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Volume III, No. 3

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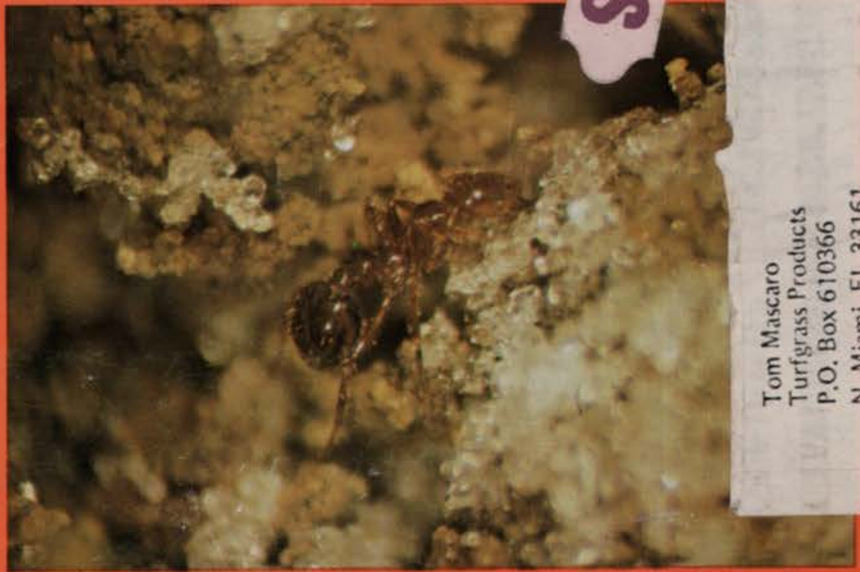

Red imported fire ant worker

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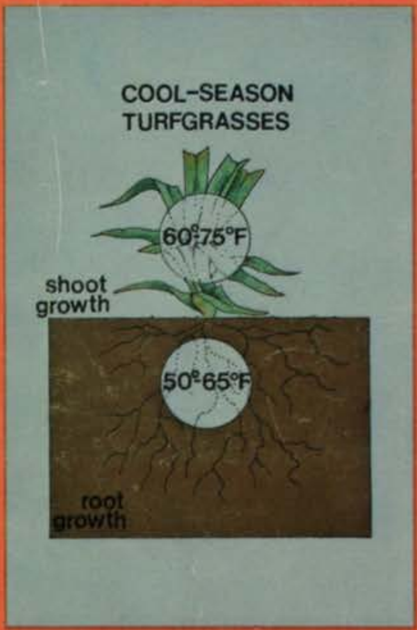


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# The Red Imported Fire Ant as a Lawn Insect Problem

**by A. D. Oliver, Louisiana State University**

*A. D. Oliver is a Professor of Entomology, at Louisiana State University, Baton Rouge, Louisiana. He received his B.S. Degree in Zoology and his M.S. Degree in Entomology at Auburn University. He received his Ph.D. in Entomology at Louisiana State University. Professor Oliver's research projects include biology and integrated control of arthropod pests of turf grass, shade trees, woody ornamentals and house-greenhouse plants.*

The red imported fire ant, *Solenopsis invicta Buren, (Fig. 1)* as the name implies, is of foreign origin. Its native homeland is Mato Grosso State Brazil. This insect was inadvertently brought into the United States about 1933 - 1940, probably at Mobile, Alabama. About 1918, an imported fire ant, *Solenopsis richteri Forel,* was found near Mobile. H. P. Loding (1919) was the first to report an official determination of an imported fire ant into the U. S. also near Mobile, Alabama. This species now known as the black imported fire ant probably came from Argentina. Until Buren (1972) properly identified and named the red imported fire ant it was believed that the two forms were one and the same species. Today the black imported fire ant is found only in a small area of northeast Mississippi and northwest Alabama and was never able to multiply and disperse with the rapidity exhibited by the red imported fire ant. It and the two native species of fire ants, *Solenopsis geminata F. and S. xyloni McCook,* have been largely displaced by *S. invicta.* Nowadays, when one discusses fire ants they are usually referring to *S. invicta* because it is the common species now found from North Carolina to Texas *(Fig. 2),* an area of approximately 200,000,000 acres. Its current distribution (beginning about 1940) was accomplished in about 40 years. Attempts to eradicate or contain the spread of the red imported fire ant have generally failed. The ultimate limit of its spread is not known but it is likely that its lack of tolerance for the cold temperatures north of North Carolina, Tennessee and Arkansas will restrict its northward dispersal. Its westward movement may be restricted by desert areas. It is also likely that people who live in the infested area of today will have to adjust their tolerance to live with this ant. Sufficient technology to rid the country of this ant is lacking. Even modern chemicals have fallen short of necessary effectiveness and have caused considerable concern among people as to their bad side effects. At this time, people who have the ant can suppress the problem with currently recommended chemicals for localized use. These recommendations may vary from state to state and should be used accordingly.

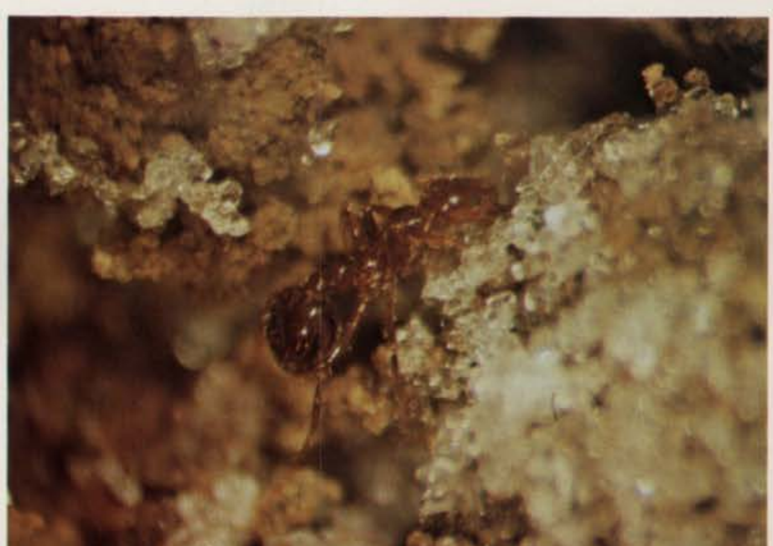

*Figure 1: A red imported fire ant worker.*


*Figure 2: Map showing approximated distribution of the red imported fire ant in the United States to 1980.*

What is the problem caused by the fire ant one may ask? Since the first eradication attempts which began in the late 1950's, claims about the horrors caused by the fire ant have been exaggerated. About $200,000,000 have been spent primarily on eradication attempts and control methods improvement. Yet, more ants and infested areas exist today than at any other time. The claims that fire ants kill significant numbers of livestock, wildlife and destroy crops have been proven false.

Some examples of printed matter which may scare many uninformed people follows: "A formidable army of South American fire ants has invaded the United States . . . Already the destructive insects have captured much of the South's best farmland and are eating their way northward and westward. Their onslaught, if not checked, may not stop short of California and Canada. The fire ant is one of the most conspicuous nuisances ever to threaten the U.S. farmers and citizens at large. It damages practically all edible plants by sucking the juices from their roots, stems, seeds and tender shoots. With the fiery sting that gives it its name, its legions rout field hands trying to gather crops like potatoes, cotton . . ." (Rankin 1957).

## Damage caused by fire ants has been greatly exaggerated

"When their mound is disturbed, these ants attack by sinking their powerful jaws into the skin, then repeatedly thrusting their poisonous stingers into the flesh. Fire ants may attack and kill newborn pigs, calves, sheep and other animals; newly hatched chicks and young ground nesting birds." (USDA-ARS, 1968).

Using such claims to justify expenditure almost became truth in the minds of some people who advocated total eradication. The free and almost free treatment of lands to rid it of the ant practically spoiled the owners to this government effort. Voters pushed the politicians for more money for fire ant eradication and as a result, considerable money was "expended" to a losing cause plus very little money was spent on conducting real research which may solve the problem. At this time more research is underway than at any other time, seeking answers to the real fire ant problem.

### TYPICAL AREAS OF INFESTATION

Areas which ideally support ant colonies are characterized generally as being in relatively sunny places with vegetation of various species and little if any debris or ground litter on the soil surface. As long as food is available the ants usually sustain the colonies in an area. By preference, food of the fire ant consists of other arthropods such as termites, springtails, crickets, caterpillars, and many other ground inhabiting species. On permanent sods where ample food is available, 50 mounds per acre may be developed. Such areas as road

## Red Fire Ant

*Figure 3: A two year old red imported fire ant mound. (Note close proximity to crepe myrtle tree).*

*Figure 4: A small red imported fire ant mound constructed during a warm day of winter 1981-82.*

sides, utility right-aways, and lawns usually support the ants if remedial action is not taken.

Populations of insects, such as the ant, that are untreated generally reach the carrying capacity of the infested area. The numbers then fluctuate around that carrying capacity as determined by food supply. The imported fire ant typically behaves in this manner as abandoned mounds are often found where no disturbance occurred.

The fire ant if not controlled may be found generally distributed along road ways, permanent pastures, cemeteries, playgounds, golf courses and in residential yards. It is in such areas where the earthen mounds *(Fig. 3)* are the largest because the soil is usually not tilled. Young colonies of ants have smaller mounds as shown in *Fig 4*. Cutting grass is effected by the mounds as they are usually high enough to encounter the blades as the grass cutter passes over. Often operators also get stung during grass cutting, especially with push type mowers. People who live in fire ant infested areas become familiar with the ant and learn to avoid getting stung. Tourists not familiar with the ant may feel that an ant mound is an excellent place to stand or sit. Such is not the case as is usually learned a few seconds after molesting the mound.

The red imported ant stings in a manner similar to any other ant, bee or wasp. The sting results in a burning like sensation which lasts for several minutes. It is not of the severity of a honeybee or yellow jacket sting. One will usually find that several fire ants sting at about the same time. This is because the person is on or was standing on or near the mound and has not noticed the ants crawling onto his socks or up the trouser leg until several have done so. Within a day after being stung, a fester usually appears at the sting site and will persist for several days. This stinging effect and fester is very annoying to some people. A small percentage of people

### New colonies are influenced by food, moisture and temperature

are hypersensitive to fire ant stings. A small percent experience anaphylactic shock and should receive medical attention. My daughter, at age two, was such a victim of red imported fire ant stings. Such patients and their parents must respect the fire ant for what it may cause in case of being stung. General allergic reactions which sensitive people experience are: tightness in the chest, larger than normal inflamed area about the sting site, pale face and anaphylaxis in extreme cases.

