The Riddle of Poa Annua Management: Can it Be Solved?

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NOTE: June 23, 1997: Second Annual CAPCA/PTRI Turfgrass Research Seminar at Pala Mesa Resort, Fallbrook, CA: The enclosed flier outlines a technically oriented program that we hope will provide you with new insights and creative applications of basic research for solving turfgrass management problems. Last year's meeting was attended by 150 superintendents, and this year's turn-out should be even larger. Seating is limited, however, so mail in your registration now! We hope to see you there.

When is a weed not a weed? When is an annual plant not an annual plant? And when does one species of a grass act like hundreds of different species? These and many other questions frame the dilemma of annual bluegrass (*Poa annua*), a weed that superintendents and researchers have tried -- and mostly failed -- to effectively control since the 1920s. In the February, 1996 issue of PACE Insights we concluded that conversion of primarily poa greens to bentgrass was well nigh impossible, and that in many cases superintendents would be better off cultivating poa rather than trying to kill it. There are, however, many situations in which efforts to control poa are an important part of golf course operations. This issue of PACE Insights is devoted to reviewing our current situation with regard to poa control, and suggesting some directions for future research.

Poa annua: Why is it so difficult to control?

Imported from Europe and currently widespread throughout North America, the growth of annual bluegrass is cultivated on some golf courses where moderate climates makes the advantages of this turf (upright growth habit that lacks grain, high shoot density, aggressive growth, shade tolerance, compaction tolerance) outweigh the disadvantages (almost continuous production of seed heads causes bumpy putting surfaces, susceptible to heat, drought, salinity and insect and disease pressure). In most cases, however, poa is perceived as a weed, and one of the most difficult to control golf course weeds in history.

The poa seed bank: Why is poa so difficult to control? First of all, it is one of the few grasses on the golf course that produces seed on an almost year round basis. While seed production is highest in the late spring, some seed is produced almost every month of the year. This seed can survive in the soil for six years or more (Christians, 1996). As a result, there is a huge **poa seed bank** in the soil at all times, ready to germinate whenever conditions are right. This makes the possibility of even temporary eradication of the weed almost impossible.

Biotypes and more biotypes: Genetic diversity is an important strength of annual bluegrass. In fact, there are not just one or two types of *Poa annua*, but rather hundreds of different biotypes, with significant differences in color, texture, rate of growth, timing and degree of seed production. We frequently (and erroneously) talk about two biotypes of poa annua -- the annual biotype known as *Poa annua annua* (characterized by seed germination in late summer, growth during fall and winter, and seed production followed by death in the spring) and the perennial biotype known as *Poa annua reptans* (characterized by increased tillering, decreased flower production and denser growth habit), but in fact there is a continuum of biotypes between these two extremes. It has been estimated that there are usually five to twenty different biotypes of poa annua on a given putting green! (Cook, 1996). What this means is that even when conditions are sub-optimal for one biotype of poa, they will probably be conducive for growth of some of the other biotypes. In this way, poa outcompetes desirable turfgrasses, which are monocultures with only one genetic biotype to fall back upon. In addition, many herbicides are active against only certain biotypes (usually the annual biotypes are more sensitive), making consistently high levels of control difficult, if not impossible. Finally, the presence of multiple biotypes enhances the possibility of development of poa resistance to herbicides. Resistance of poa to such widely used products as Prograss, Kerb and Princep have been documented in the southeast, and is likely to occur as we use more of these products in the West.

Similarity to desirable turf: Control of poa on non-overseeded warm season fairways is possible, primarily because we have available to us selective herbicides which are toxic to the cool season poa, but not to warm season turf. In contrast, control of poa on bentgrass greens and

on overseeded fairways is difficult, because herbicides (with the exception of products like Prograss) that are toxic to poa tend to be somewhat toxic to bentgrass and particularly to seedling ryegrasses and *Poa trivialis.* As a result, phytotoxicity is a concern when poa control is attempted under these conditions.

California, California, California: In our state, we have some unique conditions that contribute to the challenge of managing poa. First and foremost, our moderate climate favors year round production of poa seed, whereas in cooler areas of the country, poa is out of commission for a part of the year. In a related problem, much of our poa here has a perennial habit (making the name "annual bluegrass" a misnomer), which means that the plant can survive and spread via tillering, rather than by seeding. This means that pre-emergent herbicides, which are targeted against germinating seedlings, will have no effect on non-seeding perennial biotypes. Finally, the increasing use of *Poa trivialis* for overseeding makes control of the closely related *Poa annua* more difficult, because herbicides and cultural practices directed against *Poa annua* will likely have a negative effect on *P. trivialis* as well.

Management of Poa annua: Cultural Practices

There are some features of poa biology which we can take advantage of in developing management programs, including:

Clipping removal on greens and fairways has been shown to decrease poa levels (Gaussoin and Branham, 1989). There are several possible reasons for this, including the presence of poa seed in clippings, as well as the possibility that poa clippings contain toxins, or allelochemicals, that inhibit the growth of other turfgrasses.

