Plant Growth Regulators in Bentgrass Turf Areas

Thoughts and trends in the use of a valuable management tool.

BY CALE A. BIGELOW

Reductions in clipping yield are a major advantage for many practical reasons.

The focus of this article is plant growth regulators (PGRs) and how they can be used as a management tool for golf turf. My goal is to offer current insights, share some personal thoughts, and offer cautions and suggestions to maximize the effectiveness of their use.

Ethephon (Proxy), flurprimidol (Cutless), mefluidide (Embark T & O), paclobutrazol (Trimmit), and trinexapac-ethyl (Primo MAXX) are the primary growth regulator active ingredients currently used on fine, cool-season turf. Most golf course managers use or have used these products at one time or another. One main reason to use a PGR is to suppress vertical leaf growth. Aside from less mowing and reduced scalping potential, regularly applied PGRs provide smoother and more uniform playing surfaces, but there are many other beneficial effects. In terms of increased lateral spreading, the effects are rather variable. Rooting effects are always a concern, but for PGRs, negative effects on rooting are extremely rare. In fact, there are actually some positive rooting effects from top-growth suppression, but do not expect huge differences. There are many other possible benefits, such as seedhead suppression (mefluidide and ethephon are most effective), higher shoot density, improved color, shade tolerance, reduced water consumption, and dollar spot suppression (flurprimidol and paclobutrazol are most effective for this purpose, with paclobutrazol offering slightly more suppression).

TURFGRASS SAFETY

A major concern in past decades with PGRs was discoloration or injury. The products labeled for repeated seasonal application to fine turf, flurprimidol, paclobutrazol, and trinexapac-ethyl, are all safe to creeping bentgrass when applied correctly and according to label recommendations. Even with application rate issues or sprayer overlap at higher label rates, there is little chance the turf will actually die. The turf may appear injured (e.g., bronzing or leaf purpling, severely puckered tillers, etc.), and stressed turf may decline further, but, in my experience, it eventually recovers. This fact, however, might not hold true for mefluidide, which has a different mode of action than the aforementioned PGRs that suppress gibberellic acid synthesis.

By contrast, other species like Kentucky bluegrass may be discolored or injured by PGRs. This is important because many golf courses have Kentucky bluegrass roughs or green/tee surrounds, and paclobutrazol or mefluidide applications can cause subtle injury. These symptoms are less rare where flurprimidol or trinexapac-ethyl are used. One additional caution with PGR use: when using a DMI (demethylation inhibitor) fungicide in conjunction with a PGR program, understand that the combination of these materials may further regulate the turf.

Another suggestion when using any of these PGRs is to tank-mix a small amount of soluble nitrogen, such as urea and/or a liquid chelated iron source. This will minimize discoloration and continue to stimulate growth/density without excess clipping production.

NEW PRODUCTS AND FORMULATIONS?

At present, it does not seem that there are any new PGRs coming to the

Annual bluegrass seedhead production is a major issue in terms of playability on putting greens, and certain PGRs and combinations can be very effective in reducing their production.

marketplace. Much like the fungicide and herbicide markets, manufacturers are looking for value-added combinations of existing molecules. Currently there is one pre-mix combination product (Legacy) on the market that combines flurprimidol and trinexapac-ethyl in a liquid formulation.

The potential benefit of this combination is that it is absorbed both through the foliage and via the roots. The foliar regulation from trinexapac-ethyl happens more quickly (hours), whereas the root-absorbed flurprimidol regulation happens more slowly but offers a more steady supply of the PGR from the rootzone. This should translate to less rebound growth effect as the PGR wears off. In addition, a new liquid formulation of flurprimidol (Cutless MEC) has been introduced, allowing turf managers to more easily adjust application rates compared to the powder formulation, especially for green and tee use.

APPLICATION RATES AND TIMING

Temperature matters! When PGRs were first introduced, the goal often was to simply suppress the major cool-season turfgrass growth peaks and clipping production. Generally, summer applications were avoided. Products were applied only a few times at higher label rates, and the expected duration of regulation was 4-6 weeks. Now, many managers use PGRs throughout the entire growing season with various rate strategies (e.g., higher spring and fall rates and lower in summer, or lower early spring and tapering to increasing rates during peak spring growth plus lower in summer, or constant rates throughout the year). The goal is to provide additional, and more consistent, regulation. Superintendents have tried many options and there appears to be no single correct program.

