	842-4700 Ext. 281
Michael Reese Hospital 2929 S. Ellis	791-2050

HOSPITAL AND LOCATION	TELEPHONE
Mount Sinai Hospital California Ave. at 15th St.	542-2030
Municipal Contagious Disease Hospital 3026 S. California Ave.	247-5700 Ext. 50
Resurrection Hospital 7435 W. Talcott	774-8000 Ext. 235
University of Illinois Hospital 840 S. Wood St.	663-7297
Wyler Children's Hospital 950 E. 59th St.	947-6231

THE MARKET BASKET SURVEY, 1963-1969

H. B. Petty

This is a condensation of "Residues in Food and Feed" by R.E. Duggan et al., *Pesticides Monitoring Journal*, Sept., 1971, Vol. 5, No. 2, pp. 73-213.

The amounts of pesticides present in our food supply were determined in a five-year period of total diet studies from a high-consumption diet. Results were compared with the Acceptable Daily Intake (ADI) established by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) Expert Committee. The ADI is the number of milligrams per kilograms of body weight that could be consumed daily for a lifetime with no effect.

The amounts of these pesticide chemicals calculated from this high-consumption diet (that of a 19-year-old boy and approximately twice that consumed by an average individual) are well below the FAO and WHO Expert Committee's ADI, except for the combined residues of aldrin and dieldrin. The calculated daily intake of these chemicals has approached the ADI during this period.

Table 1. Dietary Intake of Pesticide Chemicals

	Daily milligrams per kilogram of bodyweight, considering total diet of 19-year-old boy			
Insecticide	FAO-WHO acceptable daily intake	5-year average	Amount below ADI	Factor to reach ADI
Aldrin-dieldrin	.0001	.00008	.00002	.25
Carbaryl	.02	.0005	.0195	39.0
DDT et al.	.01	.0008	.00992	12.4
Lindane	.0125	.00005	.01245	249.0
Heptachlor & epox.	.0005	.00003	.00047	15.7
Malathion	.02	.0001	.0199	199.0
Diazinon	.002	.00001	.00199	199.0
Parathion	.005	.00001	.00499	499.0

ONE STEP BEYOND: AN INQUIRY INTO RESEARCH ON DDT

J. Gordon Edwards

The following statement is a condensation of testimony by Dr. J. Gordon Edwards, Professor of Entomology, San Jose State College, California, delivered to the House Agriculture Committee's hearings on pesticides, March 18, 1971. It was published by the Terra Society, P.O. Box 110, Mt. Prospect, Illinois, which gave permission for it to be reprinted here.

Mr. Chairman, and members of the Committee on Agriculture, I thank you for the opportunity to testify before you today concerning the effects of pesticides on the environment.

I have been on the faculty of San Jose State College since 1949, and have taught Medical Entomology, Agricultural Entomology, Systematic Entomology, Larval Taxonomy, and related subjects during those years. During the Second World War, I served in the Medical Department, A.U.S., and had some opportunity to work with DDT applications in the European Theatre of Operations, I have thus been associated with the principles of chemical pest control for thirty years, and have taught college courses dealing with the subject for twenty years. I feel that this involvement with certain pesticides has provided me with some insight into the problems confronting us today, but I have never been employed by any organization dealing in those chemicals. Out Department at San Jose State College has never received any funds from any such organizations, either, hence I feel that my involvement in the controversy is that of a citizen and consumer rather than being a specialist with a vested interest in pesticides. Because my background also includes ten summers of Ranger-Naturalist duty in the National Park Service, many years of interest in ornithology, and membership in several conservation-oriented organizations (The Sierra Club, The Seattle Mountaineers and the National Audubon Society), I have felt it my responsibility to investigate the environmental effects of pesticides and to attempt to inform other conservationists of the numerous errors and misstatements in the anti-pesticide propaganda which many of them have been accepting as valid and truthful.

In these times of malnutrition and world-wide starvation it seems incredible that some persons and organizations are actively seeking to deprive farmers of the chemical tools needed for the production of food. The opponents of pesticides have chosen the relatively innocuous DDT as their major target, despite its remarkable record of safety.

The body of this paper will contain a brief discussion of the following topics: (1) the length of time required for DDT and its residues to break down under various environmental conditions; (2) the past and present status of the Osprey; (3) the past and present status of the Peregrine Falcon; (4) the past and present status of the Bald Eagle; (5) the past and present status of the Brown Pelican; and (6) the causes of thin eggshells in birds.

PERSISTENCE OF DDT

Perhaps the most remarkable charge made against DDT by the environmentalists may be their insistence that DDT persists in the environment for years or even for decades. As a side effect of this, of course, they can then express concern that it "travels around the earth in wind and water" and that it "accumulates in the oceans." A few well authenticated samples taken from the ocean, the air, from streams and from soil will refute all those secondary allegations. The persistence, under normal environmental conditions, varies greatly; however it is usually measured in days or weeks, rather than in years. DDT degrades readily in the presence of living things in soil and water, in alkaline soil or water, in the digestive tract of most kinds of animals, in cold, in heat and in sunlight. (More information on the degradation of DDT is available from Terra on request.)

OSPREYS

Long before DDT was used in this country, Dr. J.J. Hickey, in his "Guide to Bird Watching" (1943) attributed a 70% decline of Ospreys to pole trapping around fish hatcheries, but after DDT was introduced he blamed it for Osprey declines. Ospreys still thrive until man moves into their domain, then they either leave or succumb to sewage and industrial wastes. At Hawk Mountain, Pennsylvania, the survey of migrating Ospreys over the years since the introduction of DDT produced the following data: 191 Ospreys in 1946, 254 in 1951, 325 in 1961, 457 in 1967, 529 in 1969, and over 600 in 1970.

PEREGRINE FALCON

Several of the anti-pesticide lobbyists have claimed that "the Peregrine Falcon is known to have maintained a remarkably stable population prior to the DDT years." That is simply not true! The great tree-nesting Peregrine population of the Eastern United States vanished 50 years before DDT was used and the rare cliff dwelling Peregrines were nearly extinct also. Most of the contributors to the book "Peregrine Falcon Populations" (1969) blamed human disruption for the decline--shooting, nest robbing, bulldozing, et cetera. Studies of Canadian and Alaskan populations of Peregrines indicated that there was no reproductive difficulty, even in birds containing more than 30 times as much DDT and residues as the Wisconsin specimens--yet the species was nearly extinct in Wisconsin. It is also interesting to note that the British Peregrine decline, generally blamed on DDT, ended as soon as limits were placed on another insecticide (dieldrin) used as a seed dressing.

BALD EAGLE

In discussing the status of the Bald Eagle, man again appears to be the main cause for the decline (*not* DDT). An article in *Ecology*, in 1921, was entitled "Threatened Extinction of the Bald Eagle!" From 1917 to 1952 Alaska paid bounties on 115,000 Bald Eagles. Cleared timber, sewage and industrial wastes in rivers with the subsequent disappearance of fish populations, nest-trees cut down, the draining of marshes, and the replacement of natural habitats by orchards, gardens and housing developments all have contributed to local declines of eagle populations.

In 1964, the Bureau of Sport Fisheries and Wildlife reported a more than 100 percent increase in the Everglades eagle population over the previous five years. The Hawk Mountain Summary of Hawk Migrations, shows that the numbers of Bald Eagles migrating over that area more than doubled during the first six years of heavy DDT use in the Eastern United States (1946 to 1952). In 1970, the anti-DDT Audubon

Society admitted an increase from 139 to 209 in the number of Bald Eagles residing in Montana. Other increases have been reported in Nebraska and Wisconsin, and the U.S. Department of the Interior now estimates that there are 7,000 eagles in Alaska.

At Patuxent Wildlife Research Center--USDI--autopsies on all 76 Bald Eagles found dead in the Eastern United States between 1960 and 1965 showed that no deaths were blamed on DDT, however 46 had been shot or trapped. In 1967 and 1968, that laboratory traced the deaths of 29 Bald Eagles to dieldrin but none to DDT or its residues.

BROWN PELICAN

In a statement presented to the California Water Quality Control Board on February 20, 1971, Robert Finlay, Jr., of the U.S. Bureau of Sport Fisheries and Wildlife Laboratory in Denver, said that, "50,000 pelicans have disappeared from the Texas and Louisiana coast since 1961." (The same figure has been publicized by Dr. J.O. Keith, Director of that Laboratory.) There is no factual basis for that statement. In 1918, the Brown Pelican population on the Texas coast was estimated to be 5,000 but it declined to 900 by 1934. As a result of a severe freeze in January, 1940, followed by an oil spill, the population declined still further along the entire Texas coast. It does not seem possible that the pelican population could have increased to 50,000 by 1961 as Finlay and Keith would have us believe, but if it did the increase would have taken place during the greatest years of DDT use in the area!

Of great importance in the anti-DDT campaign has been the Brown Pelican population on Anacapa Island, off the coast of southern California near Ventura. *Audubon Field Notes* and other sources established the fact that the Brown Pelicans were nesting successfully and producing young on Anacapa Island up to and including the summer of 1968, "with little change in size of population since the earliest reports."

On January 28, 1969 the famous oil spill in the Santa Barbara Channel near Anacapa Island began, with severe effects on sea life and seashore life in the area. Although he visited Anacapa Island to check for oil damage, Dr. Robert Risebrough immediately postulated that "chlorinated hydrocarbon pesticides were the probably responsible" for the nesting failure of the pelicans that was suddenly discovered there after the oil spill. He was supported in his claim by the California Fish and Game Department, who refused to even investigate the possibility of a correlation between the oil spill and the thin-shell disaster. The same agency refused to release their own data showing very high levels of lead in the bones of pelicans from Anacapa Island following the spill or their figures of 17 ppm of lead in the anchovies upon which the pelicans feed. They also withheld information on the concentration of mercury in the oil and in the birds, despite Swedish studies which have shown mercury to be responsible for the great decline of birds beginning there in 1941, and apparently associated with sterility, with toxicity to embryos, and with thin eggshells.

During the spring and summer of 1970, Mr. Franklin Gress was employed by the California Fish and Game Department to study the Anacapa Island pelicans. As a result of Gress' study the Fish and Game Department released a report which overlooked many pertinent factors which were liable to be involved in the Anacapa disaster.

There was no mention of:

1. The Santa Barbara oil spill.
2. The mercury content of the spilled oil or the effects of mercury upon bird eggs and reproduction.

3. The high levels of lead found in the anchovies near Anacapa Island or in the bones of pelicans there in 1969-1970.

4. The experimental results of feeding 6 mg/kg of lead to quail, which caused thinner eggshells.

5. The dangers of PCB's (polychlorinated biphenyls) to bird health or reproduction or to the general marine environment. PCB's abound along the California coast.

Gress admits that his transportation to and from the island was by helicopter, but does *not* mention the fact that noise and excitement cause thin eggshells, even in chickens. No mention was made of the great numbers of helicopters that were landing on Anacapa just prior to, during, and following the pelican eggshell difficulties. The dates of Gress' field work on Anacapa Island are very significant, because the desertion of the reproductive colonies coincided so closely with his arrival on the island by helicopter. On three separate occasions (March 29th, April 20th and June 1st), he flew to the island and each time the pelicans abandoned the nesting colonies within two or three days after his arrival. After a prolonged absence, Gress, returning by boat on July 29th, cruised along *below* the colony seeing only one young pelican on a nest far above the water. It was the basis of his conclusion that "only one young pelican was produced from 552 nesting attempts on Anacapa Island in 1970." This statement led many people to believe that pelicans are "extinct" along the California coast! (Editors note: In addition to the thousands on Santa Barbara and the other islands in the area, Dr. Edwards in a recent visit to Anacapa Island, June 12, 1971, saw "several thousand... including *normal* numbers of year-old pelicans and dozens of brood-females on nests.")

EGGSHELL THINNING

It has been repeatedly claimed that "experimental evidence" has linked DDT with thin eggshell formation in wild birds. There are generally three articles cited as proof. They are: Bitman et al., 1969: "DDT Induces a Decrease in Eggshell Calcium," *Nature* 224:44-46; Porter and Wiemeyer, 1969: "Dieldrin and DDT, Effects on Sparrow Hawk Eggshells and Reproduction," *Science* 165:199-200; and Heath, et al., 1969: "Marked DDT Impairment of Mallard Reproduction in Controlled Studies," *Nature* 224:47-48.

Bitman's experiment was designed to produce thin eggshells regardless of whether or not DDT was included in the diet of the quail. He fed the birds on "a diet of low calcium content--0.56 percent to provide a calcium stress during egglaying." (They need 2 to 3 percent for normal shell development.) Porter and Wiemeyer fed hawks a mixture of dieldrin and DDT even though dieldrin *alone* had been shown to cause thin eggshells and strongly inhibit reproduction. Heath and associates fed their mallard ducks diets of DDT and "DDE." The 2.5 parts per million DDT diet increased productivity by 40 percent while the 10 parts per million DDT diet actually increased productivity by 81 percent. Nevertheless, Heath stated, "DDT in concentrations of 2.5 and 10 parts per million did not have measurable effects on reproduction." DDT is known to "break down" into DDE and other less toxic metabolites very rapidly, after ingestion by birds. For some reason, however, the synthetic "DDE" powder that Heath fed other mallards inhibited egg formation even though the high levels of DDE formed in his DDT-fed mallards appeared to *increase* productivity. (Obviously the synthetic "DDE" was quite different from the DDE produced via DDT breakdown in the mallard's body).

1972 Weed Control Guide

This guide for using weed control chemicals is based on research results at the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Although not all herbicides commercially available are mentioned, an attempt has been made to include materials that were tested and showed promise for controlling weeds in Illinois. Consideration was given to the soils, crops, and weed problems of the state.

The field of chemical weed control is still relatively new. The herbicides now available are not perfect. Factors such as rainfall, soil type, and method of application influence herbicide effectiveness. Under certain conditions some herbicides may damage crops to which they are applied. In some cases chemical residues in the soil may damage crops grown later.

When deciding whether to use a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. If you do not have much of a weed problem and if cultivation and other good cultural practices are adequate for control, do not use herbicides. Much of the risk can be decreased by following these precautions:

- Use herbicides only on those crops for which they are specifically approved and recommended.
- Use no more than recommended amounts. Applying too much herbicide may damage crops and may be unsafe if a crop is to be used for food or feed, and is costly.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label. Some individuals are more sensitive than others to certain herbicides.
- Guard against possible injury to nearby susceptible plants. Droplets of 2,4-D, MCPA, 2,4,5-T, and dicamba sprays may drift for several hundred yards. Take care to prevent damage to such susceptible crops as soybeans, grapes, and tomatoes. If it is necessary to spray in the vicinity of such crops, the amine form of 2,4-D is safer to use than the volatile ester form, but even with the amine form, spray may drift to susceptible crops. To reduce the chance of damage, operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed. Avoid unnecessary exposure.
- Return unused herbicides to a safe storage place promptly. Store them in original containers, away from unauthorized persons, particularly children.
- Since manufacturers' formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label.

Where trade names are used in this publication, rates refer to the amount of commercial product. Where common or generic names are used, rates refer to the amount of active ingredient. Unless otherwise stated, rates are given on a broadcast basis. Proportionately less should be used for band applications.

This guide is for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether or not they are used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Names of Some Herbicides

Trade	Common (generic)
AAtrex	atrazine
Amiben	chloramben
Amino triazole, Weedazol	amitrole
Amitrol-T, Cytrol	amitrole-T
Banvel	dicamba
Bladex	SD15418
Butoxone, Butyrac, and others	2,4-DB
Chloro-IPC	chlorpropham
Dacthal	DCPA
Dowpon, Basfapon	dalapon
Eptam	EPTC
Knoxweed	EPTC plus 2,4-D
Lasso	alachlor
Londax	propachlor plus linuron
Lorox	linuron
Milogard	propazine
Planavin	nitralin
Preforan	fluorodifen
Princep	simazine
Ramrod	propachlor
(Several)	dinoseb
(Several)	MCPA
(Several)	sodium chlorate
(Several)	2,4-D
(Several)	2,4,5-T
Solo	naptalam plus chlorpropham
Sutan	butylate
Tenoran	chloroxuron
Treflan	trifluralin
Vernam	vernolate

For clarity, trade names have been used frequently. This is not intended to discriminate against similar products not mentioned by trade names.

Herbicide Application Rates

The performance of some herbicides is influenced considerably by the organic-matter content of soil. You can estimate the organic-matter content of most Illinois soils by using the "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois" (AG-1941), available from your county extension adviser or the Publications Office, College of Agriculture, University of Illinois, Urbana, Illinois 61801. For a more precise determination of organic matter, obtain a laboratory analysis.

After you know the approximate organic-matter content of soil, Table 1 can be used for selecting herbicide rates. Using this guide should help you select rates to provide adequate weed control and minimize herbicide residue.

Table 1. — Suggested Herbicide Rates for Illinois Soils

Percent organic matter	Pounds of active ingredient per acre on a broadcast basis				
	atrazine	trifluralin	linuron[e]	nitralin	alachlor
1	.8[d]	½	½	¾	1½
2	1.6[d]	⅔	1	1	2
3	2.4	¾	1½	1⅛	2½
4	3.2[a]	1	2	1½[b]	2½
5+	4.0[a, c]	1	3[c]	...[b]	3
	Commercial formulation per acre on a broadcast basis				
	AAtrex 80% wettable powder	Treflan liquid (4 lb./gal.)	Lorox 50% wettable powder[e]	Planavin liquid (4 lb./gal.)	Lasso liquid (4 lb./gal.)
	pounds	*quarts*	*pounds*	*quarts*	*quarts*
1	1[d]	½	1	¾	1½
2	2[d]	⅔	2	1	2
3	3	¾	3	1⅛	2½
4	4[a]	1	4	1½[b]	2½
5+	5[a, c]	1	6[c]	...[b]	3

[a] If you use more than 3 pounds per acre of active atrazine, do not follow with any crop except corn or sorghum the next growing season.
[b] Adapted mainly to soils with less than 4 percent organic matter.
[c] Since results are variable on soils with 5 percent or more organic matter, consider another herbicide or a herbicide combination. Rates indicated for 5 percent or more organic matter are the maximum rates cleared.
[d] On soils with 1 to 2 percent organic matter it may sometimes be preferable to increase the rate of atrazine above that indicated. A slightly higher rate may be desirable where atrazine is incorporated, under unfavorable weather, or for improved control of some weeds.
[e] Crop tolerance with Lorex is limited. Refer to text and labels for additional guidelines to avoid crop injury.

Corn

For most effective weed control in corn, well in advance of planting plan a program that includes both cultural practices and herbicide applications. If weeds are not serious, cultural practices alone are sometimes adequate. Prepare seedbeds to kill existing weed growth and provide favorable conditions for germination and early growth of corn. Working the soil several times is not essential if weeds can be destroyed during final seedbed preparation. Working the seedbed excessively may intensify the weed problem and contribute to crusting. A relatively high plant population and perhaps narrow rows provide enough shading to discourage weed growth.

Early cultivations are very effective for killing weeds. The rotary hoe or harrow works best if you use it after weed seeds have germinated and before or as soon as the weeds appear above the soil surface. Use row cultivators while the weeds are still very small. Set the shovels for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. Throwing soil into the row can help smother weeds in the row. However, if a herbicide has given good control in the row, it is sometimes best not to move soil or weeds from the middles into the row. Where you use a preemergence herbicide, if it is not sufficiently effective, cultivate with the rotary hoe or row cultivator while the weeds are still small enough to control.

Even where herbicides are used, most farmers still use a rotary hoe or harrow for an early cultivation, followed by one or two row cultivations as needed. Some farmers, especially those with narrow rows, high populations, and large acreages, broadcast herbicides and sometimes eliminate cultivation if control is adequate.

Weigh the added expense of broadcasting herbicides against other factors, such as time saved at a critical season. Research indicates that *if weed control is adequate* and the soil is not crusted because of excessive seedbed preparation or other factors, there often is little or no yield increase from cultivation on most Illinois soils. One or two cultivations are, however, often beneficial for controlling certain weed species that are not controlled by the herbicide.

The popularity of preemergence herbicides is partly caused by the need for improved control of weeds, especially annual grasses which became more severe as farmers switched from checking to drilling and hill-dropping corn. Preemergence herbicides also offer a relatively convenient and economical means of providing early weed control and they allow faster cultivation.

You can mix some herbicides with other agricultural chemicals for application. You can apply some to the surface, but must incorporate others into the soil. You can apply some either way. Time of application depends partly on what herbicide you use.

Plan well in advance to select a weed-control program that is most appropriate for your soil, crops, weed problems, farming operations, and personal desires. Be prepared to modify your plans as required during the season.

Preplant Herbicides for Corn

Some herbicides may be applied before planting where you wish to commit yourself to broadcast application.

Preplant applications offer an opportunity to make some herbicide application before the busy planting season. This can be particularly advantageous for custom applicators and for farmers with large acreages. Preplant allows fewer attachments on the planter. The weather will often dictate the actual time for application, so here preplant applications are planned, you should also ave an alternate plan in case preplant applications are ot possible.

Preplant-incorporated applications offer an opporunity for applying herbicide, insecticide, and fertilizer t the same time if the chemicals are compatible and the incorporation gives the proper placement for each hemical.

AAtrex (atrazine) can be applied within 2 weeks beore planting corn. Although early spring and even fall pplications have been tried, research indicates that the loser to corn planting time you apply AAtrex, the more uccessful the application is likely to be.

Apply AAtrex to the soil surface or incorporate it ghtly with a shallow disking or similar operation. The eld cultivator has been successfully used for incorporaon, but results have not always been quite as good as ith a disk. Depth and thoroughness of incorporation will epend on many factors, such as type of equipment, depth f operation and other adjustments, speed, soil texture, nd soil physical condition when incorporating.

With so many factors involved, exact specifications for ncorporation cannot be given. However, one principle to eep in mind is that the deeper the herbicide is incorporated and the more soil it is mixed with, the more diluted will be. With excessive incorporation and dilution he effectiveness of the herbicide may be decreased. s a rule of thumb, incorporation devices such as a isk usually move the herbicide only to about half the epth at which the implement is operated.

The major reason for incorporating some herbicides to reduce loss of herbicide from the soil surface. Since ss of AAtrex is not very rapid, incorporation is not ssential. Moving herbicide into soil where there is ufficient moisture for weeds to absorb the chemical ay be another advantage for incorporating some herbicides.

AAtrex is very effective for control of many broadeaved weeds and is often quite satisfactory for control f annual grass weeds. However, under unfavorable onditions it may not adequately control some annual rasses such as giant foxtail, crabgrass, and panicum. onsiderable research has been done attempting to find nother herbicide that could be combined with AAtrex improve grass control.

Sutan (butylate) plus atrazine has been successfully sed as a preplant-incorporated treatment. This combiation has its greatest adaptation to soils above 3 perent organic matter. Sutan can often improve the conol of annual grass weeds and the combination gives uch better control of broad-leaved weeds than Sutan one.

For the "tank mix" combination, ½ gallon of Sutan lus 1¼ to 2 pounds of AAtrex 80W per acre broadcast is ggested. Injury to corn from this combination has not been a serious problem thus far, but occasionally injury may occur. If the premixed wettable powder with 36-percent Sutan and 12-percent atrazine is used, a broadcast rate of 8⅓ to 11⅓ pounds per acre is suggested, depending on soil and weed problems.

Sutan (butylate) may be used alone as a preplant incorporated treatment at a rate of ⅔ gallon per acre broadcast. Sutan is primarily for control of grass seedlings and may be helpful for control of fall panicum, Johnsongrass from seed, wild cane, and nutsedge. Although it has not been a serious problem thus far, corn may occasionally be injured by Sutan. *It is important to apply Sutan accurately and uniformly to avoid injury.* Certain corn hybrids may be more sensitive than others. If you use Sutan alone or in combination with AAtrex, incorporate it immediately after application.

Sutan is cleared for field corn, sweet corn, and silage corn, but not for hybrid corn grown for seed.

Lasso or Lasso plus atrazine may be used as a preplant treatment within 7 days before planting corn. Either treatment can be applied to the surface or incorporated. If the major problem is annual grass weeds, a surface application rather than incorporation of Lasso is usually preferred. However, incorporation of Lasso may improve nutsedge control. If Lasso is to be incorporated, consider using the higher rates indicated on the label. See further details under preemergence section.

Preemergence Herbicides Applied at Planting (Preferred)

AAtrex (atrazine) is one of the most popular herbicides for corn. It controls both broad-leaved and grass weeds, but is particularly effective on many broadleaves such as smartweed. Corn has very good tolerance to preemergence applications of AAtrex. It is most effective on the light soils that are relatively low in organic matter, but is also effective on soils with more organic matter if you increase the rate. Do not exceed the rates specified on the label. For help in selecting AAtrex rates on the basis of organic-matter content of the soil refer to Table 1.

AAtrex will often persist long enough to give weed control for most of the season. Unless you take proper precautions, enough AAtrex may remain in the soil to damage some crops the following season. Where you apply AAtrex in the spring, do not follow that fall or the next spring with small grains, small seeded legumes, or vegetables. If you use AAtrex 80W at a broadcast rate above 3¾ pounds per acre (or comparable rates in a band) do not plant any crop except corn or sorghum the next growing season.

Soybeans planted where AAtrex was used the previous year may show some effect, especially if you used more than the recommended amount or on ends of fields where some areas received excessive amounts. Applying AAtrex relatively late the previous year and planting soybeans early allows less time for loss of AAtrex residue and increases the possibility of injury to soybeans. Minimizing tillage before planting soybeans also increases the possibility of AAtrex residue affecting soybeans.

You can use AAtrex on most types of corn, including field corn, silage corn, seed-production fields, sweet corn, and popcorn. AAtrex is available as a wettable powder or as a liquid suspension. Both forms appear to perform equally well. Mix adequately, provide adequate agitation, and follow other precautions on the label to assure uniform application.

Ramrod (propachlor) has given very good control of annual grass weeds on soils above 3 percent organic matter. On soils with less than 3 percent organic matter, Lasso would be more appropriate than Ramrod. In addition to annual grasses, Ramrod usually controls pigweed and may give some control of lambsquarter.

Most of the commonly grown corn hybrids have good tolerance to Ramrod. It is cleared for field corn, silage corn, hybrid-seed-production fields, and sweet corn.

