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ABOUT THE COVER

Artist J.L. Samerdyke attended the WGCSA meeting in Poniatowski, Wisconsin and witnessed the latest contributions to Vroman Orth and the Wisconsin Golf Course Museum. They are the subject for her cover of the May/June 2006 issue of The Grass Roots.

"No occupation is so delightful to me as the culture of the earth."

Thomas Jefferson (1743-1826)
Third President of the United States

THE GRASS ROOTS

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Hoping 2006 is Better Than 2005!!

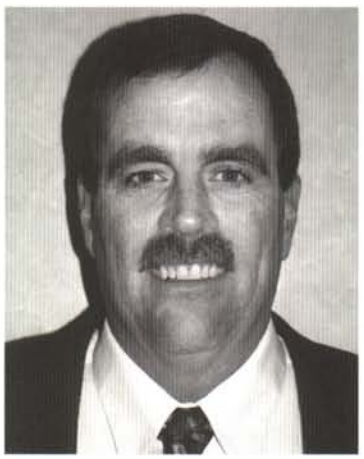
By Mike Lyons, *Golf Course Superintendent, Old Hickory Country Club*

The 2006 season is upon us. I hope everyone has come through winter well, both the golf course and you. Things here are much better than last spring. I still quiver when thinking of last year's start.

The spring business meeting was held on March 6th at the Ramada in Fond du Lac. For those who were unable to attend, you missed a very nice and thoughtful presentation given to David Brandenburg. It was my pleasure to introduce past president Kris Pinkerton who awarded David with the WGCSA Distinguished Service Award. Listening to Kris speak so highly of David and what he has done for us, his church, and his community makes me feel fortunate to have served with David on the board. I am grateful that he chose this profession. Congratulations again, David, you fit right in with all the past honorees.

Also that day, six members were awarded with their twenty-five year plaques and one who has been a member for fifty years. Congratulations to David Smith, Doug DeVries, Tom Schwab, Ken Peterson and Mark Grundman for twenty five years. And to Wisconsin Turf and Lyle Christopherson for fifty years of membership — what a rare accomplishment.

Again this year, Dr. Jason Kruse from the UW-Extension Winnebago County gave us a presentation on NR 151. Dr. Kruse, Dr. Stier and Doug DeVries have been very involved with the Standards Oversight Council and the Turf Nutrient Management Work Team in drafting the technical standard Turf Nutrient Management Plan. This plan will



provide us with the minimum requirements to develop a nutrient management plan. This program is due to go into effect by 2008. Thank you Jason, John and Doug for volunteering your time and energy to this important issue.

I would like to welcome and thank Matt Schmitz for volunteering to serve on the board of directors of our association. Matt has taken the position left vacant by Mike Werth. Mike took a position with Wisconsin Turf. We all wish you well, Mike, and thank you, Matt, for stepping in.

With spring looking better and better, I hope many of you will be able to take some time and attend our monthly meetings. The line up this year is pretty good and I truly feel there is a lot to learn by seeing other operations and talking with your peers. There is a lot of knowledge among us. Lastly, with the golfing season upon us, please don't forget to make time for your family and friends. Take care.

A Brief Review of Turfgrass Growth Regulators

By Dr. John Stier, *Department of Horticulture, University of Wisconsin-Madison*

Emergence of turf growth regulators

Interest in using growth regulators for turf management began after WW II. Urbanization was rapidly expanding and increasing the use of turf for lawns, rights-of-way, golf and other sports. The objective at the time was to reduce mowing requirements. Such growth regulators are more correctly called growth retardants as they are inhibiting growth, not increasing it. Growth retardants usually work by either suppressing cell division or reducing cell elongation.

Following WWII a number of compounds were tested but failed to suppress turfgrass growth. Examples included B-995® (N-dimethyl aminosuccinamic acid), CCC (2-chloroethyl-trimethyl-ammonium chloride), Phosphon® (2,4-dichlorobenzyl-tributyl phosphonium chloride), Ethrel® (2-chloroethyl phosphonic acid), gibberellin, and kinetin (Beard, 1973). B-995, CCC, and Phosphon all caused unacceptable injury to turfgrasses and often insufficient growth retardation to justify their use.

