BULLETIN 951
MARCH 1960

# Residual Toxicities of Insecticides to Cotton Insects

TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

# Summary

Results of experiments conducted to determine the effect of natural or simulated climatic conditions on the residual toxicities of several chlorinated hydrocarbon and organophosphorus insecticides to several species of cotton pests are summarized in this publication.

In tests on the boll weevil with the chlorinated hydrocarbon insecticides, the residual properties of endrin and Sevin appeared to be quite similar under a variety of weathering conditions. Based on residual properties alone, toxaphene and dieldrin ranked with endrin and Sevin, but the initial toxicities of dieldrin and endrin to the boll weevil were appreciably greater than those of toxaphene. The mortality rate among weevils confined on spray residues of these insecticides was reduced by 20 to 30 percent after exposure of the residues to simulated wind or rain. This reduction could result in failure to control the boll weevil under field conditions.

The residual properties of aldrin and BHC were inferior to those of endrin, Sevin, dieldrin and toxaphene under a variety of climatic conditions. The results obtained with heptachlor were erratic.

The results obtained in tests on the boll weevil were similar to the data from tests with the cotton leafworm, the salt-marsh caterpillar and the garden webworm.

Among the organophosphorus insecticides used in tests on the boll weevil, Guthion appeared to be more resistant to weathering than malathion, methyl parathion or Phosdrin. Malathion appeared to have residual properties intermediate between those of Guthion and methyl parathion, while the period of residual effectiveness of Phosdrin was very short under all conditions.

Simulated rain was the only weathering agent which appreciably reduced the residual toxicity of Guthion. In general, weathering did not reduce the residual toxicities of the organophosphorus insecticides as much in tests with cotton aphids and spider mites as in tests with the boll weevil.

When treated plants were held under varying temperature and humidity conditions for 48 hours prior to the release of insects on the plants, the residual toxicities of all the insecticides tested were reduced appreciably.

Losses in residual effectiveness among insecticidal dusts exposed to wind and rain usually were greater than among sprays of the same materials.

# Contents

# RESIDUAL TOXICITIES OF INSECTICIDES TO COTTON INSECTS

*B. G. Hightower and J. C. Gaines**

THE PERSISTENCE OF INSECTICIDE RESIDUES was recognized as a factor in insect control shortly after the advent of the chlorinated hydrocarbon and organophosphorus insecticides. Research on the effect of climatic factors on the residual toxicities of insecticides to cotton insects was begun at the Texas Agricultural Experiment Station by Gaines and Dean (1949). Data on the effect of sunshine and simulated dew on insecticide residues were presented by Gaines and Dean (1950). Further research on the effect of simulated rain, sunlight, high natural temperatures and wind on insecticide residues was conducted by Gaines and Mistric (1951, 1952), Mistric and Gaines (1953, 1954), Mistric (1954), Owen (1954), Mistric and Martin (1956), Hightower and Martin (1958) and Hightower (1959).

Growers are offered a choice of many different insecticides for use in the control of the major cotton insect pests. Many of the chlorinated hydrocarbon and organophosphorus insecticides are recommended for the control of several diverse groups of insects. In addition to selecting an insecticide known to be toxic to a particular pest species, it would be advantageous for the grower to know what residual properties to anticipate from a given insecticide under various weather conditions in the field.

## *Experimental Methods*

### INSECTICIDES

Each insecticide included in these studies was furnished by the manufacturer. All spray materials used were prepared from emulsifiable concentrates, and all dusts were formulated with commercial diluents. Fresh stocks of insecticides were obtained for use at the beginning of each new season.

Research was conducted on the following chlorinated hydrocarbon insecticides: toxaphene, dieldrin, endrin, aldrin, benzene hexachloride and heptachlor; and on the following organophosphorus insecticides: parathion, methyl parathion, malathion, Guthion and Phosdrin. Also, several preliminary tests were conducted with Sevin, a carbamate insecticide.

### CLIMATIC CONDITIONS

All of the experiments were conducted in the laboratory so that individual climatic factors could be either controlled or simulated. Natural or outdoor climatic conditions were utilized for weathering the residues in some of the tests when it was possible to avoid any complicating conditions.

In order to evaluate the weathering effect of a particular combination of climatic factors affecting insecticidal residues for a specified period of time, potted cotton plants were sprayed or dusted and separated into the following groups for detailed observation:

1. Initial toxicity — Insects were released on the sprayed or dusted plants within 45 minutes after treatment. Maximum mortalities usually were obtained on these plants and all losses in toxicity from weathering were estimated on this basis.

2. Twenty-four hour exposure — Insecticides on cotton plants were exposed to certain weather conditions for 24 hours prior to the release of the test insects on the treated plants.

3. Wind or rain — Insecticides on cotton plants were exposed to wind or simulated rain for all or part of 24 hours prior to the confinement of the insects on the treated plants.

Temperature during the exposure periods ranged from 54° to 115° F. and the relative humidity varied from 28 to 98 percent. An uninsulated room was used in some of the tests to subject treated plants to high temperatures in the absence of bright sunlight. The sun raised temperatures in the room from 110° to 115° F. for about 4 hours during a 24-hour period. For comparison, similar groups of treated plants were held in the laboratory at 85° ± 5° F. during the 24 hours prior to the release of the insects on all the treated plants.

After the insects had been released on the various groups of treated plants, they were all held under identical conditions for the remainder of the test.

Natural wind currents were simulated in the laboratory by means of a 16-inch oscillating electric fan, Figure 1. The insecticide-treated plants exposed to simulated wind were placed in a single row about 3 feet in front of the fan within the range of oscillation. A later modification of this technique involved placing the fan vertically in a rigid mount about a circular plywood table. Treated plants situated around the rim of the table were exposed for 24 hours to the uniform air currents produced by the fan. Wind velocities in both techniques varied from 3.5 to 5 miles per hour (m.p.h.).

*Respectively, formerly assistant professor and head, Department of Entomology.

