A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TurfGrass TRENDS

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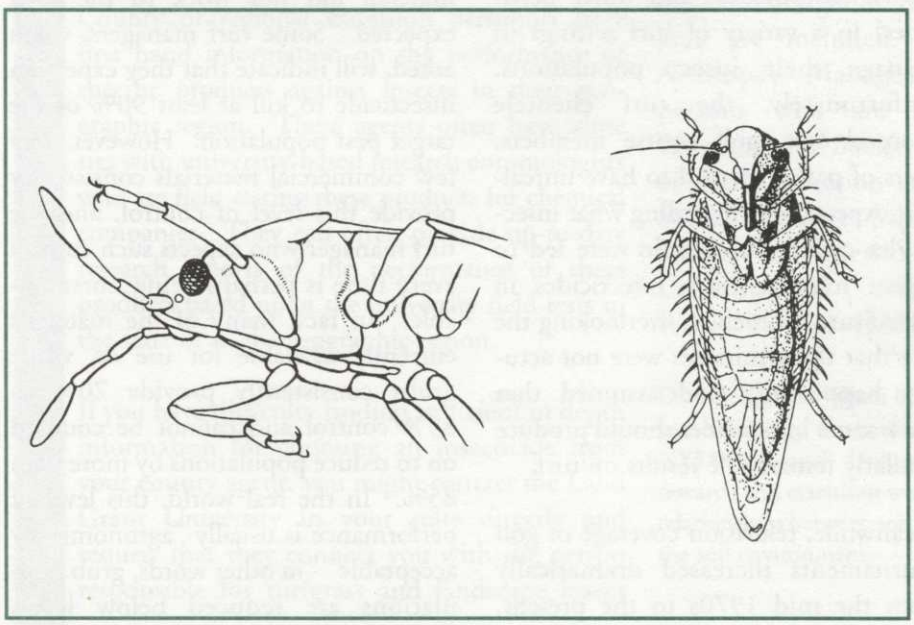
Maximizing Insect Control with Insecticide Applications

Part One: What Insecticides Can and Cannot Do

by Patricia J. Vittum
University of Massachusetts

Turfgrass managers are under increasing pressure to provide "perfect" turf. The slightest blemish, whether caused by an insect, a pathogen, or a weed, can lead clients or golf course members to demand pest-free turf. Some people even seem to believe that turf managers have enough options to guarantee "pest free" turfgrass. Nothing could be further from the truth!

This is the first in a series of articles which will examine the role of insecticides in turf management. This first article will focus on what insecticides can and cannot do (reasonable expectations, reasons why they sometimes appear to fail). Subsequent articles will look at general properties of insecticides, environmental issues, and strategies for selecting the "best" management approaches for insect pest problems.



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Historical Perspective

When pesticides first became available for use in agriculture, many people believed that the days of battling insects or other pests were over. Among the earliest pesticides were insecticides. DDT and other organochlorine compounds were used - and probably overused - in agricultural settings beginning in the 1940s, and yet the target insects eventually evolved ways to survive and flourish. Chemists developed new classes of compounds, each attacking the target insects in a slightly different way. These new materials were often effective for a few seasons, but eventually the insects developed new ways to survive exposure to these compounds and to expand their populations.

Pesticides became an increasingly popular method for crop producers to manage pest populations, despite evidence that pesticide use sometimes had a detrimental effect on birds, fish, or other organisms in the environment. At the same time, turf managers began to use insecticides (and other pesticides) in a variety of turf settings to manage their insect populations. Unfortunately, the turf clientele (homeowners, golf course members, users of parks) seemed to have unrealistic expectations regarding what insecticides could do. People were led to expect miracles from insecticides in agriculture, (somehow overlooking the fact that those miracles were not actually happening), and assumed that those same insecticides should produce similarly remarkable results on turf.

Meanwhile, television coverage of golf tournaments increased dramatically from the mid 1970s to the present. Now viewers see immaculately maintained golf courses week after week, as the professional golf tours move from one site to another. The viewers do not realize (and the announcers do not point out) that the tournament course undergoes a transformation shortly before the tournament to get it "tournament ready" and that extreme management practices which are used just before a tournament (for example, mowing heights) are moderated immediately after the tournament to allow the turfgrass to recover from the stresses of tournament golf. Instead, the viewer sees the perfect playing conditions and begins to expect the same of the local superintendent - week after week-throughout the growing season.

Such demands and expectations are unreasonable.

Reasonable Expectations of Insecticides

Sometimes a turf manager applies an insecticide in an effort to manage a pest population and believes that the material did not work to the level expected. Some turf managers, when asked, will indicate that they expect an insecticide to kill at least 90% of the target pest population. However, very few commercial materials consistently provide this level of control, and the turf manager who expects such control every time is perhaps being unreasonable. In fact, many of the materials currently available for use on white grubs consistently provide 70% to 85% control and cannot be counted on to reduce populations by more than 85%. In the real world, this level of performance is usually "agronomically acceptable" - in other words, grub populations are reduced below levels which cause visible damage.

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Where to Find Product Information

by Michael G. Villani
Cornell University

Not all products perform equal when it comes to controlling insects in turfgrass and landscape ornamentals. The listing of a specific pest on the product label indicates that this product can be legally applied to control that pest but does not guarantee that this product will perform as well as other labeled products. For example, Sevin®, Turcam®, Oftanol®, Merit®, Dylox®, Diazinon®, and Dursban® are all labeled for Japanese beetle grub control in New York State, but the field activity of these products can vary. Since not all insecticides are created equal, there is a critical need for turfgrass managers to have access to unbiased, comparative information on the suitability of specific products for their management needs. Where can you begin a search for insecticide information?

Chemical company representatives are often extremely knowledgeable about their company's line of products.

County or regional extension personnel have first hand information on the performance of specific products against insects in their geographic region. These agents often have close ties with university-based research entomologists who are field testing these products for chemical companies. They can often provide up-to-date research reports of the performance of these products based upon the university field tests in the state or in the geographic region.

If you have difficulty finding sufficient in depth information for choosing an insecticide from your county agent, you might contact the Land Grant University in your state directly and request that they connect you with the person responsible for turfgrass and landscape insect problems. Finding the correct turfgrass expert in your state may take a little patience but is often well worth the effort. These experts can often provide detailed research reports containing technical, unbiased comparisons of insecticides they tested over the past year. If they are unfamiliar with a particular pest or product, they can often point you to an entomologist elsewhere in the region with particular knowledge of your specific management problem.

The most up-to-date listing of addresses and phone numbers of university turfgrass entomologists can be found in the Handbook of Turfgrass Insect Pests, which was published by the Entomological Society of America in 1995 (an updated contact list will be included in *TurfGrass Trends* as part of this series).

