A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

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TECHNOLOGY

# Current Trends In Turfgrass Entomology

*Dr. Patricia J. Vittum, University of Massachusetts*

Turf managers in the 1990s have had to change the way they do business. The rising cost of labor has forced managers to develop highly efficient means to get the job done - for example, installing a computerized irrigation system or trimming trees to ease mowing patterns. Many people seem to perceive pesticides as unnecessary poisons and challenge pesticide applications, particularly on turfgrass. At the same time, golfers continue to demand faster and faster putting greens, perfect lies on all the fairways, and beautifully contoured landscapes. A turf manager cannot survive being a "jack of all trades" anymore, but instead must be a "master of all". That manager must use all the training and intuitional skills possible to provide the kinds of conditions expected. This article will focus on insect and insecticide issues, however many of the concepts mentioned here are also equally valid for weed, disease or nutrient management.

## Scouting and Setting Tolerance Levels

Scouting an insect population has become more important for a number of reasons. Pesticide regulations are becoming increasingly restrictive, at the federal, state, and local level, and turf professionals must be able to document the need to apply insecticides. The days of "spray and pray" are gone, and rightfully so. Now a turf manager must know how to monitor insect activity - the appropriate technique, the right time to start looking, and where the trouble spots are likely to show up first.

*Replicated plots for grub control at Stockbridge, MA. Photo by P. Vittum.*

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Articles abound describing scouting techniques. The astute manager realizes scouting and setting tolerance levels are critical to any IPM program. Key pests are those which show up regularly and cause significant damage almost every year if left unmanaged. Key locations are those trouble spots where pest activity first becomes evident, providing an indication that pests are reaching a damaging stage. Often a golf course will have two or three "problem greens" - where a disease shows up as much as a week before it shows up anywhere else. Or there may be a fairway with a south facing slope that succumbs to insect activity a week earlier than other areas. These would be examples of key locations (Hellman 1995).

Scouting includes accurate identification of insect problems and an assessment of population levels. The trickier part is determining tolerance levels - how many grubs (or mole crickets or cutworms) can be tolerated before the golfer (or customer or owner) complains? These thresholds vary from site to site, and even within a golf course or condominium complex. However, guidelines can be established that enable a turf manager to determine when insecticide applications or other management strategies are NOT necessary. Furthermore, state regulatory agencies are under pressure from the federal government to regulate pesticides that have the potential to contaminate groundwater. Each state has been developing "best management practices" or other kinds of approaches, many of which mandate the implementation of IPM programs before any sensitive pesticides can be applied. Most of those strategies involve the establishment of tolerance levels and documentation that those levels have been (or will be) exceeded before a pesticide is used.

## Stress Management

Much of turf management can be summarized as a form of stress management. Schumann et al. (1997) refer to IPM as "Intelligent Plant Management". In other words, providing the optimum growing conditions for turfgrass often allows it to outgrow damage caused by insects or to outcompete germinating weed seeds. So current turf management strategies emphasize providing ideal agronomic conditions. Some techniques that have been developed for production agriculture are being adapted for use in turf - for example, plant tissue analysis to determine fertility needs, precision applications of fertilizers (taking "spoon feeding" to another level), slow and quick release fertilizers meeting every imaginable need, pesticide formulation chemistry, amendments to alter soil profiles, new drainage designs to solve even the most challenging problems.

These techniques are not just "bells and whistles", but are critical pieces of an IPM program. Now one of the biggest unmet challenges is to convince golfers to allow their superintendents to raise the mowing height - but that is another topic unto itself!

## New Pests and Problems

Recent surveys and reports indicate that the distribution of white grubs is changing in the Northeast. The European chafer is much more widespread than had previously been noted, and is found throughout much of eastern Massachusetts and eastern New York, as well as in Michigan and along the north shore of Ohio. This insect is more damaging than most other grub species, in part because it tolerates cooler soil temperatures and returns to the root zone to feed in the spring earlier than other species. It also remains in the root zone longer in the fall. In addition it is less vulnerable to insecticides than most other species, in part because it is a larger grub.

The oriental beetle is more widely distributed throughout New England than was previously believed. It is found throughout the Connecticut River valley and most of southeastern Massachusetts, as well as Rhode Island and Connecticut. Long Islanders have long known they had the pest to deal with, but now their neighbors to the north are discovering the challenges of dealing with oriental beetles.

There is some evidence that asiatic garden beetle populations may be increasing in parts of the Northeast. One theory is that the species might be less vulnerable to imidacloprid (Merit™). WhenMerit™ is used, populations of many grub species are reduced significantly, but if asiatic garden beetles are less vulnerable, they could expand into areas where they could not compete previously. (Note that this is still a theory but certainly does provide one plausible explanation for the increase in asiatic garden beetles observed recently.)

New buffalograss cultivars have been developed for use in a variety of settings in the Great Plains and are being used in more fine turf settings. As buffalograss use increases, insect pests are becoming increasingly apparent. For example, there is a species of chinchbug that specializes on buffalograss that can cause significant damage. While buffalograss is very well adapted to conditions in the Central Plains, there are other turfgrass species and cultivars that are being used in areas well outside their natural range - for example, bentgrass in the Southeast, zoysiagrass in the Northeast. We can expect grasses in these situations to be under agronomic stresses and to sustain more insect damage than some of the better adapted grasses growing in the area.

While billbugs probably cannot be classified as "new" pests, they are perhaps the most misdiagnosed turf insect problem in many parts of the cool season turfgrass range. They do not usually cause visible damage on golf courses, but they are present in a variety of settings from golf course roughs and fairways to home lawns, athletic fields, and cemeteries. Unfortunately the damage caused by billbugs closely resembles drought stress and occurs when drought stress is most likely to occur (July and August in cool season turfgrass), so some turf managers assume their turf is succumbing to drought when, in fact, an insect might be the culprit. This is a perfect example of the value of monitoring - when drought conditions begin to develop, take a close look and determine whether anything else might be going on.

