1974

Summer 1974

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TURF BULLETIN

MASSACHUSETTS TURF AND LAWN GRASS COUNCIL INCORPORATED

Featured in this issue:

Responsible Neighbor

Maintenance of Poa Annua

Ammonia Production

SUMMER 1974

BETTER TURF THROUGH RESEARCH AND EDUCATION

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Vol. 10, No. 2 **Summer 1974**

The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster "Better turf through research and education."

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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Reprinted from Boston Globe

THE FERTILIZER FIGHT

Organic trails inorganic 8-1 in experiment . . .

Try feeding a large family off an organic garden and you might encounter some trouble, reports Ted Stamen, University of Connecticut Extension horticulture agent.

In a research project conducted by Robert C. Lambe, extension specialist in plant pathology at Virginia Polytechnic Institute, Blackburg, comparisons were made of yields from two garden plots. One was grown organically and the other was grown with the help of modern agriculture chemicals. The plots were located at the Institute's Plant Pathology and Physiology Research Station.

"The results were frightening," Lambe said. "Insects and soil-borne disease organisms completely wiped out some of the vegetable crops while causing low yields in others."

Five rows of tomatoes, for example, yielded 466 pounds in the chemically protected plot and 141½ pounds in the organic plot. Five rows of cucumbers yielded 205 pounds in the chemically-protected plot and 28¾ pounds in the organic one.

Results for other vegetables were equally dramatic. One row of white squash, grown under chemical protection, yielded 157 pounds compared to 3 pounds under organic methods. No eggplant was produced from the organic plot, due to flea beetles which attacked the plants while they were quite small, while 154¾ pounds came from the chemically protected plot.

A total of 1954 pounds of vegetables were weighed from the chemically protected garden while 237 pounds came from the organic garden. Vegetables grown included black eye peas, tomatoes, peppers, okra, lima beans, cabbage, eggplant, yellow squash, cucumbers, cantaloupe, watermelon and corn.

The trial gardens were planted in May to determine the need for fungicides and insecticides in preventing diseases and controlling insects in home vegetable production.

Two adjoining plots of the same soil type were used. A soil sample of the area, which had been cropped to corn previously, showed it to be low in nutrients.

The organic garden was fertilized with 1000 pounds of dehydrated cow manure, at a cost of $50. The chemically protected plot received 100 pounds of 10-10-10 fertilizer at a cost of $3.15. In this way, both gardens received the same amounts of nitrogen, phosphorous and potassium, Lambe said. In both cases, fertilizer was broadcast over the field and incorporated in the soil.

Before planting, the chemically protected garden was treated with methyl bromide, a fumigant applied to eradicate weeds, soil insects, nematodes and soil diseases. Total cost was $37.08. The organic garden was hoed to remove the weeds, at a cost of $18, with labor costs at $2 per hour.

Both fields were irrigated twice during the summer, receiving equal amounts of water.

"When costs for labor, fertilizer, seed, fungicides and insecticides are added up, the chemically protected garden turns out to be a little more expensive, " Lambe said. "The figures are $158.18 for the chemically protected plot and $141.95 for the organic plot. However, this difference is compensated for by the larger yields and the attractive, healthier fruits and vegetables."

He noted that the organic garden suffered extensive damage from flea bettles and Mexican bean beetles, especially on egg plant and beans. Soilborne disease organisms prevented good stands of squash and melons in the organic garden.

Fungicides used in the chemically protected garden prevented serious losses from early blight of tomatoes and anthrancnose of cucumbers, he noted.

. . . But let's not polarize

Two University of Vermont professors have teamed up for an overview of organic farming.

Dr. Sam Wiggins and nutritionist Blair Williams combined their findings in a recent issue of "Crops and Soils Magazine."

Nature's way of growing crops is fine, but it won't produce enough for us all without help, they summarized, according to Vermont Natural Resources Forum, a newsletter of the University of Vermont Extension Service.

Avoiding the polarization that often characterizes articles on this topic, they noted that higher yields often come when organic and inorganic materials are both used than when either is used separately.

But they reported no differences in nutrient analysis or quality of crop plants produced when equal amounts of nutrient are applied according to soil test recommendations. The reason is that organic fertilizers are converted into inorganic form before they enter the plants.

They found no evidence that our diets contain poisonous chemicals as the result of the use of inorganic fertilizer.

In avoiding an either-or position, they have this to say:

"Now, don't get us wrong; we are not saying that organics are worthless. The making of compost from leaves, grass and other organic wastes for application to small plots of ground is to be encouraged. The average farmer, however, cannot cover large acreages with compost since it is either not available or too expensive."

Reprinted from Farm Chemicals, Vol. 137, No. 1

Ammonia Production Must Receive Top Priority

By J. J. Clarke

The impact of the energy crisis has recently generated a barrage of information . . . and misinformation. The awakened public awareness is encouraging. For years the warnings of people in the energy industries were voices in the wilderness. No one else seemed to hear them, or believe them, or to be concerned. Today we recognize that there is a serious energy problem. We know that this shortage will have profound effects on all U.S. industry.

The sources of United States energy since 1920 projected to the year 1985 are shown in Figure I. Use of oil and gas has increased until it is now three-fourths of our national energy supply. Consumption of coal is the same today as it was 50 years ago.

There is no shortage of energy. There is a shortage of developed and available supplies of energy. We have two current sources of energy which could be expanded greatly to alleviate the problem: Coal and nuclear power. The U.S. has almost half the world's proven coal reserves. These reserves could last hundreds of years. Nuclear power could be expanded many times.

Development of coal and nuclear energy sources will be delayed many years by environmental requirements and government controls. Currently, the lead time to put a nuclear power plant into operation is 8 to 10 years. More than half of this lead time is for the paper work and obtaining the required approvals.

