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TURFGRASS TRENDS

Volume 8, Issue 7 • July 1999

ENTOMOLOGY

Black Turfgrass Ataenius

Small Pest of Increasing Importance on Highly Managed Turfgrass

By Nikki L. Rothwell, University of Massachusetts

Ataenius spretulus, otherwise known as the black turfgrass ataenius (BTA), is a scarab beetle native to North America. It was first reported damaging golf course turf in Minnesota in 1932. It was identified next in New York state in 1969, then in Ohio in 1973. Prior to the 1970s, this insect was considered only an incidental pest but, in the last 25 years, this insect has caused damage on golf courses throughout the Northeastern and Midwestern portions of the United States, as well as in California and Ontario, Canada. It has now been reported in 41 of the 48 contiguous states, though most of the severe damage appears in the Midwestern regions of the U.S.

The BTA can be easily confused with another, relatively new turfgrass pest, *Aphodius granarius*, which is also commonly found in areas where BTA is a continuous problem. Although BTA and the aphodius beetle are quite similar, they can be differentiated by the

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appearance of the hind leg of the adult beetle. Aphodius has a stair-stepped tibia, while BTA's hind leg is smooth.

BTA characteristics

The female ataenius beetle lays clusters of 10 to 15 eggs in a small cavity in the top inch of soil. The round, cream-colored eggs are extremely small — less than 0.05 inches — but can be seen without the use of a hand lens against the dark soil. The eggs hatch within two weeks into typical scarab larvae. The larvae are white, C-shaped grubs with a brown head and three pairs of easily identifiable legs. The BTA larvae have three molts or instars, with the third and final instar reaching lengths of 0.3 inch.

While the grubs of the BTA resemble other scarab pests, such as the Japanese beetle or the European chafer, BTA larvae are much smaller in comparison. Due to their small size, BTA grubs take on a grayish appearance when feeding in the soil. In addition to their small size, BTA larvae can also be identified from early instars of other scarab pests by a pair of distinct padlike forms on the tip of the abdomen.

BTA larvae have no unique raster pattern (the pattern of hairs that appears on the abdomen tip). The 45 hairs appear to be randomly placed over the abdomen end. In comparison, the other small scarab larvae, the aphodius beetle, has a raster pattern with hairs arranged in a small V.

Other than size, the pupa or resting stage (following the larval stage) of BTA resembles a Japanese beetle pupa, with both the legs and wings visible, but tucked closely against the body. Pupa coloration ranges from a creamy white in new pupa to a tan for those pupa about to pupate into adults. BTA pupa are located near the soil surface, just below the thatch line.

The BTA adult stage is a fairly small black beetle, approximately 0.1 to 0.2 inch long and 0.05 inch wide. It has a shiny appearance with definite striations that run the length of its wing covers.

BTA biology and phenology

The BTA can have multiple generations per growing season, depending on the region of the country. It has two generations per year in sectors below the southern part of Ohio and one generation per year in areas north of Ohio. A partial second generation has been observed in warmer years in areas as far north as lower Michigan. BTA may have at least three generations per year in California.

Adult beetles overwinter in wooded sites near the golf course. Many of the adults that move into hibernation survive the winter (90% to 96% survival rate). These beetles emerge from the overwintering sites in late March through early May onto greening golf course turf and bury themselves into the grass. On sunny spring days, these shiny black beetles can be seen crawling over golf course greens or flying in large numbers through the air.

Although little is known of BTA mating habits, prior observations have noted that adult females are inseminated throughout most of the summer months. In areas where only one generation occurs, egg laying may begin as early as May 1 and continue into the second week of June.

The eggs hatch and the first instar larvae immediately begin to feed on the turfgrass roots, causing only a little damage due to their small size. The larvae continue to feed and molt through June and the early part of July until reaching the third instar, the most damaging stage of BTA. These third instar larvae can cause considerable damage to the turf when turf is already under summer stress, especially in late July and early August. The larvae eventually move deeper into the soil (1 to 3 inches), where they pupate.

The adults that emerge from these pupa will move to overwintering sites, in areas where only one generation is noted, or begin to lay eggs, in locations with two generations. The second generation larvae hatch and begin to feed, although the time between molts is much shorter due to rising summer temperatures in July and August. The evidence of feeding activity from second-generation, third-instar larvae usually occurs in late August or early September and can be as damaging as the first generation larvae. The second generation pupates in September and these new adults move to overwintering sites in late September or early October.