There also is the question of what is the "best" application interval? Several researchers have explored this, and the important thing to understand is that temperature matters. It affects growth rate, PGR metabolism, and more. Drs. Jeff Beasley and Bruce Branham, University of Illinois, studied the persistence of paclobutrazol and trinexapac-ethyl inside the plant and found that as temperature increased, the amount of PGR in the leaf tissue decreased, and the half-life or persistence of paclobutrazol was much greater than for trinexepac-ethyl (Beasley and Branham, 2005). This means that the root-absorbed PGR, paclobutrazol, has longer persistence and likely provides more uniform regulation over time. Since flurprimidol is chemically so close to paclobutrazol, I would expect a similar response.

Bill Kreuser and Dr. Doug Soldat at University of Wisconsin attempted to identify a specific growing degree day (GDD) model for optimum trinexapac-ethyl application frequency (Kreuser and Soldat, 2011). They reported that compared to a standard calendar-based application schedule, trinexapac-ethyl at 6 fl. oz. per acre should be applied every 200 GDD for consistent bentgrass regulation. The take-home message is that as the temperatures get warmer you may need to to tighten the intervals to achieve consistency. The last thing you want is PGR-regulated turf to rebound with rapid growth just prior to that important summer tournament or event. In practical terms, monitor your daily clipping production and watch the daily high and low temperatures. This is especially true during long days and warm temperatures in summer.

SUMMER PGR USE FREQUENTLY ASKED QUESTIONS

Should I continue my program during stressful conditions when stand density declines, or should I stop? Honestly, nobody really knows what is best, and solid arguments can be made to continue applications or stop. My bias is that less mower injury is probably better for the turf during late-summer stress. In recovery mode you are lightly feeding soluble nutrients and these, in turn, hopefully are pushing growth. If your turf is still under regulation, there is an option of alternating daily mowing and rolling (lightweight rolling only) for surface smoothness, which is more appealing than a leggy, succulent, slow putting surface. Another consideration is the potentially rapid regrowth process as the PGR wears off. This growth could be carbohydrate intensive and exhaustive at a time when the plant is physiologically impaired. Thus, I generally recommend staying the course for a few more applications until summer tempera-

tures moderate. I feel the benefits of fine turf PGRs far outweigh the potential risk.

How do PGRs affect interseeding? This is another gray area. We do know, however that paclobutrazol, when applied two weeks after seedling emergence, can negatively affect establishment in fairway-height turf (Kaminski et al., 2004). The effect from other PGRs is less clear. One line of logic would be that if you have a thin green, you should stay on the PGR program as these products retard vertical growth and you might be able to again reduce mechanical stresses, rolling instead of mowing for greater seedling survival. But the effects of any chemical on young seedlings is always variable.

What about the interaction between PGRs and the mystery decline syndrome/disease? There have been recent discussions among the academic community regarding the potential role of PGRs in the poorly understood summer decline phenomenon syndrome (a.k.a. bacterial wilt/etiolation, mad-tiller, etiolated tiller, etc.), when individual leaves become chlorotic (yellow to almost white in some circumstances) and dramatically elongate almost overnight. The answer is, honestly, we just don't know. I can only speak from my personal observations of side-by-side, replicated research plots of bentgrass and mixed bentgrass/annual bluegrass turf with regulated turf and non-regulated turf. I have yet to see any clear differences; both treated and non-treated are affected. My sense is that there are environmental factors, cultivars, management practices, nutritional inputs, pathogens, and more all interacting.

Poa annua is suppressed differently with some PGRs. Regular application (every 14-21 days during the growing season) of one of the root-absorbed PGRs (i.e., paclobutrazol or flurprimidol) will suppress and can reduce annual bluegrass populations, often substantially (McCullough et al., 2005; Bigelow et al., 2007; Baldwin and Brede, 2011). In my research program we documented rather dramatic *Poa annua* reductions in established bentgrass/annual bluegrass research fairways/greens. In this study, conducted in West Lafayette, Ind., the effects of flurprimidol (50W formulation) applied every 28 days over two consecutive years combined with and without trinexapac-ethyl to reduce annual bluegrass populations in fairway height creeping bentgrass were studied.