Geothermal, solar, and shale oil energy will increase in the future. But it will be many years before they become significant. For at least a decade, they will not be great enough to transform us into a nation with an energy surplus.

We know we will require continued increases in our energy supply to continue a healthy economy and improvement of our national welfare. Oil and gas must be a major contributor to this increased supply. Historically, domestic oil and gas supply increased with the national requirements. Imports were a very minor part of our total supply. It is inevitable that in the immediate future there must be major increases in foreign imports (Figure 2). This projection suggests that by 1985 these imports of energy could increase by about $60 billion per year — an amount greater than our total imports of all merchandise last year.

As a nation there is only one way we can pay for these increased imports — by increased exports. Agriculture is one of the most important industries required to make up this potential deficit in the balance of trade. The agricultural industry must prepare itself, and it must receive the national support necessary to increase exports far above present levels.

Feedstock for Ammonia

In the U.S., 94% of the ammonia is manufactured from natural gas. The remaining 6% comes from byproduct gas.

Mr. Clarke is manager of development for Collier Carbon & Chemical Co.

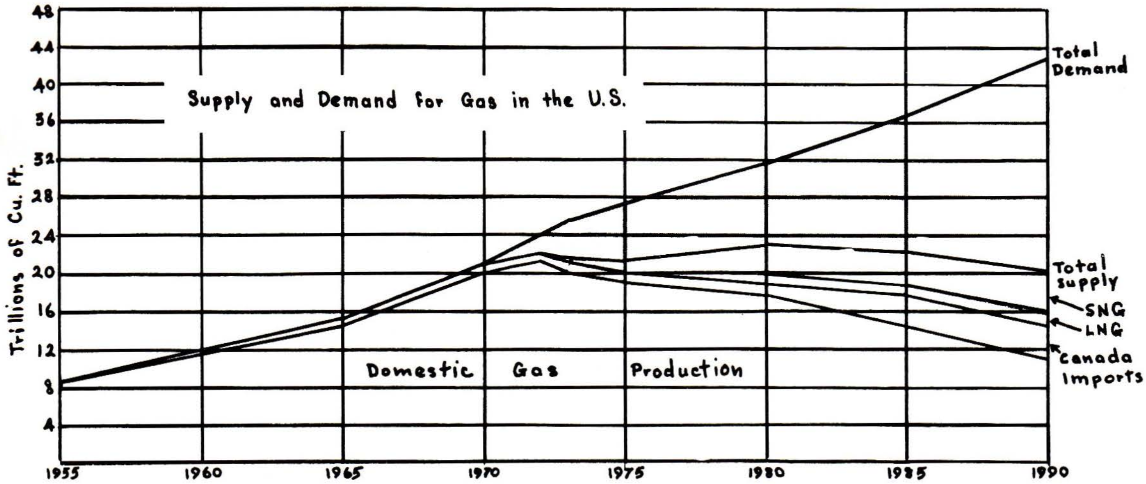

Figure 3

Hydrogen from chlorine cells, coke oven gases, and refinery gases are examples of byproduct gas. Production of byproduct ammonia is only incidental to the production of some other product and can never be expected to be a major source of ammonia.

Technologically, it is possible to use materials other than natural gas as the raw material for ammonia manufacture. Naphtha is the only other raw material used in the world to produce significant amounts of ammonia, and is used only in countries where there is no natural gas such as Japan. And these plants are in trouble because there is a world-wide shortage of naphtha.

Conversion of ammonia plants to naphtha requires very costly changes to the chemical process system. It is much more expensive than converting boilers and other gas users to liquid fuels. It would make absolutely no sense economically to consider converting U.S. ammonia plants. If naphtha were available it would be much more logical to use it as a fuel and make more natural gas available to ammonia plants.

We can never build our agricultural industry on any source of nitrogen other than ammonia from natural gas.

Allocation of Energy

The national limitation of available energy will continue for many years. It is important for our country to make certain that the limited supplies are allocated to those users that are most important to our nation as a whole.

Curtailment should not fall on those end uses which are most beneficial to the entire country. We must not curtail the uses that are essential for health. We must not curtail the basic industries which are the foundation of our entire economy. If we fail to supply our basic industries, the result will be increased shortages of many products, inflation, loss of jobs. It could also possibly result in a serious downturn in the national economy.

The agricultural industry is unquestionably one of our most critical basic industries. Last year the total value of all agricultural products at the farm gate was $59 billion. This value is multiplied many times as these products leave the farm and generate additional benefits throughout our nation's economy.

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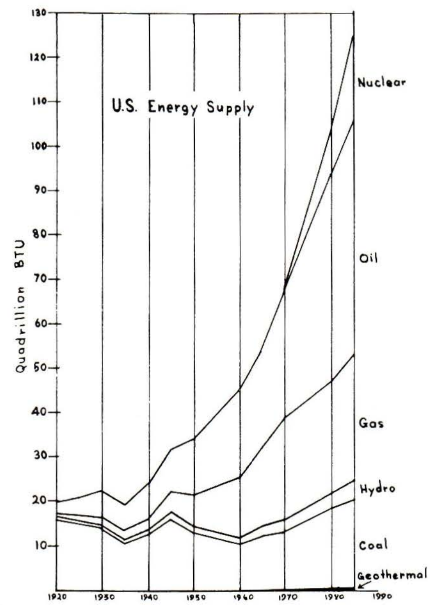