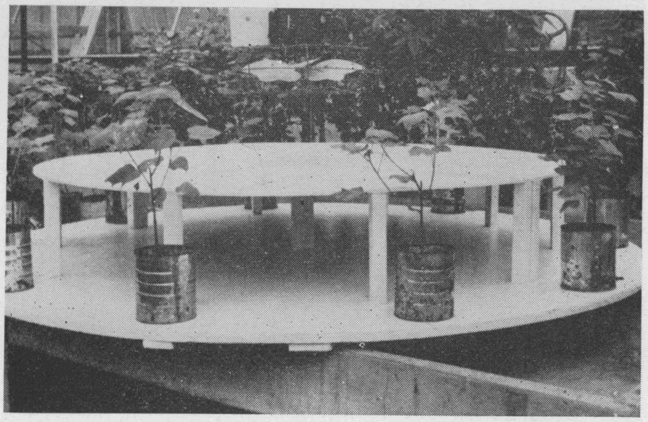


**Figure 1. Modified Dustan table for applying simulated wind to treated cotton plants.**

Rain was simulated by means of a circular garden sprinkler mounted vertically in the top of a steel frame 3 feet square and 5 feet high, Figure 2. A 16-mesh screen wire tray was mounted 15 inches below the sprinkler to break the stream of water into drops. The sprayed or dusted plants were placed on the floor directly under the sprinkler and water was allowed to fall until 0.5 inch had collected in a gauge on the floor between the plants. This simulated a hard uninterrupted shower for 3 minutes.

## TEST INSECTS

Field-collected boll weevils, *Anthonomus grandis* Boh., were used in some of the tests. However, more

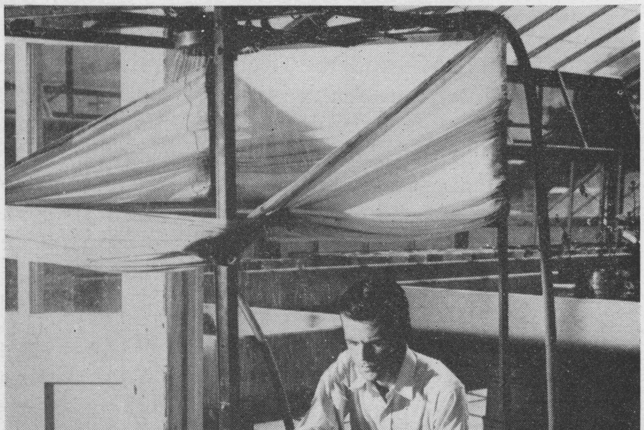


**Figure 2. Apparatus for applying simulated rain to treated cotton plants.**

uniform results generally were obtained when the insects were reared from infested squares collected in the field and held under controlled temperatures in the laboratory until the adults emerged.

Laboratory-reared third and fourth instar larvae were used in the tests involving the salt-marsh caterpillar *Estigmene acrea* (Dr.) and the cotton leafworm, *Alabama argillacea* (Hbn.). Experiments with the garden webworm *Loxostege similalis* (Guen.) were conducted only on fourth-instar larvae.

Cultures of the cotton aphid *Aphis gossypii* Glov. and the tumid spider mite *Tetranychus tumidus* Banks maintained in the laboratory on seedling cotton served as sources of supply for tests with these cotton pests.

## BIOASSAY TECHNIQUES

In the tests with spray residues, cotton plants were passed by means of a turntable device through a spray delivered by two hollow-cone nozzles operating under a pressure of 60 pounds per square inch (p.s.i.), Figure 3. The volume of liquid applied in one revolution of the turntable at a speed of 4.5 m.p.h. is equivalent to a field dosage of 5 gallons of spray per acre. The desired dosage in terms of pounds of toxicant per acre was obtained by varying the amount of concentrate in a constant volume of spray. Sprays in some of the tests were applied from the top of a tower through a solid cone nozzle at a pressure of 40 p.s.i. and at a dosage equivalent to 7.5 gallons of spray per acre, Figure 4. Insecticidal dusts were applied by compressed air from the top of a 44-inch dusting chamber. All dosages are expressed in terms of pounds of toxicant per acre and an effort was made to approximate commonly recommended field dosages.

In the boll weevil tests, four potted cotton plants were used for each treatment under each condition on a given date. Each treatment was repeated three to eight times on different dates. Ten to 15 boll weevils were released on each plant so that each treatment was tested with at least 120 insects. Essentially the same procedure was followed in tests with the cotton leafworm, the salt-marsh caterpillar and the garden webworm. Larger numbers of cotton aphids and spider mites were used in the tests on these pests. In most instances, each treatment was repeated eight times for each climatic condition under study. Mortality percentages in all tests were based on the number of insects killed within 3 to 5 days after the release of the insects on the treated plants.

# *Effect of Temperature and Humidity*

Insecticide residues on cotton plants were exposed to prevailing temperature and humidity conditions for 24 hours before the insects were placed on them.

During the tests temperatures ranged from 54° to 115° F. and relative humidities varied from 28 to 98 percent. Losses in toxicity attributed to these climatic factors are shown in the column marked "24-hour exposure" in each graph.

Temperature and humidity changes did not greatly alter the residual toxicities of toxaphene, dieldrin, endrin and Guthion. Losses in toxicity were much greater among the more volatile insecticides such as BHC, parathion, methyl parathion and Phosdrin. Within the effective limits, the ranges of temperature and humidity were not important in determining the period of residual toxicity of either group.

## CHLORINATED HYDROCARBON INSECTICIDES

TOXAPHENE. Toxaphene sprays were applied to plants at a dosage of 1.5 pounds of toxicant per acre, and the plants were exposed to temperatures ranging from 68° to 106° F. and relative humidities ranging from 34 to 98 percent. A reduction of 10 percent in mortality occurred among weevils confined on these plants compared with weevils confined on freshly sprayed plants, Figure 5. The reduction in mortality increased to 56 percent when the weevils were released on treated plants which had been weathered for 48 hours.

