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Liquid Fertilizer Use Demands Basic Knowledge

R.N. Carrow

Until recent years most of the fertilizers used in turfgrass management were in the granular formulation. However, liquid and powdered materials are now widely promoted and utilized. Each formulation offers unique advantages under certain circumstances but may not be the best material under other conditions. If a turf manager is to select the proper formulation he should understand the pros and cons of each type. The discussion in this article will be mainly on nitrogen since this is the major nutrient most often applied.

GRANULAR FORMULATIONS

Many different types of nitrogen carriers are available in the granular form. **Table 1** lists common granular nitrogen carriers and their characteristics. In addition to these carriers many mixed fertilizers are available which contain two or more different carriers mixed together. For example, a mixed fertilizer may contain 50 percent of its nitrogen from ammonium nitrate and the remainder from UF.

Turfgrass response to a particular granular fertilizer depends upon its characteristics, such as slow release, fast release, long residual, short residual, etc.

Dr. Carrow is assistant professor of ornamental horticulture and turf at Kansas State University. We are pleased to publish this much-appreciated paper that he gave at the 16th Annual Nebraska Turfgrass Conference this year.

The complete transcript continues on Page 4.

N. J. Research on Insecticide Resistance in Populations Of Japanese Beetles

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Of the many species of soil insects, grubs of the Japanese beetle, *Popillia japonica* Newman, are the most destructive pest of turfgrass in eastern states. Its current upsurge is attributed to the development of resistance to the cyclodiene insecticides (e.g., chlordane, dieldrin and heptachlor, which in the past afforded good protection against this pest), and the apparent inefficacy of currently used substitute insecticides, diazinon and dursban.

Our research on Japanese beetles commenced in the fall of 1977 with the following objectives: 1) to assess the status of cyclodiene resistance in N.J. populations, since thus far it was mainly investigated in Connecticut, New York, and Ohio; 2) to screen grubs and adults against currently used insecticides for early detection of insecticide resistance or tolerance that may be indicative of potential resistance, and 3) by a thorough examination of tolerance/resistance patterns and additional basic studies concerning the involved physiological mechanisms, to determine the prospects of the long-term control efficacy of candidate materials for Japanese beetle control.

Sensitive Technique

Our initial research was concerned with the development of a sensitive laboratory bioassay technique for Japanese beetle grubs. A topical method of insecticide application by which precisely measured amounts of insecticide could be administered to the cuticle of each grub was developed. A rearing medium to maintain grubs for the duration of the bioassay was also developed, and the symptoms of insecticide poisoning in the grubs were discerned **(Fig. 1)**.

(Page 3, please)

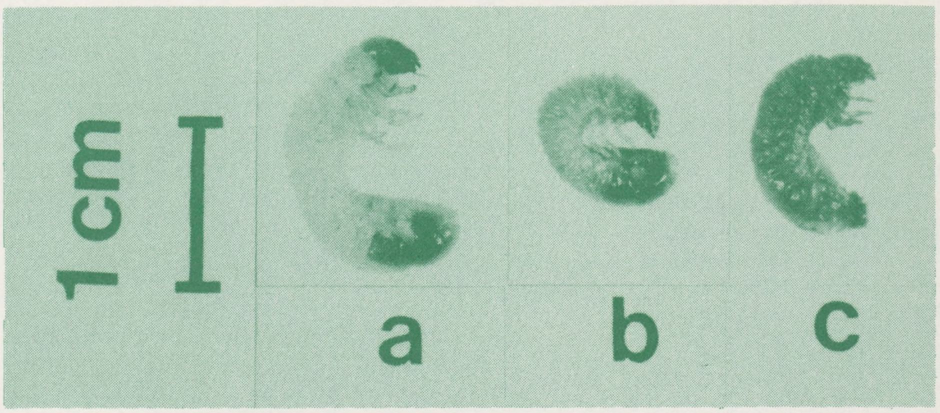

Figure 1

a) A normal third-stage grub of Japanese beetle.

b) Insecticide-poisoned SYM stage. SYM= shrinking (S) of body and reduction of body weight to about one-half of a healthy third-stage grub, yellow-brown (Y) coloration of the body, and moribundity (M). Once the insecticide-treated grubs manifest these three symptoms, they are certain to die.

c) An insecticide-treated deceased grub. Dead grubs are usually darker than the SYM grubs, and within a few hours bloat by the decomposition of the body.