Figure 1

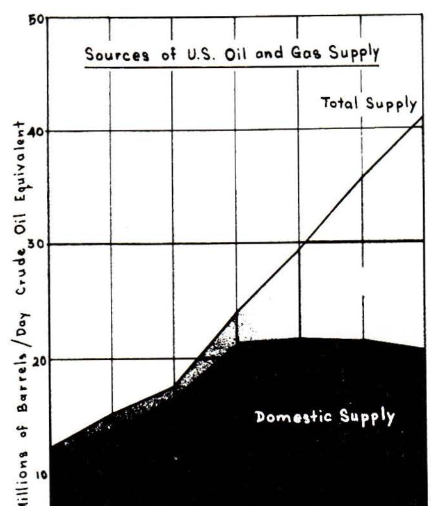

Figure 2

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As one example of the importance of fertilizer and natural gas to the farmer, estimates have been made for the State of California. Although the benefits of fertilizer vary with different crops and conditions, as average bench marks it is estimated that:

- For each ton of fertilizer nutrient used by California farmers, farm income is increased by $1900.
- The natural gas supplied to ammonia plants increases California farmers' income by $40 per 1000 cubic feet of gas used.

It is remarkable that natural gas costing about 40 cents could generate farm income of $40. It is apparent that ammonia manufacture is one of the most beneficial uses of natural gas.

Natural gas is short, and it is being allocated. We know that it will continue to be short and will continue to be allocated. It is generally accepted that the No. 1 priority will be hospitals and residences. After supplying the No. 1 priority it is much wiser for our nation to allocate the limited supply to ammonia plants instead of spreading it around among all the users which could substitute another fuel. If this policy is adopted, there will be no noticeable effect on the supply of gas to household heating or other high priority uses. This is because the nitrogen fertilizer industry uses little more than 2% of the nation's natural gas.

Rising Prices

The price of natural gas has remained almost constant for many years. When it became necessary to tap new, more expensive sources of energy, the price of all other fuels began to increase rapidly. Natural gas, however, has had only slight increase because its price has been controlled by the Federal Power Commission since 1954.

Fuel oil is the fuel which is most easily interchanged with natural gas. Until 1971, the prices of fuel oil and gas were close to each other. On the West Coast both were about 40 cents/million BTU. Since then, fuel oil prices have increased as the cost of obtaining crude oil has increased. Today, imported crude oil in the Gulf Coast is $9 per barrel. This is over $1.50/million BTU for crude oil before it is even refined into fuel oil.

Despite the increased prices of all other fuels, natural gas continues to be controlled at artificially low levels. With this situation, who is willing to convert from natural gas to other fuels?

The new sources of gas, LNG and SNG, will cost much more than gas produced from wells in the U.S. The first LNG to be imported into the U.S. is El Paso Natural Gas Co.'s project for importing gas from Algeria to the East Coast. The cost of that gas was estimated to be 90 cents/million BTU delivered to the East Coast terminal. El Paso said this will be the lowest cost LNG will ever get in this country. History is proving this to be correct. El Paso recently made an application for a second block of LNG. Part of this gas would be brought to the Gulf Coast and be transported inland to join the pipelines. Delivered to the pipelines, El Paso estimates the cost of this second block to be $1.57/million BTU.

Current estimates of cost of gas from Russia are in the range of $1.30 to $1.75/million BTU. I am certain that when the bill finally comes in we will find that the actual cost is higher than these estimates. A new record was recently set for LNG prices. A utility in Lowell, Mass. is purchasing LNG from Canada for $2.65/million BTU. However, this is for a small quantity and is not truly representative.

Future supplies of LNG and SNG will average three to six times the current cost of gas from domestic wells.

Nitrogen Supply

In the past, the U.S. has normally had a substantial surplus of ammonia manufacturing capacity. Around 1970, this surplus began to diminish. Prices were so low that some of the older, less economical plants were shut down. Although demand continued to increase, very few new plants were built because of the uncertainty of gas supply and the low fertilizer prices.

Even today when the shortage of nitrogen is apparent, very few ammonia plants are being built in the United

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States. No one can make the investment in an ammonia plant unless they can be assured of a long-term supply of raw material. Under present gas allocation policies there is no chance that enough new plants will be built in the U.S. to fulfill the future demand for nitrogen fertilizers.

Gas curtailments are becoming significant in reducing ammonia production. It is evident that these curtailments are turning a tight supply situation into a serious shortage.

Today, the gas company is telling us that in a few years our California plants will be curtailed more than 250 days per year. Costs of ammonia production increase greatly when operating at reduced rate. The plants can't operate at all if they are curtailed 250 days per year.

Failure to provide raw material for U.S. fertilizers will result in our farm industry becoming dependent upon the vagaries of foreign imports. If future nitrogen supplies must be imported, America's agriculture will be forced to bid competitively on the world market for its fertilizers. This will result in much greater price fluctuations than have been experienced in the past as well as continued uncertainty of supply.

Foreign governments will be influenced by barter and special trading agreements in their fertilizer allocation programs to the U.S. and other countries. Undoubtedly, there will be political considerations involved, both internationally and within the producing nation's domestic agricultural industry. If the foreign government decides they need the fertilizer within their own country, can we rely on their continuing to export sufficient amounts to support our agricultural industry?

BACK AND BEYOND

By Joseph Troll

Briefly reviewing last year's turfgrass growing season, it seems that few, if any, Golf Course Superintendents erred in the management of their turf. Moture nature, however, did err and last season she was instrumental in causing a considerable amount of dead or damaged grass.

Excessive spring and early summer rains weakened the fine turfgrasses. High temperatures and high relative humidity that followed the rains further weakened the plants. All of these factors predisposed the turf to susceptibility to wilt and fungus-caused diseases. Injured or sparse grass areas were subjected to invasion by weeds, especially crabgrass. Applications of preemergence crabgrass control chemicals in many cases failed to prevent investation. The inability to control crabgrass was possibly due to the washing away of the chemical by heavy rains. A number of Green Chairmen became apprehensive but the knowledgeable Superintendent saved much of his turf and the golfer continued to enjoy his game.