The BTA has been closely associated with the blooming behaviors of many indicator plants, especially in the Midwestern portions of the U.S. The first generation overwintering females lay their eggs around the time of full bloom of spirea and horse chestnut, and the earliest bloom of black locust depending on location (first half of May in southern Ohio and early June for New York). First generation larvae begin to show up at the same time multiflora rose is in full bloom and second generation eggs are laid when the Rose of Sharon is in full bloom. Many superintendents in the Midwest use these plants as indicators for timing of BTA activity.

Hosts

BTA feeds principally on golf course turf, appearing most commonly on fairways and tees, with an occasionally problem on greens. However, in California, BTA has shown itself to be a constant pest of golf course greens. BTA larvae feed just below the turf surface on the roots of Kentucky bluegrass, bentgrasses, annual bluegrass and perennial ryegrass, showing no preference for one type of grass over another.

Injury from BTA grub feeding begins to appear during the initial heat/moisture stress periods of the growing season, usually late June through July in the Midwest.

Damaged turf first appears as wilted areas that do not respond to water. This wilted appearance is most visible when looking toward the turf in the direction of the sun. After the initial wilting occurs, the turf begins to thin, even under irrigation. Small irregular thinning patches of turf begin to develop usually in areas that have a history of early moisture stress. If left untreated, larval feeding activity can lead to large areas of dead or damaged turf.

The grubs feed in the typical scarab manner, eating the turf roots and root hairs, resulting in a severely depleted and inadequate root system that is unable to supply the above ground portion of the plant with sufficient moisture to sustain itself. As the heat or moisture stress continues, the plant sloughs leaf tissue causing the aforementioned initial thinning. If the feeding activity has removed enough root tissue the plant will wither and die. This weakened or nonexistent root system allows the turf to rolled back like a carpet.

First generation larvae begin to show up at the same time multiflora rose is in full bloom and second generation eggs are laid when the Rose of Sharon is in full bloom.

Long Island, NY, and several regions of Ohio, have reported scattered incidental BTA infestations on home lawns, but with minimal damage to the turf. Most recent studies have shown that BTA prefers to feed on fairway mown turf rather than grass in the rough of a golf course, even if the grass type remains the same. Both adult and larval populations of BTA are more prevalent in fairway turf. Speculation exists to why this phenomenon occurs, but no concrete conclusions have been drawn. Recent research at Cornell has shown that other scarab turf pests show a preference for turf mowed at certain heights.

Natural enemies of BTA

Many studies have shown predatory or beneficial insects dwell in turf. The predatory insects mostly commonly found on golf courses include ants (*Formicidae*), rove beetles (*Staphylinidae*), spiders, hister beetles (*Histeridae*) and ground beetles (*Carabidae*). In laboratory studies, many of these insects have been observed feeding on eggs or larvae of turfgrass pests. Studies have also shown that low-maintenance turf that has few applications of chemicals has fewer turf pest outbreaks than turf under high maintenance conditions. It is believed that turf pests are held in check by natural insect enemies when the natural enemies are not dis-

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Distribution and Estimated Generations of BTA Per Year

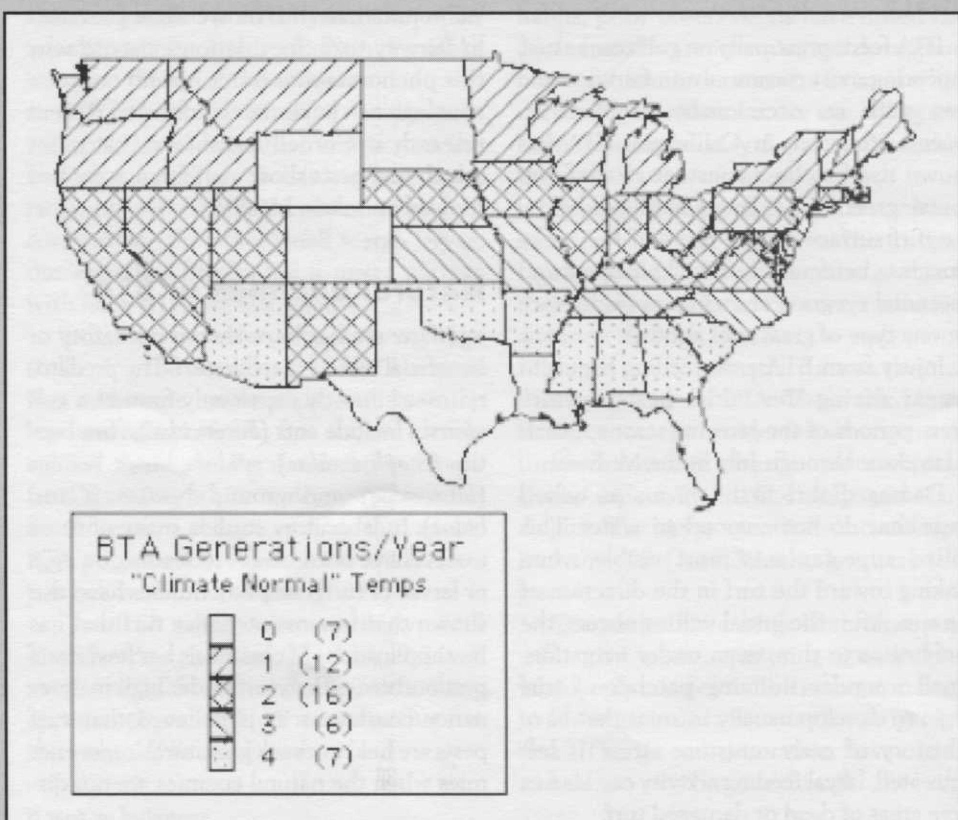
By Christopher Sann, Pest Forecasting Group Inc.