BLACK MONDAY!

Monday, August 14, 1978, was a black day for fairway turf on a number of courses. It seemed that the annual bluegrass and some bentgrass wilted faster than six watering systems could have syringed.

Two things seem to associate with the trouble. Curvularia organism was abundant on several of these sites. I noted this association in two previous summers where abrupt wilt developed.

Second, most of these damaged areas had higher nitrogen or spring fertilization. This was not a consistent association. The N. J. Superintendents played a course that had received appreciable nitrogen this season and it had excellent turf on August 17. Another superintendent reported the same experience.

I feel convinced that the fungicide program was a big factor in what happened or did not happen on August 14.

– R.E.E.

GLYPHOSATE — SOMETHING NEW

Glyphosate sold as "Roundup" by Monsanto Chemical Co., one of the few new chemicals, that has shown us that one application will give kill economically of both turf and weeds. Kill develops slowly over 10 days to two weeks but reseeding can follow the herbicide within seven days without harm. Read the label for specific directions on timing and rate.

It is easy to imagine many interesting uses for this type chemical. As with all new chemicals, starting with small scale projects is best until you are sure how everything works.

Since the chemical has no preemerge effect on germinating seeds, remember that killing the turf without reseeding or using a preemerge herbicide will give a crop of weeds.

Also, use of this chemical where soil is erodible because of slope, intense water flow or other causes may lead to a problem of soil erosion bigger than the weed problem. We must remember that a poor or weedy turf may be giving more erosion control than we appreciate.

We would be pleased to have your comments on use of this new chemical, glyphosate.

– R.E.E. and John A. Meade

A tramp was sleeping behind the bunker of a golf course when the club secretary, prowling around, kicked him none too gently and ordered him to clear out.

"And who are you?" demanded the tramp haughtily.

"I'm secretary of the club," replied the official curtly.

"Well," snorted the tramp, who knew how to save face, "That's no way to get new members."

–Family Weekly

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Are you reading us?

If you are, we would be glad to have your comments. Both turf wisdom and humor are accepted.

(BEETLES from Page 1)

Following the development of this bioassay procedure, we tested the third-stage grubs of Japanese beetle from Edgewood Country Club golf course in Rivervale, N.J. Results of this investigation showed that these grubs were most likely resistant to the cyclodiene insecticide, dieldrin. Also, it appeared that the Rivervale population of grubs was quite heterogenous in its response to the organophosphate insecticide, dursban.

Current Findings Confirm

Further studies this summer with adult Japanese beetles from Rivervale and another population from Adelphia (Soils and Crops Research Center, Rutgers Agric. Exp. Stn.), confirmed the findings of our fall, 1977 study. These data show conclusively that the Rivervale population, by comparison to the one from Adelphia (which has not been treated with any insecticide during the past several years), is highly resistant to dieldrin.

Furthermore, when the Rivervale population was compared to the Adelphia population, a three- to four-fold greater tolerance to both dursban and bendiocarb, a potential carbamate insecticide for turfgrass beetle control, was found. This greater tolerance of the Rivervale population is apparently due to the presence of a greater number of individuals inherently tolerant to insecticides. This kind of variability in insecticide response often leads to the selection of tolerant insects under continuous insecticide pressure, and ultimately to the development of a resistant strain.

Therefore, a possibility exists that with time, the Rivervale population may become resistant to organophosphates and carbamates, in addition to cyclodienes. However, unlike cyclodiene resistance which is of least concern because EPA has restricted its use due to environmental hazards, the possibility or organophosphate and carbamate insecticide resistance is alarming. Unfortunately, classes of insecticide other than the aforementioned, do not exist at the present for turfgrass beetle control.

Further Research Needs

So what are the options in the face of the potential threat of organophosphate and carbamate insecticide resistance? First, we must initiate a systematic survey of resistance/tolerance patterns involving several populations of Japanese beetle throughout the eastern U.S. to determine whether the Rivervale situation is an isolated case, or is in fact widespread.

Also, insecticide screening should be conducted every year on some selected populations, to see if the tolerance level is on the rise, and if so to what extent.