Ramrod is available as a 65-percent wettable powder and as 20-percent granules. Either formulation of Ramrod can be irritating to skin and eyes. Some individuals are more sensitive than others. Twenty pounds of the granules or 6 pounds of the wettable powder are equivalent to 4 pounds of active ingredient, which is the recommended rate per acre on a broadcast basis. Use proportionately less for band applications.

A good program is to use Ramrod either as a spray or as granules at planting time to control annual grass weeds and follow with an early postemergence application of 2,4-D to control broad-leaved weeds.

Ramrod plus atrazine, each at a reduced rate, has generally given good control of both annual broad-leaved and grass weeds. This combination is best adapted to soils with over 3 percent organic matter. For "tank-mixing" this combination, 4½ pounds of Ramrod 65-percent wettable powder plus 2 pounds of AAtrex 80W wettable powder is the suggested amount for soils with over 3 percent organic matter.

A prepackaged wettable powder combination of Ramrod plus atrazine is available. Use it at a rate of 6 to 8 pounds per acre.

The reduced rate of AAtrex will control many broad-leaved weeds, such as smartweed, but may give marginal control of velvetleaf. The reduced rate of Ramrod in the mixture is adequate for control of most annual grasses. The mixture controls broad-leaved weeds better than Ramrod alone and often controls annual grass weeds better than AAtrex alone. It reduces the AAtrex residue problem, and gives more consistent control on the darker soils or with limited rainfall than AAtrex alone.

Lasso (alachlor) is similar to Ramrod in some respects. Although Lasso has performed well on soils with more than 3 percent organic matter, it is not likely that it will entirely replace Ramrod for corn on these soils in the immediate future. Being less soluble than Ramrod, Lasso may require slightly more moisture initially, but weed control may last a little longer. Lasso performs better than Ramrod on soils with less than 3 percent organic matter. Like Ramrod, Lasso is intended primarily for control of annual grass weeds. Following Lasso with a postemergence application of 2,4-D to control broadleaves gives more complete weed control. Lasso is helpful for control of nutsedge.

Corn tolerance to Lasso has usually appeared to be relatively good. However, occasional corn injury has occurred, particularly to certain hybrids. Check with your seed corn dealer and chemical dealer to avoid using Lasso on the more susceptible hybrids.

Lasso is available as a 4-pound-per-gallon liquid concentrate and as 10-percent granules. Lasso may be used for field corn, hybrid seed corn, and silage corn. At least 12 weeks must elapse following treatment with Lasso before immature corn forage can be harvested or fed to cattle. Refer to Tables 1 and 2 and to the product labels for suggested rates.

Although Lasso is less irritating than Ramrod, the precautions listed on the label should be taken when handling Lasso.

Lasso plus atrazine may be used preemergence in a similar way to Ramrod plus atrazine. The Ramrod-atrazine combination has performed quite well on the darker soils, but the Lasso-atrazine combination is less irritating to handle and means less wettable powder to handle than with Ramrod-atrazine. Degree of weed control with either of these combinations has been somewhat comparable. The Lasso-atrazine combination is preferable to Ramrod-atrazine on soils with less than 3 percent organic matter and may improve control of some grasses such as panicum. Precautions should be taken to avoid using the Lasso-atrazine combination on corn hybrids that may be susceptible to Lasso. Suggested rates for tank-mixing Lasso-atrazine are 1½ quarts of Lasso and 1½ pounds AAtrex 80W per acre broadcast for soils with less than 3 percent organic matter or 2 quarts Lasso and 2 pounds AAtrex 80W per acre for soils with more than 3 percent organic matter.

Princep (simazine) usage for corn has been largely replaced by AAtrex. However, Princep, used alone or in combination with AAtrex may give more control of fall panicum than AAtrex alone. Princep may also give some control of wild cane. Being less soluble than AAtrex, Princep may have more residual activity. The major use for Princep would be on soils with less than 3 or 4 percent organic matter.

Bladex (SD 15418) is a new triazine corn herbicide which is similar in some respects to atrazine. Federal approval for corn may be obtained for 1972. The product probably will be available primarily as an 80-percent wetble powder, although a water dispersible liquid and anules are also being considered.

Research thus far suggests that corn has relatively good lerance to Bladex. Rates of Bladex usually need to be ghtly higher than with AAtrex for comparable control. adex may sometimes give slightly better control of some inual grasses but less control of some broad-leaved eeds than AAtrex. Length of control and residual acity are less than with equal rates of AAtrex.

Bladex is for preemergence surface application only id should not be preplant incorporated or used postnergence. Combinations of Bladex with other corn rbicides may offer some potential for the future.

reemergence Herbicides pplied at Planting (Less Preferred)

Because of greater possibility of crop injury or less weed ntrol, the following preemergence herbicides for corn e not considered as satisfactory as those discussed above.

Knoxweed is a combination of Eptam (EPTC) and 4-D. It is cleared for use on field corn, sweet corn, and age corn. Do not use it on seed production fields. noxweed has given rather erratic weed control, dependg on rainfall and soil moisture. More consistent weed ntrol is likely when rain occurs soon after application. he possibility of corn injury from Knoxweed has not een a serious problem but does exist. Knoxweed has resented no hazard to crops the next season. It is availle in both liquid and granular forms. Do not use on eats, mucks, or sands.

2,4-D ester preemergence for corn controls broadaved weeds and gives some control of grass weeds. Veed control is rather erratic. There is some chance of jury to the corn. Use only the ester form for preemernce, since the amine form is more subject to leaching. 4-D ester is available in both liquid and granular forms.

A combination of **Lorox (linuron) plus atrazine** can e used preemergence on field corn. Especially on the latively light-colored soils with low organic matter this ombination has often given satisfactory weed control. sing a reduced rate of Lorox in the combination reuces, *but does not eliminate,* the possibility of corn inry. Do not use the combination containing Lorox on ndy soils or injury may result. This combination may ve more control of panicum than atrazine alone.

Londax, a combination of Lorox and Ramrod, has earance for use on field corn for grain or silage. It conins linuron and propachlor in a ratio of 1 to 2 parts spectively of active ingredient. The 45-percent wettable owder formulation contains 15 percent linuron and 30 ercent propachlor. The 15-percent granular formulation ontains 5 percent linuron and 10 percent propachlor. ates should be very carefully selected on the basis of il texture and organic-matter content. Maximum rates are 1½ pounds of linuron plus 3 pounds of propachlor per acre on a broadcast basis. This combination has given relatively good weed control. Control of broad-leaved weeds is better than with Ramrod alone. However, the addition of Lorox *increases the chance of crop injury.* Applications should be made very accurately and uniformly to help avoid crop injury.

Amiben (chloramben) and **Lorox (linuron)** each have label clearance for preemergence use on corn, but the risk of corn injury is considered too great to recommend their use for this purpose in Illinois.

Postemergence Herbicides for Corn

2,4-D provides one of the most economical and effective treatments for many broad-leaved weeds in corn.

For greatest effectiveness, apply 2,4-D when weeds are small and easiest to kill. You can apply the spray broadcast over the top of the corn and weeds until corn is about 8 inches high. After that height, use drop extensions from the boom down to the nozzles. These "drop nozzles" help keep the 2,4-D out of the whorl of the corn and decrease the possibility of injury. You can direct the nozzles toward the row where most of the weeds will be. However, if you direct the nozzles toward the row, adjust the concentration of the spray so that excessive amounts are not applied to the corn.

Each year some corn is damaged by 2,4-D. It is virtually impossible to eliminate all cases of 2,4-D damage. The chemical usually makes corn brittle for a week or ten days. If struck by a strong wind or by the cultivator, some corn may be broken off. Some stalks may "elbow" or bend near the base. Other symptoms of 2,4-D injury are abnormal brace roots and "onion-leafing," a condition in which the upper leaves remain tightly rolled and may delay tassel emergence.

Spraying 2,4-D during very cool, wet weather when corn plants are under stress, or spraying during very hot, humid weather may increase the possibility of corn injury from 2,4-D.

Some inbreds and some hybrids are more easily injured by 2,4-D than others. It is usually best not to use 2,4-D on inbreds unless you are certain they have a high tolerance. Single crosses may or may not be more sensitive than double crosses, depending on the sensitivity of the inbred parents. Doublecross hybrids and three-way crosses also vary in their sensitivity depending on their genetic makeup.

To help avoid damage to corn, be sure to apply 2,4-D at no more than the recommended rate. The suggested rates per acre for broadcasting are: ⅙ pound of low-volatile ester; ¼ pound of high-volatile ester; or ½ pound of amine.

The ester forms of 2,4-D can volatilize and the vapors move to nearby susceptible plants to cause injury. Since the amines are not so volatile they are less likely to injure nearby desirable plants. However, when spraying either the ester or amine forms, spray particles can drift to nearby susceptible plants.

Here is an easy way to calculate the amount of 2,4-D needed. If using a formulation with 4 pounds of 2,4-D per gallon, each quart will contain 1 pound; each pint ½ pound; and each half-pint ¼ pound. It would take 1 pint of amine formulation to get ½ pound of 2,4-D. A gallon of 2,4-D amine (with 4 pounds of 2,4-D per gallon) would be enough to broadcast 8 acres (4 lb./gal. ÷ ½ lb./A. = 8 acres). A gallon of 2,4-D containing 4 pounds of 2,4-D high-volatile ester would be enough to broadcast 16 acres (4 lb./gal. ÷ ¼ lb./a. = 16 acres).

It is important to spray weeds when they are small and easiest to kill and before they have competed seriously with the crop. However, you can use high-clearance equipment relatively late in the season if you wish, especially for control of late-germinating weeds. Many of the weeds that germinate late are not very competitive with corn, but control would decrease production of weed seeds. Do not apply 2,4-D to corn from tasseling to dough stage.

Amines are salts that are dissolved to prepare liquid formulations and when mixed with water they form clear solutions. Esters of 2,4-D are formulated in oil and when mixed with water they form milky emulsions.

Dacamine and Emulsamine are amine forms of 2,4-D that are formulated in oil and are called oil-soluble amines. Since they are formulated in oil like the esters they are said to have the effectiveness of the esters, but to retain the low-volatile safety features of the amines.

The active ingredient in the various formulations of 2,4-D is still 2,4-D and when you adjust rates appropriately to provide both weed control and crop safety the various formulations are usually similar in their effectiveness.

Banvel (dicamba) is suggested only for emergency use. You can use it as a postemergence spray over the top of field corn until corn is 3 feet high. Rates are ¼ to ½ pint (⅛ to ¼ pound active ingredient) per acre on a broadcast basis. Use proportionately less if placed only over the row.

Banvel is similar to 2,4-D in some respects, but controls smartweed better than does 2,4-D. Corn injury can occur with either Banvel or 2,4-D. *Banvel has often affected soybeans in the vicinity of treated cornfields and has presented a much more serious problem than 2,4-D.* Although soybean yields may not always be reduced, they can be if injury is severe enough. Banvel can also affect other susceptible broad-leaved plants, such as vegetables and ornamentals.

Do not make more than one postemergence application of Banvel per season. You can use Banvel on field corn for grain or silage, but do not graze or harvest for dairy feed before the ensilage stage (milk stage). Use extreme care not to allow Banvel onto desirable plants either by direct application, from contaminated sprayers, or by movement through the air from treated areas.

Because of the limited advantage of Banvel over 2,4-D and the greater risk of injury to other crops in the vicinity, Banvel is usually not recommended. If you anticipate a smartweed problem in corn, AAtrex preemergence or very early postemergence usually gives good control with much less risk of injury to other nearby plants.

AAtrex (atrazine) can be applied as an early postemergence spray to corn up to 3 weeks after planting, but before weed seedlings are more than 1½ inches high. Most annual broad-leaved weeds are more susceptible than grass weeds. The addition of 1 gallon of oil formulated especially for this purpose has generally increased the effectiveness of early postemergence applications of AAtrex. *On the relatively light-colored soils of Illinois, a regular preemergence application of AAtrex will likely remain more popular than postemergence AAtrex* because AAtrex preemergence applications usually give better control with less herbicide on such soils.

On the relatively dark soils of the state there is some interest in the AAtrex-oil treatment. Research and field experience suggest that for those relatively dark soils, 2½ pounds of AAtrex 80W plus 1 gallon of oil may sometimes be just as effective, and sometimes more effective, than a preemergence application of 3¾ pounds of AAtrex 80W. However, a preemergence application is usually preferred.

As with many herbicide applications, the results with AAtrex and oil will be influenced by many factors, and results are not always consistent. For control of annual grasses, it is especially important to apply early when grasses are small.

The early postemergence application with AAtrex and oil may be of particular help where rainfall is less certain, on the darker soils, and where soil conditions are too wet for cultivation.

Although corn has displayed excellent tolerance to AAtrex alone, corn has sometimes shown a general stunting where oil was added. There have been a few cases of fairly severe injury to corn where AAtrex and oil have been used. Weather conditions, stage of growth, rate of growth, genetic differences, and rate of herbicide used with oil seem to be some of the factors involved. If AAtrex is applied after June 10, do not plant any crop except corn or sorghum the next year because of increased risk of herbicide residue. Refer to the label for other precautions and for special instructions for aerial applications.

Certain other additives might be used instead of oil to enhance the postemergence activity of AAtrex. One of these is Tronic. Although results with Tronic have not been quite as consistent as with oil, results were often quite similar. An advantage for Tronic would be the need for handling less volume — 1 pint of Tronic per

25 gallons of spray solution. Formulations of crop oil with a higher percentage of surfactants or emulsifiers are also available and allow use of less volume than the regular crop oils.

Directed Postemergence Applications for Corn

Directed sprays are sometimes considered for emergency situations when grass weeds become too tall for control with cultivation. By the time help is sought, the weeds are often too large for directed sprays to be very practical or successful. Since present directed sprays cannot be used on small corn, some other means of control must be used early. Early control with only preemergence herbicides and cultivation is often quite adequate, leaving no need for the directed sprays. Since weeds begin competing with corn quite early, place primary emphasis on early control measures, such as use of preemergence herbicides, rotary hoeing, and timely cultivation.

Directed postemergence may have some potential for controlling some relatively late-germinating grasses, such as fall panicum.

Dalapon may be applied as a directed spray when corn is 8 to 20 inches tall from ground to whorl. Dalapon is primarily for control of grass weeds, but 2,4-D can be added for control of broad-leaved weeds. Use extreme caution to keep the dalapon off the corn plant as much as possible to avoid injury. Other precautions are given on the labels. Because of the risk of injury, dalapon is not usually recommended in Illinois for application to corn.

Lorox (linuron) may be applied as a directed spray after corn is at least 15 inches high (to top of free-standing plant), but before weeds are 8 inches tall (preferably not over 5 inches). This height difference may not occur in some fields and when it does it will usually last for only a few days so the application needs to be very timely. Lorox can control both grass and broad-leaved weeds. Cover the weeds with the spray, but keep it off the corn as much as possible. Corn leaves that are contacted can be killed and injury may be sufficient to affect yields.

Consider this an emergency treatment. Refer to the label for further information and other precautions. A rate of 4 pounds of Lorox 50W on a broadcast basis or proportionately less in a directed band is suggested, but less Lorox may sometimes be adequate, especially for small weeds. Surfactant WK should be added at the rate of 1 pint per 25 gallons of spray mixture.

Soybeans

For soybeans Illinois farmers usually plow the seedbed and use a disk, field cultivator, or similar implement at least once to destroy weed growth and prepare a relatively uniform seedbed for planting. Planting in relatively warm soils helps soybeans begin rapid growth and compete better with weeds. Good weed control during the first three to five weeks is extremely important. If weed control is adequate during that early period, soybeans usually compete quite well with most of the weeds that begin growth later.

Rotary hoeing is very popular for soybeans. It not only helps control early weeds, but it aids emergence if the soil is crusted. To be most effective, use the rotary hoe after weed seeds have germinated, but before the majority of weeds have emerged. Operate the rotary hoe at 8 to 12 miles per hour and weight it enough to stir the ground properly. The soil must be moved sufficiently to kill the tiny weeds.

Following one or two rotary hoeings, use the row cultivator one or two times. Adjust the row cultivator properly and operate it fast enough to move soil into the row to smother small weeds. Avoid excessive ridging which would make harvesting difficult.

It is often said that soybeans in narrow rows provide more shade and compete better with weeds. However, with narrow rows there is more row area where weeds are difficult to control. So a good weed-control program is just as important for narrow-row beans.

There is some interest in "solid drilling" of sobyeans in 7- to 10-inch rows. However, you cannot expect present herbicides to control weeds adequately 100 percent of the time. For most situations it is preferable to keep the rows wide enough so you can use cultivation as required.

Use of preemergence herbicides for soybeans has increased rapidly. Nearly three-fourths of the soybean acreage in Illinois is treated with a preemergence herbicide. Whether you should use herbicides for soybeans will depend on the seriousness and nature of your weed problem, as well as your preference for various alternative methods of weed control. Preemergence herbicides are often extremely helpful in obtaining the necessary early control in the row. They can allow a reduction in the number of cultivations, allow faster cultivation, and reduce the amount of ridging needed to smother weeds in the row.

Even though you have used a preemergence herbicide, if it appears doubtful that it will give adequate control, use the rotary hoe while weeds are still small enough to be controlled. Use row cultivation as needed before weeds in the row become too large to be smothered.

When selecting a preemergence herbicide for soybeans, consider the kind of weeds likely to be present. Many of the preemergence herbicides for soybeans are particularly effective for controlling annual grasses. The majority give good control of pigweed, and many will also control lambsquarter. Most do not give good control of annual morningglory, and control of velvetleaf, jimsonweed, and cocklebur is rather erratic.

Many of the preemergence herbicides for soybeans may occasionally cause injury to the soybean plants. Fortunately, soybeans usually have the ability to outgrow modest amounts of early injury, and usually the benefits from weed control provided by the herbicide are much greater than any adverse effects from the herbicides. There may occasionally be exceptions and anyone using herbicides should realize there are some risks involved.

Where you use herbicides for soybeans, it is particularly important to use high-quality seed of disease-resistant varieties. Soybeans that are under stress and do not begin vigorous growth appear to be more subject to herbicide injury. And soybeans that are injured by a herbicide are likely to be more subject to disease. Any one of these factors alone may not be too serious, but several of them acting together could be.

Preplant Herbicides for Soybeans

Treflan (trifluralin) is one of the most effective herbicides for controlling annual grasses such as foxtail. It is also the major soybean herbicide suggested for controlling wild cane and Johnsongrass seedlings. Treflan may also control pigweed and lambsquarter, but does not give good control of most other broad-leaved weeds commonly found in Illinois soybean fields.

Treflan has given satisfactory control of susceptible weeds a high percentage of the time. Soybean injury is possible with Treflan. It may cause tops to be stunted and may cause a reduction in the number of lateral roots in the treated zone. Compared with the advantages of Treflan for controlling annual grasses, the injury from Treflan on a statewide basis is not considered a serious problem. However, in some individual fields where the stand of soybeans is reduced and plants are injured, the problem may be considered significant. Following instructions for rate and method of application is very important in reducing the possibility of injury.

You can apply Treflan just before planting or anytime during 10 weeks before planting. Incorporate it into the soil immediately after application, by using a disk or similar implement to reduce loss from the soil surface. Cross-disk a second time at right angles to the first disking to obtain more uniform distribution. This will help give more uniform weed control and reduce possibility of soybean injury. You can delay the second disking until anytime before planting, and using it for final seedbed preparation just before planting usually improves control.

The disk probably will incorporate the chemical to only about ½ the depth of operation. Disking about 4 inches deep to mix the majority of the chemical into about the top 2 inches usually works best. Having a harrow attached behind the disk is often helpful.

You can use implements other than the disk if they adequately mix the chemical into the top 2 inches. The field cultivator is usually not recommended for incorporating Treflan. Results with the field cultivator sometimes have been acceptable, but are usually not as good as with the disk. The degree of incorporation may vary considerably depending on type of implement, adjustment, speed, soil moisture, soil texture, and other soil physical conditions.

The rate of Treflan is between ½ and 1 quart liquid (½ to 1 pound of active ingredient) per acre on a broadcast basis. Select the rate on the basis of soil type as indicated on the label. After determining the organic-matter content of your soil by estimation or by laboratory analysis you can also use Table 1 as a guide for selecting appropriate rates for most Illinois soils. For most of the light-colored silt loams in Illinois use ½ to ¾ quart per acre; for the dark-colored silty clay loams, and clay loams with over 3 percent organic matter use ¾ to 1 quart per acre.

Treflan is also available in granular form. The granules have not been as popular as the liquid, but appear to be comparable in performance.

In a few cases Treflan residue has carried over to injure corn the following year. In many of these fields the soybean stubble had not been plowed with a moldboard plow. Some areas apparently had excessive applications.

Research also suggests some possibility of Treflan residue affecting small grain. Using no more than recommended rates and making careful applications no later than early June should reduce, but may not eliminate, the possibility of injury to subsequent crops.

Planavin (nitralin) is similar to Treflan in the kinds of weeds controlled. However, research indicates that in Illinois higher rates of Planavin are usually needed to provide about the same control obtained with Treflan.

On some of the light-colored silt loams of the southern part of Illinois, ¾ pound per acre of active ingredient of Planavin (¾ quart of liquid or 1 pound of 75-percent wettable powder) appears to be appropriate. Higher rates are needed as organic matter increases (see Table 1).

Planavin is cleared up to 1½ pounds per acre of active ingredient, but it is not well adapted to the darker soils of the northern part of Illinois. Planavin can be applied within 6 weeks before planting. Incorporate soon after application into the top 1 to 1½ inches of soil with a disk operated shallow or with similar equipment.

Lasso (alachlor) may be applied as a preplant incorporated treatment within 7 days of planting. Disking two or three times at 1- to 2-week intervals to help deplete the food reserves in nutsedge tubers and incorporating about 3 quarts of Lasso at the time of the last disking is usually helpful for controlling nutsedge.

Preemergence Herbicides Applied at Planting Time (Preferred)

Amiben (chloramben) has been one of the most popular herbicides for soybeans. It controls the majority of annual grass and broad-leaved weeds in soybeans most of the season. The major exception is annual morningglory. Control of velvetleaf, jimsonweed, and cocklebur is somewhat erratic. Amiben occasionally injures soybeans, but damage is usually not very severe. When it occurs, injury appears as malformed roots and stunting of the tops.

Amiben is adapted to a wide range of soil types. The manufacturer recommends 1 to 1½ gallons or 20 to 30 pounds of granules (2 to 3 pounds active ingredient) on a broadcast basis per acre or proportionately less for band application. University trials have shown best weed control with 1½ gallons or 30 pounds of granules per acre. If you reduce the rate, weed control may be reduced. Consider the degree of control desired, as well as the cost.

You can make a comparison of 1, 1¼, and 1½ gallons (20, 25, and 30 pounds of granules) per acre on a field and use it as a basis for selecting rates for that field in the future. Granules and liquid perform about equally well. Amiben is easy to handle and is usually applied to the soil surface at planting time.

Combinations which contain amiben include Amilon (chloramben plus linuron) and Noraben (norea plus chloramben).

Ramrod (propachlor) is cleared only for soybeans grown for seed and not for soybeans that will be harvested for food, feed, or edible oil purposes. Most of the comments on page 5 regarding Ramrod for corn apply for soybeans. Lasso is somewhat similar to Ramrod and has broader clearance for soybeans, so Lasso is usually used.

Lasso (alachlor) is intended primarily for control of annual grass weeds, but may also control pigweed and lambsquarter. Lasso is also helpful for control of nutsedge. Soybeans appear to have relatively good tolerance to Lasso although slight distortion of the leaves may appear early.

Lasso is less soluble than Ramrod and may require slightly more moisture initially, but can provide control a little longer than Ramrod. Lasso is not as irritating as Ramrod, but follow precautions listed on the label.

Lasso is available as a liquid with 4 pounds active ingredient per gallon and as 10-percent granules. Lasso has generally performed well on the darker soils and performs better than Ramrod on the lighter soils. A rate of 2 to 2½ quarts of liquid or 20 to 25 pounds of 10-percent granules (broadcast basis) is suggested for most Illinois soils. Use proportionately less for band applications.

Lorox (linuron) has given relatively good weed control in soybeans, particularly on the light-colored silt loams. Grass weeds are usually not controlled as easily as some broad-leaved weeds. The *margin of selectivity between dependable weed control and crop damage is rather narrow.*

Lorox performance is affected considerably by organic-matter content of the soil. On the low-organic-matter soils of southern Illinois where Lorox is adapted, a rate of about 1 pound of Lorox 50W is fairly common. Use considerable caution in adjusting above this rate.

Careful selection of rates and accurate and uniform applications can reduce, *but may not eliminate, the possibility of crop injury.* Do not use Lorox on sandy soils because of the risk of crop injury.

Lasso plus Lorox in combination has given good weed control, primarily on the silt loam soils with less than 3 percent organic matter. On these soils, about 1½ quarts of Lasso and about 1 pound of Lorox 50W is suggested on a broadcast basis or proportionately less in a band. Lasso improves grass control and Lorox improves control of broadleaves such as velvetleaf, cocklebur, jimsonweed, and smartweed.

There is some risk of injury from this combination, so select rates, particularly of Lorox, very carefully for your soil and be certain that applications are accurate and uniform.

Chloro-IPC (chlorpropham) has not commonly been used in Illinois, except in combination with other herbicides. When tested alone rates of Chloro-IPC sufficient to give adequate control of most weeds have sometimes caused soybean injury. However, smartweed is particularly sensitive to Chloro-IPC. For controlling smartweed in soybeans, use 2 to 3 pounds per acre of Chloro-IPC active ingredient on a broadcast basis. You can use this reduced rate of Chloro-IPC alone or in combination with some other herbicides that are weak on smartweed. Treflan may be incorporated preplant and Chloro-IPC applied to the surface at planting or soon after. Also, a tank mix of Lasso plus Chloro-IPC may be used for preemergence surface application.

Preforan (C-6989) is formulated as a 3-pound-per-gallon liquid for use at 5 to 6 quarts per acre. Preforan should be applied to the soil surface at or soon after planting time. It controls annual grasses such as foxtails, and broadleaves including pigweed, lambsquarter, and smartweed. Lack of velvetleaf control is quite evident. Soybean tolerance with Preforan seems to be fair to good. As with most soybean herbicides, a little early injury may sometimes be noticed but soybeans usually outgrow any early injury rather well.

