Liquid Versus Granular Fertilizer Applications for Shaded Tees

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Growing grass in the shade is never easy because most turfgrasses are adapted to full sun conditions. The buffered temperature fluctuations, high humidity and long periods of leaf wetness increase the potential for disease. Lack of suitable light quality and quantity greatly affect turf growth and development, decreasing their traffic tolerance and ability to recover from damage. The cut-off point for many cool-season turfgrasses subjected to traffic and with high quality expectations is approximately 30% full sunlight. When the turf receives less than 30% full sunlight management becomes difficult if not impossible.

Traditional recommendations have included reducing the amount of nitrogen (N) fertilizer to about half the normal rate. Actual data on the effects of different types of N carriers or formulations is little to nonexistent. Many turf managers, including those at Miller Park in Milwaukee, use foliar-applied N. While foliar N applications can be economical and produce a quick turf response there is little peer-reviewed information available which compared foliar to granular N sources from an agronomic perspective. Spangenberg et al. (1986) conducted one of the few scientific studies to compare liquid versus granular N applications. On Kentucky bluegrass, growing in full sun, liquid urea applications resulted in better turf color than granular applications, at least until the latter part of summer. Jiang and Hull (1999) showed turf uses energy to absorb and process N in the roots, much of which is ultimately transported to leaves. Bushoven and Hull (2001) reported foliar N applications should increase N use efficiency, allowing more energy to be allocated for root growth. Since energy levels on shaded turf are low compared to unshaded turf, it makes sense that foliar N applications should increase turf quality.

A research project was conducted during 2000 and 2001 to provide information for developing a management program for shaded golf course tees. Our goals were to identify the best grass species, application intervals for Primo (trinexapac-ethyl), and foliar versus granular urea applications. Research on Primo effects on turfgrass under reduced light conditions has been previously reported (Stier and Rogers, 2001; Goss et al. 2002).

MATERIALS AND METHODS

Plots were established in August 1999 at the O.J. Noer Turfgrass Research and Educational Facility by placing washed sod on a silt loam soil. The grass species were 'Penncross' creeping bentgrass (*Agrostis stolonifera*), 'Supranova' supina bluegrass (*Poa supina*) and a blend of five elite Kentucky bluegrass (*Poa pratensis*) cultivars. Grasses were arranged in a randomized complete block design with four replications of each species. Plots were split to evaluate the effects of Primo applied at 0.125 oz/1000 ft^2 monthly, bimonthly, or not at all. Plots were split perpendicular across the Primo applications to evaluate the effects of foliar versus granular urea applications. Urea was applied at 0.5 lb/1000 ft^2 at 14 day intervals during the growing season. Granular treatments were irrigated in immediately following application, followed by foliar applications to the rest of the plots. Foliar urea was applied by dissolving feed grade urea in water at the rate of 1.1 lb urea per gallon of water and spraying the solution onto the turf using a carrier volume of 2 gallons of water per 1000 ft^2.

Plots were maintained at 0.5 inch height and irrigated once weekly at 50% estimated evapotranspiration of fully sunlit conditions. Turf was topdressed monthly with 0.062 inch depth of 80:20 sand:peat mixture. Shading was applied by placing an 80% shade cloth approximately 7 feet above the turf each spring to coincide with approximately 80% leaf development on nearby trees. Shade cloth was removed in the autumn to coincide with loss of approximately 80% of the leaves on nearby trees. A datalogger and environmental sensors were placed in the center of the shaded area to monitor air temperature and humidity near the turf canopy, soil temperature at 2 inch depth, and photosynthetically active radiation (PAR; 400-700 nm). A second weather station at the site was situated in full sun to provide comparative data.

