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Notes

Evaluation of Mowing Height and Fertilizer Application Rate on Quality and Weed Abundance of Five Home Lawn Grasses

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Evaluation of turfgrass performance at low nitrogen fertility levels is important because many home lawns are fertilized below common recommendations. The objective of this study was to evaluate visible quality and weed susceptibility of common and alternative cool season grasses under multiple management regimes in Wisconsin. A split-split plot completely randomized block design was used to evaluate 'Kingfisher' Kentucky bluegrass (Kentucky bluegrass), 'Kenblue' Kentucky bluegrass, 'Victory II' chewings fescue, 'Grande II' tall fescue, and 'Jiffe II' perennial ryegrass. Each species was mowed at 3.5, 6.0, or 8.5 cm, and fertilized with 0, 98, or 196 kg ha^{-1} yr^{-1} of nitrogen. Visible quality and weed cover were evaluated four times annually for 3 yr. Tall fescue had the greatest turf quality across all treatments. Kingfisher Kentucky bluegrass, an improved variety, responded most dramatically to nitrogen fertilization, with quality rating improved from 5.1 to 7.1 when annual nitrogen applications totaled 196 kg ha^{-1} compared to the nonfertilized control. Kenblue Kentucky bluegrass, a common variety, had the greatest weed cover at all mowing heights and fertilizer rates. Assessment of common dandelion flowers by digital image analysis revealed that improved and common Kentucky bluegrass had greater common dandelion cover than fine or tall fescue when herbicides were withheld for 2.5 yr. Background soil fertility was found to have a significant impact on visible quality and weed cover. In an area with eroded, low-fertility soil, improved Kentucky bluegrass required 196 kg N ha^{-1} yr^{-1} to maintain high quality and limit weed invasion. These results suggest that tall fescue is best suited to low and high input conditions, while improved varieties of Kentucky bluegrass performed acceptably only under high inputs.

Nomenclature: Chewings fescue, *Festuca rubra* var. *commutata* Gaud FESRU; common dandelion, *Taraxacum officinale* G.H. Weber ex Wiggers TAROF; Kentucky bluegrass, *Poa pratensis* L. POAPR; perennial ryegrass, *Lolium perenne* L. LOLPE; tall fescue, *Lolium arundinaceum* (Schreb.) S.J. Darbyshire FESAR.

Key words: Digital image analysis, low-input turfgrass, smooth crabgrass, soil fertility.

La evaluación del desempeño del césped a niveles de fertilidad bajos en nitrógeno es importante porque los céspedes caseros son fertilizados por debajo de las recomendaciones comunes. El objetivo de este estudio fue evaluar la calidad visual y la susceptibilidad a las malezas de zacates de clima frío comunes y alternativos bajo múltiples regímenes de manejo en Wisconsin. Se usó un diseño de bloques completos al azar en parcelas subdivididas para evaluar *Poa pratensis* 'Kingfisher' y 'Kenblue', *Festuca rubra* var. *commutata* 'Victory II', *Lolium arundinaceum* 'Grande II' y *Lolium perenne* 'Jiffe II'. Cada especie fue podada a 3.55, 6.0 ó 8.5 cm, y fertilizada con 0.98 ó 196 kg ha^{-1} año^{-1} de nitrógeno. La calidad visual y la cobertura de malezas fueron evaluadas cuatro veces anualmente durante 3 años. *L. arundinaceum* tuvo la mayor calidad en todos los tratamientos. Kingfisher, una variedad mejorada, respondió más dramáticamente a la fertilización nitrogenada, con una mejora en la evaluación visual al compararse con el testigo sin fertilización de 5.1 a 7.1 cuando las aplicaciones anuales de nitrógeno totalizaron 196 kg ha^{-1}. Kenblue, una variedad común, tuvo la mayor cobertura de malezas en todas las alturas de poda y dosis de fertilización. Evaluaciones de las flores de *Taraxacum officinale*, usando análisis de imágenes digitales, revelaron que variedades comunes y mejoradas de *P. pratensis* tuvieron coberturas mayores de esta maleza que *F. rubra* y *L. arundinaceum* cuando se detuvo el uso de herbicidas durante 2.5 años. Se encontró que el nivel inicial de fertilidad del suelo tuvo un impacto significativo en la calidad visual y la cobertura de malezas. En un área con suelos erosionados y baja fertilidad, variedades mejoradas de *P. pratensis* requirieron 196 kg N ha^{-1} año^{-1} para mantener una calidad alta y limitar la invasión de malezas. Estos resultados sugieren que *L. arundinaceum* está mejor adaptado a condiciones de altos y bajos insumos, mientras que las variedades mejoradas de *P. pratensis* se desempeñaron en forma aceptable solamente bajo condiciones de altos insumos.