Turfgrass managers interested in obtaining a comprehensive technical review of university field testing of turfgrass and landscape insecticides should consider subscribing to Arthropod Management Tests. Published annually by the Entomological Society of America, this 400+ page report provides the best compilation of unbiased technical comparisons of labeled and experimental insecticides available. The results of literally hundreds of field experiments conducted throughout the country the previous year are included. The current cost for Arthropod Management Tests is $40 for persons who are not members of the Entomological Society. Current and back issues of this publication are available through the Society [contact: Sales Office, Entomological Society of America, 9301 Annapolis Rd., Lanham, MD 20706; Tel: (301)-731-4535; FAX: (301)-731-4538].

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Furthermore, turf managers seldom sample the area which is to be treated BEFORE the application. Often a scout (or other employee) notices some insect activity, reports it to the manager, and a decision is made to apply an insecticide. If an application is made without determining how many insects were present in the first place, it is impossible to determine what level of control was obtained as a result of the insecticide application. Now if the turf manager goes back to the treated area several days later and finds several live insects, he (or she) may assume that the material did not work.

Consider an example involving white grubs. An area might have an average of 30 grubs per square foot before an insecticide is applied. One week after the application, a second sampling determines that there are about five grubs per square foot in the area. Some turf managers would look at the five grubs per square foot and consider that the application had "failed" because there are still live grubs present. However, those managers who sample BEFORE an application and sample again after the application will know that the population has been reduced from 30 grubs to five grubs per square foot - about 83% control, and this is well within the normally accepted tolerance level of 8 to 12 grubs per square foot.

So expectations are very important when using insecticides. There are virtually no circumstances where we can expect a traditional insecticide to control every target insect in a given area. There have been many times in history when agricultural producers expected to eradicate an insect population, and each time some of the insects evolved ways to break down the insecticide being used, adapted their behavior, or learned some other way to avoid the toxic effects of the insecticide. We are being unreasonable if we expect an insecticide, or any other pesticide, to provide 100% control under field conditions.

Accurate Diagnosis

While most professional turf managers usually are quite good at identifying the most common turf insect problems in a given area, mistakes can be made. A recent experience served as evidence that even the best managers can be fooled now and then. At a meeting of some of the "cream of the crop" golf course superintendents at a recent national GCSAA conference, a speaker showed slides of 12 common turf insect problems (including a picture of the insect and of typical damage symptoms) and gave a brief description of the habitat (for example, turf species or specific parts of the golf course) where the insects were most commonly found. This was a national seminar and the insects shown were from different parts of the country, but surprisingly few of the superintendents were able to identify as many as eight or nine of the pests correctly.

Many of the insects which appear in the turf environment are beneficial in one way or another. For example, several tiny insects (such as springtails) are saprophytes and play a key role in breaking down organic matter in and around the thatch. Other insects are active predators. Ground beetles are common predators and are very mobile, able to move quickly and search out their prey. Studies at the University of Kentucky (Dr. Dan Potter) and other locations indicate that ground beetles can feed on significant numbers of eggs or small larvae of cutworms and even white grubs. So "the only good bug is a dead bug" is not true - and yet I have had turf managers bring in samples of ground beetles, asking for identification of the "problem". When I have explained that the insect in question is undoubtedly beneficial, and that insecticide applications should be avoided while that beetle is most active (usually for a couple weeks), the turf manager sometimes expresses disbelief or explains that the golf membership demands action because the beetles are too distracting on the putting surface. (Note that golfers are not the only users of turf who find the presence of insects distracting or unacceptable. Athletic fields, home lawns, parks, cemeteries, and other turf areas have come under increasing scrutiny in recent years, and users have come to expect "perfect" conditions which apparently leave no room for insects, even beneficial ones!)

Sometimes insects develop in an unexpected manner - or occur in places where they have never before been observed. Large numbers of insects might blow in on a storm front. (For example, several landscape insect problems have been introduced to the Northeast on hurricanes or other intense storm fronts which carry the insects from areas further south.) Sometimes insects change their behavior and begin to feed on plants which before they had not attacked.

Some turf insect pests are very small or look very similar to other insects and may be misidentified, particularly the first time they are encountered by a turf manager. Again, the white grub complex provides an example. The grub or immature stage of the Japanese beetle, European chafer, Oriental beetle, masked chafer, May (or June) beetle, and black turfgrass ataenius look virtually identical, but the life cycle and/or behavior patterns vary from one species to another. As a result, the best timing for application of an insecticide depends entirely on which species is dominant in a given location. In some cases (for example, the Japanese beetle and oriental beetle), the ideal timing for an insecticide application normally is in late July or early August (depending on the location), whereas the timing of application for black turfgrass ataenius will be in late April or May.

In some parts of the country, certain tiny mites can cause damage to the turf. Mites are not insects and are not affected by several of the turf insecticides currently on the market. If a turf manager discovers the damage, sees tiny creatures moving in the thatch, and assumes that the problem is being caused by an aphid or a chinchbug, for example, that manager might apply an insecticide which would be effective against either aphids or chinchbugs but has no activity against mites.

So it is absolutely critical to have an accurate diagnosis of the insect pest before any efforts are made to control that insect. Most turf managers (at least the successful ones!) are usually pretty good at identifying insect problems - the damage looks similar to something which has been seen before, the insects look familiar, or a colleague down the road compares notes and reports that he (or she) is having problems with "Insect X". But when in doubt, ask an Extension specialist, a university researcher, or a trusted field representative. Mistakes in diagnosis have a way of coming back and haunting a turf manager, so collect the necessary evidence and get an accurate diagnosis. No insecticide can be expected to control an insect for which it is not intended or labeled.

Choice of Material

Once a turf manager has determined that an insect population is high enough to warrant treatment, the manager must decide which material to use. There are many different insecticides available. Some work quickly and others work slowly, while some break down quickly and others last longer. Some are tied up in thatch very readily (and therefore are often less effective against soil insects), while others can penetrate thatch quickly. Some are very soluble in water and more likely to move in surface water (run-off) or through the soil profile (leaching). All of these characteristics will be discussed in more detail in a subsequent article.

Some chemicals are particularly effective against certain insect pests, while others may be labeled for a given pest but are not as effective as others. In addition, some state recommendations will list all products which are labeled (federal and state) for a given pest, while other state recommendations only include products which have been demonstrated to be effective under local conditions. Find out which approach has been used by the recommendation guide you are using. (Note that state employees, such as Extension agents and land grant university faculty, sometimes have to be very careful when answering questions so that they do not appear to be endorsing a particular product. Learn how to ask the "right" questions to extract the information you need!)