Preemergence Herbicides Applied at Planting Time (Less Preferred)

Because of the greater possibility of crop injury or less weed control, the following preemergence herbicides for soybeans are not considered as satisfactory as those previously discussed.

Solo (naptalam plus chlorpropham) sometimes gives satisfactory weed control but has been rather erratic. Crop injury can sometimes occur. Under favorable conditions, Solo can control annual grasses, smartweed, ragweed, velvetleaf, and jimsonweed. However, broad-leaved weeds are usually more easily controlled than grass weeds.

Solo is usually used at the rate of 1 to 1½ gallons of liquid or 20 to 30 pounds of granules per acre on a broadcast basis, or proportionately less when banded. This is equivalent to 2 to 3 pounds of naptalam and 2 to 3 pounds of chlorpropham active ingredient broadcast per acre.

Vernam (**vernolate**) has given good control of annual grass weeds in Illinois trials, *but some injury to soybeans may occur*. In addition to annual grasses, Vernam controls pigweed, lambsquarter, and may give some control of annual morningglory. Vernam might be considered for serious infestations of wild cane and for control of Johnsongrass seedlings where some soybean injury from the herbicide might be tolerated. Vernam is also helpful for controlling nutsedge.

It would usually be preferable to incorporate Vernam before planting. However, granules are often banded on the surface at planting. Incorporation of granules is not essential but usually improves control, especially if rainfall is delayed. Rates of active ingredient suggested vary from 2 to 3 pounds per acre depending on soil type, formulation, and method of application.

Postemergence Applications for Soybeans

Tenoran (**chloroxuron**). Tenoran may be applied at the rate of 2 to 3 pounds of the 50-percent wettable powder in 25 to 40 gallons of water per acre with 1 pint of Adjuvan T surfactant added per 25 gallons of spray solution. This is the broadcast rate, but you can use proportionately less for directed or semi-directed band spraying. Apply from the time trifoliolate soybean leaves form and when broad-leaved weeds are less than 1 to 2 inches high.

Some non-phytotoxic oils may be substituted for Adjuvan T, using 1 gallon of oil in 25 gallons of spray solution for a directed or semi-directed spray.

Under favorable conditions Tenoran may give fairly good control of pigweed, lambsquarter, smartweed, jimsonweed, morningglory, and cocklebur. Velvetleaf is more difficult to control and should be not over 1 inch when you treat it. Although intended primarily for control of broad-leaved weeds, Tenoran may give some control of grass if you apply it under favorable conditions when grass weeds are less than ½ inch.

The major interest in Tenoran would be as a possible control for some of the broad-leaved weeds where a preemergence herbicide such as Treflan or Lasso had been used preemergence. Control with Tenoran has been somewhat erratic and soybeans usually show some injury at rates required for weed control. This early season injury to soybeans by Tenoran may not necessarily reduce final yields.

2,4-DB can be considered for emergency situations where cocklebur is quite serious (as in some bottomland areas). 2,4-DB is sold under several trade names including Butoxone SB and Butyrac. This herbicide may be broadcast from 10 days before soybeans begin to bloom until midbloom or as a postemergence directed spray when soybeans are at least 8 inches tall and cockleburs are 3 inches tall, if this height difference exists.

2,4-DB may also give fairly good control of annual morningglory and giant ragweed. But do not expect good control of most other weeds found in Illinois soybean fields. Soybeans may show early wilting followed by later curving of the stems. Some cracking of stems and some proliferated growth may occur at the base of the plants. Lodging may be increased and if excessive rates are applied or unfavorable conditions exist near time of treatment, yields may be lowered. Carefully follow application rates specified on the label.

Fencerow Control

If the vegetation in fencerows consists primarily of broad-leaved weeds, use 2,4-D at the rate of ½ to 1 pound applied in 10 or more gallons of water per acre. Two miles of fencerow, 4 feet wide equals about an acre.

Make the first application of 2,4-D in May or early June to control early weeds, and make another application in July or early August to control late weeds.

If there are grass weeds such as Johnsongrass or foxtail in the fencerow, you may mix dalapon with 2,4-D for control of both broad-leaved weeds and grasses. Spray grasses before seed heads form. Use only 2,4-D where the fencerow vegetation consists primarily of broad-leaved weeds and desirable grasses. Use care to avoid injury to nearby desirable plants.

Additional Information

Not all herbicides and herbicide combinations available for corn and soybeans are mentioned in this publication. Some are relatively new and still being tested. Some are not considered to be very well adapted to Illinois or are not used very extensively. For information on other herbicides refer to the most recent Illinois Custom Spray Operator's Training School Manual available from Entomology Extension, Natural History Survey, Champaign, Illinois 61820.

For information on weed control in small grains, forage crops, and minor crops, refer to "Agronomy Facts" available through your county extension adviser or from the Agronomy Department, University of Illinois, Urbana, Illinois 61801. Information on control of specific weed species is available in the following publications and in Agronomy Facts.

Copies of the following publications may be obtained from the Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801, or from a county extension adviser.

Weeds of the North Central States. Circular 718. ($1.00)

Prevent 2,4-D Injury to Crops and Ornamental Plants. Circular 808.

Controlling Johnsongrass in Illinois. Circular 827.

Controlling Giant Foxtail in Illinois. Circular 828.

Controlling Quackgrass in Illinois. Circular 892.

Calibrating and Maintaining Spray Equipment. Circular 837.

Calibrating and Adjusting Granular Row Applicators. Circular 1008.

Controlling Poison Ivy. Circular 850.

Using Preemergence Herbicides. Circular 932.

Color Chart for Estimating Organic Matter in Mineral Soils in Illinois. AG-1941.

Wild Hemp (Marijuana): How to Control It. USDA PA-959.

Eradicating Marihuana Plants.

The following publication may be obtained from the Division of Plant Industry, Illinois Department of Agriculture, Emmerson Building, State Fairgrounds, Springfield, Ill. 62706.

Noxious Weeds in Illinois.

Herbicide Application Rates

Table 2 lists the amount of commercial herbicides to apply per acre for liquids or granules, either broadcast or banded.

Here is a guide for calculating the amount of herbicide needed for spraying bands for various row spacings:

Row spacing (inches)	Width of band (inches)	Percent of total area covered
20	12	60
20	14	70
24	12	50
28	14	50
30	12	40
30	15	50
36	12	33
38–40	13	33
42	14	33

Formula for other situations: band width ÷ row spacing = percent of area covered.

Example: 12 inches ÷ 36 inches = ⅓ or 33 percent.

By operating your equipment over 1 acre of land you can determine how much spray is used. Do this by starting with a full tank of water and after operating on 1 acre measure the amount of water needed to refill the tank. Multiply the percentage figure from the guide above for your situation times the amount of herbicide recommended for broadcasting. The answer is the amount of herbicide to add with enough water to equal the spray volume you used per acre.

Example: 28-inch rows with 14-inch band; 1 gallon per acre of herbicide recommended if broadcast; 50 percent (from table) × 1 gallon = ½ gallon per acre needed for 14-inch bands on 28-inch rows; if you used 10 gallons per acre of spray, add ½ gallon of herbicide to each 9½ gallons of water to make 10 gallons of spray solution.

When using band treatments the amount of active chemical per row doesn't change with row spacings, but the amount of chemical applied per acre does. Table 3 shows the liquid and granular band rates for 13-inch bands on various row widths.

Table 2. — Amount of Commercial Product To Apply per Acre

Herbicide	12- to 14-inch bands over 40-inch rows		Broadcast	
	Liquid[a]	Granules[b]	Liquid[a]	Granules[b]
		Corn		
AAtrex	⅚-1¼ lb.	....	2½-3¾ lb.	....
Ramrod	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Lasso	½-1 qt.	5-10 lb. (10%)	1½-3 qt.	15-30 lb.
Knoxweed	1⅓ pt.	7 lb. (14%)	2 qt.	20 lb.
2,4-D ester	1 pt.[c]	3⅓ lb. (20%)	1½ qt.[c]	10 lb.
Eptam	....	....	2 qt.	30 lb. (10%)
Sutan	....	....	⅔ gal.	40 lb. (10%)
		Soybeans		
Amiben	2 qt.	10 lb. (10%)	1½ gal.	30 lb.
Treflan	....	....	½-1 qt.	10-20 lb. (5%)
Lasso	½-1 qt.	5-10 lb. (10%)	1½-3 qt.	15-30 lb.
Solo	⅓-½ gal.	7-10 lb. (20%)	1-1½ gal.	20-30 lb.
Lorox[d]	⅓-⅔ lb.	....	1-2 lb.	....
Vernam	....	7-10 lb. (10%)	1⅓-2 qt.	20-30 lb.
Planavin[d]	¼-⅓ qt.	....	¾-1 qt.	....
Preforan	1⅔-2 qt.	....	5-6 qt.	....

[a] For broadcasting use 10 to 30 gallons of spray solution per acre for liquid formulations. For wettable powders use 20 to 30 gallons of spray per acre.

[b] The amount of granules listed is for material with the indicated amount of active ingredients.

[c] For a 2,4-D formulation containing 4 pounds acid equivalent per gallon.

[d] Amount for light-colored silt loam. See label for rates on other soils.

Table 3. — Liquid and Granular Band Rates for 13-Inch Bands on Various Row Widths

Broadcast rate (gallons per acre)	40-inch rows	38-inch rows	36-inch rows	30-inch rows	20-inch rows
		Liquid (gallons per acre)			
15	4.9	5.1	5.4	6.5	9.8
20	6.5	6.8	7.2	8.7	13.0
25	8.1	8.5	9.0	10.8	16.2
30	9.8	10.3	10.8	13.0	19.5
		Granular (pounds per acre)			
	1	1.1	1.1	1.3	2.0
	2	2.1	2.2	2.7	4.0
	3	3.2	3.3	4.0	6.0
	4	4.2	4.4	5.3	8.0
	5	5.3	5.5	6.7	10.0
	6	6.3	6.7	8.0	12.0
	7	7.4	7.8	9.3	14.0
	8	8.4	8.9	10.7	16.0
	9	9.5	10.0	12.0	18.0
	10	10.5	11.1	13.3	20.0
	11	11.6	12.2	14.7	22.0
	12	12.6	13.3	16.0	24.0
	13	13.7	14.4	17.3	26.0
	14	14.8	15.5	18.7	28.0
	15	15.8	16.7	20.0	30.0
	16	16.9	17.8	21.3	32.0

Control of Major Weed Species With Herbicides

(This chart gives a general comparative rating. Under unfavorable conditions some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions control may be better than indicated. Type of soil is also a very important factor to consider when selecting herbicides. Rate of herbicide used will also influence results. G = good, F = fair or variable, and P = poor.)

Control for Soybeans

	PREEMERGENCE Amiben	Lasso	Treflan	Planavin	Lorox	Solo	Vernam	Preforan	POSTEMERGENCE 2,4-DB	Tenoran
Grasses										
Giant foxtail	G	G	G	G	G	F	G	G	P	P
Green foxtail	G	G	G	G	G	F	G	G	P	P
Yellow foxtail	G	G	G	G	G	F	G	G	P	P
Barnyard grass	G	G	G	G	G	F	G	F	P	P
Crabgrass	G	G	G	G	G	F	G	G	P	P
Johnsongrass from seed	F	F	G	G	P	P	G	P	P	P
Wild cane	F	F	G	G	P	P	G	P	P	P
Yellow nutsedge	P	F	P	P	P	P	F	P	P	P
Broadleaves										
Pigweed	G	G	G	G	G	G	G	G	P	G
Lambsquarter	G	F	G	G	G	F	F	F	P	F
Velvetleaf	F	P	P	P	G	F	F	P	P	P
Jimsonweed	F	P	P	P	F	F	P	F	P	F
Cocklebur	F	P	P	P	F	F	P	P	G	F
Annual morningglory	P	P	F	F	P	F	F	P	F	F
Ragweed	G	F	P	P	G	G	P	F	F	F
Smartweed	G	P	P	P	G	G	P	G	P	F
Soybean tolerance	F	G	F	F	F	F	F	F	F	F

Control for Corn

	PREEMERGENCE AAtrex	Ramrod	Lasso	Ramrod+atrazine	Sutan+atrazine	Knoxweed	2,4-D ester	Londax	Sutan	Eptam	POSTEMERGENCE 2,4-D	Atrazine and oil
Grasses												
Giant foxtail	F	G	G	G	G	F	F	G	G	G	P	F
Green foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Yellow foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Barnyard grass	G	G	G	G	G	F	F	G	G	G	P	G
Crabgrass	F	G	G	G	G	F	P	G	G	G	P	P
Johnsongrass from seed	P	P	F	P	F	P	P	P	F	G	P	P
Wild cane	P	P	F	P	F	P	P	P	F	G	P	P
Yellow nutsedge	F	F	F	F	F	P	P	P	F	F	P	F
Panicum	F	F	G	F	G	F	P	F	G	G	P	P
Broadleaves												
Pigweed	G	G	G	G	G	G	G	G	G	G	G	G
Lambsquarter	G	F	F	G	G	G	G	G	P	F	G	G
Velvetleaf	F	P	P	F	G	F	F	F	F	F	F	F
Jimsonweed	G	P	P	G	G	F	F	F	P	P	F	G
Cocklebur	G	P	P	G	G	F	G	F	P	P	G	G
Annual morningglory	G	P	F	G	G	F	G	P	P	P	G	G
Ragweed	G	P	P	G	G	F	F	G	P	P	G	G
Smartweed	G	P	P	G	G	F	F	G	P	P	F	G
Corn tolerance	G	G	G	G	F	F	F	F	F	F	F	F

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1972 Suggested Insecticide Guide

Insect Control for COMMERCIAL VEGETABLE CROPS and GREENHOUSE VEGETABLES

Commercial vegetable gardeners find it impossible to produce vegetables profitably unless they control insects at maximum efficiency and minimum cost. The housewife of today will not accept unsightly wormy vegetables; not only are wormy fruits and vegetables unappetizing but the waste from trimming increases food costs. Thus the commercial vegetable gardener must produce a quality product that is acceptable and safe to the consumer. Careful and correct use of the right insecticides will enable him to do this.

This suggested insecticide guide has been prepared for use by Illinois commercial vegetable farmers; it is not for home gardeners, who should use only those insecticides that are extremely safe to handle, apply, and store. Furthermore, the commercial vegetable gardener must use a wider variety of insecticides than the home gardener in order to obtain maximum insect control at the least cost.

In using insecticides, read the label and carefully follow the instructions. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest, and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, the dilution, the rate of application per acre, and the date or dates of application.

Some of the insecticides suggested here can be poisonous to the applicator. In using them, the commercial gardener is expected to use precautions to protect himself, his workers, and his family from undue or needless exposure.

In using this guide, always refer to the table on the next page, which lists the limitations and restrictions on use. These limitations apply to the vegetables as human food. If you use any portion of a vegetable for livestock food (tops, stalks, etc.) refer to the label for instructions as to the interval required between application and feeding.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. If the trade name is more commonly used, it is listed in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

These suggestions are subject to change without notification during the growing season.

The publication was prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Requested label clearances for a few uses of insecticides, carriers, and solvents is uncertain for 1972, since many requests have not been officially cleared. Anticipating needed changes in labeling, we began modifying these suggested uses a few years ago. We have attempted to anticipate any further label changes in 1972, but an occasional use may still be canceled. Be sure to check with your county extension adviser if you are in doubt about the insecticide you plan to use. We will make announcements of label changes through the news media to keep you up to date.

Suggestions for use of insecticides effective from a practical standpoint are based on available data. Soil texture, pH of the soil, rainfall, slope of the field, wind velocity at planting, method and accuracy of application, and other unpredictable factors affect efficiency of insecticides.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 897 Urbana, Illinois, December, 1971

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

LIMITATIONS FOR FIELD VEGETABLES IN DAYS BETWEEN APPLICATION AND HARVEST AND OTHER RESTRICTIONS ON USE OF INSECTICIDES IN ILLINOIS

(Blank spaces indicate the material is not suggested for the specific use in Illinois)

Insecticide	Beans	Broccoli	Brussels sprouts	Cabbage	Cauliflower	Horseradish[1]	Radish[1]	Turnip[1]	Onions	Eggplant	Peppers	Tomatoes
azinphosmethyl (Guthion)[2]	...	15	7	21	15	...	...	...	...	...	...	...
carbaryl (Sevin)	0	3	3	3	3	3	3	3,14G	...	0	0	0
Dasanit	...	...	...	...	...	...	...	...	I, J	...	...	...
diazinon	...	5	...	7	5	...	10	10	10	...	...	1
dicofol (Kelthane)	7C	...	...	...	...	...	...	...	...	2	2	2
dimethoate (Cygon)	0C	7	...	3	7	...	...	14	...	...	0	7
endosulfan (Thiodan)	CH	7	...	7	B	...	...	...	...	...	...	...
ethion	...	...	...	...	...	...	...	...	I	...	...	...
Fundal	...	14K	14K	14K	14K	...	...	...	...	...	...	...
Galecron	...	14K	14K	14K	14K	...	...	...	...	...	...	...
malathion	1	3	7	7	7	7	7	3	3	3	3	1
methomyl (Lannate)	...	7	...	1	7	...	...	...	...	...	...	2
mevinphos (Phosdrin)[2]	...	1	3	1	3	...	...	3	...	...	...	...
naled (Dibrom)	...	1	1	1	1	...	...	4	...	...	...	...
parathion[2]	7	7	7	10	7	...	15	10	...	15	15	10
phorate (Thimet)[2]	I	...	...	...	...	...	...	...	...	...	...	...
rotenone	...	...	...	...	...	...	...	...	...	1	1	1
toxaphene	...	...	B	7D	B	C	C	C	...	5	5	3
trichlorfon (Dylox)	...	...	21	21	21	...	...	28C	...	...	21	21

Insecticide	Potatoes[1]	Collards	Kale	Lettuce	Spinach	Swiss chard	Sweet corn	Cucumbers[3]	Melons[3]	Pumpkins[3]	Squash[3] Winter	Squash[3] Summer
carbaryl (Sevin)	0	14	14	14	14	14	0	0	0	0	0	0
diazinon	...	10	10	10	10	12	I	7	3	...	3	7
dicofol (Kelthane)	...	...	...	...	...	...	...	2	2	2	2	2
dimethoate (Cygon)	0	14	14	14	14	14	...	...	3	...	...	...
dyfonate	...	...	...	...	...	...	I	...	...	...	...	...
endosulfan (Thiodan)	0	...	...	14A	...	...	...	...	...	...	...	...
Gardona	...	...	...	...	...	...	0,5G	...	...	...	...	...
malathion	0	7	7	14	7	7	5	1	1	3	1	1
methomyl (Lannate)	...	...	...	...	...	...	0,3G	...	...	...	...	...
mevinphos (Phosdrin)[2]	...	3	3	2	4	...	...	...	...	...	...	...
naled (Dibrom)	...	4	4	1	1	1	...	...	...	...	...	...
parathion[2]	5	10	10	21	14	21	12	15	7	10	15	15
phorate (Thimet)[2]	I	...	...	...	...	...	I	...	...	...	...	...
rotenone	...	1	1	1	1	1	...	...	...	...	...	...
toxaphene	0	B	28	E	21F	E	B	B	B	B	B	B
trichlorfon (Dylox)	...	28B	21	28B	...	...	...	...	...	14F	...	...

[1] Root crops such as radishes, turnips, carrots, horseradish, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

[2] Use only by professional applicators or commercial gardeners.

[3] Only apply insecticide late in the day after blossoms have closed to reduce bee kill.

A. Not more than twice per season.
B. Not after edible portions or heads begin to form.
C. Do not use tops for feed or food.
D. If outer leaves are stripped; otherwise, B.
E. Do not apply after seedling stage.
F. Not more than once per season.
G. If tops or stover is to be used as feed.
H. Not more than three times per season.
I. Soil applications at planting time only.
J. Do not use on green onion crop.
K. No more than nine applications.

LIMITATIONS FOR GREENHOUSE VEGETABLES

Insecticide	Tomatoes	Lettuce
endosulfan (Thiodan)	15 hours	...
malathion	15 hours	10 days
metaldehyde	As bait only applied to soil	
naled (Dibrom)	1 day	...
parathion[1]	10 days	21 days
tepp[1]	...	3 days

[1] Do not use aerosols that contain parathion, tepp, or the propellant methyl chloride in greenhouses connected to living quarters. Should be applied only by a trained operator.

CABBAGE AND RELATED COLE CROPS[1]

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cabbage maggot[2] (NHE-44)	All season	diazinon	3	Broadcast	Disk in just before planting. Use only for cabbage, cauliflower, and broccoli.
		diazinon granules	1	Furrow	At time of planting; on turnips a drenching spray of 1 lb. diazinon should be applied 30 days following treatment.
		azinphosmethyl diazinon	3 oz. W.P. or 2 oz. E.C. per 50 gal. transplant water 4 oz. per 50 gal. transplant water		6 fluid oz. transplant water per plant.
Aphid (NHE-47) Thrips (NHE-48)	All season	azinphosmethyl dimethoate malathion mevinphos parathion	¾ 0.3 1 ¼ 0.4	Foliage	When aphids appear, but before leaves begin to curl.
Diamond-back moth larva; imported cabbage worm; cabbage looper (NHE-45)	All season	bacillus thuringiensis[4] Fundal Galecron methomyl naled parathion with endosulfan[3]	See rates on label 0.5 0.5 0.45-0.9 1 ½ 1	Foliage	When small worms first appear, and about every 5 to 7 days thereafter. Thorough spray coverage of foliage is important. Fundal and Galecron control only the egg stage plus newly hatched worms.
Cutworm	At planting	trichlorfon toxaphene	1 1½-2	Soil	At planting, at base of plant or as needed when damage first occurs.
Flea beetle and leafhopper	All season	carbaryl	1½	Foliage	As needed.

[1] Root crops such as radishes, turnips, carrots, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.
[2] Maggots are resistant to aldrin, dieldrin, and diazinon in some areas of Illinois.
[3] When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.
[4] No time limitations.
Note: E.C. = emulsion concentrate; W.P. = wettable powder.

COLLARDS, KALE, LETTUCE, SPINACH, SWISS CHARD

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Aphid (NHE-47)	All season	diazinon dimethoate mevinphos naled parathion	½ 0.3 ¼ 1 0.4	Foliage	As needed.
Cutworm	On seedling plants	toxaphene trichlorfon	1½ 1	Base of plant and soil	When first damage appears.
Leafhopper	All season	carbaryl dimethoate malathion	1½ 0.3 1	Foliage	When first leafhoppers appear and as needed.
Caterpillar (NHE-45)	All season	bacillus thuringiensis[2] naled parathion with endosulfan[1]	See rates on label 1 ½ 1	Foliage	When small worms first appear and every 5 to 7 days thereafter.
Leaf miner	All season	diazinon dimethoate parathion	½ 0.3 0.4	Foliage	When first miners are observed.
Flea beetle	All season	carbaryl rotenone	1 ¼	Foliage	As needed.

[1] When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.
[2] No time limitations.

BEANS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Seed maggot (NHE-27)	All season	dieldrin[1] lindane[1]	Manufacturer's directions	Seed	At seeding.
		diazinon 50% W.P.[1]	3/5 oz./bu.	Seed	Treat seed no longer than 3 months before planting.
		phorate granules	1½	Soilband	Place on either or both sides of row at planting but not in contact with seed.
Bean leaf beetle (NHE-67)	Early and late season	carbaryl malathion	1 1	Foliage	When feeding first appears and weekly for 2 or 3 applications as needed.
Leafhopper (NHE-22) and plant bug (NHE-68)	All season	carbaryl dimethoate malathion	1 0.3 1	Foliage	Before plants become yellow and stunted. Repeat applications at weekly intervals as necessary.
		phorate granules	1½	Soilband	As for seed maggot.
Mexican bean beetle	Midseason and late season	carbaryl malathion	½ 1	Foliage	When occasional leaves show lacework feeding.
		phorate granules	1½	Soilband	As for seed maggot.
Aphid (NHE-47)	All season	dimethoate endosulfan malathion	0.3 ½ 1	Foliage	Usually applied when a few aphids can be found on each plant, but before leaves begin to curl and deform.
		phorate granules	1½	Soilband	As for seed maggot.
Blister beetle (NHE-72)	Midseason and late season	carbaryl	1½	Foliage	As needed.
Corn earworm (NHE-33) Corn borer	Late season	carbaryl parathion	1½ ½	Foliage	As needed, but usually after September 1. Worms may be present before bloom.
Mites	Midseason and late season	dicofol dimethoate malathion	0.4 0.3 1	Foliage	As needed, but especially during drouthy periods particularly if carbaryl has been used on crops.
		phorate granules	1½	Soilband	As for seed maggot.

[1] No restrictions when used as recommended.

CUCUMBERS AND OTHER VINE CROPS[1]

Insect	Time of attack	Insecticide[2]	Lb. of active ingredient per acre	Placement	Timing of application[2]
Striped and spotted cucumber beetles (NHE-46)	Seedling to mature plants	carbaryl parathion	1 ½	Foliage	When beetles first appear; as often as necessary thereafter.
Aphid (NHE-47)	All season	diazinon dimethoate malathion parathion	½ 0.3 1 ½	Foliage	When aphids become noticeable.
Squash bug (NHE-51)	All season	parathion trichlorfon[3]	½ 1	Foliage	Do not apply until first eggs are found hatching (about June 15 to July 15).
Leafhopper	July-August	malathion dimethoate	1 0.3	Foliage	As needed.
Squash vine borer	June-September	carbaryl	1	Base of stem for 3 ft	Weekly applications when vines begin to run—usually 5 applications.
Pickle worm	August-September	carbaryl	1	Foliage	Weekly applications, beginning in late August.
Mites	July-September	dicofol malathion parathion	½ 1 ½	Foliage	As needed.
Cutworm (NHE-77)	April-June	carbaryl toxaphene	2 1½-2	Base of plants	As needed.

