Annual bluegrass update: 12 years later

Has any progress been made since 1996 in superintendents' apparently never-ending struggle to control annual bluegrass?

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Twelve years ago, in 1996, I published an article in *GCM* titled "A historical perspective of annual bluegrass control" (5), which reviewed 85 years of attempts to control annual bluegrass *(Poa annua* L.) in golf course turf. The article began with the earliest pre-herbicide attempts to control annual bluegrass in golf greens by cutting it out with a knife and ended with the work being conducted at that time with herbicides and plant growth regulators (PGRs). Although various products had shown some regional successes, there was no universally effective answer to the annual bluegrass problem, other than completely sterilizing the soil with methyl bromide. Even that extreme procedure provided only temporary relief from the problem, and annual bluegrass generally found a way to reinfest the area in the years following treatment. The article ends with the observation that annual bluegrass tends to win the battle no matter what we throw at it. I also speculated that 50 years after the current generation of superintendents is gone, a new generation will still be talking about how to get rid of this difficult weed.

Getting personal with *Poa*

Much of the 1996 article was based on personal experience. Although I am not old enough to have observed the entire history of annual bluegrass control, I have been around long enough to observe many products and control methods come and go from the market. I was a student at Colorado State University in the late 1960s and early 1970s and entered the industry as an assistant superintendent in Boulder, Colo., in 1972. This was a very optimistic time in the industry, with many new developments such as methylene urea fertilizers, systemic fungicides, PGRs and a wide variety of new herbicides. Each annual conference brought a variety of new products, some of which actually did solve serious problems that had faced superintendents for years.

A big issue then, as it is today, was the control of annual bluegrass. One of the products being

Poa annua seedhead. **Photos by J. Fausey**

released as I entered the industry was endothal. Endothal was a PGR that could act as a herbicide to selectively remove annual bluegrass from cool-season turf. Endothal was going to "end it all" when it came to annual bluegrass. Finally, there was a truly effective control, and annual bluegrass had met its match. Before long, endothal was gone, and we had just as much annual bluegrass as before. About the same time, Po-San was released. Po-San was a combination of two PGRs that was again going to be the solution to the problem. As with endothal, it wasn't long before this product also disappeared.

The motivation for this article was a call from a former student in fall 2007. He had heard that a new annual bluegrass control was coming out soon that would be better than anything available in the past. I am not exactly sure what started this rumor, and I know of no herbicide on the horizon that would meet that expectation. However, it took me back to my days as a superintendent when there was always a new material just around the corner that would finally solve the annual bluegrass problem. Nothing had changed in 35 years.

What is *Poa annua*?

So, what is annual bluegrass, or "*Poa*" as it is commonly known in the industry, and why is it so hard to control? This species is difficult to describe. We know that it is a cool-season grass (has a C_3 photosynthetic system), but past that, it is filled with contradictions. It is generally considered a weed, but it is also commercially produced as a turf species (7). Although it is usually viewed as an unwanted invader, it's managed as the predominant turf in many locations because it simply takes over. It is particularly invasive at low mowing heights used on golf courses, but it also becomes a problem in lawns and sports fields in some regions. Both its common name and its Latin name indicate that it is an annual. Technically, it is a winter annual, meaning that it germinates in the fall and dies in the late spring or early summer after producing a seed crop. As those who work with this species know, that is not true of all annual bluegrass. Although there is usually a flush of seed production in the spring, it can produce seed throughout the season and can germinate almost anytime soil temperatures are warm enough. For a more complete discussion of the variations in life cycle, I would direct the reader to the 1996 article (5).

Persistence pays — for *Poa*

If it had been up to me to name this grass, I would not have called it *Poa annua*, I would have called it *Poa relentless*, the grass that never gives up. The hallmark of this species is persistence. I have talked with many superintendents who have tried to manually remove every plant of annual bluegrass from a newly established golf course with the intent of not letting it get established. This works for a while, usually about 10 years, but *Poa* is patient. (I realize that I'm giving a plant attributes that it cannot possibly have, but I don't care.) It will wait for the budget to change, or for the superintendent to leave, and it eventually takes over. If a control is found that provides some success in a particular region, the population can be reduced for a period of time. As soon as control strategies are stopped, the population goes back to where it started.

