TURFGRASS TRENDS

FERTILIZATION

Smart Fertilizer Provides K When and Where Needed

By Jonathan Lynch and Eric Lyons

A new fertilizer technology developed at Penn State University offers several potential benefits for turfgrass cultivation.

The new technology employs a phosphorus buffering system (PBS), which maintains a steady phosphorus concentration in the soil solution over time.

The PBS has the size and consistency of sand (Fig. 1) and can be mixed with any soil media. Once charged with phosphorus, the PBS establishes an equilibrium with the surrounding soil at a pre-established phosphorus concentration. This is useful for several reasons:

■ First, the PBS permits synchronization of phosphorus supply from the fertilizer and phosphorus demand by the plants. This is in contrast to traditional fertilizers, which are either immediately soluble or are released over time as a function of moisture and temperature, resulting in excess phosphorus supply soon after application and inadequate phosphorus supply some weeks later. Because the PBS is in equilibrium with the soil around it, phosphorus is released from the PBS only as it is being used by the roots.

Under conditions of rapid growth and phosphorus uptake, more phosphorus is released, whereas under conditions of slow plant growth and slow phosphorus uptake, little phosphorus is released by the PBS. This occurs automatically by chemical reactions and does not require any monitoring or intervention by the grower. The synchronization of phosphorus supply with phosphorus demand assures that the plants are getting a sustained, optimal level of phosphorus nutrition over time, regardless of other environmental conditions.

■ Second, the PBS can be treated to maintain phosphorus at higher or lower equilibrium concentrations, allowing precise control of phosphorus supply to the roots.

This is useful for turf cultivation since excessive phosphorus supply leads to reduced root growth, increased drought sensitivity, increased shoot growth, weaker leaves, lower leaf chlorophyll concentration and interference with micronutrient nutrition.

FIGURE 1

Solid-phase buffer (SPB) phosphorus fertilizer

Precise control of phosphorus supply via the PBS permits the grower to stimulate root growth, reduce leaf growth, improve leaf color and toughness. and improve drought

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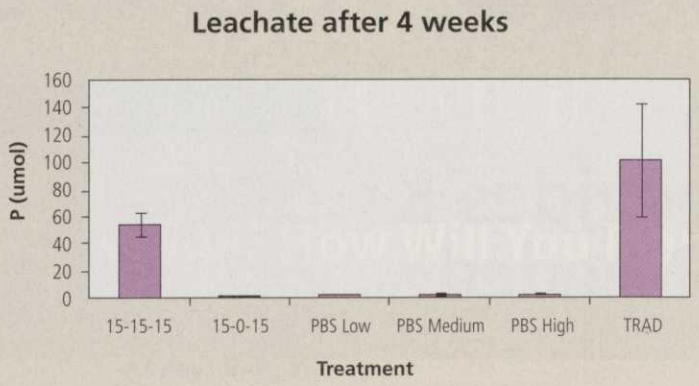
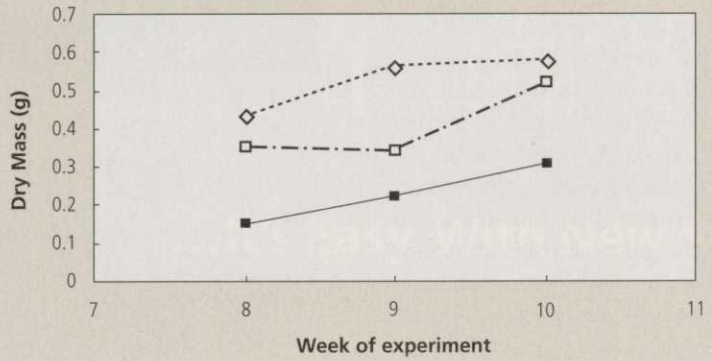
FIGURE 2



Phosphorus in the leachate of bentgrass established in sand with a PBS delivering three different phosphorus levels compared to a 15-15-15 liquid fertilizer and traditional starter fertilizer.

FIGURE 3



Root mass in the bottom 6 inches of the rootzone of turf grown with liquid phosphorus fertilizers (solid line) and with the PBS placed throughout the rootzone (Squares Dashed Line) and PBS placed in the bottom 4 inches of the rootzone (Diamonds hashed line).

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tolerance, while avoiding outright phosphorus deficiency. This level of control is not possible with conventional fertilizers.

■ Next, the low solution phosphorus concentrations maintained by the PBS result in greatly reduced phosphorus leaching into the environment (Fig. 2).

This is beneficial since phosphorus runoff and leaching is a significant threat to water quality in many parts of the United States. As an indication of the seriousness of the problems caused by phosphorus in conventional turf fertilizer, the city of Minneapolis has enacted an ordinance banning the use of phosphorus in lawn fertilizer.

■ Fourthly, the PBS permits spatial control of phosphorus availability.