The wasp, hornet, bumblebee, yellow jacket and yes, the honeybee stings are much more painful than that of the IFA. A number of people die each year from insect stings. For example bees were the cause of 124 deaths from 1950-59; wasps 69; yellow jackets 22; and hornets 10 and ants 4 (unspecified species) (Parrish 1963). Many people are also sensitive to poison ivy and must take precautions to insure safety from it. So one must simply not stand upon IFA mounds other than to deliberately get stung from an instect defending its nest.

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*Figure 5: Red imported fire ant mound showing inter-tunnels where ants move freely among brood.*

## GENERAL BIOLOGY

Young mated queen ants begin a new colony after taking her mating flight from an established colony. Upon alighting, the mated queen removes her wings and burrows into the soil and within a day has completed this activity. The burrow is a simple more or less vertical hole up to 10 centimeters deep. Near the bottom end of the burrow, an egg chamber is constructed. The brood of the new colony is now begun as the queen deposits several eggs. The queen ant tends the eggs as they incubate and feeds the larvae as they develop toward adulthood. Time required for development from egg to adult worker ants is about three to four weeks under ideal conditions. Factors which influence the new ant colony are food, moisture and temperature. As more eggs are laid, incubated and larvae reared to adult ants, the larger the mound becomes below and above soil surface. The inter-honeycombed earthen mound *(Fig. 5)* allows for ant movement as temperatures change as well as exit routes for wingless foraging ants. The social behavior of the red imported fire ant is in many respects similar to other social hymenopterous insects, e.g., bees and wasps. On ideal sites, 20 to 60 colonies of ants (mounds) per acre may be developed. As long as ample food is available, the colonies are sustained unless removed by some control measure. Food apparently heavily influences the number of colonies which occupy any given area.

While conducting fire ant control experiments, it became obvious that soil type greater influences mound height. In sandy soils, mound height is less than in clay soils. Rain tends to spread out sandy soil more than clay. Control treatments using mound drench technique were influenced by soil type. There is faster and better penetration of liquid formulation of chemicals into sandy soil than into clay. Ant mounds constructed of clay soil are also more troublesome when mowing. Those not disturbed by machinery for 2-3 years normally become 8 to 10 inches high and 20-24 inches in diameter above normal soil surface. Such mounds may contain colonies of about 50,000 ants. Undisturbed areas which have ample vegetation to support prey arthropods, (food), have the greatest number of mounds. Over a period of one year about 75% of the ants which develop in a colony are workers. The remaining 25% consists of other castes such as alate females and males. It is the worker caste which defend the colony by stinging.

The ultimate extent of the fire ant spread is not known. Temperature and soil moisture are two factors which may drastically slow its spread. *(See Fig. 2 for probable temperature limitations).*

The most important problems caused by fire ants are:

1. Their stinging of people make this insect a major nuisance in areas used for outdoor activities.
2. Their building of earthen mounds may disrupt grass cutting equipment.
3. The dislike by some people of having so many insects in an area.
4. False impressions some people have because of falsified and incorrect information placed in the news media.

No insect in the history of entomology has created more controversy than the red imported fire ant. Because many

## Red Fire Ant

people are affected in one way or another and because of lack of information, false information and misinformation, the fire ant problem ballooned into an entomological nightmare. That this was thrown into the political arenas of local, state and federal governments magnified the people problem aspect to the point of almost insanity.

The red imported fire ant is likely here to stay, therefore people who live in the infested areas should create within, a tolerance for its presence. There is no panacea for this or any other insect problem. Common sense and at least a degree of sagacious observation simply places this insect in the realm of a pest species only under certain circumstances. So are the honeybee, bumblebee, yellow jacket and others, problems under certain circumstances. We have and will live our normal lives in the presence of these stingers— and may realize considerable benefits under some circumstances.

In the case of the red imported fire ant, considerable benefits have resulted from its predatory behavior. Although many people do not realize it and others desclaim it for various reasons, the fact remains that this ant does destroy considerable numbers of arthropod pest species. Prime examples in Louisiana are lone star ticks, termites and several species of ground inhabiting larvae. These simply serve as food for colony brood.

Public education is badly needed in relation to helping people hypersensitive to the fire ant sting. Doctors and other medical professionals need to know the symptoms resulting from stings and the possibility of allergenic reactions so that appropriate medication can be promptly administered.

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xxx

# EDITORIAL

## by Maureen Mertz Managing Editor

Imagine that you must notify all homeowners within 200 feet and all beekeepers within 2000 feet of your customers prior to pesticide application. You must do this not more than three days or less than 24 hours before each application. When the applicator arrives at a customer's home, he must now post a sign adjacent to all public roadways within 200 feet, but more than 100 feet from the boundry of the property. This done, he must personally notify all homeowners within 100 feet of his customer that he intends to spray. In an average neighborhood this would mean approximately nine homes, two on each side of his customer, and the five whose property lays adjacent along the back.

Sound ridiculous? Well this is what The New Jersey Coalition for Alternatives to Pesticides (NJAP) has proposed to the New Jersey Department of Environmental Control. Similar proposals for the control of pesticides and herbicides are being made throughout the country. Trained and certified professionals now handle the bulk of chemical applications. This constitutes effective protection from environmental harm. Passage of proposals of this type are cost prohibitive and could mean the end of licensed lawn applicators. Our thanks to Jim Kelly, Professional Turf Specialties, Lansdale, PA, for bringing this one to our attention. Jim is a member of The Alliance for Environmental Concern which is fighting this proposal. Contact Rick Gilmore (201) 328-7780.

The National Coalition for a Reasonable 2,4-D Policy which is supported by the PLCAA, also needs our support, contact June Hedrich, Secretary at 435 N. Michigan Avenue, Chicago, IL 60611, (312) 644-0828.

This is our industry and each of us has a responsibility to take an active part in its future.

xxx








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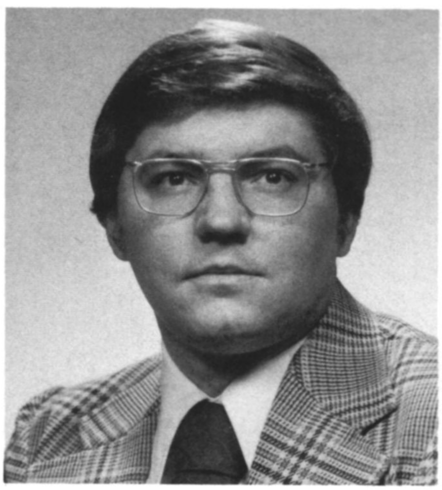
# Complications in Nitrogen Fertilization of Turfgrass

by John R. Street, Ohio State University



*John R. Street is an Assoc. Professor of Agronomy/Turfgrass Science at the Ohio State University. He received his B.S. degree from Calif. State College in plant physiology and his M.S. and PhD degrees from the Ohio State University in Agronomy. Dr. Street's chief research interests are in turfgrass nutrition, nitrogen fertilizers, and weed control.*

Turfgrass growth is dependent upon an adequate supply of all essential plant nutrients, as well as a multiplicity of other cultural and edaphic factors. Research in plant nutrition has shown that at least 16 elements are essential for plant growth and development *(Table 1)*. Those essential elements used in greatest quantities by the plant are referred to as macronutrients. Micronutrients are required in relatively small quantities by the plant. Nitrogen receives the most attention in turfgrass fertilization programs for several reasons. First, nitrogen is the essential element to which turfgrass is most responsive. Nitrogen can be described as the "growth-control element". Supplies of other elements are kept at adequate levels and the manager regulates growth by adding or withholding nitrogen. Second, the turfgrass plant contains more nitrogen than any other essential element *(Table 1)*. Third, nitrogen is a very dynamic element in the soil system. Its concentration in the soil is constantly changing. It may be depleted or lost from soils by leaching, volatilization, denitrification, immobilization, clipping removal, or nitrogen fixation in the lattice structure of certain clays. The other essential elements are more stable in soils. Thus, nitrogen must be added to turfgrass areas on a routine basis to maintain a soil level that is sufficient for turfgrass growth.

Generally, nitrogen additions to the turfgrass system from clipping return, decomposition of organic matter, topdressing, nitrogen fixation, and rainfall are not sufficient to supply the needs of high-quality turf. The main source of added nitrogen is nitrogeneous fertilizers, which are initially added to the turfgrass system as ammonium ($NH_4^+$), nitrate ($NO_3^-$), or both or as some nitrogen carrier that eventually breaks down into ammonium. Although the turfgrass

**TABLE 1: Essential Plant Nutrients Required for Turfgrass Growth and Development[a]**

| Macronutrients | Typical Percentage in Turfgrass Tissue[b] |
|---|---|
| Nitrogen | 3-6 |
| Phosphorus | .2-.5 |
| Potassium | 2-3 |
| Calcium | .4-.6 |
| Magnesium | .2-.4 |
| Sulfur | .2-.3 |
| **Micronutrients** | **Typical parts per million (ppm) in Turfgrass Tissue** |
| Iron | 40-200 |
| Zinc | 40-120 |
| Molybdenum | .1-.2 |
| Manganese | 20-150 |
| Copper | 15-20 |
| Boron | 5-20 |

[a]Carbon, hydrogen and oxygen are also essential elements supplied predominantly from air and water.

[b]Elemental percentages will vary to some extent depending on turfgrass species and cultivars, environmental conditions and other variables.

plant absorbs nitrogen from the soil as either ammonium or nitrate, the latter is the predominant form absorbed by the plant because ammonium is rapidly converted to nitrate by soil bacteria. This biological oxidation of ammonium to nitrate is nitrification, a two-step process in which the ammonium is converted to nitrite ($NO_2^-$) by Nitrosomonas bacteria and then to nitrate by Nitrobacter bacteria. The process is temperature dependent and increases with soil temperatures from 32°F to an optimum range of 85° to 95°F.

Once absorbed into the plant, nitrate can be stored in the cell or reduced back into the ammonium form. The storage of free nitrate within the plant cells results in a luxury consumption of nitrate (absorption of more than is used). This use of nitrogen is probably inefficient, especially if the clippings are removed. Nitrate must be converted to the ammonium form before it can be further utilized by the plant. The reduction process ($NO_3^-$ to $NH_4^+$) within the plant requires at least two enzymes (compounds that assist in the reaction).

