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IN THIS ISSUE

Where Did All the Weeds Come From This Spring?

Fred Yelverton

As cool-season turf starts to resume growth and warm-season turf starts to green up in spring, one of the most common questions is "where did all of these weeds come from?" About this time of year, weeds seem to come out of nowhere to invade turfgrasses. As a result, turfgrass managers are busy implementing spray programs to eradicate them. Weeds that flower in the spring are usually winter annual weeds. Winter annuals are weeds that complete their life cycle in less than one year (go from seed to seed in less than one year). Some are perennials that only grow through the winter months and go dormant in summer, but these are much fewer in number than winter annuals.

Two questions arise from the presence of these winter annual weeds: (1) when did these weeds germinate? and (2) when is the best time to control them?

When did these weeds germinate? There is a lot of misunderstanding on this topic. Because these weeds are only readily visible in the spring, it is easy to assume that they germinated in the spring. However, this is seldom the case. **A vast majority of winter annuals germinate in late summer or autumn.** They go dormant in the coolest part of winter (December through February/March) and as soon as temperatures start to warm in spring, they resume growth and flower in spring followed by seed production and death in early summer. They can be found before the onset of winter, but you usually have to look for them. This requires looking down through the turf canopy. In summary, for most winter annuals, they are there in the autumn but they cannot be seen unless you look for them. This brings us to the second question.

When is the best time to control these weeds? Let's approach this question in reverse. The worst time to try to control winter annuals is when they are the most problematic. That is when they are large and flowering in the spring. When they are at this stage of growth, winter weeds are the most difficult to control with postemergence herbicides because they are mature. **Control of winter annuals with herbicides in late spring generally requires the highest herbicide rates.** In addition, you could also argue against trying to kill them with herbicides because they are getting ready to die from hot weather anyway.

The best time to control winter annual weeds is either in late autumn when they are young or in very early spring just as soon as growth resumes after the winter. In either case, the weeds are very small and can be successfully killed with low herbicide rates. For most turfgrass managers, control in the very early spring is the best option. When temperatures start to warm in early spring and the turfgrass species start to resume growth, winter annual weeds also start to resume growth. Excellent control with low rates of postemergence herbicides can be obtained on warm days in early spring. As the winter annuals resume growth, the leaf cuticle is more easily penetrated by postemergence herbicides, which results in more herbicide uptake. In addition, because weeds are still immature, they are easier to kill. If the winter annuals are killed when small, they do not compete with spring greenup of turf. This often translates to a more vigorous turf in spring.

FEATURE ARTICLE

Fungicide Application

Peter H. Dernoeden

Most fungicides are diluted in water and sprayed onto turfgrasses. Nearly all efficacy research with fungicides involves sprayable formulations. Little effort, however, has been devoted to comparing sprayable formulations with granular forms. Because of this lack of research information, it is difficult to predict the performance of granular forms and make comparisons with sprayable fungicide formulations. In general, granular forms of fungicides are more expensive and contact fungicides applied on granules may provide a shorter period of residual control than their sprayable counterpart. Granular fungicides that penetrate plant tissue provide effective control of foliar blighting pathogens, but generally have reduced activity against root pathogens. Granulars can move in surface water if a heavy rain occurs soon after application. This may leave turf in surface water drainage patterns unprotected. Granulars, however, have an important place in disease management programs. They can be used rapidly without the logistical problems associated with spraying. They are particularly useful in small units where diseases are localized and spraying is impractical. For example, if only a portion of one or two tees or greens is showing disease symptoms on a Sunday morning it is more prudent to quickly spot-treat with a granular fungicide rather than to prepare a tank for broadcast spraying.

Aside from improper sprayer calibration, perhaps the single greatest error in using fungicides is applying them in insufficient amounts of water to provide good plant coverage. Sprayable fungicides should be applied in a minimum of 2 gallons of water per 1,000 ft^2 or 90 gallons of water per acre (841 L/ha). A higher water dilution of 3 to 5 gallons per 1,000 ft^2 (130 to 218 gal/A; 1,222 to 2,036 L/ha), however, is recommended by most manufacturers. Increasing the amount of water delivered improves coverage and performance, which usually equates to longer residual effectiveness. Hence, spraying with low water dilutions often results in less control and is wasteful in terms of dollars spent on buying additional product for more frequent applications. If it is not possible to use higher water dilutions, fungicides should be applied early in the morning when there is a heavy dew. In the absence of dew, the turf should be syringed prior to applying the fungicide(s).