To add to the confusion, there are several species of billbugs that can occur in a given area. While the bluegrass billbug is the most common species throughout much of the cool season turf zone, there are other species that have similar life stages and cause similar damage. However, the life cycle for each varies a bit, and detailed information is lacking. Monitoring for adult activity in the spring, using pitfall traps, is an ideal way to establish the presence (or absence) of billbugs before it is too late to take action.

*Turf and landscape managers may not have as sympathetic an ear "on the Hill" as lobbyists representing various environmental groups.*

## Pesticide Issues

**Food Quality Protection Act.** The federal government passed the Food Quality Protection Act (FQPA) unanimously in 1996. One of the driving forces in this act was to address the controversies which had been swirling around the Delaney Clause, a 1958 amendment to a federal law which greatly restricted (and generally prohibited) the use on processed food of any pesticide that had been shown to cause cancer in laboratory animals. The Delaney Clause used a "zero tolerance" approach which was workable in the 1950s, when laboratories could only detect chemicals at "parts per thouand" or occasionally "parts per million". However, laboratory detection techniques have improved tremendously and now laboratories can detect materials at "parts per trillion" or even smaller amounts. The language of the amendment, however, said if ANY of the material could be found (regardless of the dose that was necessary to generate an increased incidence of cancer in test animals), the residues on food crops would be greatly reduced or use would be prohibited outright.

The agricultural industry lobbied for a relaxation of the Delaney Clause while people representing various environmental groups lobbied for retention of the clause. The Food Quality Protection Act was the result of considerable debate and haggling.

In essence, it replaces the "zero tolerance" with language that allows use patterns with "virtually no chance of increased harm" from cancer or other unintended and undesirable side effects of pesticide use.

Under the auspices of FQPA, the government is reviewing the registrations of all pesticides during the next ten years, and reassessing their status. All possible methods of exposure are being quantified as accurately as possible - such things as unintended exposures from drift from agricultural applications, exposures in restaurants or hospitals, legal residues on food products, and applications to turf. Whenever there is insufficient information available, the government takes a conservative approach. For example, if a label permits four applications of a product per year, each at a rate of 2 to 4 pounds active ingredient per acre, the government assumes that four applications are made, each at the highest allowable rate.

All products that have a similar mode of action are being assessed together, and a "risk cup" analysis is conducted, determining the level of total exposure an average person should be able to tolerate (based on daily exposure for 70 years) with no increased probability of harm. While the intent of the law is good, the logistics are nightmarish. The bottom line for turf managers is that the government feels the "risk cup" for organophosphates and carbamates is already full or nearly full, and companies marketing such products will be deciding how to decrease the "exposures". Some of their options include reducing application rates or frequency, removing sites from the label, or voluntarily withdrawing their registrations.

*Turf managers must target their information providing efforts at 80% of the people who are neither proponents or opponents of pesticides.*

While it is still too early to tell just what will happen with the "risk cup" analyses, some people in the federal government and elsewhere believe that an unstated intent of FQPA is to eliminate many uses of the organophosphates and carbamates. If this happens, turf managers will have to make some major adjustments. Imagine maintaining turfgrass without chlorpyrifos (Dursban™) for cutworms and webworms, or acephate (Orthene™) for mole cricket baits, or isofenphos (Oftanol™) or bendiocarb (Turcam™) for grubs. And we would lose trichloron (Proxol™, Dylox™), one of the best spot treatment materials available.

So keep an eye on developments with FQPA. Several members of the House of Representatives Agriculture Committee have expressed concern that the EPA's interpretations of the wording have been much more conservative than they had intended and that further development in this direction could have grave impact on production agriculture. But turf and landscape managers might not have as sympathetic an ear "on the Hill" - where other lobbyists representing various environmental groups are equally adament that the conservative estimates should be continued or even expanded.

**Public Perceptions of Pesticides.** The "10 - 80 -10" rule seems to hold true for human attitudes toward pesticides - 10 percent of the population actively supports pesticide use, 10 percent adamently opposes their use in virtually any guise, and 80 percent falls somewhere in between. Those who oppose pesticides often articulate well and generate enough public support to convince legislators to pass legislation that restricts pesticide use based on public perception issues rather than data generated from laboratory and field tests. Human interest stories - for example, the plight of chemically sensitive individuals, exposure of migrant workers to pesticides, or the effect of pesticides on children - invariably catch the attention of the media.

In my opinion, much of the "negative" press that seems to surround pesticide issues stems from a lack of understanding of the total picture. Production agriculture in the United States depends on pesticide use to maintain the current level of productivity. Major changes in pesticide use patterns almost certainly would result in losses of yield and require that additional land be used for production agriculture. Much of the prime agricultural land is already being used for agriculture, so that expansion would be into marginal land.

Turf managers must continue to search for ways to educate the public - their own golfing membership, neighbors, health officials in the local community, and state and federal legislators. If we can target our efforts at the 80% of the people who are somewhere in the middle, and can provide information that addresses some of the most frequently asked questions, perhaps we can make progress and convince people that pesticides, properly used, are a critical tool in turf management as well as production agriculture, and that our quality of life generally is enhanced by proper use of pesticides. At the same time, we must support aggressive enforcement of pesticide regulations, ensuring that those who fail for respect pesticides pay a heavy penalty.

**Emphasis on Reducing Pesticide Use.** As a result of new federal legislation and, in many cases, state regulations, many turf managers are looking for ways to reduce pesticide use, either by reducing the number of applications or the area treated or finding non-chemical alternatives. Some of the impetus for this "change" comes from the general public and their misunderstanding or mistrust of pesticides. Regardless of the source, new (or retooled) techniques and options have been developed recently that should be considered.