In tests with the cotton leafworm confined on toxaphene residues which had been exposed to an effective temperature range of 76° to 106° F. and a humidity range of 36 to 62 percent, the reduction in mortality averaged 15 percent, Figure 6. Under temperatures ranging from 67° to 77° F., a spray of 0.5 pound of toxaphene per acre was more toxic to the leafworm than 0.06 pound of toxaphene per acre applied as a dust.

Salt-marsh caterpillars were confined on the residues of toxaphene sprays applied at dosages of 0.3 to 1 pound of toxicant per acre. Mortality among the insects confined on freshly sprayed plants averaged 25 percent greater than that recorded when exposure of the insects on treated plants was delayed for 24 hours, Figure 7. In a similar series of tests with the garden webworm only a 7 percent reduction in mortality was recorded.

DIELDRIN. Spray dosages ranging from 0.15 to 0.33 pound of dieldrin per acre were used to evaluate the residual toxicity of this insecticide to the boll weevil. A 20 percent reduction in mortality occurred when treated plants were weathered 24 hours before the weevils were confined on them. The residual toxicity of dieldrin was greatly reduced after a 48-hour weathering period.

Loss of residual toxicity of dieldrin was more striking in tests with the cotton leafworm. A 74 percent reduction in the residual toxicity of dieldrin

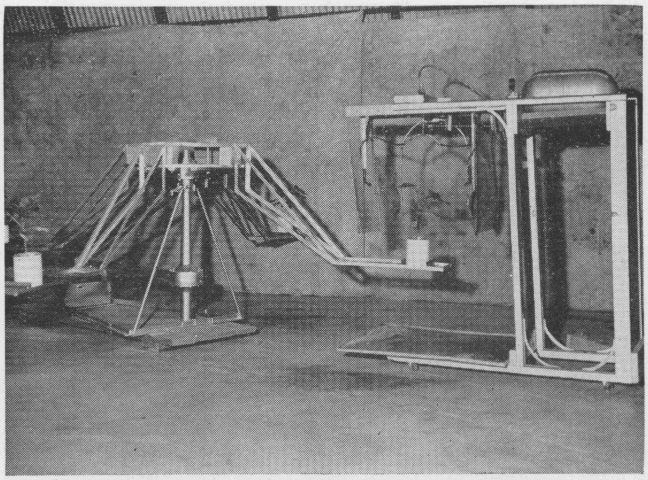


**Figure 3. A machine for spraying cotton plants in the laboratory. The plants are revolved through the spray at a speed of 4.5 miles per hour, simulating tractor spraying in the field.**

to this pest occurred after the insecticide had been on the plants for 24 hours. However, it should be noted that only 0.05 pound of dieldrin per acre was used in these tests.

In tests with the salt-marsh caterpillar, dieldrin was applied on plants at the rate of 1 pound per acre. Mortalities were reduced by 22 percent on treated plants which had been exposed to prevailing temperatures for 24 hours.

Residues from a spray application of 0.5 pound of dieldrin per acre killed 47 percent fewer garden

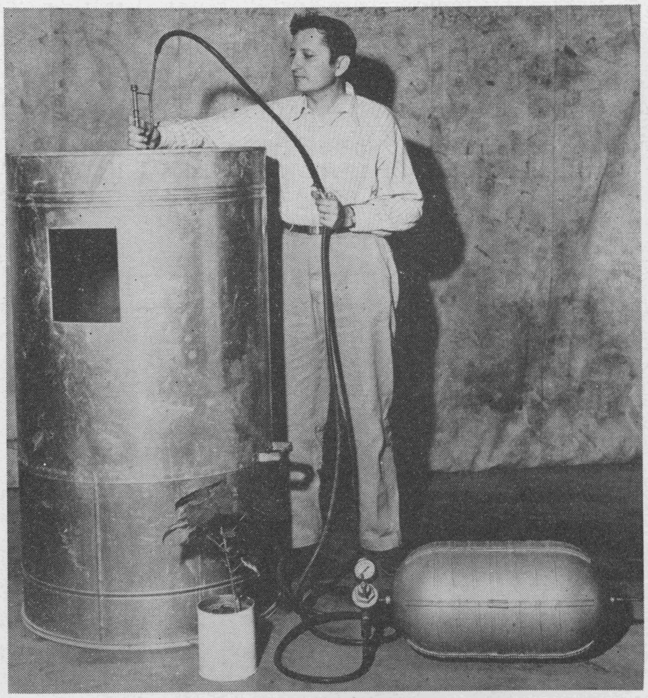


**Figure 4. Tower used to apply predetermined dosages of spray emulsions or dusts of insecticides to individual cotton plants.**