Unlike other soil dwelling and damaging insects of turfgrass, black turfgrass ataenius (BTA) can have several generations per year. In fact, the relatively small number of accumulated degree-days required between full generations are much more akin to several of the surface dwelling insect pests of turf — armyworms, chinch-bugs and cutworms.

This relatively small number of accumulated degree-days (~1100 @ base 50) means that multiple generations of BTA may be more of a problem to turfgrass managers than they realize during an average year and much more of a problem in the warmer years that we have recently been experiencing in the 1990s.

In northern areas of BTA's traditional distribution (the Northeast and Midwest) this can mean one to two full or partial generations per year during a climatologically normal year. In a warm year, the number of generations can increase to a second or third partial or full generation. This added generation, combined with the moisture stress that often accompanies these warmer years, can lead to substantially increased levels of damage, particularly at sites with irrigation.

In southern areas of BTA's distribution, managers need to be familiar with the probable number of generations that will occur under normal or average climate



conditions. It is not inconceivable that in warmer, slightly dryer years, the three to four partial or full generations per year normally found in these areas could increase to as many as five to six partial or full generations.

The concept of increasing multiple partial or full generations per year is very important to understand for all turfgrass managers and especially those in newly identified distribution areas. In cooler regions, an additional partial or full generation may increase late season danger from actively feeding grub populations by a factor of two, depending the site characteristics. But the danger in more southern zones, from exploding late season BTA grub populations in warmer years, could increase by a factor of four or more. Keep in mind an additional partial generation can pose as much or more current year risk as a full generation, which will likely pose added risk in the following year.

Based on an analysis of the estimated number of generations per year per NOAA Climatological District (CD), the potential variation in estimated generations year can differ considerably within a state. The difference between assuming two generations a year and actually having four is significant. Managers in states with a wide variance in climate, should consider the table below.

POSSIBLE VARIENCE IN NUMBER OF BTA GENERATIONS*

State	NOAA CD #	Area Name	Generations/yr.
Alabama	01	Northern Valley	4.0
	08	Gulf	5.5
Arizona	02	Northwest	2.2
	05	Southeast	7.2
California	03	Northeast Basin	1.2
	07	Southeast Desert Basin	5.3
Georgia	03	Northeast	3.6
	09	Southeast	5.4
Maryland	02	Central Eastern Shore	3.4
	08	Allegheny Plateau	1.9
Nevada	01	Northwest	1.9
	04	Extreme Southern	5.3
New York	03	Northern Plateau	1.3
	04	Long Island	2.6
North Carolina	01	Southern Mountains	2.9
	06	Southern Coastal Plain	4.2
Oklahoma	01	Panhandle	3.6
	08	South Central	4.7
Oregon	05	High Plateau	0.8
	09	Southeast	2.0
South Carolina	01	Mountain	3.4
	07	Southern	5.0
Utah	02	Dixie	3.0
	05	Northern Mountains	1.3
Virginia	01	Tidewater	3.6
	06	Southwestern Mountains	2.3
Washington	01	West Olympic Coastal	1.0
	08	Central Basin	2.3
Wyoming	02	Snake River Drainage	0.6
	07	Cheyene Drainage	1.9

* States where the difference in the number of BTA generations in the different regions was equal to or less than 1.0 are not included on this list.

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turbed by abundant chemical applications.

Beneficial insects are also found in association with BTA. Recent studies have shown that higher populations of BTA larvae are found in locales where beneficial enemies are at low numbers. In areas where these natural enemies are in high populations, BTA larvae seem to be in low numbers. These observations suggest that beneficial insects play a large role in the location of BTA outbreaks on golf course turf. However, more research must be done to verify these new findings.