Gibberellins were interesting because these were hormones produced by plants. Scientists found treating plants with additional gibberellins actually stimulated growth. In the 1950s it was thought that gibberellins would be useful for greatly enhancing food production. It was with dismay that scientists and crop producers realized a 20 foot stem did not necessarily result in greater yield. In turf, gibberellins generally reduced root growth and shoot density in addition to turning turf plants a lighter green color.

Kinetins were another group of plant hormones that could stimulate lateral bud growth in some plants. In turf, though, a practical use was never found though some speculation existed that kinetin might improve turf establishment rates. Ethrel (common name ethephon) went on to become widely used in greenhouse production of herbaceous ornamentals. It wasn't until the late 1990s that its potential was re-evaluated for turf (Stier, 1999).

Chlorflurenol and maleic hydrazide were the only two compounds during this time that showed sufficient turf growth reduction to warrant further examination. Chlorflurenol (methyl 2-chloro-9-hydroxyfluorene-9-carboxylate) was a foliar-absorbed compound that inhibited apical bud formation but stimulated lateral shoots. It was marketed as Maintain CF-125® (Watschke et al., 1992). Treated leaves had a darker green color than untreated plants. Additional testing showed the phytotoxicity did not warrant the marginal growth reduction of turfgrasses: in fact, it had better activity on broadleaf species. Maleic hydrazide inhibits cell division and has been used for years in the potato industry as a (leaf) desiccant applied prior to harvest. In turf it has been labeled as Royal Slo-Gro®. Although a great deal of research and observation was done in the 1950s and 1960s, its use has been largely relegated to roadsides and rights-of-way as it is too phytotoxic for use on most turfs.

The 1970's and 80's

During the 1970s newer turf growth retardants became available which promised less phytotoxicity than older chemistry. Mefluidide was commercialized in 1978 under the trade name Embark® and is still available. Unlike other foliar-applied growth regulators, mefluidide does not translocate well to other organs. It appears to inhibit both cell division and, at lower rates, possibly cell elongation (WSSA, 1983; Elkins,

1983). Embark effectively reduces foliar growth for several weeks after application. Embark is especially effective for controlling seedhead production of *Poa annua*. In some trials at Michigan State University I have seen it reduce seedhead formation over 90%. A number of users have reported reduced turf density following mefluidide applications (Watschke et al., 1992). Unfortunately it is too phytotoxic for use on bentgrass greens though it has been used on fairways where phytotoxicity is not quite as severe and is more tolerated. EPTC (S-ethyl dipropylthiocarbamate) has been sold for growth regulation and seedhead suppression on tall fescue. A number of studies were conducted on it in the mid 1980s. Despite good reactions with tall fescue EPTC caused unacceptable injury to Kentucky bluegrass. Consequently it failed to maintain a market for turf. Most other label uses have been cancelled due to environmental concerns.

Amidochlor, sold as Limit® beginning in 1985, inhibits cell elongation though also possibly cell division. Unlike mefluidide and maleic hydrazide, Limit is root absorbed. Less phytotoxic than mefluidide, Limit effectively reduces foliar growth and can inhibit seedhead development. When reports are reviewed collectively Limit is shown to have variable efficacy. Currently no amidochlor products are labeled for turf (PAN, 2006). All of the plant growth regulators (PGRs) discussed up to this point are loosely grouped together as Type I PGRs.

Gibberellic acid inhibitors

A new generation of turf growth regulators appeared in the 1980s with the advent of paclobutrazol. Paclobutrazol, and the chemically-similar flurprimidol, reduce vertical turf growth without generally reducing tillering or other development. In some cases tillering and even root growth can be enhanced. Both compounds act by inhibiting production of the plant hormone gibberellic acid (GA) and so have become known as Type II PGRs. The GA hormone is responsible for cell expansion but not cell division, allowing new shoots, roots, and tillers such as rhizomes and stolons to be produced. Leaves of treated turf tend to be darker green because cell expansion is reduced, causing chlorophyll to be condensed into a smaller surface area.