For home lawns, the University of Wisconsin recommends the application of 147 kg N ha^{-1} yr^{-1} where clippings are returned (Kussow et al. 2011). However, it is estimated that only about 15% of homeowners apply at least this amount of fertilizer in the United States, and an estimated 59% of homeowners do not apply any fertilizer to their lawns (Augustin 2007). Because of the increasing public scrutiny of the impact of lawn management practices on the environment, development of species recommendations for low-input maintenance conditions are needed in the North Central region of the United States (Watkins et al. 2011).

Kentucky bluegrass, perennial ryegrass, and fine fescues *Festuca* spp. are commonly found in home lawns in the North Central region. Tall fescue is less common, especially in the North Central region because of poorer cold and ice tolerance

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(Hollman and Stier 2002; Dierking et al. 2012) than the traditional choices, but most studies evaluating cold tolerance were performed prior to the development of improved cultivars (Beard 1966; Burns and Chamblee 1976). However, tall fescue has been shown to perform well under low-input conditions in the upper midwestern states (Diesburg et al. 1997).

In addition to proper species selection, cultural practices have a pronounced effect on turfgrass performance and weed invasion (Calhoun et al. 2005). Fertilizing has been shown to increase turf quality, while reducing weed abundance (Busey 2003; Dernoeden et al. 1993; Dunn et al. 1981; Voigt et al. 2001). Lower than recommended mowing heights are also related to weed invasion of turfgrass stands (Busey 2003; Davis 1958; Turgeon 2005).

The objective of this study was to evaluate visible quality and weed susceptibility of a variety of cool season grasses under multiple management regimes in Wisconsin. This information will be used to guide home lawn recommendations in Wisconsin and states with similar climates.

Materials and Methods

Field Site and Experimental Design. The study was performed from May 2007 to October 2010 at the O.J. Noer Turfgrass Research and Education Facility in Madison, WI. Plots measuring 1.5 by 4.5 m were arranged in a split-split plot randomized complete block design. Two blocks were established on a Troxel silt loam (fine-silty, mixed, superactive, mesic Pachic Argiudoll) and a third on a Dresden silt loam (fine-loamy over sandy or sandy-skeletal, mixed, active, mesic Mollic Hapludalf). Soil properties can be found in Table 1.

Treatments and Management. A 14-28-12 ($N–P_2O_5–K_2O$) starter fertilizer was applied to all plots at 44 kg P ha^{-1} prior to establishment, tilled to a 0.1-m depth, and raked level. Plots were seeded on May 30, 2007, with either an improved America-type cultivar of Kentucky bluegrass ('Kingfisher'), a common variety of Kentucky bluegrass ('Kenblue'), chewings fine fescue ('Victory II'), a turf-type tall fescue ('Grande II'), or improved perennial ryegrass ('Jiffe II'). Seed was applied with a drop spreader at the following rates: Kentucky bluegrass at 120 kg ha^{-1}, chewings fescue at 240 kg ha^{-1}, and tall fescue and perennial ryegrass at 350 kg ha^{-1}. Plots were covered with straw mulch and irrigated three times daily from May 30 to July 12, 2007, after which all plots were irrigated at 80% of potential evapotranspiration three times weekly as determined by an on-site weather station. All plots were treated with Q4® Turf Herbicide (5.69% quinclorac, 0.69% sulfentrazone, 12.02% 2,4-dichlorophenoxyacetic acid, 1.38% dicamba; PBI/Gordon Corporation, Kansas City, MO) at a rate of 9.3 L ha^{-1} delivered in 800 L ha^{-1} of water to control broadleaf and grassy weeds on August 1, 2007. No other herbicide applications were made through the duration of the study.

The first mowing occurred June 19, 2007, 3 wk after seeding, at 3.5-, 6.0-, or 8.5-cm height of cut with a rotary mulching mower. Plots were mowed weekly at the specified heights for the duration of the study. Fertilizer with analysis 34-0-11 was applied at 0, 98, or 196 kg N ha^{-1} yr^{-1} with a drop spreader in increments of 49 kg N ha^{-1}. Treatments receiving 98 kg N ha^{-1} yr^{-1} were fertilized in May and September. Treatments receiving 196 kg N ha^{-1} yr^{-1} were fertilized in May, July, September, and October.

Data Collection. All data collection was performed 3 wk after the most recent fertilizer application. Visible turf quality was evaluated on a 1 to 9 scale, on which 1 represents absent, dead, or dormant turf; 6, acceptable turf; and 9, exceptional turf. Weed cover was evaluated by visually estimating the percentage of weeds in each plot in 2008 and by the point-intersect method to determine weed concentration and composition in 2009 (Woolhouse 1976). The intersection apparatus was 1.5 m^2 with 25 evenly distributed intersections. Additionally, on May 12, 2011, percent common dandelion cover was evaluated using digital images (C-8080, Olympus America, Inc., Center Valley, PA) taken from the center of each plot within a 0.6 by 0.4 by 0.5 m aluminum box used to shield ambient sunlight. Consistent internal illumination was maintained with four 9-W compact fluorescent bulbs. Images were analyzed with SigmaScan (Systat Software Inc., San Jose, CA) software and a macro designed to assess turfgrass cover (Karcher and Richardson 2005) modified to evaluate the yellow common dandelion flower.

