A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

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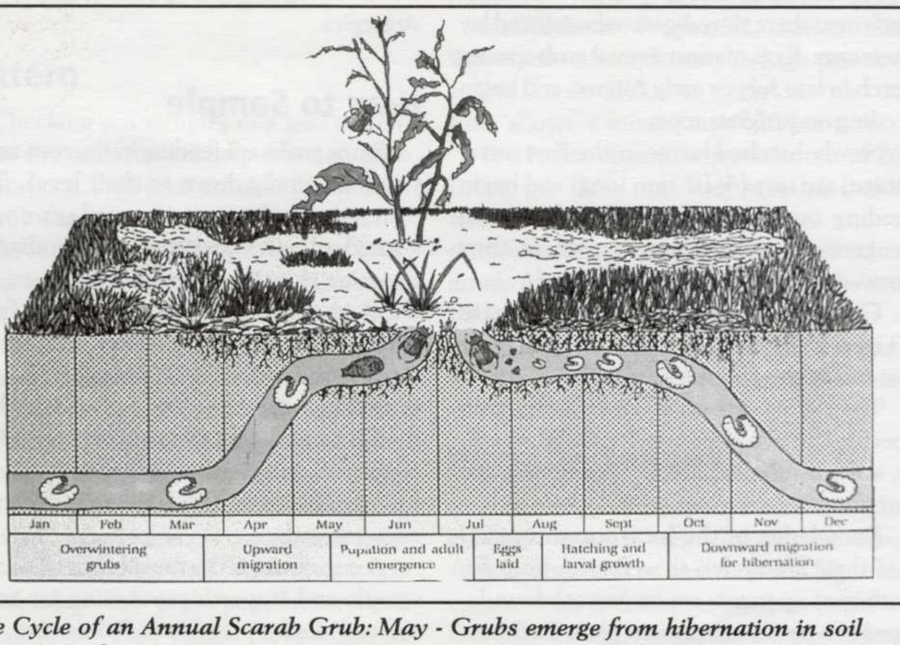
ENTOMOLOGY

Scarab Grubs
Sampling and Identification

By Jennifer A. Grant, Turfgrass Entomologist, Cornell University

At this time of year, turfgrass managers are concerned about infestations of Scarab grubs in the soil. These insects are present throughout the United States, but their damage tends to be the most ubiquitous and severe in the eastern and central states. Scarabs which are considered pests of turf include the Japanese beetle (*Popillia japonica* Newman), oriental beetle (*Anomala orientalis*), green June beetle (*Cotinis nitida*), Asiatic garden beetle (*Maladera castenea*), May and June beetles (*Phyllophaga* spp.), black turf-



Life Cycle of an Annual Scarab Grub: May - Grubs emerge from hibernation in soil beneath the frost line and tunnel up to warmer soil where they feed on grass roots for 3 to 4 weeks. June - Grubs build a cell where they pupate and emerge from the soil several weeks later as adults. July - Adult beetles fly to foliage and cluster together feeding and mating. Females lay eggs in the soil during their 4 to 6 week life span. Aug - Eggs hatch in 9 to 30 days, generally by mid-August. The young grubs begin feeding on roots near the surface. Control grubs now before their size and appetites are fully developed. Sept - Grubs grow larger and feed more heavily. Visible damage common. Oct - Turf damage more evident, as large grubs have been feeding for months. Nov - As the weather gets colder, grubs burrow deep into the soil for winter hibernation.

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grass ataenius (*Ataenius spretulus*), masked chafers (*Cyclocephala borealis* and *C. lurida*), and the European chafer (*Rhizotrogus majalis*). White grubs are the immature stages of these beetles, and they live in soil and feed on turfgrass roots, resulting in wilting, reduced strength and eventual plant death and loss of turf cover.

The most common scarab pests have an annual life cycle, producing one generation per year. Adult beetles emerge from the soil in late spring or early summer and proceed to feed, mate and lay eggs.

Some beetles, such as the Japanese beetle, are voracious feeders and attack the foliage of grapes, roses, linden trees and several hundred other plants. Other beetles, such as the European chafer, are not known to feed as adults. Regardless of feeding activity, mating beetles can be a nuisance as they "roll" down golf course fairways and playing fields, or swarm around trees in recreational areas.

