Users Drive Research Into New Growth Regulator Applications

By Dennis Shepard

Plant growth regulators (PGRs) were initially developed to slow turf growth and suppress seedheads. Their use on high-quality turf was limited because of potential phytotoxicity, unpredictable turf response and differences in activity on cool- and warm-season turf.

Trinexapac-ethyl (Primo MAXX) was the first PGR to provide growth suppression and improved turf quality in all the major turfgrasses. Research projects, combined with suggestions from Primo MAXX users, helped develop uses that had not been successful with other PGRs. These include use during overseeding, tank mixing with fungicides to enhance activity, pre-stress turf conditioning, use on greens, sod production and others.

PGR mode of action

PGR products work in different ways to affect turf growth and development. They either slow cell division in meristematic areas, inhibit cell elongation by slowing the production of gibberellic acid, or act by enhancing ethylene gas release, which affects flowering.

Mefluidide (Embark, Embark Lite), developed in the 1970s, is absorbed through the leaves, slows cell division. Paclobutrazol (Trimmit 2SC, Turf Enhancer 2SC) and flurprimidol (Cutless), developed in the 1980s, are root-absorbed and slow cell elongation by stopping formation of the more than 120 forms of gibberellic acid early in the biosynthetic pathway.

Never apply a product to an entire golf course, lawn or athletic field without first trying it on a practice green, sideline or small side yard.

Trinexapac-ethyl (TE) has foliar uptake and slows cell elongation by stopping the conversion of one gibberellic acid (GA_{20}) to another [GA_1], which is the final step in gibberellic acid production. This leads to slower plant growth.

Ethephon (Proxy) was registered for use on turf in 1998. It affects turfgrass growth and development by enhancing the release of ethylene gas.

PGR development and use

In high-quality, cool-season turf areas, mefluidide is primarily used to reduce *Poa annua* seedheads. When applied at the correct time, it does an excellent job. Superintendents should be aware that turf plants use much of their stored energy during seed production and flowering, and there is potential for phytotoxicity from any PGR during this period because of the weakened state of the turfgrass plant.

Paclobutrazol is primarily used on cool-season turfgrasses to slow growth and reduce *Poa annua* in bentgrass golf courses. Application rates range from 6.4 ounces to 24 ounces of product per acre (greens vs. fairway use). It will suppress turfgrass growth for a six- to eight-week period.

Poa annua appears to be more sensitive to paclobutrazol than creeping bentgrass. Superintendents should evaluate the amount of *Poa annua* they have before using paclobutrazol, and determine if they want to keep it or reduce it. The turf response depends on the regulator rate. Higher rates can be used for two to three applications in the spring and fall when the risk of phytotoxicity to the creeping bentgrass is lower. As temperatures grow warmer, superintendents should reduce the rate of paclobutrazol, not use a PGR or switch to TE.

Ethephon was labeled for use on turfgrass in 1998, and research has been conducted to determine rates and turf response. It is primarily used on cool-season species. A key area of research has been on suppressing *Poa annua* seedheads. Research in California has shown a single application of Proxy (21.7 percent ethephon) at rates of 5 or 10 ounces/1,000 square feet, reduced *Poa annua* seedheads 80 percent to 90 percent.

Proxy has little effect on seedheads that are present at the time of application (Gelernter). Research is continuing in other areas of the country.

Trinexapac-ethyl (TE) has been the most widely researched PGR to date, with hundreds of research projects at land-grant universities in the United States. Growth reduction and improved quality of warm- and cool-season turf, successful use on greens and fairways, a predictable response and lack of phytotoxicity aided acceptance by turf managers and inspired new research.

Growth management with trinexapac-ethyl

Initial research into TE in the late 1980s and early 1990s investigated rates and response on highway roadside turf, home and commercial lawns, and golf course fairways. It was a new class of chemistry (cyclohexadione) that exhibited different growth responses from other PGRs.