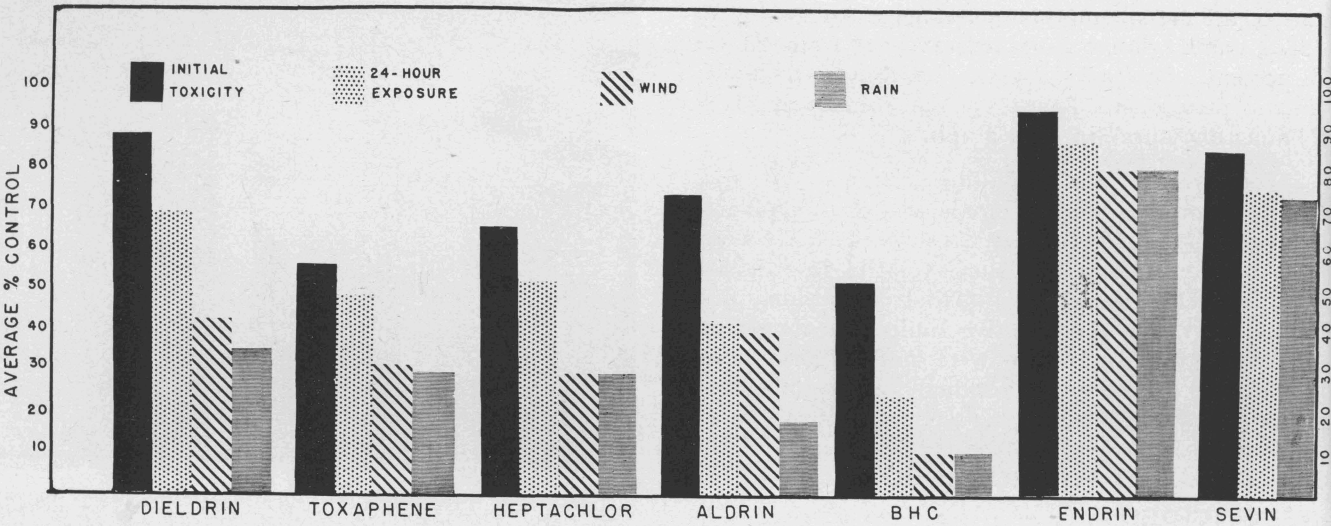



**Figure 5. Effect of various climatic factors on the toxicities of six chlorinated hydrocarbon insecticides and Sevin to the boll weevil, *Anthonomus grandis* Boh.**

webworms after the treated plants had been held for 24 hours prior to the release of the worms. Temperatures during this period ranged from 74° to 110° F. and relative humidities varied between 22 and 98 percent.

BENZENE HEXACHLORIDE. In tests with the boll weevil, emulsion sprays of BHC were applied to cotton plants at a dosage equivalent to 0.33 pound of BHC per acre. On treated plants weathered for 24 hours, weevil mortality averaged 50 percent less than on freshly sprayed plants.

After plants were treated with BHC and exposed to prevailing temperature for 48 hours, less than 20 percent of the weevils confined on them were killed.

In a series of tests with the cotton leafworm, BHC was sprayed on plants at the rate of 0.25 pound per acre. After a 24-hour weathering period the mortality rate was 22 percent less than kills of leafworms confined on freshly sprayed plants.

Benzene hexachloride was sprayed on seedling cotton plants at the rate of 1 pound per acre and cotton aphids were placed on one group of plants shortly after the spray had dried. In a second group the plants were exposed to prevailing temperature for 24 hours prior to the release of the aphids. Kills among the aphids were reduced 25 percent after the 24-hour delay period.

ALDRIN. On aldrin-treated plants, which had been exposed to prevailing temperatures for 24 hours, the mortality rate among confined weevils was 45 percent less than among those confined on freshly treated plants. The dosage was equivalent to 0.33 pound of aldrin per acre. The mortality rate among weevils confined on aldrin-treated plants which had been exposed to prevailing temperatures for 48 hours was reduced by 84 percent below the kills obtained on freshly sprayed plants.

In tests with the cotton leafworm, aldrin was sprayed on the plants at the rate of 0.25 pound per acre. After the treated plants had been exposed to prevailing temperatures for 24 hours, the mortality rate among leafworms released on them was reduced by 30 percent compared with mortalities obtained from releases on freshly sprayed aldrin.

Plants were sprayed with aldrin at the rate of 2 pounds of toxicant per acre in tests with the salt-marsh caterpillar. Kills among the insects confined on the residues were reduced by 70 per cent after the treated plants had been exposed to prevailing temperatures for 24 hours. Similar results were obtained in tests with the garden webworm.

ENDRIN. Spray residues of endrin on cotton plants were equally toxic to the boll weevil both before and after a 24-hour exposure to prevailing temperatures. The spray was applied at a rate equivalent to 0.12 pound of endrin per acre. Forty-eight hours after the plants had been sprayed kills of weevils on the residues were reduced by 18 percent below mortalities obtained on freshly treated plants.

Endrin applied to plants at the rate of 0.01 pound per acre was highly toxic to the cotton leafworm. A reduction of 17 percent in mortality occurred when the leafworms were confined on treated plants which had been exposed to prevailing temperatures for 24 hours. Similar results were obtained in tests with the salt-marsh caterpillar and the garden webworm. However, the spray dosages were increased up to 0.30 pound of endrin in the latter tests. In general endrin dusts were as effective as sprays.

HEPTACHLOR. Sprays of heptachlor applied to plants at the rate of 0.33 pound of toxicant per acre were used in tests with the boll weevil. Mortalities among weevils confined on freshly treated plants varied from 41 to 85 percent. After the sprayed plants had been exposed to prevailing temperatures for 24 hours, weevil kills on the residues were reduced by 25 percent.

## ORGANOPHOSPHORUS INSECTICIDES

PARATHION. In tests with the cotton leafworm, parathion was sprayed on plants at the rate of 0.005 pound per acre. High mortality rates were noted when leafworms were exposed to residues on treated plants which had been kept in the laboratory for 24 hours; however, leafworms were not killed by feeding on treated plants which had been left outdoors for 24 hours.

Sprays of parathion were toxic to the tumid spider mite, Figure 8. Parathion was applied to plants at a rate of 0.1 pound per acre. A reduction in mortality of 20 percent occurred when mites were placed on treated plants which had been weathered for 24 hours. Kills of mites on freshly sprayed plants were used for comparison.

A spray dosage of parathion equivalent to 0.1 pound per acre was used in tests with the cotton aphid. The mortality rate among cotton aphids confined on freshly sprayed plants was 38 percent higher than among aphids confined on treated plants which had been exposed to temperatures ranging from 65° to 98° F. for 24 hours, Figure 9.

METHYL PARATHION. In tests with the boll weevil, methyl parathion was sprayed on plants at dosages equivalent to 0.125 to 0.33 pound of toxicant per acre. Almost 100 percent of the weevils confined on freshly sprayed plants were killed, Figure 10. The mortality rate was reduced by about 19 percent when weevils were confined on treated plants which had been held in the laboratory at 85° F. for 24 hours. No further reduction in weevil mortality occurred on treated plants which had been held in the laboratory for 24 hours at temperatures up to 110° F. However, the average mortality was reduced by 65 percent when weevils were placed on treated plants which had been held outdoors for 24 hours. Bright sunlight may have contributed to these losses in residual toxicity.

Tests with the cotton leafworm showed that the residual toxicity of methyl parathion to this insect was reduced when treated plants were held in the laboratory for 24 hours before leafworms were placed on them.