After mating, females search for suitable turf sites where they dig into the soil and lay their eggs. Eggs of most annual grub species hatch in late July or early August, and begin feeding on turfgrass roots.

Newly hatched larvae in the first instar (stage) are tiny (4-10 mm long) and begin feeding on minute root hairs, but soon progress to eating larger roots as they grow.

Grubs molt twice to become large (up to 23 mm long) third instar grubs, usually by the end of the growing season.

The timing of each stage varies by grub species, climatic region and seasonal weather, and must be verified by monitoring and sampling.

Knowledge of the local scarab species and their life cycles, as well as options for grub management, are important foundations of a pest management plan. Each turfgrass site must be monitored for the presence and abundance of grubs, and the species identified in order to optimize management decisions.

The following sections detail how to sample, identify grubs and problem areas and make treatment decisions.

Sampling

Turfgrass grown on golf course fairways, front yards or institutional grounds is likely to be inhabited by grubs. However, the presence of grubs does not necessarily indicate a problem. In fact, research has shown that grubs are only found at damaging populations levels 20 percent of the time on both golf course and residential turf in New York State. The time spent sampling is minimal compared to the environmental and financial savings of reduced pesticide use on golf courses, residential properties, parks, schools and sod farms.

Sampling is necessary to determine the species of grubs infesting turfgrass plantings, their locations, densities and developmental stages. This information enables managers to make more educated pest management and cultural decisions for individual turfgrass situations. A "Grub Checklist" should be kept to track grub and beetle activity and plan management strategies.

How to Sample

Since grubs are feeding in the root zone, you have to dig down to their level. The easiest method is to remove soil cores with a standard golf cup cutter (11-cm diam.). Examine the core for grubs and place the checked soil back into the hole it from which it was removed. Afterwards, firmly replace the sod cap. If drought stress is avoided, damage from the sampling should be undetectable. Inspections take a couple of minutes per core, depending on soil conditions and the quantity of grubs encountered.

A cup cutter is the most efficient way to sample and is worth purchasing for commercial turf operations. Otherwise, cut three sides of a square-foot turf area with a shovel. Peel back the sod and look for grubs on the soil surface and at the bottom of the sod mat. A bulb planter can also be used for small sites.

Regardless of the tool used, record the number of grubs found on a data sheet or

Sampling is faster and more precise with helpful tools such as a cup cutter, a surface on which to count grubs and a checklist.

map and note the predominate stage (instar) and species of the grubs.

Pattern

Checking soil samples in a grid pattern across any turf area will help delineate grub infestations. Prioritize areas with histories of grub damage and where beetle activity has been observed. Sample the turf area, based on the amount of time available. Specific recommendations for different turf sites follow.

Golf Courses - On fairways, a pattern of four cup-cut cores taken across the fairway at 20-30 meter intervals is suggested. Samples can be skewed towards the roughs, where grub populations are often higher. Irrigation heads serve as convenient landmarks for sampling lines. After data is collected, map the grub population on a course map. Plan on 36 labor hours to check an 18-hole course; a four-person team can check an entire course in one day.

Residential Properties - A minimum sample of 20 cores (distributed throughout the area) is suggested for any home lawn. More samples are recommended on lawns larger than a half acre. Concentrate efforts in open, sunny areas, near flowerbeds and in front yards, where grubs are more prevalent.

Institutional Properties, Parks, and Cemeteries - Sample only in high priority, visible areas. Take as many samples as time allows, a minimum of 20 per acre.

Sod Farms - Examine a minimum of 20 cores per acre on sod scheduled for harvest in the current season and a minimum of 10 cores per acre in all other areas. Alternatively, sod strips and the soil underneath can be inspected behind a sod-cutting machine. Monitor populations in newly cut sod whenever possible.

When to Sample

Knowledge of the species inhabiting the area will indicate when local monitoring should begin. Most annual grubs lay their eggs in July, and inspections can begin in late July through mid-August, depending on regional and local weather patterns. Observations of heavy adult activity also serve as indicators that grub sampling can begin two to three weeks later.