Turf quality (density and uniformity) and color were rated biweekly on a one to nine scale, with one equivalent to dead turf and nine equivalent to ideal turf; a rating of six was considered acceptable. Turf density was evaluated each spring, summer, and fall using an optical point quadrat method. Divots were made using a divoting tool each season, backfilled with a sand:peat topdressing, and evaluated for percent regrowth. Nitrogen and chlorophyll concentrations were measured twice in leaf clippings during 2001. Chlorophyll fluorescence measurements were collected several times in both years to provide an indication of photosynthetic efficiency. Core samples were collected each autumn to determine root mass of each treatment. The trial was conducted over two full growing seasons, 2000 and 2001, to help ensure accurate data interpretation.

RESULTS

Environmental data

Shading averaged 80% of full sun plus or minus 4% during 2000-2001. The lowest PAR values were recorded in early October before the shade cloth was removed (approximately 2 mol m^{-2} day^{-1}) and the highest were recorded during the summer solstice in June (approximately 7 to 9 mol m^{-2} day^{1}).

Effect of Nitrogen type

For purposes of brevity, only the data directly concerned with fertility will be described. There were no interactions between fertility and PGR. The type of N fertility did not affect divot recovery, root mass, or photosynthetic efficiency. There were, however, surprising and consistent interactions between type of urea application and grass species.

Turf quality of creeping bentgrass was significantly better when foliar urea was used compared to granular applications (Table 1). Conversely, Kentucky bluegrass responded better to granular applications of urea compared to foliar applications. While creeping bentgrass turf quality was the same or better than Kentucky bluegrass quality, supina bluegrass turf quality was as good or better than creeping bentgrass. When the data were averaged for each year, supina bluegrass appeared to perform similarly regardless of N type. In reality, supina bluegrass quality was enhanced during late summer and fall when foliar applications of urea were used (Fig. 1). Fertilizer effects on turf density were similar to the effects on turf quality.

Color of supina bluegrass was greatly enhanced by Primo to the point that when data were averaged across all Primo treatments, supina bluegrass color was not often significantly different than creeping bentgrass or Kentucky bluegrass (data not shown). Nitrogen content of leaves, though, indicated supina bluegrass had significantly less N than creeping bentgrass or Kentucky

Table 1. Interaction between urea N and species on average turf quality under 80% shade, Verona, WI.

	2000		2001	
	Nitrogen type			
Species	Granular	Foliar	Granular	Foliar
Creeping bentgrass	6.3	6.9	5.7	6.5
Supina bluegrass	7.2	6.8	6.7	6.7
Kentucky bluegrass	6.5	5.6	6.0	5.4
LSD (0.05)	0.3		0.4	

Table 2. Interaction between urea N type and turf species on total leaf nitrogen content, Verona, WI, 2001. Nitrogen was applied biweekly during season, including 20 July and 4 August at 0.5 lb N per thousand square feet.

	Nitrogen concentration (% total N)			
	3 August		15 August	
Species	Granular	Foliar	Granular	Foliar
Creeping bentgrass	5.4	5.3	5.3	5.2
Supina bluegrass	4.9	4.4	4.8	4.4
Kentucky bluegrass	5.2	4.8	5.2	4.7
LSD (0.05)	0.2		0.2	