Insecticides are formulated (or packaged) in several different ways. (NOTE - formulations will be discussed in more detail in a subsequent article.) For

some insects (e.g., white grubs), the formulation does not affect the overall effectiveness of an insecticide. In other words, a granular formulation of Chemical X will kill about the same number of grubs as a sprayable formulation of Chemical X, assuming they are both applied at the same rate of active ingredient. However, some turf managers and turf researchers have reported differences in effectiveness between granular and sprayable formulations when trying to control cutworms and other caterpillars.

Do not "send a boy to do a man's job". Be sure that a material is labeled for the pest in question, and check with local turf specialists (preferably people who do not have a vested interest in the information being provided) to determine which materials appear to be most effective in your area. Performance can vary from one region of the country to another, sometimes because of water or soil conditions. Familiarize yourself with local conditions and choose your insecticides wisely.

Timing of Application

Insects complete a series of stages of development from egg to adult. Some insects (e.g., mole crickets, grasshoppers, and aphids) go through gradual development, in which each stage (after the egg) looks like an adult of the species except that it is smaller and does not yet have wings. Other insects (for example, cutworm caterpillars which become moths, white grubs which become beetles) go through a series of immature (larval) stages before passing through a pupa (the stage of transition between larva and adult) and on to the adult stage.

As a general rule, insect eggs and pupae are virtually impossible to control with insecticides. In contrast , the youngest immature stages are usually the most susceptible to chemicals. Generally, turf insect control strategies are most effective when directed against the damaging stage (usually the immature stages and not the adult), but there are a few exceptions.

One of the keys to successful control of turf insects is to understand the life cycle of the target insect and to apply insecticides when the insect is in its most vulnerable stage - usually the young immature stages. For each insect pest, there is a "window of opportunity" during which the insect is quite susceptible. Another important consideration is that some insecticides work much more quickly than others, so if an insect is already fairly well into its development (i.e., late in the window of opportunity), a turf manager would be wise to choose one of the fast acting products. On the other hand, if a turf manager can apply a material when the insect is still very young (early in the window of opportunity), he (or she) may use a slower acting but longer lasting material.

Applications of fast acting materials which break down quickly usually should not be made early in an insect's life cycle because sometimes not all individuals have emerged from the eggs, and the material will break down before those late eggs hatch. At the same time, slow acting products should not be used late in an insect's development because many of the insects will continue to feed aggressively and cause damage before the product has a chance to be effective. (This concept will be discussed in more detail in subsequent articles.)

Accurate Application

Most insecticides have more than one rate of application listed on the label. These rates have been established after several years of laboratory and field testing and reflect the variation in response of different target insects. Very simply, the rates provided on the label are there for a reason and should be followed very closely. Failure to do so may result in overapplication (which uses more material than necessary and costs money, or may lead to unintended detrimental effects in the environment) or underapplication (which may not control the target insect and therefore wastes money and time). There is also some evidence from traditional agriculture that underapplication may lead to an increased likelihood of an insect developing resistance to a material.

Some of the insecticide "failures" which have occurred on turf were traced to inaccurate applications. Often this happens when equipment has not been calibrated accurately or recently. Most turf managers are careful to calibrate equipment before the growing season, but some forget to schedule overhauls and recalibrations once it gets busy during the growing season. As nozzles are used, they can erode or corrode and lead to changes in delivery rate and pattern. The efficiency of a pump changes over time, so that hydraulic pressure (and the ultimate delivery rate) may vary. Even spreaders need to be recalibrated - sometimes because a manufacturer changes the granular carrier and it passes through the system differently than a former formulation.

Finally, application patterns are a critical part of the application process. Sometimes an applicator fails to overlap adequately and leaves strips of turf which are improperly treated. Some insects are remarkably gifted at locating untreated strips. In heavily infested areas, considerable damage may occur in untreated strips, leaving the turf manager to explain the pattern of damage. In other cases, an applicator may overspray an area, treating certain sections more than once. This may have a detrimental effect on insect control (because it appears that some insects are able to detect certain insecticides when they are applied at elevated rates and are repelled from those treated areas). Such overapplication also results in an overuse of the material, which can lead to unintended effects on the environment.

An insecticide cannot reach its maximum effectiveness if it is not applied correctly in the first place.

Use of Water

Many turf insecticide labels note that water must be applied (immediately or some other wording) after application. Some labels mandate (or state guides recommend) watering the area before application. Some of the watering statements are intended to improve the effectiveness of the material. For example, some insecticides which are targeted against soil insects such as mole crickets or white grubs must be watered in heavily (0.25 to 0.5 inch) as soon after application as possible to help move the material through the thatch and to draw the target insects higher into the thatch zone. The result is that the insects come in contact with more of the material and the mortality rate is increased.

Sometimes water use statements are on a pesticide label to mitigate environmental exposure concerns. Often materials are watered in after application partly to reduce surface exposure to unintended target organisms (e.g., soccer players on an athletic field, squirrels running across a golf course, or dogs playing on a lawn).

In unusually dry soil conditions, some soil insects will alter their behavior and migrate deeper in the soil profile to avoid temperature and moisture extremes near the surface. In these cases, the insects are well below the depth to which an insecticide can penetrate, so insecticide applications are futile. However, if a turf manager waters the area 24 to 36 hours BEFORE applying an insecticide, the water will begin to move through the thatch and upper root zone and change the soil moisture profile enough to draw the target insects (for example, white grubs or mole crickets) back into the upper root zone. Then, when the insecticide is applied, the insects are closer to the point of contact, and the application tends to be much more effective. (Note that these applications still need to be watered in after application.)

Water - before and after application - is an important tool which can help a turf manager get the most out of an insecticide application. The water-use statements are on pesticide labels for a reason - heed them!

Movement and Breakdown

Insecticides may break down into inactive forms under natural conditions or they may move from the original point of application. All of these fates

will be discussed in more detail in a subsequent article. However, a few points are appropriate to the current discussion.

Some insecticides break down very rapidly in water of high pH (very alkaline, or the opposite of acid). pH is a means which chemists use to measure how acid or basic (alkaline) a solution is. A neutral material (neither acid nor base) is defined as having a pH of 7.0, while alkaline materials have higher pHs and acid materials have lower pHs. If the water supply which is used to fill a tank has a pH of 8.5 or higher, some insecticides will begin to break down in the tank very quickly, sometimes in a matter of minutes. Some insecticide "failures" can be traced to using water of high pH. (Note that there are additives which can be included in a tank mix to buffer the water so that pH effects are minimized, but turf managers must be aware of the potential for rapid breakdown in water with high pH.)

