BY ADAM VAN DYKE, M.S., PAUL G. JOHNSON, PH.D. AND PAUL R. GROSSL, PH.D.

Honing in on humic substances

Researchers in the Intermountain West find that humic substances may provide other benefits, but they may not improve turf quality or reduce water or P fertilizer on putting greens.

Creeping bentgrass (*Agrostis stolonifera* L.) is the predominant cool-season grass grown and managed on putting greens in the Intermountain West region of the United States. While adapted to golf course conditions, both the climate and calcareous soils of the region can impose difficult growing conditions for this and other turfgrass species. The large transpiration gradient created by warm temperatures and low humidity during the summer can create stressful conditions for bentgrass growth. Plus, sand root zones have low water-holding capacity that requires frequent irrigation. The calcareous sand commonly used in the Intermountain West has a relatively high pH (~ 7.5-8.5), making phosphorus and some micronutrients less available to the turf. In addition to these challenges, many golf course superintendents are expected to reduce water use, especially during droughts, and minimize fertilizer use while still maintaining high-quality turf. Thus, they're always seeking ways to be more efficient with their management practices while improving turf health.

To meet these demands, one management practice that's often implemented is the use of natural organic products, such as those containing humic substances. However, many questions exist regarding their effectiveness and what exactly these products can do for putting green turf (8).

Humic substances are a component of soil humus, which can be divided into fractions of fulvic acid, humic acid and humin, depending on their solubility as a function of pH (literature cited 13). Humic substances have been studied and used on a variety of agricultural crops for years, but only in the last 20 years have they been studied on turfgrass systems. Of the humic substances that have been studied, humic acid is the most common, but results with creeping bentgrass have been highly variable (4).

Humic substances increased photosynthesis in creeping bentgrass (9, 17) and root mass (9) and length (4) in controlled studies. However, similar responses have not been observed in the field (7).

The lack of responses on turf when using humic substances in the field may be attributed to the difficulty in isolating the effects of nutrients and other ingredients often included in humic substance products, and the confounding effects of the variability and uncontrolled nature of field conditions.

Regardless of the inconsistencies that have been reported, products containing humic substances are common in the turf industry, with claimed benefits including the ability to increase soil moisture and nutrient availability.

While the positive growth effects of humic substances on creeping bentgrass have been well documented, scientific literature on improved moisture retention in putting greens has not. Our study tested organic acids, including a pure humic acid, and commercial humic substance products on established putting greens to test their effects on 1) water retention, and 2) uptake of nutrients by creeping bentgrass in sand.

Table 1. Effect of organic acid and humic substance products on volumetric water content of soil and chlorophyll content (color) of creeping bentgrass at golf course locations in 2006.

Treatment	Volumetric Water Content[y]	Chlorophyll Content[z]
	(%)	(color index)
Control	17.6 a[x]	226 ab
Citric acid	17.4 ab	230 a
H-85	17.1 ab	226 ab
Focus	17.0 ab	226 ab
Fulvic acid	16.9 ab	226 ab
Tannic acid	16.8 ab	227 ab
Launch	16.8 ab	223 b
Humic acid	16.0 b	228 a

x Means within same column with same letter are not different significantly P=0.05.
y Volumetric water content measured with a TDR probe.
z Chlorophyll content measured with a CM-1000 chlorophyll meter.

PUTTING GREEN EXPERIMENTS

Two experiments were conducted with humic substances. One involved three golf courses in Utah, and the other took place at a research putting green at Utah State University. Organic acids, including a pure humic acid, and commercial humic substance products were applied to established creeping bentgrass putting greens. Evaluations were done during the summer growing season (June, July and August) of 2006 and 2007 at the research putting green at Utah State University and in 2006 at the three golf courses in Utah.