**Figure 1a: Turfgrass disease incidence as affected by nitrogen fertility.**

## High Nitrogen

PYTHIUM
BROWN PATCH
FUSARIUM BLIGHT
STRIPE SMUT
SNOW MOLD
LEAFSPOT

## Low Nitrogen

DOLLAR SPOT
RED THREAD
RUST

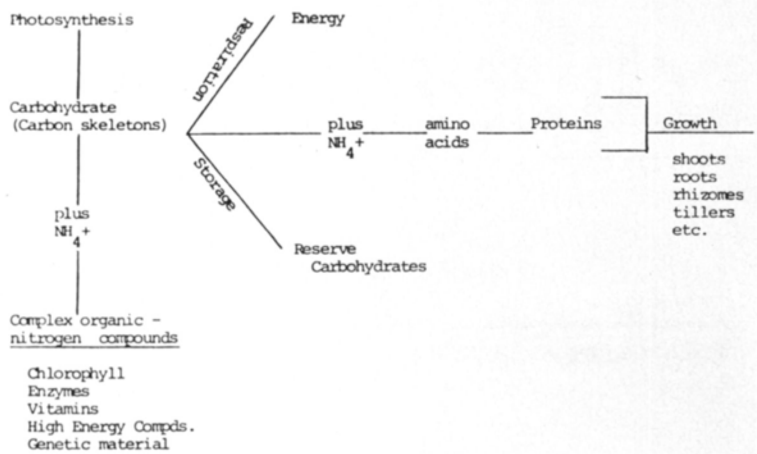



*Figure 1: A brief outline of carbohydrate utilization and nitrogen assimilation.*

Nitrate reductase is the enzyme involved in the conversion of nitrate to nitrite. Nitrite reductase is the enzyme involved in the conversion of nitrite to ammonium. In grasses, the reduction process predominatly occurs in the shoot or foliar portion of the plant, although some reduction may occur in the roots. The ammonium ion is then readily combined into various complex organic (carbon) compounds within the plant. Chlorophyll, amino acids, proteins, enzymes, and vitamins are among some of the organic compounds containing nitrogen *(Figure 1)*. Photosynthesis provides the source of carbohydrates or organic skeltons for the nitrogen assimilation processes.

Carbohydrates, produced by photosynthesis, are the necessary precursors for the formation of nitrogen-containing amino acids and proteins, which are utilized in the growth processes *(Figure 1)*. The more the turfgrass grows, the greater its demand for carbohydrate. Thus, growth is a carbohydrate-utilizing process. Carbohydrate is also the key source of energy for maintaining all the various growth and physiological processes within the plant. Carbohydrates are broken down into carbon dioxide and water through respiration, and energy is released. Respiration, therefore, is a carbohydrate-utilizing process. When the rate of photosynthesis (carbohydrate production) exceeds the rate of respiration and the requirement for growth (carbohydrate utilization), carbohydrates accumulate as reserves. These reserves are usually stored in the crowns, rhizomes, and stolons of cool-season grasses. Carbohydrate reserves are desirable because they serve as an immediate source of energy and carbon skeletons for regrowth and recovery from defoliation or stresses that may injure or thin the turf. Recovery and regrowth from summer and winter dormancy rely on carbohydrate reserves. A carbohydrate deficit may develop when respiration rates are high, growth is rapid, or both. Usually any factor that stimulates rapid topgrowth will deplete or drain carbohydrate reserves. The turfgrass manager should manipulate cultural practices so as to maintain an adequate level of carbohydrates within the plant for normal as well as unusual energy and growth demands. The carbohydrate reserve status of the plant is important because it reflects the plant's energy, recovery, and stress tolerance status.

Nitrogen fertilization has a definite effect upon the carbohydrate status of turfgrasses. Nitrogen applications favor turfgrass growth. As nitrogen rates are increased, usually more topgrowth is

# Nitrogen Fertilization

**TABLE 2: Nitrogen Treatment Effects on a Merion Kentucky Bluegrass Sod[a]**

| Nitrogen rate (lb./acre/month) | Annual clipping yield (lb./acre dry wt. | Nitrogen content in clippings (percent) | Sod strength (lb. to tear) | Rhizomes (grams) |
|---|---|---|---|---|
| 0 | 463 | 3.0 | 146 | 99 |
| 15 | 1,807 | 3.3 | 188 | 89 |
| 30 | 2,555 | 3.6 | 130 | 120 |
| 60 | 5,676 | 4.5 | 97 | 43 |
| 120 | 8,447 | 5.4 | 67 | 14 |

[a]Source: Rieke, 1975.

produced. More topgrowth results in the use of more carbohydrate. Like shoots, roots and rhizomes require carbohydrate (carbon skeletons) for growth. Physiologically, under rapid growth conditions shoots take priority over roots and rhizomes for available carbohydrate. Shoot growth will usually continue to respond to higher suppression of root growth and other growth processes (e.g. rhizomes).

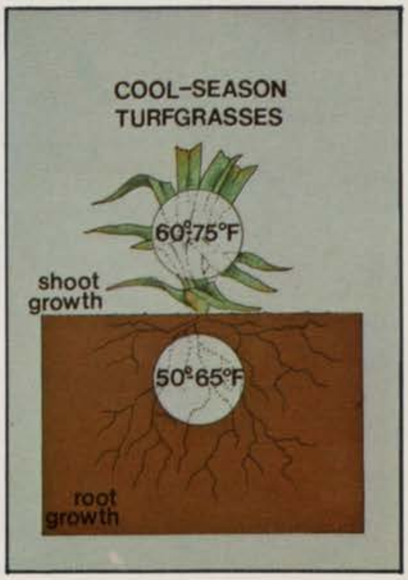
These effects are well illustrated by a fertilization study evaluating the response of a Merion Kentucky bluegrass sod to incremental rates of nitrogen *(Table 2)* (Rieke, 1975). Higher nitrogen rates resulted in an increase in clipping yield (topgrowth) and the nitrogen content of the clippings. In contrast, sod strength (a reflection of root and rhizome growth) and rhizome weight decreased at the higher nitrogen levels. Thus, when most of the plant's carbohydrate was directed toward producing shoot growth, root growth and other plant growth processes suffered accordingly. Agronomists recognize that a grass plant is no better than the root system that supports it.

Research has shown that a considerable amount of root initiation and root growth of cool-season grasses occurs in the spring (Beard and Daniel, 1966). Liberal nitrogen fertilization in the spring will tend to restrict root growth. The turfgrass plant will go into the summer with a shorter root system than if moderate rates of nitrogen fertilizer were used. Furthermore, high amounts of nitrogen will increase topgrowth and the need for more frequent mowing in the spring. The rapid topgrowth may result in the removal of large amounts of clippings at each

## Excessive removal of foliage during mowing retards tiller and root development

mowing. The removal of excess foliage (i.e., more than a third of the foliage at any one mowing) is known to retard both tiller and root development. Thus, mismanagement of nitrogen during the spring can have a dramatic effect on the turfgrass root system as it goes into the summer. Nitrogen is needed in the spring, of course, for root and rhizome growth as well as shoot growth, but high nitrogen fertility rates in the spring will eventually create problems.

Liberal nitrogen fertilization also causes a lush, succulent plant growth that is characterized by decreased cell wall and cuticle thickness, increased cell size, and an increased level of plant tissue hydration. The thinner plant cell walls are most likely the result of more rapid plant growth and the production of fewer structural carbohydrates *(Figure 1)*. This type of growth increases the severity of plant disease and lowers the hardiness of the plant to heat, cold, and drought. Lush, succulent tissue also contains high concentrations of nitrogen-rich compounds, which accumulate in guttation fluid (leaf




*Late-season nitrogen fertilization takes advantage of temperature differences for optimum growth of roots and shoots.*

**TABLE 3: Effects of Various Spring Fertilization Rates and Mowing Heights on the Incidence of Fusarium Blight on Several Kentucky Bluegrass Cultivars[a]**

| Fertilizer rate[b] (lb. N/1,000 ft$^2$) | | Mowing height (inches) | Kentucky bluegrass varieties[c] | | | | |
|---|---|---|---|---|---|---|---|
| May | June | | Nugget | Merion | Fylking | Pennstar | Kenblue |
| 1 | 0 | 0.75 | 1.0 | 1.3 | 2.3 | 1.7 | 4.7 |
| 1 | 0 | 1.5 | 1.0 | 1.3 | 2.3 | 1.0 | 4.0 |
| 1 | 1 | 0.75 | 1.0 | 2.0 | 1.7 | 2.7 | 4.0 |
| 1 | 1 | 1.5 | 1.7 | 3.0 | 2.0 | 2.0 | 4.0 |
| 2 | 1 | 0.75 | 1.0 | 2.3 | 3.7 | 4.3 | 4.0 |
| 2 | 1 | 1.5 | 3.0 | 3.7 | 4.0 | 4.0 | 4.0 |
| 2 | 2 | 0.75 | 2.3 | 3.0 | 5.7 | 5.3 | 4.7 |
| 2 | 2 | 1.5 | 3.7 | 5.3 | 6.0 | 3.7 | 4.3 |

[a]Source: Turgeon and Meyer, 1974.

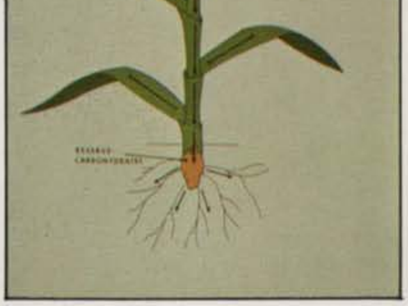
[b]A water-soluble nitrogen fertilizer was used.

[c]Visual ratings of disease were made using a scale of 1 through 9, with 1 representing no apparent disease and 9 representing complete blighting of the turf.

exudates). The guttation fluid serves as an ideal medium for the enhancement of many turfgrass diseases. Thus, mismanagement of nitrogen in the spring can take the plant into the summer in a soft growth condition in which it is more vulnerable to disease, heat, and drought.