There are several other conditions under which insecticides may break down naturally, which will be discussed in a later article. However, in most cases this breakdown occurs more frequently in situations where the same material (or a closely related material) is used on the same location repeatedly.

Some environmental conditions may increase the likelihood that an insecticide will move from the original point of application. Two of the more familiar circumstances involve the horizontal movement of the material in water (run-off) or vertical movement of the material through the soil profile (leaching). While these will be discussed in much more detail in a subsequent article, both occur when there is too much rainfall or irrigation, either before, during, or shortly after an application.

To avoid unintended movement or breakdown of insecticides, use common sense. Insecticides which are applied without concern for breakdown or movement will be sure to disappoint. Check water pH and use tank additives when needed to moderate the water pH. Avoid using any product repeatedly on the same location. Avoid applying insecticides (or other pesticides or fertilizers) when the soil is already saturated or heavy rainfall is predicted or other conditions appear to favor the likelihood of run-off or leaching.

Final Thoughts

Insecticides can be a very important tool for turf managers as they attempt to manage insect pest populations. However, like many management tools, the effectiveness of insecticides is limited by several "real life" considerations. Insecticide applications alone normally will not manage insect populations, but when they are coupled with other management practices and common sense techniques, they can be very useful. However, do not expect miracles - keep your expectations reasonable, be sure you have diagnosed the problem accurately, choose a material which is known to be effective for the insect you have, time the application so that the target insect is in its most vulnerable stage, apply the product at the correct rate, and use water as directed to maximize the effectiveness of the application. Give the insecticides a fair chance to do the job they were designed to do.

Helpful Hints

1. Do not expect an insecticide (or any other pesticide) to provide 100% control of a pest under field conditions.
2. Be sure to obtain an accurate diagnosis of the insect (or other pest) which is causing a problem.
3. Do not expect an insecticide to control an insect for which it is not intended or labeled.
4. Choose an insecticide carefully, based on its label and on its performance under your local conditions.
5. Apply the insecticide when the insect is in its most vulnerable stage.
6. Be sure equipment is calibrated accurately and that application patterns are well planned to avoid "skips" and overlaps.
7. Use water wisely. Sometimes this means watering the area before and after application, sometimes it means watering heavily and at other times it means watering lightly.
8. Avoid using insecticides which are most likely to run-off or leach, especially in sensitive areas or where heavy precipitation is expected.

Terms to know

INSECTICIDE - a chemical or other substance which is designed to kill, or otherwise control, insects.

LARVA - an immature stage of an insect which undergoes complete metamorphosis (change).

LEACHING - the vertical movement of water (or a pesticide or fertilizer dissolved in the water) through the soil profile, ultimately to ground water.

PESTICIDE - a general term referring to a chemical or other substance which is designed to kill, or otherwise control, a pest (which might be an insect, a fungus, a rodent, a weed, or a number of other organisms).

pH - a measure of the degree of acidity or alkalinity in a solution. Neutral is defined to have a pH of 7.0, while acid materials have a pH less than 7.0 and alkaline (basic) materials have a pH of more than 7.0. The more a number varies from 7.0, the more acid (or alkaline) the material is.

RUN-OFF - the horizontal movement of water (or a pesticide or fertilizer dissolved in the water), ultimately to surface water or to an area where the water begins to leach (see above).

WHITE GRUB - The larval form of several turf insect pests common in many parts of the country, the immature stage (grub) of which is cream-colored and C-shaped and feeds on roots of several turfgrasses.

Dr. Patricia J. Vittum is an associate professor of Entomology at the University of Massachusetts. She has a B.A. in Chemistry from the College of Wooster (Ohio), and a M.S. and Ph.D. in Entomology from Cornell University. She conducts research and extension programs on the ecology and control (including biological control) of white grubs, annual bluegrass weevils, and other turf insects. She has spoken at numerous regional and national conferences and teaches the GCSAA seminar on IPM for Golf Courses each year. She also teaches two courses ("Pesticides, Public Policy, and the Environment" and "Turfgrass Entomology") each year. This is part one of a series on insects and insecticides to be published by *TurfGrass TRENDS.*

Integrated Disease Control at North Shore Country Club

by Peter L. McCormick
TurfNet Associates, Inc.

While some may "talk the talk" or simply take a "wait and see" position toward biological disease control, Dan Dinelli has forged ahead with a comprehensive integrated turf disease control program in place now at North Shore Country Club in Glenview, IL.

Dinelli is taking advantage of two new products on the market as the cornerstones of his biological disease control strategy: the BioJect® system for culturing and applying *Pseudomonas aureofaceans* bacteria through his irrigation system, and Bio-Trek 22G®, a newly-registered biological fungicide that incorporates a dormant beneficial fungus (Trichoderma harzianum) in granular form. Dinelli's goal is broad spectrum natural disease suppression, thereby reducing his reliance on synthetic fungicide applications to keep turf diseases in check. His target is a 40% reduction in fungicide usage on the tees and fairways at North Shore.

The BioJect® system (from EcoSoil Systems, Inc. of San Diego, CA) was installed at North Shore Country Club early in 1995. It includes a 175 gallon bioreactor, which is a fermentation tank in which a special strain of *Pseudomonas aureofaceans* bacteria (developed by Dr. Joe Vargas at Michigan State University) is fed with simple sugars under controlled conditions so it multiplies rapidly. The bacteria slurry is then injected into the irrigation system while watering at night. When depleted, new food source material is injected into the bioreactor as it refills with water, and the *Pseudomonas* culture replenishes itself in time for the next night's scheduled irrigation.

Mode of action

Members of the genus *Pseudomonas* occur naturally in great numbers in soils and aquatic systems, particularly around the root systems of plants. Their primary food source is carbohydrates (glucose and other simple sugars) obtained from dead plant material and root secretions. These organic exudates foster microbial activity in general, including disease organisms. *Pseudomonas* can remain viable over a wide range of conditions in the soil environment but must compete with billions of other microbes to establish themselves in sufficient quantities to become an effective turf disease control agent.

Various species of *Pseudomonas* have been shown to produce anti-fungal antibiotics, which are one method by which bacteria can suppress turfgrass pathogens. Antibiotics may be loosely defined as any material produced by one organism which inhibits or kills another organism. *Pseudomonas aureofaceans*, the organism utilized in the BioJect® system, secretes a material (phenoxyzine carbolic acid) which inhibits fungal protein synthesis in pathogenic fungi. Given sufficient concentration of *P. aureofaceans* in the soil environment, pathogenic fungi are held in check due to their inability to synthesize necessary proteins.