The research sites for this experiment were the Utah State University Greenville Research Farm in North Logan, Birch Creek Golf Course in Smithfield, The Country Club in Salt Lake City and Talons Cove Golf Course in Saratoga Springs. At the golf courses, plots were laid out on practice putting greens. The root zones consisted of primarily calcareous sands. None of the putting greens were built to USGA recommendations, with the research putting green being the closest of all the sites. At the research putting green, the sand mix contained higher percentages of fine (14 percent) and very fine (9 percent) sand particles. The Talons Cove putting green was built to California-style specifications. The Country Club and Birch Creek greens were native soil push-up greens with sand top-dressing applied. In all locations, the putting green turf was predominantly creeping bentgrass (*Agrostis palustris* L.) with varying percentages of annual bluegrass (*Poa annua* L.). Cultural practices at all of the locations were considered typical for the Intermountain West region of the United States, but were different at each. At the three golf courses, the putting greens were used extensively by golfers, but no traffic was applied on the research putting green at Utah State University.

>> SUMMARY

Humic substances are often used as an amendment in putting greens to improve turf health, but little is known about their effects on soil moisture retention. Commercial humic substance products and pure organic acids were applied to three golf course putting greens in Utah in 2006 and the Utah State University research putting green in 2006 and 2007. These treatments were evaluated for effects on soil volumetric water content, phosphorus (P) uptake and chlorophyll content of creeping bentgrass. Three irrigation levels, 80 percent, 70 percent and 60 percent of reference evapotranspiration (ET_0) were imposed on the turf at the research putting green.

RESULTS INDICATE:

- **Humic substances did not increase moisture retention in putting green soils as pure humic acid significantly decreased soil volumetric water content compared to the control. Both humic acid- and fulvic acid-treated plots had lower soil moisture content readings than the control at a depth of 10 to 15 centimeters during the growing season.**
- **Uptake of P by creeping bentgrass was significantly decreased with the application of humic acid.**
- **No differences were observed for chlorophyll content of the turf with any humic substance treatment, suggesting turf color is not enhanced when using humic substances.**

EXPERIMENT DESIGN AND DETAILS

Individual organic treatment plots measured 5 feet by 5 feet with three replications. At the research putting green only, each block of organic treatments was centered in a 35 feet by 35 feet irrigation block where different irrigation levels were applied. Irrigation treatments consisted of 80 percent, 70 percent and 60 percent of reference evapotranspiration (ET_0) replaced (1). The ET percentages imposed on the turf corresponded to watering approximately every two to three days for 80 percent, every three to four days for 70 percent and every four to five days for 60 percent, depending on the weather conditions. Evapotranspiration replacement percentages were determined by a Weather Reach controller. The irrigation blocks and individual treatment plots were not re-randomized in 2007 at the research putting green to reduce any confounding factors of possible residual effects from these products occurring in the soil over time. The experimental design, except for irrigation levels, was the same at each golf course. Irrigation treatments were not possible at the golf courses, but irrigation was reduced to stress the turf at the superintendents' discretion.

TREATMENTS AND APPLICATION TECHNIQUES

The plots were treated with reagent grade organic acids, four commercial humic substance products and evaluated against a water-only control. These treatments included the organic acids citric acid (4 ounces per 1,000 square feet), tannic acid (3.2 ounces per 1,000 square feet), and leonardite humic acid (2.8 ounces per 1,000 square feet). The commercial products included three humic acid products, H-85 (6 ounces per 1,000 square feet), Focus (7.5 ounces per 1,000 square feet) and Launch (15 ounces per 1,000 square feet), and a fulvic acid (40 ounces per 1,000 square feet). The commercial humic substance products were selected because of humic substance content, particularly humic acid and availability to turf managers in the Intermountain West.

Applications were made at recommended label rates for the commercial products, the rates of application for the fulvic acid and organic acid treatments were normalized to equal carbon rates between these products. Three separate applications were done approximately 30 days apart, according to the label, on June 7, July 5 and Aug. 3, 2006, at Birch Creek golf course, and June 1, July 6 and Aug. 2, 2006, at the Salt Lake Country Club and Talons Cove golf courses. Applications at the research putting green were done on June 5, July 5 and Aug. 4, 2006, and June 1, July 2 and Aug, 1, 2007. All treatments were applied with approximately 605 GPA of water and made using a CO2 backpack sprayer at 40 psi.