Both compounds are primarily root absorbed and the label states application must be followed by irrigation or rainfall. Growth reduction usually lasts for a minimum of 4-8 weeks though longer times are possible. In my own studies I have seen

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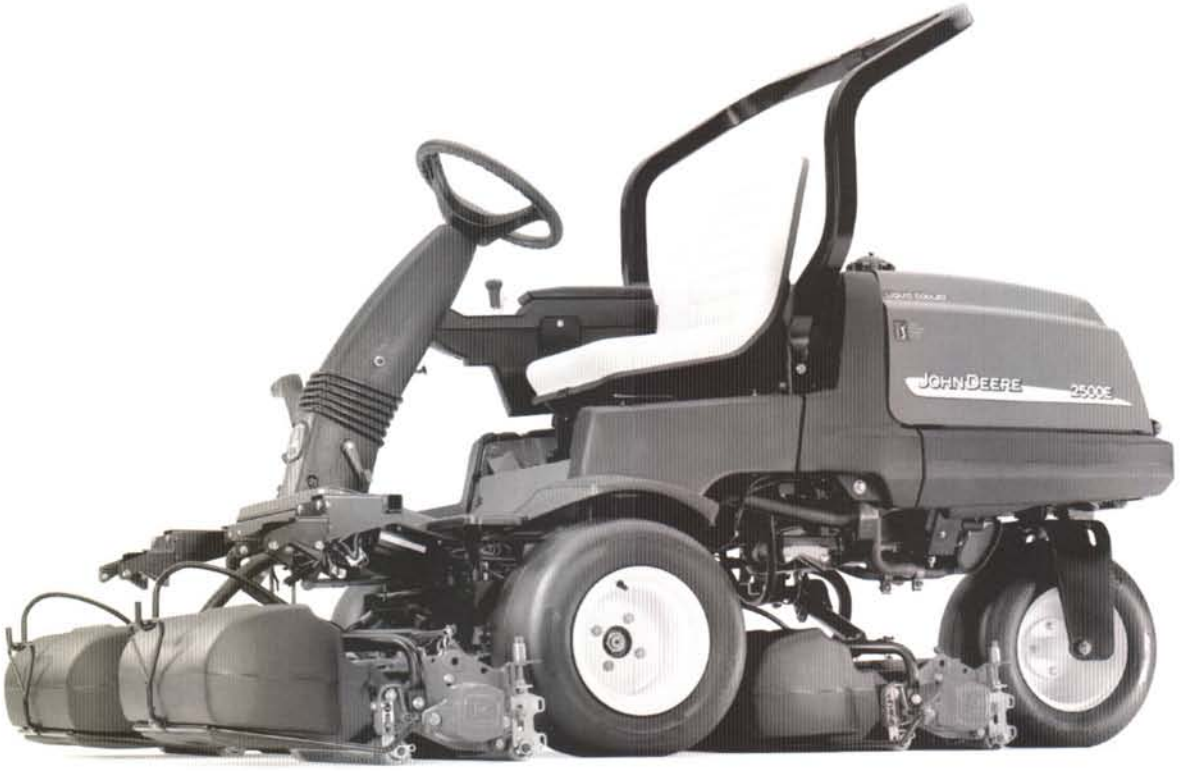

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stunting of turf 11 months after a June application which was not followed by irrigation or precipitation, indicating shoot absorption is possible. Both compounds were popular during the 1980s and early 1990s. Paclobutrazol remains fairly popular due to a long history with golf course superintendents who have incorporated its use into their *Poa* management programs. Flurprimidol remains a fairly minor product compared to paclobutrazol and the newer products discussed below.

In 1993 a foliar-absorbed Type II PGR was commercialized and changed the way PGRs were viewed and used. Though paclobutrazol and flurprimidol were significantly less phytotoxic than Type I PGRs, discoloration was still often a problem and masking the problem through iron application was not a thoroughly desirable solution. The need to irrigate or else time with rainfall also limited their application to primarily fairway, tee, and sometimes putting greens. The new Type II PGR was originally given the common name of cimectacarb which was changed to trinexapac-ethyl in 1994. The product was, and continues to be, marketed as Primo/Primo Maxx.

