Potassium and Plant Stress in Turf

By Robert N. Carrow

Potassium (K) has an important role in turfgrass culture, especially on recreational sites. Fertilization recommendations for K on turf are based on maximizing tolerance to high temperature, low temperature, drought and wear stresses. On very sandy soils, nitrogen (N):K_2O fertilization ratios are often used to determine K rates rather than soil testing.

PROPER K fertilization is particularly important on recreational turfgrass sites where frequent traffic, close mowing, and high maintenance make the grass prone to environmental and wear stresses. Many sports turf sites have high sand root zone media that are low in K, while frequent irrigation and removal of clippings further deplete soil K. Even when the soil is fine textured, soil K may be low if the predominate clays are kaolinite, illite, or hydrous iron-aluminum oxides; if high rainfall has leached the K; if the soils are acidic with low content of base cations; or, if heavy cropping has depleted soil K levels.

Potassium and Plant Health

Potassium is an essential nutrient required in high amounts by turf plants; it ranges from 1 to 4 percent by dry weight of vegetative tissues. Many plant enzymes require K as a cofactor for their activation. The production of high energy adenosine triphosphate (ATP) in photosynthesis and respiration requires K. When K deficiency limits ATP, processes requiring energy from ATP are restricted, such as sugar translocation, N uptake, and protein synthesis.

Additionally, K plays a major role in plant water relations. Without sufficient K, plants cannot maintain adequate turgor pressure in vegetative tissues; leaf water potential declines; yet, stomata remain open, causing high transpiration. Stresses on turfgrasses that are especially sensitive to K are: a) drought, b) high temperature, c) low temperature . . . K is a major solute in the "hardening" of turfgrasses for drought and high/low temperature tolerances, and d) wear, physical injury from traffic induced pressure, tearing and scuffing. Wear tolerant tissues have high turgor pressure.

Avoiding excess salts is also important for turf management on sandy soils. Potassium and associated ions can increase soil salinity as well as cause foliar burn to vegetative issues if applied at too high a rate. Salinity is especially a problem on irrigated sandy soils in arid regions or during prolonged drought periods.

Complicating K fertilization of turfgrasses are the interactions between N and K. Both nutrients are required at relatively high levels on recreational turf and both influence turfgrass water relationships by several mechanisms.

Georgia Research

A study at Griffin, GA, on a 'Penncross' creeping bentgrass golf green, examined interactions of N and K. Nitrogen was applied at annual rates of 262 (average) and 394 (high) lb/A, while K_2O was applied at 0, 131, 262 and 394 lb/A. The K source was potassium sulfate (K_2SO_4) with split applications of 33 percent in March, 16 percent in June, 16 percent in late July, and 33 percent in September. The golf green soil was 96.7 percent sand, 2.3 percent silt, 1.0 percent clay and 0.84 percent organic matter.

As **Table 1** indicates, low K was most detrimental to visual quality in the summer at high N appplication rates and in the driest year, year 2. High K, however, also

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Table 1. Potassium and N interaction effects on visual quality of creeping bentgrass.

Rate, lb/A		Visual quality[1]				Relative clipping yield, %	
		Year 1		Year 2		Year 1	Year 2
N	K_2O	Jul	Aug	Jul	Aug	Aug	Aug
262	0	7.4	7.4	7.0	7.2	100	100
262	131	7.3	7.5	7.3	7.5	101	142
262	262	7.5	7.3	7.3	7.4	113	166
262	394	7.3	7.2	7.1	7.0	99	104
394	0	7.7	7.1	5.4	5.7	113	79
394	131	7.5	7.1	7.0	6.9	106	141
394	262	7.6	7.0	7.0	7.1	137	200
394	394	7.5	6.6	5.6	5.7	121	98

[1]9 = ideal; 1 = no live turf.

caused visual quality to decline in the driest year when N was high. Clipping yield data reflected the same N-K_2O trend responses. **Table 2** shows that when drought stress was imposed, wilt symptoms were highest at low K, especially in conjunction with high N.

These shoot responses were related to deep rooting and water extraction. As K application rates increased, deep rooting increased up to 262 lb/A K_2O at 262 lb/A N and to 131 lb/A K_2O at 394 lb/A N, then rooting declined. Thus, applied K improved deep rooting up to a point, then it declined. When high N was applied, this trend occurred at a lower K rate than when a lower N rate was used.