EVALUATION OF TREATMENTS

Moisture content of the root zones was

monitored weekly throughout the summer growing period using a handheld time-domain reflectometry (TDR) probe. The Campbell Scientific TDR 100 device was connected to a Campbell Scientific CR10X datalogger and a power supply that was assembled to be portable in the field. The TDR probe was assembled and calibrated for determining volumetric water content for this application using Win TDR software, and the water content measurement was averaged over the length of the probe. A 6-inch probe was used at the research putting green and Talons Cove golf course, but a 4-inch probe was needed at the Birch Creek and Salt Lake Country Club golf courses because of a shallow sand layer. At the research putting green only, measurements were taken daily for two weeks at the end of July and again in August in both years. This was done to track soil water content more accurately when the different irrigation levels were being applied. Turf color also was measured using a CM1000 chlorophyll meter (Spectrum Technologies) at approximately 3 feet off the ground on the same days soil volumetric water content was measured. The chlorophyll index measured by this meter has been highly correlated with visual color ratings (10). Chlorophyll measurements were taken at three random locations within in each plot and averaged to get the plot mean. Measurements were taken between 11 a.m. and 1 p.m.

Leaf tissue was collected in 2006 and 2007 to evaluate nutrient uptake effects of the treatments. This was only possible at the research putting green site due to greater control over the management practices. Leaf tissue was collected with a walking greensmower at the end of August and analyzed for elemental content, most notably for phosphorus. Due to cost constraints, only tissue from the pure humic acid-treated plots and the control were collected. Leaf tissue also was collected prior to the experiment in each year to provide a baseline of tissue elemental concentrations.

EFFECTS ON SOIL MOISTURE RETENTION

Overall, no differences in soil volumetric water content were observed for any treatment in either experiment. Even though the organic treatment effect was not significant in the golf course experiment or the research putting green experiment in 2006, when means were compared, water content readings indicated some differences. The soil volumetric water content for the humic acid-treated plots was significantly lower than the control plots at the golf courses (see Table 1 on page 74). At the research putting green in 2006, the soil volumetric water content for plots treated with humic acid and fulvic acid were significantly lower than the Launch-treated plots, and the fulvic acid-treated plots were significantly lower than the control plots (see Table 2, below). Throughout the experiments, the control plots had one of the highest volumetric water content means, while the humic acid- and fulvic acid-treated plots usually had one of the lowest. We also observed a decrease in soil moisture retention in a greenhouse experiment where humic acid was applied to simulated USGA putting greens, as turf irrigated with humic acid resulted in faster drying of the soil and more frequent irrigations than the control treatment (15). Previous research has shown that humic substances may have the potential to reduce soil moisture by adsorbing to, and enhancing, the water repellency of surface soil layers (16).

EFFECT ON TURF CHLOROPHYLL CONTENT AND NUTRIENT UPTAKE

Little or no differences in the color of the turf as measured by the chlorophyll meter were observed for any treatment in either experiment. Even though the organic treatment effect was not significant in the golf course experiment or research putting green experiment in 2006, mean separation of chlorophyll meter readings indicated some differences. The citric acid- and humic acid-treated plots were significantly higher than the Launch-treated plots at the golf courses (Table 1). At the research putting green, chlorophyll meter readings for the control and tannic acid-treated plots were significantly higher than the H-85-treated plots in 2006 (Table 2).

Phosphorus uptake as measured by leaf tissue concentration was significantly influenced by the treatments in 2006, but not in 2007 (see Table 3 at right). In 2006, tissue levels of P were significantly higher for the control plots, compared to the humic acid-treated plots; this result was contrary to previous research (5). There was no increase in tissue concentration reported in creeping bentgrass when grown in sand (9, 15) or solution (4) when humic acid was foliarly applied, but tissue levels were increased when humic acid was incorporated into sand (4). Turfgrass plants, including creeping bentgrass, are efficient at the uptake of P, and capable of obtaining adequate amounts of P at soil levels above 3 mg P kg-1 (6).

Table 2. Effect of organic acid and humic substance products on volumetric water content of soil and chlorophyll content (color) of creeping bentgrass at the USU research putting green in 2006 and 2007.