Observations suggest that beneficial insects play a large role in the location of BTA outbreaks on golf course turf.

The only pathogen reported on BTA is known as milky disease, caused by *Bacillus popillae*. Milky spore disease is a bacteria that infects many of the scarab pests found in golf course turf. The spores of the bacteria live in the soil. The grub ingests these spores as it is feeding on the turf roots. The spores multiply in the blood (hemolymph) of the grub and build up to such a high population in the body that the grub has a milky white appearance. Eventually, the spores of the bacteria will build up to such high numbers, they will kill the grub. The milky disease that infects BTA is specific to only BTA; it does not infect any other scarab turfgrass pest and is not available commercially.

The incidence of milky disease found in BTA has a variable incident rate in all areas where BTA has been found. In a study done in Rochester, NY, in 1969, approximately 70% of the BTA sampled contained milky disease. Many BTA grubs in other regions have shown some evidence of the milky disease infection, but little information is known about the level of infection rate that actually kills the grub.

In Michigan, BTA larvae were collected from both the fairway and rough areas of the golf course. The grubs collected from the rough had a 67.7% infection rate of milky disease compared to only a 34.4% infection rate of grubs collected from the fairway turf.

This experiment may be a precursor to future studies to discover why BTA grubs are infected with milky spore disease more often in longer turf, which in turn may help milky spore disease become a more effective agent against damaging BTA populations.

Thresholds

Adult BTA can be monitored with black light traps placed on the golf course in April and May to capture beetles emerging from overwintering sites. A soapy flush (one to two gallons of water with one or two tablespoons of lemon scented dish detergent over a one to two foot turf area) poured onto a green can bring up the buried adult beetles. However, monitoring adult activity is not directly correlated with high populations of BTA larvae on golf course turf. Monitoring adults may give the superintendent an idea of the populations present in the area, but the presence of adults is not a guaranteed indicator of larval activity.

The most effective way to scout for larval activity is to sample the turf with a typical golf course cup cutter (a 4.25-inch diameter cup cutter is about 0.1 square feet). Collect two-inch-depth cup cutter cores in areas that appear to be under stress. Break up each turf core, examining the turf, thatch and soil layers for the small white grubs.

Economic thresholds for BTA have not been established for golf course turf, but observational thresholds exist. Also, it is difficult to determine economic thresholds for turfgrass infested with BTA because of the many factors affecting the vigor of the turf: water, desiccation, fertilization, compaction, other insect problems, disease and mowing height. However, non-stressed turf usually can tolerate approximately 50 BTA grubs per square foot or five grubs per cup cutter sample. If the turf is under any type of stress, this threshold level will decrease to approximately 30 grubs per square foot or three grubs per cup cutter, depending on the level of turf stress. Also, turf may have a lower threshold for second generation grubs because of the summer heat stress on the turf in August.

Control Methods

Standard insecticides known to be effective against Japanese beetle and other white grub pests have also been shown to be effective for black turfgrass ataenius. The traditional method of pesticide application has been to apply insecticide shortly after the female beetles have laid their eggs. Spray for BTA larvae around the time of horse chestnut or Van Houtte spirea in full bloom, around the first of June in the Midwest.

These applications of insecticides should be watered in heavily to be most effective at controlling BTA, with at least 0.25 to 0.5 inches of water immediately after in-secticide applications.

Bendiocarb should be applied for BTA at 2 to 3 pounds of active ingredient (AI) per acre. Isofenphos is applied at 2 pounds of AI/acre, but this material should only be applied once per year for any grubs targeted. Trichlofon penetrates the thatch layer more readily than the other traditional insecticides; therefore, it is the optimal material for spot treating for BTA, after grubs have been observed. This insecticide should be administered at 8 pounds of AI/acre. However, state regulations vary, so check the labels before applying any chemicals to the turf.

The two new chemicals currently on the market for white grub control, halofenozide and imidacloprid, have also been shown to be effective at controlling populations of BTA. However, these materials should only be applied to the turf once per season. Halofenozide should be applied the turf at the rate of 1.5 pounds of AI/acre, usually in late May. (The data for halofenozide is inconclusive at this time.)

Imidacloprid is applied at a much lower rate, only 0.3 pounds of AI/acre.Imidacloprid should be applied in late April or early May in the Midwest, or about the time of BTA egg laying in other regions. This material is only effective when applied to the turfgrass before the larvae are present. Also, imidacloprid is not effective when used to spot treat areas where third instar larvae are causing considerable damage.

Another approach to control BTA infestations was developed at The Ohio State University in the late 1970s. This approach targets the adult male and female beetle populations upon emerging from overwintering, before the fertilized female beetles have the opportunity to lay eggs.