For most diseases, fungicides must be allowed to dry on leaves prior to irrigating to be effective. Contact fungicides can lose most of their effectiveness if a rain storm occurs prior to the fungicide drying on leaves. Even fungicides that penetrate tissues can exhibit reduced effectiveness if rain or irrigation occurs before the chemical completely dries on leaves. **There are a few exceptions to this no post application irrigation principle, and they largely apply to fungicides used to control root diseases.** For example, thiophanates (CL 3336®, Fungo 50®) provide better summer patch (*Magnaporthe poae*) control if watered-in before they have time to dry on leaf surfaces. With the exception of Aliette Signature® (fosetyl-aluminum), fungicides that target Pythium-induced root diseases should be watered-in, but only to a soil depth of 0.5 to 1.0 inch (1.3–2.5 cm).

Fungicides should be sprayed through nozzles that atomize droplets. Flat-fan, hollow cone, and rain drop nozzles are generally more efficient than nozzles that deliver a large droplet, such as flood jet nozzles. **Overall, flat fan nozzles are most often used for delivering fungicides as well as herbicides and plant growth regulators.** Sprayers that deliver water droplets upward, and allowing them to cascade downward to the turf may not effectively cover plant tissues. Research needs to be conducted to determine if coverage by the aforementioned type of sprayer is as efficient as those that deliver the fungicide directly into the turf. Low pressure produces larger droplets, and can be another cause of reduced effectiveness. **Pressure in the spray boom at delivery should be in the range of 30 to 60 psi (207 to 414 kPa).** In short, it is important to use enough water and pressure to blast fungicide(s) into the turf canopy so that the chemical(s) can wash-down between leaf sheaths and contact stem bases.

Sprayers need to be accurately calibrated prior to mixing fungicides. **Recheck calibration after every three days of use or more often.** Screens and nozzles should be visually checked prior to each spray to ensure uniform delivery of the fungicide. Turn on the agitation system before adding fungicides, and allow it to run continuously. **Spray tanks should be filled halfway with water before adding any fungicide(s).** When tank-mixing products always place water insoluble materials, which are formulated as wettable powders, dry dispersible granules, or flowables, into the tank first. Soluble materials such as emulsifiable concentrates, liquids, or soluble powders are

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Fungicide Application

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added to the tank after insolubles. **Do not tank-mix more than one emulsifiable concentrate as turf burning may occur, particularly when treating putting greens.** Fungicides should not be tank-mixed with insecticides formulated as emulsifiable concentrates. Low water dilutions also increase the possibility of phytotoxicity when applying emulsifiable concentrates. **In general, fungicides should not be tank-mixed with insecticides or herbicides unless otherwise stated on labels.** For example, insecticides targeted for white grubs and some preemergence herbicides targeted for annual grass weeds should be watered-in immediately and this practice would likely negate any benefits of a fungicide. Whenever in doubt, apply materials separately rather than in tank-mix combination. **Thoroughly clean the spray tank, hose, boom, and nozzles after each use.** All too often, disasters have occurred when a fungicide was applied through an improperly cleaned sprayer that was previously used for a nonselective herbicide application.

Little information exists regarding the chemical interactions of tank mixes. Most well-known chemical incompatibilities are noted on pesticide labels. There are two general types of incompatibilities: chemical and physical.

Chemical incompatibilities generally occur when the pH of the final solution or the presence of one of the compounds reduces the efficacy or increases the phytotoxicity of a pesticide. Some examples of chemical incompatibilities are as follows: mixing lime or an alkaline-reacting fertilizer with a benzimidazole or an ethylenebis-dithiocarbamate fungicide (see Table 1) can reduce their effectiveness; tank-mixing iron sulfate with an emulsifiable concentrate may cause phytotoxicity; and tank-mixing a triazole or pyrimidine fungicide (see Table 1) with some plant growth regulators (especially Trimmit® = paclobutrazol, and Cutless® = flurprimidol) may discolor or damage annual bluegrass (*Poa annua*) and creeping bentgrass (*Agrostis stolonifera*). There have been no reported problems, however, with tank-mixing Primo MAXX® (trinexapac-ethyl) with fungicides. Tank-mixing Pythium-targeted fungicides (especially Aliette Signature® = fosetyl aluminum; Koban® = ethazol; and Terramec SP® = chloroneb) with herbicides (especially Acclaim Extra® = fenoxaprop-ethyl; Drive® = quinclorac; and organic arsenicals = MSMA and DSMA) should be avoided. Aliette Signature® or acid reacting fertilizers (especially phosphoric acid and phosphate) can dramatically drop the pH of the mixture. Hence, Aliette Signature® may not be compatible with some fertilizers or copper-based pesticides (e.g., Junction®). **The pH of the final tank-mixture should be between 6.5 and 7.0. Additives are available for adjusting the pH of spray solutions.** A pH meter should be purchased by managers who spray pesticides more than a few times per year. These meters require frequent calibration and stock buffer solutions should be purchased for the purpose of recalibration.