Treatment	Volumetric Water Content[y]		Chlorophyll Content[z]	
	2006	2007	2006	2007
	(%)		(color index)	
Launch	12.2 a[x]	11.8 a	173 ab	179 a
Control	12.1 ab	11.8 a	177 a	178 a
Citric acid	11.9 abc	11.6 a	174 ab	175 a
H-85	11.9 abc	11.4 a	172 b	177 a
Focus	11.9 abc	11.5 a	176 ab	178 a
Tannic acid	11.8 abc	11.5 a	172 b	177 a
Humic acid	11.7 bc	11.2 a	174 ab	178 a
Fulvic acid	11.6 c	11.2 a	173 ab	177 a

x Means within same column with same letter are not different significantly P=0.05.
y Volumetric water content measured with a TDR probe.
z Chlorophyll content measured with a CM-1000 chlorophyll meter.

Table 3. Effect of humic acid application on tissue nutrient concentration of creeping bentgrass at the USU research green in 2006 and 2007.

	P		K		Ca		Mg		S		Fe		Cu	Zn	Mn	Na
Treatment	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2007			
	%										mg/kg					
Control	0.43 a†	0.43 a	1.4 a	1.2 a	0.74 a	0.75 a	0.26 a	0.29 a	0.32 a	0.31 a	234 a	523 a	9.6 a	30 a	31 a	55 a
Humic acid	0.41 b	0.42 a	1.5 a	1.1 a	0.69 a	0.68 a	0.26 a	0.28 a	0.29 b	0.29 a	214 a	421 a	9.5 a	27 a	27 a	51 a

†Means within same column with same letter are not different significantly P=0.05.

Few differences of other nutrient levels in plant tissue were affected by the application of humic acid in our study. Sulfur (S) was significantly lower for the humic acid treatment compared to the control in 2006, but all other nutrient concentrations were not significantly influenced (Table 3). Although not an essential nutrient, sodium (Na) levels present in humic substance products after the sodium hydroxide extraction process can be a concern for turf managers by contributing to poor soil structure and reduced water infiltration. No differences in tissue concentration of Na were observed in our study, and high Na may not be present in all humic substances applied to turf, but other research has found increased levels in some commercial products (12).

The differences in P uptake observed here may have been influenced by the distribution of roots in the soil. Based on results from a controlled greenhouse experiment (15), possible hydrophobic properties of the humic substances present near the soil surface (11, 14), may have contributed to preferential flow, or fingering, in the root zone (3, 2), and facilitated the movement of water into the subsurface. Consequently root growth may have followed water distribution. Fewer roots in the upper rootzone would not have accessed available P when fertilizers were surface applied.

CONCLUSION

Overall, the humic substances used in our experiments did not have any substantial effect on the water holding capacity in sand putting greens. The humic substances contributed to lower soil moisture retention than the control, as the volumetric water content for humic acid treated plots were approximately 1 percent lower than the control. Perhaps, the adsorption of humic substances to sand particle surfaces in putting greens contributed to increased water repellency, thus lowering the water-holding capacity of the humic acid- and fulvic acid-treated plots. This effect may be important if soil water is frequently allowed to approach the wilting point or if there are cumulative effects over time. Humic acid-treated turf had lower levels of tissue P than the control, and while these differences were statistically significant, in practical application the effects on water-holding capacity and P nutrition may not warrant a change in management practices.

We used the chlorophyll meter in the place of quality ratings in the plots for this study and no differences were observed for any of the humic substances used in our experiments. It was interesting to note that one significant finding of this study was the potential to irrigate creeping bentgrass at 60 percent ETo during the summer months (June through August) in the Intermountain West with no reduction in turf quality. From the results of our study, it appears that irrigating every four to five days may be a way to reduce water without sacrificing turf quality on Intermountain West putting greens. However, this result was obtained on a putting green that did not receive the level of traffic that would be experienced at a typical golf course. While they may provide other benefits, humic substances may not provide superintendents with benefits of improved turf quality, or reducing water or P fertilizer on putting greens. **GCI**

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Commercial humic substance products were applied to three course greens in Utah in 2006 and the USU research green in 2006 and 2007.

