TURFGRASS TRENDS

SAND GREENS

How to Retain Nutrients on Calcerous Sand Greens

By Paul G. Johnson, Rich Koenig and Kelly Kopp

Nitrogen usually gets the most attention when it comes to fertilization, and there are good reasons for that. It's the nutrient with the most visual effect and results in the greatest effects to the plant. However potassium (K) is also essential, as is phosphorous (P).

We all know how to apply nitrogen using the range of fertilizer sources available today to superintendents and field managers. But what about P and K? Can we put on large amounts once or twice a year and have good results, or is the management more complicated than that?

In most soils, few applications are just fine, but in the modified root zones that we often deal with fertilization practices may not be that straightforward. This may be the particular case with calcareous sands that are found throughout North America, but are common in the intermountain West. Sands in general leach quickly, but to compound the low nutrient-holding capacity, the high pH of these sands often limits the availability of many important nutrients.

P levels can be maintained at very low levels and possibly discourage the germination of *Poa annua* without reducing the quality of the bentgrass turf.

In most cases, new sand root zones quickly gain cation exchange capacity because of the large amounts of organic matter deposited from the growing turfgrasses. However, sometimes in calcareous sands, this organic matter deposition is delayed because of slow turfgrass growth. Also, turf grown on these sands sometimes has substantial thatch layers because of low microbial activity.

To gain more information on proper management of these sands, we studied nitrogen (N), P, and K and their interactions on a creeping bentgrass (*Agrostis stolonifera* Huds.) green built with the calcareous sands common to the intermountain West region of North America.

Materials and methods

We conducted our experiments from 1998 to 2001 on a putting green established in 1995 to modified USGA recommendations (11) in North Logan, Utah. The sand differed from USGA specs by having an increased percentage of fine particles (23.1 percent in the .15 mm to .25-mm particle size and 12.1 percent in the .05 mm to .15-mm particle size).

When built, the root zone mix was prepared as 95 percent sand and 5 percent peat, but at the beginning of the experiment the percentage of organic matter was still very low. Soil particle breakdown was 95 percent sand, 5 percent silt and clay, and .5 per-

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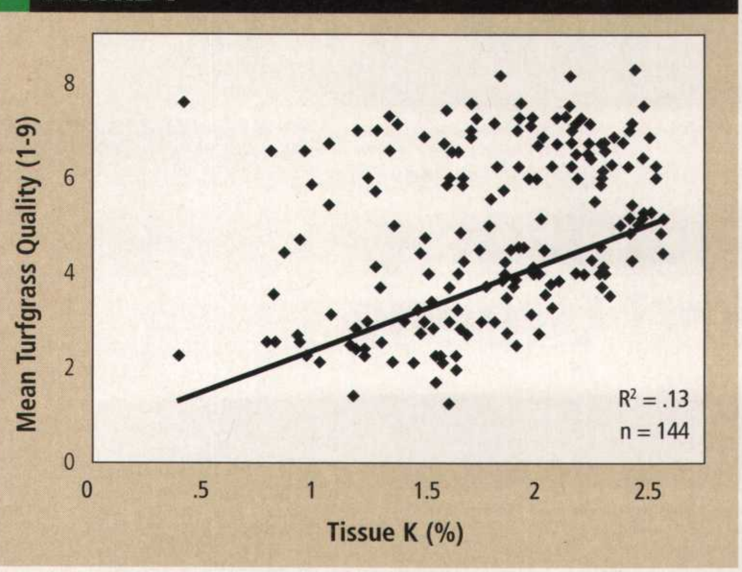
FIGURE 1



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cent organic matter. The bentgrass variety was Providence.

Nutrient levels at the start of the experiment were low in P and K. Zinc and sulfur levels were also low, but were amended at the start of the experiment with elemental sulfur at 87.5 pounds per acre and a micronutrient fertilizer. In general, the turfgrass quality of the putting green at the start of the experiments would not have been acceptable for a typical golf course because of poor density and lack of growth.

We conducted two separate but related experiments. In Experiment 1, P and K rates were varied, and N was held constant. In Experiment 2, we varied rates of N and K with constant levels of added P. In 1999, the fertilizer treatments were divided among six applications between April and November. This schedule caused some burning of the turf. To prevent these effects in 2000 and 2001, we divided the same yearly nutrient amounts among 12 applications to more closely simulate fertilization intervals on putting greens. The fertilizer treatments are summarized in Table 1.

The plots were irrigated with .1 inch of water immediately after the treatments were applied. Irrigation during the growing season was scheduled to replace approximately 80 percent of evapotranspiration every two days. Weather data was determined by an on-site Campbell Scientific weather station. The turf was mowed at .16 inches four times each week and clippings were removed at each mowing. The summer growing seasons of 1999, 2000 and 2001 were nearly rain-free, so the water applied to the experiment was highly controlled.

We rated turfgrass quality of the plots at least once each month using a 1 to 9 scale, where 1 is brown, dormant turf and 9 represents the best quality. Shoot density and color were also rated at least once each year. Soil samples from each plot were collected five times each year and analyzed for P and K levels. Tissue samples were also collected and analyzed yearly in early August. To determine the relationships between turfgrass quality and soil test P and tissue P, we used models to estimate critical levels of soil and tissue test P above which turfgrass quality was not improved.

TABLE 1

Nitrogen, phosphorus and potassium fertilizer rates used in Experiment 1 and 2.