Physical incompatibility is normally associated with excessive foaming or settling-out of particles. Mixing pre-packaged mixtures of 2,4-D + MCPP + dicamba with some wettable powder fungicides may cause the formation of a precipitate (i.e., solid particles that separate-out of the suspension or solution to form a solid material at the bottom of the tank). Mixing flowable formulations of chlorothalonil (Daconil®) or mancozeb (Fore® or Fore Rainshield®) with fosetyl-aluminum (Aliette Signature®) may also form a precipitate. **Physical incompatibility can indicate that there is an equipment problem.** For example, wettable powders mixed without sufficient agitation or without a sufficient amount of water will clog screens. Pre-wetting and creating a slurry is helpful in getting wettable powders into suspension, especially when spraying with a small quantity of water. **It is important to always keep the agitation system running, even during breaks or when in transit.**

Only enough material that can be sprayed in one day should be prepared. Chemicals will interact in the tank and if enough time elapses the effectiveness of pesticides may diminish. Temperature also influences pesticide effectiveness. As temperature in the tank is increased, the reaction rate of chemicals will increase and the likelihood of reduced efficacy is enhanced. Time and temperature, however, affect the performance of insecticides and fertilizers more significantly than fungicides.

As previously noted, many incompatible combinations are listed on pesticide labels. Frequently, however, compatibility questions arise, especially when dealing with new formulations of pesticides or when unusual combinations are being considered. **It therefore becomes necessary to test the compatibility of a mix yourself. This is best achieved through a simple, two step test. Step 1** involves placing a mixture of the precise dosage of pesticides plus the appropriate amount of water in a quart jar for 30 minutes. If separation of chemicals occurs or if materials settle-out or form scums or flakes it is probably unwise to use the mixture. Also, if the jar begins to feel warm, chemical reactions are occurring and the mix should be considered incompatible. Step 2 should be performed regardless of results acquired in Step 1. In **Step 2** the mixture is applied in a test strip to turf. Preferably, the mixture should be applied during adverse environmental conditions, such as hot, dry weather, and intentionally overlapped to ensure that phytotoxicity does not occur. A minimum of 72 hours should elapse before the response can be properly evaluated.

Low Sunlight on Closely Mowed Putting Greens

James B Beard

Reports of distinctly slowed leaf growth and even thinning of closely mowed putting greens are occurring more frequently. This is associated with the shift to the very close mowing heights of 3.2 to 2.5 mm (1/8–1/10 inch) that are being practiced to meet the demands for more speed on putting greens. **The problem may be associated with tree shade that extends onto a portion of the putting green, or in some cases it is associated with a two-to-four-week period of extended cloudy weather, especially during the autumn period.**

The shade stress problem has been observed on both creeping bentgrass (*Agrostis stolonifera*) and (*Cynodon dactylon* x *C. transvaalensis*) cultivars, with somewhat greater thinning of the turf with the hybrid bermudagrasses. **The cause is attributed to the very close mowing, because the problem was not previously noticed on Tifdwarf hybrid bermudagrass.** However, the change to more close-mowing heights resulted in the shade stress being observed, including cultivars such as Tifdwarf, Champion, MS Supreme, and TifEagle. Controlled low sunlight studies have revealed Champion to be slightly better adapted to low sunlight conditions than Tifdwarf.

One approach to correcting this problem is by raising the cutting height in the affected area. This will allow increased leaf area for the capture of sunlight to be used in photosynthesis to produce more carbohydrates for shoot and leaf growth. If the problem is caused by tree shade, it frequently occurs on the perimeter area of the putting greens where a double trim mowing is practiced. Lifting the mower every other mowing or every two out of three mowings while passing over the shaded area is very beneficial. In the case of an extended cloud cover for two to four weeks, the practice of elevating the cutting height for the entire putting green surface is advisable. Subsequently, when more normal sunlight levels return, the cutting height should be returned to its normal lower level.