Turfgrasses came out of the 73-74 winter with very little injury, if any. Gray snow mold was less prevalent. Shorter periods of snow cover and without doubt protective fungicides helped prevent the disease.

To date, rainfall has been ample but not excessive. However, rain could become excessive and multiply turf problems as they did last year. Temperatures have been cool and a good number of the nights have had frost.

Because of the low temperature, bentgrasses are not gorwing well; they lack color. Fertilizers applied to greens have not enhanced either color or growth. Additional applications should not be made until climatic conditions favor growth. If the turf contains a heavy thatch, added fertilizer could accumulate and with a sudden temperature rise explode and cause a burn.

Annual bluegrass is forming seed but even it is a bit behind schedule. In a number of areas *Pao annua* is also off color; it is yellow rather than a light green. Fairway and home lawn Kentucky bluegrass and its cultivars are severely infected with helminthosporium. On some sites the organism is causing crown rot. Continuation of the cool and moist weather will require repeated application of fungicides such as Actidione, Tersan LR, Daconil, etc.

What is going to happen to fine turfgrass the rest of the season is as predictable as the weather. It is most certain that the Superintendent will adjust his management practices to cope with any drastic changes in the elements.

Just a few broad points are made below that might assist in making the rest of the season more explainable and playable.

The energy crisis, is one sense, may aid the professional turfgrass manager. The cost of fertilizer and some petroleum based pesticides have increased drastically. The judicious use of these chemicals could help offset their cost but more importantly help to produce a more hardy plant.

Lesser amounts of fertilizers, practicularly nitrogen, should be applied to golf greens. More frequent soil tests could be taken to determine fertilizer needs. Raising the height of cut should be employed when and where possible, to increase photosynthetic areas and encourage deeper roots. Excess nitrogen and water can lead to succulent turf which is more often susceptible to disease; has shallow roots and is a totally less hardy plant. A dark green grass plant is not necessarily a healthy plant. It is best to keep turf in greens slightly on the hungry and dry side.

Continually wet soils enhance compaction which in turn causes poor thin turf. The Superintendent is cognizant of these facts and he should be able to close the course during periods of stress. Golf carts should be kept off the course when there is excessive moisture. Actually, even when the course is playable, carts should be confined to the rough and allowed only to the ball at right angles from the rough.

The membership must have faith in their Superintendent and be understanding of the problems he must deal with. Good rapport between the Superintendent and Green Chairman and self-policing by the members will help to make golfing more pleasurable this and every season.

Reprinted from Down to Earth, Vol. 29, No. 3

Herbicides — are they safe?

By W. R. Mullison, Dow Chemical U.S.A.

In today's dark, doomsday atmosphere lighted with frightening headlines, it is fashionable to consider chemicals as particularly nasty and to condemn their usage especially if the chemical is a pesticide. Because they are so important to us all, interest in the development and safe use of pesticides in the production of our agricultural products is a legitimate concern of everyone. Certainly pest control is necessary to modern civilization, but the practice also must be safe. It is this subject of safety in using chemical pesticides, particularly herbicides, that will be discussed in detail here.

Safety in the manufacture, handling, distribution, and use of chemicals has been a great concern of The Dow Chemical Company for a long time. Dow's industrial toxicology laboratory was established back in 1933, since even at that time it was realized that it was necessary to develop toxicological information for chemicals made and sold. This was considered necessary to protect not only our manufacturing personnel, but also our customers. Thus, long before the current concern with safety, Dow developed strong internal regulations and guidelines on the safe handling and use of our products.

EARLY CONCEPTS

Naturally, over the years, concepts of safety have changed and developed with increasing knowledge and new technology. In the late 1940's we were conscious of possible toxic effects on birds and had used our screening test for effects on coccidia (causes an intestinal disease in chickens) to give us an idea of the toxicity of a chemical in birds. Testing the effect of chemicals upon aquatic animals such as fish and snails, and on food chain organisms like Daphnia was begun in 1957. Thus, our original concern with human safety was expanded to include wildlife and other environmental aspects.

By 1960, we had developed standard tests that were considered quite sophisticated for dealing with toxicological properties of agricultural chemicals, not only in relation to humans but also non-target organisms and the environment generally.

It is interesting to note that this methodology was developed prior to the publication of the late Rachel Carson's "Silent Spring" and before the December 1969 Mrak Committee report on pesticides and their relationship to environmental health.

TERMINOLOGY

In considering safety in the use of chemical pesticides it is advisable to define and briefly discuss a few terms currently used in the field of toxicology.

Toxicity of a substance refers to its capability to harm or injure a living organism by chemical or physiological action. Just as chemical and physical properties are determined experimentally, toxicological properties are determined and measured using carefully designed experiments.

From long experience, a fundamental fact emerges: In large enough doses, all chemicals, natural and synthetic, are capable of causing toxic symptoms in animals. However, the more important aspect is how much is required to cause toxic effects and under what conditions they occur. To illustrate — ordinarily oxygen is essential for life and commonly is considered non-toxic, but too much oxygen administered to a premature baby can cause blindness. Thus, too much oxygen can be toxic. Similarily, water is essential to life, but in the lungs can cause death. Vitamin A is a necessary part of our diet, but too much (as well as too little) can cause illness. Table salt taken in large quantities can be fatal, yet we consume it every day. Toxicity, therefore, is a quantitative chemical property under a given set of conditions.

TOXICITY

That chemicals can be toxic at some concentration under some conditions has been recognized for a long time.