It was challenging to determine where it could be the most benefit to turf management. Rates were determined for 50 percent growth suppression for species maintained at fairway heights. Research has also been conducted on the effect of multiple TE applications to turfgrass growth and quality (Fagerness, Lickfeldt).

Along with suppressing turf vertical growth, TE affects a number of other turf morphological characteristics. Turf density normally increases with repeat applications due to enhanced lateral growth of stolons and rhizomes, and increased tillering.

Turf treated with TE normally turns darker green. Research has determined that chlorophyll content increases, and there is a higher concentration in the smaller, more compact leaves (Ervin, Heckman). Scalping is reduced when mowings are missed due to rainfall or other problems.

Superintendents with kikuyugrass fairways have found TE dramatically reduces scalping throughout the growing season (Gelernter).

Mowing equipment performance and lifespan may be enhanced because of less mowing and less force required to mow the turf. Catching and dragging of clippings can often be eliminated, which saves time and labor. In addition, tasks such as trimming and edging are reduced.

TE effects on cultural practices

Turf managers should apply their normal fertilizer program to TE-treated turf. Nitrogen is a key component of amino acids, proteins, enzymes and chlorophyll. The turf plant can better use the nitrogen and other nutrients for other purposes instead of using them to stimulate foliar growth.

> The only turfgrass systems that will likely benefit from the addition of diazotrophs in terms of supplying nitrogen are those grown without nitrogen fertilizer inputs.

TE application to warm-season turf prior to overseeding enhances establishment. Superintendents often apply TE one to five days prior to overseeding to slow growth and competition of the warm-season turf (usually bermudagrass) with the developing overseeded species.

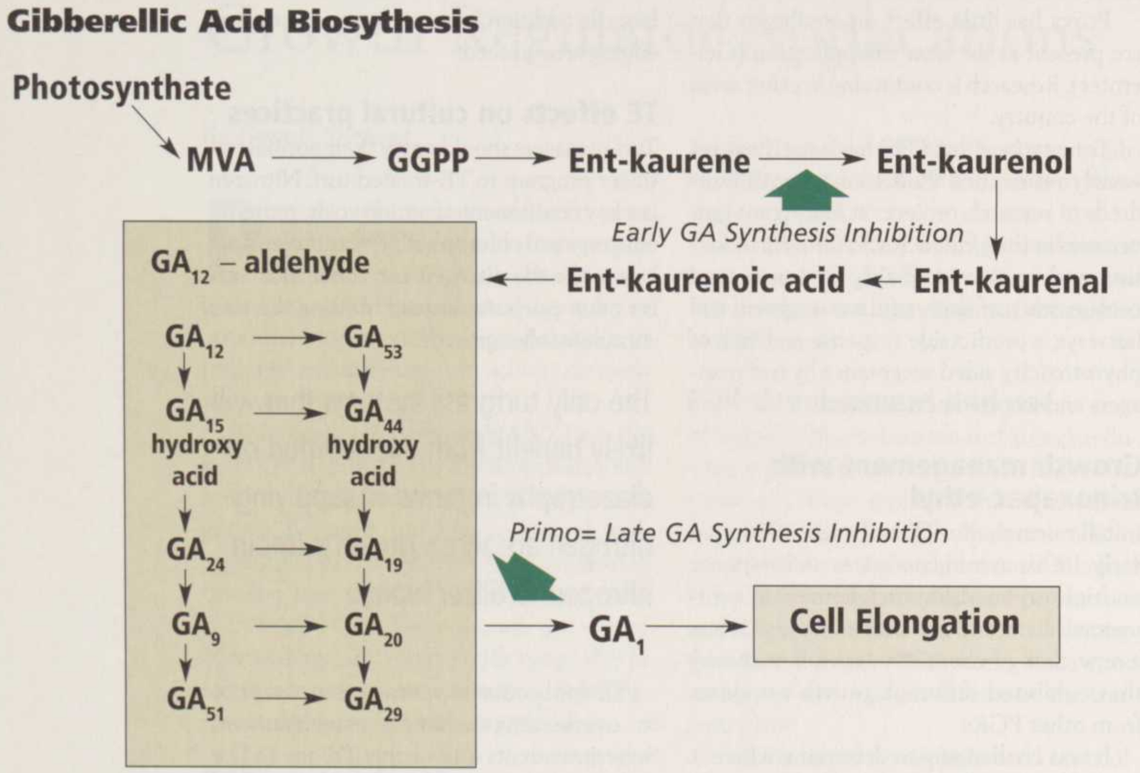
TE can be applied at twice the normal application rates prior to overseeding for extended growth suppression. A post-overseeding application is normally made after the first mowing of the overseeded species. Superintendents have also reported that TE application to creeping bentgrass aids transition when interseeding and/or converting from one cultivar to another. This is commonly done when converting from an older cultivar like Penncross to a newer cultivar like the A or G series of bentgrass.