Besides these early-warning studies, we ought to initiate investigations of other pest management options. This will require a good knowledge of population dynamics, and the development of a good sampling technique for predicting Japanese beetle population with accuracy.

Research is also needed in the area of micropathogens, i.e., milky spore disease that is reportedly becoming ineffective, parasites and predators and other biotic factors that may be useful in the integrated control of this pest. Recently, the sex-pheromone (chemical given out by females to attract males for mating) for this species has been isolated. This substance may be exploited as an effective lure for trapping male beetles soon after adult emergence, thereby preventing mating and subsequent egg-laying.

Finally, a possibility exists for developing some of the new experimental insect growth inhibitors such as dimilin and EL -494 and related materials for grub control.

(FERTILIZER from Page 1)

Careful selection of a solid fertilizer can allow nitrogen availability to closely match the plants' needs. In spring and fall a higher proportion of nitrogen could be of the fast-release type for cool season turf, while slow-release forms are appropriate for summer. The ability to release nitrogen over an extended period is an advantage for many granular products.

On large acreages of turf, solid fertilizers are the easiest to apply. However, on small sites such as home lawns, golf greens and tees, liquid or powdered formulations may be faster and easier to apply.

Granular materials have some disadvantages if not used properly. Physiological drought, leaching, and excessive stimulation of growth can occur if water-soluble materials are applied at too high rates. Volatilization and foliar burn are likely to result if water-soluble forms are not adequately watered into the soil. On close-cut turfs, mowers can pick up coarse granules.

LIQUID FORMULATIONS

In granular materials the nutrient carrier is a solid, while in liquid fertilizers the carrier is water. Since the nutrients are dissolved in water, absorption can occur immediately upon contact with leaf surfaces or roots.

Most liquid fertilizers are combinations of salt fertilizers **(Table 2).**

Many different analyses can be produced by various combinations. In addition to the three major nutrients (N,P, K), other ingredients may be claimed such as calcium, magnesium, iron, manganese, boron, copper, zinc, molybdenum, sulfur, vitamins, wetting agents, growth stimulants, and chlorophyll. Liquid fertilizers can be applied by soil drench or foliar feeding.

Soil drench involves application of nutrients in sufficient water (25 gal. per 1000 ft.) that a majority of the nutrients are washed into the soil. Absorption of the nutrients by the plant is predominantly through the root system. Soil drench fertilization is commonly utilized by the home lawn care industry, for small sites such as golf greens and tees and for large acreage by "fertigation."

Advantages of Applying Liquid Fertilizers As a Soil Drench:

- Ease and efficiency of application. On small sites a soil drench can be applied quickly and uniformly with a sprayer or a hand hose connected to a spray tank. Application time can be reduced by about one half compared to granular application.
- Other chemicals can often be mixed into the tank and thereby further reduce applicaton time.
- Nutrients are readily available to the plant. However, some nutrients such as phosphorus and iron can be quickly absorbed by the soil colloids and become unavailable. Nitrogen is readily available and well-timed soil drench can supplement your normal fertilization program.

Precautions and Disadvantages of a Soil Drench:

- Large volumes of water are

Table 1. Common nitrogen carriers available in the granular form and their characteristics.

N carrier	Characteristics
Synthetic inorganic (salts)	
Ammonium nitrate	Water soluble
Ammonium sulfate	Rapid initial plant response
Calcium nitrate	Short residual (2-4 weeks)
Sodium nitrate	Subject to leaching
	High foliar burn potential
Natural organics:	
Activated sewage sludge	Not water soluble
Bone meal	Depends on microbial activity for N release; soil temperatures greater than 55 °F
Cottonseed meal	Low leaching potential
Fish scraps	Low foliar burn potential
	Medium-long residual (4-8 weeks)

Table 2. Compounds used to formulate liquid fertilizers.

Compound	Analysis
Ammonium nitrate	33-0-0
Ammonium sulfate	20-0-0
Calcium nitrate	15-0-0 (40% Ca)
Calcium sulfate	0-0-0 (30% Ca, 70% SO4)
Diammonium phosphate	21-53-0
Monoammonium phosphate	12-61-0
Monoammonium phosphate, commercial grade	11-48-0
Potassium nitrate	13-0-44
Potassium chloride	0-0-60
Potassium sulfate	0-0-48
Potassium phosphate	0-52-35
Potassium phosphate	0-41-54
Sodium nitrate	16-0-0
Urea	45-0-0

required. For large areas a soil drench can require much more time per application due to the necessity of refilling the spray tank. If less than 25 gallons of water per 1000 sq. ft. is used then nitrogen should be restricted to 0.5 lb. nitrogen or less per application. Applications of over 1.5 lb. N/1000 sq. ft. should not be attempted, even with large quantities of water.