It was neatly said by Paracelsus at the end of the Middle Ages in a Latin phrase that may be freely translated, "The toxicity of a substance is determined by its dosage."

The converse is also true. Chemicals normally considered toxic or poisonous have some dosage below which they cause no harmful effect. For example, the poison arsenic is used safely as a medicine.

When considering toxicity one also thinks of the word "poison" — that is, a substance which in a small amount will cause serious injury or even death. A poison can be defined as a substance possessing a high degree of toxicity. Toxicology, then, can be considered to be the science of dealing with poisonous or toxic substances. As has been discussed, some chemicals are beneficial in some amounts and harmful in larger amounts. Toxicity, therefore, is the result of getting too much and the job of the toxicologist is to find out how much is too much.

HAZARD

This leads to another general concept, that of hazard. Hazard is the likelihood or probability that harm will result. It refers to the risk involved. Toxicity is but one of the factors in evaluating the hazard from the use of a herbicide or in determining the amount of risk involved from such use. Other factors are physical and chemical properties, warning properties such as odor and pain, the amount of exposure expected to result from normal use, and the training and experience of the users.

For example, Compounds A and B have the same mammalian toxicity. However A is odorless, whereas B in small quantities causes tears. This annoying property of B acts as a warning and can be expected to render it less of a practical hazard than A. Or A may be an oily liquid and B a crystalline solid. If skin contact should occur, A is less easily removed and consequently greater absorption may result in a greater practical hazard. Finally, if the pesticide is to be used only by trained personnel or in a relatively uninhabited area, the probability of toxic exposure is greatly lessened irrespective of the toxicity of the material.

LD_{50} —LC_{50}

The expression LD_{50} is commonly used as a measurement of toxicity. LD is an abbreviation for lethal dose and LD_{50} is the amount of material that is expected to cause the death of 50% of the test animals under the conditions of the test. This dosage is based on the weight of the animal. It is usually expressed in milligrams per kilogram of body weight, abbreviated mg/kg. The higher a substance's LD_{50} the lower its toxicity for the test animal under test conditions. When this term is used, it should be qualified to indicate the type of test and test animal used as well as the figure obtained from the experimental data.

As an illustration, consider the statement that the acute oral LD_{50} in rats for picloram* is 8200 mg/kg. Acute oral means intake through the mouth in a single dose. Assuming all rats weighed 0.3 kg[(a)], the actual amount given according to the LD_{50} dose would be 2460 mg[(a)] per rat. In actual practice, each animal is weighed and the dosage adjusted to fit its weight. (This same principle applies in medicine and parents are well aware of the fact that the drug dosage for a child is less than for an adult.) In the preceding illustration, if rats were given a single oral dose at this rate of 8200 mg/kg, half would be expected to die and half would be expected to live. Incidentally, this acute oral LD_{50} figure for picloram is quite high, meaning the toxicity of this herbicide, when administered to such rats, is quite low.

There is another term—LC_{50}—related to the LD_{50} The

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*Common name for the active ingredient in TORDON® herbicides.
(a) one kilogram is 2.2 pounds, 1 gram is 100 milligrams, and 5 grams of water is approximately 1 teaspoon.

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LC_{50} is the concentration of the chemical in the environment that kills 50% of the test organisms exposed to it. LC_{50} values are used in inhalation studies and in many toxicity experiments with fish and other wildlife.

For example, an LC_{50} may refer to inhalation exposure or to exposure in water. If the exposure is by inhalation, it is necessary to define the length of the exposure as well as the concentration inhaled. If the inhalation exposure is to particles (dust or mist), it is essential that the size of the particles be described.

If the LC_{50} is used to describe a study in birds, it probably means the chemical was fed in the diet for at least 5 days and that about 50% of the birds fed that concentration would be expected to die.

If the LC_{50} describes toxicity to fish, it means that about 50% of the fish placed in water containing that concentration can be expected to die during the exposure period, usually 24, 48, or 96 hours.

Practically speaking, in the end result, there is no difference between these two terms. There are, however, subtle differences in their meaning. With the LD_{50} the chemical is administered in a single dose into or onto the test animal, whereas for the LC_{50} the test animal is exposed for a period of time to the chemical in its living environment. Thus, the entire amount does not get onto or inside the animal all at once. Because of differences like these, toxicity figures should not be compared unless they are derived from the same type of study.

TECHNICAL VS. FORMULATION

In considering toxicity figures, care should be taken to note whether they refer to the technical grade active ingredient, or to the formulation. For example, it is stated in the preface of the Herbicide Handbook of the Weed Science Society of America, that the toxicology information is for the active ingredient. Many formulations are dilutions of the active ingredient, and are generally less toxic than the technical grade compound.

To give an idea of the relative toxicity of several commonly used herbicides, Table 1 was compiled from an extension service bulletin (2) published by the University of Idaho. This gives two important types of herbicide toxicity values, expressed as acute oral and dermal ratings to small animals.

OTHER TESTS

This is just part of the story. The pesticide manufacturer also conducts studies on eye and skin irritation. The effect of repeated doses and investigations of sub-acute and chronic toxicity are evaluated in dietary feeding studies. For example, studies are carried out at several dosage levels in the foods of dogs for 3 to 6 months, and of rats for 30 days up to 2 years. Treated animals are carefully observed during the experiment, and clinical data are obtained on blood and urine samples. At the end of the experiment, the animals are sacrificed and more data are obtained from gross and microscopic examinations of various organs such as the liver and kidney.

Long-term feeding studies are designed to establish what dosage levels cause no effect during a long exposure as well as what levels cause toxic signs and symptoms. It is essential in establishing tolerances for herbicides used on food crops and is a registration requirement for such uses.