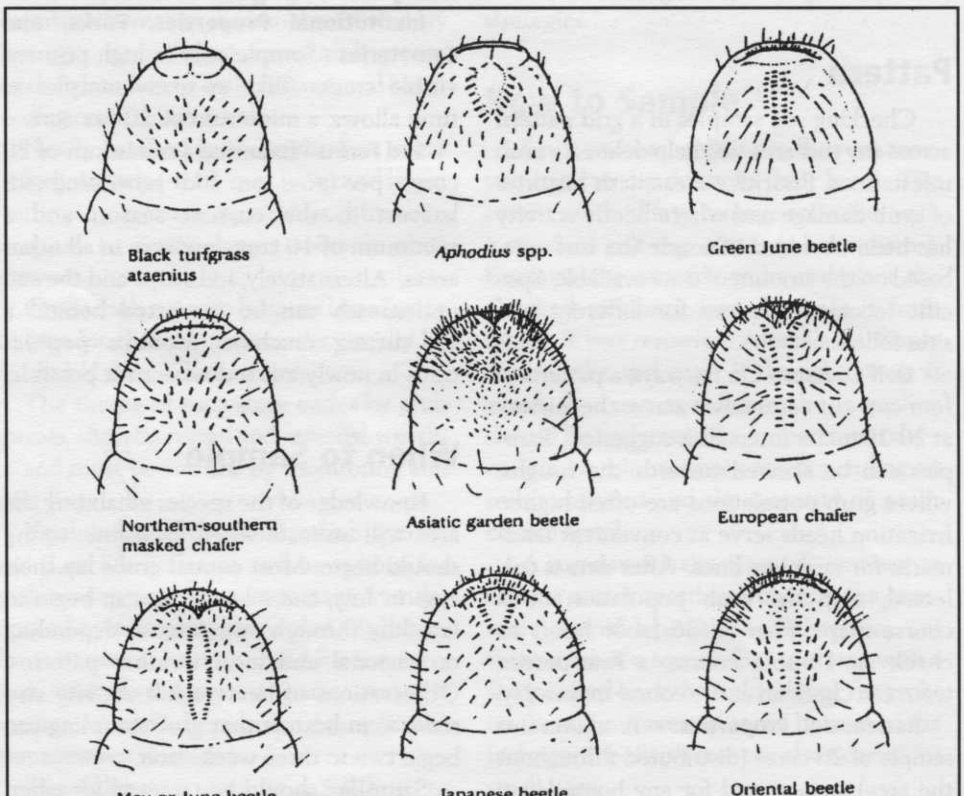
Sampling should be targeted for when grubs are small (1st and 2nd instar) before they cause significant damage. This window of opportunity is approximately two to four weeks after egg hatch. Sampling indicator areas several weeks before grubs are expected will monitor the insect's development and suggest when to begin comprehensive sampling at each turfgrass site. Indicator areas should be monitored even if a prophylactic treatment, such as Imidacloprid (Merit) has been applied. Maps of these early instar grub populations are used to make immediate treatment decisions before damage is visible.

Examine soil in infested areas two to four weeks after a treatment, and count and map live grubs to evaluate the effectiveness of the control practice.

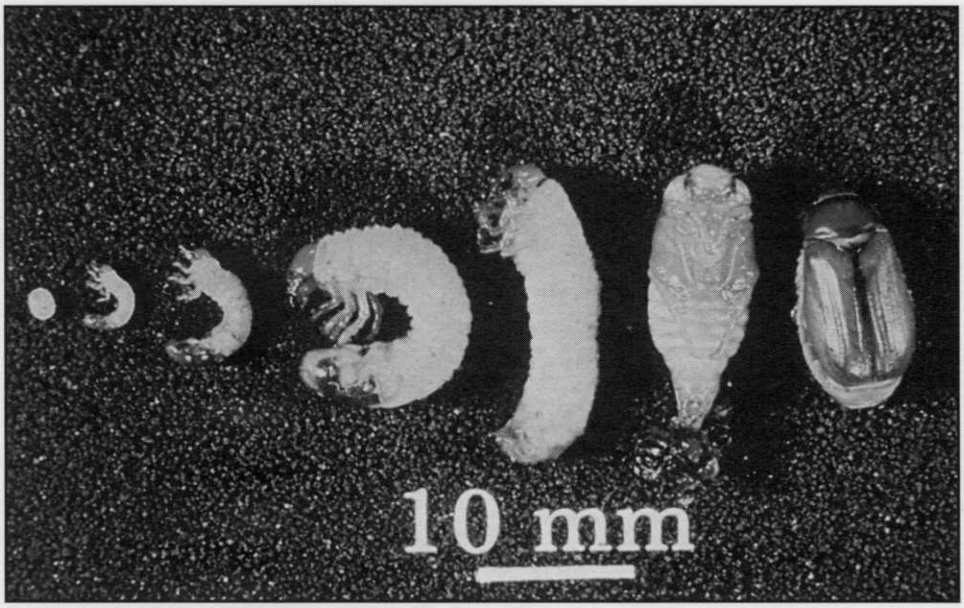
Sampling after a control practice has been implemented is also important. Examine soil in infested areas two to four weeks after a treatment, and count and map live grubs to evaluate the effectiveness of the control practice. Spot monitoring is sufficient to judge whether a control measure was successful. This practice is termed a "post-treatment efficacy evaluation", and provides information on the value of grub management strategies.

