Potassium for Enhancement of Turfgrass Wear Tolerance

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The influence of potassium (K) on wear tolerance of two warm-season turfgrass species was evaluated at the University of Georgia. Potassium tissue concentration was an important factor which enhanced wear tolerance of both species, primarily through maintenance of turgor pressure and shoot tissue moisture. Application of K significantly increased wear tolerance and visual quality of seashore paspalum growing on a clay soil. No response to K was seen in turf growing on a high sand-based green. Warm-season turfgrass managers should base their K fertility program on soil and tissue K levels to maintain adequate tissue K for enhancement of wear tolerance, especially in stress environments.

Potassium is an important component of a turfgrass fertility program. Although effects from K application may not be readily evidenced through increased turf shoot growth or darker green leaf color, K can reduce numerous stresses on turf. One of the primary ways that K reduces turf stress is through regulation of stomatal functioning, which enhances shoot water potential of the turfgrass plant. Maintenance of turgor potential by K can also help overcome stress effects of cold temperatures, salinity, drought, or wear injury from traffic.

A series of studies at the University of Georgia looked at turfgrass wear tolerance and how it may be influenced by fertility. In one study, three hybrid bermudagrass cultivars and seven ecotypes of seashore paspalum were evaluated. The grasses were established on an Appling sandy clay loam. Paspalum is currently undergoing testing for use on golf courses, athletic fields, lawns, and landscaped venues where a high quality, stress tolerant turf is required. This species is native to coastal and marshy environments worldwide, often growing in close proximity to extremely saline water.

Research results indicated that greater shoot density, shoot moisture, and shoot tissue K concentration improved wear tolerance in both species (**Table 1**). Potassium, which increased cell turgidity and reduced tissue succulence, provided shoot tissue with greater mechanical strength to withstand the pressure and abrasion resulting from wear injury. Another important mechanism of wear tolerance in paspalum was a reduction of total cell wall (TCW) content in leaf tissue. This allowed for greater flexibility of shoot tissue and resulted in less shoot tissue injury.

A second study, also conducted on a clay soil, looked at the effect of K silicate [21 percent silicon (Si)] on wear tolerance of two paspalum ecotypes. Turf quality, color, shoot density, and wear tolerance of both grasses were enhanced due to application of 0.36 lb K_2O/1,000 sq. ft. biweekly or application of K silicate, which supplied an equivalent amount of K_2O and 0.5 lb Si/1,000 sq. ft. (**Table 2**). Analysis of tissue nutrient levels showed that there was an inverse relationship between concentrations of K and Si, with preferential K uptake occurring at the expense of Si uptake. Preferential K uptake is most likely attributable to the evolution of this species in coastal venues, where efficient

K uptake may alleviate salinity stress. Although this inherent characteristic of efficient K uptake may initially provide paspalum with ample shoot K levels, it also may result in depletion of soil K over time. It is therefore important that turfgrass managers monitor soil and tissue K levels to ensure that adequate soil K is available for paspalum.

TABLE 1. Factors which increased wear tolerance of seashore paspalum and hybrid bermudagrass.

Factor	Seashore paspalum	Hybrid bermudagrass
High K shoot concentration[1]	Yes	Yes
Greater shoot density	Yes	Yes
Higher shoot moisture[1]	Yes	Yes
Reduced TCW content[1]	Yes	Yes

[1]Factors which are influenced by K fertility.

TABLE 2. Turf responses which were improved due to application of K or K + Si as K silicate.

Treatment, lb/1,000 sq. ft.	Turf quality	Turf color	Shoot density	Wear tolerance
0.36 K_2O	Yes	Yes	Yes	Yes
0.36 K_2O + 0.5 Si	Yes	Yes	Yes	Yes

TABLE 3. Effects of K and Si shoot tissue concentration on turf quality scores.

Shoot nutrient	Turf quality	Turf color	Shoot density	Si concentration
K	Increased	Increased	Increased	Decreased
Si	Decreased	Decreased	Decreased	*

*Due to the K and Si interaction, increasing rate of K silicate did not necessarily increase Si tissue concentration.