Long-term feeding studies also provide information on possible tumorigenic (cancer causing) effects of the chemical. In addition, a three-generation fertility and reproduction study is run on a mammalian species. Teratogenic studies are also conducted to evaluate whether birth defects can be produced by giving the chemical to pregnant animals. Sometimes, these are combined with three-generation reproduction-fertility experiments. Untreated controls are always included in each study for comparison with the effects noted in the treated animals.

Dow often conducts acute oral toxicity tests on the following: cattle, sheep, swine, ducks, turkeys, chickens, dogs and cats. Mallard ducks and Japanese or Bobwhite quail may be used as representative wild-bird species for toxicity studies. Studies on aquatic species are generally done using bluegills, rainbow trout and food chain organisms such as Daphnia, algae and snails by exposing them to various concentrations of a pesticide to determine

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the no-effect and the LC_{50} dosage levels. A degradation and/or metabolic pathway scheme is put together utilizing all the available experimental and theoretical information known about the chemical in question. Radioactive tracer techniques are used to determine degradation or metabolic pathways for a given compound. Toxicological studies are also conducted on the metabolic breakdown products.

All of this information is useful in evaluating the possible hazards in handling and using chemical herbicides.

FOOD RESIDUES

A recent article by Getzendaner (1) discusses the measurement of pesticidal residues in foods and other agricultural products. This article treats the subject matter in considerable depth. One is impressed by the meticulous care used in designing these residue experiments from beginning with the methods used in taking samples to the sensitivity and precision of the analytical methods used in determining the amount of residue present.

This is most reassuring in considering questions about the amount of residues present in agricultural products particularly our food. We do have cleaner and more nutritious food now than at anytime in our history. Chemicals have played an important part in this achievement.

HOW SAFE IS SAFE?

The foregoing brings us to the heart of the matter. Even after obtaining the tremendous amount of data now required before a product can be registered, how sure are we that it is really safe?

There is no such thing as absolute safety and scientists are in agreement that this concept can never be completely proven. Regardless of how extensive the data, some unanswered questions always remain or questions can be raised about some untested situation.

However, from a realistic viewpoint, herbicides are not approved for use by EPA unless the mass of data submitted at the time of registration indicates that they are safe enough to justify their approval for use. Further, if data are not available on certain points or questions on safety remain unanswered, the company is required to do additional experiments. The data are interpreted not only by competent company toxicologists and scientists, but must also satisfy competent government toxicologists and scientists. Therefore, when a proposed product passes the toxicological hurdles required before marketing can be started, the public may be assured that extensive testing indicates that it is safe for use as specified on the label. In this connection, everyone in the business should stress the primary importance of careful reading of the label. If this is done by everyone using a pesticide, a great deal of progress will be made toward the goal of using "safe" pesticides safely.

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TABLE I. Relative Toxicity of Some Industrial Herbicides to Small Animals

Common Name	Trade Names	Oral LD_{50} mg/kg	Oral Toxicity Rating[a]	Dermal Response Rating[a]
amitrole	Amitrole T* AMINOTRIAZOLE*	5000	5	4
aspirin (for comparison)	Many Brands	1500[1]	4	—
bromacil	HYVAR X*	5200	5	5
2,4-D	ESTERON* 99, FORMULA 40* and Many Brands	500	4	4
dalapon	DOWPON*M	9300	4	4
dinoseb	Dow General*, PREMERGE* SINOX PE*	58[2]	2	1
diuron	KARMEX*	3400	4	4
erbon	ERBON 4	1000	4	3
fenuron	DVBAR*	6400	5	4
karbutilate	TANDEX*	3000	4	5
monuron	TELVAR*	3500	4	4
MSMA	ANSAR*, DACONATE*	700	4	4
MH	MH 30*	3240	4	5
picloram	TORDON*	8200	5	4
silvex	KURON*, WEEDONE TP	500	4	4
simazine	PRINCEP*	5000	4	5
sodium arsenite	ATLAS A*, TRIOX*	10	2	1-2
2,4,5-T	ESTERON* 245 and other brands	300	3	4
table salt (for comparison)	Many Brands	3320	4	—
TBA	TRYSBEN* 200	1644	4	5
TCA	Sodium TCA	3370	4	2
terbacil	SINBAR	7500	5	5

[1] Taken from the Handbook of Toxicology. W. S. Spencer 1955 Wright Air Development Center.
[2] Herbicides Handbook of the Weed Science Society of America (3rd edition).
* Registered trademark.

[a] These ratings were based on the following classifications:

Oral Toxicity	Oral LD_{50} mg/kg	Probable Lethal Dose for 150 lb. man	Dermal Response
1- Extremely toxic	less than 5	A taste (Less than 7 drops)	Absorbed and poisonous
2- Very toxic	5-49	7 drops to 1 teaspoonful	Causes burns and blisters
3-Moderately toxic	50-499	1 teaspoonful to 1 ounce	Moderately irritating
4-Slightly toxic	500-4999	1 ounce to 1 pint (1 lb)	Mildly irritating
5- Almost non-toxic	5000-14,999	1 pint to 1 quart	Non-irritating

To those not familiar with the metric measuring system one drop from the average size medicine dropper contains approximately 50 mg of water and one level teaspoon contains approximately 5 grams or 5000 milligrams of water.