When both insecticides were applied at the same dosage, methyl parathion was less toxic to the tumid spider mite than parathion under all test conditions. Essentially the same results were obtained in tests with the cotton aphids.

MALATHION. The residual properties of malathion were similar to those of methyl parathion in tests with the boll weevil. In these tests, malathion was sprayed on plants at dosages equivalent to 0.5 pound of toxicant per acre. Mortalities among weevils

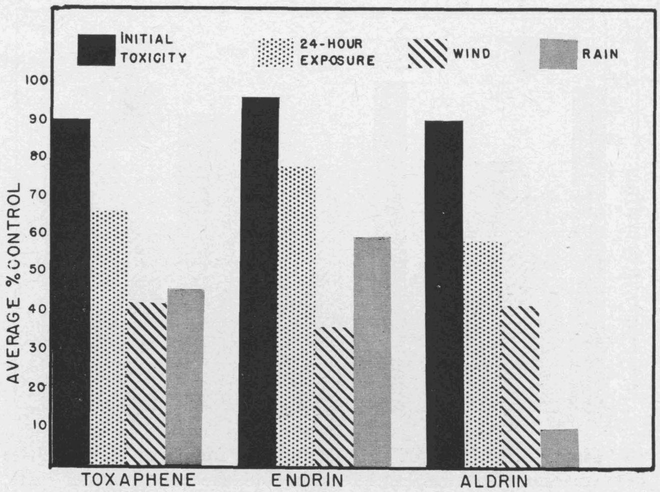



**Figure 6. Effects of various climatic factors on the toxicities of toxaphene, endrin and aldrin to the cotton leafworm, *Alabama argillacea* (Hubner).**

confined on freshly sprayed plants were 19 percent greater than mortalities among these insects confined on treated plants which had been exposed to prevailing temperatures for 24 hours. Temperatures above 100° F. in the absence of bright sunlight did not further reduce the residual toxicity of malathion. The residual effectiveness of this insecticide was greatly reduced when treated plants were exposed to high temperatures and bright sunlight before weevils were confined on them.

In tests with the cotton leafworm, spray residues of malathion from an application equivalent to 0.25 pound per acre were no longer toxic to this insect after the treated plants had been exposed to prevailing temperatures for 24 hours.

The extent of mortality among cotton aphids on spray residues of malathion was reduced 50 percent after treated plants had been exposed to prevailing temperatures for 24 hours.

GUTHION. Dosages of Guthion equivalent to 0.04 pound per acre were used in tests with the boll

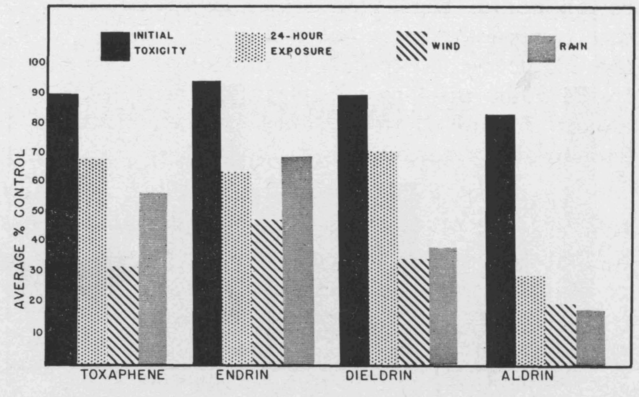



**Figure 7. Effects of various climatic factors on the toxicities of four chlorinated hydrocarbon insecticides to the salt-marsh caterpillar, *Estigmene acrea* (Drury).**

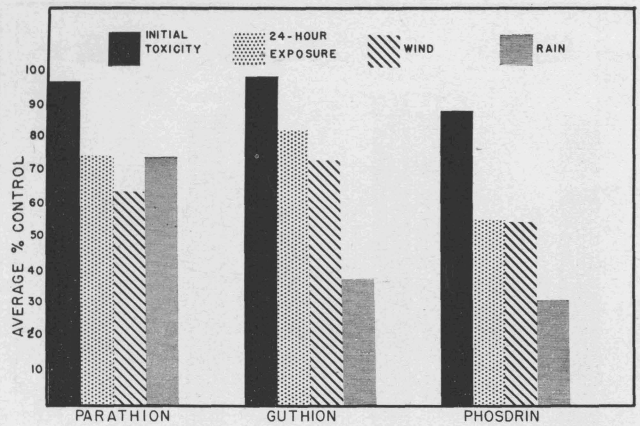



**Figure 8. Effects of various climatic factors on the toxicities of parathion, Guthion, and Phosdrin to the tumid spider mite, *Tetranychus tumidus* Banks.**

weevil. Excellent kills of weevils were obtained on freshly treated plants and also on treated plants which had been exposed to prevailing temperatures for 24 hours. In these tests, temperatures above 100° F. did not affect the residual toxicity of Guthion. Dusts of Guthion were equally effective under these conditions.

Dosages of Guthion equivalent to 0.5 pound of toxicant per acre were highly toxic to the tumid spider mite. The extent of mortality among the mites was reduced only 18 percent when they were confined on treated plants which had been exposed to prevailing temperatures for 24 hours. However, smaller dosages of Guthion were ineffective under these conditions.

## *Effect of Simulated Rain*

In general, simulated rain appreciably reduced the residual toxicities of the chlorinated hydrocarbon insecticides to all the test insects. It is doubtful that the residues on treated plants remaining after a half-inch rain would be sufficient to insure protection from insect damage. Residues of endrin appeared to be least affected by rain, while the residual toxicities of aldrin and BHC were almost completely destroyed.