[1] Pumpkins should not be grown on soil that has been treated with aldrin, dieldrin, or heptachlor the preceding year.
[2] Spray vine crops with insecticide only late in the day after blossoms have closed to reduce bee kill.
[3] Pumpkin is the only vine crop for which trichlorfon should be used for squash bug control. Apply only once per season.

TOMATOES, PEPPERS, EGGPLANT

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cutworm (NHE-77)	Early and midseason	carbaryl toxaphene trichlorfon	2 3 1	Base of plants or foliage	As needed.
Flea beetle	May-June	carbaryl rotenone	2 0.2-0.4	Foliage	Apply every week as long as needed.
Aphid (NHE-47)	May-July	diazinon dimethoate malathion parathion	¼ 0.3 1 0.4	Foliage	As needed, but before leaves curl.
Corn earworm Corn borer	July-September; occasionally in June	carbaryl toxaphene methomyl[2]	2 2 .45-.9	Foliage	Add to weekly applications of fungicide sprays beginning at first fruit set. If spraying is infrequent, use 6 lb. of toxaphene.
Hornworm	July-September	carbaryl trichlorfon	2 1	Foliage	When first small worms appear.
Mites	July-September	carbophenothion dicofol malathion parathion	1 ½ 1 0.4	Foliage	As needed.
Russet mite	July-September	parathion sulfur dust[1] sulfur spray[1]	0.4 10 10	Foliage	As needed.
Blister beetle (NHE-72)	June-September	carbaryl parathion toxaphene	1½ ¼ 2	Foliage	As needed.
Fruit fly and picnic beetle	August-October	diazinon spray diazinon granules	½ 1	Foliage	When flies or beetles first appear.
		pyrethrin dust[1]	1	Foliage	Apply to hamper immediately after it is filled.

[1] No limitations on use.
[2] Use cleared only on tomatoes, not on peppers or eggplant.

ASPARAGUS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Asparagus beetle (NHE-49)	Early and mid-season on spears and ferns	carbaryl[1] malathion[1] rotenone[1]	1½ 1 0.2-0.4	Spears and ferns Spears	As needed, not more often than every 3 days. As needed.

[1] One-day restriction between last application and harvest.

SWEET CORN

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Soil insects (NHE-26, 27, 43)	April-August	diazinon dyfonate phorate	1 1 1	Row	Apply on soil surface behind planter shoe and ahead of press wheel.
Cutworm (NHE-38)	April-June	carbaryl[1] carbaryl bait toxaphene	2-3 1 3	Base of plants	When first damage appears.
Flea beetle (NHE-36)	April-July	carbaryl[1]	1½	Foliage	As necessary.
Japanese beetle (NHE-32)	July-September	carbaryl[1]	1	Ear zone	As necessary.
Corn borer	June-September	carbaryl spray, dust,[1] or granules diazinon granules	2 1½	Foliage	Make first application when tassel ratio is 30 to 40. Repeat every 4 to 5 days as long as field has 20 or more unhatched egg masses per 100 plants.
Corn earworm[2] (NHE-33)	June-September	carbaryl[1] Gardona methomyl	2 1½ 0.45	Ear zone	Market corn: At first silk and every 2 to 3 days for 5 to 8 applications. On very early or late planted corn, treatment may be necessary before silking when eggs are being laid on stalks and flag leaves. Canning corn: At 30 to 50% silk and every 3 days thereafter until corn is within 1 week of harvest.
Sap beetle (NHE-10) Picnic beetle	July-September	carbaryl[1] diazinon malathion parathion	2 1 1 ½	Foliage	When adults first appear in field; usually between pollen-shedding and silk-drying.
Corn leaf aphid (NHE-29)	July-September	malathion parathion	1 ½	Foliage	As needed to produce attractive ears for fresh market.

[1] During pollen shed, apply carbaryl as late in the day as possible (preferably after 4 p.m.) to reduce bee kill.
[2] Addition of 0.5 to 0.75 pound of parathion to carbaryl improves earworm control.

ONIONS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Onion maggot (NHE-50)	All season	diazinon W.P. ethion W.P.	½-1 for 40-50 lb. of seed 1 for 40-50 lb. of seed	Seed	Seed treatment for set onions only. Use lighter dosage of diazinon on sandy, highly mineral soils.
		Dasanit granules diazinon granules ethion granules	1 ½-1 ½-2	Furrow	Use 1 lb. active ingredient per acre for rows 12″ apart; ¾ lb. for rows 18″ apart; ½ lb. for rows 24″ apart. Up to twice these amounts are needed for ethion on muck soils. Do not use Dasanit on green onions.
		diazinon	2	Broadcast	Preplanting; disk into upper 1 to 2 inches of soil. Supplement with foliage spray below.
		diazinon malathion	⅓ 1	Foliage	Supplemental to soil treatment. Make first application when first adult flies are seen; make another 1 week later. From then on only as necessary.
Thrips (NHE-48)	Midseason and late season	diazinon malathion	½ 1	Foliage	When injury first appears and every 10 days as necessary.

POTATOES[1]

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Flea beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 ½ 1	Foliage	When first damage appears on leaves, and repeat as needed.
Colorado potato beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 ½ 1	Foliage	As needed.
Potato leafhopper (NHE-22)	May-July	carbaryl dimethoate endosulfan spray endosulfan dust	1 0.3 ½ 1	Foliage	Weekly applications when leafhoppers first appear
		phorate granules	2 to 3	Soilband	Place on either or both sides of row at planting but not in contact with seed. Use lower rate on sandy soils and heavier rate on heavy soils. Do not use on muck soils.
Aphid (NHE-47)	All season	dimethoate endosulfan spray endosulfan dust malathion parathion	0.3 ½ 1 1 ¼	Foliage	As needed.
		phorate granules	2 to 3	Soilband	As for leafhoppers.
Blister beetle (NHE-72)	All season	carbaryl toxaphene	1½ 2	Foliage	As needed.
Wireworm (NHE-43)	All season	phorate granules	2 to 3	Soil	Preplanting, disk in; or use as soilband at planting.
White grub (NHE-23)	All season	phorate granules	3	Soil	Preplanting, disk in; or use as soilband at planting.
Grasshopper (NHE-74)	July-September	carbaryl toxaphene	¾ 1½	Foliage	As needed, control in fence rows, roadsides, ditch banks, etc., before migration.

[1] Potatoes should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

GREENHOUSE LETTUCE

Insect	Insecticide[1]	Dosage and formulation	Application
Aphid	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Garden fleahopper	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Whitefly	tepp aerosol	1 lb. 5% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Armyworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Cabbage looper Cutworm Sowbug	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

[1] See page 2 for limitations between application and harvest.

GREENHOUSE TOMATOES

Insect	Insecticide[1]	Dosage and formulation	Application
Aphid	endosulfan aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Whitefly	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
	naled vapor	5 oz. of 4% E.C. per 50,000 cu. ft.	Apply on steampipes.
	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Russet mite Thrip		Use malathion or parathion aerosol as suggested for aphid and whitefly.	
Armyworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Cabbage looper Cutworm Tomato fruitworm	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

[1] See page 2 for limitations between application and harvest.

FOR ADDITIONAL INFORMATION

Leaflets describing the life history, biology, and habits of some of the insects mentioned can be obtained from the offices of county extension advisers or by writing to Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801. These are indicated by an NHE number in the tables.

Other circulars on insect control are:

Circular 898 — Insect Control for Livestock and Livestock Barns;
Circular 899 — Insect Control for Field Crops;
Circular 900 — Insect Control by the Homeowner;
Circular 1004 — Pest Control in Commercial Fruit Plantings

These can be obtained from the above offices or from the College of Agriculture, Urbana.

FOR YOUR PROTECTION

Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
6. Wash out and then bury, burn, or haul to refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops or onto bee hives.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

7M—12-71—19989

1972 Suggested Insecticide Guides

Insect Control for LIVESTOCK AND LIVESTOCK BARNS

Livestock producers must follow a sound program of pest control if they are to attain maximum income for their farming investment. Flies, lice, mites, ticks, and grubs irritate animals and some of them suck their blood. This reduces meat, milk, and egg production. On occasion, individual animals actually have been killed by attacks of large numbers of pests like horse flies, lice, and mites. Several of these pests can transmit diseases such as anaplasmosis and pink-eye from animal to animal. Thus losses from these pests each year cost Illinois farmers millions of dollars. A livestock producer does not need to share his profits with these insects. They can be readily controlled and in many cases eradicated.

In the following charts only the safest, most effective insecticides are suggested for each specific insect on each type of livestock. Other insecticides that may have label approval for use on livestock are not included because they are less effective or more toxic or present potential residue problems. Blank spaces in the table of limitations (back cover) mean that we do not suggest the insecticide for that specific purpose in Illinois.

In using insecticides read the label carefully and follow all instructions. Do not exceed the rates suggested; observe the interval between application and slaughter and apply only to those animals for which use has been approved. Keep a record of the insecticide used, the trade name, the percentage of active ingredients, the dilution, rate of application, and dates of application. If you are ever questioned, you have the records.

Most of the insecticides are suggested for use as emulsion concentrates since these are the easiest formulations to handle. However, wettable powders can be substituted for emulsion concentrates providing the finished spray is agitated.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations (back cover) the common names are listed first. Should the trade name be more commonly used, it is listed in parentheses with the common name. Throughout the tables of suggested insecticides on pages 2 and 3, however, only the common name is used where there is one. In case of question, refer to the table of limitations.

These suggestions are printed annually. Be sure you have the current year's issue. Labels may be cancelled and the product removed from the market at any time. New labels may be granted. We have attempted to anticipate any further label changes, but there still may be an occasional change. It is imperative that you check with your local county extension adviser if you are not sure about the insecticide you plan to use. We will make announcements of label changes through the news media in an attempt to keep you up to date.

Suggestions for use of insecticides, effective from a practical standpoint, are based on available data. Rainfall, temperature, and many other factors affect efficiency of insecticides. Report the details of control failures to us.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Fact sheets and Circular 925, Insect Pests of Cattle, describing the life history, biology, and habits of most of the insects mentioned, can be obtained from the offices of county extension advisers or by writing to Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801. These fact sheets are indicated by an NHE number in the tables.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;
Circular 899 — Insect Control for Field Crops;
Circular 900 — Insect Control by the Homeowner;
Circular 936 — Pest Control in Commercial Fruit Plantings.

These can be obtained from the same offices.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 898 Urbana, Illinois, December, 1971

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
JOHN B. CLAAR, *Director*, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

(18M—12-71—19988)

DAIRY CATTLE, BEEF CATTLE, SWINE, AND SHEEP

(Refer to table of limitations on back page before using insecticides)

	Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply
Dairy Cattle	Lice and mange (NHE-18)	crotoxyphos E.C., 1.1 lb. per gal.	6 pt.	1–2 gal. per animal. Spray entire animal to saturation. Make 2 treatments 14 days apart.
Pastured cattle only	Face flies[4] (NHE-106) Horn flies[4] (NHE-59) Stable flies[5] (NHE-61)	crotoxyphos E.C., 1.1 lb. per gal.	2 qt. per 3 gal. water	1–2 oz. per animal; 2–4 times per week.[2]
		crotoxyphos E.C., 1.1 lb. per gal.	7½ gal.	1–2 pt. per adult animal per week.[2]
		crotoxyphos 2.0% O.		1–2 oz. per animal; 2–4 times per week.[2]
	Horn flies[4] Stable flies[5]	dichlorvos 1.0% O.[1]		1–2 oz. per animal daily.[2]
		pyrethrin 0.1% + synergist O.[1]		
	Horse flies (NHE-60)	pyrethrin 0.5% + synergist O.[1]		2 oz. per animal 3 times per week.[2]
		pyrethrin 1% + synergist E.C.	10 gal.	1–2 qt. per animal every 3 days.[2]
	Horn flies only	crotoxyphos 3.0% D. or 1.0% O. coumaphos 5.0% D. or 1.0% O. dichlorvos 0.25% O.	In dust bags or face and back oilers	Use only in exits of milk parlors or barns. Apply daily.
Beef Cattle	Lice and mange (NHE-18)	lindane 20% E.C.	1½ pt.[3]	1–2 gal. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.
		lindane 12.4% E.C.	1 qt.[3]	
		malathion 50–57% E.C.	3 qt.	
Pastured cattle only	Face flies[4] (NHE-106) Horn flies[4] (NHE-59) Stable flies[5] (NHE-61)	crotoxyphos E.C., 1.1 lb. per gal.	2 qt. per 3 gal. water	1–2 oz. per animal; 2–4 times per week from automatic sprayer.
			7½ gal.	1–2 pt. per adult animal per week.[2]
		crotoxyphos 2.0% O.		1–2 oz. per animal; 2–4 times per week from automatic sprayer.
	Horn flies[4] (NHE-59) Stable flies[5] (NHE-61)	toxaphene 60% E.C.	5 pt.	1–2 qt. per animal every 3 weeks. Only partially controls stable flies.[2]
		toxaphene 5% O.		Saturate cloth, canvas, or burlap back oiler every 2 weeks. Only partially controls stable flies and face flies.
	Horse flies (NHE-60)	Use as directed for dairy cattle above.		
	Grubs	The following systemic insecticides, coumaphos, crufomate, and trichlorfon, as sprays provide excellent control of grubs and good control of lice. Use only on *native beef cattle* in herds having a history of grub problems. Treat only those animals between 4 months and 2½ years of age. Apply during August or September in the southern half of the state and in September or October in the northern half of the state.		
Swine	Mange and lice	crotoxyphos E.C. 1.1 lb. per gal.	1 gal. + 7 pt.	2–4 qt. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.
		malathion 50–57% E.C.	3 qt.	
Sheep	Ticks, lice, and scab (NHE-53)	lindane 20% E.C.	1 qt.[3]	Spray entire animal to saturation. Use ½ strength in dipping vat for scab.
		lindane 12.4% E.C.	3 pt.[3]	
		toxaphene 60% E.C.	3 qt.[3]	Spray entire animal to saturation or use in dipping vat for scab.
	Nose bot	crufomate 21% E.C.		Administer 2 cc. per 10 lb. of body weight as a drench.

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder, D. = dust.

[1] The same dosage of a water-base spray may be used.

[2] Spray head, back, sides, belly, and legs carefully. Start treatments in June.

[3] Add 2 pounds of detergent per 100 gallons of spray for better wetting effects.

[4] Place cattle in confinement to avoid attack by face flies and horn flies.

[5] Remove decaying straw, hay, and feed from barns and lots, and spread to dry so stable fly breeding will be reduced.

CHICKENS, LIVESTOCK BARNS, AND SHEDS

(Refer to table of limitations on back page before using insecticides)

	Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply
Chickens	Common red mites, bed-bugs, and lice (NHE-54)	carbaryl 80% W.P. (not for lice)	4 oz. per 5 gal. water	Spray roosts, back walls, side walls, and around nests.
		Rabon 50% W.P.	6.5 oz. per 5 gal. water	Spray roosts, back walls, side walls, and around nests.
		coumaphos 25% W.P.	6 oz. per 5 gal. water	Spray roosts, back walls, side walls, and nests.
		malathion 50–57% E.C.	10 oz. per 5 gal. water	
	Northern fowl mites and lice (NHE-54)	carbaryl 5% D.		Apply to litter, 1 lb. per 40 sq. ft., and 1 lb. per 100 male birds.[1]
		coumaphos 0.5% D.		Apply to litter and nests, 1 lb. per 20 sq. ft.; 1 lb. per 100 male birds.[1]
		malathion 4% D.		Apply to litter and nests, 1 lb. per 50 sq. ft.; 1 lb. per 100 male birds.[1]
	Northern fowl mites, common red mites, bed-bugs, and lice (NHE-54)	carbaryl 80% W.P.	4 oz. per 5 gal. water	Spray birds and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		Rabon 50% W.P.	6.5 oz. per 5 gal. water	
		coumaphos 25% W.P.	3 oz. per 5 gal. water	Spray birds, nests and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		malathion 50–57% E.C.	5 oz. per 5 gal. water	
Residual Sprays for Livestock Barns and Sheds[4]	House flies (NHE-16, 88) Stable flies (NHE-61) Other flies, mosquitoes, and gnats	fenthion 45% E.C.	3 gal.	Start treatments in June and maintain good sanitation. Apply 2 gal. per 1,000 sq. ft. or to runoff to ceilings, walls, and support posts, and outside around doors and windows. Lasts about 4–6 weeks.[2]
		diazinon 50% W.P.	16 lb.	Lasts about 2–3 weeks.[2] Apply as for fenthion.
		dimethoate 25% E.C.	4 gal.	Lasts about 3–4 weeks.[2] Apply as for fenthion.
		Rabon 50% W.P.	16 lb.	Lasts about 2–4 weeks.[2] Apply as for fenthion.
		Ravap {Rabon 21% E.C. / dichlorvos 6% E.C.	4 gal.	
		ronnel 24% E.C.	4 gal.	Lasts about 1–2 weeks.[2] Apply as for fenthion.
Space Sprays for Feed Lots and Sheds[4]	House flies (NHE-16, 88) Stable flies (NHE-61)	dichlorvos 22% E.C.	2 gal.	Apply at 5 gal. per acre with mist blower over the top of animals and pens every 3 to 7 days.
	Other flies, mosquitoes, and gnats	naled 37% E.C.[3]	1 gal.	Apply as for dichlorvos.
Baits as Supplements for Livestock Barn and Shed Sprays[4]	House flies (NHE-16, 88)	dichlorvos 22% E.C.	4 oz. per 1 gal. corn sirup and ½ gal. warm water	Apply to favorite fly-roosting areas from tank sprayer as needed to supplement residual spray treatment.
		naled 37% E.C.	2 oz. per 1 gal. corn sirup and ½ gal. warm water	Apply as for dichlorvos.

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder, D. = dust.

[1] The male birds will not require dusting for the control of lice.

[2] Lasting effects are shortened during periods of hot, dry weather.

[3] Temporary stinging of eyes may occur from mist but this is not hazardous.

[4] Good sanitation is the basic step in barn fly control. Remove manure, decaying straw, hay and feed, and spread to dry each week. Insecticides will not cover the sins of poor sanitation.

LIMITATIONS FOR SUGGESTED INSECTICIDES APPLIED TO LIVESTOCK OR IN LIVESTOCK BARNS

(Blank spaces in the table denote that the material is not suggested for that specific use in Illinois)

	Dairy		Beef		Swine		Sheep		Chickens	
	Animals	Barns	Animals	Barns	Animals	Barns	Animals	Barns	Birds	Barns
carbaryl (Sevin)	...	...	...	...	...	...	...	...	E, I	E, I
coumaphos (Coral)	B, D	...	B, D, K	...	...	...	...	...	I	I
crotoxyphos (Ciodrin)	B, D	...	B, D	...	B, D	...	...	...	...	...
crufomate (Ruelene)	...	...	B, A, K, D	...	...	...	L, M	...	...	...
diazinon	...	H, D	...	H, D	...	H	...	H	...	H
dichlorvos (DDVP) (Vapona)	B, D	C, J	...	C, J	...	C, J	...	C, J	...	C, N
dimethoate (Cygon)	...	H, D	...	H, D	...	H	...	H	...	H
fenthion (Baytex)	...	H, D	...	H, D	...	H	...	H	...	H
lindane	...	...	B, G, K	...	...	...	B, G	...	...	...
malathion	...	...	B, D	...	B	...	...	...	I	I
naled (Dibrom)	...	C, N	...	C, J	...	C, J	...	C, J	...	C, N
pyrethrin	B	...	B	...	...	...	...	...	...	...
Rabon	...	H, D	...	H, D	...	H	...	H	I, O	I
Ravap	...	H, D	...	H, D	...	H	...	H	...	...
ronnel (Korlan)	...	H, D	...	H, D	...	H	...	H	...	I
toxaphene	...	...	B, F, K	...	...	...	B, F	...	...	...
trichlorfon (Neguvon)	...	...	B, D, L, K	...	...	...	...	...	...	...

A. Do not apply within 28 days of slaughter. Do not apply repeat applications within 28 days.
B. Do not contaminate feed, water, milk, or milking equipment.
C. As a bait. Do not apply within reach of animals or in milk rooms. Do not contaminate feed, water, milk, or milking equipment.
D. Do not apply in conjunction with the feeding of phenothiazine or organophosphate insecticides.
E. Do not apply within 7 days of slaughter and do not treat nesting material. Do not repeat within 4 weeks.
F. Do not apply within 28 days of slaughter.
G. Do not spray within 30 days of slaughter. Do not dip within 60 days of slaughter.
H. When used as a spray, remove animals before treating barn and cover feed and watering troughs. Do not use in milk rooms. Do not apply to animals.
I. Gather eggs before treatment and do not contaminate feed and water.
J. As a space spray; may be applied with animals present, but avoid direct application to exposed feed and water. Do not apply in conjunction with the feeding of phenothiazine or the feeding or use as animal or shelter treatments of organophosphate or carbamate insecticides.
K. Do not treat cattle less than 4 months old or pigs before weaning. Do not treat sick or stressed animals.
L. Do not apply within 14 days of slaughter.
M. Do not drench sick, weak, or overheated animals; lambs under 30 pounds; animals being fed in confinement; or pregnant animals within one month of lambing.
N. As a space spray; do not apply when dairy cattle or poultry are in building and avoid direct application to exposed feed and water.
O. Do not repeat more often than every 14 days. Do not apply to birds if used on walls for fly control.

FOR YOUR PROTECTION

Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet or room.
6. Wash out and bury or burn empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies. Do not allow treated animals in fish-bearing waters or other water supplies until the spray has dried.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops and onto beehives.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray when weather conditions favor drift.
15. Observe all precautions listed on the label.

1972 Suggested Insecticide Guides

Insect Control for FIELD CROPS

Insects and related pests play a major role in field crop production in Illinois. Although agronomic practices developed during the past century have reduced the importance of many insect pests, a large number of others, including several new invaders, have continued to threaten grain and forage production. Agronomic practices such as certain tillage operations, destruction of crop residues, selection of resistant hybrids, adjustment of planting dates, rotation of crops, etc., if used properly, still serve to suppress insect populations. Where possible, these practices continue to be used to provide more balanced insect control.

Practical applications of many insect-control techniques continue to be thoroughly investigated. Such control methods as insect sterilization, release of insect parasites, attractants for insect baits and traps, propagation and dissemination of insect disease organisms, as well as the use of insecticides, are being vigorously pursued. Despite the most optimistic reports, however, it is readily apparent that insecticides will be an important part of pest management for many years to come.

Certain precautionary steps should be taken when handling insecticides. Some of the insecticides suggested in the publication can be poisonous to the applicator. The farmer is expected to protect himself, his workers, and his family from undue or needless exposure.

When using insecticides, apply all the scientific knowledge available to insure that there will be no illegal residue on the marketed crop. Such knowledge is condensed on the label. Read it carefully and follow the instructions. But the label should be recent and not from a container several years old. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest; and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, dilution, rate of application per acre, and the date or dates of application.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. Should the trade name be more commonly used, it is in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

These suggestions for the use of insecticides are based on available data. Soil texture, soil pH, rainfall, slope of the field, wind velocity at planting, and other unpredictable factors affect the efficiency. Please report control failures and the circumstances associated with such failures to us.

Requested label clearances for a few uses of some insecticides, carriers, and solvents are uncertain for 1972, since many requests have not yet been officially cleared. Anticipating needed changes in labeling, we began modifying these suggested uses a few years ago. We have attempted to anticipate any further label changes in 1972, but an occasional use may still be canceled. Be sure to check with your county extension adviser if you are in doubt about the insecticide you plan to use. We will make announcements of label changes through the news media to keep you up to date.

This circular lists only suggested uses of insecticides for the control of many Illinois field crop pests, and is not designed to discuss other methods of control. Fact sheets discussing non-chemical control methods, descriptions of specific insects, and their life history and biology are designated as NHE numbers in this circular. This additional information can be obtained from the county extension adviser or by writing to the Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801.

Other Suggested Insecticide Guides are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 900 — Insect Control by the Homeowner;

Circular 1004 — Pest Control in Commercial Fruit Plantings.

These suggestions are revised annually by entomologists of the College of Agriculture and the Illinois Natural History Survey.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 899 Urbana, Illinois, December, 1971

SPECIAL SUGGESTIONS AND MAJOR CHANGES FOR 1972

Federal Laws

Registration of pesticides is now the duty of the U.S. Environmental Protection Agency, not the USDA. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is being revised. If passed, this Act requires that all pesticides be listed either for general use or for restricted use, and that all persons have a private or commercial license to apply the restricted-use ones. Farmers who apply restricted pesticides even on their own land would need to have a private applicator's license.

State Laws

Dairy farms. We recommended in 1965 that several chlorinated hydrocarbons (DDT, aldrin, heptachlor, etc.) not be used or stored on dairy farms. At that time, slight residues of the products could be found in milk produced where these products had been used for some years. The illegal amounts present in milk were not of public-health significance.

Most dairy farmers discontinued the use and storage of the several chlorinated-hydrocarbon products on their farms, but a few farmers did not. Occasional milk-residue problems continued to occur, and the milk was barred from the market. In 1971, the Interagency Committee on Pesticides disapproved the use or storage of certain insecticides on dairy farms.

The Illinois Department of Public Health has therefore announced that it is illegal for dairymen to apply or store the chlorinated-hydrocarbon insecticides — aldrin, chlordane, dieldrin, endrin, lindane, or heptachlor — on their farms, except for use in the farm residence. Previously the use of DDT was prohibited except by permit from the Illinois Departments of Agriculture or Public Health.

Methoxychlor and toxaphene can still be used on dairy farms for certain crops. They have a lower rate of storage in the fat of animals and are eliminated more rapidly from the animal's body than the other compounds. To avoid problems with residues in milk, however, dairymen must apply them carefully and exactly according to the directions on the label.

Applicator Licensing Revisions

Two types of licenses will be issued to those who apply pesticides commercially in Illinois. An applicator's license is required for those who determine the pesticide to be used, the rates, importance of wind velocity, crops to be sprayed, etc. The operator's license will be required for those who actually operate the machine but do not make decisions about rates and similar matters.

This revision broadens the law to include those who apply landscape and turf pesticides commercially. All governmental employees who apply pesticides must also be licensed.

For details, write to the Department of Agriculture, Division of Plant Industry, Springfield, Illinois 62700.