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IMPACT ON THE BUSINESS

Using humic acid to improve microbial activity

SUPERINTENDENT CHRIS TRITABAUGH USES HUMIC ACID IN ADDITION TO OTHER ORGANIC SUBSTANCES.

BY MARISA PALMIERI

Chris Tritabaugh is one golf course superintendent that's taking a partially organic approach to golf course maintenance. Part of his strategy includes humic acid applications.

"Like a lot of the organic stuff, with humic acid, you're not going to spray it, come back the next day and say 'I really see a difference,'" says the superintendent at Northland Country Club in Duluth, Minn. "It's part of an organic program that, over time, is going to bring about a change in our soil structure and microbial population."

The focus on improving microbial activity is the crux of many of Tritabaugh's organic methods.

"The microbes in your soil feed on organic matter," he says. "What they're really after are the humates. We have a lot of organic matter in our fairways, for example, but a lot of it is thatch, which doesn't have a very high concentration of humates. The microbes are not after what's in the thatch without the humates."

Similarly, Tritabaugh uses compost tea, which he brews in a compost brewer with compost from the Western Lake Superior Sanitary District in Duluth, to increase the soil microbiological activity, and in turn improve water-holding capacity and the plant's natural defenses, which may reduce the incidence of disease and amount of fertilizer necessary.

In addition to humic acid and compost tea, Tritabaugh uses other organic substances to improve microbial activity, including hydrolyzed fish, seaweed concentrate, yucca extract, molasses and soy protein.

"I'm new to this whole organic thing, so I'm bringing in bits and pieces from those who have done it before me," he says, noting it's not his goal to go entirely organic, just to reduce inputs and improve the turf. Tritabaugh consults with other superintendents and reads up on organic practices both inside and outside the golf maintenance realm – including organic farming.

How's it working?

"The results are going to come over time," Tritabaugh says. "But even now, our turf is far and away better than two years ago."

Halfway through the 2007 season, when Tritabaugh joined Northland, is when the facility began using humic acid and other organic substances. Northland was on the program for all of last season, and this year makes the third year.

That first season was dry, and the turf didn't handle it well.

"We even lost some areas where there was weak *Poa*," he says. "Going into last year, our weather was more favorable, but even when it did start to dry out, we didn't see that drastic effect. The turf was more willing and able to handle it.

"Even now, in the spring as the snow starts to melt, I see turf that looks really good coming out of the winter. I think that's all a part of the program we've been on for the last year and a half."

Though he's aware of a number of commercial products on the market that include humic substances, Tritabaugh prefers to use humic acid, which he purchases for about $22 per gallon.

"It's cheap and it allows us all sorts of flexibility to change rates whether we're spraying greens, tees or fairways and to add it or take it away depending on what we're going for," he says.

Because of the rates Tritabaugh's using – ½ ounce to 1 ounce per 1,000 square feet – the costs remain low. On greens for example, he's currently using 1 ounce per 1,000 square feet ever two weeks, which equals about a gallon per application.

"At about $22 every two weeks, that's a manageable cost." GCI

BY DAVID M. KOPEC, PH.D.

Poa annua in review

The first in a two-part series looking at annual bluegrass. This month: its origins, ability to self pollinate and behavior as a perennial.

Next month: CONTROL METHODS

Poa annua, or annual bluegrass, is the most prevalent winter/spring grassy weed in golf course and sports turf management. It's been around for a long time. If you wrote down every research project title that was ever conducted in turfgrass science and management in the last 100 years, *Poa annua* would most likely win the contest as the most "research prone" topic to date. There are a couple of reasons for this.

On an evolutionary scale, *Poa* is a unique plant genus, with grass plants growing in all kinds of environments from alpine climates to deserts. Some *Poas* are perennials, while others are annuals. *Poa* "chromosomes" often reside in related complexes, that is, they often share certain chromosomes. Therefore, chance groupings of chromosomes may either come together (converge), or split away from each other (diverge), allowing for bridging (chromosome swapping or passing), and or new species of *Poa* to form. *Poa annua* most likely came from a chance cross of *Poa infirma* with *Poa supina*, producing a 14 chromosome mule that could not reproduce by seed. This mule no doubt went through a spontaneous doubling of its chromosomes, to produce our modern day 28 chromosome *Poa annua*. These plants can be true annuals, perennials or something in between.