**Global Positioning Systems and Other Precision Mapping.** "Global Positioning Systems" take advantage of technology that was developed originally by the United States military. A radio-like device sends a signal to satellites overhead and senses the reflection of that signal. A computer chip then calculates the precise location based on the time it took the signal to travel to the satellite and bounce back and on the location of the satellites. While military versions are incredibly precise, commercial versions can pinpoint locations within a few feet.

Other mapping techniques, such as aerial photography using infrared-sensitive film and "Geographical Information Systems", can be used to identify soil types and conditions (drainage patterns, localized dry spots, diseased turf). Computer-generated maps can be developed that indicate nutritional needs (based on leaf tissue analysis) or insect trouble spots (based on scouting the area and marking areas with heaviest populations).

The technology now exists to incorporate the information from these maps with the Global Positioning System, and set up a locating sensor on a spray rig. As the operator drives the rig, the computer determines where an application is needed and the GPS determines when the rig is at the designated location and turns on the sprayer only at those locations. This technology is being used in production agriculture and was demonstrated at turf trade shows this winter. Some readers might view this approach as a loss of control for the turf manager, but it does have potential in the turf market. If the information provided to the system is accurate, it will provide an outstanding means to minimize pesticide or fertilizer applications. Of course if the input is inaccurate, the results will be less than pleasing.

*At the same time, we must support aggressive enforcement of pesticide regulations, ensuring that those who fail to respect pesticides pay a heavy penalty.*

**Sub-surface Applications.** There are several ways a turf manager can apply insecticides beneath the surface of the turf, including high pressure liquid injection and slicing. The slicing approach can be used to drop granules into a slit (not unlike a slicer-seeder) or liquids at very low pressures. The technology has been refined over the past five years, and is used widely for the application of fipronil (Chipco Choice™) and other materials against mole crickets in the Southeast. Field research has also documented that the approach works very well against white grubs, but it has not been as widely embraced by the industry.

As turf managers come under increasing pressure to reduce pesticide use or exposure, sub-surface applications may become more popular. Our field trials indicate that sub-surface applications reduce surface exposures at least 50 percent in many cases (at least in cool season grasses) and greatly reduce the risk of unintended drift. Meanwhile when targeting white grubs and using sub-surface application technology, some active ingredients can be applied at less than the labelled rate without a loss in efficacy. While some of the "new" insecticides are highly effective against grubs and do not need to be applied below the surface, the technology still provides benefits that should not be overlooked.

**Emphasis on non-chemical approaches.** There are several cultural or biological control alternatives that are available for use in turfgrass, including such things as endophytic cultivars, entomopathogenic nematodes, and various strains of *Bacillus thuringiensis*. All of these have been addressed in some detail in previous articles in ***TurfGrass Trends***, and will not be discussed here. However, turf managers should note that manufacturers of the various biological control agents continue to refine their production and formulation techniques, and the reliability of these products should continue to improve with time.

## New Insecticide Chemistry

**Merit™** - While imidacloprid (Merit™) can no longer be considered a "new" compound, its appearance on the turf market has changed many aspects of turf management. This material is much slower acting and longer lasting than any turf insecticides we have had since the mid 1970s, when chlordane was available for use against white grubs. Many turf managers apply Merit™ in the spring (for black turfgrass ataenius or other spring-active insects) and expect season long-control, including white grubs that appear the following August. Such a use pattern sometimes results in less emphasis on monitoring insect activity, and some turf managers have encountered unpleasant surprises - for example, an unusual insect problem that gets established because a turf manager has let down his or her guard and has not been scouting regularly. In any case, Merit™ has become a mainstay for many turf managers, and has many favorable characteristics, including lower toxicity to humans than some of the "standard" insecticides that have been used over the years.

**Mach 2™** - Halofenozide (Mach 2™) is another exciting new compound, with a very different mode of action. This material is a "molt accelerating compound", and induces an immature insect to molt before it has sufficient reserves to survive the process. The molt is aborted midstream and the insect does not survive. One of the attractions of the material is that it is much less toxic to humans and other vertebrates because vertebrates don't molt! While the compound received federal registration in late summer 1997, it is still awaiting registration in some states (as of May 1998).

The material should be applied before the target insect has reached intermediate larval stages, and can be applied at the time eggs are being laid. The company (RohMid™, which was formed solely to market the product) indicates white grub treatments can be made as early as June, but our field data suggest July and early August applications are preferable. Other researchers have documented that Mach 2™ can be effective against black cutworms, especially when the cutworms are small at the time of application.

Turf management has changed drastically in the past several years, with increased expectations and different tools. While some traditional insecticides may become less appropriate or less available, other options are being developed. The successful turf manager will have to make a conscious effort to stay informed abou;t the changes as they occur, and to implement the new strategies as they become available.

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# New Research Targets

## Improved Management Strategies For Warm-Season Turf Pests

R. L. Brandenburg, North Carolina State University

The key to effective pest management, whether it be weeds, diseases, or insects, is a good basic understanding of the pest's biology and ecology. This includes the life cycle and any environmental circumstances that enhance the likelihood of the pest occurring. Furthermore, this basic understanding of the pest adds to our ability to effectively manage it by allowing us to exploit its weakness and to use control strategies in the most effective way. A good working knowledge about the pest is the foundation to environmentally-sound pest management programs. This information can be developed only through quality research programs dedicated to turfgrass pest management.

As one examines the warm-season turfgrass industry in the South and its supporting data base, there is a significant void of needed research information. This statement is not to put blame on anyone for having shirked their responsibilities, but rather is a statement of fact that reflects two important points about warm-season turfgrass in the South. First, all aspects of the industry have grown quite rapidly in the last twenty years and this growth has essentially outstripped the research resources to keep up with emerging problems. In North Carolina alone there are more than two million acres of turf and over 500 golf courses hosting more than 15.3 millions rounds of golf. The rapid increase in population in the South over the past twenty years has resulted in more subdivisions with home lawns, more parks, more athletic fields, more golf courses, sod farms, and commercial properties. Along with this has come the typical pest problems we had experienced all along. New problems occur from this increasing abundance of healthy, lush turfgrass. Examples of emerging pest problems will be discussed later in this article. In addition, the extended growing season in the South offers a longer season for a variety of pests to cause problems.