- Since the nutrients are water-soluble salts, they have all the disadvantages of water-soluble granular materials. Leaching can occur from excessive irrigation or precipitation. Foliar burn may result if too little water is applied. It is a good practice to irrigate after a soil drench. Nitrogen residual is normally only two to four weeks. If higher rates of nitrogen are used excessive stimulation of the turf can occur.
- Excessive thatch can inhibit nutrient penetration. This is especially a problem during hot, dry periods where salts may accumulate in the drench layer and cause salt injury.
- Liquid fertilizers generally have a marked effect on soil pH. Some materials increase pH but most reduce pH, especially urea and ammonia forms of nitrogen. Check the pH periodically and apply limestone if necessary.
- If a complete (has N-P-K) liquid fertilizer is consistently used, phosphorus and potassium levels may become excessive. This could result in *Poa annua* or clover encroachment. Also, liquid fertilizers containing micronutrients should not be applied unless a specific deficiency is evident.
- Frequent, light fertilization is often necessary with a soil drench since soluble fertilizers have a short residual. In midsummer crabgrass, foxtail, and goosegrass may respond more to such frequent, light fertilization than will cool-season grasses.
- Care should be taken not to overstimulate the turf by too frequent fertilizations. A soft succulent turf will result which will be less tolerant to heat, cold, drought, wear, and disease stresses.
- Spray drift has often been a problem with soil drench applications. However, careful selection of nozzles and good technique will eliminate this potential problem.

Foliar Feeding

Foliar feeding is the application of small amounts of nutrients in a limited volume of water (0.5 gal per 1000 sq. ft.) so that nutrients are absorbed through the shoot tissues. Foliar feeding has not been extensively used in turfgrass culture. However, iron, magnesium, manganese, and small quantities of nitrogen can be effectively applied in this manner. Also, fertigation systems can be utilized for foliar feeding.

The major advantage of foliar fertilization is that certain nutrients (N, Fe, Mg, Mn) can be quickly absorbed through the leaves and result in rapid color and growth responses. When conditions restrict root uptake (waterlogged soils, compaction, nutrient fixation by soils), foliar feeding will correct nutrient deficiencies, while soil applications would be of little benefit.

A second advantage of foliar feeding is that it can often be incorporated with pesticide applications. No more than 0.5 gal of water per 1000 sq. ft. should be used and care should be taken to insure compatibility of chemicals.

A third advantage is that nutrient leaching losses are greatly reduced since only small quantities are applied at any one time.

Disadvantage of Foliar Nutrient Applications:

- Only small quantities of nutrients can be safely applied at any one time. For example, nitrogen is generally applied at 0.05-0.125 lb. per 1000 sq. ft. High rates could easily result in foliar burn for salts or phytotoxic levels for micronutrients.
- Repeated, frequent applications are necessary to provide an ample nutrient supply. Generally applications every one or two weeks are required.
- Since the leaf tissues are the absorption sites, nutrient uptake will be adversely affected by anything which reduces leaf area or physiological health of the leaves. Close-cut turfs and turf exhibiting

(Page 6, please)

ABSTRACT

Atypical Symptoms of Rhizoctonia Infection on Zoysia, J. L. Dale. Plant Disease Reporter. 62: 645-647, 1978.

In the fall of 1976 and 1977 unusual disease symptoms resembling Fusarium blight disease were observed on zoysia in northwest Arkansas. In both years, however, *Rhizoctonia* sp. was isolated from the infected turf. In culture the *Rhizoctonia* grew faster at 24° than at 28°C. Average growth rate of cultures on potato-dextrose agar at 24°C was 9.1 mm. per day. Hyphal cell diameter averaged 4.5 μm. Stained mycelium indicated that hyphal cells were consistently binucleate. Attempts to produce the perfect state were not successful. Consistent binucleate condition of hyphal cells and other characteristics of the fungus, however, suggest that the *Rhizoctonia* involved is of the *Ceratobasidium* group rather than being *R. solani,* which is normally associated with diseased turf.