SO WHY IS IT PESKY?

Poa annua is a problem because it's found almost anywhere there is moisture in some part of a "cool season" climate. Thus, it's essentially everywhere, listed by the USDA in all 50 states, including Hawaii, where it's found at higher elevations. There's even *Poa annua* in Death Valley, Calif. Areas that receive 20 to 40 inches of rain (or more) a year and have a real fall, winter and spring often have *Poa annua* germination flashes that occur in late summer/early fall and then again in lesser amounts in the late winter/early spring. In arid areas that have a brief rainy season in the fall, annual bluegrass has the largest germination period in the fall.

In any case, *Poa annua* seedlings emerge and have tremendous seedling vigor. After germination and establishment, they build up food reserves, they flower (often) profusely, and then die, leaving an ample amount of seed to survive under harsh soil temperatures until just the right time next year when the next generation germinates. This is the case of the annual type or *Poa annua*, as it's referred to.

To make things worse (better for

Poa annua, pictured here in test plots, is listed by the USDA in all 50 states, including Hawaii, where it's found at higher elevations. Areas that receive 20 to 40 inches or more of rain per year and have a real fall, winter and spring often have *Poa* germination flashes that occur in late summer/early fall, and then again in lesser amounts in the late winter/early spring. Arid areas with a brief rainy season in the fall see their largest *Poa* germinations in the fall.

DAVID M. KOPEC

Poa), *Poa annua* seed heads can adapt to mowing heights readily. Flowering plants often flare-out and send their flower stalks out in a circle pattern, hugging the ground just lower than the mowing height. *Poa annua* will flower at ⅛-inch mowing height on greens, and it will flower profusely at heights of ⅜ inch to 1.5 inches. At taller heights, it flowers somewhat less when it has competition from other turfgrasses in maintained turf.

WAIT, THERE'S MORE

Poa annua plants can exhibit a unique habit of having some of the individual flowers shed pollen before the seed head even opens up. Thus, the seed stalk can have viable seeds produced in heads that have been mowed down before the seed head ever opens up.

There's more to the story. *Poa annua* is self pollinating. It doesn't need another plant to get different pollen to make seed. So, theoretically, you can get one seed from one plant on your course, and it produces dozens, hundreds and thousands of plants in just three years. In year four, hundreds of thousands, and in year five, millions.

The process of self pollination has some real-life genetic consequences, which also make *Poa annua* the problem that it is. When a plant pollinates itself, it locks in gene sequences in a state that promotes genetic uniformity by 50 percent each time it self pollinates for the next generation. Thus, self pollination quickly sets in generational plants that have a relatively urgent selection pressure for survival in any given environment. The results are near immediate. A significant group of plants can be poorly adapted and die out. At the same time, a small group of plants can have the right combination of genetic traits that give it a strong local adaptation (called fitness). These plants quickly dominate the weaker ones and then pre-dominate the population of plants after that.

In each subsequent flowering generation, the desirable genes become "highly fixed," in combinations that are in a quick-acting state in response to the type of environment it has become adapted to. The result is lots of plants in a relatively short period of time that can reproduce and make more like plants from seed and thrive in that environment, year after year. The downside is that on a long-term evolutionary scale, if a major change in environment occurs, the selection pressure is quick to get rid of the now existing population of fixed plants.

So, if you're counting on global warming to get rid of your *Poa annua*, don't count on it. Why? Because *Poa annua* keeps its options open by occasionally cross pollinating with a neighboring plant. The result of this out-crossing or cross pollination event results in immediate genetic diversity. Different combinations of gene arrangements arise from cross pollinating, and these forms are more environmentally flexible. They can adapt to changes in the environment rather quickly, since these plants have more subtle but important options in their physiological pathways to respond to new and different environments. There are many new gene combinations for this to occur on, so, the long-term survival of the species is maintained, simply by out-crossing.

After these new diverse plants arise after the first cross pollination, these plants can divert back to self pollination, which causes rapid selection pressure for highly adapted plants that are the predominate in each subsequent generation.