*The rapid increase in population in the South over the past 20 years has resulted in more subdivisions, parks, athletic fields, golf courses, sod farms, and commercial properties.*

Another factor that has influenced our ability to effectively manage warm-season turfgrass in the South has been a lack of turfgrass research programs with a long history of support to the industry. As compared to universities in the North and Mid-

**PREDICTING BEETLE EMERGENCE**

| Target Degree Days | Base 50 degrees F. |
|---|---|
| N. Masked Chafer 1st Adults | 898-905 |
| N. Masked Chafer 90% Adults | 1,377-1,579 |
| S. Masked Chafer 1st Adults | 1,000-1,109 |
| S. Masked Chafer 90% Adults | 1,526-1,679 |
| Japanese Beetle 1st Adults | 1,050-1,180 |
| Japanese Beetle 90% Adults | 1,590-1,925 |

*Table 1. Degree day accumulations for emergence of scarab grub adults.*

west, the agricultural universities in the South, as a general rule, have not had large, comprehensive turfgrass research programs in place for many years. Rather, many had small programs and, as the industry has grown, they are making every effort to grow with them. This means that in many cases there is not an extensive data base on pests and pest management from which to build. In some instances, we are still working to develop basic information data bases. This is a growing pain associated with an industry that has seen phenomenal growth.

While the problem of supporting a rapidly growing industry is certainly a good problem to have, it does challenges those involved in the development of pest management programs that are an integral part of maintaining the vitality of the industry. Additionally, new regulations and continued concern over pesticide use, human health, and the environment, fuel the need to develop new, alternative pest management strategies. We also are still quite unsure as to the overall impact the Food Quality Protection Act signed in 1996 will have on the turfgrass industry. The EPA is moving slowly on its implementation and no one is quite sure as to its impact other than the fact that we know it will impact the turfgrass industry.

*Many pest problems on turf have increased in the past twenty years in the South.*

As mentioned at the onset, our goal in the development of pest management programs is to base them on sound biological information. The better the researchers understand each pest, the more information can be passed along to you, the turfgrass manager, and ultimately, the better you can manage the pests that affect the turfgrass for which you are responsible. The importance of understanding the biology and ecology of the pests cannot be overstated. While pest occurrence has consistent trends in specific locations, there are always local variations that influence the timing and abundance of pest occurrence. A working knowledge of each pest can help you customize your pest control to obtain optimum results.

## Increasing Insect Damage

Many pest problems on turf have increased in the past twenty years in the South. From an insect perspective, we have seen more damage from mole crickets, green June beetle grubs, twolined spittlebugs, and fire ants. The increase in fire ants is a direct reflection of their constant march across the South after their introduction into the U.S. Mole crickets are similar in that they have spread from the initial point of entry in south Georgia. While these insects would have spread regardless of the size and growth of the turf industry, the fact that there are more acres of lush, well maintained turf than ever before provides a quality habitat and food source for the crickets.

The twolined spittlebug is a good example of an insect taking advantage of the environment we create for it. The twolined spittlebug adult feeds on ornamentals, particulary several species of hollies. The spittlebug nymph feeds on turfgrass. Put the two together, as we usually have in any new subdivision, and we have provided the complete "buffet" for the insect in all of its life stages and created a very attractive site for pest outbreaks. Dr. Kris Braman, University of Georgia has conducted research on this pest that will help us better understand it and do a better job managing it.

A similar situation is observed in those areas where Japanese beetles are a problem. The adults love to feed on a variety of ornamentals, including crape myrtles, roses, purple leaf and other plums, golden sycamores, witchhazels, and many varieties of grapes. When used in the landscape these plants can attract the beetles into the turf area. Since Japanese beetles fly during the day and their eggs require sufficient soil moisture to prevent dessication, the beetles seek out areas that appear to have good soil moisture (eg. areas where the turf is quite green and lush).

Once again, the environment created through landscaping and turf maintenance increases the likelihood of pest outbreaks.