Liberal nitrogen fertilization is known to increase the severity of Phythium, brown patch, Fusarium blight, stripe smut, snow mold, and Helminthosporium (leafspot) diseases (Vargas, 1975). Leafspot, a serious disease of both Kentucky bluegrass and bentgrass in the Midwest, is much more serious at high nitrogen levels, especially in the spring. Kentucky bluegrass varieties like Park, Kenblue, and Delta are very susceptible to leafspot. Many lawns and older turfgrass areas have been established to these common-type Kentucky bluegrass varieties. Research (Turgeon and Meyer, 1974) has shown that the incidence of Fusarium blight in the summer is greater with increasing nitrogen application rates in the spring *(Table 3)*. Nugget, Merion, Fylking, and Pennstar were highly susceptible to the disease when more than a total of 2 pounds of soluble nitrogen per 1,000 square feet was applied in the spring. Kenblue was affected by the disease at all the fertility levels. This information lends support to the practice of using moderate levels of nitrogen fertilizer in the spring. It more specifically suggests a critical limit of using no more than 2 pounds of total soluble nitrogen per 1,000 square feet in the spring. High nitrogen fertility in the spring can not only have detrimental effects in the spring but detrimental carryover effects in the summer as well.

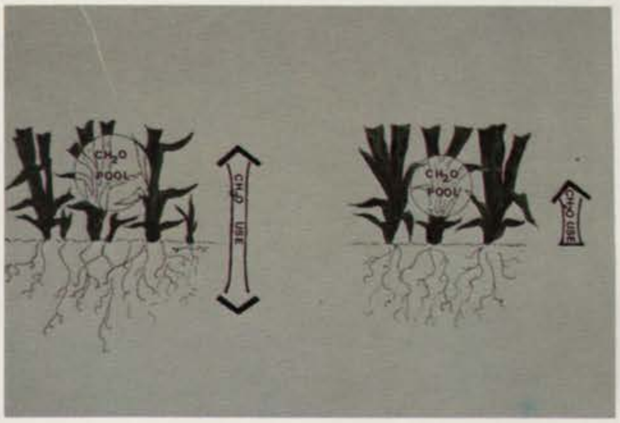
High nitrogen fertilization is also critical during the summer (Beard, 1973). As seasonal temperatures increase, photosynthesis of cool-season grasses decreases and respiration increases. Carbohydrates are consumed during respiration. Respiration is also known to increase with increasing nitrogen fertility levels. Thus, during periods of high temperature, liberal nitrogen fertilization may reduce carbohydrate reserves because of rapid growth and high respiration. Additional plant stress may result from lower photosynthetic rates. Because photosynthesis is low and respiration is high during the summer, nitrogen should be applied at low rates for cool-season turfgrasses.



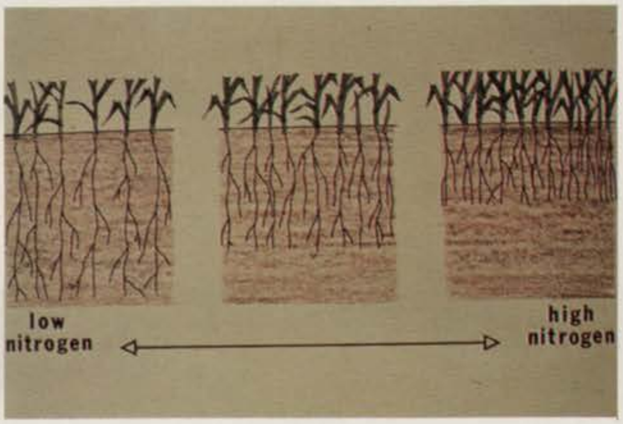
*Photosynthesis is the source of carbohydrate for nitrogen assimilation and plant growth. Excess carbohydrate is stored in the basal portions of the turfgrass plant (i.e. crowns) for later use.*

## Nitrogen should be applied at low rates for cool-season turfgrasses

Nitrogen fertilization has proven beneficial during the late fall (late season) on cool-season turfgrasses. Decreased disease, improved stress tolerance, and increased rhizome and root growth are among several of the claimed advantages to the "late-season" nitrogen fertilization program. This program is based on optimum temperatures that exist between (1) root-rhizome growth versus shoot growth and (2) photo-




*A large carbohydrate pool (left) results in adequate translocation of carbohydrate downward for underground plant growth like roots and rhizomes. A small carbohydrate pool (right), especially under rapid growth, results in insufficient translocation of carbohydrate downward for underground plant growth.*



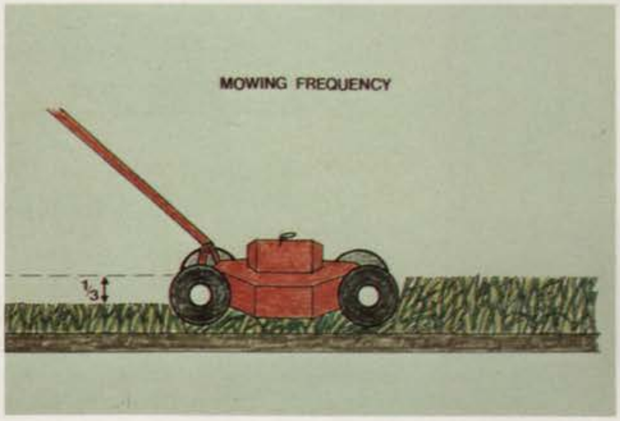

*High nitrogen fertility results in a shorter, less prolific root system.*

synthesis versus respiration.

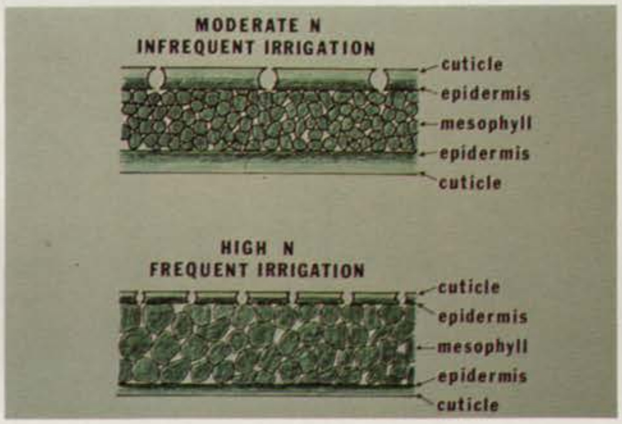
Shoot and root growth of cool-season turfgrasses occur most readily in the temperature range of 60-75°F and 50-65°F, respectively. Root growth of cool-season grasses will continue at soil temperatures close to freezing. Under late-season fertilization, nitrogen applications should be made when vertical shoot growth has stopped, but the turf leaves are still green to produce carbohydrate via photosynthesis. The carbohydrate produced will be more efficiently used for root and rhizome growth during the late fall and winter periods. It is critical that the nitrogen be applied prior to dormancy. "Late-season" fertilization is not dormant fertilization.

During late fall, photosynthesis is normally higher than respiration for cool-season turfgrasses. This leads to maximum carbohydrate production and carbohydrate storage for reserves. The positive carbohydrate balance favors root and rhizome growth over top-growth since air temperatures are well below that considered optimum for shoot growth.

Nitrogen is a key component of turfgrass fertilization programs. It has an influence on both the morphology and physiology of the turf plant. High-quality turf exhibiting acceptable green color and density requires periodic




*Never remove more than 1/3 of the plant foliage at any one mowing. High nitrogen fertility may create a severe defoliation problem.*




*High nitrogen fertility produces a soft, succulent plant condition (bottom) characterized by decreased cell size, and an increased level of plant tissue hydration. This condition contributes to increased plant disease and lower plant tolerance.*

applications of nitrogen. Nitrogen, however, is frequently referred to as the "TNT" of turfgrass fertilization programs. It can be just as detrimental as beneficial if it is mismanaged. Physiologically, the turf manager must maintain a good carbohydrate reserve. Proper timing and rate of application are important in successful long-term programs. Always remember: greener is not always better. A happy medium must be reached between agronomics and aesthetics.

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# Fusarium Blight
## Its Development and Management

by Joseph M. Vargas, Jr., Michigan State University

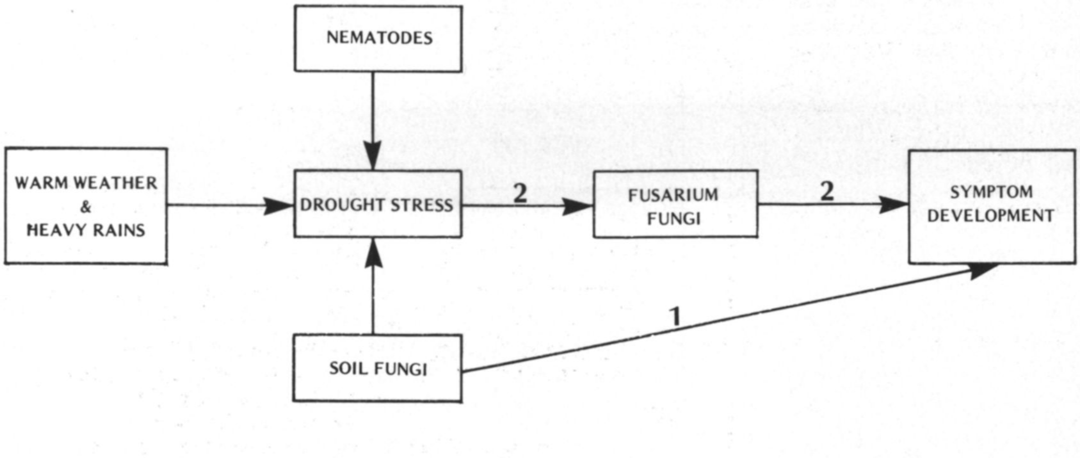
*Dr. Vargas received his Ph.D. degree from Oklahoma State University of Minnesota in 1968. He was assistant professor, botany and plant pathology, Michigan State University, 1968-74; assistant professor, Institute of Agriculture Technology, 1972-74; associate professor, 1974.*

The disease *Fusarium* blight was officially named in the mid 1960's.[2] A more proper name would have been *Fusarium* patch or *Fusarium* spot. *Fusarium* patch could not be used, as it was the common name given to a disease caused by *Fusarium* nivale, also known as pink snow mold. Blight was probably chosen over spot because it sounds more dramatic or devastating. Since that time, *Fusarium* blight has been at the center of controversy among turfgrass pathologists, as to its cause and management.