Bacteria can also inhibit growth of patho-genic fungi by competing with the fungi for essential nutrients or growing space in the favored growth environment of the pathogen. By restricting the availability of nutrients, the bacteria may make the fungal pathogens more susceptible to the antibiotic substances they secrete. As the pathogenic fungal populations decline, the bacteria gain access to the nutrient sources once controlled by the fungi, further strengthening their position as fungal antagonists.

The caveat

While all this sounds great, the challenge has been to establish populations of these bacteria in a highly-competitive soil environment sufficient enough to achieve the desired level of disease suppression. According to Dinelli, that's where the new BioJect technology comes into play.

"There is currently more skepticism than optimism among the university professionals doing this type of research," said Dinelli. "None of the scientists dispute the disease suppressive abilities of *Pseudomonas spp.* They do, however, doubt the ability of the organism to establish itself on a long-term basis in the competitiveness of the real world soil environment," he continued. "And they're right."

The key, according to Dinelli's experience, is the constant re-inoculation of the root and crown environment with *Pseudomonas* bacteria with each irrigation application. Spoon-feeding, if you will. Before the BioJect® system became available, the only method of applying *Pseudomonas* was by mixing dormant bacteria from a bottle into a spray wagon. There were the obvious logistical challenges of applying sufficient quantities of bacterial agent at a frequency proper to maintain the desired bacterial population. Aggravating the situation was the ultraviolet sensitivity of *Pseudomonas* bacteria; they are optimally applied in the dark.

BioJect® solved these issues by incorporating into the system vastly greater quantities of bacteria, which are maintained live in the bioreactor (rather than dormant, as before). By applying them via irrigation at night, ultraviolet degradation becomes a non-issue. And, as long as you're irrigating, frequency of application concerns are also overcome.

Field trials at North Shore

"We set up some test areas last year around our golf course that were not to be sprayed with preventive fungicides," said Dinelli. "Our #8 fairway, a par 3 of creeping bentgrass and *Poa annua* approximately one acre is size, was used along with two of our bentgrass nurseries. The nurseries were maintained like putting greens. One of the nurseries, containing 7 varieties of bentgrass, was disconnected

from our irrigation water source and connected to village water, so it received no preventive fungicide applications or any *Pseudomonas* inoculant," according to Dinelli. "It was our true control."

"The second nursery had 35 varieties of creeping bentgrass, many of which are unnamed experimental varieties. This nursery received only *Pseudomonas* applications through the irrigation water. No preventive fungicides were applied. The rest of the golf course was treated as we normally would," explained Dinelli.

"In retrospect, the weather we experienced during the 1995 season here in the Chicago area created a worst-case 'acid test' of environmental extremes and disease pressure, a perfect opportunity to see what this biological control system would (or would not) do," said Dinelli.

"By the end of July, our 'bare-bones' control nursery was literally wiped-out by brown patch, Pythium and dollar spot. We actually stopped mowing it, it was so bad. During the third week in August, we had three consecutive days of rain, totalling over 2.5", with extremely high temperatures and humidity. We were obviously not irrigating during this period, so the *Pseudomonas* bacteria were not being applied, either. Four days after the rain stopped, we saw brown patch move into the #8 fairway. The next day it appeared in the second nursery. We applied Thiram to check the brown patch, which was the only fungicide application these areas received all season until snow mold control in November," Dinelli noted.

"The brown patch did not kill to the ground and grew out within two weeks. By that time," according to Dinelli, "we were back into the watering regimen, applying Pseudomonas again."

"During this period of extremely high disease pressure (aggravated by heavy rains), the apparent population of *Pseudomonas* bacteria fell under the threshold for adequate control after 4-5 days. We now know to intensify our scouting efforts after a similar period, and apply a contact fungicide as needed until we get back into a regular watering regime to re-establish the *Pseudomonas* population," advised Dinelli. "Given proper drainage, it would be possible to run through a syringe cycle even while raining. But we have old soil push-up greens here, and the overall agronomic downside of the added water outweighs any benefit from the added bacteria, in my mind," he concluded.

Enter *Trichoderma*

While the BioJect® system had a season-long trial last year at North Shore, only late in the season did Dan Dinelli load the second barrel in his biological arsenal, that with a hybridized strain of *Trichoderma harzianum* (T.h.). Available commercially on the market now under the trade name Bio-Trek 22G® (from Wilbur-Ellis Co. Fresno,CA), T.h. was developed by a trio of researchers at Cornell University (Eric Nelson, C-T Lo, and Gary Harman). Unlike the bacterium *Pseudomonas, Trichoderma* is a fungus that is applied dormant in dry granular form. T.h. is very efficient at establishing itself in the rhizosphere by colonizing roots so efficient, in fact, that the fungus continues to colonize plant roots as they grow and has been shown to overwinter on turf roots even in harsh northern climes.

Trichoderma fungi, in the form of Bio-Trek 22G®, are applied by broadcast spreader at the rate of 1.5 lbs./1000 sq. feet. The dormant fungi are activated upon contact with moisture on the soil surface or in the thatch layer. Two applications, in most instances, should give season-long control of many soil-borne fungal pathogens. It is not effective against foliar diseases.

While Dinelli's *Trichoderma* application last fall was too late to affect any disease pressure, soil samples sent to Dr. Gary Harman at Cornell for analysis show a 10-fold increase in *Trichoderma* populations since application. "This indicates an ability of *Trichoderma* to establish itself readily in the soils here," noted Dinelli. "Based upon the numbers of colony-forming units (CFUs) indicated by the soil tests, we should see positive results this season."

1+1=3D3

Given the tremendous results seen last year from the *Pseudomonas* treatments at North Shore, why would Dinelli bother with *Trichoderma?* "The two products really are complementary in their modes of action," he noted. "While *Pseudomonas* has difficulty achieving naturally self-sustaining populations in the soil here, we know for a fact (from Gary Harman's report from Cornell) that Trichoderma will colonize the roots readily. *Pseudomonas* is effective in the leaf and crown area, while *Trichoderma* is not. By using the BioJect® system to constantly renew *Pseudomonas* populations in the leaf and crown zone (and as far into the soil as it will go), and with *Trichoderma* colonizing the roots, we should have some form of biological disease control from root tip to shoot tip. The practical benefit will be increased root growth and overall plant health due to reduced stress from pathogenic fungi, and a dramatic reduction in our chemical fungicide applications."

Dollars and Sense

So what does all this cost? The BioJect® system is custom-tailored to each specific site and will vary depending on acreage to be treated. Dinelli is leasing the BioJect system at a cost of $18,000 annually. That includes the bioreactor, injection system, gallon jugs of resting *Pseuodomonas,* and the food source. "It's a complete package, with no surprises," according to Dinelli.