The traditional method of pesticide application has been to apply insecticide shortly after the female laid their eggs.

The insecticide is applied to the turf and remains bound in the thatch where the adults reside during most of the spring. Chlorpyrifos used in this manner has been shown to be effective in the control of adult BTA populations. It should be applied in two applications. The first application should be made approximately at the time between forsythia full bloom and dogwood full bloom. A second application is then made two weeks later. The applications are made with a reduced rate of chlorpyrifos, 1 to 2 pounds of AI/acre, and they should be watered in lightly.

This approach should only be used in locales where BTA populations have been high in recent years. The reason for caution for this control approach is because large populations of adult beetles do not always lead to large damaging populations of BTA grubs. Conceivably, this approach could lead to wasted chemical applications and unnecessary labor and equipment expenditures if the preliminary information on BTA activity from recent growing seasons is not known for a site.

Biological control methods for BTA have been under investigation for years, but to date have not lead to overwhelming success in any area. Field trials at the University of Rhode Island have shown that the entomopathogenic nematode, *Steinernema carpocapsae*, can suppress BTA larval populations, but at a rate of nematodes 10 times the recommended and commercially viable rate. Although expensive, nematodes may possibly be a viable option for biological control against white grub pests, such as BTA. However, currently the nematodes continue to yield mixed results when used in field applications.

Natural pathogen infestations of milky disease, *B. popillae*, have shown to be effective in suppressing BTA populations after the disease has been established in an area for three to four years. Work at Michigan State University has also shown milky disease to be higher in BTA larvae that reside in longer mowed turfgrass than larvae in shorter cut turf. Hopefully, work will continue for BTA grub control to make milky spore disease a feasible option in the future.

The beetles are extremely unpredictable in their duration in an area. They will show up at a golf course for three years in a row, but on the fourth year, BTA populations will be no where in sight.

Although considerable research has been conducted on the black turfgrass ataenius in the last five years, much more still needs to be discovered. Black turfgrass ataenius research is now needed more than ever as we see an increase in damaging BTA populations across the Midwest, Northeast and Mid-Atlantic regions of the U.S.

Because little is known of the insect's basic biology and because it is a relatively new pest to turfgrass, much mystery still surrounds BTA. The beetles are extremely unpredictable in their duration in an area. For instance, they will show up at a golf course for three years in a row, but on the fourth year, BTA populations will be no where in sight. They also show no discrimination for a particular type of turfgrass nor do they appear in proximity to certain overwintering sites or appear to be widespread in affecting all golf courses in a particular area.

Although the black turfgrass ataenius is an enigma, research will continue to piece the BTA puzzle together to aid superintendents in combating this turfgrass pest.

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The Food Quality Protection Act

And Its Impact on Turfgrass Management

By R.L.Brandenburg, North Carolina State University

One of the most recent laws regulating pesticide use in the United States was signed by President Bill Clinton during the summer of 1996. This bill, the Food Quality Protection Act (FQPA), is beginning its third year, but much uncertainty still surrounds its overall effect on pesticide availability. Even less clear is the impact the FQPA will have on the turfgrass industry in the area of integrated pest management. But before we get into the possible implications of the FQPA or your ability to manage high quality turfgrass, it is important to understand the purpose and intent of the law.

What's the FQPA all about?

The FQPA was developed as a replacement for provisions that were considered to be outdated. It amends provisions of two statutes related to pesticides: the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act. Under the FQPA, a uniform health based standard is applied to raw and processed food, children's health is the top priority and consumers have a right to know about pesticides in the food they buy at the grocery store.

The principles involved in developing the FQPA include using sound science, protecting children, protecting the environment, streamlining the regulators process, and preventing pollution. Such principles generated strong support from President Clinton, Vice President Al Gore and EPA Administrator Carol Browne. The U.S. Congress unanimously passed the bill. President Clinton stated that it proves we don't have to choose between a healthy environment and a healthy economy

The EPA is required to review all pesticide tolerances within ten years. The timetable to review thousands of tolerances requires a quick turnaround time by the EPA.

One major change is the inclusion of a ten-fold safety factor to ensure that tolerances are protective of children. The new approach for setting tolerances is tough. It requires a complete and realistic data base of pesticide use and exposure. Of great importance to the use of pesticides in the turfgrass industry is that the FQPA requires an evaluation of aggregate exposures. In other words, looking at all the possible avenues in which the public might encounter pesticides.

The Food Quality Protection Act is a very ambitious new set of standards. It is ambitious, not only in the sense that it is modernizing the pesticide review process, but it strives more than ever to integrate the best available science into the system. In addition, the EPA is required to review all pesticide tolerances within ten years.