Fungicide Application

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Table 1. Common chemical name, trade names, and chemical class or properties of turfgrass fungicides.

Common Name	Some Trade Name(s)	Class/Type	Contact/ Penetrant[c]
Azoxystrobin	Heritage	Strobilurin	P
Benomyl[a]	Benlate	Benzimidazole	P
Chloroneb	Terramec SP, Terraneb SP	Substituted aromatic hydrocarbon	P
Chlorothalonil	Daconil Ultrex, Concorde, others	Substituted aromatic hydrocarbon	C
Ethazol/Etridiazol	Koban, Terrazole	Substituted aromatic hydrocarbon	C
Fenarimol	Rubigan	Pyrimidine	P
Fosetyl-aluminum	Aliette Signature	Ethyl phosphonate	P
Flutolanil	ProStar	Benzamide	P
Iprodione	Chipco 26 GT, Rovral	Dicarboximide	P
Maneb	Pentathalon	Ethylenebis-dithiocarbamate	C
Mancozeb	Dithane M-45, Fore Rainshield	Ethylenebis-dithiocarbamate	C
Mefenoxam	Subdue MAXX	Acylalanine	P
Myclobutanil	Eagle	Triazole	P
Propamocarb	Banol	Carbamate	P
Propiconazole	Banner MAXX	Triazole	P
Quintozene	PCNB, PenStar, Revere, Terraclor	Substituted aromatic hydrocarbon	C
Terbuconazole[b]	Lynx	Triazole	P
Thiophanate-ethyl	Cleary's 3336	Benzimidazole	P
Thiophanate-methyl	Fungo 50	Benzimidazole	P
Thiram	Spotrete, Thiramad	Dialkl dithiocarbamate	C
Triadimefon	Bayleton	Triazole	P
Triticonazole	Triton	Triazole	P
Trifloxystrobin	Compass	Strobilurin	P
Vinclozolin	Curalan, Touche, Vorlan	Dicarboximide	P

[a] Voluntarily withdrawn from the turfgrass market, future status unknown.
[b] Names proposed or pending U.S. EPA registration.
[c] Contact = Fungicide is only active on leaf and sheath surfaces.
Penetrant = Fungicide is absorbed and can provide activity both on the outside and inside of plant tissues.

FEATURE ARTICLE

Multiple Targeting: Value Added or Value Subtracted?

Daniel A. Potter

Multiple targeting involves applying an insecticide with intent to control two or more pest species by the same treatment. Sometimes this approach targets two major pests, as when golf superintendents apply a long-residual soil insecticide such as Merit® or MACH 2® in late April or May to control first-generation black turfgrass ataenius (BTA) grubs that appear in late May or June, as well as annual grub species, such as masked chafers or Japanese beetles, that hatch from eggs in late July or August. Multiple targeting also can provide "added value" by reducing the need for additional applications to control secondary targets. Thus, a lawn care applicator who applies MACH 2® in June for preventive control of white grubs would likely also suppress whatever sod webworms might be present at the time of application or over the active residual life of the insecticide. **But, multiple-targeting can sometimes backfire if you try to stretch an insecticide's residual limits so far that the optimum treatment window for the main target is missed.**

Registration of imidacloprid (Bayer's Merit®) and halofenozide (RohMid's MACH 2®) during the 1990s opened a new era of preventive insect control. Multiple targeting with these products gained favor on golf courses in the cool-season and transition zones where the BTA is a sporadic, but sometimes severe pest. The seasonal life cycle of BTA differs from that of other grub species in that there are two generations per year throughout most of the species' range. The adult beetles overwinter under plant debris or in thatch or soil. They emerge in the spring and fly to fairways or putting greens where eggs are laid. Superintendents who normally expect to see grub damage in late summer may be caught off guard to find very high densities of the relatively small BTA grubs damaging the roots in June. A second brood of BTA grubs normally shows up in August, about when the grubs of masked chafers, Japanese beetles, and other annual species are just getting started. **Either Merit® or MACH 2®, applied in mid- to late May, will control first-generation BTA grubs and generally have enough residual persistence to control annual grubs that appear later in summer.**