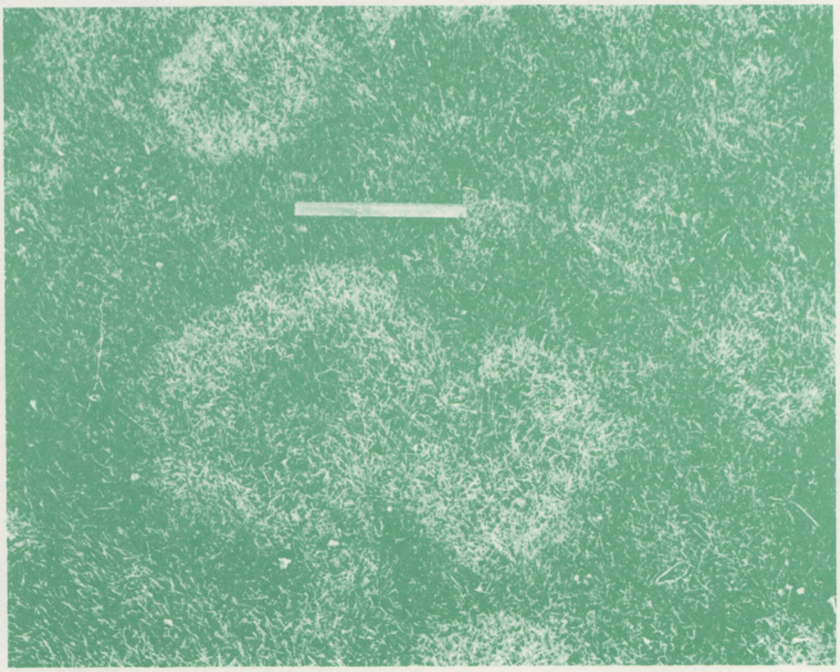
COMMENTS:

When zoysia was first introduced for turf in Northeast United States, some statements said it was a disease-free grass. Its tough leaf tissue would appear to resist any disease. Sadly, like all things biological this grass has a few problems.

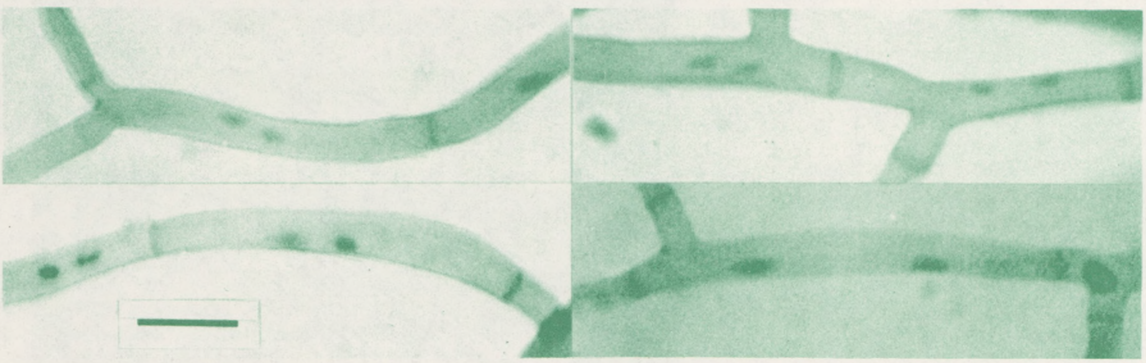
The above abstract showing *Rhizoctonia* on zoysia is of special interest because disease-like rings have occurred on more than one occasion in New Jersey. Drs. Spencer Davis and Philip Halisky have isolated *Rhizoctonia* from these. Also, the organism was isolated from one sample collected in Southern New Jersey.

The infected areas are similar to those found in Arkansas. The injured turf has the same bleached appearance with partial kill of the zoysia plants in the circle. The circles have a well-defined edge and they persist for months. The injury occurring in New Jersey differs in size of the circles which frequently range up to 8 or 12 feet in diameter.

– R.E.E. and S. H. Davis



Zoysia turf showing atypical bleached spots and "frog-eye" symptoms produced by *Rhizoctonia* sp. in autumn 1977. Ruler in photograph is 0.3 m. in length.