The timetable to review thousands of tolerances requires a quick turnaround time by the EPA. All new and existing pesticide registrations must meet the new safety standard. Over 9,000 tolerances must be reviewed within ten years.

The law also directs the EPA to develop a process to speed the review and registration of pesticides that reduce risk to human health, non-target organisms and ground and surface water. Also included are the development of procedures to broaden the adoption of integrated pest management strategies. Improving the registration process for safer pesticides will give the end user of pesticides more options for integrated pest management. An important provision of the FQPA is that it seeks *stakeholder* (that means you and me!) and *public* involvement in the whole process. Various advisory committees such as the Tolerance Reassessment Advisory Committee, Pesticide Program Dialogue Committee, Food Safety Advisory Committee and the Endocrine Disruption Screening and Testing Advisory Committee provide stakeholder input and provide guidance to the EPA

While there is little consideration of the benefits of pesticides, new processes have been established to expedite the review of safer pesticides.

In summary, the key provisions are:

• The FQPA is a single, health-based standard that includes all non-occupational exposures to pesticides with a common mechanism of toxicity when setting a tolerance.

• The FQPA has special provisions for the safety of children and infants.

• In addition, while there is little consideration of the benefits of pesticides, new processes have been established to expedite the review of safer pesticides.

Why will it affect current pesticide registrations?

One significant change to the setting of residue tolerances is the need to consider both the aggregate exposure to pesticide residues (including food, drinking water, and residential use) and the exposure to all pesticides with a common mechanism of toxicity. A major challenge is that all of this must be accomplished within ten years.

A tolerance is the amount of pesticide residue that can legally be present in or on food. The FQPA has dramatically changed the way pesticide tolerances are determined. Before the FQPA became law, each pesticide was individually examined when establishing a residue tolerance. Under the directives of the FQPA, the EPA must now consider the *cumulative* effect of all pesticides with a common mechanism of toxicity. A common mechanism of toxicity would mean all pesticides that act in the same manner on human health.

An example of this would be the organophosphate insecticides. The organosphosphate insecticides (OP) have historically been products that have enjoyed widespread use in agriculture, landscape, turf as well as in and around the home. They include products such as chlorpyrifos, malathion and diazinon. Since all these OPs have a common mechanism of toxicity, the cumulative effects of *all* of them is considered when establishing a residue tolerance for *one* of them. This is a significant change from how tolerances were established in the past.

Of equal significance and impact is that the EPA must combine the risks of dietary exposure from the pesticide's use on food crops in agricultural use, along with the risks of residue potentially found in drinking water and from residential use. This residential use can be household pest control, lawns and other exposures like golf courses. The FQPA is not just to protect food from harmful residues, but to keep total human exposure to a safe level.

Putting all of these exposure data, for all uses of pesticides, with similar modes of action produces large, complicated sets of numbers. How does the EPA then set tolerances for all their exposures? They are using the concept of "risk cup." A risk cup, when full, represents the amount of pesticide that a person could receive every day for 70 years without significant health risks. The size of the risk cup is determined through laboratory animal studies. These studies determine the no-effect level of exposure for a specific pesticide. To determine the daily/lifetime safe exposure for humans, this amount is then reduced by a 100 to

CHARACTERISTICS OF ORGANOPHOSPHATE INSECTICIDES

1. Generally more toxic to vertebrates (including mammals) than other current insecticides.
2. One of the older classes of pesticides on the market (many products developed in the 1940s and 1950s).
3. Originally sought as a less persistent alternative to the persistent organochlorines (e.g., DDT).
4. Act on the nervous system by inhibiting enzymes known as acetylcholinesterase.

10,000 fold factor. Once a risk cup for a pesticide group (such as the organophosphates) is full, then new uses will be difficult to establish.

In reality, the risk cup for many pesticide groups such as the organosphosphates and carbamates may already be overflowing. This is because many of those products have very wide uses. If a group of pesticides exceeds the risk cup capacity, then some uses must be restricted or eliminated to reduce the exposure risk to an acceptable level. These use changes could be the label applications on turfgrass.

Which products will this affect and how quickly will it happen?

The EPA has developed a timetable to pursue those products they feel pose the greatest human health risk. The first group includes the organophosphate insecticides, carbamate insecticides and the carcinogens. The process to begin a comprehensive analysis of the organophosphate insecticides began in the summer of 1998. The original schedule called for a complete analysis of the organophosphate insecticides by August 1999. As previously stated, this is an ambitious timetable for such a large undertaking, considering all the data and stakeholders involved. Recently, the EPA has acknowledged that it will not be able to meet the August deadline for completing the reassessment of the organosphosphate and carbamate insecticides.