In year 1, all treatments exhibited higher root length density than in year 2, and deep water extraction was not strongly influenced by K. **Table 2** also shows that deep water extraction did decrease as N rate increased. However, in year 2, deep water extraction improved as K application increased, but then declined, especially under the high N level.

In the second year of the study, at the high N rate, wilt tended to decrease as K increased, but then went up at the highest K level. This trend was observed at other wilt readings in this study. A possible reason could be the buildup of salts within the root zone which could reduce water uptake. This often happens in arid regions on sand greens unless extra water is applied for leaching . . . and year 2 of the study was an unusually dry summer.

Turfgrass Recommendations

A common observation on recreational turfgrasses grown on high sand soils is that soil K levels always test low due to

Table 2. Potassium and N interactions on wilt, deep root growth, and deep water extraction of creeping bentgrass.

Rate, lb/A		Wilt, % / plot		Root length density 4 to 8 inch depth, cm/cm^3		Water extraction, 4 to 8 inch depth[1], inches H_2O	
N	K_2O	July Year 1	August Year 2	July Year 1	August Year 2	July Year 1	August Year 2
262	0	18	20	0.32	0.17	0.33	0.23
262	131	10	20	0.44	0.26	0.30	0.27
262	262	6	13	0.52	0.31	0.33	0.22
262	394	6	10	0.34	0.23	0.34	0.20
394	0	25	30	0.44	0.10	0.28	0.19
394	131	12	23	0.52	0.17	0.29	0.25
394	262	6	13	0.41	0.14	0.27	0.16
394	394	6	23	0.40	0.13	0.25	0.15

[1]Water extraction over 2 days from 4 to 8 inch root zone depth.

leaching and/or clipping removal. On all other soils, soil testing is the best means of evaluating K needs, but on sandy soils, turf managers often determine K needs based on applied N. Some also use tissue tests to monitor plant K levels.

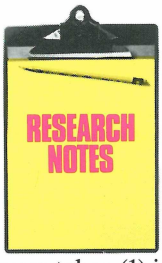
Under Georgia climatic conditions, recommendations on high sand sites for all recreational turfgrasses are:

- When fertilizing at 40 to 120 lb/A annual N, use a 1:1.5 N:K_2O ratio;
- When fertilizing at 121 to 225 lb/A annual N, use a 1:1.0 N:K_2O ratio;
- At above 225 lb/A annual N, use a 1:0.50 to 1:0.75 N:K_2O ratio.

In the summer months, especially on bentgrass, excess fertilizer applications at any one time should be avoided. For salt type K carriers, 10 to 20 lb/A K_2O can be applied every 2 to 6 weeks to maintain adequate K. Slow release K sources are also being developed to allow less frequent applications.

For finer-textured soils, where soil tests are the best measure of K needs, recommendations normally account for the higher K needs of recreational turf versus general use turf. On these sites, the turf manager should not use the previous guidelines based on N:K_2O ratios.

Potassium fertilization is also very important for winter hardiness of warm season turfgrasses. Many turfgrass managers apply a portion of the annual K in early to midfall prior to dormancy. Rates of 20 to 40 lb/A K_2O are recommended for this purpose. ■



Mississippi

Soil Sampling Band-Fertilized Fields

MANY COTTON FIELDS in the Mid-South receive band placement of fertilizers. The soil sampling procedure used to obtain representative samples for testing without a biased influence of the fertilizer band is an important consideration. A potassium (K) research project was initiated on a farmer field near Greenwood, MS, where K had been applied in a deep placed band below the drill for six years. Soil samples were taken (1) in the drill, (2) in 6-inch increments from the drill to the row middle, and (3) by random sampling. Random sampling resulted in soil test K levels similar to the average of values for samples taken from the drill to the row middle. Sampling only in the drill where fertilizer had been banded resulted in higher soil test K levels, shown by data in table. Soil sampling where cores were taken randomly–in the drill row, the row middle, and in between, in no set pattern–was adequate for sampling fields with band applied fertilizers. ■

Soil test K levels from three soil sampling procedures

Soil depth, inches	Sampling procedure: In band	Random	Band to middle average
	Soil test K level, lb/A		
0 to 6	234	140	147
6 to 12	111	78	72

Source: Dr. Jac Varco, Dept. of Plant and Soil Science, Mississippi State University, Mississippi State, MS 39762.