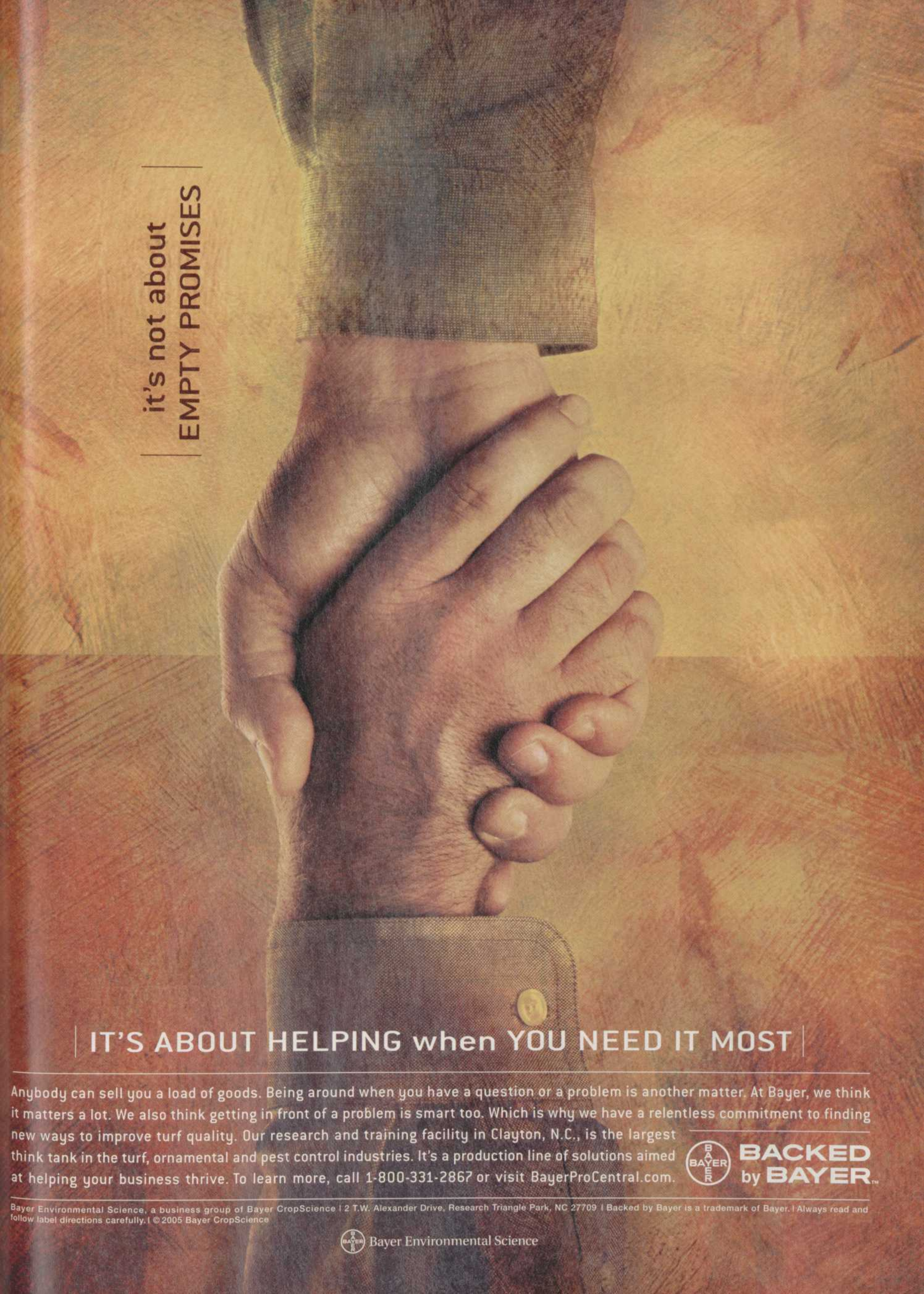
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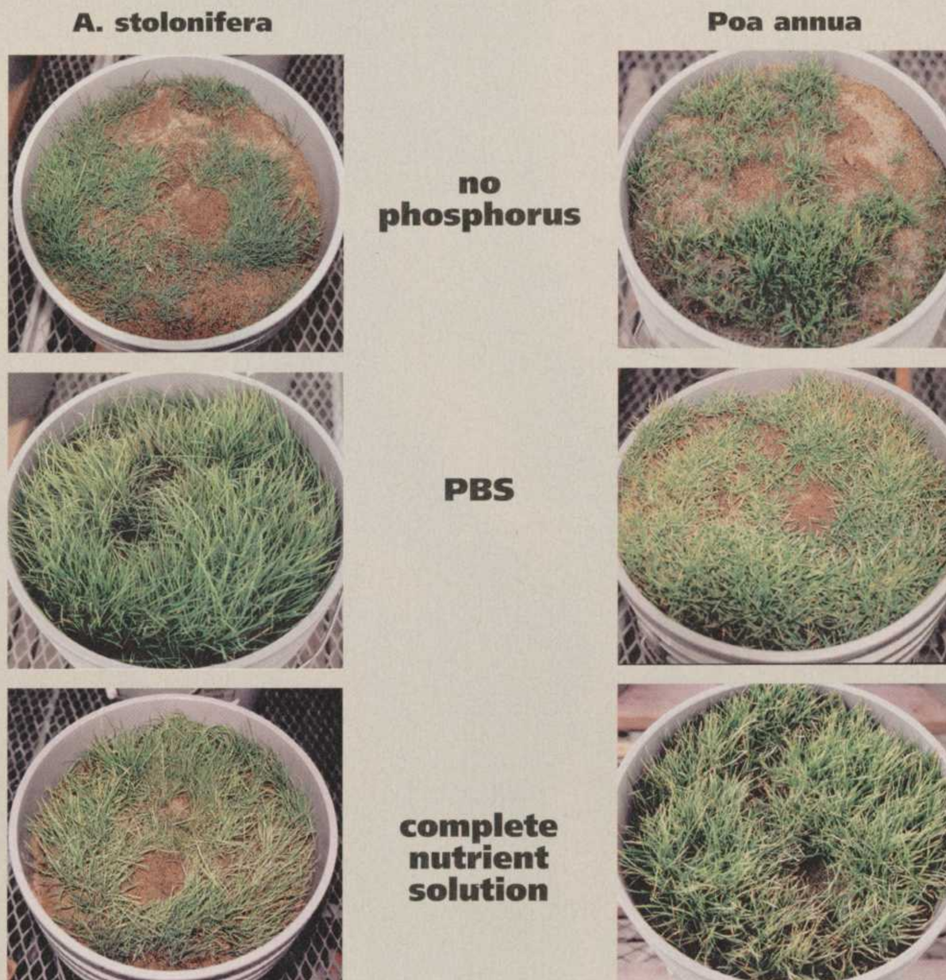
FIGURE 4