Maintenance of *Poa annua*

By R. N. Carrow
University of Massachusetts

Poa annua (annual bluegrass) originated in Europe but is now found in all parts of the world, especially under irrigated close cut, and high maintenance conditions. Under such conditions it can provide a very high quality turf. However, annual bluegrass has several undesirable qualities: (1) seedhead production even at very low heights of cut produces an unsightly turf which is difficult to putt on; (2) lack of low temperature tolerance results in damage to *Poa annua* at temperatures 5-10° F warmer than injury would occur on Kentucky bluegrass or bentgrass; (3) lack of high temperature tolerance is responsible for much damage to annual bluegrass during summer months. *Poa annua* can be killed at temperatures as low as 100° F if the plant is under moisture stress. Also, waterlogged or compacted soil conditions reduce the tolerance of annual bluegrass to high temperatures. Kentucky bluegrass and bentgrass are much less affected by high temperatures; (4) susceptibility to ice cover injury during winters when the turf is under 60-70 days of continuous ice cover is another limitation. In contrast, Kentucky bluegrass withstands 75-90 days and bentgrass 120 days of ice cover before damage occurs; (5) low drought tolerance also is a problem, especially during mid-summer; (6) annual bluegrass is very susceptible to smog injury which can limit its use in some urban areas.

The two general approaches to the *Poa annua* problem has been control and maintenance. Control may involve several means such as mechanical removal, biological removal with the *Hyperodes* weevil, competition from aggressive grasses, and chemical methods. Selective preemergence herbicides such as terbutol (Azak), benefin (Balan), bensulide (Betasan), DCPA (Dacthal), Kreb (in the South) and tricalcium arsenate have been used with varying degrees of success. Tricalcium arsenate can also be applied for postemergence control and may be effective if used properly. Unfortunately, tricalcium arsenate production has stopped at least temporarily. Chemicals which prevent seedhead formation have also been utilized but with erratic results.

If a turf manager is to successfully maintain *Poa annua* he must be aware of how the various environmental factors and cultural practices affect its growth and persistence. There is more information on how to maintain Kentucky bluegrasses or bentgrasses than on maintenance of annual bluegrass. However, *Poa annua* will receive greater emphasis in the future. The following sections will discuss the general culture of annual bluegrass and maintenance during environmental stress periods.

Fertilization. Encroachment of *Poa annua* into an area can often be related to the fertilization program. Bentgrasses and Kentucky bluegrasses, which have received excessive nitrogen, will be more susceptible to environmental stresses and disease injury. Over a period of time these grasses can be thinned and annual bluegrass may infest the area. Also, under low fertility levels *Poa annua* can easily invade bentgrass turfs, especially the less aggressive bentgrasses.

Annual bluegrass growth is optimum under high fertility conditions. Nitrogen rates of 0.5 to 1.0 lbs N/1000 sq. ft. per month are generally recommended. However, during times of environmental stress nitrogen should be applied judiciously so as not to increase the probability of injury. This is especially important during periods of high

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temperature and excessive moisture. A balanced fertilization program including sufficient phosphorous and potassium is highly desirable. Adequate potassium can improve the low and high temperature tolerances of annual bluegrass and other turfgrasses.

The type of fertilizer can affect *Poa annua* growth. Acid forming fertilizers tend to prevent invasion while slow release organic nitrogen sources may promote infestation. In early to mid-spring a soluble nitrogen source would provide adequate growth. After soil temperatures increase, natural or synthetic organic nitrogen carriers could be utilized.

Soil Reaction. Growth of annual bluegrass is best in the pH range of 5.5 to 6.5. Below pH 5.5 rooting is severely restricted and growth is not vigorous. In polystands of bentgrass and *Poa annua* some turf managers have kept pH levels low (below 5.5) to control the annual bluegrass. This is a poor practice because the bentgrass will not grow well due to restricted rooting, poor nutrient availability and nutrient imbalances. Bentgrass is most competitive and aggressive at pH 5.5 to 6.5.

Irrigation. Careful irrigation is necessary if the superintendent wishes to maintain annual bluegrass. *Poa annua* thrives in moist soils but does not tolerate waterlogged or droughty conditions. On soils which are excessively wet due to compaction, poor drainage or over irrigation *Poa annua* is very susceptible to injury in both the winter and summer months. In the winter low temperature injury can result due to crown hydration while in the summer high temperature kill is likely to occur.

On droughty soils *Poa annua* is quite susceptible to either dessication or high temperature kill. Whenever wilt signs appear the superintendent should immediately irrigate or syringe, especially on hot days. Syringing at 11:00 a.m. on hot days can reduce the temperatures in the turf canopy by several degrees and decrease the possibility of high temperature kill.

Drainage. Good surface and subsurface drainage are prerequisites for maintenance of annual bluegrass. *Poa annua* can tolerate wet soils better than Kentucky bluegrass or bentgrass and may invade such sites in the spring or fall months. However, it is easily injured in the summer or winter periods in these same areas. If *Poa annua* is to be maintained on a course then the superintendent should provide adequate drainage. Filling in small depressions on fairways, slit trenches, tile drains, dry wells, contouring, and aerification can be used to improve water movement.

Cultivation. Kentucky bluegrasses and bentgrasses are easily injured on compacted soils (or waterlogged soils) due to poor aeration, increased disease severity, and susceptibility to environmental stresses. Once the desirable species are thinned *Poa annua* encroaches. However, under such conditions the annual bluegrass will be shallow rooted, susceptible to various injuries and slow to recover when injured.

In the compacted sites a regular aerification program should be used to help improve the soil physical conditions. Coring is the most effective cultivation procedure. Traffic control, especially during wet periods, and avoiding excessive irrigation will also help improve turf growth.

Cutting Height. Annual bluegrass can tolerate a wide range in cutting height and is often found in greens, tees and fairways. It is most competitive at a cutting height of 1.0 inch, but is aggressive at heights down to 0.2 inch. At higher mowing heights *Poa annua* may thatch.