An example of a product under review is chlorpyrifos. One trade name in turf and residential uses is Dursban and one in agricultural is Lorsban. Chlorpyrifos is used extensively in agriculture, for termite and roach control and by many homeowners, lawn care companies, commercial property managers and golf course superintendents. A lot of uses of just one of a number of organophosphates can add a lot the OP risk cup. There are several OPs used on turfgrass and many more in agriculture.

Will some uses of chlorpyrifos be deleted? It would seem very likely. At this time, it would be speculative to try to guess what changes might result in the chlorpyrifos use label.

Another factor that may affect pesticides with multiple uses, is that in general, the EPA will allow a range of 5% to 20% of the total risk cup be set aside for nonoccupational pesticide exposure (such as golf courses, sports fields and home lawns) and the remaining 80% to 95% must be left for dietary risk.

The EPA has acknowledged that they will not be able to meet the FQPA mandated August deadline for completing the reassessment of the organosphosphate and carbamate insecticides.

Economics, market shares, risks and other factors will undoubtedly play a role when manufacturers have to work with the EPA to reduce the overflowing level for a risk cup.

Whether or not a manufacturer or registrant decides to keep agricultural or golf course uses may depend on which use site is most profitable or which use adds the most to the risk cup. Sometimes risks and the cost of developing data bases about certain uses are greater and thus less attractive uses to maintain.

Other companies may try to outguess competitors and risk maintaining a use they think they can gain a larger market share because a competitor will delete a product use from its label. All of this will be interesting to watch as it sorts itself out. Much of it may not be completed until the eleventh hour.

How will this affect me as a turfgrass manager?

Will the FQPA affect pesticide availability and use on turfgrass? I think without reservation we can say yes. We have already heard news of several recent pesticides canceling turf use sites, probably in conjunction with the FQPA. Without a doubt, some products currently registered for turf will not be labeled for such uses in the future. Just how many and how soon is anyone's guess.

Other possibilities for change include label modifications that might reduce the EPA perceived human risk from pesticide use in turfgrass. This could include rate reductions, reduced number of applications per year, extended reentry periods or buffer areas. Such changes could reduce a product's contribution to the risk cup, but at the same time could reduce the product's profitability for the manufacturer.

One area in this whole process that remains a point of controversy for many is the process by which the EPA determines exposure. This whole concept is based upon how much product is used at each label site. Some use sites have excellent data bases that accurately document the rates used and number of applications. In some cases, much less reliable data on pesticide use are available. When such data gaps exist, the EPA may be forced to use default assumptions. This basically means they must

COMMON TURF INSECTICIDES UNDER FQPA REVIEW

Common Name	Examples of trade name[1]	Class	Pests commonly treated
carbaryl	Sevin	carbamate	caterpillars, white grubs, chinch bugs
bendiocarb	Turcam	carbamate	white grubs, chinch bugs
chlorpyrifos	Dursban	OP	mole crickets, caterpillars, fire ants, chinch bugs, billbugs
acephate	Orthene	OP	mole crickets, caterpillars, fire ants
trichlorfon	Dylox	OP	white grubs
isofenphos	Oftanol	OP	white grubs, mole crickets, billbugs, chinch bugs
ethoprop	Mocap	OP	mole crickets

[1] Listing of trade names does not constitute produce endorsement nor discrimination against products not mentioned.

assume the worst scenario. In other words, that the pesticide is used at the maximum use rate, and the maximum number of times allowed on the label during the season. While we may all know this is not how most pesticides are used, when in doubt, the EPA must err on the side of safety.

User testimonials may carry substantial weight in helping the EPA make wise decisions. While the land-grant universities have been involved in providing crop profiles (including turfgrass) to the EPA to help determine pesticide uses (organophosphates and carbamates) and the importance of each product, every turfgrass manager has an opportunity to provide input on the process to the EPA.

The FQPA can be a powerful tool to enhance public confidence in the pesticides that we use in turfgrass management. I feel we can use this legislation to our advantage in the turfgrass industry.

Let's assume a pesticide use for turfgrass is deleted. In many cases, cost-effective alternatives may be available. Should there be situations in which products will be lost due to the FQPA, a transition period will most likely be established. This transition period will allow time for alternative pest strategies to be developed. The U. S. Dept. of Agriculture will work closely with the EPA to assure smooth transitions.