Hyphae of *Rhizoctonia* sp. isolate from zoysia showing binucleate condition after Giemsa staining of mycelium.

(FERTILIZER from Page 5)

nutrient deficiencies are less effective nutrient absorbers than high-cut, healthy grasses. In many situations a spreader or sticker aids in good coverage of the leaf.

- Once on the leaves, nutrients enter the plant through stomata and to some extent through the cuticle. For maximum uptake the leaf environment must be moist and the stomata open. Hot temperatures and low humidity can decrease uptake by inducing stomatal closure and drying out the leaf surfaces before uptake can occur. Such conditions also promote volatilization losses of nutrients.
- Nutrients are not absorbed at the same rate by leaf tissues. For example, nitrogen is absorbed much more rapidly than phosphorus which can result in nutrient imbalances.

Fertigation

Fertigation is the application of nutrients through an irrigation system. Fertigation can be used to apply nutrients as either soil drench or a foliar feeding. Whichever method is

SUSTAINING MEMBERS

(As of August 1978)

A-L Services
Andrew Wilson, Inc.
Lewis W. Barton Co.
W. A. Cleary Corporation
The Country Greenery, Inc.
Kelly DeFreitas & Assoc.
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Pine Island Turf Nursery
Playboy Resort & Country Club
Rockland Chemical Co.
Seacoast Laboratories
Storr Tractor Co.
Techniturf, Inc.
The Terre Company
Vaughan-Jacklin Corp.
Wide Sky Farm, Inc.

Can't Beat Dandelions? Then Eat 'em (Or Drink 'em)

As a lawn care businessman, you may spend certain times of the year doing nothing but worrying about getting rid of your customers' dandelions, but in Vineland, N.J., the first harvest of the lowly yellow weed is a cause for celebration.

"If you can't beat 'em, eat 'em — and if you can't can't eat 'em, drink 'em," said Mayor Patrick Fiorilli. More than 400 townsfolk in the rural south Jersey town paid homage to the dandelions with unabashed fanfare.

They jammed a grammar school gymnasium at $12 each to feast on crisp dandelion salad, murky dandelion soup, fresh dandelion ravioli, tender veal tips with dandelion, dandelion gelatin and dandelion wine — lots of dandelion wine.

Dandelions are a serious spring crop in the area, where 16 farmers plant the weed's seeds in August and harvest dandelions as the ground thaws in March. Dandelions for salad greens are worth $40,000 a year to local farmers.

— Lawn Care Industry

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used will have all the advantages and disadvantages that were previously discussed. However, it has some additional pros and cons which are worthy of discussion.

The primary advantage of fertigation is in labor saving. Large areas can be fertilized with little additional labor beyond that needed for normal irrigation.

The major problem encountered with fertigation is poor distribution. The uniformity of fertilizer distribution will be no better than the uniformity of irrigation. Overlaps and misses in the irrigation system will be accentuated with fertigation. In the Central Plains high winds often distort irrigation patterns. Distribution patterns can be evaluated by placing cans at various distances from each head and noting the quantity of water per can. If an area consistently receives twice as much water compared to another site, then it will also receive twice as many nutrients with fertigation.

Irrigation systems that are not flexible present problems with proper fertilization. Roughs, fairways, tees, aprons, approaches and greens may all require different fertilization regimens. With fertigation this can only be done if the system has much flexibility.

Other drawbacks of fertigation systems include corrosion of equipment and fertilizer precipitation. These can be corrected with proper equipment and maintenance.

POWDERED FORMULATIONS

In recent years ureaformaldehyde (UF) has been available in a powdered formulation which can be applied through a spray system. The lawn care industry has been very much interested in this material since it has low foliar burn, does not leach, and has a longer residual than water-soluble carriers, whether applied as a granular or liquid material. Very little research data is available on powdered UF. However, much research has been conducted on granular UF. Since the powdered UF has a much greater surface area, it would not be expected to have as long a soil residual as granular UF. Thus, turf response to the granular and powdered formulations may not be identical. Normally powdered UF is applied at 1 to 2 lb. N in 5 gal. H_2O/1000 ft. At this rate of water application, clippings must be returned since appreciable nitrogen will collect on leaves, especially in hot, dry weather.