Diseases and Insects. Diseases are as much of a problem on *Poa annua* as on bentgrasses. During warm weather periods diseases which may cause injury are dollar spot, *Fusarium* blight, brown patch and *Pythium* blight. In either cool or warm periods *Helminthosporium* leaf spot, stripe smut, red thread or *Ophiobolus* patch may cause injury. During the winter, annual bluegrass is susceptible to *Fusarium* patch and *Typhula* blight. The insect *Hyperodes* weevil has caused serious damage in certain sections of the country. Appropriate pesticides should be applied on a preventive or corrective basis to control diseases and insects.

In summary, *Poa annua* is a turfgrass which is quite susceptible to low temperature, high temperature, drought, and ice cover injuries. If the superintendent wishes to maintain annual bluegrass as a component in the turfgrass stand then he should adjust his cultural practices to minimize the probability of these environmental stresses. Of particular importance are the fertilization, irrigation and drainage practices employed by the turf manager.

A RESPONSIBLE NEIGHBOR

By Gerald Moscato

Americans today, whether they live in the inner city or suburbs, feel the effects of higher taxes, pollution and the onslaught of development. A golf course can help hold down rising taxes by withholding land from development, supplying recreational activities and helping to curtail the effects of pollution through the life process of turf and trees. Therefore, few demands will be made on municipalities for schools, recreational areas and environmental clean-up.

We can begin by examining the most abundant thing on the golf course . . . green grass. Everything we eat, whether it be plant or animal begins with something green.

Through the process of photosynthesis, the only food-making process on earth, green plants convert light energy into chemical energy. During this process, some of the atmosphere pollutants given off by the burning of fossil type fuel, are absorbed and pure oxygen is emitted. Research in this area has proven that the average 18 hole golf course of approximately 150 acres generates enough oxygen to support 10,350 people per year.

Trees, like grass, are essential to the game of golf, but are of particular importance to the atmosphere. Aside from being green and carrying on photosynthesis, the static electricity given off by their leaves, attract and hold millions of tons of dust per year. The dust is trapped until the next rain fall, where it is washed to the earth's surface and incorporated into the soil matter. Trees literally sweep the atmosphere!

Soils not only collect the dust held by trees after a good rain fall, but absorb carbon monoxide, sulfur dioxide and ozone, all of which are atmospheric pollutants caused by our highly merchanized and industrialized society. For the city dweller, this is important because of the high concentration of automobiles, trucks, and factories within the city.

Noise pollution cannot be overlooked, especially for people living within the inner city. Unlike the pollution mentioned above, noise effects people as soon as it occurs. Turf, trees and the soil that supports them absorb noise and act as a barrier between it and the population it effects, hence making our inner cities a bit more habitable.

For many years, golf courses were looked upon as a means of recreation for those who partook in the sport. In the 20th century America, where a million acres of land per year are being developed or paved over for highways, we must not only evaluate a golf course for the recreational activity it provides but how it can be a responsible member of the community in which it exists.

We regret the loss of Richard McGahan who was a credit to the Turfgrass Managers profession and a good friend to the Massachusetts Lawn and Turfgrass Council.

FROM

MASSACHUSETTS TURF AND LAWN GRASS COUNCIL
INCORPORATED

RFD #2, HADLEY, MASS. 01035

University of Massachusetts Turfgrass Research Fund

We would like to take this opportunity to thank the following for their generous contribution to the Massachusetts Turf and Lawn Grass Council and apologize to those we have failed to mention.

An important event that is an intrical part of the Council's activity is coming up! Our annual field day will be held on July 31 at the turf plots located on Route 116 in South Deerfield at the base of Mt. Sugarloaf, weather permitting. Rain date is August 1. Hope to see you July 31!

Leon St. Pierre	$ 10.00
Tom Rewinski	$ 10.00
Norman Mucciarone	$ 10.00
George Thompson	$150.00
John Lynch	$ 25.00
Joseph Choquette	$ 25.00
John G. Wistrand	$ 50.00
Robert Capstick	$ 10.00
'74 Winter School	$ 65.00
Edward Horton	$ 50.00
Robert Clark	$ 10.00
Turf Club—'73-'74	$200.00
Bellevue Golf Course, Melrose, MA.	$ 50.00
Farms Country Club, Wallingford, CT.	$ 25.00
Milton-Hoosic Club, Canton, MA.	$ 50.00
Sil Paulini, Inc., Natick, MA.	$100.00
Long Island GCSA, Garden City, NY.	$500.00
Mount Pleasant Golf Course, Lowell, MA.	$ 50.00
Karnig and Mike Ovian	$ 50.00
D. R. McMillan	$ 25.00
Weston Golf Club, Weston, MA.	$100.00
Mohawk Valley GCSA, New Hartford, NY.	$100.00
Lofts Seed Co., Arlington, MA.	$500.00
Upjohn Co., Kalamazoo, MICH.	$500.00
GCSAA, Lawrence, KA.	$750.00
Pittsburgh Plate Glass, Pittsburgh, PA.	$300.00
Associated Landscape Contractors of MA., INC.	$250.00
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For more information write:

Mass. Turf and Lawn Grass Council
attn.: Dr. Joseph Troll
RFD #2, Hadley, Mass., 01035

The Massachusetts Turf and Lawn Grass Council is a non-profit corporation. Its officers derive no benefits except the satisfaction of keeping Massachusetts and its neighbors first in turf. It was founded on the principle of "Better Turf Through Research and Education." We must support our University to accomplish this, and we can with a large and strong Turf Council.

Membership is not restricted to Massachusetts residents or turf professionals alone, all are welcome to take part. Write today.

Our advertisers' contributions help make it possible for us to give you interesting issues of TURF BULLETIN. We shall appreciate your mentioning to them that you saw their advertising in our columns.