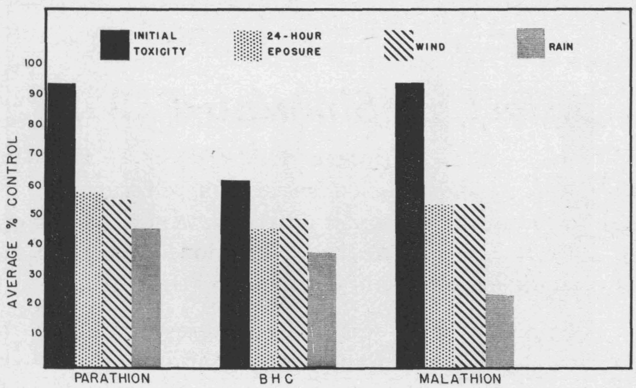



**Figure 9. Effects of various climatic factors on the toxicities of parathion, malathion, and BHC to the cotton aphid, *Aphis gossypii* Glover.**

Among the organophosphorus compounds, Guthion and malathion were considerably less effective after a rain. However, most of the other insecticides in this group had short periods of residual effectiveness even in the absence of rain.

### CHLORINATED HYDROCARBON INSECTICIDES

TOXAPHENE. Several experiments were conducted to determine the effect of rain on the residual toxicity of toxaphene to the boll weevil. All the materials were applied as emulsion sprays. One-half inch of simulated rain was applied as soon as the sprays had dried on the plants and the weevils were released on plants within 30 to 45 minutes. No reductions in mortality could be attributed to the rain treatments in four of the tests while reductions above 50 percent occurred in the remaining three tests. It is noteworthy that reductions in mortality occurred in those tests where the kill of weevils on the freshly sprayed plants was relatively high. When all the treatments were weathered for 24 hours and reductions in residual toxicity caused by other factors were discounted, simulated rain did not further reduce the residual toxicity of toxaphene.

In tests with the cotton leafworm, simulated rain was detrimental to toxic residues of toxaphene. Mortalities among worms were about 30 percent less on spray residues of this insecticide which had been exposed to simulated rain than those obtained on treatments held under the usual laboratory conditions. The residual effectiveness of toxaphene dust were virtually destroyed by simulated rain in these tests.

In tests on the salt-marsh caterpillar, spray dosages of toxaphene equivalent to 0.35 pound of toxicant per acre killed 55 percent of the caterpillars on the residues weathered by simulated rain. The residual effectiveness of toxaphene dusts for these insects was destroyed by simulated rain.

DIELDRIN. Mortalities among boll weevils confined on plants treated with dieldrin were reduced by approximately 50 percent after the plants had been exposed to simulated rain. However, some of the mortality rates averaged less than 30 percent even on the freshly sprayed plants.

In tests on the salt-marsh caterpillar, the residual effectiveness of dieldrin was adversely affected by exposure of the sprayed plants to simulated rain. Mortalities among the caterpillars were reduced from 90 percent on freshly sprayed plants to 34 percent on the treated plants subjected to simulated rain.

BENZENE HEXACHLORIDE. Simulated rain completely destroyed the residual toxicity of BHC dusts to the cotton leafworm when the dusts were applied at dosages equivalent to 0.04 to 0.08 pound of toxicant per acre.

The effect of rain on spray residues of BHC could not be evaluated in tests on the boll weevil and the cotton aphid because a 24-hour exposure period in the absence of rain was almost as detrimental to the residual toxicity as exposure to rain.

ALDRIN. Residues of aldrin on plants were no longer effective in killing boll weevils after being subjected to simulated rain. Simulated rain was applied as soon as the spray had dried on the plants. Even this short exposure resulted in a 67 percent decrease in mortality compared with mortalities among weevils confined on freshly sprayed plants.

ENDRIN. Endrin spray applied to plants at a dosage equivalent to 0.196 pound per acre killed 80 percent of the boll weevils released on treated plants which had been exposed to simulated rain.

When the cotton leafworm was used as a test insect, simulated rain reduced the residual toxicity of endrin spray in one series of tests, but had no effect on the residual toxicity in the other.

Mortalities among salt-marsh caterpillars from spray residues of endrin were reduced from 95 percent to 70 percent by a 24-hour exposure period which included simulated rain.

HEPTACHLOR. The residual toxicity of heptachlor sprays to the boll weevil was adversely affected by rain. Mortalities among weevils confined on sprayed plants were reduced by approximately 50 percent when the treated plants were exposed to simulated rain.

A spray application of heptachlor equivalent to 0.4 pound of toxicant per acre killed only 20 percent of the salt-marsh caterpillars released on treated plants which had been exposed to rain compared to a 77 percent mortality rate obtained on freshly sprayed plants.

### ORGANOPHOSPHORUS INSECTICIDES

PARATHION. The residual toxicity of parathion to the tumid spider mite was not affected by simulated rain when the spray was applied at a dosage equivalent to 0.3 pound of toxicant per acre.

Kills of the cotton aphid on spray residues of parathion were reduced by approximately 25 percent below the kills obtained on residues held for 24 hours in the absence of rain. The initial dosages of parathion in these experiments were equivalent to 0.25 pound of toxicant per acre.

METHYL PARATHION. When boll weevils were used in tests with this compound, most of the losses in toxicity occurred during the 24-hour weathering period. No additional losses due to simulated rain were apparent. Dosages of methyl parathion equivalent to 0.2 pound per acre were ineffective to the boll weevil 24 hours after the insecticide was applied. Similar results were obtained in tests with the cotton leafworm.

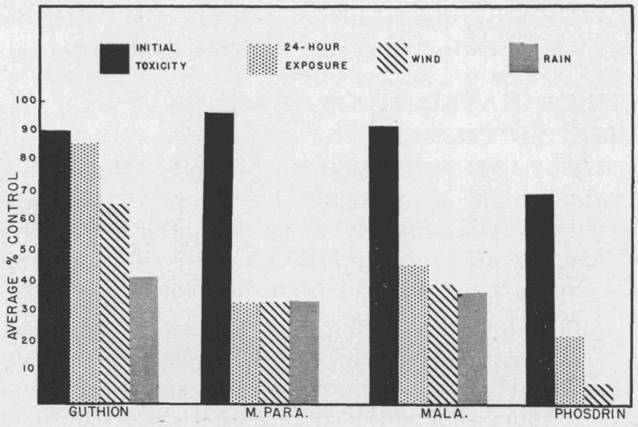



**Figure 10. Effects of various climatic factors on the toxicities of four organophosphorus insecticides to the boll weevil, *Anthonomus grandis* Boh.**

MALATHION. Sprays of malathion were ineffective for killing the boll weevil after the residues were exposed to simulated rain. The reductions in kills were less striking in tests on the cotton leafworm, but the detrimental effect of rain was still clearly evident. Exposures to simulated rain reduced kills of cotton aphids from residues of malathion by more than 50 percent.