Irrigation: Because poa is a shallow rooted plant, daily, light irrigation favors its growth. In contrast, deep and infrequent irrigation will favor turfgrasses with deeper root systems.

Fertility: Various publications advocate the use of moderate nitrogen and potassium to decrease poa survival. Research trials however, (Gaussoin and Branham, 1989), indicate that changes in fertility had little impact on poa survival.

Turf variety selection: It stands to reason that poa invasion will be inhibited if the desirable turfgrass species is healthy and highly competitive. Results of bentgrass variety trials in the National Turfgrass Evaluation Program (NTEP) (Harivandi and Hagan, 1995) and in an independently conducted trial at Mesa Verde Country Club (Reed Yenny, superintendent) bear this out. In these trials, researchers have found that the highest quality bentgrasses were those most likely to resist poa invasion (see Table 1 and Table 2 below). Therefore, selection of the bentgrass variety most likely to produce a dense, healthy stand under your golf course's conditions will be less susceptible to poa invasion. It should be pointed out, however, that none of the bentgrass varieties tested were able to completely stop poa invasion over a period of 3 or more years, with 8 - 10% poa invasion the best that can be expected from varieties such as Southshore, Cato, Crenshaw, SR 1020 and Cobra.

Mechanical control of poa, via the use of knives, ice picks, propane torches and hand weeding has been practiced on golf course greens since at least 1915 (Christians), and is still practiced today, with great success, at several California courses. While this type of program requires vigilance and high intensity labor, it is the one approach to poa control that consistently works. The caveat is that the program must begin when greens are new and poa invasion is less than 1 to 2 percent.

Table 1. Mean bentgrass quality and Poa annua invasion of bentgrass varieties under greens maintenance conditions. Mesa Verde Country Club, 1993 - 1997. Quality was rated on a scale of 1 - 9, with 9 the best possible turf. Numbers followed by the same letter are not significantly different (Fisher's LSD, $p<0.05$).

Variety	Quality	% poa invasion
Southshore	8.23 h	8.00
Crenshaw (SYN 3)	8.10 gh	11.67
Cato (SYN 4)	8.03 gh	15.00
C-N-C (SYN 12)	8.00 fg	9.00
SR 1020	7.83 f	11.67
Providence	7.52 e	15.67
Putter	7.51 e	15.00
Pennlinks	6.74 d	16.67
Carmen	6.70 d	16.67
Cobra	6.33 c	16.67
Regent	6.20 bc	30.00
Penncross	6.13 b	25.00
National	6.13 b	15.67
Emerald	5.16 a	36.67

Table 2. Mean bentgrass quality and Poa annua invasion of bentgrass varieties under greens maintenance conditions at Sunnyvale Golf

Course, 1991 - 1993. Data from Harivandi and Hagan, 1995. Quality was rated on a scale of 1 - 9, with 9 the best possible turf.

Variety	Quality	% poa invasion
Cobra	6.3	11.8
SR 1020	6.1	10.7
TAMU-88-1	6.0	12.0
Pro/Cup	5.9	27.1
Putter	5.9	11.1
Regent	5.9	15.7
Penncross	5.7	14.9
Pennlinks	5.7	16.0
Carmen	5.4	22.8
Emerald	5.4	20.8
Egmont	5.1	26.8
National	4.9	42.8
Tracenta	4.4	46.2
Bardot	4.3	42.1
Allure	4.2	48.6

Biological control products: For several years, Mycogen Corporation was developing a bacterial herbicide based on the bacterium *Xanthomonas campestris,* for control of poa. Unfortunately, inconsistent results have led the company to drop this product from commercial consideration in the U.S. At this point, there are no other biological controls for poa that are being actively developed.

Although the cultural controls above are worth investigation at your course, their impact will probably be minor, and we should not expect any one practice (with the exception of mechanical control) to produce more than very small decreases in poa populations.

Management of Poa annua: Chemical Products

As Table 3 (see insert) illustrates, there is no dearth of products that are labeled for poa control. Yet despite this fact, poa control at most courses is less than optimal, particularly on greens and overseeded fairways. All of the reasons mentioned above contribute to the problem -- the difficulty of controlling all poa biotypes with a single herbicide, the related problem of the development of herbicide resistance, the sensitivity of desirable turf to many of the poa control herbicides, and difficulty in accurately timing herbicide applications to achieve optimum efficacy without damaging turf. And since pre-emergence herbicides target germinating seedlings, this last issue is particularly important for golf courses that overseed and cannot afford to have herbicides targeted against poa affecting the germinating rye or other overseeded turf. For this reason, many pre-emergence herbicides have specific instructions to avoid application within a certain number of weeks or months before overseeding (see Table 3). While these prohibitions help protect turf, they also unfortunately decrease the flexibility of pre-emergent products. In addition, because restrictions force us to use pre-emerge materials so early in the year, their effectiveness has worn off by the time they are really needed -- in the fall, when poa germination peaks.

