Managing Potassium in Putting Greens

By Dr. Wayne R. Kussow
Department of Soil Science
University of Wisconsin-Madison

Among the 17 essential plant nutrients, none has a wider spectrum of influences on turfgrass physiology and growth than does potassium. Potassium, through its role in cell hydration, regulates the rate of elongation of newly formed cells in the growing points of leaves, stems and roots and the opening and closing of leaf stomata. Insufficient levels of potassium lead to reduced rates of photosynthesis and carbohydrate production and of carbohydrate transfer to roots and shoots. Amino acid and protein synthesis are also dependent on potassium supply.

Given these far reaching effects of potassium on turfgrass physiology and growth, one can readily understand how the nutrient can have multiple effects on turfgrass. Observed responses to potassium fertilization include increased rooting, greater drought and heat tolerance, improved winter hardiness, reduced disease susceptibility and increased wear tolerance. Does this mean that if you increase the amount of potassium you're applying to your putting greens, all of these benefits will become evident?

Applying more potassium will be beneficial only if current supplies do not meet the needs of the turfgrass. Herein lies a dilemma in turfgrass research. A large majority of the reports on positive responses of turfgrass to increased potassium usage fail to indicate what were the soil and plant concentrations of the nutrient prior to and after treatment. This leaves us with little basis on which to judge whether or not application of additional potassium will be beneficial or a waste of time and money.

We've all heard about "luxury uptake" of potassium by plants. This situation arises when potassium concentrations within plants exceed the amounts thought to be necessary for basic physiological processes. Potassium is a unique nutrient in that it is not tightly bound to any plant constituent. It exists largely as a free ion. Thus, it is very difficult to determine what is an adequate amount and what is excessive. The mere fact that plants exert considerable control over potassium uptake suggests that there really is no such thing as "luxury" uptake. In fact, we know that alfalfa that goes into the winter with so-called luxury amounts of potassium has a higher winter survival rate than does alfalfa with lower levels of the nutrient. Thus, what may be a luxury supply of potassium in some climates may be considered adequate for our climate.

So where does this leave us in regard to management of potassium in putting greens? We have to start with the fact that clippings from healthy creeping bentgrass contain at least 2% potassium. In an average 24-week growing season, the total dry weight of the clipping will range between 80 and 100 lb/M. With a potassium concentration of 2%, the amount of potassium in the clippings ranges from 1.6 to 2.0 lb/M. Thus, to replace the potassium removed in the clippings we would need to apply 1.6 to 2.0 lb K/M, which translates into 1.9 to 2.4 lb K2O/M/season and a N:K2O ratio of 1.7 to 2.1. So where does the idea come from that the N:K2O ratio for sand putting greens should be at least 1:1?

It comes from two assumptions. The first is that turfgrass, like agronomic crops, will recover only about 75% of the potassium applied. The second assumption is that potassium leaches readily in sand putting greens and we have to compensate for this.

If we buy into the idea that turfgrass recovers 75% of the potassium applied, then we divide the 1.9 to 2.4 lb K2O removal rate by 0.75 and conclude that we really need to apply 2.5 to 3.2lb K2O/M/season to compensate for less than 100% turfgrass recovery. Then there's the leaching loss of potassium. You may as well pick a number from the air because I've yet to see research that gives a good idea of what this loss might be in a single season. Let's assume a 25% loss rate. Adding 25% to the 2.5 and 3.2lb K2O results in 3.1 to 4 lb K2O and a N:K2O ratio of 1.3:1 to 1:1.

Now let's go back and examine the assumption that plants recover an average of only 75% of the potassium applied. This figure is, in fact, an average derived from multiple studies conducted with agronomic crops on various types of soils. As a general rule, the higher the clay content of the soil, then lower the potassium recovery. This has led to the idea that recovery of potassium is less than 100% because of initial fixation by the clay and subsequent slow release of potassium to successive crops. If we're talking about native soil greens, these observations and concepts may be valid. But what about sand greens

where the maximum allowable clay content is only 3%? I seriously doubt that potassium fixation is of any consequence in these greens.

Until this past season, I ascribed to the notion that N and K2O applications on sand putting greens should be at a 1:1 ratio. For two successive seasons we've applied N and K2O at a ratio of about 1.4:1 to greens whose rootzone mixes were constructed using different sands and amendments. In 1994 clippings were removed on three different dates and analyzed because I was concerned that our K fertilization rates may be too low. Was I surprised. The clippings contained 2.4 to 4.3% K! If ever there was luxury K uptake, it is occurring in some, if not all, of our putting greens. This tells me that we do not have a problem with K fixation and leaching losses are far less than assumed.

Our research indicates that applying N and K2O at a 1:1 ratio to sand putting greens will result in bentgrass uptake of excessive amounts of potassium. One precautionary note is in order. We're applying the potassium in small amounts throughout the season in the form of 15-0-30 and 18-4-10 fertilizers. Sand putting greens have the capacity to retain only about 250 lb K/A or 100 ppm K in the exchangeable form. If you exceed this amount by applying relatively high rates of potassium infrequently, you can expect leaching losses to be high. How high? This a question that we're trying to answer now in our research program. If you have sand putting greens and their soil test K exceeds 250 lb/A or 100 ppm, my recommendation is to reduce your annual K2O rates to a N:K2O ratio of about 1.2:1 to 1.4:1. The K rate should be tied to your N rate because one of the primary determinants of K uptake is the bentgrass's demand for K and this is determined by your N rate. If you're not ready to make this type of adjustment, then I suggest that you adopt a fertilization program that embodies light but frequent K applications throughout the season.

For those of you with native soil putting greens, how you might best manage potassium depends on the texture of the soil in the greens and soil tests. Sandy loam or loamy sand greens are likely to behave much like USGA greens. Soil tests above about 300 lb K/A or 150 ppm should be considered very high and the time has come when you can back off a bit on your K fertilization rates by increasing the ratio of N:K2O being applied. Soils of silt loam texture or finer are going to fix significant amounts of potassium, but due to their relatively high cation exchange capacities, allow you to store plant available K in them. You can meet bentgrass demands for K very easily with only one or two fertilizer K applications per season. If soil tests are above 250 lb K/A or about 125 ppm K, this is adequate and all you need to do is keep them near this level by applying about 2.0 to 2.5 lb K2O/M/season. Then re-test you greens every 2 to 3 years to make sure the soil K levels are remaining near these optimum values.