GUTHION. Simulated rain was probably the most important single factor contributing to the loss of the residual toxicity of Guthion with all species of the test insects. Toxic residues of this material were relatively stable under all the other climatic conditions encountered during these investigations. In tests on the boll weevil, dosages of Guthion equivalent to 0.125 pound per acre were ineffective after the residues had been exposed to simulated rain. In tests on the tumid spider mite, dosages of Guthion equivalent to 0.5 pound per acre lost about 50 percent of the residual effectiveness after weathering by rain.

PHOSDRIN. The effective residual period of Phosdrin was too short to evaluate the effects of simulated wind and rain on the residues. Temperature and humidity conditions incident to the holding period were sufficient to destroy most of the residual toxicity of this material.

## *Effect of Simulated Wind*

Among the chlorinated hydrocarbon insecticides, there was little difference between the effects of simulated wind and rain on residual toxicities. However, it is likely that under field conditions the effects of rain would be more noticeable.

Simulated wind was less damaging than rain to the residual toxicities of Guthion and malathion in most of the tests. The results with parathion and methyl parathion were about the same whether the period of weathering included simulated wind or rain.

Generally, insecticide dusts were affected more by simulated wind than sprays of the same materials.

## CHLORINATED HYDROCARBON INSECTICIDES

TOXAPHENE. Simulated wind reduced the residual toxicity of toxaphene sprays to the boll weevil by approximately 40 percent after the effects of temperature and humidity on the residues during the exposure periods had been discounted.

The effect of wind on dust residues of toxaphene was evident in tests on the salt-marsh caterpillar. After dusted plants were exposed to simulated wind for 24 hours, mortalities among caterpillars confined on these plants were reduced 55 percent.

DIELDRIN. Spray residues of dieldrin were less toxic to the boll weevil after exposure to simulated wind. Kills of weevils on treated plants, which had been subjected to air currents for 24 hours, were reduced by 33 percent compared with those obtained on treated plants exposed for the same period of time in the absence of simulated wind.

In tests with dieldrin dusts on the salt-marsh caterpillar, 80 to 90 percent of the test insects were killed by dosages of dieldrin equivalent to 1.0 pound of toxicant per acre; however, only 30 to 40 percent were killed when placed on treated plants which had been subjected to simulated wind for 24 hours. Essentially the same results were obtained with sprays of dieldrin applied at dosages equivalent to 0.15 to 0.33 pound of toxicant per acre.

BENZENE HEXACHLORIDE. The residual toxicity of BHC to the boll weevil was practically destroyed by simulated wind.

In tests with the cotton leafworm BHC was sprayed on plants at the rate of 0.25 pound per acre. After the treated plants had been exposed to simulated wind for 24 hours the kills among confined leafworms were reduced by 30 percent.

There was little difference in the residual toxicity of BHC to the cotton aphid when simulated wind was added to the weathering factors affecting the treated plants.

ALDRIN. Toxic residues of aldrin were dissipated so rapidly by temperature and moisture conditions during the exposure periods that it was difficult to evaluate the role of wind in the reduction of the residual toxicity to the boll weevil of this compound. However, kills of the salt-marsh caterpillar and the garden webworm were reduced by about 40 percent by the action of wind on spray and dust residues of aldrin.

Simulated wind appreciably reduced the residual toxicity of aldrin to the leafworm.

ENDRIN. Wind apparently had little effect on the residual toxicity of endrin to the boll weevil. Compared with 78 percent mortality obtained on freshly sprayed plants, spray residues of endrin subjected to wind currents for 24 hours killed only 36 percent of the cotton leafworms released on them. However, it should be noted that the dosage of endrin used in this experiment was equivalent to only 0.01 pound of toxicant per acre.

Dosages of endrin equivalent to 0.25 pound of toxicant per acre killed about 50 percent of the test population of salt-marsh caterpillars on residues which previously had been exposed to simulated wind. However, when the dosage was reduced to 0.15 pound per acre, the kills averaged about 60 percent less than those obtained among the insects confined on the residues weathered in the absence of simulated wind.

HEPTACHLOR. The residual toxicity of heptachlor to the boll weevil was reduced appreciably by simulated wind. Mortalities among weevils confined on sprayed plants were reduced by 50 percent by exposure of the treated plants to either simulated wind or rain. Similar results were recorded in tests with the salt-marsh caterpillar.

## ORGANOPHOSPHORUS INSECTICIDES

PARATHION. Simulated wind did not reduce the residual toxicity of parathion spray to the cotton leafworm even when the dosages of insecticide were reduced to 0.005 pound of toxicant per acre.

In tests on the tumid spider mite, simulated wind acting on the parathion spray residues reduced the kills about 19 percent below those obtained from residues held in the absence of wind. Essentially the same results were obtained in tests using the cotton aphid.

METHYL PARATHION. When dosages equivalent to 0.5 pound per acre of this insecticide were applied to plants to kill boll weevils, simulated wind did not reduce the residual toxicity below that on treated plants held in the absence of wind. In this instance most of the toxic residues were dissipated by temperature and humidity conditions inherent in the holding period. No additional losses of residual toxicity could be attributed to wind in tests on the tumid spider mite. However, mortalities obtained on sprayed plants held for 24 hours in the absence of wind were quite low.

The residual toxicity of methyl parathion to the cotton leafworm was virtually destroyed when treated plants were exposed to wind for 24 hours.

MALATHION. In tests with the boll weevil, malathion was applied to plants at the rate of 0.5 pound per acre. At this dosage the residual toxicity of malathion to weevils was not reduced appreciably by simulated wind.