Finally, one might ask if there are truly any real benefits to the turfgrass manager as a result of the FQPA. First, it replaces the outdated and unacceptable Delaney Clause that had previously regulated pesticide use. Second, it provides incentives for the development and more rapid registration of low risk pesticides, which is something we would all like to see. In addition, it ensures that our exposures to pesticides are safe. Finally, the FQPA can be a powerful tool to enhance public confidence in the pesticides that we use in turfgrass management. I feel we can use this legislation to our advantage in the turfgrass industry. We can state, without reservation, that we are working under the strictest guidelines ever, that President Clinton called the peace of mind act. While the new law may provide challenges, at the same time, let's use it to our advantage as an effective public relations tool documenting the safety of our pest management programs.

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Golf Green Construction
A Review of the UC Method

By M. Ali Harivandi, U.C. Cooperative Extension, San Francisco

During the mid-1960s, Dr. John Madison and Bill Davis from U.C. Davis began to look at the problems associated with heavy use of golf greens, including failure due primarily to compaction of the growing media. They studied all types of amendments with various sand gradations and concluded that the "right" sand, unamended, can produce the most acceptable golf greens.

There are two potential problems with the pure-sand green concept, which must be addressed before superintendents and golf course architects are willing to accept it. First, sands are droughty and do not hold sufficient water to make them suitable as a field-growing medium. Secondly, sands have very poor cation exchange capacity and, therefore, do not hold nutrients needed for plant growth.

These two objections to the concept are valid for sand as a general soil medium. However, the sand recommended for golf green construction is a specific sand that, under conditions of extensive use, will not compact. This sand is uniform on the fine side and retains moisture in the root zone sufficient for two to three days between irrigation events at normal summer evapotranspiration rates. Such a sand drains excess water from the root zone in less than 15 minutes, no matter how much water it receives in a short period of time.

The real key to selection of the right sand is a medium in which 90% to 100% of the particles are no larger than 1 mm in diameter and no finer than 0.1 mm, with the dominant fraction between 0.5 and 0.25 mm.

As for nutrients, problems with fertility management are no greater for pure-sand greens than they are for other putting green media. However, during establishment, greater attention to fertility is required. Sands that meet the above specifications are becoming more available as the golf market continues to grow.

Most greens are graded evenly at the subbase to have a 2% to 4% slope from back to front. Since water reaching the green will infiltrate readily, surface drainage is not needed.

At most construction sites, the parent soil has a very low water infiltration rate, less than an inch per hour. The infiltration rate of sand (always test yours before construction) varies from 10 to 50 inches per hour when compacted. A sand green does not depend on surface drainage to remove water.

A perched water table can be produced at the interface between the sand and the subbase soil during heavy rains or excessive irrigation. Therefore, a tile system is recommended to remove this excess water. The most important drain tile location on the green is the lowest area, generally the front of the green. Water must be removed so that it does not produce a soft approach into the green. The spacing and need for additional tile depends on the size of the green, the slope of the soil around it and the rate of excess water falling on the green.

Nutrients in sand vary depending on whether or not the sand contains any secondary minerals or is pure quartz. Thirty-five suitable sands for golf green construction have been tested by the University of California. All sands were deficient in nitrogen and sulfur. Turf would die without supplemental nitrogen and sulfur applications. Nitrogen and sulfur should be supplied every two to three weeks until the green is well established.

Fifty percent of sands had adequate phosphorus and only nine percent had a severe deficiency when supplemental phosphorus was withheld. Fifty-three percent of the sands had a naturally adequate supply of potassium, with only three percent severely deficient. Even though many of the sands appeared to need only nitrogen and sulfur, a starter fertilizer containing phosphate and potassium is recommended.

After many years of study and observation of sand greens, it appears that they are effective solutions to problems associated with high-use putting greens, particularly when coupled with a program of light, frequent sand topdressing.

Like any green, a sand green can be mismanaged by daily irrigation during periods of low evapotranspiration, causing excess leaching of nitrogen and potassium. Overuse of all nutrients produces excess thatch. Use of natural organic fertilizers (particularly sewage sludges) can seriously reduce infiltration. Furthermore, overuse of herbicides and fungicides can be toxic to roots. Diseases are generally reduced due to the rapid drainage characteristics of sand greens.

Properly managed sand greens are firm, fast greens when cut at normal height and frequency. For the golfer, sand greens can provide a quality putting surface 365 days per year, even under high use.

M. Ali Harivandi, Ph.D., environmental horticulture advisor, San Francisco Bay area, University of California Cooperative Extension.

[Dr. Harivandi recommends superintendents and sports turf managers obtain a copy of *"Sand Putting Green Construction and Management"* by Bill Davis, environmental horticulturist emeritus, University of California, Davis. The price is $10 and is available from ANR Communication Services, University of California, 6701 San Pablo Ave., Oakland, CA 94608. You can call in your order to (800) 994-8849. Ask for publication number 21448.]

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