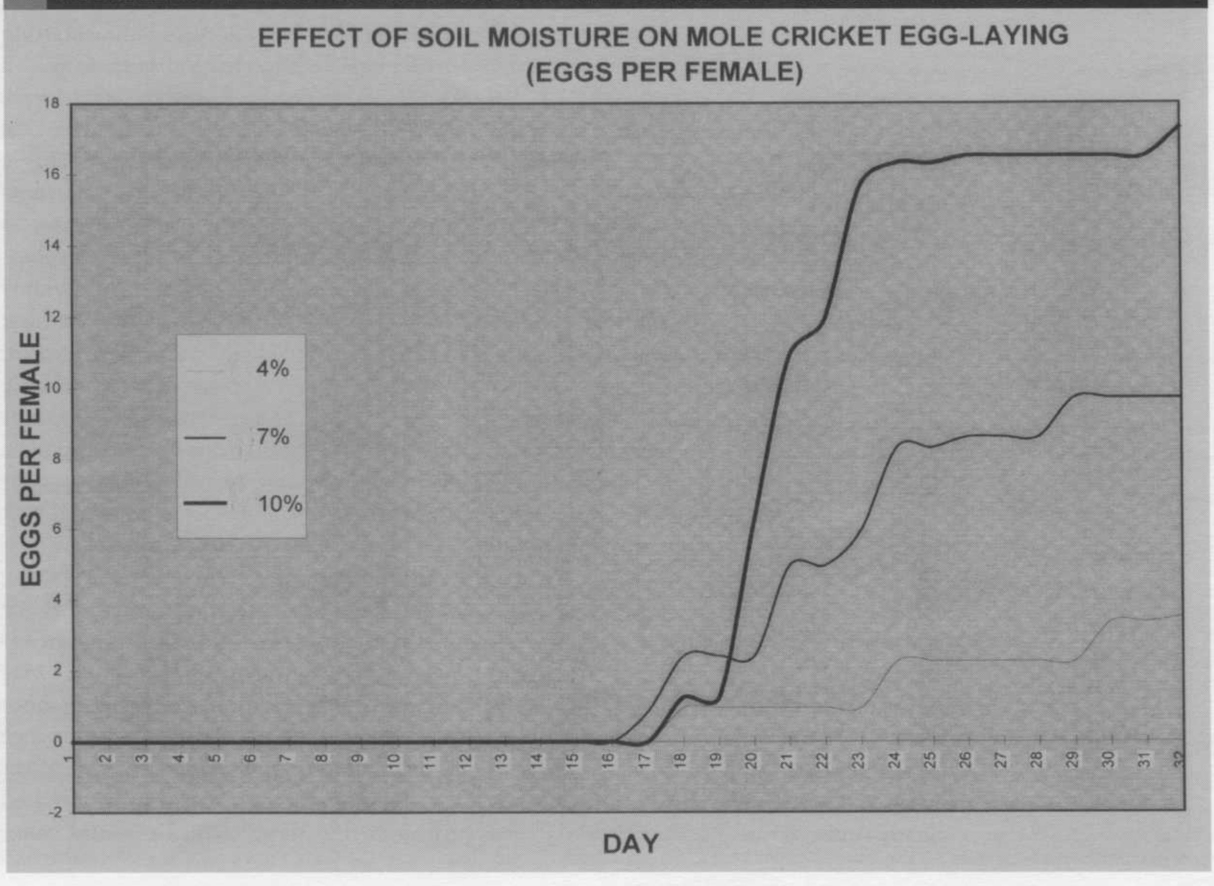
Forecast models have been developed in the North and Midwest to predict the emergence of the Japanese beetles in the spring and these have been quite accurate. Since much of an insect's development is based on how warm it is or degree day accumulation, some of these models can be used in the South. Our research in the southern coastal areas of North Carolina have shown that the same model is an accurate predictor of Japanese beetle emergence in the South (Table 1). The newer chemistries for preventative grub control make timing more critical than ever. Consequently, accurate information on beetle emergence can help us to plan applications.

Perhaps one of the most troublesome pests in the South and one of the most challenging to manage (along with fire ants) has been mole crickets. Numerous researchers throughout the Southeast are currently investigating management of this pest with studies on the pests biology and control with both conventional and biological products. Much of the challenge of managing this insect arises from the fact that it is a soil insect pest and its subterranean nature makes most of its habits and activities unknown to the turfgrass manager. Soil insects, as a general rule, are also more difficult to control because the turf, thatch , and soil often act as a buffer, which protects them from the control agent. The rest of this article will attempt to illustrate how a better understanding of pest biology, ecology, and even behavior is critical in developing cost-effective and environmentally-sound management strategies for this, or any other pest. While the focus may be on mole crickets, the need to understand the pest and the benefits from doing so are true for all pests in a good IPM program.

*Mole crickets have become one of the most frustrating and expensive insect pests to control.*

Mole crickets have become one of the most frustrating and expensive insect pests to control, particularly in golf course settings. However, in many areas they also are a problem on sod farms, home lawns, athletic fields, and commercial properties. Most products do not provide the kind of

**FIGURE 1. EFFECT OF SOIL MOISTURE ON MOLE CRICKET EGG LAYING**



control desired with a single application. The cost and time involved with multiple applications is frustrating for the turfgrass manager and the resulting damage, despite control efforts, often exceeds tolerable levels. We also observe a lot of variability in the level of control with the same product from year to year and from one location to another. Based upon the research focusing on white grubs in turf conducted by Dr. Mike Villani at Cornell University there was reason to believe that mole cricket behavior in the soil played an important role in control agent effectiveness. His studies, in collaboration with several colleagues, found grub activity and ultimately grub control was influenced by soil type, soil moisture, and a variety of other environmental characteristics that influenced the behavior of the grub in the soil. It seemed quite possible that a more mobile soil insect, such as the mole cricket, might have greater control over its destiny when subjected to a variety of control agents.

*The ability to identify high risk areas subject to mole cricket infestations would allow turfgrass managers to target their efforts more efficiently.*

Our studies have revealed that mole crickets are not only well adapted to take advantage of the turf environment we produce, but are also quite well adapted at withstanding many of the control efforts we throw at them. Mole cricket egg survival is better under higher soil moisture conditions (Figure 1). This is similar to the scenario we see with the Japanese beetles selecting those areas where the turf is greener and lush. Mole crickets prefer those areas and the males use areas with adequate soil moisture to develop their "calling chamber". Chambers built in moist soil project sound more efficiently and enhance the likelihood of mating. The females often lay eggs near the site of mating and thus take advantage of the higher soil moisture which improves the likelihood of egg survival.

Other factors that mole crickets consider when determining areas to infest are not clearly understood. We are currently conducting studies that are investigating a variety of soil factors that could influence site selection and or survival of the mole crickets. Parameters under investigation include turf cover, soil moisture, soil texture, soil color, pH, and organic matter. The ability to identify high risk areas subject to mole cricket infestations would allow turfgrass managers to target their efforts more efficiently to those sites most likely to be infested.

Recent studies have also attempted to determine if degree day or heat unit accumulations can be used to forecast or predict mole cricket egg hatch and development as previously mentioned for the Japanese beetle. Since most control options work best when applied to newly-hatched nymphs and since these nymphs are hidden in the soil, timing of treatment is critical, yet often difficult. There is considerable variation from one year to the next in the timing of egg hatch (Figure 2) and this can mean the difference between success and failure of a treatment.