Grub Species Identification

Correct identification of grub species is essential for determining damage potential and developing appropriate short and long-term management strategies. Some grubs are small (e.g. black turfgrass ataenius) and large populations are required to damage turf. Others, such as European and masked chafer grubs, may be encountered when small, but will grow into large, voracious eaters. The timing of developmental stages



Raster locations and patterns of common scarab grubs.



Growth stages of a European chafer. Illustrations courtesy New York State Agricultural Extension Service.

and adult eating habits are also species dependent. In addition, different grubs are affected differently by various biological and chemical control agents.

Grubs have soft, C-shaped bodies with three pairs of legs and a brown head capsule. Note that other soil-inhabiting insects such as billbugs and annual bluegrass weevils may look similar, but lack legs.

The only way to reliably differentiate scarab grub species is by examining the pattern of rastral hairs and the shape of the anal slit in the last abdominal segment of the insect. These features are located on the insect's raster.

Hold the grub gently between thumb and forefinger, and examine the end of the grub with a hand lens. The anal slit is either crescent or "Y" shaped, and a set of stiff hairs located directly below the slit form a distinct pattern.

The combination of anal slit shape and rastral hair pattern is species-specific, as shown in the accompanying drawing. Turf managers can easily learn to identify common grubs. However, local Cornell Cooperative Extension offices and turfgrass consultants also provide this service.

Management Decisions and Strategies

The potential for turf damage can be evaluated by comparing sampling results with damage threshold values (see Table 1 on page 6). Tolerance to grub injury varies greatly by turfgrass species, site characteristics and stress factors. Generally speaking, healthy turf with strong roots, adequate soil moisture and low stress will tolerate grub infestations above the threshold level. Conversely, stressed turf will be susceptible to damage at, or even below, threshold levels. Therefore, thresholds serve only as guidelines for management decisions.

The only way to reliably differentiate scarab grub species is by examining the pattern of rastral hairs and the shape of the anal slit in the last abdominal segment of the insect.

Assess damage potential by looking at a map of grub populations, not by averaging counts over a wide area. Intervention may be warranted if three or more adjacent samples reach or exceed the threshold level; whereas isolated spots of grub activity

TABLE 1. COMMON GRUB THRESHOLDS

Grub Type	Common Grub Thresholds per ft^2	per 4-inch cup-cut
Ataenius	30-50	3-5
Asiatic garden beetle	18-20	2
Masked Chafers	8-20	1-2
Japanese Beetle	8-10	any
European Chafer	5-7	any
Oriental Beetle	5-7	any
Green June Beetle	5	any
May and June Beetles	3-4	any

rarely cause visible damage. Adherence to thresholds can be conservative in high priority areas and liberal on low maintenance turf.

High population areas, delineated by sampling, can be targeted for spot treatments rather than treating an entire turf area. The maps shown illustrate typical treatment decisions based on sampling results.

Grubs are most vulnerable to stress in the early instars, typically found in August. As they grow, grub susceptibility decreases as their appetites increase. Therefore, the optimal time for most biological and chemical control practices is directly after sampling. If intervention is necessary, consider the grub species and developmental stage, thatch, and soil type when selecting the most appropriate management practice or product. Successful treatment at this time will prevent significant damage from occurring. Irrigation and overseeding in the fall can also minimize visible damage from low to moderate infestations of grubs in healthy turf.

Grubs are most vulnerable to stress in the early instars, typically found in August. Grub susceptibility decreases as they grow, and their appetites increase.