Owing partly to competitive advertising, as well as uncertainty about the products' residual limits, some sources promoted application of Merit® or MACH 2® as early as mid-April to provide "season-long" control of annual grubs as well as a spectrum of other turf pests. **Although treatments made before May 15 often do provide satisfactory control, I have heard reports of treatment failures where such early applications apparently "ran out of gas" before eggs of Japanese beetles, masked chafers, or other annual grubs had hatched.** According to Bayer's technical literature, the half-life of Merit® when applied to turf is 61 to 107 days. MACH 2® and Meridian®, the new soil insecticide from Novartis (registration expected in 2001), have half-lives in that same ballpark. In the cool-season turfgrass zones where eggs of annual grubs will typically hatch from late July to mid-August, residues from an April or early May application will have degraded in the soil for at least 90 days before the vulnerable, first-instar grubs are present. Thus, if you are concerned mainly with annual grubs, it makes no biological sense to apply your preventive insecticide several months before egg hatch. The optimum treatment window for such grubs is any time during the month to six weeks before egg hatch. This window generally falls from early June to mid-July in the transition zone, and about two weeks later in more northern states. For golf courses where BTA is a concern, late May application is a reasonable compromise to preventively control both its larvae and the annual grub species.

Given the turf industry's growing dependence on preventive insecticides, stewardship of these products is important. Placing residues in the soil several months before the optimum date for primary targets exposes them to chemical and microbial degradation for longer than is necessary. **Accelerated microbial degradation, wherein soil microbes become adapted to pesticides such that they degrade the residues much faster than is normal, also is a concern.** A decade ago, accelerated microbial degradation resulted in treatment failures on sites that had been repeatedly treated with isofenphos (Oftanol®), a relatively long-residual organophosphate. Although accelerated breakdown is not known to occur with either Merit® or MACH 2®, there is much that we do not know about this phenomenon. Another potential concern is long-range pest resistance. Although resistance is more likely to occur with pests having multiple generations per year than those with having a 1-year life cycle, note that preventive applications in April or May expose *two* generations (overwintered grubs and the newly-hatched larvae) to the residues. **Resistance to modern preventive insecticides has not been documented for turf pests, but resistance to imidacloprid already has occurred in certain pests of greenhouse and field crops.** Note, too, that Merit® and Meridian® are both neonicotinyls, and thus are chemically

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FEATURE ARTICLE

Temperature Optimums and Lethal Thresholds

James B Beard

Turfgrasses can grow and/or survive across an amazingly wide range in temperatures. Actually the turf canopy interface between the soil and the atmosphere is the main surface for reflection, absorption, and reradiation of solar radiation. Thus **turfs are subjected to a wider range of extremes in temperature during a 24-hour period than either higher heights in the atmosphere or below in the root zone.** Temperatures for optimum growth and/or stress thresholds are summarized in the accompanying table as grouped by C_4 warm-season and C_3 cool-season turfgrass. Note that in most cases a temperature range is provided. This is because there are significant differences among individual turfgrass species and also among cultivars within a species. In addition, the environmental conditions for plant hardening and the physiological state of the plant as affected by cultural practices and the rate at which the temperature stress is imposed all influence the lethal temperature threshold for a given grass plant.

Soil Temperature. Many root growth responses are controlled specifically by the soil temperature. This **requires monitoring the soil temperature on site, preferably at a depth of 4 inches (100 mm) in the root zone.** This temperature gives you the best long-term prediction of temperature trends and minimizes sharp day-to-day variations that have minimal influence in most cases.

Canopy Temperature. Typically canopy temperature represents a composite integration that is affected by the soil temperature and nocturnal air temperature. High atmospheric temperatures that occur in June at soil temperatures below 80°F (27°C) are far less likely to cause heat kill than if they occur in August when soil temperatures might be at 85 to 90°F (26–32°C). The most practical way for monitoring canopy temperature is by the use of an infrared thermometer.

Tissue Temperature. The actual temperature in the tissue, especially the meristematic tissue, determines whether a grass plant will or will not be killed. Thus, a plant may grow successfully at atmospheric temperatures of 120°F as long as the tissue temperature remains below the lethal threshold point, which in the case of annual bluegrass (*Poa annua*) is in the order of 108°F (42°C). The plant will survive as long as the transpirational rate of the grass plant sustains a cooling effect to prevent tissue temperatures from rising to the lethal threshold point. Thus, the reason for stating that the tissue temperature is the critical lethal temperature and not the air temperature, especially in the case of aboveground grass shoots.