Poa annua's massive seedbanks in the soil give it a competitive advantage over creeping bentgrass.

Annual bluegrass is one of the most widely distributed weeds on earth. I have been teaching educational seminars for GCSAA for more than 25 years to superintendents from around the world. They come from different climatic zones, have different soil types, manage various species of turf and face a wide array of grass-related challenges, but nearly all of them have one problem in common: annual bluegrass. I often find that one of the main reasons that they take my "Fundamentals of Turfgrass Management II" seminar is for the discussion of *Poa annua* control, which usually sparks the liveliest debate.

Distribution

Why *Poa annua* is so widely distributed, and why it is so hard to get rid of once it becomes

established, has been the subject of much speculation over the years. There are clearly a number of complex, ecological factors involved in its distribution. Most biotypes have an incredible capacity for reproduction. They produce large amounts of seed each year that can remain viable in the soil for years (22). Mary Lush (16), who worked extensively with annual bluegrass, estimated that soil from an older green with an active population of annual bluegrass contains as many as 210,000 seeds/square meter, or approximately 19,500 seeds/square foot. This seedbank is one of the reasons that annual bluegrass has such an advantage over creeping bentgrass, which generally does not produce seed at low mowing heights.

Genetic diversity

One of the primary reasons for the success of *Poa annua* as a species is its genetic diversity, which is also why it is so hard to describe its attributes. Most annual bluegrass is tetraploid with 28 chromosomes, however, geneticists have also identified a number of diploid (14 chromosomes) types with physical and reproductive characteristics that vary from the tetraploid types (2,8). Annual bluegrass can be an annual or a perennial, which is a contradiction in terms. It can be a bunch grass or a stoloniferous grass. It can take on varying textures and shades of green within the space of a few yards. Those of us who conduct research on annual bluegrass control commonly see various biotypes of the species respond in widely varying ways to the herbicides and PGRs that we apply to it. I have personally observed effective control of one biotype with an experimental herbicide, only to find another biotype 50 miles away that was not damaged by 12 times the rate of the same material.

Annual bluegrass can produce seedheads at amazingly low mowing heights.

Two distinctly different *Poa annua* biotypes side by side on the same green. **Photos by N. Christians**

New research on genetic variation

I had a good understanding of the genetic variations that exist within this species when I wrote the 1996 article, but since then more work has clarified the point. In 2001, Van Cline of The Toro Co. completed a Ph.D. dissertation titled "Population dynamics of *Poa annua* L. on a northern golf course" (8). Cline conducted his work on an 80-year-old golf course in Edina, Minn., where annual bluegrass biotypes had many decades to acclimate to the varying conditions found on greens, tees, fairways and roughs. What he found was that there were real genetic differences among annual bluegrass biotypes from different areas on the course. The annual bluegrass biotypes from greens were capable of forming a highly dense stand, they put more of their energy into seed production and less into vegetative growth. They also produced large numbers of small seed. Annual bluegrass from the fairways and roughs took longer to reproduce and put more of their energy into vegetative growth. They produced fewer, larger seed than the types found on greens. Another researcher, Mary Lush, showed that tetraploid populations found in the greens on the course were relatively intolerant of high temperatures, whereas the diploid types collected from greens had a greater tolerance of high temperatures (17). She also found that when she tried to establish one biotype in the environment best suited for another biotype, the invader would generally not survive.

Cline also used a procedure known as random amplified polymorphic DNA (RAPD) to study genetic markers that can establish the existence of genetic differences at a molecular level among members of a population. After establishing profiles for 96 individual annual bluegrass plants collected under various levels of management on the golf course, he was able to show clear genetic differences within the group.

Control

So how about control? Has anything changed in 12 years? An electronic search of new publications on this subject on the Turfgrass Information File (TGIF; http://turf.lib.msu.edu/) from 1996 to the present lists between 500 and 1,000 publications on the subject, depending on how the search is conducted. Clearly, the subject generates a lot of interest.