Our efforts to predict egg hatch based solely on degree day accumulations starting on January 1 have been disappointing in that we have not been able to target a very narrow range of degree days that coincide with peak egg hatch. This is probably a reflection of the fact that varying percentages of mole crickets enter the winter as nymphs and adults each year and development during the winter varies considerably based upon the temperatures in November and December. Unlike areas in the North, biological activity does not necessarily come to a halt in the winter. This makes it somewhat difficult to use January 1 as a starting point, which assumes development has come to a stop at that point and that it will be consistent from year to year.

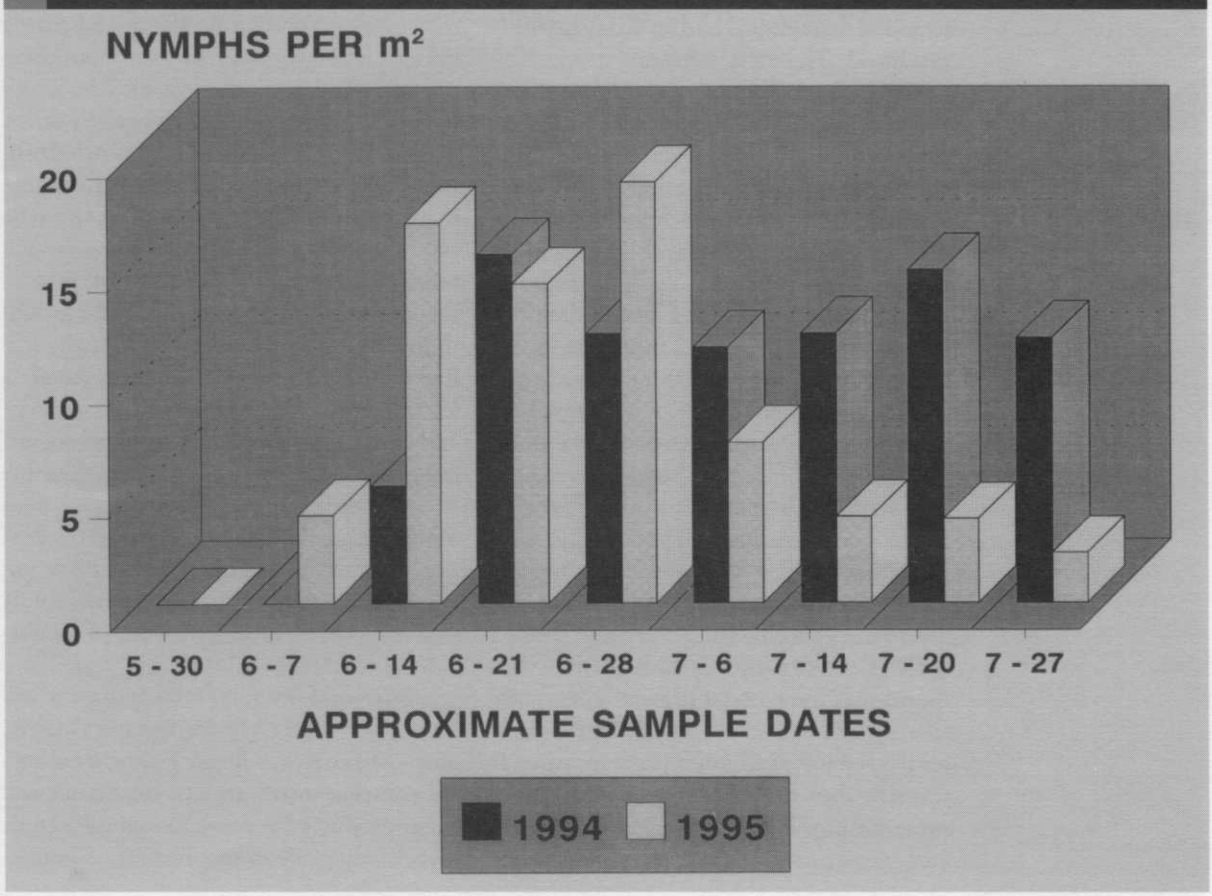
Rather than using January 1 as a starting point, we are investigating the use of major mating flight peaks as a starting point for degree day accumulations (Figure 3). Once mating occurs, it is more likely we can monitor degree days to predict egg-laying, egg hatch, and nymph development. Monitoring mating flights can be automated through the use of acoustic sound caller traps and daily counting of captured individuals. This research continues to provide an early warning system for mole cricket infestations.

Further research to investigate the reason behind the considerable variation we observe in control by the same products from one location to another focused on the effects of both post and pre-irrigation regimens. Despite comparing such dramatic difference such as pre-irrigation of plots, post-irrigation of plots, both pre and post-irrigation of plots as compared to no irrigation at all, no significant or consistent trends were noted. To the causal observer it only made sense that adequate watering to move the insecticide down into the soil would provide better control than where the pesticide was allowed to dry on the surface by avoiding all irrigation. In addition, studies were conducted to investigate the use of subsurface application equipment to apply the insecticide directly into the soil where the cricket resides. This would put a higher percentage of the product in close proximity of the pest, reduce pesticide breakdown from ultraviolet degradation, less binding of pesticide in the thatch, and possibly reduce microbial breakdown. While we observed a general effect of increased efficacy with this application technology, the results were often somewhat subtle and ultimately tell us that poor control was not simply a matter of the control agent not getting down in the soil where the mole cricket would be exposed.

*Investigation into variation in control by the same products from one location to another focused on the effects of both post and pre-irrigation.*

Similar results were obtained in evaluations of various biological control agents. The use of the fungal pathogen, *Beauveria bassiana*, has shown promising but extremely variable results in field testing. Previous trials over a number of years found the use of a variety of entomogenous nematode

**FIGURE 2. EMERGENCE OF SMALL MOLE CRICKETS IN 1994 AND 1995.**



products to provide, at best modest, and at times, poor control of crickets. Current trials are investigating the use of various surfactants and even sublethal doses of conventional pesticides to enhance the performance of the *Beauveria* fungal pathogen products. However, this extreme variability in the use of most all products, conventional or biological, suggests a much greater need to understand cricket behavior and responses to such treatments rather than a blind attempts at improving performance through application techniques.