In summary, the temperature at which the grass is growing or surviving has many effects on which cultural practices are best accomplished and when. Accordingly, a microclimate monitoring system on the golf course that is connected to recording and processing software in the Operations Center for daily readouts can be a very important asset in day-to-day decision making concerning key cultural practices.

Summary of temperature criteria affecting cool- and warm-season turfgrasses.

Temperature Parameter	Most C_3 Cool-Season Turfgrasses		Most C_4 Warm-Season Turfgrasses	
Optimum* Shoot Growth	60 to 75°F	(16 to 24°C)	80 to 95°F	(27 to 35°C)
Optimum** Root Growth	50 to 65°F	(10 to 18°C)	75 to 85°F	(16 to 26°C)
Root Heat** Stress	>80°F	(27°C)	>100°F	(38°C)
High Temperature*** Kill	104 to 112°F	(40 to 44°C)	110 to 120°F	(43 to 49°C)
Cold* Hardening	40 to 34°F	(4 to 1°C)	58 to 66°F	(15 to 19°C)
Chill* Stress	None		54 to 60°F	(12 to 16°C)
Low Temperature*** Kill	26 to –20°F	(–3 to –29°C)	31 to 20°F	(–1 to –7°C)

* Canopy temperature
** Soil temperature
*** Tissue temperature

JB Comments

Cultivar Conversion on Creeping Bentgrass Greens

With the recent introduction of the Penn A and G series cultivars of creeping bentgrass (*Agrostis stolonifera*) that can sustain high shoot densities at extraordinarily close mowing heights, a frequently asked question has been the potential to interseed into an existing cultivar stand such as Penncross with the objective of converting to the new cultivar. A number of efforts have been made in this regard over the past few years with mixed results. I have not been able to answer this question specifically in terms of a clear yes or no relative to successful experiences.

However, for the first time I can relate experiences with comparative interseeding. My observations have been in Japan in a relatively cool climatic area near the foot of Mt. Fuji, west of Tokyo. Two golf courses in this area have conducted an interseeding program for three years with the goal of converting Penncross to Penn A-2. Both golf courses employed similar interseeding practices conducted in the late-summer period of early September. The procedure involved:

- **Close mowing** of 1/8 inch (3.2 mm) for a period of several weeks prior to interseeding.
- **Vertical cutting** in two to three directions with excess organic material removed.
- **Coring** with high-density 0.3 inch (8 mm) diameter tines to a 0.8 inch (20 mm) depth on a 1.1 inch (27.5 mm) spacing. The cores were removed.
- **Seeding, topdressing** and **brushing,** using 2 lb per 1,000 ft^2 (10 g/m^2) with coated seed.

An application of phosphorus also was made to the seedbed prior to seeding. Subsequently, daily to twice daily irrigation was applied as needed to avoid surface water stress to the germinating seedlings. This interseeding process was repeated in the second year. It should be noted that both golf courses have a double-green system, which allowed a two-week post-interseeding period where play was not allowed on the interseeded set of 18 greens.

I have made visitations to both sites for three consecutive years during the autumn period. Dramatic differences were observed in the autumn of the year 2000. One golf course has achieved a dramatic conversion to Penn A-2, which is visually evident in terms of a narrower leaf width, higher shoot density, and more erect growth habit. In contrast, the other golf course remains dominated by Penncross creeping bentgrass. **There has been one key difference between the two golf courses. On the course where the conversion was successful, they sustained a cutting height in the 1/8 to 3/32 inch (3.2 to 3.0 mm) range for the three-year period. Whereas the golf course where success has been far less dramatic and Penncross appears to remain dominant, the cutting height was maintained at a 4 mm height, except for lowering during a two-week period for several key tournaments each year.** It should be noted that in the second year on the course that was successful there was a temporary thinning of the Penncross turf cover on the greens. Whether this could have been avoided or not is unclear, but may not necessarily need to have occurred.

This comparative set of golf courses demonstrates there is at least one key cultural element that aids in successful conversion to the higher density, extraordinarily close mowing tolerant cultivars, that being a very close mowing height which stresses the Penncross. There most probably are other cultural practices that may also contribute, but to what degree and whether they have an additive effect remains to be determined.

Multiple Targeting...

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similar. As always, it is good practice not to overdo it with any one class of pesticide.