Changes in Suggestions for 1972

Corn insect complex in soil. Many farms in Illinois have no major corn-insect problem, and a seed treatment of diazinon at planting time is sufficient. This will protect against attack by seed-corn beetles and seed-corn maggots during germination. Fewest seeding-rate problems will occur when the correct amount of diazinon seed-treater is premixed with the seed just before it is put in the planter box.

If other insect problems are anticipated, the following insecticides — applied as a 7-inch band on the soil surface at planting — may be helpful:

Dasanit	1 pound actual per acre
diazinon	1½ pounds actual per acre
Dyfonate	1 pound actual per acre
phorate (Thimet)	1 pound actual per acre
prophos (Mocap or Jolt)	1 pound actual per acre

We do not recommend any planting-time insecticide applications for the control of black cutworms. Apply baits or sprays at the first signs of a black-cutworm infestation. Early treatment is imperative.

Dyfonate controls garden symphlans. Other insecticides used for rootworm control may also give practical protection.

Rootworm complex. Three species of corn rootworms - northern, southern, and western — are present each year in Ill nois. The southern corn rootworm adults migrate into Illino each year. The northern and western corn rootworms ove winter as eggs in the soil of Illinois cornfields. The adults feed on corn silks during August and September when they lay eggs in the soil. Fields that had 5 or more of these rootworm beetle per cornstalk in August, 1971, may have a severe rootworm problem in 1972. Fields with fewer beetles may have a light t severe infestation in 1972.

If a very severe rootworm infestation is anticipated, 1 pound of carbofuran (Furadan) per acre will provide the best result If light to moderately severe infestations are expected, any of of the following insecticides will provide practical control.

	Pounds actual per acre (40-inch rows; check label for other row spaces)	
	Planting time	*Cultivation*
Bux	1	1
carbofuran (Furadan)	¾	¾
Dasanit	1	1
Dyfonate	1	1
phorate (Thimet)	1	1
prophos (Mocap or Jolt)	1	...

If you plan to use insecticides for cultivation-time treatments, use a seed-treater at planting.

Piles of granules may accumulate when you stop your planter-applicator. To avoid loss of livestock and wildlife, these piles should be scattered and covered. If you see granules in the row, drag a chain or use a cover wheel behind the press wheel to completely cover granules.

European corn borer. Phorate has been labeled for the control of first-generation corn borers. We are not encouraging its use for corn-borer control, but leftover supplies of phorate from corn-rootworm control can be used for this purpose rather than to store them over the winter, when they are accident hazards. As we read the regulation, phorate can be used at planting with one additional application — but not within 30 days of grazing or cutting for forage. Either a cultivation treatment for rootworms or a corn-borer application later would be acceptable but not both.

In our experience, ¾ to 1 pound per acre of carbofuran a corn-planting time will not give enough control of first-generation corn borers to measure; much higher but illegal dosages will control first-generation corn borers to some extent.

Stored-Grain Insects

Resistance of the Indian meal moth to malathion has been confirmed in Illinois. The malathion wheat-dust protectant formulation has been dropped from the 1972 suggested recommendations. Unsatisfactory control is expected to occur in about 10 to 20 percent of the cases this year and will increase next year. However, malathion is effectively controlling the other stored-grain insects (about 12 important ones).

Substitute pyrethrin plus piperonyl butoxide spray for malathion in controlling Indian meal moth on stored grains. Repeated monthly treatments will probably be needed. Although not registered for use, dichlorvos (Vapona) resin strips in experiments have controlled infestations of Indian meal moths.

Clover and alfalfa pests. Beneficial insects often develop in clover and alfalfa fields. When the hay crop is cut, these beneficial insects move to other crops in search of insects as their food. Lady beetles, flower flies, aphis lions, big-eyed bugs, insidious flower bugs, and others that feed on other insects are commonly found in hay crop fields. If your hay supply is critical, follow the recommendations for insecticide use on these crops. If you can afford minor yield losses, manipulate cutting dates if possible to avoid insecticide application. It is better to use insecticides, however, than to allow the pest to kill the crop.

LIMITATIONS IN DAYS BETWEEN APPLICATION OF THE INSECTICIDE AND HARVEST OF THE CROP AND OTHER RESTRICTIONS ON THE USE OF INSECTICIDES FOR FIELD CROP INSECT CONTROL

(Blanks in the table denote that the material is not suggested for that specific use in Illinois)

	Field corn				Sorghum	Forage crops			
	Seed and soil	Grain	Ensilage	Stover		Alfalfa	Clover	Pasture	Seed
azinphosmethyl (Guthion)[1]	...	...	...	...	...	16,E	16,E	...	16,E
Bux	A	...	...	...	...	...	...	...	...
carbaryl (Sevin)	...	0	0	0	21	0	0	0	...
carbofuran (Furadan)[1]	A	...	...	...	...	...	...	...	...
Dasanit	A	...	...	...	...	...	...	...	...
demeton (Systox)[1]	...	...	...	...	...	21,E	21,E	...	21,E
diazinon	A	...	10	10	7	7	7	...	7
Dyfonate[1]	A	...	...	...	...	...	...	...	...
Gardona	...	5	5	5	...	...	...	...	...
Imidan	...	...	...	...	...	7,E	...	...	...
malathion	...	5	5	5	7	0	0	0	0
methoxychlor	...	...	...	...	...	7	7	7	7
mevinphos (Phosdrin)	...	...	...	...	3	...	...	...	...
naled (Dibrom)	...	...	...	...	...	4	...	4	4
methyl-parathion[1]	...	...	...	...	...	15	15	15	15
parathion[1]	...	...	...	...	...	...	...	...	...
phorate (Thimet)[1]	A	B	B	B	...	...	...	...	...
prophos (Mocap or Jolt)	A	...	...	...	...	...	...	...	...
toxaphene	...	A	C	C	...	...	...	...	D
trichlorfon (Dylox)	...	28,H	28,H	28,H	...	...	...	...	...

	Barley		Oats		Rye		Wheat		Soybeans	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Forage
azinphosmethyl (Guthion)[1]	...	...	...	...	...	...	...	...	21	D
carbaryl (Sevin)	...	...	...	...	...	...	...	...	0	0
carbophenothion (Trithion)[1]	...	...	...	...	...	...	...	...	7	D
demeton (Systox)[1]	45,F	21,F	45,F	21,F	...	...	45,F	21,F	...	...
disulfoton (Di-Syston)[1]	...	...	...	...	...	...	...	G	...	...
malathion	7	7	7	7	7	7	7	7	0	0
parathion[1]	15	15	...	...	...	...	15	15	...	...
phorate (Thimet)[1]	...	...	...	...	...	...	...	G	...	...
toxaphene	A	D	A	D	A	D	A	D	21	D
trichlorfon (Dylox)	21	3	21	3	...	...	21	3	...	...

[1] Sprays to be applied only by experienced operators wearing proper protective clothing.

A. No specific restriction when used as recommended.

B. Do not apply after tasseling.

C. Do not feed treated forage to dairy animals. Do not feed sprayed forage or granular-treated corn silage to livestock fattening for slaughter nor granular-treated stover within 28 days of slaughter.

D. Do not feed treated forage to dairy animals, livestock fattening for slaughter, or poultry.

E. Once per cutting.

F. Apply no more than twice per season with at least 14 days between applications.

G. Do not graze treated wheat.

H. Once only per season when plants are 3-12 inches tall.

TOXICITY AND PERSISTENCY RATINGS FOR INSECTICIDES[1]

	Toxicity to			Persistency as a residue		Toxicity to			Persistency as a residue
Insecticide	Warm-blooded animals	Fish	Honey bees[2]		Insecticide	Warm-blooded animals	Fish	Honey bees[2]	
azinphosmethyl	1	...	1	3	methoxychlor	6	1	4	4
carbaryl	4	6	1	4	methyl parathion	1	6	1	6
carbophenothion	1	...	3	2	naled	3	2	5	6
demeton	1	3	3	3	parathion	1	2	1	6
diazinon	3	2	2	3	phorate	1	...	3	4
Gardona	6	1	2	1	toxaphene	3	1	5	1
Imidan	3	...	...	...	trichlorfon	4	6	4	5
malathion	5	3	1	3					

[1] A rating of 1 indicates high toxicity or persistence of residue; a rating of 6 indicates low toxicity (relatively safe) and little persistency.

[2] When applied at the optimum time to avoid bee-kill.

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Corn rootworms[2] (NHE-26)	June-August	Bux carbofuran Dasanit Dyfonate phorate prophos	1 ¾ 1 1 1 1	Soil surface	As 7-inch band ahead of planter press wheel. For severe infestations, 1 pound of carbofuran is most effective. Basal treatments during cultivation with Bux, carbofuran, Dasanit, Dyfonate or phorate are effective.
Seed-corn maggot Seed-corn beetle	At germination	diazinon	See page 3	On seed	For band treatment, see wireworm.
Wireworm (NHE-43) White grub (NHE-23) Grape colaspis (NHE-25)	May-July May-October May-July	Wireworms may be partially controlled by Dasanit, diazinon, Dyfonate, phorate (Thimet), or prophos. Along with these five, carbofuran will give partial control of grape colaspis and white grubs. For rates, see page 2.			
Sod webworm (NHE-42)	May-June	carbaryl	1	At base of plant	At time of initial attack.
Cutworms (NHE-38)	May-June	carbaryl bait	1	Broadcast	When cutting starts. Repeat if needed.
		carbaryl plus molasses or Tractum	1 to 2	Direct at base of plant	Same as above.
		trichlorfon	1	At base of plant	Same as above. One application only permitted.
Billbugs (NHE-37)	May-June	carbaryl diazinon	1 1	At base of plant	As needed.
Garden symphylan	May-July	Dyfonate	1 in row at planting 2 broadcast before planting		If suspected as a problem, use dyfonate for soil insect control.
Grasshopper (NHE-74)	June-September	carbaryl toxaphene	¾ 1½	Over row as spray	As needed. For ensilage corn use carbaryl, diazinon, or malathion.
Flea beetle (NHE-36)	May-June	carbaryl toxaphene	¾ 1½	Over row as spray	When damage becomes apparent on small corn.
Armyworm (NHE-21)	May-June	carbaryl malathion toxaphene trichlorfon	1½ 1 1½ 1	Over row as spray	At first migration or when damage first becomes apparent.
	Late July-August	toxaphene	1½	Broadcast over infested area	When leaves below ear level are consumed and worms eating leaves above ear level.
Fall armyworm (NHE-34)	June; August-September	carbaryl diazinon Gardona toxaphene	1½ 1 1½ 1½	In whorls	Granules preferred when worms deep in whorl. If worms are small and out on leaves, sprays will be satisfactory. When silking (see earworm).
Chinch bug (NHE-35)	June-August	carbaryl	1	Spray at base of plant	At beginning of migration. If applied in adjacent grain, do not harvest small grain.
Thrips (NHE-39)	June	carbaryl	1	On foliage as spray	When severe wilting and discoloration are noticed.
Corn leaf aphid (NHE-29)		diazinon granules phorate granules	1 1	In whorl	Just before tasseling when aphids are appearing on individual plants. Preventive treatment. Not after tassel emerges.
		malathion diazinon	1 1	As a foliage spray	Apply during late whorl to early tassel when 50% of the plants have light to moderate infestations.

FIELD CORN (continued)

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Corn rootworm adults	Late July, early August	carbaryl malathion diazinon	1 1 1	Overall spray or directed towards silk	When silking is not over 50% and there are more than an average of 5 beetles per ear. Only to protect pollination.
Corn borer, first generation	June-July	carbaryl granules diazinon granules	1½ 1	On upper ⅓ of plant and into whorl	When tassel ratio is 30 to 50, and 75% or more plants show recent borer feeding in whorl.
Corn borer, second generation	Mid-August	carbaryl diazinon	As for first generation	From ear upward	At first hatch when there are 1 or more egg masses per plant.
Corn earworm (NHE-33)	July-August	carbaryl Gardona	1½ 1½	Spray ear zone	2 applications at 3- to 5-day intervals, starting at 30-50% silk. 25 gal. of finished spray per acre.

[1] See page 3 for insecticide restrictions. [2] Rotations will control rootworms. To prevent damage from western corn rootworms, rotate corn with some other crop annually. To prevent damage from northern corn rootworms, do not grow corn more than 2 years consecutively in the same field.

SOYBEANS

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Bean leaf beetle (NHE-67)	May-June, August	carbaryl[2] toxaphene[3]	1 1½	On foliage	When leaf feeding becomes severe, but before plants killed or pods eaten.
Clover root curculio adult (NHE-71)	May-June	carbaryl[2] toxaphene[3]	1 1½	On marginal rows	When clover is plowed, beetles migrate to adjacent beans.
Grasshopper (NHE-74)	June-September	carbaryl[2] toxaphene[3]	¾ 1½	On foliage	When migration from adjacent crops begins.
Flea beetle	May-June	carbaryl[2] toxaphene[3]	1 1½	On foliage	Seedlings usually attacked. Treat when needed.
Green clover worm (NHE-75) and webworm (NHE-42)	August	carbaryl[2] malathion	1 1	On foliage	When damage appears and small worms are numerous between blossom and pod fill.
Mites	June-August	carbophenothion[4] azinphosmethyl[4]	¾ ½	On foliage	As needed on field margins and entire field.
Stink bugs	July and August	carbaryl[2] malathion	1 1	To foliage	As needed but when stink bugs are numerous.
Thrips Leafhoppers	June-August	malathion	1	To foliage	As needed.

[1] See page 3 for insecticide restrictions on soybeans.
[2] Carbaryl should not be used at more than 1 lb. per acre. Higher rates may damage plants.
[3] For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.
[4] To be applied only by experienced operators or those wearing protective clothing.

CLOVER AND ALFALFA

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application[2] (See table of limitations)
Alfalfa weevil (NHE-89)	March-June	Imidan azinphosmethyl[3, 4] methyl parathion[3]	1 ½ ½	On foliage	When 25% of the tips are being skeletonized treat immediately; two treatments may be necessary on first cutting; regrowth following first cutting may need protection. By ground, use a minimum of 20 gal. of finished spray per acre (10 gal. on stubble) or 4 gal. by air. Do not apply during bloom. Instead cut and remove hay.
		malathion[5] with methoxychlor	¾ ¾		
		diazinon[5] with methoxychlor	½ 1		
		malathion[6]	1¼		
		methyl parathion[3] azinphosmethyl[3]	½ ½	On foliage	Sprays in November or early March suggested to kill adults and prevent egg laying. This also spares the parasites that later will attack the larvae. Apply after two or three warm days (above 45°F.). Proven method in southern ½ to ⅓ of Illinois. Not yet tried in northern Illinois. *This timing preferred over later spring treatments.*
		malathion[5] and methoxychlor	¾ ¾		
		diazinon[5] and methoxychlor	½ 1		
		Imidan	1		
Clover leaf weevil (NHE-12)	March-April	malathion	1	On foliage	When larvae are numerous and damage is noticeable, usually early to mid-April.
Spittlebug (NHE-13)	Late April, early May	methoxychlor	¾	On foliage	When bugs begin to hatch and tiny spittle masses are found in crowns of plants.
Aphid (NHE-14 and 19)	April-May	demeton[3] diazinon malathion	¼ ½ 1	On foliage	When aphids are becoming abundant and lady beetle larvae and adults, parasites, and disease are slight.
Leafhopper (NHE-22)	Early July	carbaryl methoxychlor	1 1	On foliage	When second-growth alfalfa is 1 to 6 inches high, or as needed.
Garden webworm (NHE-42)	July-August	carbaryl toxaphene[7]	1 1½	On foliage	When first damage appears. Use toxaphene only on new fall seedlings.
Cutworm (NHE-77)	April-June	carbaryl	1½	On foliage	Cut, remove hay, and spray immediately.
Armyworm (NHE-21)	May-June, September	carbaryl malathion	1½ 1	On foliage	Only when grasses are abundant.
Seed crop insects	July-August	toxaphene[7]	1½	On foliage	No later than 10% bloom.
Grasshopper (NHE-74)	June-September	carbaryl diazinon malathion naled	¾ ½ 1 ¾	On foliage	When grasshoppers are small and before damage is severe. When bees are frequenting bloom, do not apply carbaryl. Apply others only late in day.
Sweet clover weevil (NHE-15)	April-May	toxaphene[7]	1½	On foliage	When 50% of foliage has been eaten. New seedlings only.

[1] See page 3 for insecticide restrictions.
[2] Before applying insecticides, be certain to clean all herbicides out of equipment. During pollination, apply very late in day.
[3] To be applied only by experienced operators or those wearing protective clothing.
[4] Water temperature should be above 55°F.
[5] Use no less than these amounts.
[6] Use only when air temperature is above 60°F.
[7] Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.

GRAIN SORGHUM

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Webworm	After heads form	carbaryl diazinon malathion	1½ ½ 0.9	On grain head	Before population reaches 5 larvae per head. Pest usually bad in wet seasons on late planted grain.
Corn leaf aphid	All season	malathion	0.9	Broadcast	Degree of infestation to warrant treatment not determined.
Corn earworm	After heads form	carbaryl	1½	Direct at head or broadcast	When 5 to 10 percent of heads are first infested by small worms.
Midge	August-September	diazinon	1	Direct at head	Late plantings only within 4 days of 90% head emergence.

[1] See page 3 for insecticide restrictions.

STORED GRAIN (Corn, Wheat, and Oats)[1,2]

Insect	Time of attack	Insecticide and dilution[3]	Dosage	Placement	Suggestions (See table of limitations)
Angoumois grain moth (earcorn) (NHE-62)	April-October (Southern ⅓ of Illinois only).	malathion 57% E.C., 3 oz. per gal. water	Apply to runoff	Spray surface and sides May 1 and August 1	Plant tight husk varieties. Store as shelled corn to avoid all but surface damage by angoumois moth.
Meal moths and surface infestations only (NHE-63)	April-October	malathion 57% E.C., 3 oz. per gal. water[4]	2 gal. per 1,000 sq. ft.	Spray grain surface, bin walls, and ceiling	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain. Apply treatments June 1 or July 1 and August 15.
		pyrethrin 6% + piperonyl butoxide 60% E.C., 4½ oz. per gal. water	2 gal. per 1,000 sq. ft.	Spray grain surface	Apply at storage and monthly thereafter during summer months.
General Internal and external feeders (NHE-64, 65) Rice and granary weevils	April-October	malathion 57% E.C., 1 pt. per 3-5 gal. water[5]	3-5 gal. per 1,000 bu.	Spray uniformly as grain is binned	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain. Spray surface grain at storage and again about August 15.
Flat grain beetle Saw-toothed grain beetle Rusty grain beetle Foreign grain beetle Cadelle beetle Flour beetle		liquid fumigant[6]	3-5 gal. per 1,000 bu.	On surface; repeat if necessary	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain. Apply in late July and September in the southern half of Illinois; apply in mid-August in the northern half of Illinois. Use surface treatment of malathion as recommended for meal moths.
		73 mixture[6]	As directed	On surface	(as above)
		phostoxin[6]	180 tablets per 1,000 bu.	Tablets 2 feet apart	(as above)

[1] Corn need not be treated at harvest with a protectant unless it is to be carried over the following summer.
[2] Wheat and oats should be treated if they are to be held for one month or more in storage after harvest.
[3] Use only the grade of malathion labeled for use on stored grain. Malathion vaporizes and is lost rapidly when grain is heat-dried.
[4] On some farms, Indian meal moth resistance to malathion results in failure. Use pyrethrin instead.
[5] Malathion dust no longer suggested because of greater likelihood of failure to control Indian meal moth.
[6] Use with extreme caution. Apply only under calm conditions and when grain temperature is 70°F. or above. Grain should be 8 inches below the lip of the bin and should be leveled before fumigating.

SMALL GRAINS

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Grasshopper (NHE-74)	June-August	toxaphene[2]	1½	On entire plant	Control early while grasshoppers are small.
Chinch bug (NHE-35)	June-July	carbaryl	1	At base of stalk	After grain harvest, treat strip in stubble to protect corn from migrating bugs.
Armyworm (NHE-21)	May-June	malathion toxaphene[2] trichlorfon	1½ 1½ ¾	On foliage	When worms are still small and before damage is done. Do not use malathion on barley or trichlorfon on rye.
Greenbug English grain aphid	May-June	demeton[3] parathion[3]	¼ ¼	On foliage	When needed.
Hessian fly	Sept.-October; April-May	disulfoton phorate	½ ½	In drill row	Use granules in a grass-seeder for susceptible varieties planted early. Do not graze.

[1] See page 3 for insecticide restrictions.
[2] For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.
[3] To be applied only by experienced operators or those wearing protective clothing.

FOR YOUR PROTECTION: Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening, pouring from, or emptying insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked building. Do not store near livestock feeds. Better yet, buy no more pesticide than you will use. This eliminates a pesticide storage and disposal problem.
6. Wash out and bury, burn, or haul to the refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticides.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray or dust when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

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1972 Suggested Insecticide Guide

Insect Control BY THE HOMEOWNER

Much has been said about the effects of pesticides, particularly insecticides, on the health and well-being of the American people. The homeowner, however, is also aware that he is constantly faced with a horde of insects, intent upon destroying his property or making his life uncomfortable. Occasionally he can avoid or reduce the destruction wrought by some pests without using an insecticide, but to control most insects, he must rely on an insecticide. This will provide the satisfactory control that he demands.

By careful use of insecticides, the homeowner can enjoy reasonable freedom from insects without endangering either himself, his family, or his pets. He must recognize, however, that insecticides are designed to destroy one group of animals — insects — and can be harmful to other animals, including man himself, if used with disregard of normal safety precautions. It is up to each insecticide user to handle, apply, and store insecticides safely to reap their benefits without suffering from their dangers. For further information on safe use of pesticides Circular 906 is available from the College of Agriculture at Urbana.

The suggestions in this publication list certain insecticides to control insect pests of food, fabrics, structures, man and animals, lawns, shrubs, trees, flowers, and vegetables. We have tried to suggest only the safest materials that the homeowner needs. Many people prefer to employ the services of a professional exterminator or custom applicator rather than to become involved with selection and application of an insecticide.

The names used in these tables are the common coined chemical names, not the trade names, and as such may not be familiar to you. For instance, the common name for *Cygon* is *dimethoate*. If there is no coined chemical name, the trade name is used but is capitalized.

Requested label clearances for a few uses of some insecticides, carriers, and solvents is uncertain for 1972, since many requests have not yet been officially cleared. Consequently, labels may be cancelled and the product removed from the market at any time. Anticipating this we took a conservative attitude a few years ago and began modifying these suggested uses. We have attempted to anticipate any further label changes in 1972, but there still may be an occasional use cancelled. Be sure to check with your local county extension adviser if you are not sure about the insecticide you plan to use. We will make announcements of label changes through the news media in an attempt to keep you up to date.

Suggestions for use of insecticides, effective from a practical standpoint, are based on available data. Many factors affect efficiency of control. Report details of control failures to us.

In using these tables always read the footnotes before using the insecticides. They list precautions and other pertinent information.

Leaflets on specific insects, their life history, habits, damage, and cultural control methods are available from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois College of Agriculture, Urbana, Illinois 61801. They are indicated in tables by NHE or Circular numbers.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 899 — Insect Control for Field Crops;

Circular 1004 — Pest Control in Commercial Fruit Plantings.

These are available from the county offices or the College of Agriculture at Urbana.

These suggestions are subject to change without notification during the year.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 900 Urbana, Illinois, December, 1971

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

VEGETABLE INSECTS

Insects	Crop	Insecticide	Suggestions
Aphids (NHE-47) Leafhoppers (NHE-22) Mites (NHE-58) Thrips	Most garden crops	malathion	Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web on the underside of leaves; apply insecticide to underside of leaves early before extensive webbing occurs.
Blister beetles (NHE-72) Cutworms (NHE-77) Flea beetles (NHE-36) Grasshoppers (NHE-74) Leafhoppers (NHE-22) Picnic beetles (NHE-40)	Most garden crops	carbaryl	For cutworms, attach collars of paper, aluminum foil, or metal at planting for small numbers of plants, or apply insecticide to base of plants at first sign of cutting. Control grasshoppers in garden borders when hoppers are small. For picnic beetles, pick and destroy overripe or damaged vegetables.
Wireworms (NHE-43) and other soil insects (NHE-23, 27)	Most garden crops	diazinon	When tearing up sod for a garden, apply to soil and rake in before planting.
All cabbage worms (NHE-45)	Cabbage and related crops, salad crops, and leafy vegetables	bacillus thuringiensis[2] carbaryl or malathion	Presence of white butterflies signals start of infestation. Control worms when small. It is almost impossible to raise cole crops in Illinois without controlling these pests.
Hornworms (NHE-130)	Tomatoes	carbaryl	Handpicking usually provides satisfactory control.
Earworms (NHE-33)	Tomatoes and sweet corn	carbaryl	Apply to late-maturing tomatoes 3 to 4 times at 5- to 10-day intervals from small-fruit stage. Apply at fresh-silk stage to early and late corn every 2 days 4 to 5 times.
Colorado potato beetles	Eggplant, potatoes, tomatoes	carbaryl	Apply as needed. Insects usually present only in late May and June.
Potato leafhoppers (NHE-22)	Potatoes, beans	carbaryl or malathion	Apply 3 to 4 times at weekly intervals starting in late May or early June. Late potatoes and beans require additional treatments. Most serious pest of potatoes and beans in Illinois.
Bean leaf beetles (NHE-67)	Beans	carbaryl	Leaves are riddled in early plantings. Apply once or twice as needed.
Mexican bean beetle	Beans	carbaryl	Except for southern Illinois, only a pest of late beans. Apply insecticide to underside of leaves.
Cucumber beetles (NHE-46)	Vine crops	carbaryl or malathion	Apply as soon as beetles appear in spring. When blossoming begins, apply insecticide late in the day so as not to interfere with pollination by bees.
Squash vine borers	Squash	carbaryl	Make weekly applications to crowns and runners when plants begin to vine. Apply late in day.
Squash bugs (NHE-51)	Squash and pumpkins	carbaryl	Apply as soon as small nymphs are seen and as needed. Does not kill large nymphs and mature bugs. Apply late in day.
Corn borer	Sweet corn	carbaryl	Apply 4 times every 3 days to whorl and ear zone of early corn when feeding appears on whorl leaves.