*Studies found that mole crickets avoid insecticide treated soil and construct their tunnels in such a fashion as to minimize exposure.*

Recent research has used radiography and wax castings to monitor mole cricket tunneling activity and behavior. Large boxes of soil containing mole crickets are used to determine mole cricket tunneling characteristics. Once the mole crickets acclimate to the box and after completing their tunnel structures, the boxes are subjected to radiography and an X-ray image is produced. The most damaging species, the tawny mole cricket, consistently produces the same type of tunnel structure with a "Y" shaped branch near the soil surface This consistent and uniform tunnel construction would indicate this characteristic is important for mole cricket survival. Even when a tunnel structure is partially destroyed, the cricket will rebuild it in a similar fashion. Validation of this tunnel structure in the field has been confirmed through wax castings. Pouring melted wax down tunnels in the field and subsequent excavation following hardening of the wax has produced tunnels similar in structure to those found in the laboratory radiograph boxes. This confirms that the laboratory and X-ray findings closely simulate real world activities.

Further studies with insecticide treated soil in the laboratory and subsequent X-rays found that mole crickets avoid insecticide treated soil and construct their tunnels in such a fashion as to minimize exposure. It appears that the crickets can detect the presence of the insecticide and either seek areas near the surface without insecticide or move deep into the soil. This has significant implications for control and might certainly help explain the significant variability we observe in control efficacy. Moreover, this response may be dose related. In other words, the higher the rate of application, the greater the avoidance response. Such behavior may explain why we occasionally observe a reverse rate response. In other words, the lower rate of insecticide sometimes works better than the higher rate. We have also observed similar interactions with the use of biological materials. This help us understand why proper rates and applying products under the right environmental conditions are so important. Such information is critical in our efforts to improve mole cricket management programs. Only through such information are we able to develop the type of precision control programs we need for the future that are both economically and environmentally sound.

The mole cricket project helps illustrate the complexity of effective pest management. As we already know its not just a matter of spraying a pesticide and sitting back to let it work. It is much more complicated. And, with the loss of older products, the development of newer chemistries, and increased regulations, our knowledge of pest biology and ecology will only become increasingly important. Many of the new products and biological materials are much more specific as to the stage of pest to which they should be applied and the conditions under which they work best. To utilize these new products most effectively a knowledge of the pest's biology, ecology, and behavior is gong to be standard operating procedure. Hopefully the example given by the mole cricket research serves as a model to utilize such information in pest management programs. Research at universities throughout the South are rapidly building data bases of similar support information for all pests of turf.

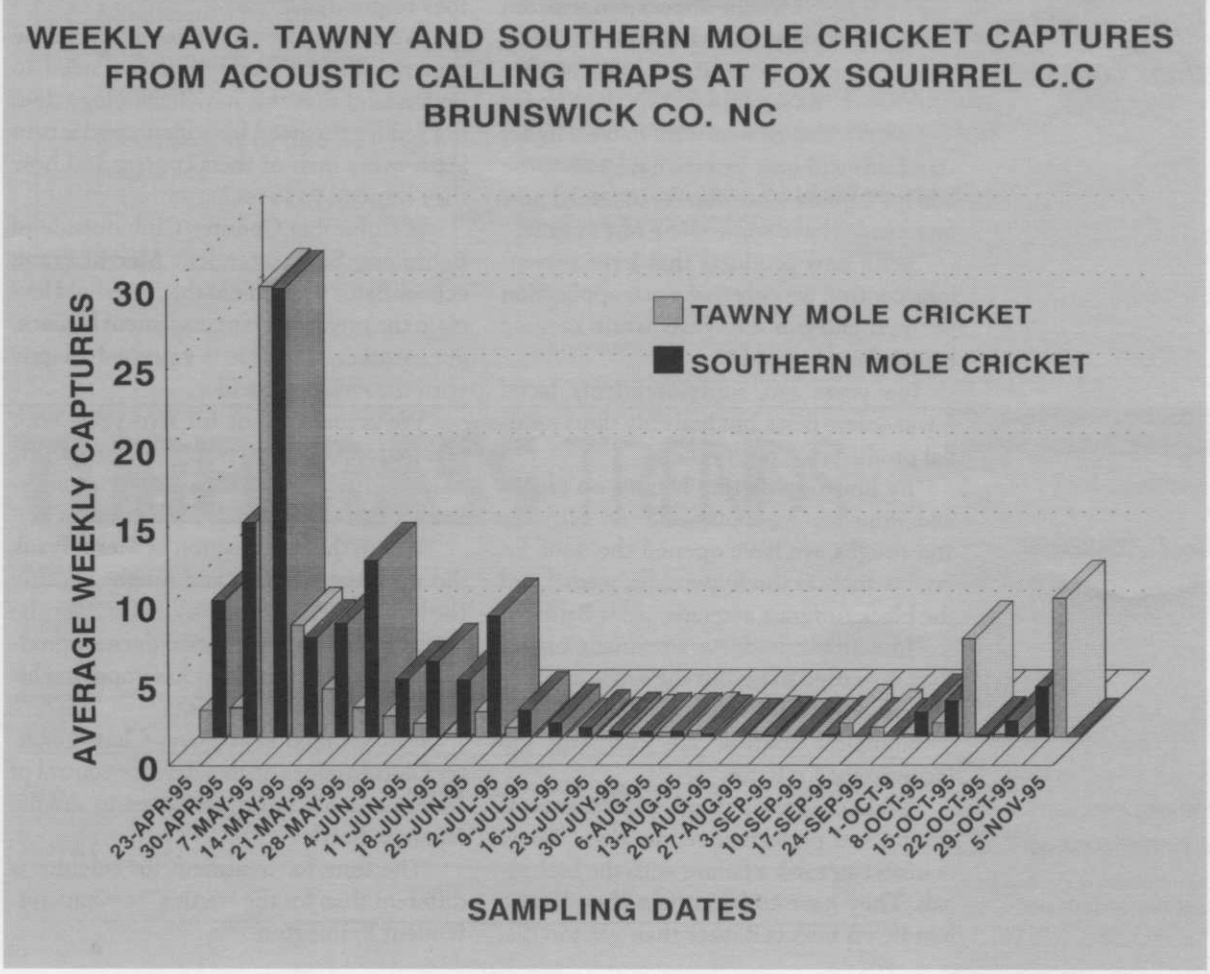
As new information is developed it will be important for turfgrass managers to keep abreast of these findings. The new biological controls, insect growth regulators, and other products are going to require an new level of vigilance in monitoring pest abundance and distribution. They might also require knowledge upgrades about the pests we battle each year. The benefit from all this is improved pest control, less need for retreatment, and the most environmentally sound approach to best management practices obtainable. Those benefits make everyone happy and is good for the industry as a whole. This article also illustrates that being a turfgrass manager is going to get more complex and continuing education will be critical.