Part of the controversy has resulted from Koch's postulates not originally being completed. Koch's postulates are a set of rules followed by most plant pathologists when they are determining the causal organism involved in a disease problem. Step 3 & 4 of Koch's postulates were not completed in the original work.[2] A "frog eye" symptom, which is a characteristic of the disease, was not demonstrated. The *Fusarium* fungi was shown to be pathogenic on the foilage, causing a leaf spot symptom, which rarely, if ever occurs under field conditions.[2]

Nematodes have been associated with the disease.[5] However, it would appear that nematodes act as a predispositioning factor, rather than the actual cause of the disease. Senescing, or natural dying from "old age", have been implicated in the disease.[4] While this may be a factor, it does not really explain the circular patterns. Soil fungi which makes the soils hydrophobic, have been implicated as the actual cause of the problem (instead of *Fusarium roseum* & *F. Tricinctum*). The soil fungi may act as predispositioning factors that cause the plants to undergo drought stress and to then be attacked by the Fusarium fungi when

*Figure 1: Model of Fusarium blight development.*



they are in the drought stress condition.[3]

Taking all the aspects into account and modeling them, one would come up with a diagram like *Figure 1*. Smiley's work[4] indicates a heavy rain is necessary to "trigger" *Fusarium* blight development, we have also made similar observations. The key to *Fusarium* blight symptom development is drought stress. Most turfgrass pathologists agree on that. This can occur naturally through drought, be more acute where high nematode populations exist, or be caused by soil fungi growing as saprophytes causing the soil in the area they are growing in to be hydrophobic. This would explain the circular pattern associated with the disease as most fungi grow out from a central point in a more or less circular pattern. The turf in these spots would wilt and die. The dead and dying patches would then be colonized by the *Fusarium* fungi. In this instance the *Fusarium* would merely be acting as sopropytes on the dead and dying tissue and not as the primary cause of the disease. The other explanation involves pathway 2. The *Fusarium* fungi attack grass plants undergoing drought stress producing the disease symptoms. This theory would also explain the circular pattern of the disease as stated before, because fungi tend to grow in circular patterns. Hopefully, someday the true nature of the disease called *Fusarium* blight, will be known.

## FUSARIUM BLIGHT MANAGEMENT

While the exact cause is still open to controversy, a set of management tools have been developed for *Fusarium* blight. The various management tools available are listed in *Table 1*. They should all be used for the most effective *Fusarium* blight management. Satisfactory management of *Fusarium* may not be obtained if only 1 or 2 of these tools are used.

## CULTIVARS

Where resistant cultivars have been used, the disease has been greatly reduced. Unfortunately, some of the newer cultivars have developed other diseases which are just as devastating, i.e. *Nigrospora* patch and *Yellow* patch (cool temperature brown patch). In the future, cultivars with good agronomic qualities that suit the needs of the user will have to be selected and managed culturally and chemically, to reduce or prevent the development of the diseases that may occur on them.

**TABLE 1: Tools to manage *Fusarium* blight.**

1. **Resistant Cultivars**
2. **Cultural**
   - a. Cultivation– coring
   - b. Thatch Reduction– coring
   - c. Eliminate layering– coring
   - d. Daily Irrigation– summer months
3. **Biological**
   Daily irrigation to build up antagonistic bacteria
4. **Chemical**
   - a. Preventative or Curative
     - 1) Cleary's 3336
     - 2) Fungo 50
     - 3) Tersan 1991
   - b. Preventative Only
     - 1) Bayleton

## CULTURAL

Cultivation: Coring should be done to improve root development, reduce thatch, and eliminate layering caused by two different soil types. Home lawn turf is often grown on poor soil. Many times, these soils are compacted sub soil, where the top soil was removed before the housing development was started. Providing holes for root development through coring will provide a healthier turf. Thatch reduction is best accomplished by coring, breaking up the cores by vertical mowing or power raking, and incorporating the soil back into the thatch layer. Power raking does little for thatch reduction. It removes leaf tissue which is readily broken down and does nothing to remove the rhizomes and roots which are primarly responsible for thatch formation. Layering occurs when two different soil types are placed one on top of the other. This often occurs in the home lawn situation after sodding. Under favorable environmental conditions this is not a problem. Under stress conditions the entire turfgrass root system is only in the upper layer. This layer may be no more than an inch in depth. Obviously, drought stress diseases like *Fusarium* blight and *Nigrospora* patch are going to be more severe. Integrating the two soil layers through a coring program should make for a deeper rooted, healthier turf.

It is often said that such equipment is not available to the homeowner, but it is available to the lawn sprayer or landscaper. Sell them a new service. It is a good way to increase your profit without obtaining new customers.

Fertility: Nitrogen fertility in the summer months of June, July and August, will reduce the severity of *Fusarium* blight. Approximately ½ lb. of actural nitrogen/1,000 sq. ft./month should be adequate.

Irrigation: Supplemental irrigation can culturally reduce *Fusarium* blight if applied on a daily basis. If applied at mid-day, on a daily basis, it will cool the plants as well as provide water for the short and limited root system of the *Fusarium* blight infected plants.

Biological: These two *Fusarium* fungi cause a similar root and crown disease in wheat. Scientists have shown that where the mat is kept moist antagonistic bacteria are developed, which will destroy the *Fusarium* fungi. A daily

## Fusarium Blight

irrigation program on *Fusarium* blighted turfs in the summer months may also cause the build-up of antagonistic bacteria that may destroy the *Fusarium* fungi. The daily irrigation method of disease management is often critized because it will cause short root development. In cool-season turfgrasses, such as Kentucky bluegrass, root shortening is a natural occurrence during the summer months due to warm soil temperatures. Deep infrequent irrigation won't cause the formation of deep roots anymore than light frequent irrigation will shorten them. Irrigate infrequently and deeply in the spring and fall when cool soil temperatures will allow for deep root development. Light frequent irrigation in the summer will keep your customer's lawn free of *Fusarium* blight.

### CHEMICAL

Cleary's 3336, Fungo 50 and Tersan 1991, are good fungicides for the management of *Fusarium* blight. They all have the same basic chemistry and the turf area to be treated should be irrigated the night before and drenched in before they dry on the foilage. They can be used either curatively or preventively on *Fusarium* blight. The fourth fungicide Bayleton, does not have to be drenched in to be effective. However, it does have to be used as a preventative fungicide. This means it has to be applied before the disease becomes active during the current season. If two applications are made, the first should be applied 1 month ahead of when the disease normally appears (approximately June 15 in mid-Michigan) with a second application being made around July 15. If only one application of Bayleton is made, it should be applied 2 weeks prior to the normal occurrence of the disease (approximately July 1st in mid-Michigan). Regardless of which approach is taken, having your customer follow good cultural and biological management practices will make the fungicides more effective.

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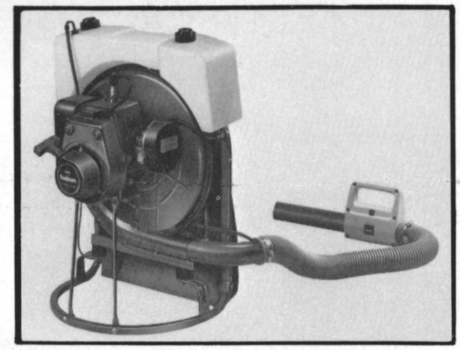
## Hudson Porta-Pak Ultra-Low-Volume Sprayer



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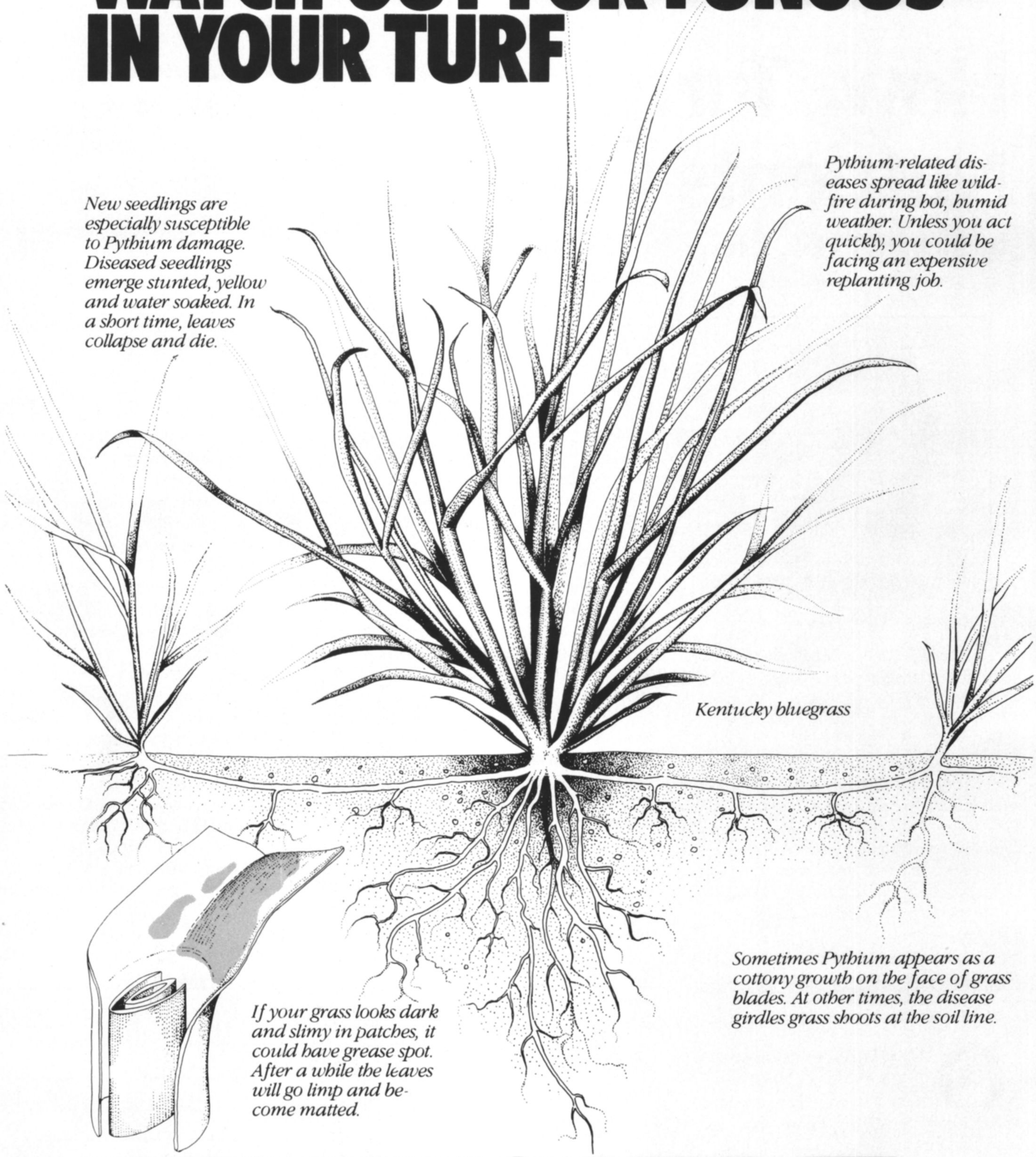