Sampling data is useful beyond making immediate management decisions. Records compiled over several seasons at individual sites indicate favored and susceptible areas for grub infestation. Managers can also customize threshold levels for their own turfgrass by comparing grub counts and resultant damage in indicator areas. In addition, post-treatment efficacy evaluations are essential for evaluating the cost effectiveness of previous and future management strategies. In short, you can't afford not to sample.

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GRUB CHECKLIST

	Occur locally?	History on- site?	Damage threshold (ft2)	History of high populations?
ANNUAL GRUBS				
Japanese beetles				
Oriental beetles				
Masked chafers				
European chafers				
Asaiatic gearden beetles				
Green June beetles				
THREE-YEAR GRUBS				
May and June Beetles				

Adult Activity	**Species**	**Date**	**Where**	**"Feeeding, mating, around lights or in traps"**

Management Options	
Preventive	
Biological	
Chemical	

Turfgrass Pests
Remain a Constant Challenge

By R. L. Brandenburg, Turfgrass Entomologist, N. C. State University

Each year seems to offer its own set of challenges for turfgrass managers. Unusual weather patterns, pest outbreaks, and product performance can create their own concerns each year. Most of these situations are difficult to predict, so it generally leaves the turfgrass manager with little advance notice about pest problems. The most appropriate remedy often changes with each situation. The past two years have presented significant challenges from both a pest and a regulatory perspective.

1998: Fall armyworm year

For example, in 1998, many areas of the Southeast suffered through a record year for fall armyworms. Fortunately, these severe outbreaks only occur on an infrequent basis, but when they happen, it is a major concern. Unfortunately, such outbreaks could occur again any year, so being prepared is the best defense.

In 1998, many areas of the Southeast suffered through a record year for fall armyworms

One obvious challenge is that of early detection. Small worms are hard to see, and by the time the worms are large, they are harder to control and have already caused a lot of damage. Early detection is possible by using a soapy water fluid (2 tbs. liquid dishwashing detergent in 2 gallons of water).

While small armyworms feed day and night, larger ones hide during the day. Even so, both sizes are hard to see without the help of a soapy flush. The presence of birds searching for food in the turf is often the first indication that an insect problem is developing.

Control is most effective if applied against smaller worms. Treating late in the day also helps. If one can avoid irrigation as well as mowing the turf for at least 24 hours following treatment, better control will be obtained. In some years, multiple applications of treatments are necessary.

Another mild winter

Much of the South has experienced three consecutive mild winters. This winter was perhaps the mildest of all in many areas, particularly in the Southeast. The only really cold weather experienced was from around Christmas to New Year's Day. Other than that brief period, many areas experienced temperatures 4 to 6 degrees above normal, which is a rather significant shift over a several month period.

Whenever we have unusual winters, either warmer or colder than normal, individuals in the insect pest control business get inundated with calls concerning what impact the unusual weather will have on the summer's insect problems.

While warm weather can favor the survival and development of some insect pests, it might also favor natural enemies of these insects. The ecology of most insects is fairly complex and affected by a number of factors.

Hot Spots

During 1999, we have seen plenty of fire ants in the northern extremes of their range, probably due to the mild winters.

Most turfgrass managers saw fewer Japanese beetles this year due to extreme drought and heat of the summer.

Problems associated with southern chinch bugs on St. Augustinegrass were greatly enhanced due to these same weather patterns.

We experienced an abundance of two-lined spittlebugs in many areas, possibly due to the increasing use of centipedegrass in home lawns, which the nymphs prefer and hollies in the landscape, which the adults like. This has been an increasing problem in many high growth areas of the Southeast.

Mole cricket egg hatch occurred early in the Carolinas this year despite the dry weather, and we are starting to see them spread more into bahiagrass similar to the situation observed in Florida for many years.

Growing Concerns

As the population growth in the Sun Belt continues, we see increasing problems with pests in turfgrass. It only makes sense that, as the number of lawns, commercial properties, athletic fields, park, golf courses, and other turf areas increase, the pests will take advantage of what we offer them.

In recent years, we have observed increases in the incidence of green June beetles, two-lined spittlebugs, fire ants and short-tailed crickets. In addition, we are seeing more of the Oriental beetle white grub in the South. Historically, this has been a pest in the northeastern United States.

Is it simply a result of increasing populations and urban sprawl in the southeastern United States and other areas? Is it the result of higher expectations and simply noticing more problems in turf? Or is it the result of the loss of the old broad-spectrum, long-residual-activity compounds that killed every bug and lasted forever?