Days to Wait Between Application and Harvest

	Collards, kale, and other leafy crops	Beans	Lettuce	Cabbage and related crops	Sweet corn	Onions	Vine crops[1]	Tomatoes	Pumpkin	Eggplant	Peas	Potatoes
carbaryl	14	0	14	3	0	..	0	0	0	0	0	0
malathion	7	1	14	7	5	3	1	1	3	3	3	0

[1] Only apply insecticide late in the day after blossoms have closed to avoid bee kill. [2] No time limitations.

Amount of Insecticide for Volume of Spray

	1 gal.	6 gal.	100 gal.	Commercial dust
carbaryl (Sevin) 50% W.P.	2 tbl.	¾ cup	2 lb.	5%
malathion 50-57% E.C.	2 tsp.	4 tbl.	1 qt.	4%

Apply 1 ounce of actual diazinon per 1,000 square feet. To do this mix ¼ pint (4 fluid ounces) of 25% diazinon emulsion in enough water to cover 1,000 square feet, usually 2 to 3 gallons of water. Rake into soil.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

FLOWER INSECTS

Insect	Insecticide[1]	Dosage	Suggestions
Ants, soil-nesting wasps, and sowbugs (NHE-17, 79, 93, 111)	Same as for ants under lawn insects on page 5.		
White grubs	Same as for white grubs under lawn insects on page 5.		
Aphids, mealybugs, lacebugs, scales, and white flies (NHE-7, 114)	malathion 50-57% E.C.	2 tsp. per gal. water	Spray foliage thoroughly. Repeat treatments may be needed.
Blister beetles (NHE-72)	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments may be needed.
Cutworms (NHE-77)	diazinon 25% E.C. diazinon 2% granules	6 oz. per 2-3 gal. water 5 lb. per 1,000 sq. ft.	Spray 1,000 sq. ft. soil at base of plants. Do not spray on plant foliage. Small numbers of plants can be protected with collars of paper, aluminum foil, or metal.
Grasshoppers (NHE-74)	carbaryl 50% W.P. malathion 50-57% E.C.	2 tbl. per gal. water 2 tsp. per gal. water	Spray foliage and also adjacent grassy or weedy areas.
Iris borer	dimethoate (Cygon, DeFend) 23.4% E.C. or 25% W.P.	4 tsp. per gal. water	Apply when irises are in bloom, but not on blooms and make only one application. Add a small amount of liquid detergent to spray mix to improve coverage on leaves.
Leaf-feeding beetles	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments if needed.
Leaf-feeding caterpillars	Same as for leaf-feeding beetles		
Plant bugs and leafhoppers	Same as for leaf-feeding beetles		
Slugs (NHE-84)	Metaldehyde		Apply as a bait to soil. Remove old leaves, stalks, poles, boards, and other debris where slugs like to hide and lay eggs.
Spider mites (NHE-58)	chlorobenzilate 25% W.P. dicofol 18.5% E.C.	1 tsp. per gal. water 2 tsp. per gal. water	Pay particular attention to underside of leaves when spraying. Apply 2 or 3 times at weekly intervals.
Springtails	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water	Spray foliage and soil. Apply to soil at base of plants.
Stalk borers (NHE-24)	Same as for leaf-feeding beetles		Spray foliage thoroughly and frequently.
Thrips	Same as for leaf-feeding beetles		Spray foliage carefully.

[1] Do not use oil-base sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of carbaryl foliage sprays may cause mite or aphid infestations to increase and become damaging. Do not use insecticides during full bloom. Do not use dimethoate on chrysanthemums.

Note: E.C. = emulsion concentrate; W.P. = wettable powder. An emulsion concentrate is a chemical pesticide dissolved in a solvent to which an emulsifier has been added. It can then be mixed with water to the desired strength before being used.

FOR YOUR PROTECTION

1. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
2. If you use a bait around or in the home, place it after the children have retired and pick it up in the morning before they get up. Furthermore, place it out of their reach. At present we do not encourage use of baits for insect control.
3. Avoid breathing insecticide sprays and dusts over an extended period. This is particularly true in enclosed areas such as crawl spaces, closets, basements, and attics.
4. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
5. Wear rubber gloves when handling insecticide concentrates.
6. Do not smoke while handling or using insecticides.
7. Leave unused insecticides in their original containers with the labels on them and in locked cabinets.
8. Wash out and bury or burn and haul to the refuse dump empty insecticide containers.
9. Do not leave puddles of spray on impervious surfaces.
10. Do not apply insecticides to fish ponds.
11. Do not apply insecticides near dug wells or cisterns.
12. Observe all precautions listed on the label.

TREE AND SHRUB INSECTS

Insects	Insecticide	Suggestions[1]
Aphids (NHE-7)	diazinon malathion	Spray foliage thoroughly with force. Repeat as needed.
Bagworms (NHE-6)	carbaryl diazinon malathion	Spray foliage thoroughly. Apply June 15. Later sprays are less effective.
Borers (NHE-8)	dimethoate	Spray trunk and limbs thoroughly in late May or early June. Wrap trunks of newly set trees with heavy paper for first two years or until trees are growing vigorously. Provide adequate water and fertilizer for vigorous growth.
Catalpa sphinx	carbaryl malathion	Spray foliage when feeding or worms are first noticed.
Eastern tent caterpillars	Same as for catalpa sphinx	Spray when nests are first noticed.
Elm leaf beetle (NHE-82)	carbaryl	Spray as soon as damage is noticed.
European pine shoot moths and Nantucket pine moth (NHE-83)	dimethoate	Spray ends of branches thoroughly in early June for European species and in mid-May for Nantucket species.
Fall webworms	carbaryl diazinon malathion	Spray when first webs appear; clip off and destroy infested branches or burn out webs.
Galls (NHE-80, 81) Elm cockscomb Hickory Maple bladder	 diazinon malathion	 Spray foliage thoroughly when buds are unfolding.
Hackberry blister	diazinon malathion	Spray foliage thoroughly in late May. Kills psyllids in galls.
Cooley spruce Eastern spruce	diazinon malathion	Apply in late September or October or early spring just before buds swell.
Green-striped mapleworms	Same as for catalpa sphinx	Spray as soon as damage is noticed.
Leaf miners Birch Boxwood Hawthorn Oak	diazinon malathion	Spray foliage thoroughly when mines first appear. Repeat treatment in 10 to 12 days.
Mealybugs	malathion	Spray foliage thoroughly and with force. Repeat in two weeks.
Mimosa webworms (NHE-109)	carbaryl malathion	Spray foliage thoroughly when first nests appear (June, July). A repeat treatment may be needed.
Mites (NHE-58)	chlorobenzilate dicofol	Pay particular attention to underside of leaves. Apply 2 or 3 times at weekly intervals.
Oak kermes	malathion	Spray foliage thoroughly about July 1 to kill the crawlers.
Periodical cicadas (NHE-113)	carbaryl	Spray all branches thoroughly when adults appear. Repeat in 7 to 10 days.
Sawflies	Same as for fall webworms	Spray as soon as worms or damage is evident.
Scale (NHE-114)	diazinon malathion	Spray foliage thoroughly in early April for *Fletcher* and *European elm scale*; in late May for *pine needle* and *sweet gum scale*; in early June for *scurfy*, *oystershell*, and *euonymous scale*; in early July for *cottony maple*, *Juniper*, and *dogwood scales*; in mid-July for *spruce bud scale*; and again in early August for *oystershell scale*.
Putnam San Jose Tulip tree	dormant oil diluted according to label	Apply when plants are still dormant in late winter. Do not use on evergreens. For tulip tree scale, a malathion spray in late September or in early spring is also effective.

[1] Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

TREE AND SHRUB INSECTS (continued)

Insects	Insecticide	Suggestions[1]
Spring cankerworms	Same as for catalpa sphinx	When leaf buds open in spring, while worms are still small.
Sycamore lace bugs	carbaryl malathion	Spray when nymphs appear, usually in late May.
Thrips	Same as for aphids	Mainly on privet. Spray foliage thoroughly.
Yellow-necked caterpillars	Same as for catalpa sphinx	Spray foliage when worms are small.
Zimmerman pine moths	malathion	Spray in mid-August and again two weeks later. In each spray use twice the amount of malathion suggested in the chart below.

[1] Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Amount of Insecticide Needed for Volume of Spray

	1 gal.	6 gal.	100 gal.		1 gal.	6 gal.	100 gal.
carbaryl (Sevin) 50% W.P.[1]	2 tbl.	¾ cup	2 lb.	dicofol (Kelthane) 18.5% E.C.	2 tsp.	4 tbl.	1 qt.
diazinon 25% E.C.[2]	2 tsp.	4 tbl.	1 qt.	dimethoate (Cygon, DeFend)	2 tsp.	4 tbl.	1 qt.
malathion 50-57% E.C.[3]	2 tsp.	4 tbl.	1 qt.	23.4% E.C., 25% W.P.[4]			
chlorobenzilate 25% W.P.	1 tsp.	2 tbl.	2 lb.				

[1] Do not use on Boston ivy. [2] Do not use on ferns or hibiscus. [3] Do not use on canaert red cedar. [4] Do not use on chrysanthemums.
Note: E.C. = emulsion concentrate; W.P. = wettable powder.

LAWN INSECTS

Insects	Insecticide[1]	Dosage per 1,000 sq. ft.[2]	Suggestions
True white grubs (NHE-23) Annual white grubs Japanese beetle larvae Green June beetle larvae Ants (NHE-111)	chlordane 45% E.C. 40% W.P. 10% G. 5%	½ cup 5 oz. 1¼ lb. 2½ lb.	This treatment provides 5-year protection. In established sod, apply as granules or spray to small area and then water in very thoroughly before treating another small area. For new seedings, mix in soil before planting. Do not plant vegetable root crops in treated soil for 5 years.
Ants (NHE-111) Cicada killer and other soil-nesting wasps (NHE-57, 79)	diazinon 25% E.C. 2% G.	¾ cup 5 lb.	Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest. Seal in with dirt.
Sod webworms Millipedes and sowbugs (NHE-93, 115)	carbaryl 50% W.P. 5% G. diazinon 25% E.C. 2% G. trichlorfon 50% W.P. 5% G.	½ lb. 4 lb. ¾ cup 5 lb. 4 oz. 2½ lb.	As sprays, use at least 2.5 gal. of water per 1,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader.
Armyworms Cutworms Chinch bugs	carbaryl 50% W.P. 5% G.	2 oz. 1 lb.	Apply as sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft.
Leafhoppers	carbaryl 50% W.P. methoxychlor 25% E.C.	2 oz. 2 oz.	Apply as a spray.
Aphids	malathion 50-57% E.C.	1 tbl.	Spray grass thoroughly.
Chiggers	diazinon	1 tbl.	Spray grass thoroughly.
Mites	dicofol 18.5% E.C. malathion 50-57% E.C.	1 tbl. 1 tbl.	Spray grass thoroughly, 2 to 2.5 gal. of water per 1,000 sq. ft.
Slugs (NHE-84)	Slug baits	Scatter in grass	Apply where slugs are numerous.

[1] E.C. = emulsion concentrate; W.P. = wettable powder; G. = granules.
[2] To determine lawn size in square feet, multiply length times width of lawn and subtract non-lawn areas including house, driveway, garden, etc. Do not allow people or pets on lawn until the spray has dried.

Insects[1]	Insecticide[2]	Method of application	Suggestions
Ants (NHE-111) Crickets Spiders (NHE-116) (NHE-17)	chlordane 1% spray diazinon 0.5% spray diazinon 0.5% P.S.C. Baygon 0.5% P.S.C.	*Outdoors:* Use a waterbase spray of chlordane or diazinon. Spray on outside of foundation of house.	To prevent insect migrations into house, spray completely around outside foundation wall and adjacent 4-inch strip of soil. *Indoors:* Use diazinon or Baygon oil-base sprays in pressurized spray cans. Apply to baseboards, cracks, and door thresholds.
Bed bugs	malathion 1% spray	Spray slats, springs, and bed frame thoroughly.	Apply a light spray to seams, tufts, and folds of mattresses. Dry before use. Use clean bedding.
Booklice or barklice	diazinon 0.5% in P.S.C. Baygon 0.5% in P.S.C.	Spray undersides of bookshelves and infested areas.	Remove books and papers from damp storage areas; spray where booklice are found. Improve ventilation.
Boxelder bugs (NHE-9)	diazinon 0.5% spray carbaryl 1% spray	*Outdoors:* Spray trunks of infested boxelder trees during late summer when bugs are present.	*Outdoors:* Spray the clusters of boxelder bugs on trunks of trees, foundation walls, under eaves, and other areas where they gather. Removal of seed-bearing boxelder trees is also helpful. *Indoors:* Remove with vacuum or broom.
Chiggers (NHE-127)	malathion 1% spray diazinon 0.5% spray	*Outdoors:* Treat bushes, lawn, fence rows, along roadsides, and areas not regularly mowed.	For personal protection repellents such as DEET, OFF, 612, etc., will prevent attack.
Wood ticks (NHE-56)	carbaryl 1% spray diazinon 0.5% spray malathion 1% spray		
Clover mites (NHE-2)	chlorobenzilate 0.03% spray dicofol 0.03% spray malathion 1% spray pyrethrin 0.1% P.S.C.	Purchase E.C. and dilute with water. Spray outside of house from ground up to windows and adjacent 10 ft. of lawn. Repeat in 7-10 days if necessary.	Remove grass and weeds from 18-inch strip next to foundation. *Indoors:* Vacuum, or spray with 0.1% pyrethrin in house.
Cluster flies (NHE-1)	dichlorvos 20% resin strip[3] pyrethrin 0.1% P.S.C.	1 strip per 1,000 cu. ft. in attic or room. Fog lightly in room. Repeat as needed.	Seal cracks around windows, eaves, and siding to prevent entry.
Drain flies (NHE-91)	*Outdoors:* malathion 0.5% spray	Spray shrubbery, tall grass and refuse containers.	*Indoors:* Use chemicals only after solving sanitation problems. Clean out overflow drains, drain traps, and cellar drains. Pour boiling water or rubbing alcohol into overflow drain to eliminate maggots.
	Indoors: pyrethrin 0.1% in P.S.C., or 20% dichlorvos resin strip[3]	Use fine mist or fog of pyrethrin or 1 resin strip per 1,000 cu. ft.	
Elm leaf beetles (NHE-82)	pyrethrin 0.1% P.S.C. carbaryl 1% spray	Use aerosol sprays for quick kill, or collect with vacuum or broom.	Sprays with carbaryl on nearby Chinese elm trees for control of elm leaf beetle larvae will help.
Fleas (NHE-107) Brown dog tick (NHE-56)	carbaryl 5% dust malathion 4% dust diazinon 0.5% P.S.C. Baygon 0.5% P.S.C.	Dust areas inside and outside the home where the pet rests. Dust pets directly as needed.	*Indoors:* For heavy infestations of ticks or fleas use diazinon or Baygon to treat baseboards, around rugs, under furniture, door casings, cracks, etc. Vacuum rugs and upholstered furniture thoroughly.
Flies (NHE-16) Gnats Mosquitoes (NHE-94)	*Outdoors:* malathion 1% spray	Purchase E.C. and dilute with water. Spray shrubbery, flowers, tall grass, around doorways and refuse containers and other resting sites.	Dispose of refuse twice each week. Eliminate standing water in eaves, troughs, old tires, toys, tin cans, etc.
	Indoors: pyrethrin 0.1% space spray; or dichlorvos 20% resin strips[3]	Use fine mist or fog of pyrethrin or use one 20% slow release dichlorvos resin strip per 1,000 cu. ft.	Use screening and keep repaired. Dichlorvos resin strips give good control in tight enclosed areas for about 3 months. Fly swatters are also effective.

[1] Leaflets on specific insects, their life history, habits, damage, and cultural control methods are indicated by NHE or circular numbers. These are available from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois College of Agriculture, Urbana, Illinois 61801.

[2] Whenever possible purchase specially prepared ready-to-use forms of insecticides for indoor use. When preparing a quantity of 1 gallon or more of a spray of a desired percentage, use the dilution table on page 8. You need to know only the formulation of the insecticide when using the dilution table.

[3] Do not use in pet shops or if tropical fish are present. Do not use in kitchens, restaurants, or areas where food is present. Do not use in nurseries or rooms where infants, ill, or aged persons are confined.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; P.S.C. = pressurized spray can; O. = oil solution (usually in pressurized spray can).

(SEE PESTICIDE DILUTION TABLE ON PAGE 8)

ANIMAL AND NUISANCE INSECTS (Continued)

Insects[1]	Insecticide[2]	Method of application	Suggestions
Ground beetles Black vine weevils Clover leaf weevils	chlordane 1% spray diazinon 0.5% spray carbaryl 1% spray	Spray outside foundation of house.	*Indoors:* Use vacuum and pick up beetles. They are attracted to indoor and porch lights. Where possible use yellow bulbs outside.
Millipedes, centipedes, sowbugs (NHE-93)	diazinon 0.5% spray carbaryl 1% spray trichlorfon 1% spray	Spray outside foundation and at least 3 ft. of adjacent soil.	Treat entire lawn as for webworms if pests are abundant. Remove debris from ground along foundation. Collect with vacuum when found indoors.
Picnic Beetles	carbaryl 1% spray malathion 1% spray diazinon 0.5% spray	Apply to garbage pails, decaying vegetables, and refuse frequented by these beetles.	Additional treatments every 4 or 5 days may be needed. Pick fruits and vegetables before they become overripe to reduce the problem.
Springtails (NHE-70)	chlordane 1% spray diazinon 0.5% spray malathion 0.5% spray	*Outdoors:* Spray soil next to the house, especially grassy moist areas.	Eliminate low moist spots around the house. *Indoors:* Use vacuum.
Wasps (NHE-79) Hornets (NHE-17) Bees	dichlorvos 0.5% P.S.C. dichlorvos 20% resin strip[3] carbaryl 1% spray or 5% dust; or malathion 1% spray or 4% dust	Treat nests of bees, wasps, or hornets after dark. Hanging dichlorvos resin strips in attic will help prevent infestations.	For nests below ground, apply carbaryl and seal opening with soil. For bees, spray nests in partitions. Drill holes through siding to inject insecticide, if necessary. Nests and honey should be removed and destroyed.

FOOD, FABRIC, AND STRUCTURAL INSECTS

Insects[1]	Insecticide[2]	Method of application	Suggestions
Carpenter ants (NHE-10)	chlordane 2% O. or 5% dust	Spray or dust nest entrances and runways.	Use foundation spray as recommended for ants. They are difficult to control. Nests should be treated directly for best results.
Carpet beetles (NHE-87) Tissue paper beetles Clothes moths (NHE-87) Larder beetles	diazinon 0.5% P.S.C.	Spray storage areas and infested places like the back and edge of carpeting, baseboards, beneath drawers, etc.	Prevent lint and dust from accumulating. Treat crevices, cracks, closets, and infested areas of shelving. Clean hot air registers and cold air shafts. Dry cleaning kills these pests. Store cleaned or washed woolens in insect-free chests and plastic bags.
Cockroaches: German (NHE-3) Brown-banded (NHE-4) American (NHE-5) Oriental (NHE-5)	diazinon 0.5% P.S.C. Baygon 0.5% P.S.C.	Spray runways and hiding places. Repeat treatments may be needed in 2 or 3 weeks.	Treat under sink, refrigerator, cabinets, on baseboards, etc. Complete treatment throughout home may be needed for successful control of brown-banded roach.
Pantry and cereal insects Saw-toothed grain beetles (NHE-11) Cigarette beetles	diazinon 0.5% P.S.C.[4] Baygon 0.5% P.S.C.[4] pyrethrin 0.1% P.S.C.	Spray inside of food cabinets very lightly and only after shelves are empty and cleaned.	Discard infected packages. Scrub or vacuum food cabinets and shelves. Force spray into cracks and crevices; allow to dry; cover shelves with clean, fresh paper. Do not contaminate food or utensils with insecticide.
Powder-post beetles (NHE-85)	chlordane 2% O. Pentachlorophenol 5% O.	Paint, spray, or dip to saturate infested wood.	Pentachlorophenol is a wood preservative also, but it has a strong persistent odor. Follow label directions.
Silverfish (NHE-86)	diazinon 0.5% P.S.C. Baygon 0.5% P.S.C.	Spray runways, baseboards, closets, and places where pipes go through the walls.	Repeat treatments in 2 weeks if needed. Keep books and papers in dry places.
Termites (NHE-57)	chlordane 1% Purchase E.C. and dilute with water or oil	Soak 6-inch width of soil down to footing around and beneath building, 1 gal. per 2 cu. ft. of soil.	Remove termite mud tubes connecting wood to soil. Eliminate wood-to-soil contacts. Ventilate to keep unexcavated areas dry.

[1] Leaflets on specific insects, their life history, habits, damage, and cultural control methods are indicated by NHE or circular numbers. These are available from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois College of Agriculture, Urbana, Illinois 61801.

[2] Whenever possible purchase specially prepared ready-to-use forms of insecticides for indoor use. When preparing a quantity of 1 gallon or more of a spray of a desired percentage, use the dilution table on page 8. You need to know only the formulation of the insecticide when using the dilution table.

[3] Do not use in pet shops or if tropical fish are present. Do not use in kitchens, restaurants, or areas where food is present. Do not use in nurseries or rooms where infants, ill, or aged persons are confined.

[4] For use only by pest control operators. Homeowners should use 0.1% pyrethrin.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; P.S.C. = pressurized spray can; O. = oil solution (usually in pressurized spray can).

(SEE PESTICIDE DILUTION TABLE ON PAGE 8)

PESTICIDE DILUTION TABLE

HOW TO USE: When preparing a spray of a desired percentage you need to know only the formulation of the particular product. (Examples: Kelthane 18.5% wettable powder; Kelthane 18.5% emulsion concentrate.) For instance, if you were preparing a 1% chlordane solution for spraying the foundation of the home, you would mix 5 tablespoons of chlordane 45% E.C. into each gallon of water. The formulations of insecticides in the following table may be purchased from hardware stores, pest control establishments, lawn and garden centers, and other sources. For some jobs, such as spraying outdoors to control flies or mosquitoes, a gallon or more of properly diluted spray is required. To obtain the percent concentration suggested for controlling a particular insect, add the amount of pesticide suggested in the following table to one gallon of water.

Pesticide formulation	Amount of insecticide needed per gallon of spray		
	Desired concentration		
	0.03%	0.5%	1.0%
carbaryl (Sevin) 50% W.P.	..	4 tbsp.	8 tbsp.
chlordane 45% E.C.	..	8 tsp.	5 tbsp.
chlordane 72% E.C.	..	4 tsp.	8 tsp.
chlorobenzilate 25% E.C.	1 tsp.	..	..
chlorobenzilate 45% E.C.	½ tsp.	..	..
chlorobenzilate 25% W.P.	1½ tsp.	..	..
diazinon (Spectracide) 25% E.C.	..	5 tbsp.	10 tbsp.
dicofol (Kelthane) 18.5% W.P.	2 tsp.	..	..
dicofol (Kelthane) 18.5% E.C.	1½ tsp.	..	..
malathion 50–57% E.C.	..	7 tsp.	4½ tbsp.
trichlorfon (Dylox) 80% W.P.	..	8 tsp.	1¾ oz.

(tbsp. = tablespoon; tsp. = teaspoon)

CONVERSION TABLE FOR SMALL QUANTITIES

1 level tablespoon = 3 level teaspoons
1 fluid ounce = 2 tablespoons
1 cup = 8 fluid ounces or 16 tablespoons
1 pint = 2 cups
1 quart = 2 pints or 32 fluid ounces
1 gallon = 4 quarts or 128 fluid ounces

COMMON NAMES OF INSECTICIDES

Below is a list of the common names of insecticides used in these tables, followed by the commercial trade name in parentheses, and the chemical name. These are listed to aid you in purchasing pesticides in pressurized spray cans. The label on the container usually lists these products by the common name or chemical name. Be sure to read the label.

carbaryl (Sevin) .... 1-naphthyl methylcarbamate
chlorobenzilate (Acaraben) .... ethyl 4, 4'-dichlorobenzilate
deet (Off, Kik) .... N, N-diethyl-m-toluamide
diazinon (Spectracide) .... O, O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate
dichlorvos (Vapona, DDVP) .... 2,2-dichlorovinyl dimethyl phosphate
dicofol (Kelthane) .... 4,4'-dichloro-a-(tri = chloromethyl) benzhydrol
dimethoate (DeFend, Cygon) .... O, O-Dimethyl S-(N-Methyl carbamoyl methyl) phosphorodithioate
ethyl hexanediol (6-12, Rutgers 612) 2-ethyl-1, 3-hexanediol
malathion (Cythion) .... diethyl mercaptosuccinate, S-ester with O,O-dimethyl phosphorothioate
propoxur (Baygon) .... O-isopropoxyphenyl methylcarbamate
pyrethrin .... principally from plant species *Chrysanthemum cinariaefolium*

25M—12-71—19990

Herbicide Guide 1972
FOR COMMERCIAL VEGETABLE GROWERS

WEED GROWTH reduces vegetable growers' income in the United States by millions of dollars annually as a result of lower yields, poorer quality, and added labor in harvesting and processing the crops.

This guide should be used together with the grower's knowledge of soil types and the crop and weed history of the area to be treated. The decision of whether to use herbicides or other means of weed control depends in part on the severity of past weed infestations. Several herbicides may be suggested for some crops. These herbicides have shown good control with no injury to the vegetables under test conditions. Not all herbicides cleared for use on a species are necessarily listed. Where the choice of more than one herbicide is suggested, the decision rests with the grower and is based on his knowledge of past weed infestation and cost of material. Where one herbicide will not control the weed spectrum present a combination of herbicides is suggested. When using an herbicide for the first time, a small-scale trial is advised.