Where do we go from here?

The information above highlights the depressing fact that there is no one perfect herbicide product, and no one perfect management program that will solve the riddle of poa control in California, especially for greens and overseeded turf. Yet there are some rays of hope. For non-overseeded fairways, poa control programs that combine several of the control practices discussed above (cultural management, the use of pre- and post-emergence herbicides) can be successful, although testing at your golf course (see below) will be required to determine the optimal program. There are also some actions we can take now to improve this situation, including:

Applied research: Efficacy, timing and rates of the products listed in Table 3 have not been fully explored under California conditions. For example, there is evidence from researchers Fred Yelverton (North Carolina State) and Bert McCarty (University of Florida) that the pre-emergence product Ronstar can be applied up to 6 - 8 weeks before overseeding without damage to ryegrass, as opposed to the 4 month restriction on the current label. If repeatable in California, this would provide us with a good, long residual product for poa control on overseeded fairways. At PTRI, we plan to start testing with this product in the next month, with the support of Rhone-Poulenc. Similarly, researchers in the southeast report good to excellent results with the plant growth regulator paclobutrazole (Scott's TGR or Turf Enhancer) which selectively slows the growth of poa vs. other grasses. This product is not currently registered in California, but we plan to investigate its efficacy, as well as that of several other products. We also hope to evaluate the cumulative effect of the use of several products over a period of years, since one or two applications may not tell the whole story.

On-site testing: You have often heard that each golf course is different, and that new products and management practices must be tried on your own site to determine efficacy. This statement has never been more true than when we talk about poa, since each golf course potentially has a unique grouping of poa biotypes, each with differing responses to cultural and chemical control practices. Remember to always take good notes on products rates, application dates, and results and always leave an area that is non-treated. If you have any questions at all about setting up a testing program of this sort, please give us a call.

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Table 3. Some chemical control options for *Poa annua*. Always apply products according to the label directions on the container.

ACTIVE INGREDIENT	TRADE NAME	LABELED USES	ISSUES
PRE-EMERGENCE CONTROL OF POA			
benefin	Balan	certain cool & warm season tees, fairways & roughs	- not labeled on bentgrass - must be applied >6 weeks before overseeding - weak residual activity (30 - 60 days)
benefin + oryzalin	XL	tall fescue/warm season fairways & roughs	
bensulide	Betasan	cool & warm season turf	- active only on annual biotypes - must be applied >4 months before overseeding - weaker residual activity (30 - 60 days)
bensulide + oxadiazon	Goosegrass/Crabgrass Control	cool & warm season greens, tees, fairways & roughs	- not labeled for poa control; only for crabgrass and goosegrass - must be applied >4 months before overseeding
fenarimol	Rubigan	bermudagrass greens & tees	- effective only on annual biotype - will be labeled for use on fairways soon - must be applied >2 - 4 wks before overseeding
flurprimidol	Cutless	cool & warm season tee, fairways & roughs; bentgrass greens	- PGR used for gradual poa to bentgrass conversion - inconsistent results in university trials - not registered on turf in CA
oryzalin	Surflan	tall fescue/warm season fairways & roughs	
oxadiazon	Ronstar	cool & warm season tees, fairways & roughs	- must be applied >4 months before overseeding
paclobutrazol	TGR Turf Enhancer	cool & warm season turf	- PGR used for gradual poa to bentgrass conversion - very good to excellent results - not registered on turf in CA
pendimethalin	Pendulum	cool & warm season tees, fairways & roughs	- may damage overseeded warm season grasses - must be applied >3 months before overseeding
prodiamine	Barricade	cool & warm season tees, fairways & roughs	-must be applied >4 months before overseeding
trinexapac-ethyl	Primo	cool & warm season tees, fairways & roughs; for greens, bentgrass, Tifdwarf & Tifgreen only	- plant growth regulator used for gradual poa to bentgrass conversion - inconsistent results in university trials
PRE- AND EARLY POST-EMERGENCE CONTROL OF POA			
dithiopyr	Dimension	cool & warm season greens, tees, fairways & roughs	- phytotoxic to some creeping & Colonial bentgrass, Tifgreen bermudagrass & some fine fescues - active on only some poa biotypes
ethofumesate	Prograss	cool & warm season tees, fariways & roughs; on bermudagrass only if dormant	- safe for perennial rye, even in seedling stage - cannot be applied within 8 wks after PGR application - poa resistance has been documented - may be used on overseeded turf, but spring green-up of bermudagrass may be negatively impacted
pronamide	Kerb	bermudagrass	- active only on annual biotypes - must be applied >3 months before overseeding - resistance observed in southeastern U.S. - weaker residual activity (30 -60 days)
simazine	Princep	warm season fairways	- poa resistance documented in some areas
POST EMERGENCE CONTROL OF POA			
glyphosate	Roundup	for use on dormant bermudagrass only	- for spot applications, can be applied w/rope or sponge wick applications where absorbent material containing Roundup is rubbed onto the weed

PGR = plant growth regulator