As mentioned earlier, certain weather conditions do encourage specific pest problems on a short-term basis (e.g. chinch bugs), but the debate over global warming makes one wonder if those who predict the doom of warmer temperatures are seeing the initial phases of their predictions come true.

During 1999, and any other year, the key to cost-effective pest management was timely implementation of management strategies. This is made possible through an efficient program of scouting and monitoring pest populations, including weeds, insects and diseases on a regular basis. Time spent on such monitoring generally pays big dividends.

New Control Options

Research is continually producing new tools to aid in the battle against insect pests in turf. Recently, there has been a bit of emphasis on "natural" or biological controls and new classes of chemistry. In 1998, we saw products such as Mach 2 and Deltagard registered and marketed for a wide range of turfgrass pests.

Previously when we treated for one pest, we generally cleaned up most of the other problems we had. Now it is possible when you treat with one of the newer, more environmentally friendly products, you will not obtain control of other pests present, and their populations may increase.

Mach 2 entered primarily into the white grub market as a "reduced risk" insecticide, similar to the manner Merit was introduced.

Deltagard joined the list of broad spectrum pyrethroid insecticides, characterized by low use rates, such as Talstar, Scimitar, Tempo, Astro and Mavrik.

In recent years, the registration of other products with different chemistries, such as Chipco Choice for mole crickets, ConserveSC, and Merit has broadened the range of materials available for use on turfgrass. New products for 1999 included Distance Fire Ant Bait from Valent, which works as an insect growth regulator and continues this trend of new chemistries against our major pests.

One point that is true for many of the newer products, such as Chipco Choice, Merit, and Mach 2, is that the spectrum of insects they control is narrower than some of the older products we used. It used to be that when we treated for one pest, we generally cleaned up most of the other problems we might have had. Now, it is possible that when you treat with one of the newer, more environmentally friendly products, you will not obtain control of other pests present and their populations can increase. Such "secondary pest" problems might explain some of the increases in pests we have seen.

The constant search for new materials is critical to our future. Some of the older compounds, such as chlorpyrifos (eg. Dursban), could have an uncertain future under the Food Quality Protection Act, and new replacement compounds might be necessary. Some of the older compounds used on golf courses for grub control, such as diazinon, have been lost. The label for Oftanol for turf was voluntarily withdrawn by Bayer Corp. Mach 2 and Merit help fill the void left by the loss of these "old standards."

Research on the development of biological materials continues with products such as entomogenous nematodes, fungal and bacterial pathogens and natural compounds. While we have seen increasing success with many of these products, they are yet to provide consistency of control seen with many of the conventional pesticides. However, that gap is narrowing.

The greatest success stories are from turfgrass managers who were persistent and have found a particular technique to get the most out of these products.

FQPA Will Shift Pest Control Approaches

The Environmental Protection Agency continues to move forward in the implementation of the FQPA. This legislation will affect the availability of some pesticides for use on turfgrass.

Generally, the groups of pesticides that are the initial targets are the older chemistries like the organophosphates and carbamates. This means as a general rule, the newer products are not currently affected by this law. The first group of pesticides going through this process are the organophosphates (such as Dursban and Mocap) and the carbamates (such as Sevin and Turcam). Under this new law, some uses of some products on turf could be lost.

In an effort to help compensate for any pesticide losses from a commodity, the EPA is taking several steps. One of these is to facilitate the registration of "reduced risk" pesticides and biological pesticides. In 1998, almost half of the new pesticides registered by the EPA were biological or natural type products.

The EPA is also funding research to develop new alternatives to many of the older pesticides that may eventually be lost.

This funding will encourage the development of new approaches to pest control, while FQPA itself indirectly encourages companies to pursue new pesticide chemistry. In the long run, this will undoubtedly create a rather significant shift in the types of materials we are using as pest management tools.

Of course, this legislation and its impact on the availability of certain pesticides further adds to the uncertainty of each year. The question of which pests will occur is difficult to answer, and the uncertain future of many of our broad spectrum products that would cure whatever ails us make planning even more difficult. The newer, narrow spectrum pesticides make it difficult to keep a small inventory of one or two products to cover all potential problems. From the pests to the pesticides, it's a continually evolving picture that requires a lot of effort to keep abreast of the latest information. This scenario further emphasizes the need we all have for continued education in the area of pest management.

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