These suggestions for chemical weed control in vegetables are based on research at the Illinois Agricultural Experiment Station, the U.S. Department of Agriculture, and other research institutions. The University of Illinois and its agents assume no responsibility for results from the use of these herbicides, whether or not they were used in accordance with suggestions, recommendations, or directions of the manufacturer or any governmental agency

Reading the label of the herbicide container is the most profitable time you spend in weed control. Use of the material and methods of use depend on registration of the herbicide by the federal Environmental Protection Agency (EPA). Do not use any herbicide *unless the label states that it is cleared for the use on the crop to be treated.*

Where mixtures of chemicals are applied the *user* will assume the responsibility for freedom from residues if such applications are not labeled by the EPA as a mixture.

Suggestions sometimes change during the growing season based on EPA clearances after date of issue. These suggestions are printed only once each year, and are therefore subject to change without notification.

Watch for notice of changes in EPA registration of herbicides (as they are identified by the EPA) in the Illinois Vegetable Farmer's Letter. The Letter is available from the Department of Horticulture, University of Illinois, Urbana 61801.

PUBLICATIONS ABOUT HERBICIDE EQUIPMENT: The following publications may be obtained from your county extension adviser or the Office of Agricultural Publications, 123 Mumford Hall, Urbana, Illinois 61801. Circular 791, "Band Spraying Preemergence Herbicides"; Circular 1038, "Calibrating and Maintaining Spray Equipment"; and Circular 1008, "Calibrating and Adjusting Granular Row Applicators."

NOTE: In the suggestions table on the following pages, the trade names of the herbicides are usually used. The list immediately below shows trade names and their corresponding common names.

Common name	Trade name	Common name	Trade name	Common name	Trade name
atrazine	AAtrex	diuron	Karmex	naptalam	Alanap
benefin	Balan	DCPA	Dacthal	nitralin	Planavin
bensulide	Prefar	diphenamid	Dymid, Enide	nitrofen	TOK
butylate	Sutan	EPTC	Eptam	pebulate	Tillam
CDAA	Randox	fluorodifen	Preforan	propachlor	Ramrod
chloramben	Amiben, Vegiben	linuron	Lorox	pyrazon	Pyramin
chloroxuron	Tenoran	metabromuron	Patoran	simazine	Princep
chlorpropham	Chloro IPC	monuron	Telvar	trifluralin	Treflan
cycloate	Ro-Neet	MCPA	Numerous	Petroleum solvent	Stoddard Solvent
dalapon	Dowpon	MCPB	Numerous	2,4-D (amine)	Numerous

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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
Prepared by H. J. Hopen, Department of Horticulture
CIRCULAR 907

Crop	*Herbicide*	*Rate of active ingredient per acre actually covered*[1]	*Weeds controlled*	*Best time of application (based on crop stage)*	*Remarks, cautions, limitations*
Asparagus (seedlings)	Amiben	3 lb.	Annuals	Immediately after seeding	Irrigation or rainfall after treatment will give maximu control.
Asparagus (established plantings)	Dowpon	5-10 lb.	Perennial grass	End of harvest season following disking	Apply when grass weeds are 3 to 4 inches tall. Direct spr under fern growth.
	Telvar	3 lb.	Annuals	In spring before spears emerge and immediately following harvest	Apply Telvar after disking. Do not exceed 6 lb. per gro ing season.
	Karmex	1.5-3 lb.	Annuals		Apply Karmex after disking. Do not exceed 4.8 lb. p growing season. Do not replant treated area to any oth crop for 2 years after last application.
	Princep	3-4 lb.	Annuals	In spring and after harvest	Apply after disking. Do not treat during last year in aspa agus because of residue. With Telvar, Karmex and Princep — usually weed infest tion will be reduced and spring application will be sufficie after first year.
Beans, lima and dry	Amiben	2-3 lb.	Broad spectrum of annual weeds	Immediately after seeding	Field may be rotary-hoed without destroying herbici action. Do not feed foliage to livestock.
	Amiben plus Randox	2 lb. +2 lb.	Broad spectrum of annual weeds	Immediately after seeding	Gives sustained annual grass control.
	Treflan	0.5-0.75 lb.	Annuals[2] (primarily grasses)	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after applicatio Can be used up to 1 lb. on dry beans.
Beans, dry	Preforan	3.5-4.5 lb.	Broad spectrum of annual weeds	Immediately after seeding Rainfall or irrigation needed soon after application	Do not follow treated crop in the same growing seas with any crop except those stated on the container lab Do not use treated plants for feed or forage within days of application.
	Planavin	1-1.5 lb.	Annuals (primarily grasses)	Preplant soil application Incorporate with soil	Can be used on sandy soil.
Beans, snap	Eptam	3 lb.	Annual grasses and nutgrass[4]	Preplant soil application Incorporate with soil immediately	
	Treflan	0.5-0.75 lb.	Annuals[2] (primarily grasses)	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after applicatio
	Preforan	3.5-4.5 lb.	Broad spectrum of annual weeds	Immediately after seeding Rainfall or irrigation needed soon after application	Do not follow treated crop in the same growing seaso with any crop except those stated on the container labe Do not use treated plants for feed or forage within 6 days of application.
	Dacthal	6-10 lb.	Annuals[3] (primarily grass)	Immediately after seeding	Do not feed treated plant parts to livestock.
	Planavin	1-1.5 lb.	Annuals (primarily grass)	Preplant soil application Incorporate with soil	Can be used on sandy soil.
Beets, garden	Pyramin	4 lb.	Annuals (primarily broad-leaved)	Preemergence or after beets emerge and before weeds have 2 true leaves	Where grasses are a severe problem, use 4 lb. Pyramin + 4 lb. Ro-Neet.
	Ro-Neet	4 lb.	Annual grasses	Preplant soil application Incorporate with soil immediately	Use a combination treatment with Pyramin to broade control spectrum.
	Preemergence — direct-seeded				
Broccoli Brussels sprouts Cabbage Cauliflower	Treflan	0.5-0.75 lb.	Annuals[2] (primarily grasses)	Preplant soil application Incorporate with soil immediately	Stunting or growth reduction may occur at recommende rates under growth stress conditions.
	Dacthal	6-10 lb.	Annuals[3] (primarily grasses)	Immediately after seeding	
	Preemergence — transplanted				
	Treflan	0.5-1 lb.	Annuals[2] (primarily grass)	Preplant soil application Incorporate with soil immediately	Transplant after application to 3 weeks later.
	Planavin	1-1.5 lb.	Annuals (primarily grass)	Preplant soil application Incorporate with soil	Transplant after application. Can be used on sandy soil
	Postemergence — direct-seeded or transplanted				
	TOK[7]	3-5 lb.	Broad-leaved weeds[6]	One to 2 weeks after crop emergence or transplanting, while weeds are in seedling stage	Use wettable powder formulation to reduce injury poten tial
	Preemergence				
Carrots	Treflan	0.5-1.0 lb.	Annuals[2] (primarily grass)	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later.
	Lorox	1-1.5 lb.	Annuals	Preemergence	Do not feed treated foliage to livestock or replant treated area for 4 months. Can also be used on parsnips, but do not use on parsnips on sandy soil.

[1] Based on active ingredients (actual amount of active herbicide in material or acid equivalent). Use lower rate on sandy soil and higher rate on clay and loam soils. When using a band application over the row, adjust amount of material applied to the part of an acre treated. See Illinois Circular 791.
[2] May not control ragweed and panicum. [3] May not control ragweed, smartweed, and velvetleaf. [4] May not control smartweed. [5] May not control smartweed and velvetleaf. [6] May not control crabgrass. [7] Use of 50% wettable powder is suggested for cabbage and horseradish. [8] May not control ragweed or chickweed. Grass control is sometimes marginal. [9] Do *not* use Alanap Plus, Solo, Whistle, or Amoco Soybean herbicide. These materials all contain Alanap plus another ingredient which may cause injury.

Crop	*Herbicide*	*Rate of active ingredient per acre actually covered*[1]	*Weeds controlled*	*Best time of application (based on crop stage)*	*Remarks, cautions, limitations*
	Postemergence				
Carrots (continued)	Lorox	1-1.5 lb.	Annuals	Postemergence on carrots only after crop is 2-6 inches tall	Do not feed treated foliage to livestock or replant treated area for 4 months.
	TOK	3-5 lb.	Broad-leaved weeds[6]	While weeds are in seedling stage	Can also be used on celery and parsley.
	Tenoran	4 lb.	Broad-leaved weeds	After true leaves formed on carrots; before weeds are over one inch tall	Do not apply within 60 days before harvest.
	Stoddard Solvent	60-80 gal.	Annuals	After 2 true leaves have appeared (do not apply to carrots or parsnips after they are ½ inch diameter, since oily taste may result)	Most effective when sprayed on cloudy days or during high humidity, and when weeds are not more than 2 inches high. May not control ragweed. Do not apply within 40 days of harvest. Can also be used on celery, dill, parsnips, and parsley.
Cucumbers Muskmelons Watermelons	Alanap[5]	3-5 lb.	Annuals[4]	Immediately after seeding or transplanting	Do not use on cold soil. Rainfall or irrigation after treatment gives maximum control.
		3-3.5 lb.		After transplanting or vining	Use granular form. Keep away from foliage. Apply to soil after weeds have been removed.
	Prefar	4-6 lb.	Annuals (primarily grasses)	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarter. Consult label for sensitive crops within 18 months after application. Prefar can be used in rotation only with tomatoes, broccoli, Brussels sprouts, cauliflower, and lettuce, within 18 months of application.
	Prefar plus Alanap	3-4 lb. +2-3 lb.	Grasses and broadleaves	Preplant soil incorporation for Prefar; Alanap as an immediate post seeding application	Has value for broad spectrum weed control. Consult label for sensitive crops within 18 months after Prefar application.
Eggplant	Dacthal	6-10 lb.	Annuals[4] (primarily grass)	Immediately after transplanting	
Horseradish	TOK[7]	3-5 lb.	Broad-leaved weeds[4]	Before weeds are 1 inch tall One application per growing season only	Will not consistently control weeds over 1 inch tall. Some emerging annual grass may be controlled by this treatment. Lower rate will control seedling purslane.
Lettuce	Balan	1.5 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. Seed after application to 3 weeks later. Do not plant wheat, barley, rye, grass, onions, oats, beets, or spinach for 12 months after application.
	Preemergence				
Onions	Dacthal	6-10 lb.	Annuals[3] (primarily grasses)	Immediately after seeding or transplanting	May not kill smartweed or common ragweed. Can be used on seeds, sets, or seedlings. Use only on mineral soils. Use lower rates on sandy soils.
	Randox	4-6 lb.	Annuals[4] (primarily grasses)	Just before onions emerge	Use on muck soils. Heavy rainfall may reduce stand. Very effective on purslane and pigweed.
	Postemergence				
	TOK	3-4 lb.	Broadleaf weed control	When weeds are in seedling stage and not over 1 inch tall	Use a single application of E.C. or W.P. per growing season. Do not apply E.C. until onions are in the 2-3 leaf stage. *Premergence* use of TOK with heavy rainfall may reduce stand.
	Tenoran	4 lb.	Broad-leaved weeds	After 2 to 3 onion leaves have formed, before weeds are over 1 inch tall	Do not apply within 30 days of harvest. Tenoran used in combination with CIPC or the insecticide diazinon may cause injury. See container label for precautions.
	Chloro-IPC	3-6 lb.	Broadleaf control (especially smartweed)	On seeded onions: loop stage or after 3- to 4-leaf stage	In the later sprays, direct at base of onion plant. If more than one application is applied do not exceed 6 lb. per acre for the season. *Use lower rates in cool, wet weather.* Use no later than 30 days before harvest.
Peas	Ramrod	4-4.9 lb.	Annuals	Preemergence	Do *not* use on sandy soil.
	Treflan	0.5-0.75 lb.	Annuals[3]	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later. Some reduction of growth and stand reduction possible under stress.
	MCPB	1 lb.	Broad-leaved weed and Canada thistle	When peas are 3-7 inches tall and no later than 4 nodes prior to pea blossom	May delay maturity 1 to 4 days. Use at least 20 gal. of water per acre. Do not feed vines to livestock.
	MCPA	¼-½ lb.			MCPA is more effective on mustard. MCPB is less injurious to peas.
Potatoes, Irish	Eptam	3-5 lb.	Annual grasses and nutgrass[4]	Preplant soil application or drag-off treatment at emergence Incorporate with soil immediately	Use lower rate on sandy soil.
	Lorox	1-2 lb.	Annuals	At very start of potato emergence	Plant tubers at least 2 inches deep. Do not replant treated area to other crops for 4 months after treatment. May injure crop on light sandy soil.
	Patoran	2-3 lb.	Annuals	At very start of potato emergence	Do not apply within 90 days before harvest.
	Dowpon	7 lb.	Quackgrass	Before plowing in spring; wait 4 days before plowing and planting	Not for fields intended for red-skinned varieties or White Rose. Do not plant potatoes for 4 weeks.

(See footnotes on page 2.)

Crop	Herbicide	Rate of active ingredient per acre actually covered[1]	Weeds controlled	Best time of application (based on crop stage)	Remarks, cautions, limitations
Potatoes, sweet	Dacthal	6-10 lb.	Annuals[3] (primarily grasses)	Immediately after planting	May not control smartweed or common ragweed. Preferred on sandy soil.
	Amiben	3 lb.	Annuals	Immediately after planting	Preferred on loam soils. Do not feed foliage to livestock.
Spinach	Chloro-IPC	1-3 lb.	Annuals	Immediately after seeding	Use 1 lb. if the temperature is below 60°.
	Ro-Neet	4 lb.	Annuals (primarily grasses)	Preplant soil application Incorporate with soil immediately	
Squash Pumpkins	Alanap[9]	3-3.5 lb.	Annuals[4]	Immediately after seeding	Do not use early when soil is cold. Moisture is necessary for good control. Use 3-lb. rate on sandy soils.
	Amiben	3-4 lb.	Annuals	As soon after seeding as possible	Use on loam soils.
Squash	Prefar	4-6 lb.	Annuals (primarily grasses)	Preplant soil application Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarters. Consult label for sensitive crops within 18 months after application. Use in combination with Alanap as suggested for cucumbers.
	Preemergence				
Sweet corn	AAtrex	2-3 lb.	Annuals, annual and perennial grasses[6]	Preemergence, apply no later than 3 weeks after seeding Shallow cultivation may improve weed control during dry weather	Grow corn a second year without AAtrex treatment. This chemical has a high soil residue. Do not plant other vegetable crops on a sprayed area until a second year of corn has been grown. Use AAtrex where quackgrass is a problem. Residue hazard decreased when banded or in combination with Ramrod or Sutan.
	Ramrod	4-5 lb.	Annuals	Preemergence	Do *not* use on sandy soils.
	AAtrex plus Ramrod	1.5 lb +3 lb.	Annuals and perennial grasses	Preemergence	Use to reduce AAtrex residue.
	Sutan	3-4 lb.	Primarily annual grasses	Preplant soil application Incorporate with soil	Use on sandy soil and where nutgrass is a problem.
	AAtrex plus Sutan	1 lb. +3 lb.	Annuals and perennial grasses	Preplant soil incorporation Incorporate with soil immediately	Use where nutgrass is a problem and to reduce AAtrex residue.
	Postemergence				
	2,4-D (amine)	½ lb.	Broad-leaved	Postemergence	Preferably, apply before corn is 6 inches tall. If corn is over 12 inches reduce rate to ¼ lb.
	AAtrex	2 lb.	Annuals, annual and perennial grasses[6]	Directed spray 3 weeks after emergence	Can be combined with crop oils for post emergence application as an emergency measure. This may increase residue to following year. Preemergence use preferred. Do not graze or feed treated foliage for 21 days after treatment.
Tomatoes, direct-seeded	Dymid, Enide	4-6 lb.	Annuals	Preemergence	Do not plant other food crops on treated areas for 6 months.
	Tillam	4 lb.	Annuals (primarily grasses)	Preplant soil incorporation Use a 2-4 inch incorporation	Direct seed as soon after application as possible.
Tomatoes and Peppers, transplanted	Vegiben	3-4 lb.	Annuals	Wait 3 days after transplanting to apply	Use granular formulation only. Do not use on sandy soils.
	Treflan	0.5-1 lb.	Annuals[3] (primarily grasses)	Preplant soil application Incorporate with soil immediately	Some reduction of growth may be possible under growth stress conditions or if rates are higher than suggested for soil type.
	Dymid, Enide	4-6 lb.	Annuals	After transplanting	Use 4 lb. on light soils. Use a maximum of 5 lb. on peppers.
	Planavin	1-1.5 lb.	Annuals (primarily grasses)	Preplant soil application Incorporate with soil	Can be used on sandy soil.

(See footnotes on page 2.)

Storage of Pesticides and Containers

Keep pesticides and containers in a separate building, room, or enclosure used only for this purpose. Such buildings or rooms should be dry, ventilated, and locked. Fence outside storage areas to protect children and animals and to discourage pilferage. CAUTION: Do not store weedkillers, herbicides, or defoliants in the same room with insecticides. Chlorate salts can create a fire or explosion hazard. Remove only the pesticides needed for one day's operation and return empty containers — and any unused pesticide — to the storage area each day.

Disposing of Pesticides and Containers

Disposal methods and precautions depend on the type of container and facilities available. Drain any left-over pesticide into a pit dug in sandy soil. Rinse glass and small metal containers several times with the diluent being used and include the rinse in your spray. Keep lids and bungs tightened.

Do not burn volatile weedkiller containers. Weedkillers such as 2,4-D and its derivitives can volatilize, and the resulting vapor may damage nearby plants, crops, and shrubbery. Herbicides or defoliants containing chlorates may explode when heated. *Dispose of containers in this manner:* break glass containers and chop holes in the top, bottom, and sides of metal containers so they cannot be used again or collect water; bury all weedkiller containers 18 inches deep at a safe disposal site or take them to a dump to be covered with soil.

1972 Suggested Fungicide Guide

Fungicide Guide for COMMERCIAL VEGETABLE GROWERS

Vegetable fungicide tolerances and intervals approved by the Food and Drug Administration and the Environmental Protection Agency as of January 1, 1972 are presented in this publication. The tables on pages 2 and 3 give the tolerances in parts per million (ppm) and the number of days between the last application at normal rate and the harvest *or* they give the date of last application that will keep residues within tolerances set by the FDA.

The listing of a chemical for a crop does not necessarily constitute recommendation for control of a disease on that crop by the Illinois Cooperative Extension Service and the Agricultural Experiment Station. Specific recommendations are given on pages 4 to 7.

In some instances a tolerance (ppm) has been set but a definite interval has not been established. The absence of an interval does not necessarily mean that the fungicide may not be used on that crop. Use of the fungicide would require such restrictions as "do not apply after first blooms appear" or "do not apply after edible parts form."

In a few cases the interval and dosage have been established, but the allowable ppm residue has not been determined. Here again this does not mean that the fungicide may not be used on that crop. It does mean, however, that until a tolerance is established it must be considered to be zero. Zero tolerances are reviewed each year. Some are cancelled as the manufacturer supplies the EPA with additional data.

Growers must follow a disease control program that will assure the production of vegetables with no excessive fungicide residues. Vegetables marketed with residues exceeding FDA tolerances may be injurious to consumers, may be confiscated, and may cause the grower to be brought to court.

Growers have nothing to fear from the law so long as they use fungicides and other pesticides according to the current label only on the *crops specified,* in the *amounts specified,* and at the *times specified.* The safe grower keeps a record of the products and trade names used, the percentage of active ingredients, dilutions, rates of application per acre, and dates of application. The record sheet provided on page 8 is a convenient place to keep such information.

This circular will be revised each year. Be sure you have the most up-to-date copy.

Prepared by Malcolm C. Shurtleff, Edward E. Burns, and T. H. Bowyer, Department of Plant Pathology

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE

Urbana, Illinois Circular 999 December, 1971

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

FUNGICIDE USES FOR VEGETABLES, APPROVED BY USDA, JANUARY 1, 1972[a,b]

Crop	FDA-permitted tolerance							
	Amobam, 7-25 ppm, Z, 7-45 ppm, M	Captan (D) (See ppm below)	Dyrene, 10 ppm	Folpet, 15-50 ppm	Maneb, 7 or 10 ppm	Maneb & zinc ion[c] (See ppm below)	Zineb, 7 or 25 ppm	Ziram, 7 ppm
Asparagus	..	root dip	..	..	A[d]	(0.1 ppm), A	A[d], ph	..
Beans (dry, lima, snap)	(7-Z, 4-M)[e]	(25 ppm-pp) 0[e]	..	..	4	..	7, D	4 (snap)
Beet, garden	..	(2 ppm-root, 100 ppm-green) 0	..	..	..	..	7 (top)	7 (top)
Broccoli	(7-Z, 3-M-wash)	(2 ppm-pp)	..	..	3 or trim and wash	..	7	7
Brussels sprouts	(7-Z, 0-M)	(2 ppm-pp)	..	..	0	..	7	0
Cabbage	(7-Z, M)	(2 ppm-pp)	..	..	7	..	7	7
Cantaloupe (muskmelon)	(0-Z, M)	(25 ppm) 0, ph[d], pp, D	0	(17 ppm) 0	..	(0 ppm in edible parts), 0[e]	0	0
Carrot	(7-Z, 0-M)	(2 ppm) 0	..	..	0	(2 ppm) 7, B (tops)	7 (tops)	7 (tops)
Cauliflower	(7-Z, M)	(2 ppm-pp)	..	..	0	..	7	7
Celery	(0-Z, M) strip and wash	(50 ppm) 0	0 (strip and wash)	(50 ppm) 7	0 (strip and wash)	(10 ppm), 7	0 (strip and wash)	0 (strip and wash)
Chinese cabbage	..	..	..	..	..	..	7	..
Corn, sweet and pop	(0-Z, M), B	(2 ppm-no husk), 10, B, D	..	..	0, B (cob and kernel)	..	0, B	..
Cucumber	(0-Z, M)	(25 ppm) 0, ph	0	(15 ppm) 0	0	(7 ppm), 0	0	0
Eggplant	..	(25 ppm) 0, pp	..	..	0	..	0	0
Endive, escarole	(7-Z, M)	..	..	..	7 and wash	..	7	0
Kale, collard	..	(2 ppm-pp)	..	..	7 and wash	..	7	0
Kohlrabi	..	..	..	..	0	..	(half grown)	7
Lettuce	(head: 5-Z, 7-M) (leaf: 7-Z, M)	(100 ppm) 0, pp	..	(50 ppm) 0	7 (strip and wash)	..	5 (head), 7 (leaf)	..
Mustard green	..	(2 ppm-pp)	..	..	7 and wash	..	7	..
Onion	(7-Z, green-0-M)	(50 ppm green, 25 dry) 0, ph	(1 ppm) 0 dry	(15 ppm dry) (50 ppm green) 0	0	(0.5 ppm dry) 7	7 (green)	0 (dry)
Pea	..	(2 ppm)	..	..	..	..	(10, pp, D)	7
Pepper	soil drench	(25 ppm) 0	..	..	0	..	(10, pp, D)	7
Potato, Irish[d]	(0-M)	(25 ppm) 0, ph	(1 ppm) 0	..	0 (.1 ppm)	(10 ppm) 0, B	0 and seed	..
Pumpkin	..	(25 ppm) 0	0	(15 ppm) 0	0	..	0	0
Radish	..	..	..	..	..	..	0	0
Rhubarb	..	(25 ppm) 0	..	..	0	..	..	..
Spinach	(7-Z, M-wash)	(100 ppm) 0	..	..	7 and wash	..	7	0
Squash	(0-Z, M)	(25 ppm) 0	0	(15 ppm) 0	0	(7 ppm) 0	0	0
Sugar beet[d]	(10-M), B	..	..	..	10 (45 ppm), B	(65 ppm-tops) 14, (2 ppm-roots) 10, B	..	..
Swiss chard	..	..	..	..	..	..	7	..
Tomato	(0-Z, M)	(25 ppm) 0	0	(25 ppm) 0	0, C	(7 ppm) 0	0	0
Turnip, rutabaga	..	(2 ppm-pp)	..	..	7 and wash	..	(0-root, 7-top)	0
Watermelon	..	(25 ppm) 0, D	0	(15 ppm) 0	..	(0 ppm edible parts) 0[e]	0	0

[a] No tolerances have been set for these fungicides on dill, horseradish, okra, parsley, and parsnip.
[b] The following abbreviations are used:
- A = Post-harvest application to ferns only or to young plantings that will not be harvested.
- B = Do *not* feed treated tops or forage to dairy animals or animals being finished for slaughter.
- C = To avoid damage, do not use on tender young plants.
- D = Do not use treated seed for food or feed.
- M = Maneb.
- Z = Zineb.
- ph = Cleared for use as a post-harvest dip at 0.12 percent (0.25 percent for captan on cantaloupe and cucumber).
- pp = Cleared for use as a preplanting soil treatment only.
- ppm = parts per million.

[c] Maneb and zinc ion are sold as Dithane M-45 and Manzate 200.
[d] Tolerances are not needed for pesticides applied *only* to the foliage and not translocated to the tubers or roots.
[e] Number indicates number of days between last application and harvest; 0 = up to harvest. (Numbers in parentheses refer to ppm.)