Over regulation can result in turfgrass injury and usually is more damaging to Poa annua *than to creeping bentgrass. The* Poa annua *in this example is experiencing much more severe regulation than the adjacent bentgrass.*

Applications were begun in mid-May and made monthly from May through October for two consecutive years to a recently established L-93 creeping bentgrass stand containing approximately 30% annual bluegrass that had established from an existing soil-seedbank. The most effective treatments were flurprimidol Cutless 50W alone at 16 oz/A or Cutless 50W flurprimidol + trinexapac-ethyl PrimoMaxx at 16 + 6 oz/A (Table 1). These results are encouraging and demonstrate that even with initial annual bluegrass populations of 30%, monthly root-absorbed PGR applications throughout the growing season can effectively reduce populations to more tolerable (less than 10%) levels. Of course, it is implied that these products work best when combined with sound cultural practices, such as adequate fertility, a reasonable mowing height, and proper compaction and thatch management.

A few other notes: Should I alter rates? My bias is to keep it simple. A single rate throughout the season is often as effective as varying the rate, with the added benefit of less room for applicator mixing errors. Second, take the applications into mid-autumn, if you can, to suppress annual bluegrass seedlings at the time when the majority

Table 1
Effect of monthly applications of flurprimidol (Cutless 50W) with and without trinexapac-ethyl (PrimoMaxx) on annual bluegrass reductions in a creeping bentgrass research fairway

		Percent change in annual bluegrass from initial[y]	
PGR	oz/A	Nov. Year 1	May 2 Years Later
Cutless 50W	8	- 39 a[z]	- 79 ab
Cutless 50W	16	- 24 ab	-75 abc
Cutless + Primo Maxx	4 + 6	- 28 a	- 38 d
Cutless + Primo Maxx	8 + 6	- 19 ab	-52 bcd
Cutless + Primo Maxx	16 + 6	- 36 a	- 87 a
Primo Maxx	12	+ 11 b	- 4 e
Untreated	—	+ 13.0 b	-44 cd

[y] Percentage annual bluegrass reductions were calculated based on initial populations recorded prior to growth regulator treatment.

[z] Means in the same column followed by the same letter are not significantly different according to Fisher's protected LSD t-test (p=0.05).

of them emerge throughout much of the cool-humid region (Kaminski and Dernoeden, 2007).

THE DISCLAIMER AND THE "FINE PRINT"

Annual bluegrass populations are highly variable. What works on one turf area or on one golf course can very easily not work down the street. The true annual biotypes seem more sensitive to these PGR programs than the more established perennial biotypes. Also, underestimating annual bluegrass populations can result in thin areas or, worse yet, noticeable voids in the turf canopy and golfer frustration if they are unaware of the long-term goals with the PGR program. Also, there may be some periodic and unpredictable discoloration (mild leaf bronzing/purpling) due to environmental conditions following application (mostly early spring or autumn with cold nights).

FUTURE RESEARCH

There is still much to learn about PGR use. In my research program we are focusing on understanding use patterns and improved efficacy. Questions such as the integrated effect of nitrogen sources, nutrition programs, and plant health supplements (a.k.a. biostimulants), soil water content issues, and if PGRs may help reduce water use and improve surface conditioning, are things we are evaluating. Stay tuned for more information.

In summary, I see PGRs as a vital tool for managing bentgrass on golf courses. There are many benefits beyond general vertical growth suppression, most notably annual bluegrass suppression. This is a tremendous benefit for bentgrass managers because bentgrass is more reliable during stressful summers than annual bluegrass. Long-term success, however, is somewhat like regularly taking medication for a chronic problem. The bottom line is they do work, but if you stop, results are uncertain and annual bluegrass will likely return.

Extended periods of wet weather can produce excess growth, and playability can suffer terribly if the turf is too wet to mow for a few days. PGRs are a major aid in reducing growth under these conditions, and this can translate to better playability and fewer scalping problems.

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