The residual toxicity of malathion to the cotton leafworm was reduced by wind. However, the dosages of malathion used in tests on this insect were equivalent to only 0.025 pound of toxicant per acre.

No reduction in residual toxicity of malathion to the cotton aphid owing to simulated wind was recorded.

GUTHION. Residues from an application of Guthion dust exposed to simulated wind for 24 hours killed about 60 percent of the boll weevils released on them compared to an 80 percent kill obtained on residues held in the absence of wind. However, it should be noted that the dosage of Guthion in this experiment was equivadent to only 0.06 pound of technical material per acre. Essentially the same results were obtained in tests on spray applications of Guthion. A 25 percent reduction in kills of weevils was noted after treated plants were exposed to simulated wind for 24 hours. Spray residues of Guthion did not appear to be adversely affected by wind in tests on the tumid spider mite when the initial dosages were equivalent to 0.5 pound of toxicant per acre.

## *Effect of Simulated Dew on Insecticides*

Exposing plants treated with dusts or sprays of toxaphene-DDT and BHC-DDT to dews reduced the toxicities of these materials to the boll weevil. In general, the toxaphene and toxaphene-DDT sprays remained more toxic after these exposures than toxaphene dust or BHC sprays or dusts.

The residual toxicity of aldrin to the boll weevil was virtually destroyed by a 24-hour exposure to ambient temperatures accompanied by a dew.

In general, dew was no more detrimental to the residual toxicities of the organophosphorus insecticides than the temperature and humidity conditions inherent in the holding periods.

## *Effect of Sunlight on Insecticides*

No techniques were devised to investigate the effect of sunlight on insecticide residues in the absence of high temperature and low relative humidities. Outdoor climatic conditions during the summer included maximum light intensities of from 7,000 to 13,000 foot candles. The residual toxicities of all the insecticides tested except Guthion were more adversely affected by outdoor exposures than by exposures to comparable high temperature and low humidity conditions on the laboratory or greenhouse. It is doubtful that these differences were caused solely by variations in light intensities.

## *Effects of Climatic Factors on Sevin*

Several preliminary tests were conducted on the effects of temperature and humidity conditions and simulated rain on the residual toxicity of Sevin to the boll weevil. Wettable powders of Sevin sprayed on plants at a dosage equivalent to 1 pound of toxicant per acre remained equally toxic to the boll weevil after a 24-hour exposure to midsummer light, temperature and humidity conditions, or to 0.5 inch of simulated rain. The mortality rates among weevils on these treated plants were not significantly different from the kills obtained on treated plants held in the laboratory at 85° F.

## *Literature Cited*


**Gaines, J. C., and H. A. Dean. 1949. Effect of temperature and humidity on the toxicity of certain insecticides. Jour. Econ. Ent. 42: 429-433.**

**Gaines, J. C., and H. A. Dean. 1950. Effect of climatic factors on the toxicity of certain insecticides. Jour. Econ. Ent. 43: 602-605.**

**Gaines, J. C., and W. J. Mistric, Jr. 1951. Effect of rainfall and other factors on the toxicity of certain insecticides. Jour. Econ. Ent. 44: 580-585.**

**Gaines, J. C., and W. J. Mistric, Jr. 1952. Effect of environmental factors on the toxicity of certain insecticides. Jour. Econ. Ent. 45: 409-416.**

**Mistric, W. J., Jr., and J. C. Gaines. 1953. Effect of wind and other factors on the toxicity of certain insecticides. Jour. Econ. Ent. 46: 341-349.**

**Mistric, W. J., Jr., and J. C. Gaines. 1954. Effect of weather factors on the toxicity of certain insecticides. Jour. Econ. Ent. 47: 646-651.**

**Mistric, W. J., Jr. 1954. The effect of climatic factors on the toxicity of certain organic insecticides. Dissertation. A & M College of Texas.**

**Owen, B. L. 1954. The effect of air currents on the toxicity of spray and dust formulation of toxaphene, aldrin and dieldrin. Thesis. A & M College of Texas.**

**Mistric, W. J., Jr., and D. F. Martin. 1956. Effect of sunlight and other factors on the toxicity of certain insecticides. Jour. Econ. Ent. 49: 757-760.**

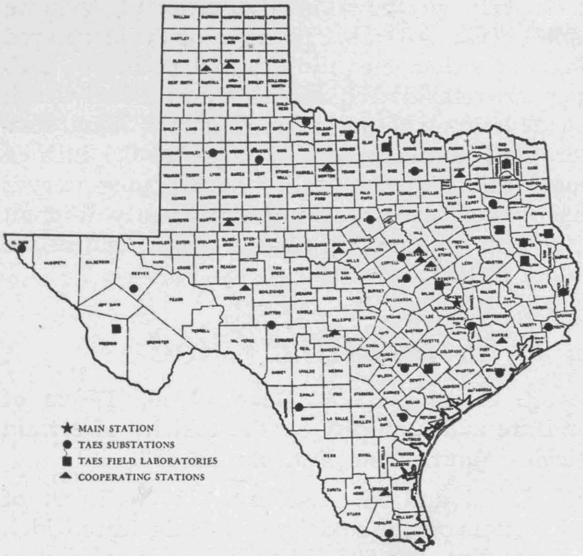
**Hightower, B. G., and D. F. Martin. 1958. Effect of certain climatic factors on the toxicities of several organic phosphorus insecticides. Jour. Econ. Ent. 51: 669-671.**

**Hightower, B. G. 1959. Bioassays of weathered residues of several organic phosphorus insecticides. Jour. Econ. Ent. 52. 840-842.**


## *Acknowledgments*


**The authors express their appreciation to H. A. Dean, W. J. Mistric, Jr., D. F. Martin, B. L. Owen and H. J. Reinhard for their contributions.**

**This work was conducted in cooperation with the Entomology Research Bureau, U. S. Department of Agriculture.**




Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

# State-wide Research

★

**The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System**

## ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

## OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

*Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service*

**AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.**

*Today's Research Is Tommorrow's Progress*