Establishment of two turfgrass species as affected by source of phosphorus nutrition.



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benefits of drainage and resistance to compaction of sand while also having the buffering capacity of natural soils.

Researchers are now interested in evaluating this material in large-scale field trials, including various possibilities for applying the PBS material to established greens.

One of the most important lessons that working with this material has taught us is that excess nutrients, even nutrients thought to increase root growth, actually result in shallower, less hardy roots (Lyons, 2004). There are many ways turfgrass managers can manipulate the growth of the turf using nutrients, and it is important to remember that it is not only amount of fertilizer but also where that fertilizer is applied.

Jonathan Lynch has been a professor of plant nutrition at Penn State University since 1991. His research includes the development of next generation fertilizers, such as the buffered phosphorus system described in this article. Penn State has taken a patent out on this technology, with Lynch and Eric Lyons as co-inventors.

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Penn State Marks 10 Years of Breeding *Poa Annua*

By David Huff

It's been 10 years since we first initiated the Penn State greens-type *Poa annua* breeding program. So it seems to be an appropriate time to review what we've learned and what's left to do.

Initially when we started the project we were very cautious and somewhat skeptical. After all, *Poa annua* is considered by many to be nothing more than a weed. However, from each new collection and field plot trial, we learned to appreciate its beauty as turf and its unparalleled ability to adapt to a range of management conditions. Slowly and steadily our momentum built. It was the golf course superintendents of Pennsylvania, and later those from across the world, who enthusiastically encouraged our efforts and provided our initial financial support.

After several years into the project, major funding from the USGA then elevated this part-time project into a full-time project, where it has been for the past seven years.

The purpose of the breeding program is to develop commercial seed supplies of perennial *Poa annua* f. *reptans* (Hausskn.) T. Koyama for use on golf course putting greens. We call these special types of *Poa* "greens-types" to mark their distinction from the many other types, or forms, of *Poa* that inhabit other turf areas such as fairways, lawns, roughs and utility turfs.