Several of the products that were regionally successful in 1996 are still around. Prograss (ethofumesate) is still used on perennial ryegrass fairways. This remains one of the most successful materials for selective removal of annual bluegrass from cool-season grass fairways, but it is useful in the relatively small geographic area where perennial ryegrass is the predominant fairway species. Since 1996, gray leaf spot has reduced the size of this region. The giberellic acid (GA)-inhibiting PGRs Cutless (flurprimidol) and Trimmit (paclobutrazol) were also in use in 1996. These two products have proven effective in at least reducing populations of some biotypes of annual bluegrass, particularly in creeping bentgrass turf.

Proxy

Proxy (ethephon), another PGR with a different mode of action from that of the GA-inhibitors, has received some attention in the management of annual bluegrass in recent years. It is primarily a seedhead inhibitor (15). A few years ago, a number of us involved in research on this material compared our results at a *Poa annua* summit (1). As with many materials before it, we found that the results were highly regional, with the best inhibition reported by researchers from the western U.S.

Pendimethalin

Although pre-emergence herbicides have never been effective for annual bluegrass control, Bruce Branham (4) did some work with pendimethalin, a widely used pre-emergence herbicide, that indicated some post-emergence activity on annual bluegrass in Kentucky bluegrass turf when applied in a sprayable form at 3 pounds ai/acre (3.36 kilograms ai/hectare).

Poa annua loss from winter damage in the spring of 2008. Both the green and the collar were covered during the winter, but the *P. annua* on the collar died and the *P. annua* on the green survived. Could it be due to biotype differences?

Velocity

The principal herbicide for selective annual bluegrass control that has been released since 1996 is Velocity (bispryribac-sodium). This herbicide was originally developed for use in the rice industry and was registered in October 2004 for use on creeping bentgrass fairways and on bermudagrass fairways overseeded with perennial ryegrass (19). Velocity is a member of a group of herbicides known as acetolacetate synthace (ALS) inhibitors (3). Velocity has been reported to be very effective against annual bluegrass, although my personal observations have been that it may be somewhat biotype-selective. This, of course, has been the problem with every selective herbicide that we've used against this difficult weed since the beginning of herbicide research on the problem.

The other problem with Velocity is that it tends to yellow creeping bentgrass and other cool-season grasses. Although these grasses recover, the unsightly yellowing is a problem for superintendents and has limited its use. When annual bluegrass is the predominant species in a mixed annual bluegrass/creeping bentgrass stand, removing all the annual bluegrass at once with Velocity would result in unacceptable damage. In these situations, it has been proposed that GA inhibitors could be used first to reduce annual bluegrass populations to acceptable levels, followed by the use of Velocity to remove the rest of it (20). I have not tried this

myself, but it sounds like a reasonable approach.

I have watched the progress of Velocity closely since its release. Every time that I talk to a group of superintendents, I request a quick show of hands to find out how many are using the product and then hold some discussion on how well it's been working for them. The results have been mixed. Some superintendents have reported excellent results and are very pleased. Some report that the results are too good and that they had much more annual bluegrass than they realized. Others report more mixed results and express a lot of concern about the yellowing of desirable turf.

As with earlier materials, my recommendation is that this product be tried on a test area first to be sure that it can be used effectively on the course. Once an effective strategy has been developed, its use can be expanded to a larger area. Never apply a new material to the entire course until you are absolutely sure that you know how it's going to work.

Other herbicides

Other herbicides that have received some attention in recent years include Beacon (primisulfuron) (13), Certainty (sulfosulfuron) (18), TranXit (rimsulfuron) and Tenacity (mesotrione). Beacon has been tested for removal of annual bluegrass from Kentucky bluegrass at fairway mowing heights with promising results (13). Although it has a special 24-C label for use on Kentucky bluegrass seed production areas and sod farms in a few states, it has not been labeled for fairways at this time. Certainty is labeled for a variety of uses on cool-season turf, and has been shown to be of some use in reducing annual bluegrass from Kentucky bluegrass fairways (13). Its current label recommends that 1.25 to 2.0 ounces product/acre (87.6 to 140.1 grams/hectare) be applied to annual bluegrass in the early stage of growth before tillering. TranXit is limited to warm-season grasses and is currently used for annual bluegrass control in bermudagrass (24).