The PBS can be placed at specific depths in the soil profile, favoring the growth of deeper-rooted species such as *Agrostis* while starving undesirable species with shallow roots such as *Poa* and moss. Since roots proliferate in areas with high nutrient status, deep placement of the PBS will increase rooting depth, with benefits for drought tolerance and traffic resistance (Fig. 3).

Implications of PBS

It is well known that turfgrass established in the absence of adequate phosphorus is slow to establish and has minimal root development. This has prompted many turf managers to ensure that they have excess phosphorus available to encourage root growth. While this may be the quickest way to a dense canopy, this is at a cost to root development and also has an environmental cost.

Phosphorus is known to be a potential pollutant causing eutrophication, such as algal blooms, in fresh water ecosystems. As early as 1948 it was observed that low phosphorus fertilizers produced a bentgrass turf with greater root mass than fertilizers with high phosphorus levels (Holt and Davis, 1948). Low phosphorus rates have been linked to darker green color, greater drought tolerance and decreased presence of annual bluegrass (Waddington et al. 1978).

The PBS has been evaluated in several indoor and outdoor horticultural production systems, and has been shown to provide adequate phosphorus in turf systems in controlled environments while virtually eliminating phosphorus from leaching through a sand profile (Fig. 2). Under greenhouse conditions, we have also been able to increase rooting depth of unmowed turf by placing the PBS deeper in the rootzone (Fig. 3). The PBS providing low phosphorus levels was adequate for creeping bentgrass growth and appeared to limit the establishment of annual bluegrass (Fig. 4). For most plants growing in soil, the components of the soil itself act as a buffer. In the case of constructed sand root-zones, this buffering capacity is absent. It is possible that PBS and other smart fertilizer technologies will someday allow turfgrass managers to have the

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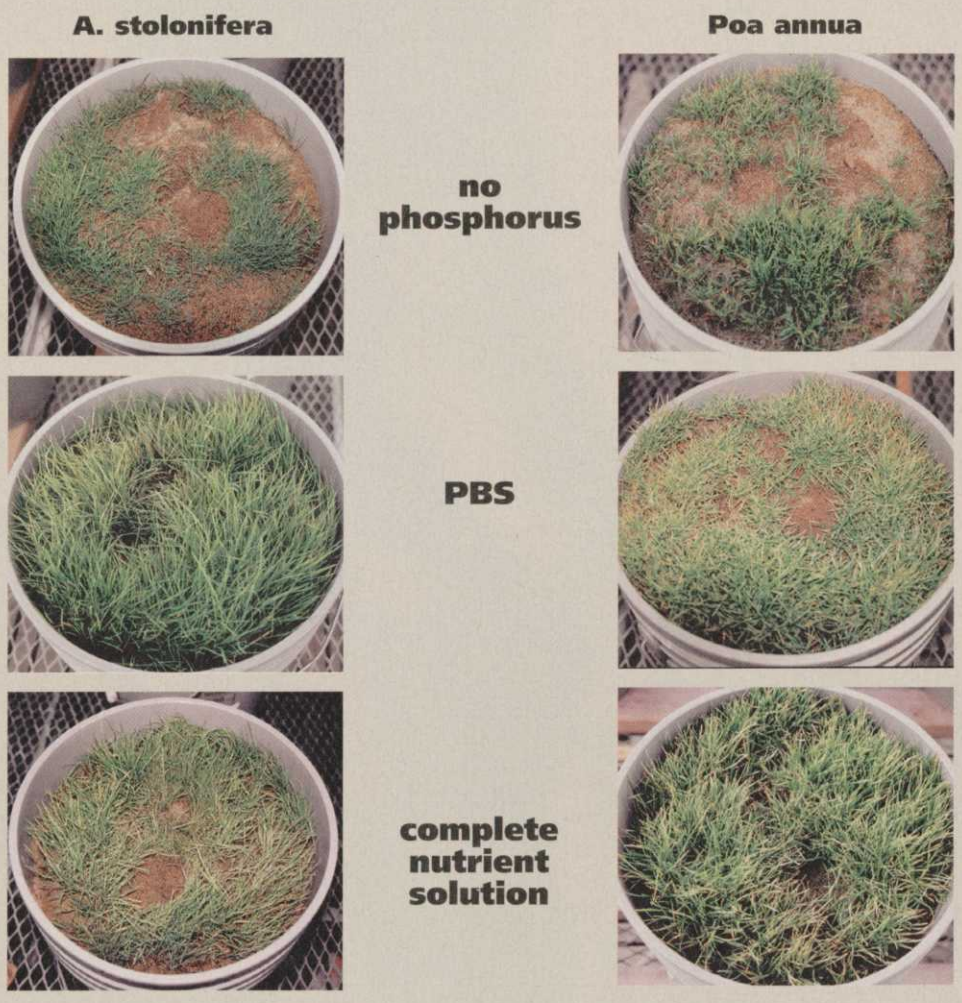
FIGURE 4

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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