Around the world these different forms are collectively known as annual bluegrass, annual meadow grass (Europe) and by similar names in 20 different languages (Fig. 1).

FIGURE 1

Many different types of *Poa* exist in nature ,ranging from wild, weedy annuals (top plants) to perennial greens-type (bottom plants).

There is no question that *Poa* plays a large role in the golf industry today. This role is particularly noticeable at very old, well-established courses, the kind often featuring U.S. Open events where fast, durable greens present a historical challenge to modern-day golfers.

Poa seems prevalent in climatic regions that favor its growth and survival. In North America, *Poa* is adapted to the cool regions along the U.S.-Canadian border and particularly along the Pacific west coast province and states. We find it capable of dominating putting greens in these cool and humid regions as well as western and central Europe, the Scandinavian countries (Sweden, Denmark, Norway and Finland) and New Zealand (Huff, 2003).

We have also observed that *Poa* is regularly maintained as putting greens in some subtropical climates as well. For example, greens comprised of nearly 100 percent greens-type *Poa* that are surrounded by bermudagrass fairways exist on many courses near Melbourne and Sydney, Australia.

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FIGURE 2

(Fig. 2a) Experimental *Poa* cultivars on the Club at Nevillewood and (Fig. 2b) at Apawamis Golf Club.

Therein lies a problem: seed is an extremely difficult commodity to produce from these forms of *Poa annua.*

Continued from page 54

Across some of these regions, our best experimental *Poa* cultivars have shown varied performance, ranging from very good to poor. Our selections all died in Sweden from their severe winter. However, in Australia these same selections performed well, including under conditions of high salt content (intentional) and drought stress (non-intentional). They have also performed well in research plot trials in California, Washington and Pennsylvania but not well at all in New Jersey.

Limited applications have been performed on golf courses near Pittsburgh and New York City, with encouraging results (Fig. 2a & 2b).

So much so that the most common question we receive is no longer, "Why are you breeding *Poa*?" But rather, "Where can I buy seed?" And then people ask, "Do you have any seed?" And that is followed by, "When will you have seed?" And therein lies a problem: Seed is an extremely difficult commodity to produce from these forms of *Poa annua* (Fig. 3).

This year we began working with the seed company, DLF International, located in Oregon, to evaluate the seed yield potential from our best materials within the breeding program. From this point on, only time will tell if we will be successful, but I believe we will. We have several selections that have excellent turf quality and a "reasonable" seed yield. However, production will need to be tightly controlled as some strains of *Poa* are beginning to indicate to us that their genetic stability might be somewhat ephemeral in nature.

In other words, if too many consecutive generations of seed are produced in some strains under field conditions, then the seed progeny begin to look like something different than the parents.

We're not sure why this happens but we are currently conducting the genetic experiments required to sort this out. *Poa annua* is known to do some strange (uncommon) things genetically. For example, some plants have twice as much DNA (the genetic information) as other plants, and yet each has the same number of chromosomes (discrete packages of DNA). Other plants we've found possess only half the number of chromosomes as "normal" *Poa annua* and, as a result, produce completely sterile flowers, existing only through vege-

FIGURE 3

Seed production of various strains of perennial greens-type *Poa annua.*

tative propagation. Yet even these plants, we believe, are capable of occasionally producing a "sport" (vegetative offshoot) that contains the full compliment of chromosomes, thereby restoring seed fertility to that particular shoot.

Suffice it to say that we believe there are genetic mechanisms at work in *Poa* that we do not, as of yet, fully understand. As a geneticist, this makes *Poa annua* an even more fascinating species than what it already is.

It is fascinating because it performs so successfully in so many different environments and is essentially found worldwide, including the islands of Antarctica. It is fascinating because it seems to have out-maneuvered every chemical and management technique attempted by the turf industry to control its occupation of putting greens (with the exception of hand-weeding). And it's fascinating because of its exceptionally high turf quality when unstressed. And when it's stressed it always comes back (Fig. 4).

We are only now beginning to understand some of the ecological factors related to its dominance on the green when it is in competition with creeping bentgrass.

For example, *Poa* annuas are typically shallower-rooted and exhibit less winter tolerance and less heat tolerance than creeping bentgrass. *Poas* are also generally more susceptible to diseases and insect pests than bents. With only this information we would have to wonder why there is any *Poa* out there at all. We believe the reason why *Poa* persists on greens is that some plants are actually tolerant of these above stresses, enabling them to persist through stressful periods (Fig. 5a, 5b & 5c).