Tenacity (mesotrione) is just now being released for use in turf. It has a number of uses in Kentucky bluegrass, including the selective removal of creeping bentgrass (14), pre- and post-emergence control of crabgrass (*Digitaria* species), including control of crabgrass in spring seedings. The results have been mixed on the control of annual bluegrass in Kentucky bluegrass, and more work will be needed before it can be recommended for this purpose (21,23).

Genetically modified grasses

Finally, the most dramatic development in annual bluegrass control in recent years has come not from the development of a new herbicide, but from the field of molecular biology. This has been the development of Roundup Ready grasses. Roundup (glyphosate) is an older nonselective, post-emergence herbicide that kills most grasses and broadleaves. Scientists at the O.M. Scotts Co. of Marysville, Ohio, in conjunction with scientists from the Monsanto Co. of St. Louis, have found a way to insert the Roundup Ready gene into several grasses, including creeping bentgrass and Kentucky bluegrass.

The insertion of this gene results in a grass that is tolerant of Roundup, which in turn allows for the selective removal of annual bluegrass and other weeds that are not tolerant of the herbicide. This is a very creative approach to an old problem. At Iowa State University, we have worked extensively with these genetically modified grasses (9,10,11,12). These grasses are still under review by federal regulators and have not been released to the market as of the publication of this article. There are still a number of questions about their use, some of which I have discussed in a previous article (6). Overall, I believe that these genetically modified species hold a great deal of promise for providing greens and fairways that are free of annual bluegrass, and I'm looking forward to their release.

Velocity is labeled for removal of *Poa annua* from fairways, but superintendents should think carefully before removing *P. annua* from heavily infested turf. **Photo by R. Calhoun**

Conclusions

Have 12 more years of research brought us any closer to eliminating annual bluegrass from golf course turf? Clearly, the single herbicide that

will effectively and selectively control all types of annual bluegrass has not been found. It is still my opinion that such a herbicide will not be developed in the foreseeable future. Some products will continue to be regional successes in certain narrowly defined situations, such as Prograss in perennial ryegrass fairways. However, *Poa annua* is simply too genetically diverse for the development of that single magic bullet that will completely solve the problem. If anything would change my mind about superintendents still struggling with annual bluegrass 50 years from now, it would be the field of molecular biology. We're not there yet, but the incredible potential of this new field of science may still prove me wrong and give us the edge that is needed to finally beat this old enemy.