The granular *Trichoderma* applications cost between $10-$15/1000 sq. ft. annually, depending upon rate and number of applications.

"I am projecting an average savings of $25,000 annually from reduced fungicide applications, due to the BioJect® treatment alone," said Dinelli. "That will vary, however, depending upon the weather each particular year. In a dry year, we may save $40,000; in a wet year, maybe only $15,000. There is a potential budgetary concern with running into one of those bad years. You really need to figure a way to integrate some buffer or contingency into your budget to cover the added expense of extra fungicide applications, when needed (in the case of a rainy year)." Those estimated savings, notes Dinelli, "are strictly from pesticide expenditures alone. They don't take into account labor savings, or the ripple effects from better nutrient absorption or overall increased plant health. One of the big intangibles might be the effect on the soil microflora from reducing fungicide applications. Plus, by applying Pseudomonas through the irrigation system, we are treating areas (surrounds, tee banks, etc.) that would not normally be sprayed."

"Our goal last year was, very simply, disease suppression. We experienced very broad spectrum control, even broader than what I had hoped for initially," summarized Dinelli. "These products have brought the science of biological disease control from the laboratory to practical reality in the field. While not an end-all-be-all, they fit well into an IPM program and give us another tool from a different perspective. Hopefully, in addition to greater disease control, the healthier plants that result will be better able to deal with the other stresses they encounter throughout the growing season."

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References:

TurfNet
Tel. (800) 314-7929, Fax (908) 359-3389,
e-mail: turfnet@nerc.com
web site at http://www.turfnet.com

BioJect: EcoSoil Systems, Inc., San Diego, CA
Tel. (800) 331-8773, Fax (619) 675-1662

Bio-Trek product info: Wilbur Ellis Co., Fresno, CA
Tel. (209) 422-1220, Fax (209) 442-4089

Bio-Trek 22G Cornell study:
TurfGrass TRENDS, 5/96
Tel. (202) 483-TURF, Fax (202) 483-5797,
e-mail: 76517,2451@CompuServe.com

Pseudomonas aurefaceans bacteria study:
Michigan State University, Dr. Joe Vargas
Tel. (517) 353-9082, Fax (517) 353-5598

Fungicide Index

EPA Registered Fungicides for Turfgrass Applications in the United States

Each year it becomes more and more difficult to keep track of the new turf management products appearing on the market. This is particularly true of pest control products. Manufacturers are now marketing not only their own products but those of others. The result is dozens of trade names and/or formulations for each active ingredient. Fungicides are no exception. The active ingredient triadimefon, for example, comes with two dozen or more different trade names and formulations. Many other fungicide active ingredients have a least a dozen different trade names. With so many choices for the same material, it is often difficult to determine whether a new fungicide trade name is only a reformulation of an existing active ingredient, and therefore something you may already have on your shelf, or a genuinely new product.

To help you find order in this increasing chaos, *Turfgrass TRENDS* has compiled a list of all the fungicides currently registered for turfgrass applications in the United States. These are listed according to active ingredient, trade name(s), formulation(s), and EPA registration number. We are also including the manufacturer or sub-registrants's address and, were available, a telephone number you can use to obtain more information on product availability, formulations and application.

Information compiled by Dr. Eric B. Nelson

Formulations

AS	Aqueous suspension	F/FLO	Flowable suspension	W	Wettable powder
DF	Dry flowable	G	Granular	WDG	Water-dispersible granule
E	Emulsifiable concentrate	SC	Soluble concentrate	WSP	Water-soluble packet

Index of Fungicides Registered for Turfgrass Disease Control in the United States

Fungicide Class

Active Ingredient	Trade Name(s)	Formulation	EPA Regis. Number	Manufacturer or Sub-Registrant
Aromatic Hydrocarbons				
Chloroneb	Terreneb SP	65W	41014-00006	Kincaid Enterprises, Inc., PO Box 549, Nitro, WV 25143
	Terremec SP	65W	02217-00692	PBI-Gordon Corp., PO Box 4090, Kansas City, MO 64101
	Foremec 80	80W	02217-00426	PBI-Gordon Corp., PO Box 4090, Kansas City, MO 64101
	Proturf Fungicide V	6.25G	00538-00103	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Fungicide IX	3.26G	00538-00242	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Twin Light Chloroneb	7.5G	01159-00186	Seacoast Laboratories, Inc., PO Box 373, Dayton, NJ 08810
Etridiazole	Koban 30	30W	58185-00005	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Koban 1.3G	1.3G	58185-00016	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Terrazole	35W	00400-00416	Uniroyal Chemical Co., Inc., 74 Amity Rd., Bethany, CT 06524
Quintozene	Terrachlor	75W	00400-00399	Uniroyal Chemical Co., Inc., 74 Amity Rd., Bethany, CT 06524
	Turfcide	10G	00400-00407	Uniroyal Chemical Co., Inc., 74 Amity Rd., Bethany, CT 06524
	Turfcide	40G	00400-00454	Uniroyal Chemical Co., Inc., 74 Amity Rd., Bethany, CT 06524
	Proturf 14-3-3 FF II	15.4F	00538-00108	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Penstar	10G	05481-00211	AmVac Chemical Corp., 2110 Davie Ave., City of Commerce, CA 90040
	Penstar	75W	05481-00419	AmVac Chemical Corp., 2110 Davie Ave., City of Commerce, CA 90040
	Lesco Revere	75WDG	05481-00441	AmVac Chemical Corp., 2110 Davie Ave., City of Commerce, CA 90040
	Turfgo Engage	10G	05481-00444	AmVac Chemical Corp., 2110 Davie Ave., City of Commerce, CA 90040
	Ferti-Lome Containing Fungicide	4.7G	07401-00197	Voluntary Purchasing Group, Inc., PO Box 460, Bonham, TX 75418
	Lesco 10-3-23 + PCNB	12.5G	10404-00037	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Lesco PCNB	10G	10404-00038	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Defend	10G	05481-00444	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Defend	75W	05481-00419	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Defend	4F	05481-00443	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
Benzamides				
Flutolanil	ProStar	50W	45639-00153	AgrEvo USA Company, Little Falls Centre One, Wilmington, DE 19808