Moreover, we have found that greens-type *Poas* are able to fix more than 23 percent more carbon through photosynthesis and yet produce half as much clipping yields and half as much root mass as Penn A-4 creeping bentgrass (Fig. 6a & 6b) (Lyons 2002; Knievel and Huff 2003).

Carbon acquisition through photosynthesis is what enables plants to grow. Greens-type *Poas* seem to use their abundant supply of carbon not for deeper roots or long leaf blades but rather to produce a steady supply of tillers (shoots) in order to crowd out neighboring plants, including bentgrass as well as other non-greens-type forms of *Poa annua* (Fig. 7).

Our selections currently being evaluated for seed yield produce 26 percent more tillers than

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FIGURE 4

Greens-type *Poa annua* exhibit exceptionally high turf quality.

FIGURE 5

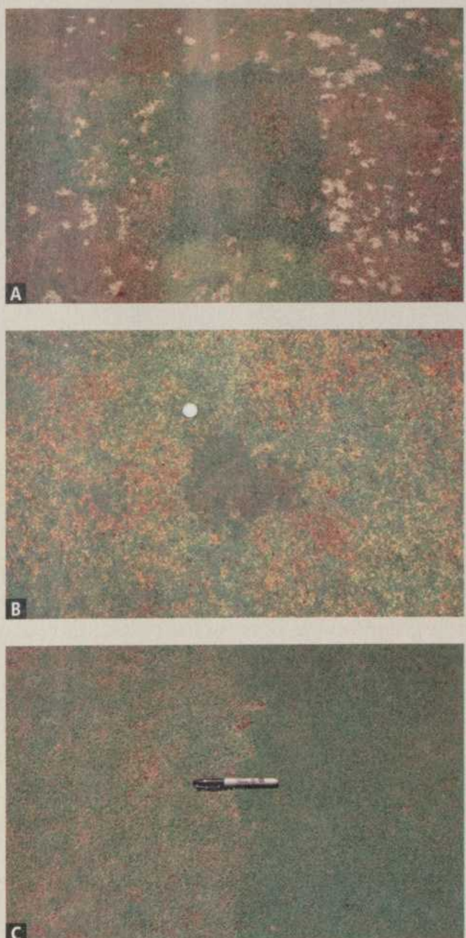
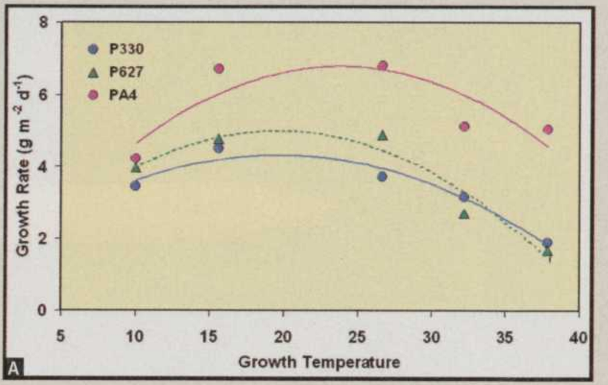


Fig. 5a. Dollar spot disease resistance in *Poa*. 5b. Anthracnose disease resistant patch of *Poa*. 5c. Plots of anthracnose disease resistant greens-type *Poa*.

FIGURE 6



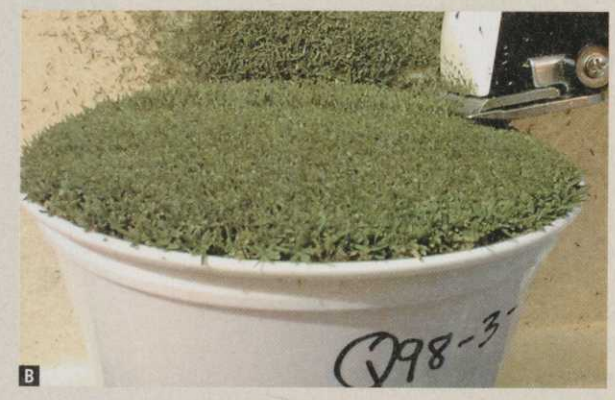
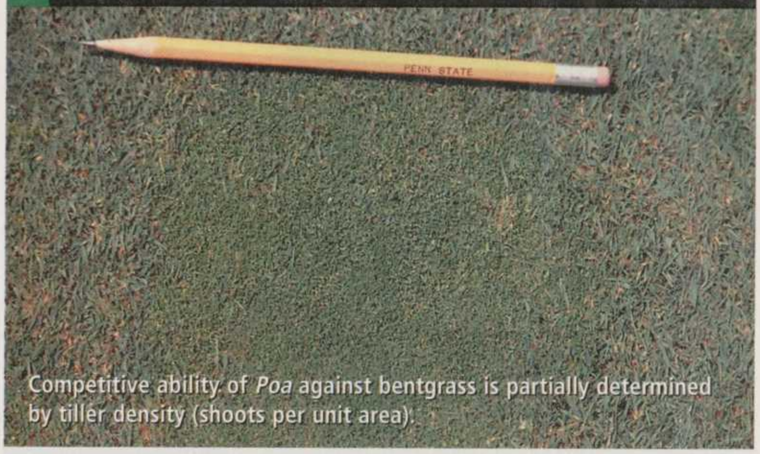