Nutrient	Exp. 1: PxK Study	Exp. 2: NxK Study	Nutrient Source (1999)	Nutrient Source (2000-1)
-----pounds of nutrient per 1,000 square feet per year -----				
N	5	2, 3, 5, 7	urea	urea
P_2O_5	.25, 1.25, 2.5, 5	5	phosphoric acid	monoammonium phosphate
K2O	0, 2.5, 5, 7.5	0, 2.5, 5, 7.5, 10	potassium chloride	potassium chloride

Results and discussion

We began this research particularly interested in the interactions of the applied nutrients, particularly N and K. In other words, we were looking for different responses of K at different rates of N fertilization. However, we observed no such interactions. As a result, all the results will be on the simple effects of N, P and K fertilization.

Phosphorous: Very little phosphorous was required by the bentgrass turf in this experiment. Prior to the experiments, the bentgrass turf showed classic P deficiency symptoms of purple coloration together with very stunted growth. The quality dramatically increased as soon as the P fertilization began. Only the lowest P level (.25 pounds of phosphorus pentoxide per 1,000 square feet per year) did not provide adequate quality turf. These results indicate that P levels can be maintained at very low levels and possibly discourage the germination of *Poa annua*, without reducing the qual-

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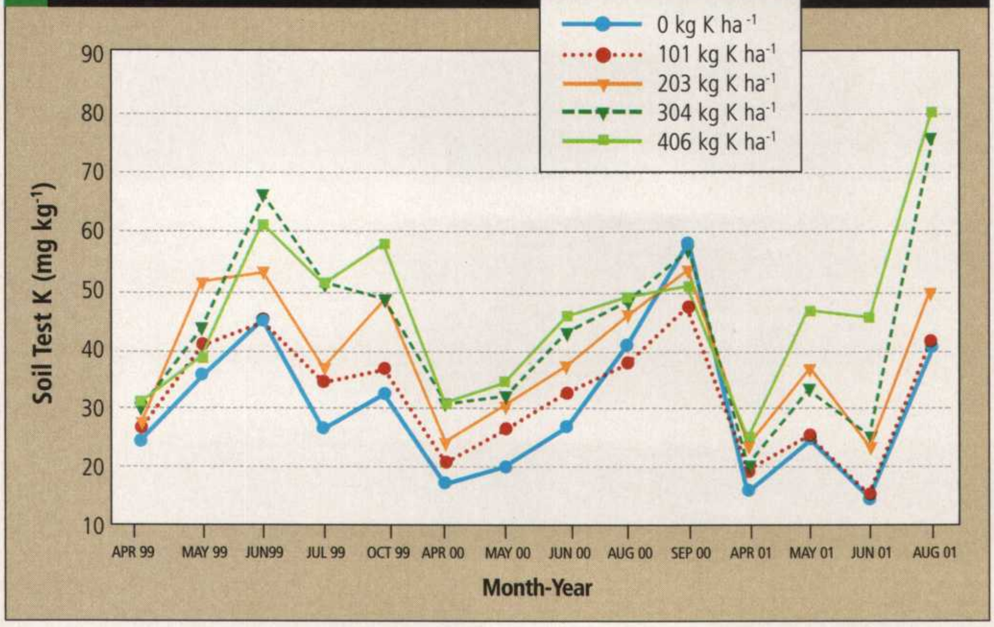
FIGURE 2



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ity of the bentgrass turf. Levels of P can also be maintained at low levels to reduce any water-quality concerns.

Nitrogen: Our results with nitrogen treatments were nothing new and similar to other research and observations by many superintendents. The optimal fertilization rate per year was between 3 pounds and 5 pounds per 1,000 square feet per year. Seven pounds per 1,000 square feet per year was excessive. The plots fertilized at the highest N rate were very dense and dark green, but quickly developed substantial thatch layers increasing the tendency for scalping by the mowers. They also experienced more localized dry spot problems.

Potassium: Potassium responses of the creeping bentgrass turf were essentially not present. Even though K is commonly referred to as the second most important nutrient for healthy golf turf, we observed little or no positive influence of high K fertilization rates. Levels of K in the soil increased with higher application rates, but not in the proportion one might expect. When higher amounts of K were found in the plants, there was a slight increase in quality, but the relationship was very weak (Fig. 1). One likely reason for this lack of response is simply the inability of the sands to hold even moderate amounts of potassium. Even low application rates may have exceeded the nutrient holding capacity. Most likely, the K is leaching through the root zone.

We often worry about leaching of nitrogen, especially because of environmental concerns of nitrate in the groundwater. But leaching of K may also be an issue, more for the plants than the environment, however. The most effective management of turf on these sand root zones might be through the use of slow-release K fertilizers, foliar applications or frequent treatments. With these methods, nutrients will be available to the plant and not as much lost through leaching.

The lack of response to K is not only characteristic of calcareous sands, but turf on all soils. Potassium is known to have its greatest influence when the plants are under stress, especially moisture and traffic stress. Neither of these stresses were present in our study. As a result, any future work on this topic will involve drought stress and heavy simulated traffic treatments.

This leaching of K in the root zone was most pronounced in spring when soil test K was very low after leaching throughout the winter (Fig. 2). This low level of K may slow the development of a healthy and stress tolerant turf in the spring in preparation for the heat stress of summer. Special efforts to raise the levels of K in the soil and in the plant tissue may be an especially important spring fertilization management goal on sites with low nutrient-holding capacity.

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REFERENCES

Johnson, P.G., R. Koenig and K. Kopp. 2003. "Nitrogen, phosphorous and potassium responses and requirements in calcareous sand greens." *Agron. J.* 95:697-702.