During the mid to late 1990s, turf managers who had never used PGRs before began relying on Primo. Primo has consistently displayed significantly less phytotoxicity on a range of turfgrass species compared to earlier PGRs. Its foliar-absorption is attractive to users as there is no need to irrigate following application. Some users decry its somewhat shorter window of activity, perhaps four weeks compared to six or eight for the other Type II PGRs. On the other hand the shorter activity allows more ready manipulation of the turf in case of stress. Moderate to high rates of nitrogen fertilizer can force new growth better than when soil-applied PGRs are used. As with any Type II PGRs an application of GA can bring the turf out of growth regulation though I suspect it may be easier to do with the foliar-applied trinexapac-ethyl compared to soil-applied compounds.

While trinexapac-ethyl can certainly reduce leaf clippings similarly to other Type II PGRs, many superintendents use it for enhancement of turf quality. It is not, however, nearly as effective as paclobutrazol for *Poa annua* control. In some cases users have noticed a "kick-back" effect: once the trinexapac-ethyl is fully degraded by the plant, treated plants exhibit a short term flush of growth greater than untreated turf. This is not typically seen when

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PGRs are routinely applied, with subsequent applications being applied as the effects of the former applications are dissipating.

Ethephon: A new look at an old compound

In the late 1990s a unique type of PGR was released for turf management. Sold as Proxy, the common name for the active ingredient is ethephon, which had first been tested for use on turf over thirty years ago. Ethephon is unique among turf growth regulators as the chemical, 2-chloroethyl phosphonic acid, is metabolized by plants to form ethylene gas. Ethylene gas is a natural plant hormone which stimulates ripening in fruits like bananas and is involved in plant senescence (aging). Growth reduction occurs because ethylene stops cell growth.

Aside from being the only hormone existing as a gas, ethylene is autocatalytic. In other words, ethylene production stimulates more ethylene production. The next time you buy green bananas at the store, place one bunch in a sealed container overnight and leave the other on the kitchen counter. The bunch sealed in the container will ripen significantly faster than the ones on the counter because the ethylene gas maintains contact with the fruit, stimulating production of even more ethylene gas. The unenclosed bananas take longer to ripen because the ethylene is quickly diluted by the ambient air.

When applied to turf ethephon can stimulate internode elongation though shorter leaves result in reduced clipping yield. In some cases a lighter green color occurs though it couldn't really be called phytotoxicity. Our results at the O.J. Noer facilty indicated its effects may last slightly longer than those of trinexapac-ethyl (Stier, 1999). Perhaps most interesting and useful were our observations that tank-mixes of ethephon with mefluidide resulted in nearly no *Poa annua* seed production at Blackhawk Country Club along with reduced bentgrass phytotoxicity (Stier and Gregos, 2001). Other researchers have noted similar activity almost as if the ethephon is protecting chlorophyll from the mefluidide. When ethephon is mixed with trinexapac-ethyl the time period for growth regulation is often enhanced by one to three weeks.

Table 1. Commercially available turf growth regulators.

Common name	Trade name(s)	Manufacturer/Distributor	Other
Mefluidide	Embark	PBI Gordon	Foliar-absorbed, seedhead prevention, phytotoxicity likely
Paclobutrazol	Varies	The Andersons/Scotts Co.	Root-absorbed
Flurprimidol	Cutless	SePro Corp.	Root-absorbed
Trinexapac-ethyl	Primo	Syngenta	Foliar-absorbed, enhanced turf quality
Ethephon	Proxy	Bayer	Foliar-absorbed

The bottom line

Type I PGRs usually have caused too much phytotoxicity to remain in the turf market. Mefluidide is one exception and is more effective for controlling *Poa annua* seedheads than any other PGR. Type II PGRs have less phytotoxicity than Type I and effectively limit clipping yields for usually four to eight weeks depending on the compound used and the environment. Many superintendents like the additional higher quality turf resulting from use of trinexapac-ethyl. Paclobutrazol remains a standard in many programs because it can reduce or at least prevent additional *Poa annua* encroachment. Ethephon is a unique PGR and can be effective by itself or mixed with either mefluidide or trinexapac-ethyl.