Fig. 6a. Turf canopy growth rate response to a range of temperatures. 6b (inset) Clipping a greens-type *Poa* canopy.

FIGURE 7



Competitive ability of *Poa* against bentgrass is partially determined by tiller density (shoots per unit area).

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Penn A-4 under one-eighth inch greens mowing height. Some of our other experimental cultivars produce nearly 10 times that amount of tillers. Hence, useful management practices for such greens-type *Poas* include the following: vertical mowing to open up the canopy making room for new tillers, and the use of liquid as well as granular fertilizers in order to supply each tiller with an adequate supply of nutrients for growth and maintenance.

However, is shoot density (tiller number per unit area) the only reason for *Poa*'s competitive advantage against creeping bentgrass? Almost certainly not. We have preliminary evidence that such greens-type *Poas* are also more tolerant of traffic and have a higher seedling survival rate than bentgrass on established greens.

Thus, as we continue our efforts in seed production, we are also investigating these and other ecological and genetic factors which enable *Poa* to be so variable as a species and yet so highly specialized to such unique environments as a golf course putting green.

To that end we have over the past 10 years provided seed of our *Poas* to many different research institutions who have performed their own experiments and have trained many students. Such research requests are increasing. So as 10 years come to a close, it feels good to have accomplished what we have and to know that many more questions still need to be addressed.

David R. Huff is an associate professor of plant genetics and turfgrass breeding at Penn State University. He works to solve basic and applied genetics problems for a wide range of grass and turfgrass species. He holds a M.S. and Ph.D. in genetics from the University of California-Davis and earned his B.S. in crop and soil sciences at Michigan State University.

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Varieties Bred for a Purpose

By Brian T. Scully

Turfgrass breeders are always on the lookout for the next new grass variety, perhaps the next breakthrough or even the next "great" or "superlative" grass. But the search for improved turfgrass varieties is not undertaken without some thought toward the end result.

At the University of Florida, a team of researchers has developed four new turfgrass varieties, including UltimateFlora Zoysia, Hammock Centipede, PristineFlora Zoysia and Aloha Seashore Paspalum. These varieties are the result of nearly a seven-year research effort that included plant breeders, agronomists, plant physiologists and entomologists. Over the course of the development period, lesser breeding lines were tested and dropped from the breeding program. These four elite breeding lines survived the "winnowing" process and ultimately became the four cultivars that met the criteria defined at the beginning of the process.

In other words, these cultivars were bred for a purpose based on a set of breeding objectives delineated at the outset of the program.

The process began with the general goal of creating new grasses that could, at one extreme, replace existing varieties but more realistically provide sod growers and consumers with a set of alternative grass varieties that would be easier to manage and maintain.

In the case of residential lawn grasses, our purpose was to develop one or more cultivars that could help diversify the Florida landscape environment, which is presently dominated by Floratam St. Augustine. In actuality, St. Augustinegrass was originally used as a forage grass, and Floratam was derived from that germplasm base. However, it was bred to have a more refined growth habit that was better suited and adapted to the landscape. By some standards, St Augustine grasses are coarse textured, and many Florida residents who have moved here from Northern states remark that the St. Augustinegrass in their yards looks like the crabgrass they used to kill out of their lawns up north. This is perhaps unfair to a grass that has served our industry so well for so long, but unfortunately perception often usurps reality.

Aesthetic reasons alone were not sufficient motivation to seek an alternative to St. Augustinegrass. The real impetus was to enlarge the array of grass varieties in the marketplace and to find a set of adapted genotypes within

Author Brian Scully talks about Aloha Seashore Paspalum at a field day held last fall at the Emerald Island Turf farm in Avon Park, Fla.