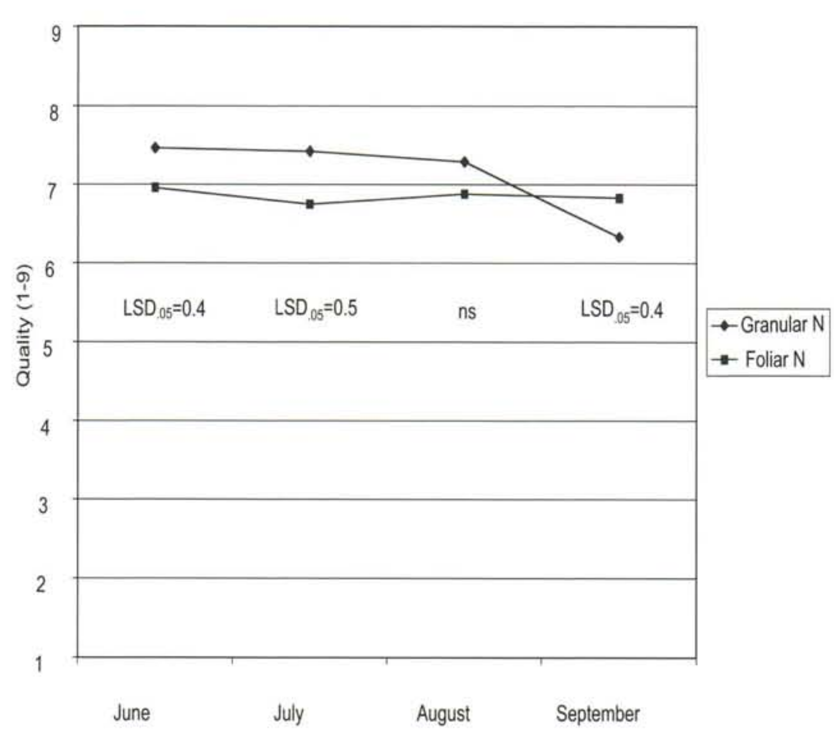

Figure 1. Turf quality of supina bluegrass depends on type of urea and time of year, Verona, WI, 2000.

bluegrass. Granular fertilization significantly increased the N content in leaves of both supina bluegrass and Kentucky bluegrass while N content in clippings of creeping bentgrass was not affected by N type (Table 2). Nitrogen content did not seem to correlate with chlorophyll concentration, however, as foliar N resulted in significantly ($p = 0.05$) greater chlorophyll amounts for all species compared to granular N treatments (approximately 26 versus 23 to 24 micrograms of chlorophyll per gram of fresh leaf tissue).

Root masses among the three species were not statistically different in 2000. Root masses in the top 2 inches of turf average 0.635 g for creeping bentgrass, 0.844 for supina bluegrass, and 0.938 g for Kentucky bluegrass. In 2001 Kentucky bluegrass had significantly more root mass (0.488 g) than either supina bluegrass (0.215 g) or creeping bentgrass (0.162 g).

DISCUSSION

The data indicating a differential response to N carrier on turf in shaded conditions is important because it has not previously been reported. The information is especially important because it allows us to solve another "piece of the puzzle" in the development of management programs for shaded turf areas. Although the turf in the study was maintained as a "tee box" turf, the fertility treatments should have similar effects at both lower and higher mowing heights (although to be sure these variables should also be investigated). The fact there were no interactions between PGR and N type is also important as this also had not previously been reported for shaded conditions (or full sun for that matter).

We are currently examining the reasons for the differential species response to nitrogen carriers.

Kentucky bluegrass, despite its poor turf quality, had substantially greater root mass than either creeping bentgrass or supina bluegrass, while supina bluegrass had greater root mass than creeping bentgrass. Although data were not collected in the fall during establishment, it appears Kentucky bluegrass lost its root system at a slower rate than supina bluegrass or creeping bentgrass. Beard (1973) indicated Kentucky bluegrass has a perennial root system while creeping bentgrass has an annual root system. The slower root turnover (i.e., greater mass) of bluegrass may have allowed it to absorb more N from granular urea compared to the smaller root mass of creeping bentgrass. Kussow (2001) reported that much of the urea applied to turf foliage in liquid form may be lost due to volatilization or trapped in the plant cuticle. In some cases only 40% of the N may actually be absorbed into the plant. The fine leaf texture of creeping bentgrass may have resulted in more efficient capture and absorption of foliar N compared to the coarser-textured Kentucky bluegrass. Since leaf N content in creeping bentgrass was not affected by N type, however, it is likely there were other factors affecting the N response.

CONCLUSION

The best turf for shaded tees can be obtained using supina bluegrass and fertilizing it with granular urea in the spring and early summer, switching to foliar applications of urea in August. If creeping bentgrass is used, it should be fertilized primarily or only with liquid urea applications directed at the foliage. Kentucky bluegrass should generally not be used for tees subject to 80% or more shade.

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