There is no one ideal fertilizer for all turfgrasses and situations. One consideration when selecting a fertilizer is the correct physical formulation. This requires knowledge of the growth pattern of the grass, equipment and labor capabilities, and a basic understanding of the characteristics of each type of fertilizer carrier.

Our forefathers went out and built empires; today you must have a permit to add a room to your home.

— Hudson Valley Foreground

ABSTRACT

Influence of the Chemical Form of Mercury on Its Adsorption and Ability to Leach Through Soils, by T. J. Hogg, J. B. W. Stewart and J. R. Bettany. J. Environ. Quality 7: 440-445. 1978.

The adsorption of Hg by two soils, differing in chemical and physical characteristics, indicated that both organic Hg compounds (methyl mercuric chloride [MMC] and phenyl mercuric acetate [PMA]) and inorganic compounds (mercuric chloride [$HgCl_2$]) followed the linear form of the Langmuir adsorption isotherm. The highest adsorption maxima for all Hg compounds were found for the soils which had the higher organic matter content and clay content. Adsorption maxima increased in the order MMC < PMA < $HgCl_2$.

A two-rate effluent leaching experiment was conducted utilizing undisturbed soil cores of the same two soils and the same three Hg compounds (labeled with ^{203}Hg) which were applied uniformly to the top 0-10 cm. of each column. In contrast to the movement of other cations in the effluent and soil, even at the higher irrigation rate, none of the applied Hg was found to move below the 10- to 20-cm. soil layer. More MMC than $HgCl_2$ or PMA were found in the 10- to 20-cm. layer; however, the differences were small. The lack of movement of Hg and the high adsorption maxima was a consequence of the strong binding between Hg compounds and soil. The inability of weak chemical extractants ($CaCl_2$, NH_4OAc, DTPA, EDTA) to remove significant quantities of Hg confirmed this hyphothesis. Seven to 31 percent of the applied Hg was lost from the columns during the experiment, presumably by volatilization.

ABSTRACT

The Uptake of ^{203} Hg-Labeled Mercury Compounds by Bromegrass from Irrigated Undisturbed Soil Columns – by T. J. Hogg, J. R. Bettany, and J. W. B. Stewart.

Bromegrass (*Bromus inermis)* was grown under conditions of sewage effluent irrigation on undisturbed soil columns in which the 0- to 10-cm. layers had been treated with 10 μg Hg/g soil as ^{203}Hg-labeled mercuric chloride ($HgCl_2$), phenyl mercuric acetate (PMA), and methyl mercuric chloride (MMC). Mercury concentrations in plant dry matter decreased over three successive harvests and highest values were found on MMC-treated soils of fine texture and low organic matter content (2.0 to 0.2 μg Hg/g for first and third harvest, respectively).

Exposure of the plants and soils to simulated fall conditions resulted in a small but significant increase in the Hg concentration of plant dry matter. Higher levels of Hg were found in plant stems (up to 0.88 μg Hg/g) than plant foliage (up to 0.24 μg Hg/g) at the termination of the experiment and even higher levels in the main roots (up to 42.5 μg Hg/g) and fine roots (up to 106.4 μg Hg/g) separated from the 0- 10 cm. soil layer. Mercury concentration of roots decreased with depth for all Hg treatments but were still 150 times greater than background levels in the MMC-treated soils at the 40- to 60-cm. depth. A significant amount of all forms of applied Hg (10-32 percent) was lost during the experiment, presumably by volatilization. The majority of the remaining Hg in the soil was found to be strongly bound and not extractable by weak salt solutions, dilute acids, and chelates.

EDITOR'S NOTE: While we turf growers or agriculturalists would never use the quantity of mercury used in the past, we miss mercury fungicides when turf starts dying in summer and winter.

Of course, all of us have had concern where the mercury resides after it has been applied to turf. Turf growing experience and earlier studies have not indicated significant mercury accumulation problems in turf soils.

These two studies show mercury has not left the turf site in major quantity through leaching or removal in plant materials. The authors conclude the logical explanation that mercury escapes through volatilization, as has been theorized.

Whether turf or agriculture uses mercury or not, it seems this chemical will follow its ubiquitous nature and be about everywhere unless it is sealed in a jug or other container.

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