Literature cited

1. Anonymous. 2001. Summit takes aim at *Poa annua*. *Golf Course Management* 69(6):11.
2. Beard, J.B., P.E. Rieke, A.J. Turgeon and J.M. Vargas Jr. 1978. Annual bluegrass (*Poa annua* L.) description, adaptation, culture and control. Research Report No. 352. Michigan State University Agricultural Experiment Station, East Lansing.
3. Branham, B., and R. Calhoun. 2005. Velocity: *Poa annua* control at last? *Golf Course Management* 73(10):73-77.
4. Branham, B., and W. Sharp. 2005. Pendimethalin controls *Poa annua* postemergence. 2005 Annual Meeting Abstracts ASA/CSSA/SSSA/CSSS http://crops.confex.com/crops/2005am/techprogram/P8163.HTM (verified April 22, 2008).
5. Christians, N.E. 1996. A historical perspective of annual bluegrass control. *Golf Course Management* 64(11):49-57.
6. Christians, N.E. 2006. Control options: What's next for *Poa annua* control? *Grounds Maintenance* 41(3):28-30, 33.
7. Christians, N.E. 2008. Fundamentals of turfgrass management. 3rd ed. John Wiley and Sons, Hoboken, N.J.
8. Cline, V.W. 2001. Population dynamics of *Poa annua* L. on a northern golf course. Ph.D. dissertation, University of Minnesota, St. Paul.
9. Dant, L.A. 2005. Rapid conversion of golf course turf to glyphosate-resistant creeping bentgrass. M.S. thesis, Iowa State University, Ames. ISU 2005 D 367.
10. Dant, L., and N.E. Christians. 2004. Path to conversion: Research focuses on the best way to convert conventional turfgrass areas to Roundup Ready creeping bentgrass. *Grounds Maintenance* 39(7):61-68.
11. Dant, L.A., and N.E. Christians. 2005. Control of glyphosate-resistant creeping bentgrass with postemergence herbicides. 2005 Iowa Turfgrass Research Report, p. 31-35.
12. Dant, L.A., N.E. Christians and S.Z. Fei. 2005. Timing of Roundup application critical when converting golf course turf to Roundup Ready creeping bentgrass. *International Turfgrass Society Research Journal* 10 (Part 1):333-338.
13. Hart, S.E., and P.E. McCullough. 2007. Annual bluegrass (*Poa annua*) control in Kentucky bluegrass (*Poa pratensis*) with bispyribac-sodium, primisulfuron, and sulfosulfuron. *Weed Technology* 21(3):702-708.
14. Jones, M.A., and N.E. Christians. 2008. Controlling creeping bentgrass in Kentucky bluegrass: A new herbicide safely and effectively removes creeping bentgrass from Kentucky bluegrass. *Golf Course Management* 76(3):121-124.
15. Kopec, D.M., J. Gilbert and M. Bates. 2004. Application of Proxy PGR for *Poa* seed head suppression. 2004 Turfgrass, Landscape and Urban IPM Research Summary. College of Agriculture & Life Sciences, The University of Arizona. http://cals.arizona.edu/pubs/crops/az1359/index.html (verified April 22, 2008).
16. Lush, W.M. 1988. Biology of *Poa annua* in a temperate zone golf putting green (*Agrostis stolonifera*/*Poa annua*) II. The seed bank. *Journal of Applied Ecology* 25(3):989-997.
17. Lush, W.M. 1989. Adaptation and differentiation of golf course populations of annual bluegrass (*Poa annua*). *Weed Science* 37:54-59.
18. Lycan, D.W., S.E. Hart and J.A. Murphy. 2005. Annual bluegrass control in Kentucky bluegrass with sulfosulfuron. *International Turfgrass Society Research Journal* 10 (Part 2):1222-1226.
19. McCarty, B., and A. Estes. 2005. A new weapon in the fight against *Poa annua*. *Golf Course Management* 73(2):106-109.
20. McCullough, P.E. 2006. Annual bluegrass control: Implications for eliminating a historic weed in golf course turfgrass. *Golf Course Management* Web Exclusives October. www.gcsaa.org/GCM/2006/oct/WebEx.asp (verified April 22, 2008.)
21. Reicher, Z., and D. Weisenberger. 2005. Long-term *Poa annua* control strategies with mesotrione and Dimension. 2005 Annual Report: Purdue University Turfgrass Science Program. www.agry.purdue.edu/turf/report/2005/index.htm (verified April 22, 2008).
22. Roberts, H.A., and P.A Feast. 1973. Emergence and longevity of seeds of annual weeds in cultivated and undisturbed soil. *Journal of Applied Ecology* 10:133-143.
23. Sharp, W., and B.E. Branham. 2005. *Poa annua* control and mesotrione — a new herbicide with promise. 2005 University of Illinois Turf & Nursery Field Day. p. 22-23. www.turf.uiuc.edu/2005%20Field%20Day%20Booklett2.pdf (verified April 22, 2008).
24. Walker, R.H., G.R. Wehtje and J.L. Belcher. 2003. *Poa annua* control with rimsulfuron. *Golf Course Management* 71(3):120-123.

GCM

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The research says

→ Annual bluegrass is highly successful because it produces such large amounts of seed that enormous numbers remain in the soil as a seedbank; it is also very genetically diverse, adapting to all types of environments and evading chemical control.

→ No one product has been able to control annual bluegrass in all situations, but some products have been useful in limited areas: Prograss on perennial ryegrass fairways; Cutless and Trimmit for reducing some biotypes; and Proxy for reducing seedheads. Pendimethalin may have post-emergent activity on annual bluegrass in Kentucky bluegrass.

→ Velocity is successful in controlling annual bluegrass, but often causes unacceptable yellowing of creeping bentgrass and other cool-season grasses. It also can remove all the annual bluegrass in a stand, leaving very little turf.

→ Beacon, Certainty and Tenacity all show some promise in removing *Poa annua* from Kentucky bluegrass, but Beacon has not been labeled for fairways and Tenacity has received mixed reviews.

→ The field of molecular biology may hold the key to controlling *Poa annua* in the future.