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Circle No. 10 on Reader Reply Card

# How Turfgrasses Absorb Nutrients

## by Richard J. Hull, University of Rhode Island

*Richard J. Hull is a Professor of Plant and Soil Science at the University of Rhode Island. He received his B.S. and M.S. degrees from the University of Rhode Island in agriculture and agronomy respectively and the Ph.D. in botany from the University of California at Davis. For five years, Dr. Hull studied the physiology of perennial weeds at Purdue University in Indiana. At Rhode Island, his research has concentrated on the nutrition of turfgrasses, woody ornamentals, and tidal salt marsh vegetation.*

One of the more costly aspects of a lawn management program is the purchase and application of fertilizer. These materials are applied each year, usually in the autumn and spring, and are often regarded by lawn care professionals as the single most important investment in maintaining quality turf. However, if you were to ask most turf specialists exactly how grass acquires fertilizer nutrients and takes them into root cells, most would be hard-pressed to give a specific answer. This should come as no surprise, because it has only been within the past few years, that a well defined mechanism of nutrient absorption has been developed. This break-through in our undertanding of how plants absorb nutrients has resulted from the application of a theory developed by Peter Mitchell in the early 1960's to explain the synthesis of high energy phosphate bonds during respiration and photosynthesis (Mitchell 1961). This theory, for which Mitchell was awarded the Nobel prize in 1978, has done much to explain how chemical energy generated in respiration can be used to do mechanical work such as concentrate nutrient ions within root cells.

The problem facing grass plants growing in a normal soil is how to accumulate mineral nutrients from the dilute soil solution in concentrations sufficient to support plant functions. The magnitude of this problem is illustrated by comparing the nutrient concentration of Kentucky bluegrass plants with that of the soil solution in which they are growing *(Table 1)*. It is apparent that the plant must accumulate nutrients to concentrations several times in excess of the soil solution. How does a grass plant do this?

The problem of nutrient accumulation by roots is partly solved by the transfer of dissolved minerals to the root surface in the flow of water moving from the soil through the plant in the process of transpiration. Stanley Barber at Purdue University has described the processes by which nutrients in the soil solution move toward the root surface (Barber 1974). He has demonstrated that the delivery of calcium, mangesium, and sulfate to the root surface is greater than the plant can absorb. This results in a concentration of these nutrients around the roots at levels much greater than that found in the bulk soil solution. Consequently the process of accumulating these nutrients in root cells is made easier due to their mass flow transport to and concentration at the root surface.

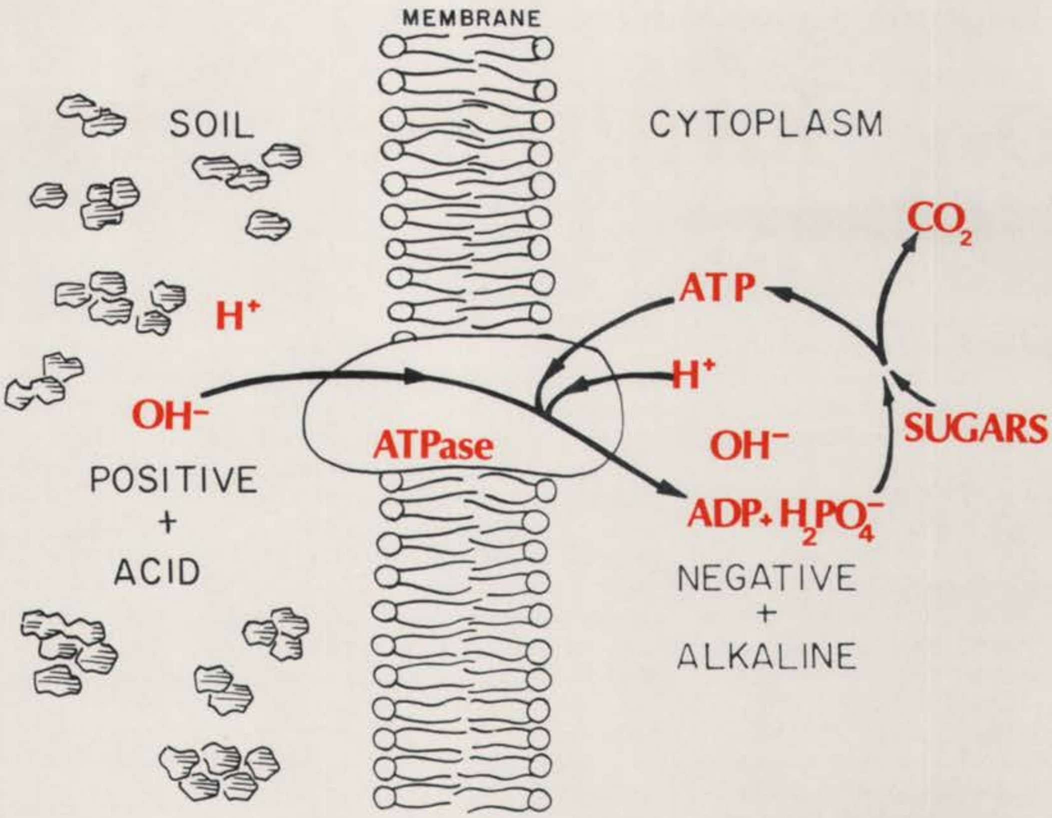
This phenomenon does not explain the accumulation of potassium, phosphate, and nitrate which are absorbed more rapidly than they are transported to the roots. This results in a nutrient depletion of the soil solution immediately around the roots. As a result, the root must absorb these nutrients

**Table 1: Nutrient content of a soil solution and of Kentucky bluegrass leaf tissue from sod growing in that soil.**

| N-$P_2O_5$-$K_2O$ lbs/1000 sq. ft. | Soil Solution* N | P | K | Grass Tissue N | P | K |
|---|---|---|---|---|---|---|
| | ppm | | | ppm fresh wt. | | |
| 2.5-1-1 | 7.0 | 119 | 102 | 3907 | 572 | 1279 |
| 5-2-2 | 8.5 | 116 | 89 | 4189 | 536 | 1264 |
| 10-4-4 | 15.2 | 127 | 101 | 5000 | 503 | 1291 |

*Based on extractable nutrients, so actual solution content would be less than these values.

*Figure 1. The cleavage of ATP to ADP and phosphate creates a pH gradient accross the plasma membrane.*




from a soil solution even more dilute than that indicated in Table 1. Here the plant must expend energy to transfer nutrients from the soil solution of low concentration surrounding the root to the cell sap of much higher concentration within the roots. The application of Peter Mitchell's chemiosmotic theory and some recent advances in cellular electrochemistry have provided an explanation of how the plant root accomplished this feat of nutrient accumulation.

The energy source of nutrient absorption seems to be the organic molecule adenosine triphosphate (ATP) which is a product of respiration in root cells. ATP contains chemical energy because it has a strong tendency to discharge one of its three phosphates to form adenosine diphosphate (ADP) and one molecule of inorganic phosphate. For this reaction to occur, one water molecule must enter into the products formed:

$$ATP + H_2O \xrightarrow{ATPase} ADP + H_2PO_4^- + ENERGY$$

This reaction proceeds readily to the right because there is considerably less energy in the products, ADP and phosphate, than there is in ATP. Exactly where in the cell this reaction occurs is determined by the presence of the enzyme ATPase which catalyzes the hydrolytic cleavage of phosphate from ATP and the release of energy.

Several researchers including Tom Hodges at Purdue University have demonstrated the presence of an ATPase

## The plant must accumulate nutrients to concentrations several times in excess of the soil solution

in the plasma membrane which surrounds each root cell (Hodges 1973). In this membrane, the ATPase is positioned so that when ATP is cleaved to ADP and phosphate the components of water ($H^{\pm}$ and $OH^-$) are drawn from different sides of the membrane *(Fig. 1)*. The $OH^-$ is taken from the outside, cell wall or soil solution, and the $H^{\pm}$ is taken from the cytoplasm inside. When an $OH^-$ is removed from the solution outside the cell an $H^+$ is left behind. Conversely when an $H^+$ is drawn from the cytoplasm, a free $OH^-$ remains. The net effect of this reaction is a concentration of $H^{\pm}$ outside the cell and OH inside. In other words, a pH gradient is created across the plasma membrane with the outside becoming acid and the cytoplasm alkaline. An acidity difference of 1.5 pH units is not uncommon between the cell wall or soil solution immediately surrounding a healthy root and the cytoplasm within root cells.

Peter Mitchell observed that a pH gradient produced in photosynthesis or respiration was the driving force responsible for the synthesis of ATP. The reverse of this reaction utilizes the energy in ATP to create a pH gradient across the plasma membrane of root cells. Before we consider how this pH difference is utilized to concentrate nutrients within cells, it is necessary to understand that there are two components to a pH gradient that have a bearing on nutrient absorption and concentration. Because $H^{\pm}$ contains a positive charge and OH a negative charge, the pH gradient re-