Further analysis of shoot tissue levels indicated that increasing K concentration imparted greater turf quality, turf color, and shoot density in both ecotypes, while Si concentration decreased these characteristics (**Table 3**). This implied that any enhancement of turf visual scores due to application of K silicate was likely a response to K and not to Si within the treatment.

Potassium additionally had an effect on cell wall components in the first trial of this study, conducted from May to July during active growth of paspalum. Total cell wall constituents at this time were significantly lower in plots receiving the highest rates of K silicate or K alone. Reduction of TCW content, which had previously been shown to increase wear tolerance of paspalum, may be another mechanism by which K improves wear tolerance in this species.

In a third study to evaluate the effects of nitrogen (N) and K on a high sand-based surface similar to a putting green, no responses to K in terms of turfgrass growth, quality, or wear tolerance were observed. Two greens-type paspalum ecotypes received K biweekly at rates of either 0.24 or 0.96 lb K_2O/1,000 sq. ft., for a total annual rate of 2.4 or 9.6 lb K_2O/1,000 sq. ft. Differences in K leaf tissue levels were observed on only one ecotype in two consecutive trials of this study. In the case where differences occurred, significantly greater K levels were found in tissue from plots which received the higher rate of K. In the other cases, K tissue levels ranged from 1.9 to 2.8 percent, regardless of amount of applied K, averaged over both ecotypes. The lack of difference in tissue levels may imply that a) paspalum is extremely efficient at uptake and utilization of K and therefore exhibits no response to the higher rate of K; b) root growth or morphology was not sufficient to take up the additional K; or c) the treatments were leached through the sand profile. As K uptake efficiency is largely determined by root growth or morphology, this could be a consideration in new turfgrass stands that have not yet fully developed their root systems. However, in this case, analysis of root depth indicated that roots of these grasses were adequately and uniformly developed. The most probable cause of lack of response exhibited would be extremely efficient uptake capacity.

The implication of these studies for

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to determine the critical period of weed control in corn as influenced by nitrogen (N) fertilizer rate, implement comparative growth analysis of corn grown under weedy versus weed-free conditions among various N levels, and calculate N use efficiency of corn as influenced by duration of weedy and weed-free periods, including the partitioning of N between weeds and corn.

Nathan Ormond Nelson was born in Logan, Utah. He received his B.S. degree at Kansas State University in 1998 and completed his M.S. degree at North Carolina State University in December of last year. He is currently studying for his Ph.D. degree at North Carolina State University. He has been honored with many awards and other recognition, including the J. Fielding Reed Scholarship and the Morris K. Udal Scholarship in Environmental Excellence. He is a member of Phi Kappa Phi. For his Ph.D. research program, Mr. Nelson will study phosphorus (P) leaching and subsurface P transport. His research project will involve monitoring, quantifying, and predicting P loss in subsurface drainage beneath agricultural waste application fields. He hopes that his research can assist in determining environmentally and economically sustainable methods of maintaining high levels of agricultural production.

The Fellowships are named in honor of Dr. J. Fielding Reed, who served as President of the Institute from 1964 to 1975. Dr. Reed passed away in 1999.

The Fellowship winners are selected by a committee of PPI scientists. Dr. A.E. Ludwick, PPI's Western U.S. Director, served as chairman of the selection committee for the 2001 Fellowships. BC

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turfgrass breeding programs is to select for ecotypes with high inherent K tissue content in both paspalum and bermudagrass when screening for wear tolerance. This will enhance wear tolerance through maintenance of shoot turgor potential and, in paspalum, through reduction of TCW content.

For turfgrass managers, these results demonstrate that paspalum growing on clay soils similar to those in Georgia and the Piedmont region may exhibit increased turf quality, color, and density and reduced shoot tissue injury from traffic when tissue K levels are adequate. Although paspalum is very efficient at K uptake and utilization, it is important that soil and tissue levels continue to be monitored, or available soil K could become depleted due to the efficient uptake capacity of this species. Monitoring K tissue levels will assist turfgrass managers in scheduling K fertility programs and may result in application of less K than required by hybrid bermudagrass. On a sand-based soil, or where salinity may require extra leaching to remove salt build-up, K tissue tests can provide the most accurate information on K fertility needs of the turfgrass. Maintenance of adequate K tissue levels is important for enhancement of wear tolerance in both paspalum and hybrid bermudagrass. BC

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