Active Ingredient	Trade Name(s)	Formulation	EPA Regis. Number	Manufacturer or Sub-Registrant
Benzimidazoles				
Thiophanate methyl	Clearys 3336	50W	01001-00063	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Dragon Systemic Fungicide	50W	01001-00063	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Clearys 3336F	4F	01001-00069	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Clearys 3336G	2.08F	01001-00070	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Proturf Systemic Fungicide	2.3G	00538-00088	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf Fluid Fungicide	19.7F	00538-00183	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf 23-3-3 + Fungicide VIII	1.8G	00538-00194	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Disease Control+Lawn Fertilizer	1.8G	00538-00217	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Fungicide IX	1.6G	00538-00242	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Fungo FLO	46F	04581-00352	Elf AtoChem North America, Inc., 200 Market St., 21st Floor, Philadelphia, PA 19103
	Fungo	85DF	04581-00372	Elf AtoChem North America, Inc., 200 Market St., 21st Floor, Philadelphia, PA 19103
	SysTec 1998	46F	48234-00012	Regal Chemical Company, P.O. Box 900, Alpharetta, GA 30239
	SysTec 1998	WDG	48234-00013	Regal Chemical Company, P.O. Box 900, Alpharetta, GA 30239
	Fungo 50	50W	58185-00009	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Duosan WSB	15.6W	58185-00031	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Duosan	15.6W	58185-00032	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
Carbamates				
Mancozeb	Pace	70W	00100-00690	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Duosan	64W	58185-00032	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Fore WSP	64WSP	58185-00031	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Fore	80W	00707-00087	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Fore Flowable	FLO	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Dragon Lawn & Vegetable Disease Control	37W	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Lesco 4 Flowable	4F	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Dithane WF	4F	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Dragon Mancozeb	4F	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Bonide Mancozeb Flowable with Zinc	4F	00707-00156	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Protect T/O	80W	01001-00065	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Dithane T/O	80W	00707-00180	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
	Lesco Mancozeb DG	75DG	00707-00180	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
Propamocarb	Banol	6SC	45639-00088	AgrEvo USA Company, Little Falls Centre One, Wilmington, DE 19808

Active Ingredient	Trade Name(s)	Formulation	EPA Regis. Number	Manufacturer or Sub-Registrant
Thiram	Spotrete F	42F	01001-00011	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Spotrete	75WDG	01001-00060	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Thimer Plus F	33.4W	01001-00062	W.A. Cleary Chemical Corp., PO Box 10, 1049 Route #27, Somerset, NJ 08875
	Twin Light Disease Stopper	10G	00004-00180	Bonide Products Company, Inc., 2 Wurz Ave., Yorkville, NY 13495
	Prolawn Thiram 4F	42F	08590-00566	Agway, Inc., PO Box 460, Minneapolis, MN 55440
	Lesco Thiram	75WDG	10404-00010	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	ProTurf Fluid Fungicide III	40.8F	00538-00216	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
Dicarboximides				
Iprodione	Chipco 26019	2F	00264-00480	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Prk, NC 27709
	Chipco 26019	50W	00264-00481	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Prk, NC 27709
	Chipco 26019	50WDG	00264-00527	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Prk, NC 27709
	Fungicide X	1.3G	00538-00159	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf Fluid Fungicide	19.7F	00538-00183	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf 23-3-3+Fungicide VIII	0.9G	00538-00194	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Disease Control+Lawn Fertilizer	0.9G	00538-00217	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
Vinclozolin	Vorlan	50W	58185-00017	Scotts-Sierra Crop Protection Co., 14111 Scottslawn Rd., Marysville, OH 43041
	Vorlan Flo	41.3F	07969-00062	BASF Corp., PO Box 13528, Research Triangle Park, NC 27709
	Vorlan DF	50DF	07969-00085	BASF Corp., PO Box 13528, Research Triangle Park, NC 27709
	Touch	4.17F	07969-00062	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Curalan DF	50DF	07969-00085	BASF Corp., PO Box 13528, Research Triangle Park, NC 27709
	Curalan	4.17SC	07969-00062	BASF Corp., PO Box 13528, Research Triangle Park, NC 27709
Nitriles				
Chlorothalonil	Daconil 2787	75W	50534-00004	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Daconil 2787	40F	50534-00009	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Daconil 2787	90WDG	50534-00195	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Daconil Ultrex	82.5WDG	50534-00202	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Lesco Manicure	40.4F	50534-00009	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Lesco Manicure	90DG	50534-00195	ISK Biosciences Corp., PO Box 8000, Mentor, OH 44061
	Echo 500	40F	60063-00005	Sostram Corp., 70 Mansell Court, Suite 230, Roswell, GA 30076
	Echo 720 T/O	60F	60063-00007	Sostram Corp., 70 Mansell Court, Suite 230, Roswell, GA 30076
	Echo 90DF	90DF	9779-280 60063	Sostram Corp., 70 Mansell Court, Suite 230, Roswell, GA 30076
	Multi-Purpose Fungicide	30W	00239-02522	The Solaris Group, PO Box 5006, San Ramon, CA 94583

Active Ingredient	Trade Name(s)	Formulation	EPA Regis. Number	Manufacturer or Sub-Registrant
	Rockland Lawn Fungicide	2.5G	00572-00280	Rockland Corporation, PO Box 809, 686 Passaic Ave., W. Caldwell, NJ, 07007
	Lebanon Turf Fungicide	5G	00961-00277	Lebanon Chemical Corp., PO Box 180, Lebanon, PA 17042
	Tee Time Turf Fungicide	5G	01159-00189	Seacoast Laboratories, Inc., PO Box 373, Dayton, NJ 08810
	Lesco TwoSome	4.42F	10404-00060	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Hi-Yield Daconil Lawn Vegetable & Flower Fungicide	12.5W	07401-00065	Voluntary Purchasing Group, Inc., PO Box 460, Bonham, TX 75418
	Green Gold Turf Fungicide	5G	00961-00277	Lebanon Chemical Corp., PO Box 180, Lebanon, PA 17042
	ConSyst WDG	66.7WDG	48234-00007	Regal Chemical Co., PO Box 900, Alpharetta, GA 30239
Phenylamides				
Metalaxyl	Apron	25W	00100-00639	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Apron	50W	00100-00738	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Subdue	2E	00100-00619	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Subdue	2G	00100-00676	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Subdue+WSP	25WSP	00100-00718	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Pace	70W	00100-00742	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Proturf Pythium Control	1.2G	00538-00185	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf Fluid Fungicide II	16F	00538-00203	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
Phosphonates				
Fosetyl Al	Aliette	80W	00264-00467	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
	Aliette	80WDG	00264-00515	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
	Aliette Signature	80WDG	00264-00515	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
	Terra Aliette T/O	80WDG	00264-00515	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
	Blue Ribbon Aliette	80WDG	00264-00515	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
	Lesco Prodigy	80WDG	00264-00515	Rhone-Poulenc Ag Co, PO Box 12014, Research Triangle Park, NC 27709
Sterol Inhibitors				
Cyproconazole	Sentinel	40WG	55947-00132	Sandoz Agro, Inc., 1300 Touhy Ave., Des Plaines, IL 60018
Fenarimol	Rubigan	50WSP	62719-00249	DowElanco Specialty Products, Quad III: 9002 Purdue Rd., Indianapolis, IN 46268
	Rubigan E.C.	1.0EC	62719-00134	DowElanco Specialty Products, Quad III: 9002 Purdue Rd., Indianapolis, IN 46268
	Rubigan AS	1.0F	62719-00142	DowElanco Specialty Products, Quad III: 9002 Purdue Rd., Indianapolis, IN 46268
	Rubigan AS	11.6AS	01471-00155	Elanco Products, Quad IV: 9002 Purdue Rd., Indianapolis, IN 46268
	Lesco TwoSome	4.42F	10404-00060	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116