# How Turfgrasses Absorb Nutrients

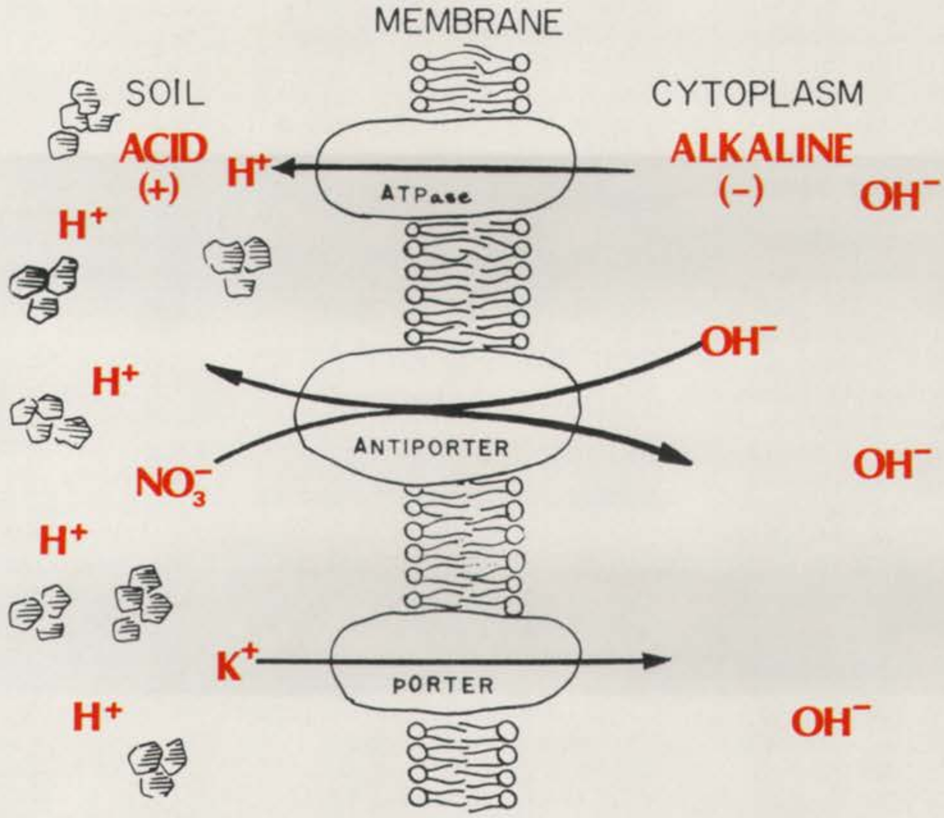
sults in a charge separation across the plasma membrane. The cell exterior is positive with respect to the interior which is negative. This charge separation forms an electrical potential across the membrane which in healthy root cells has been measured at 150 millivolts. Thus there is a chemical gradient of $H^+$ and $OH^-$ and an electrical gradient across the cell plasma membrane.

It is this electrochemical gradient which drives nutrient transport from the soil solution into root cells. Because nutrient elements are present in the soil solution in the form of charged ions, they will come under the influence of the electrical gradients established between the inside and outside of root cells. The positively charged cationic nutrients, e.g. potassium ($K^+$), magnesium ($Mg^{++}$), and calcium ($Ca^{++}$) will be attracted to the cell interior because it is negative. Thus, even though the concentration of $K^+$ inside the cell may be greater than it is outside, $K^+$ will continue to enter the cell because the electrical gradient favors the influx of positively charged ions. This results in a concentration of cations within the cell *(Fig. 2)*.

The plasma membrane, across which nutrient ions must move, is composed of a bilayer of phospholipids which resists the passage of water soluble ions. Entry into the cell is facilitated by integral proteins which extend across the lipid layer and provide aqueous micropores through which ions can move in response to chemical or electrical gradients *(Fig. 2)*. These proteins which serve as ion transporters, porters for short, are so constructed that only certain ions can move through them and enter the cell. Presumably there is a specific porter protein built into the plasma membrane for each nutrient ion (Epstein 1976). Therefore, while the electrical gradient across the membrane provides the energy for cation absorption, the specific porter proteins determine which cations will enter the cell and at what rate entry will occur.

This is fine for cations which can move down an energy gradient from a positive exterior to a negative interior, but how does this work for negatively charged anionic nutrients, e.g. nitrate ($NO_3^-$), phosphate ($H_2PO_4^-$), or sulfate ($SO_4^{=}$)? These ions will be repelled by the negative interior of root cells. Here the chemical potential of $OH^-$ being more concentrated inside the cell with $H^+$ being greater outside is utilized. Another specific ion porter inserted across the lipid membrane allows $OH^-$ ions to leave the cell, which they have a strong tendency to do. However, their exit from the cell is linked to the entry of an ion from

*Figure 2. Through the action of transport proteins inserted across the plasma membrane, the pH gradient is used to drive the uptake of nutrients into the cell.*



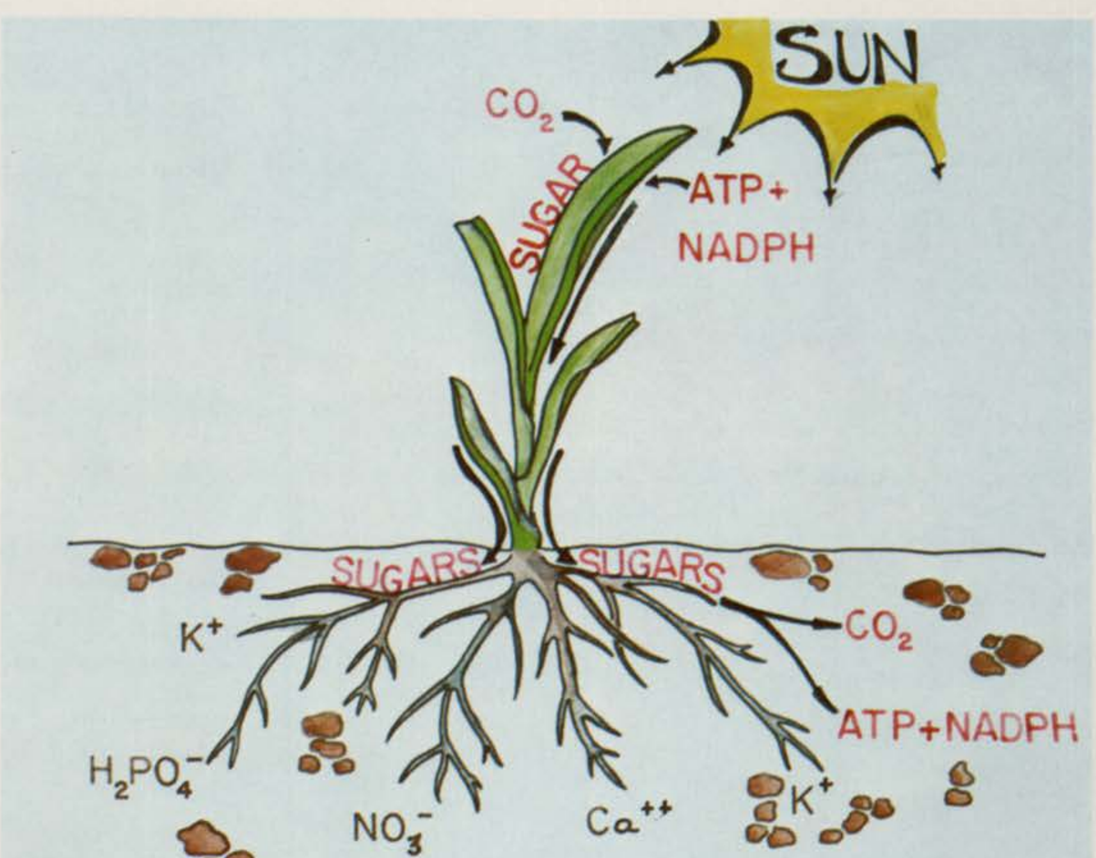
outside the cell. This antiporter *(Fig. 2)* functions as an ion exchange transporter in that for every $OH^-$ that leaves the cell a $NO_3^-$ or some other anion must enter. The only reason this antiporter works is because the force driving $OH^-$ out of the cell is greater than the resistance to nutrient anions entering the cell. Thus the pH gradient created across the plasma membrane of root cells by the hydrolysis of ATP is utilized through the action of specific ion porters to concentrate both cationic and anionic nutrients inside root cells.

This then can be related to lawn care. If nutrient recovery by roots is recognized as being directly dependent on the function of leaves, the management of lawns takes on a different perspective. Turf nutrition becomes much more than the application of fertilizer. In an earlier **ALA** article, (Hull, 1981) I indicated the advantages of autumn fertilizer application. The nutrient recovery from fall application apparently occurs readily and adverse effects on winter survival are rarely encountered. This response to fall fertilization is explained by the energy analysis of nutrient uptake presented here. Fertilizer applied in the autumn is made available to an established plant with a well developed root system. As cool weather commences, shoot growth is less rapid and more photosynthetic products are available for transport to roots where they can be used as the energy source for nutrient absorption. If the fertilizer application extends the season of green grass, more photosynthesis will occur and more energy will be available for nutrient recovery. If photosynthetic activity can be prolonged into the winter and resume more quickly in the spring, more soil nutrients obtained from decomposing organic matter or fertilizer will be absorbed by energy sufficient roots and less will be leached from the soil.

**Nutrient recovery by roots is directly dependent on the function of leaves**

One obvious question you are probably asking by now is, what does all this have to do with maintaining a quality lawn? The answer to this becomes obvious when you consider the ultimate source of the ATP required for ion absorption by roots *(Fig. 3)*.

*Figure 3. Photosynthesis traps solar energy in the form of sugars which are transported from leaves to roots where they provide energy for nutrient uptake.*



# How Turfgrasses Absorb Nutrients

In the leaves, the first stable products of the photosynthetic light reactions are ATP and reducing equivalents called NADPH. These products are used for the reduction of $CO_2$ to sugars. The sugars are transported from the leaves to whereever they are needed including the roots. In the roots, sugars are oxidized through respiration to resynthesize ATP and reducing equivalents, with the release of $CO_2$. The ATP is then available to generate a pH gradient across the plasma membrane and power the absorption of nutrient ions from the soil solution. Thus the energy required for ion uptake by roots is directly dependent on the photosynthetic activity in the leaves.

Because photosynthetic activity and nutrient uptake by roots are linked, any practice or circumstance which injures or decreases leaf area will impair nutrient recovery. Scalping, herbicide burn, insect feeding, or drought injury, all will have a negative impact on nutrient uptake by roots. Similarly during midsummer, when grass is heat and drought stressed, efficient fertilizer use should not be expected. Turf diseases that cause leaf injury, e.g. leaf spot, powdery mildew, etc. will discourage efficient nutrient uptake because they deprive the roots of energy. Fertilizer nutrients will be utilized most effectively if applied when the grass leaves are in good condition and able to supply energy to the roots. Because excessive leaf growth is not the traditional goal of proper lawn management, fertilizer should be applied when shoot growth will not be stimulated. The only time when grass is in a favorable situation to export most photosynthetic energy to roots and will not respond with unwanted foliar growth is in the early autumn. Thus an understanding of turfgrass energy requirements for nutrient use can lead to efficient fertilizer strategy.

Obviously there are other aspects of lawn management which may benefit from an appreciation of this relationship between leaf function and efficient nutrient recovery by roots. The knowledgeable and imaginative lawn manager can recognize these situations and make them work to his advantage.