Therefore, I disagree with some authorities who broadly promote early spring preventive treatments under the auspices of multiple targeting. One publication, for example, states that if grubs are the primary target, early May is the optimal time to apply Merit® on northern golf courses because such timing also gives season-long control of secondary pests such as billbug larvae, first-generation cutworm larvae, greenbug aphids, and frit fly. In my experience, those secondary pests don't often occur at high enough levels in fairways to justify applying a grub treatment that early. The same source recommends late April through May as the optimal time to apply Merit® for grub control on northern lawns because secondary pests, such as billbug larvae, greenbug aphid, and chinch bugs, will also be suppressed. Again, in my view, those pests don't occur often enough, or at high enough levels, to warrant treating 1–2 months earlier than the optimum window for the primary target. Should surface-feeding pests, such as sod webworms and cutworms, approach intolerable levels, they are relatively easy to control by spot-treating with a fast-acting, short residual insecticide.

When multiple-targeting BTA and annual grub species with preventive soil insecticides, use the highest labeled rate and treat shortly before egg hatch of BTA. This treatment timing, generally mid- to late-May, increases the likelihood that sufficient residue will persist into July and August. For grub management on lawns or sports fields, or on golf courses without a history of BTA, there is little justification to apply Merit® or MACH 2® any earlier than early to mid-June. Stewardship of these products warrants that we use them selectively, during optimum windows, rather than as a routine, season-long cure-all for secondary pests that only occasionally occur at damaging levels.

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Research Summary

Salt Tolerance Comparisons Among Bentgrass Cultivars

The comparative salinity tolerance of 33 creeping bentgrass (*Agrostis stolonifera*), one colonial bentgrass (*Agrostis capillaris*), and one velvetgrass (*Agrostis canina*) cultivar(s) were assessed by hydroponic methods in a controlled-environment glasshouse. Following gradual acclimation, the individual cultivar treatments were exposed to moderate salinity stress of 8dS•m^{-2} for 10 weeks to simulate chronic salinity. Turfgrass responses to chronic salinity levels were assessed in terms of leaf clippings dry weight, percent green leaf area, root dry weight, and root length. Ranking with good salt tolerant in this investigation were Mariner, Grand Prix, Seaside, and Seaside II, while Avalon (velvet), Ambrosia (colonial), SR 1119, Regent, Putter, Pencross, and Penn G-6, were found to be salt sensitive. Ranking intermediate in salt tolerance were L-93, 18th Green, Penn G-2, and Syn 96-1. These results indicate a substantial range in the salinity tolerance among the 33 *Agrostis* cultivars. Total shoot death occurred after nine weeks for Putter, Ambrosia, and Avalon, and after ten weeks for Penn G-6, Penncross, Regent, and SR 1119.

Comments. For those turf sites where salinity problems may already be present in the existing soil or where irrigation water may contain significant levels of salts that can result in a buildup in the soil, it is advisable to select a salt tolerant cultivar of *Agrostis stolonifera,* if this is the species required for the use site. These findings indicate there are great differences in salt tolerance among the various bentgrass cultivars. Among the cool-season turfgrasses, bentgrass (*Agrostis*) has relatively good salt tolerance. However, one should be reminded that superior salt tolerance can be found in several warm-season grasses, including seashore paspalum (*Paspalum vaginatum*), bermudagrass (*Cynodon* spp.), St. Augustinegrass (*Stenotaphrum secundatum*), and certain zoysiagrasses (*Zoysia* spp.). **"Salinity tolerance of 35 bentgrass cultivars." Kenneth B. Marcum. *HortScience,* 36(2): 374–376, 2001.**

Ask Dr. Beard

Q *Are there any specific situations where a growth inhibitor should not be used on turfgrasses?*

A **It is generally advisable to not apply a plant growth regulator (PGR) in situations where the turfgrass either has been or will be in the near term badly thinned and/or browned by the environmental, pest, or traffic stresses.** Under these conditions shoot growth is needed to recover the original density, health, and appearance of the turf. A growth regulator that blocks normal tiller initiation and vertical shoot growth will create problems and its use should be avoided in these conditions. Typical examples would be the pathways or entrances and exits where the turf tends to be badly thinned by concentrated traffic in a small area. Another situation would be a turf composed of a turfgrass species/cultivar that is known to be severely thinned by a particular disease common to a specific region. Since a number of PGRs are effective for a specific period of time, this may mean that the avoidance and use of it may be specific to a certain period during the growing but not the entire growing season.

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