Applications of PGRs in the spring should start after complete spring greenup to avoid delaying greenup. For clipping yield reduction, PGRs have the greatest impact when applied in mid May to mid June since this is the period of time with greatest vertical leaf growth. Final applications of PGRs at the end of the growing season should be made early enough to allow full metabolism by the turf before winter. Applications made too late in the fall can delay spring greenup. In Wisconsin, root-absorbed PGRs should not be applied later than mid to late August depending on if the application is being made in northern or southern Wisconsin. Foliar-absorbed PGRs can be applied up to early September in northern Wisconsin and mid-September in southern Wisconsin.

Many PGRs have been assessed but only a few have consistently been used and marketed. The primary types available today are shown in Table 1.

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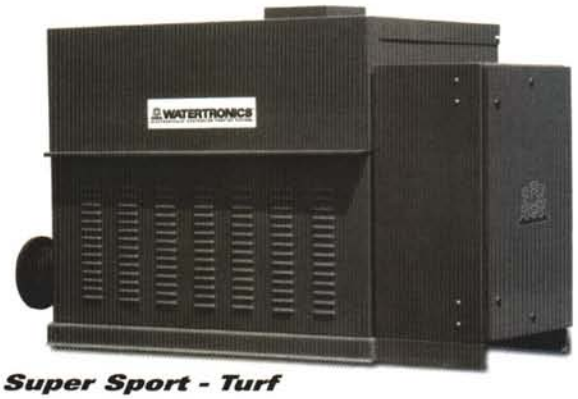

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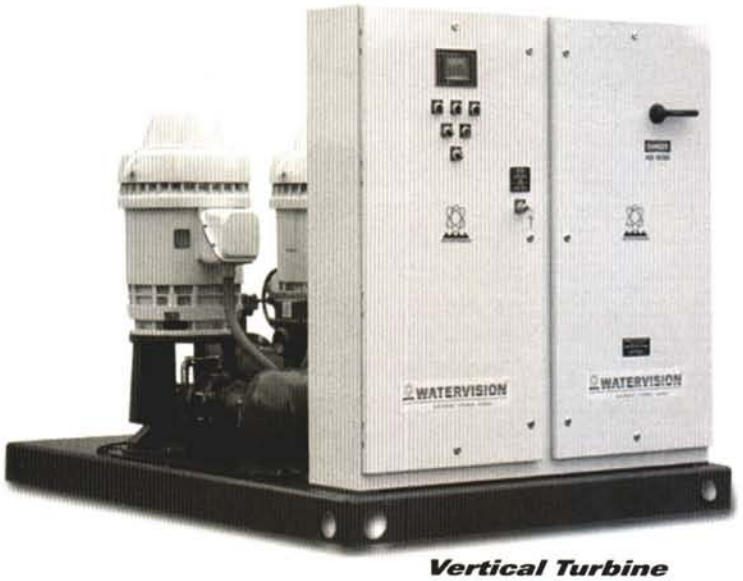

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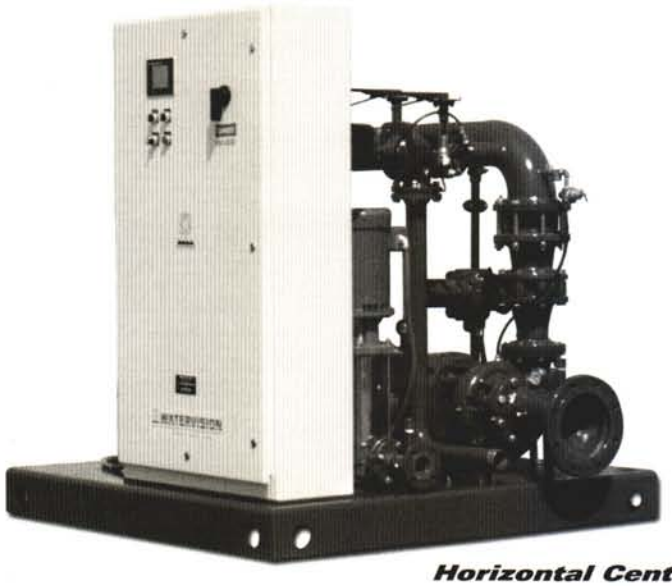

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