ACKNOWLEDGMENT

*The assistance of Ms. Stacey Frost in preparing Figures 1-3 is gratefully acknowledged.*

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2. Epstein, E. 1976. Kinetics of ion transport and carrier concept p. 70-94. in U. Luttge and M.G. Pitman. (eds). Transport in Plants II, Part B Tissues and Organs. Encyclopedia of Plant Physiology, Springer-Verlag.

3. Hodges, T.K. 1973. Ion absorption by plant roots. Advances in Agronomy 25: 163-207.

4. Hull, R.J. 1981. Bluegrass energy distribution. AMERICAN LAWN APPLICATOR 2(2):8-9, and 2(3):6-8.

5. Mitchell, P. 1961. Coupling of phosphorylation to electron and hydrogen transfer by a chemiosmotic type of mechanism. Nature 191: 144-148.

## Banol Registered by EPA

Banol Turf Fungicide has now been registered by the EPA. Marketed by Tuco Ag. Chem., Div of the Upjohn Co., Banol has demonstrated high efficacy in control of Pythium blight. It is a water soluble liquid concentrate with propamocarb hydrochloride as active ingredient.

Laboratory and field research indicate that Banol provides residual protection against this turfgrass disease, which can damage turfgrass within 24 hours.

A brochure is available detailing use of Banol in preventative, curative and overseeding programs. To receive a copy of this brochure, or for more information, write Banol, Tuco Agricultural Chemicals, Div. of The Upjohn Co. 9823-190-45, Kalamazoo, MI 49001, or use reply card.

Circle No. 11 on Reader Reply Card

## Soil Testing

Green Pro Cooperative Services announces a Professional Soil Testing Service especially designed for the turf and ornamental industry. The service provides a complete laboratory analysis with recommendations which cover 14 essential points; type of soil, organic matter content, pH, primary, secondary, micro-nutrients, and soluble salts. The items tested are measured in parts per million and show what is present and available to the plant, as well as the plant's nutrient requirements.

All the necessary materials and sales aids for taking and marketing the tests are furnished to you with a fifty dollar deposit. The tests are billed as used, for $10.50 each, suggested charges range from $18.75 to $25.00 per test. The results and recommendations are returned within two weeks. For further information, contact Green Pro Cooperative Services, 380 S. Franklin Street, Hempstead, New York 11550 (516) 483-0100.

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## MAY/JUNE 1982 ISSUE

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# PLCAA's Regional One Day Seminars

**Philadelphia, Pa. – May 22**
Jim Kelly – Professional Turf Specialties – (215) 362-5988 Cherry Hill Hyatt, Cherry Hill, N.J. Subjects: Pesticide Application Restriction Laws/Estimate of Cost; Service after the Sell; Applicator Training

**Washington, D. C. – June 2,** Ramada Inn (Rockville, Md.,) Frank Stevens – Pro-Lawn Plus – (301 665-4771 Subject: Business Planning, John T. Tekoian, speaker; Pesticide Legislative Update, Jerry Faulring, speaker; Chem Lawn speaker, Phil Catron

**Atlanta, Ga. – June 9**
Fred Rowley – Rollins Lawncare – (404) 493-6835. (date and subject to be announced)

**Cincinnati, Ohio – June 16,** Ramada Inn (I-71 & Pfeiffer). Richard Steinau – Greenlon – (513) 761-4100. Subject: Creation of the Complete Sales Person

**Worcester, Mass. – July**
John Kenny – Turf Doctor - (617) 8794510
(date and subjects to be announced)

**Buffalo, NY – July 15**
Des Rice – The Weed Man LTD – (416) 279-5448

**Detroit (Livonia), Mich. – July 21**
Holiday Inn, Livonia (I-275 & 6 Mile Rd.) 9 a.m. to 4:30 p.m. Steve Brown – TruGreen, Inc. – (517) 351-7227. Subjects: Nigrospora Identification?, Dr. Malcolm Shurtleff, University of Illinois; Computer Hardware, Computer Software, Davidson and Deyonker, Associated Computer;

*continued on next page*

*continued from page 27*

## PLCAA Seminars con't

Growth Regulators, Dr. Perkins, Elanco Prod.; Financing Small Business, Darlene Mahler, Michigan National Bank; Pesticide Safety, Bob Robinson, Corporate Agronomist– Chem Lawn; Direct Mail, Phil Miller; Communicating, Dr. Hall Hepler, Chairman Dept. of Communications, Michigan State University. *VENDOR TABLES ARE AVAILABLE*

**Cleveland, Ohio – July 21,** Brown Derby Inn (Rt. 8 & Turnpike Exit 12) Larry Rininger – Kwik-Turf, Inc., (614) 872-3859. Subjects: Pesticide Handling, Cholinesterase Monitoring; Marketing Techniques in Lawn Care; Phone Power – Ohio Bell.

**Chicago, Ill., – July 21,** Elmhurst Country Club, Wood Dale, Ill., Charles McGinty – McGinty Bros. Inc. (312) 438-5161. Subjects: Financial Management; Physical Stress; Core Aerification; Similarities: Fusarium & Brown Patch Disease; Insect Update–Midwest

xxx



## Classified Ads

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7600 gallon upright STORAGE TANKS, excellent condition. $1,500 each. Contact: Atwood Lawnspray. Inc., 6489 Metro Parkway, Sterling Heights, MI 48077, Phone (313) 939-3636.

SPRAY TRUCK– 1979 Chevy one ton truck– 750 gallon tank– mechanical agitation– excellent spraying condition– low mileage– must sell– $9200. Call (502) 456-6777, ask for Pat McConnell.

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SPYDER FORKLIFT/TRAILOR, 200 hours, exc. cond., Zionsville, IN $12,400. Call George (317) 873-5231 or 873-5937

# A.L.A. Celebrates 2nd Year

## With a Salute to Our Advertisers

This issue of **American Lawn Applicator** marks our second anniversary. Over the past two years, the following companies have supported us in an effort to bring technical turfgrass information to you. We ask that you support them when you are purchasing chemicals and equipment. If you would like to receive product information from any of the following, you may do so by using the assigned circle number.

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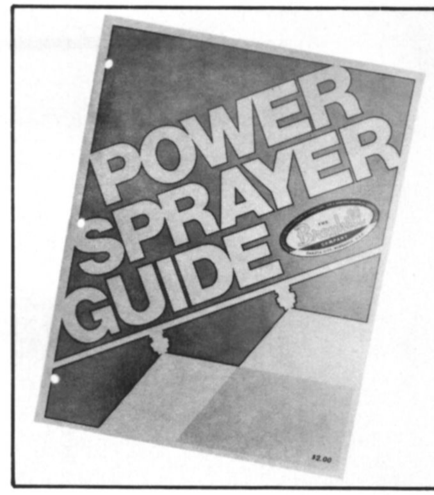
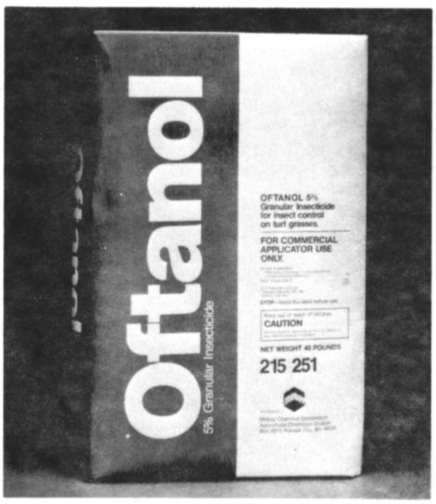
## Power Sprayer Guide




Broyhill's new Power Sprayer Guide contains a broad spectrum of information to help assist the applicator with the knowledge he needs to spray effectively and efficiently. Information on Pumps, Nozzles & Trips, Agitation, Spray Booms, Operating Spraying Equipment, Sprayer Calibration and much more are included.

The price on this guide is $2.00. Act today, supply is limited. Contact The Broyhill Company, North Market Square, Dakota City, Nebraska 68731, or call (402) 987-3412.

## ®OFTANOL in Florida




®Oftanol 5% Granular insecticide is now registered in Florida for the control of mole cricket. The insecticide from Mobay Chemical Corporation, can be used on both commercial and residential turf, and must be applied by certified pest control operators or commercial applicators.

Through extensive testing in Florida, Oftanol has proven to have effective residual control of mole cricket, a widespread, economically significant turf pest. These tests indicate that Oftanol offers 90 to 100% control in 7 days with residual control for at least 90 days. In addition to mole cricket, Oftanol the insecticide is also effective in controlling white grub larvae, billbugs, chinch bugs and sod webworm larvae.

Oftanol 5% Granular Insecticide is available in convenient 40 lb. bags. For further information, contact Mobay Chemical Corporation, Box 4913, Kansas City, MO 64120, or use Reply Card.

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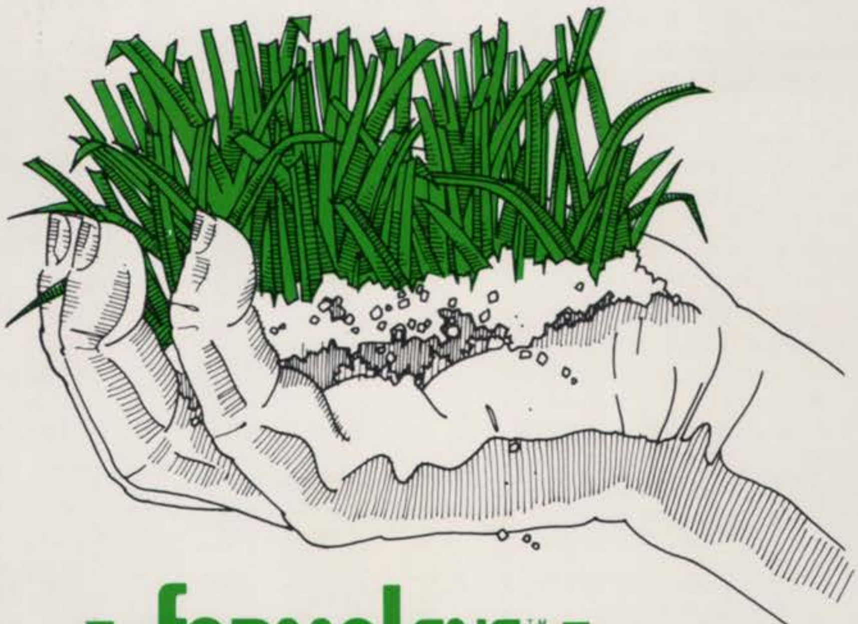
# Q. What's green and keeps customers happy all summer long?



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