The foliage absorbs TE within one hour of application and there is no soil residual to affect seed germination negatively.

Prestress conditioning of golf turf

TE can be applied to turf at reduced rates more frequently. Many superintendents, primarily those with creeping bentgrass, have incorporated this practice into their spray program. They are typically spraying some-

FIGURE 1



thing every seven to 10 days during parts of the year, and they often add TE at one-half to one-third the label rate, with activity expected to last 10 to 14 days.

Tank mixes with TE and fungicides are especially beneficial. The turf is growing slower, and less fungicide is removed with each mowing. There is no evidence that any PGR causes or enhances turf diseases.

Fertility and PGRs can influence disease development (Golembiewski). However, if a disease is present at the time of PGR application, it will take longer for new growth to mask the symptoms. PGRs should not be applied to diseased turf.

Once TE was labeled for use on fairways, research began for its potential use on greens. This use was added to the 1996 label revision.

Superintendents were primarily interested in TE use on greens to increase speed, and hopefully provide another tool to fight *Poa annua*. When used with other cultural practices, TE can help increase putting speed 6 to 12 inches as determined by a Stimpmeter. Mowing height is a key factor that influences putting speed.

With any turfgrass, if too much leaf tissue is continually removed, photosynthesis is reduced and turf vigor will gradually decline and make it susceptible to diseases and cultural stresses. Superintendents have reported they can apply TE and slightly raise mowing heights and maintain acceptable speed. This will help with the overall health of the turf.

TE is also used extensively on Tifdwarf, Tifgreen and ultradwarf bermudagrass greens. In areas like Florida and the Gulf Coast states, extended cloud cover and low mowing heights typically cause bermudagrass greens to become thin, and algae can develop. TE helps maintain turf density and quality. Rates as low as 1 to 2 ounces per acre can provide considerable improvement (Foy).

Turfgrasses prefer to grow in sunlight, and quality will decrease when turf is maintained in shade. The turf stand eventually thins and the shoots are spindly. Gibberellic acid (GA) levels can increase under low light, and this contributes to enhanced vertical growth. Research has determined that TE application to newly established turf in shade environments will maintain turf quality for longer periods than untreated turf (Goss, Qian). TE suppresses GA levels and growth is slowed.

Water-use research projects with TE have found it may reduce irrigation requirements (Fry). Possible explanations of how TE can influence water-use rates include:

- TE-treated turf has smaller, more compact leaves, which may reduce water loss through transpiration.
- The turf is more dense and water loss from soil evaporation may be reduced.
- As turf vertical growth is reduced, plant energy is redirected to enhance development of lateral stems and roots for access to soil moisture.
- As GA levels decrease, abscisic acid (ABA) levels increase, which play a role in stomatal closure and water conversation.

PGRs either slow cell division in meristematic areas, slow cell elongation by slowing the production of gibberellic acid or enhance ethylene gas release, which affects flowering.

The future

The development of TE has been a cooperative effort of industry, university researchers and suggestions from turf managers.

As use of TE increased, new uses and ideas were developed, and research projects were established to investigate. This has helped develop new areas of research that should continue.

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