POA AS A PERENNIAL

The *Poa annua* we've described is more or less the annual type of annual bluegrass, which comes year after year from seed, and often it seeds, it flowers and dies.

As smart as these plants are from the genetic adaptation strategies we talked about, do you think there's another survival mechanism?

The answer is yes. In the right environment, *Poa annua* can maintain itself as a year-round perennial. This occurs in areas that have seven to 10 months of cool, moist conditions or other continental and/or maritime climates that have adequate rainfall and a short period of stress (hot and/or humid period) for three to four months at most.

In this general case, *Poa annua* can live in a somewhat less stressful environment and switch its thinking from seed production to vegetative persistence for survival. Thus, perennial *Poa annua* diverts most of its food reserves into vegetative growth (more

"These plants are mutts that have flexible survival skills, and look as different as you do from your brothers and sisters. Mutts make the toughest dogs, don't they?"

Poa annua has a diverse portfolio of survival schemes and genetic adaptation mechanisms, either creating its own diversity, or becoming many types of breeds.

leaves and shoots), rather than a terminal devotion to heavy flowering. Therefore, perennial *Poa annua* plants form and persist in environments where it can compete with other grasses that usually undergo the same stresses as its neighboring plants, surviving the plant community's trials and tribulations just like the next guy, year after year.

Since most perennial *Poa annua* types are believed to originate as beneficial plants from cross pollinations, you often see many diverse-looking plants of perennial type in a given area (even on a single golf course green). These plants are mutts that have flexible survival skills, and look as different as you do from your brothers and sisters. Mutts make the toughest dogs, don't they? Their innate diversity keeps them flexible to handle life's challenges. If they need to ramp up the genetic amplification, there's always self pollination, even in "perennial" *Poa annua* plants. Perennials develop on greens and fairways within five years of a new turf establishment.

As you can see, *Poa annua* is an incredible plant. It has a diverse portfolio of survival schemes and genetic adaptation mechanisms, either creating its own diversity, or becoming many types of pure breeds on its own. It makes its own stocks, bonds and treasury bills and never needs a bail-out. **GCI**

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IMPACT ON THE BUSINESS

Making it work

AT POLE CREEK GOLF CLUB IT MAKES SENSE TO MANAGE POA RATHER THAN GET RID OF IT.

BY MARISA PALMIERI

Most golf course superintendents are tasked with eradicating *Poa annua*.

But that's not always economically feasible, and it's not always necessary, either, says golf course superintendent Craig Cahalane at Pole Creek Golf Club in Tabernash, Colo.

The municipal course's greens, once all-bentgrass, are now 90 percent *Poa*. That may seem like a nightmare to some, but, Cahalane says that in the three years he's been at Pole Creek, he's only had several complaints from golfers.

"No one complains as long as you manage it well," he says. "With the Proxy/Primo program we use, we control the seedheads well, so the golfers don't mind."

While the ideal situation would be to shrink or completely eliminate the *Poa* population, it's just too costly for Pole Creek, which is a 27-hole municipal course owned by the Frazier Valley Metropolitan Recreation District.

"At this point, it would probably have to come out of a capital budget, and we're spending capital on equipment, we just built some restrooms and we just redid our irrigation system for $1.7 million."

In short, the golfers don't mind, so it's not a priority.

As far as getting rid of *Poa* goes, "We aren't going to go there right now," Cahalane says.

He estimates it would cost hundreds of thousands of dollars to eradicate *Poa* from the facility's 27 greens (plus two putting and chipping holes). The last cost estimate Cahalane received was between $10,000 to $15,000 per green.

So instead, Cahalane manages the *Poa* with plant growth regulators – five to six applications of Primo at the beginning of the summer (about two or three per month) and three Proxy applications (one per month).

Cahalane spends about $1,600 on PGRs for the whole year. His maintenance budget is about $720,000, which Cahalane considers to be low- to mid-range.

In addition to the dollars it would take to eradicate Poa, such an undertaking would cause lost revenue for Pole Creek, because the facility would have to close 9 holes at a time.

"We're only open for five months a year, so we'd be losing too much revenue by doing that," Cahalane says. GCI