A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

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Maximizing Insect Control with Insecticide Applications

Part One: What Insecticides Can and Cannot Do

by Patricia J. Vittum
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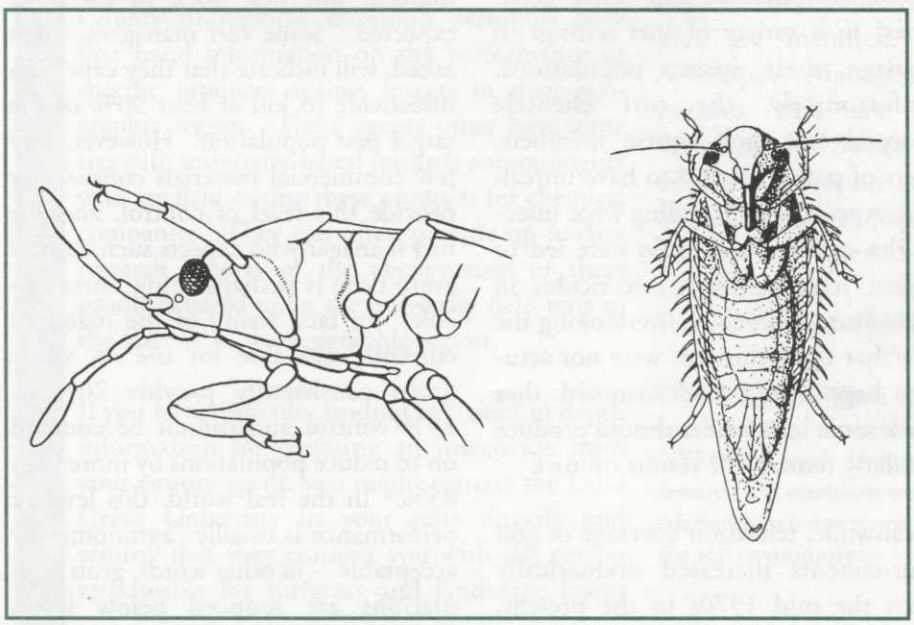
Turfgrass managers are under increasing pressure to provide "perfect" turf. The slightest blemish, whether caused by an insect, a pathogen, or a weed, can lead clients or golf course members to demand pest-free turf. Some people even seem to believe that turf managers have enough options to guarantee "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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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.

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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.