Active Ingredient	Trade Name(s)	Formulation	EPA Regis. Number	Manufacturer or Sub-Registrant
Myclobutanil	Eagle	40WSP	00707-00232	Rohm and Haas Co., 100 Independance Mall West, Philadelphia, PA 19106
Propiconazole	Banner	1.1E	00100-00641	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Banner GL	41.8WSP	00100-00736	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
	Banner MAXX	1.24E	00100-00741	Ciba-Geigy Corp., PO Box 18300, Greensboro, NC 27419
Triadimefon	Bayleton	50WSP	03125-00340	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton	25W	03125-00318	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton	50DF	03125-00320	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton 25	25WSP	03125-00413	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton 0.5% Granular	0.5G	03125-00364	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton 1% Granular	1G	03125-00363	Bayer Corp., Agricultural Div., PO Box 4913, Kansas City, MO 64120
	Bayleton 1% Granular Turf and Sod Production Fungicide	1G	03125-00460	Bayer Corp., Agricultural Div., PO Box 4913, ,Kansas City, MO 64120
	Turfgo Accost	1G	03125-00363	United Horticulture Supply, 4564 Ridge Drive NE, Salem OR 97303
	1% Turf Fungicide w/Bayleton	1G	03125-00363-572	Rockland Corporation, P.O. Box 809, 686 Passaic Ave, W. Caldwell, NJ 07007
	Proturf Fungicide VII	0.6G	00538-00161	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf 28-0-12 + Fungicide	0.6G	00538-00174	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Proturf Fluid Fungicide II	16F	00538-00203	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	ProTurf Fluid Fungicide III	1.6F	00538-00216	The Scotts Company, 14111 Scottslawn Rd., Marysville, OH 43041
	Turf Fungicide	0.5G	00961-00353	Lebanon Chemical Corp., PO Box 180, Lebanon, PA 17042
	Lebanon Turf Fungicide	1G	00961-00354	Lebanon Chemical Corp., PO Box 180, Lebanon, PA 17042
	Hi-Yield Lawn Fungicide	0.5G	07401-00432	Voluntary Purchasing Group, Inc., PO Box 460, Bonham, TX 75418
	Twin Light Disease Stopper	1G	09198-00111	The Anderson Lawn Fertilizer, PO Box 119, Maumee, OH 43537
	GroWell Lawn Fungicide	0.5G	09198-00112	The Anderson Lawn Fertilizer, PO Box 119, Maumee, OH 43537
	Jonathan Green Lawn Fungicide	0.5G	09198-00112	The Anderson Lawn Fertilizer, PO Box 119, Maumee, OH 43537
	Procide G	0.5G	10370-00202	Ford's Chemical & Service, Inc., 95 Chestnut Ridge Rd., Montvale, NJ07645
	Lesco Granular Turf Fungicide	1G	10404-00058	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Lesco 17-0-17 Elite Fertilizer	0.5G	10404-00065	Lesco, Inc., 20005 Lake Rd., Rocky River, OH 44116
	Lawn Fungicide	0.5G	32802-00042	Howard Johnsons Enterprises, Inc., PO Box 2990, Milwaukee, WI 53201
	Bonide Lawn Fungicide	0.5G	00004-00342	Bonide Products Company, Inc., 2 Wurz Ave., Yorkville, NY 13495

Letter From the Publisher

Dear Readers:

We are constantly searching for ways to make *TurfGrass TRENDS* more useful to you. We bring you review articles on recent research findings. We supplement those articles with experience-based recommendations on how to use those findings to solve turf management problems. We also supplement those articles with references to additional materials. These materials give you, in some instances, Wider and deeper coverage of the subject under discussion, and in other instances simply a different viewpoint on the subject so what an article says can be better understood and more easily applied. In any case, they insure that those who wish to pursue a subject further will be "ahead of the game" when they set off for the library.

This issue of *TurfGrass TRENDS* takes that search still further.

The lead article starts a new series on turfgrass pests and pesticides. This time, Dr. Patricia Vittum and her colleagues discuss insects and insecticides. And in order to help you gain the most from the use of insecticides, we are supplementing Dr. Vittum's article with a discussion by Dr. Michael Villani on readily-available sources of practical advice on selecting appropriate insecticides to apply.

This issue's second article by Peter McCormick of TurfNet Associates, Inc. initiates another new departure. It's a supplement to Dr. Gary Harman's article on Bio-Trek 22G® in the May issue of 1996 *TurfGrass TRENDS.* We're reprinting it because it provides a wholly different perspective on the pluses and minutes of paying serious attention to Integrated Pest Management (IPM). It appeared in a publication many of *TurfGrass TRENDS* readers might not normally see. It describes the experiences of a golf course superintendent, Dan Dinelli of the North Shore Country Club in Glenview, IL, employing advanced pest control materials and application technology in this case, an integrated turf disease control program. The article lays out his objectives, the initiatives he took to achieve them, the problems he encountered along the way and how they were overcome, and why he made the choices he did. These are the kinds of insights from which all can profit. It will be interesting to hear reactions to this undertaking, and to learn of other such efforts. The participants invite your contributions. Feel free to contact them directly, or call me.

Finally, we are continuing Dr. Eric Nelson's recent series of articles on "Maximizing Disease Control with Fungides" by publishing an index to the fungides currently registered with the EPA for application to turfgrasses here in the United States. There are so many fungicides, sold under so many differing trade names, available in so many different formulations, that you "can't tell the players without a program." This index identifies all the active ingredients, trade names, formulations, EPA registration numbers and manufacturers' or sub-registrants addresses (in case you need more information), and pulls them together in a way that makes it easy for you to find the one(s) you need.

Kind regards,

Maria L. Haber

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In Future Issues

- Managing Turf for Minimum Water Use
- The Intricacies of an Irritation Maintenance Budget
- Nitrogen Use by Turfgrasses
- Disease Management with Nitrogen

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