With all of that said, I believe the future is exciting and promising. Never before in the South have we have more people working on turfgrass and branching out into areas of biotechnology and high technology turfgrass management. Its going to be an exciting industry to be a part of.

*R. L. Brandenburg is Turf Entomologist at North Carolina State University.*

***Recent research has used radiography and wax castings to monitor mole cricket tunneling activity and behavior.***

**FIGURE 3. SOUND TRAP CATCHES OF MATING ADULT MOLE CRICKETS.**



# Balancing IPM

## New products, new pest challenges

There is no substitute for a dedicated There is no substitute for a dedicated superintendent who has intimate knowledge of every square inch of a golf course, points out **Dick Bator**, golf course turf consultant in Pittsfield, Mass. That goes for insect control, disease controlf and just about anything else you can name. Furthermore, superintendents need assistants who are equally sensitized to details on a course.

*New technologies do not reduce the need for superintendents to learn every inch of their courses.*

Integrated pest management is part of the superintendent's understanding of what makes his or her course react to weather, play and maintenance.

"Only the superintendent can make the decision regarding what constitutes an acceptable threshold of insect damage for his course" says Bator. Higher standards and new insects have raised the bar for superintendents. Fortunately, new insecticides have come along just in time.

"With new products that have season-long control, we only make one application per year and can skip years while keeping below the threshold."

Ten years ago, superintendents faced fewer severe pests, but had only short residual products to control them.

"By lowering cutting heights on greens and improving maintenance on fairways and roughs, we have opened the door for insects such as the hyperoides weevil and the black turfgrass aetenius," adds Bator.

"Insecticide budgets are much higher than they used to be, but the single application products are less labor intensive."

Biological controls are currently too inconsistent for Bator.

"Slight changes in weather can throw off timing and performance," he says. "Many courses can't risk a failure with the biologicals. They have to be certain they have a handle on insects.Rather than get too distracted by trying to improve the consistency of biologicals, the superintendent should pay attention to the timing of insecticide applications, the pH of water in his spray tank and using irrigation to get the insecticide into the soil."

Bator sees new technology, such as global information systems and mapping as important tools for superintendents to record course history and to alert them about potential problems.

"We need to use everything available," he remarks. "At the same time, we need to understand that this new technology does not reduce the need for superintendents to learn every inch of their courses and how they respond to stress."

"We need to use everything available," he remarks. "At the same time, we need to understand that this new technology does not reduce the need for superintendents to learn every inch of their courses and how they respond to stress."

At Columbia Country Club outside of Baltimore, Superintendent **Merrill Frank** echoes Bator's sentiment that threshold levels in the private club management business are esentially zero. He is extremely happy with the new insecticides.

"We've used Merit for two years with great success," says Frank. "We are trying Mach 2 this year and are considering alternating the two materials in the future."

Prior to the introduction of Merit, Frank did not treat fairways and roughs because the length of control was too short. Now he treats them once a year with the new products and believes that this has improved his control on tees and greens.

**Sean Remington** at Chevy Chase Country Club employs degree days for control of June beetle, black turfgrass aetenius and the Japanese beetle.

"The time for treatment for aetenius is different than for the beetles," says superintendent Remington.

"We work closely with **Dr. Kevin Mathias**, an entomologist in our area."

"I've requested an on-site weather station so we can get better degree day readings. We have been using Merit with excellent results. Using IPM with the new insecticides has been very effective. IPM is one of the reasons to improve our irrigation system."

Paying attention, whether by satellite or by walking the course, is the most important key to insect control, say these superintendents. They welcome new technology, but keep close, personal observation on top of the list.

## In Future Issues

- Magnesium for turf
- Brown patch modeling research
- Mechanisms of disease resistance

# CD-ROM team wins

American Phytopathology Society members Gail Schumann and Jim MacDonald have received an Award of Excellence from the National Association of Colleges and Teachers of Agriculture, for the Turfgrass Diseases: Diagnosis and Management.

The CD has been available for more than a year, and contains visuals of more than 65 turfgrass diseases and disease agents. "We are very pleased to receive this award from NACTA," says Dr. Schumann, associate professor and turfgrass pathologist at the University of Massachusetts.

"We've had a very positive response from turf managers who use the CD-ROM in their day-to-day operations," says Schumann, "but it is particularly gratifying that our teaching colleagues consider it a valuable instructional program.

"We worked hard to make a user-friendly, interactive program for both students and turf managers."

To order the CD-ROM ($169 plus $4 shipping) call APS at 612-454-7250.

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