LABEL INFORMATION ON FUNGICIDES OF LESS GENERAL USE

Fungicide (tolerance)	Crops and use restrictions
Botran	**Greenhouse tomato** — to harvest. Do not drench seedlings or newly set transplants. **Carrot** — post-harvest dip or spray, see label; **Garlic, Onion** — soil application before seeding or spray to soil around sets or bulbs. *Do not plant spinach* as follow-up crop in treated soil. **Leaf lettuce** (greenhouse) — 14 days[a] (do not apply to wilted plants or seedlings). **Celery** — 7 days; **Cucumber** (greenhouse) — see label; **Rhubarb** (greenhouse) — 3 days; **Irish potato** — 14 days (do *not* feed to livestock).
Bravo W-75 (tetrachloroisophthalonitrile)	On **Broccoli, Brussels sprouts, Cabbage, Cauliflower, Cantaloupe (Melons), Pumpkin, Squash, Carrots, Cucumber, Potato,** and **Tomato** — to harvest. Seven days before harvest on **Beans** and **Celery**. *Note:* bean plants not to be used for feed. Fourteen days for **Corn** which is to be used for fresh market only.
Copper, fixed, neutral, and basic (including Bordeaux mixture)	Exempt if used in accordance with good agricultural practices. Not exempt if used at time of or after harvest. See label.
Dexon	Cleared *only* for seed-treatment use on **Beans, Beets, Corn, Cucumbers, Peas, Sugar beets.** Do not use treated seed for food, feed, or oil purposes. Slurry seed treatment for planting in light soils or soils high in clay or organic matter.
Difolatan	**Irish potato** — no-residue basis; no limitations on time before harvest is required. **Corn** — seed treatment only. Do *not* use for food or feed, or with oil.
Dinocap (Karathane)	**Cantaloupe (Muskmelon), Cucumber, Honeydew melon, Pumpkin, Squash, Watermelon** — 7 days.
Hexachlorophene (Nabac) (0 ppm)[b]	**Cucumber** — 3 days; **Pepper, Tomato** — 5 days, or preemergence application.
Nabam, 17-22% liquid (1-60 ppm)	Used *with* iron, manganese, or zinc salts, the tolerances for ferbam, maneb, or zineb apply. As with zineb, **Beans, Beets, Broccoli, Cabbage, Carrots, Cauliflower, Kale, Lettuce** (leaf), **Mustard greens, Spinach, Squash** (summer), **Swiss chard,** and **Turnip** have 7-day limitations. **Head lettuce** has a 5-day limitation. **Cantaloupe, Corn, Cucumber, Eggplant, Peppers, Tomatoes,** and **Watermelon** have no time limitation. Corn, however, can not be used as forage or fodder. **Asparagus** can only be treated after harvest. As a **Potato** seed-piece dip, plant immediately after drying.
Nabam, 93% WP[b] (Dithane A-40)	Used *with* iron, manganese, or zinc salts, the tolerances for ferbam, maneb, or zineb apply. **Celery** should be stripped and washed. Treated **Potato** seed-pieces, should not be used for feed. **Cantaloupe, Corn, Cucumber, Tomato,** and **Watermelon** can be treated to harvest. **Lettuce heads** have a 5-day limitation. **Beans (lima, snap), Beets, Broccoli, Cabbage, Carrot, Cauliflower, Kale, Lettuce, Mustard greens, Onion (green), Spinach, Squash (summer), Swiss chard,** and **Turnips** have a 7-day limitation.
Oxyquinoline sulfate (Fulex A-D-O, Sunox, Wilson's Anti-Damp)	Soil treatment. Preplanting or as seedlings emerge. (1 oz. of 67.5% solution in 20 gallons of water. Apply 1 quart per square foot).
Polyethylene polymer (Polyram) (0 ppm)	**Cantaloupe, Celery, Cucumber, Potato, Sugar beet, Tomato** — no time limitations; **Potato** — seed-piece treatment. Do *not* feed **Sugar beet** tops to meat or dairy animals; **Celery** — remove excess residues by stripping, trimming, and washing. Post-harvest application to **Asparagus ferns.**
PCNB (Terraclor, Brassicol, Fungiclor) (0 ppm)	**Beans** — base of plants *before* blossoming, soil and seed treatment at planting, or foliar spray. Do *not* feed treated **Bean** vines to livestock. **Broccoli, Brussels sprouts, Cabbage, Cauliflower** — transplant solution (¾ pint per plant) or row treatment before transplanting; **Lettuce** (head) — band treatment when plants are 2 to 3 inches tall, and then 10 and 20 days later; **Pepper, Potato, Tomato** — soil treatment at or before planting; **Tomato** (greenhouse) — transplant solution (½ pt. of 0.2% per plant).
Sodium dimethyldithiocarbamate (Sodam)	Used with ferric or zinc sulfate. See Ferbam or Ziram.
Streptomycin	**Celery, Pepper, Tomato** — plant beds only (200 ppm spray); **Potato** — seed-piece treatment only (100 ppm dip or dust). Soak cut seed pieces 30 min.
Sulfur, lime, and lime-sulfur	Exempt when used in accordance with good agricultural practices. *Caution* — these fungicides are often combined with other pesticides that may not be exempt from tolerance restrictions. See label.
Thiram, TMTD (7 ppm)	**Onion** — Furrow treatment; **Celery** — 7 days (strip, trim, and wash); **Sweet potato** — preplant root dip. Seed treatment: **Beans, Corn, Okra, Onion** (bulb, seed, and set), **Peanut, Tomato.** *Warning:* Do *not* use treated seed for food or feed, or with oil.)

[a] Number of days between last application and harvest.
[b] ppm = parts per million; WP = wettable powder.

CONDENSED FUNGICIDE RECOMMENDATIONS FOR DISEASES OF COMMERCIAL VEGETABLE CROPS FOR 1971

Vegetable	Diseases	Fungicide (lb./A.)[a]	Remarks
Asparagus	Rust (RPD934)[b], leaf and branchlet blights	Zineb, maneb, maneb and zinc ion, or Polyram (2-3 lb./A.)	Apply to non-harvested fields *throughout* season to August 15; to harvested fields *after* cutting only. Apply at 7- to 10-day intervals. May combine with insecticides to control asparagus beetles, cutworms, etc. (Cir. 897).[b] Polyram on ferns only.
Beans (garden, wax, and lima)	Seed decay (RPD915), damping-off, and seed-borne stem blights and root rots	Thiram or captan *plus* insecticide	Treat seed any time if not previously treated by producer. Plant *only certified*, western-grown seed in warm soil above 65° F.
	Bacterial blights	Fixed copper (2-3 lb. metallic/A.)	Apply at weekly intervals. Plant *only certified* western-grown seed.
	Rust, anthracnose, fungus leaf spots, pod and stem spots	Maneb, zineb, or Bravo W-75 (2-3 lb./A.)	Apply at 7- to 10-day intervals during moist weather. Combine with insecticides to control bean beetles, aphids, leafhoppers, blister beetles, etc. (Cir. 897).
	Mosaics		Use insecticides to control aphids (NHE-47)[b] that transmit the viruses. Kill aphids *before* they feed (Cir. 897). Control weeds in and around fields (Cir. 907).
	White mold	PCNB 20 (20 lb./A.) or PCNB 75 (5 lb./A.)	Apply to base of plants just before bloom. Do not feed treated vines to livestock.
Beets (garden and sugar), Mangel, Mangold, Spinach, Swiss chard, New Zealand spinach	Seed rot (RPD915), damping-off, and seed-borne leaf spot and anthracnose	Thiram or captan	Treat seed any time or buy treated seed. To control damping-off apply captan (5-7 lb. of 50% WP in 25-30 gal. water/A. or 25-30 lb. of 10% dust/A. in furrow at planting time.
	Cercospora leaf spot (RPD951), downy mildew	Maneb or zineb (2-3 lb./A.) or fixed copper (2-3 lb. metallic/A.)	Apply every 1 to 2 weeks during rainy periods. May combine with insecticides to control aphids, leafhoppers, caterpillars, leaf miners, etc. (Cir. 897).
	Mosaics, virus yellows		Use insecticides to control aphids (NHE-47) and plant bugs that transmit the viruses. Kill insects before they feed (Cir. 897).
Broccoli, Brussels sprouts, Cauliflower, Cabbage, Chinese cabbage, Collard, Horseradish, Mustard, Kale, Kohlrabi, Radish, Rutabaga, Peppergrass, Watercress	Seed rot (RPD915), damping-off, black rot (RPD924), blackleg (RPD955), radish black root (RPD948), alternaria blight	Hot water, then thiram or captan	Buy western-grown seed. Sow *only* seed treated with hot water. Control cabbage root maggots, cutworms, cabbage worms, etc. (Cir. 897). Four-year rotation with non-crucifer crops.
	Wirestem (*Rhizoctonia*) (RPD902), damping-off, seed rot (RPD916), botrytis blight (RPD942)	PCNB-captan mixture	Dust or spray on soil just before, at, or after planting seed. Follow manufacturer's directions.
	Clubroot (RPD923)	PCNB 75 (3 lb./50 gal.)	Apply in transplant water or starter solution, ¾ pt. per plant (about 400 to 600 gal./A.). Do *not* use emulsion form of PCNB.
	Downy mildew, leaf spots, white rust (RPD960), anthracnose, botrytis blight (RPD942)	Maneb, zineb, or Bravo W-75 (2-3 lb./A.)	Apply at 5- to 7-day intervals (3-5 days for radish) in wet weather. Use maneb in seedbed (2 lb./100 gal.). Good coverage important. May need spreader-sticker. May combine with insecticides to control aphids, cabbage worms, etc. (Cir. 897).
	Mosiacs, black ringspot		Use insecticides to control aphids (NHE-47) and cabbage worms (NHE-45) that transmit the viruses. Kill insects *before* they feed — especially in seedbeds (Cir. 897).
	Brittle root or curly-top (primarily horseradish)		Use insecticides to control leafhoppers that transmit the virus (Cir. 897). Apply when leafhoppers are *first* noticed. Additional applications may be necessary if infestation is severe.
Carrot, Parsnip	Seed rot (RPD915), damping-off	Thiram	Treat seed any time. May combine with insecticides.
	Aster yellows (RPD903)		Use insecticides to kill leafhoppers that transmit the mycoplasma, *before* they feed (Cir. 897). Begin when plants are 2-3 inches tall; apply weekly for 4 weeks. Control weeds in and around plantings (Cir. 907).
	Cercospora leaf spot, alternaria leaf blight (RPD938)	Captan, maneb, maneb and zinc ion, or zineb (2-3 lb./A.)	Apply at 5- to 10-day intervals in rainy periods. Thorough coverage essential. Start around June 15.

[a] **Dosages: The quantity of material listed is the pounds of active (actual) ingredient to be applied to 1 acre unless stated otherwise (i.e., 3 lb./A.; 2 lb. 50% WP; 20 lb. 5% dust). Abbreviations used: A = acre; WP = wettable powder; pt. = pint(s); gal. = gallon(s); T. = tablespoon(s) (level); sq. ft. = square foot or feet.**

[b] **RPD = Report on Plant Diseases; NHE = Natural History Entomology publication. General references: Illinois Circular 802 (revised), Vegetable Diseases; Circular 893, Soil Disinfestation Methods and Materials; Circular 897, Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables; and Circular 907, Herbicide Guide for Commercial Vegetable Growers. Materials available in County Extension Offices.**

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
Celery, Celeriac, Dill, Parsley	Seed rot (RPD915), damping-off, seed-borne blights	Hot water, then thiram or captan	Treat seed just before planting or buy treated seed. If damping-off starts, spray plants and soil 2 to 3 times, 5-7 days apart. Use zineb (1 T./gal.). Three-year-old seed is free of late blight.
	Leaf blights and leaf spots	Maneb, thiram, or zineb (2-3 lb./A.)	Use ziram, ferbam, or thiram (2 T./gal.) in seedbed. Apply every 7-10 days in field except during very dry weather.
	Mosaics, calico, ringspot		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids *before* they feed (Cir. 897). Control weeds in and around plantings.
	Aster yellows (RPD903)		Use insecticides to control leafhoppers that transmit the mycoplasma. Kill insects *before* they feed. Control weeds in and around plantings (Cir. 907).
Corn (sweet and pop)	Seed rot (RPD915), seedling blights, seed-borne root and stalk rots, leaf blights	Captan, difolatan, Bravo W-75, or thiram *plus* insecticide	Treat seed any time or buy seed treated with both a fungicide and an insecticide (NHE-27).
	Bacterial wilt (RPD907)		Apply insecticides over row to control flea beetles (NHE-36) that transmit the wilt bacteria (Cir. 897). One to 6 sprays may be needed, 3 to 5 days apart. Start the day *before* corn comes up.
Cucumber, Muskmelon (Cantaloupe), Pumpkin, Squash, Watermelon, Chayote, Gherkin	Seed rot (RPD915), damping-off, angular and alternaria leaf spots, fusarium wilt, gummy stem blight or black rot, anthracnose, scab	Bravo W-75, Captan, or thiram *plus* insecticide	Sow *only* certified, western-grown seed. Watering after planting with captan 50W (2 lb./100 gal. at 1 gal./125 sq. ft., every 5-7 days) controls damping-off. May combine with insecticides (Cir. 897) to control seed-corn maggots (NHE-27) in seedbed. Use 3- to 4-year rotation.
	Bacterial wilt (RPD905)		Use insecticides to control cucumber beetles (NHE-46) that transmit the causal bacteria. Kill beetles *before* they feed (Cir. 897). Applications needed from young seedlings to mature plants. Thorough coverage is essential.
	Anthracnose (RPD920), downy mildew (RPD927), scab (RPD928), blossom blight, leaf spots and blights (RPD918), fruit spots and rots, gummy stem blight or black rot	Maneb, maneb plus zinc ion, zineb, or Bravo W-75 (2-3 lb./A.); or difolatan (2½ pt./50 gal./A.)	Use captan or ziram (2-3 lb./100 gal.) on young plants. Apply at 7- to 10-day intervals from seedling emergence to vining. Start maneb or zineb *after* vines begin to run. Repeat at 5- to 10-day intervals to 7-10 days before harvest; keep new growth protected. May combine with insecticides to control cucumber beetles, aphids, vine borer, pickle worm, etc. (Cir. 897).
	Angular leaf spot (RPD919)	Fixed copper (2-3 lb. metallic/A.) or soluble copper	Apply at 5- to 7-day intervals in warm, wet weather; or mix with zineb or maneb (2 lb./A.). Begin when plants start to vine or disease *first* appears.
	Mosaics (RPD926)		Use insecticides to control aphids (NHE-47) and beetles (NHE-46) that transmit the viruses (Cir. 897). Kill insects *before* they feed. Control weeds (Cir. 907).
	Powdery mildew (RPD925)	Karathane WD (8 oz./100 gal.) *plus* spreader-sticker	Dust or spray. Thorough coverage essential. Repeat 5-10 days later. Do not apply within 7 days of harvest.
Eggplant	Seed rot (RPD915), seed-borne anthracnose, phomopsis blight (RPD949), and verticillium wilt (RPD950)	Hot water, then thiram or captan	Treat seed just before planting.
	Seed rot, stem blight, damping-off (RPD916)	Captan or zineb (1-2 lb./100 gal.)	Seedbed or flat spray, 5 gal./100 sq. ft. Repeat at 5- to 7-day intervals.
	Blight (phomopsis, alternaria, cercospora) (RPD949), anthracnose	Maneb, zineb, ziram, or captan (3 lb./A.)	Start when disease is first evident, *or* when first fruits are half mature. Repeat at 7- to 10-day intervals. *Do not use copper fungicides on eggplant.* May combine with insecticides (Cir. 897).
Lettuce, Endive, Escarole, Salsify	Seed rot (RPD915), damping-off (RPD916), gray mold (RPD942)	Captan, then PCNB-captan mixture	Dust seed lightly with captan 75. Then apply PCNB-captan as dust or spray just before or just after seeding. For *field use only.*
	Bottom rot, and drop, stem, or crown rot	PCNB-captan mixture	*Use on head lettuce only.* Begin when plants are 2-3 inches tall. Repeat 10 and 20 days later. Follow manufacturer's directions.
	Aster yellows (RPD903), white heart		Use insecticides to control leafhoppers that transmit the mycoplasma. Kill leafhoppers *before* they feed (Cir. 897). Applications needed throughout season. Dust or spray weed borders.
	Mosaics (RPD946)		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids *before* they feed (Cir. 897). Sow *only* mosaic-indexed seed. Control weeds in and around plant-growing areas (Cir. 907). Keep new and old beds as far apart as possible.

CONDENSED FUNGICIDE RECOMMENDATIONS (continued)

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
	Gray mold (RPD942), downy mildew, other fungus leaf spots, white rust	Maneb or zineb (2-3 lb./A.)	Apply at 5- to 7-day intervals in cool, damp weather. Do *not* apply within 10 days of harvest. May combine with insecticides to control aphids, leafhoppers, flea beetles, etc. (Cir. 897).
Okra	Seed rot (RPD915), damping-off	Thiram	Seed treatment. Apply any time.
Onion, Garlic	Smut (RPD933), seed decay (RPD915), damping-off, seed-borne purple blotch	Thiram or captan	Apply to seed any time (RPD933). For *onion sets*, use 1 lb. (100% active) to 20 lb. seed; for *bulb onions*, wet seed with Methocel sticker then treat with 8 lb. thiram 75 or captan 75 to 8 lb. seed. For *pickling and green bunching onions*, same as for bulb onions; but use half dosage. Control seed- and bulb-feeding insects (Cir. 897).
	Blast (RPD931), downy mildew, purple blotch, gray mold blight (RPD942), neck rot (RPD930)	Maneb, maneb and zinc ion, or zineb (1½-3 lb./A.) plus spreader-sticker	Apply every 5 to 7 days in moist weather. May combine with insecticides to control thrips, onion maggots, cutworms, etc. (Cir. 897).
	Yellow dwarf, mosaics		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids *before* they feed (Cir. 897). Keep new and old plantings *as far apart* as possible.
Pea, Lentil	Seed decay (RPD915), damping-off, seed-borne foot rots, ascochyta and mycosphaerella blights (RPD945), fusarium wilts (RPD912), and bacterial blights	Thiram, captan, or zineb *plus* insecticide	Treat seed any time or buy seed treated with fungicide-insecticide. Sow certified, western-grown seed. Where captan or thiram are used, friction may reduce seeding rate; add graphite (1 oz./bu.).
	Leaf and stem spots or blights (RPD945)	Zineb (2 lb./A.)	Apply weekly in rainy weather where diseases have been severe in past.
	Mosaics (RPD947), streaks, stunt, mottle, wilt		Use insecticides to control aphids (NHE-47) and other insects that transmit the viruses. Kill insects *before* they feed (Cir. 897). Also treat field borders.
	Powdery mildew	Lime-sulfur dust (4-6 ratio) 30 lb./A.	Do not apply at air temperature above 80° F. or when plants are in flower. Two applications, a week apart, when mildew *first* appears, should be sufficient.
Peanut	Seed rot (RPD915), seedling blights	Thiram, difolatan, or captan	Treat seed anytime. Do not use treated seed for food, feed, or oil.
Potato, Irish	Seed-piece decays (RPD915), and seed-borne verticillium wilt (RPD950)	Captan, maneb, Polyram, zineb, or maneb plus zinc ion	Apply as dust or dip to cut and uncut tubers. Follow manufacturer's directions. Tubers should be well corked over. Plant in warm (over 50° F.) soil.
	Blackleg (RPD943)	Streptomycin	May combine with treatment for seed-piece decays. Use uncut, B-size, certified seed.
	Early blight (RPD935), late blight (RPD936), and minor leaf spots and blights	Maneb, maneb and zinc ion, difolatan, Bravo W-75, or Polyram (2-3 lb./A.)	Apply at 4- to 10-day intervals. If rainy, shorten interval; if dry, lengthen. For "finish-up" sprays use fixed copper (3 lb. metallic/A.). May combine with insecticides (Cir. 897).
	Common scab (RPD909), and black scurf (*Rhizoctonia*)	PCNB(various formulations)	May help on *mineral* soils. Work into top 4-6 inches of soil at or before planting. Follow manufacturer's directions carefully. Dust seed pieces with difolatan or maneb and zinc ion.
	Mosaics, leafroll, mottle, purple-top, yellow dwarf, etc.		Use insecticides to control aphids (NHE-47), leafhoppers (NHE-22), etc., that transmit the viruses. Kill insects *before* they feed (Cir. 897).
Rhubarb	Root and crown rots	Fixed copper (3 lb. metallic/A.)	Drench crowns early in spring and after harvest. Plant *only* in *well-drained* soil.
	Leaf and stalk spots, anthracnose	Maneb, fixed copper or captan (2-3 lb./A.)	Avoid applications from 2 weeks before harvest until cutting is completed. May combine with insecticides (Cir. 897).
	Mosaics, ringspots		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids *before* they feed (Cir. 897).
Sweet potato	Black rot (RPD953), fusarium wilt (RPD954), scurf (RPD957)	Thiram	Dip disease-free roots or sprouts just before planting. Follow manufacturer's directions. Seedbed disinfestation (Cir. 893). Three- to 4-year rotation. Strict sanitation.

CONDENSED FUNGICIDE RECOMMENDATIONS (concluded)

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
	Fusarium wilt (RPD954), foot rot (RPD958), scurf (RPD957)	Same as for black rot or use zineb or thiram (1½ oz./gal.)	Dip roots and base of sprouts just before planting. Do *not* rinse after treatment. Seedbed disinfestation (Cir. 893). Four- to 5-year rotation. Strict sanitation in seedbed and field.
	Storage rots (RPD952)	Botran (as post-harvest dip or in wash water)	Helps reduce transit and market losses caused by rhizopus soft rot and black rot. Fumigate storage houses with formaldehyde.
Tomato, Pepper	Seed decay (RPD915), seed-borne bacterial spot (RPD910), speck and canker (RPD962), early blight (RPD908), septoria blight, anthracnose, fusarium wilt (RPD929), leaf mold (RPD941)	Hot water, then captan, thiram, or Bravo W-75	Treat seed, buy treated seed, or certified, disease-free transplants (Cir. 912).
	Bacterial spot (RPD910)	Fixed copper-streptomycin mixture	Start when seedlings emerge and apply every 5 days. In *field*, use fixed copper (2-3 lb. metallic/A.) plus maneb or maneb and zinc ion (2 lb./A.).
	Damping-off (RPD916) and seedling blights, collar rot (RPD908)	Captan	Dust or spray in seedbed. Apply as plants emerge so spray runs down stems. Repeat every 4 to 7 days until 10 days before transplanting. Follow the manufacturer's directions.
	Septoria blight (RPD908), early blight, anthracnose, late blight (RPD913) and buckeye rot, gray leaf spot, leaf mold (RPD941)	Maneb, maneb and zinc ion, Polyram, or zineb (2½-4 lb./A.); or difolatan (2½ pt./100 gal./A.)	Apply every 7 to 10 days *after* first fruit clusters form. Five or more sprays may be necessary, depending on weather. Combine with insecticides to control flea beetles, climbing cutworms, hornworms, fruit flies, etc. (Cir. 897). *Soil surface spray of maneb or difolatan after last cultivation improves anthracnose control.*
	Mosaics (RPD917)		Use insecticides to control aphids (NHE-47) and beetles that transmit the viruses. Kill insects *before* they feed (Cir. 897). Control weeds in and around plant-growing area (Cir. 907). Set out certified, virus-free transplants or start with virus-free seed.
	Blossom-end rot (RDP906)	Calcium nitrate (4-6 lb./A.)	Application of 4 or more consecutive sprays in the regular schedule may reduce losses. Start when fruits are the size of grapes. Irrigate to maintain uniform soil moisture.
	Cloudy spot (RPD914)		Use insecticides to control stink bugs that produce cloudy spot by feeding punctures (Cir. 897).
(General diseases that attack most vegetable crops)	Damping-off (RPD916) and seedlings blights; gray mold (RPD942) or botrytis blight	After planting apply captan, thiram, or zineb (1 T./gal.); ferbam or ziram (2 T./gal.)	Disinfest seedbed soil (Cir. 893), then apply seed treatment (RPD915). Then apply sprays or drenches after planting. Apply *only* if damping-off appears in seedbed and when seedlings need water. (*For crucifers, pepper, peas, beans, tomato, lettuce*, add PCNB to other fungicides to give broad-spectrum control.) Use at least 5 gal. per 1,000 sq. ft. of bed. Repeat at 5- to 7-day intervals when temperature is below 75° F.
	Root knot and other nematodes; fusarium wilts of various crops (RPD901,904,912,929, 954)	Heat or chemicals may be used. Consult Cir. 893 for names, general precautions, and directions	Disinfest seedbed soil (heat preferred, if available). Follow manufacturer's directions exactly. Fumigants work best in light, loose soils, free of trash, clods, and lumps. Avoid recontamination of treated soil. Best to apply fumigants during the fall that precedes planting. In general, soils must be at least 55° F. at the 6-inch depth with a time lapse of 21-28 days between treating and seeding. Some require gas-tight plastic covers.
	Root and stem or crown rots of various crops (RPD902,911,922,923, 932,948,953)		
	Verticillium wilt (RPD950)		

RECORD SHEET FOR FUNGICIDE USERS

Date	Vegetable	Chemical	Dosage per acre	Remarks

4M—12-71—19851

ENTOMOLOGY A CENTURY AGO—SO WHAT'S NEW?

First Annual Report on the Noxious Insects of the State of Illinois by William LeBaron, M.D., State Entomologist, 1871, page 45: "The absence of the Chalcis (wasp parasite) of the Bark-louse (oyster-shell scale) in this locality will furnish an excellent opportunity for testing the practicability of transporting it thither from those places where it is known to exist. . . . If such an experiment could be conducted to a successful issue, it would furnish one of the most admirable instances on record of the triumph of science, in its application to economic entomology." Captain Edw. H. Beebe of Galena, Illinois tried this in May-July 1871. Then in the Third Annual Report, 1873, page 202: "In conducting an experiment of so delicate a nature I am well aware that the greatest caution must be exercised to avoid jumping to conclusions, and that observations of a number of succeeding years will be necessary before we can arrive at a definite conclusion that the experiment has been followed by a practical, as well as a scientific success." Today, Dr. LeBaron, we call this biological control. We are still trying! Either dormant oil sprays or malathion summer sprays do a good job too.

Second Annual Report on the Noxious Insects of the State of Illinois. William LeBaron, M.D., State Entomologist, 1872:

Page 109: "Mr. John Tinker (Clinton, Wisconsin) states that apple-trees will perish after having been defoliated three years in succession. With respect to the orchard in which I have made observations, I have learned that the Cankerworms first made their appearance in it four years ago, and now some of the trees are dead and others are in a dying condition." It's still happening. Dr. LeBaron.

Page 143: "This will give as the amounts actually destroyed by chinch-bugs 7,500,000 bushels of wheat; 500,000 bushels of barley, and in round numbers 3,300,000 bushels of oats." No damage from chinch bugs like this since 1935 or maybe 1944. Nitrogen and sturdy thick grain have helped reduce damage by this pest.

Page 118: "Mr. Walsh designated this insect . . . rascally leaf-crumpler and to another . . . he applied the epithet of the hateful grasshopper." Dr. LeBaron continued, "However injurious or obnoxious some insects may be to us, the application to them of epithets indicative of rascality or malignity is incorrect, and repugnant to good taste." Same old insects today, Dr. LeBaron, just different descriptive adjectives.