Soil cores were collected following the completion of the study to compare physical and chemical soil properties. Five cores were collected from each block with a 2-cm-diam soil probe, and split into 15-cm depth increments. Soil organic matter by weight loss on ignition was measured on the 2-mm

Table 1. Difference in soil organic matter by depth, estimated nitrogen mineralization, pH, quality, and percent weed cover as affected by two different soil series. Standard error of the mean for organic matter loss on ignition (LOI) is 0.3 for the 15- to 30-cm depth. Standard error of the mean for estimated nitrogen mineralization at the 0–15 cm depth is 2, and 8 for the 15- to 30-cm and 0- to 30-cm depth. Standard error of the mean for quality is 0.2 and weed cover is 4.

	Organic matter LOI		Estimated N mineralization					
	Sample depth		Sample depth			pH		
Soil series	0–15 cm	15–30 cm	0–15 cm	15–30 cm	0–30 cm	Sample depth	Quality	Weed cover
	%		kg ha^{-1}			0–15 cm	1–9	%
Dresden	4.18	2.1 B[a]	113	56 B	169 B	6.9	5.9 B†	17 A
Troxel 1	4.14	3.0 A	112	80 A	192 A	7.2	6.6 A	7 B
Troxel 2	4.34	2.9 A	117	77 A	194 A	7.2	6.6 A	6 B

[a] Means followed by a different letter are significantly different ($P < 0.05$) and can be compared within a column.

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fraction of each sample by ignition at 360 C. The following equation was used to convert from organic matter content to estimated nitrogen mineralization (Havlin et al. 2005):

$$N_{MIN} = \%OM \times \%N \times M_S \times Min_R \quad [1]$$

where N_{MIN} is the annual rate of soil organic nitrogen mineralization, % OM is the amount of organic matter in the soil, % N is the amount of nitrogen contained in soil organic matter, M_S is the mass of the soil assuming a bulk density of 1.2 Mg m^{-3}, and Min_R is the annual rate of organic matter mineralization. Assumptions were that 5% of OM is nitrogen, the annual organic matter turnover rate is 3%, and the soil bulk density is 1.2 Mg m^{-3} (Havlin et al. 2005).

Statistical Analysis. All statistics were analyzed by ANOVA and LSD using the GLIMMIX procedure of SAS 9 (SAS Institute Inc., Cary, NC). A log transformation was used for weed abundance in order to meet model assumptions. Visual quality and weed abundance results were analyzed as means for the entire study period. Additionally, a block main effect for visual quality and weed abundance was analyzed by ANOVA and LSD using the GLIMMIX procedure of SAS 9 to compare the impact soil series had on response variables.

Results and Discussion

Turf Quality. In general, as fertilizer rates increased, turfgrass quality also increased, although the species differed in their responses to nitrogen fertilization. Averaged over the study period, tall fescue had the greatest quality of all turfgrass species at each nitrogen application rate, with a visual quality of 6.5 at 0 kg N ha^{-1} yr^{-1}, 7.2 at 98 kg N ha^{-1} yr^{-1}, and 7.5 at 196 kg N ha^{-1} yr^{-1} (Table 2). Tall fescue maintained acceptable quality (> 6.0) over the duration of the study with only a single application of starter fertilizer at establishment. Lack of a statistically significant visual quality difference between the 98 and 196 kg N ha^{-1} yr^{-1} treatments suggests 98 kg N ha^{-1} yr^{-1} or less is the optimum fertilization rate for tall fescue under the study conditions.

Fine fescue, perennial ryegrass, and both Kentucky bluegrass varieties performed poorly when nitrogen fertilizer was withheld, all having unacceptable turfgrass quality. Application of 98 kg N ha^{-1} yr^{-1} improved visual quality rating to an acceptable level for those species, although still significantly below the tall fescue. The Kenblue Kentucky bluegrass (common variety) quality did not respond to further nitrogen fertilization. In contrast, Kingfisher Kentucky bluegrass (improved variety), fine fescue, and perennial ryegrass continued to respond to increased nitrogen fertilization. Kingfisher Kentucky bluegrass was most responsive to nitrogen fertilization rate compared to the other grass species evaluated. These results are illustrated by a photograph taken in May 2010, 3 yr after establishment (Figure 1). Quality of perennial ryegrass was consistently hindered by disease outbreaks, most notably by annual rust (caused by *Puccinia* spp.) outbreaks during the summer.

Mowing at the 3.5-cm height of cut resulted in significantly lower turfgrass quality across all species, whereas all turfgrass species showed acceptable and similar quality across both the 6.0- and 8.5-cm height of cut (Table 2). Tall fescue was the only species to have acceptable quality ratings at all heights of cut; however, it was statistically better at the 6.0- and 8.5-cm height of cut. This trend is similar to findings of Voigt et al. (2001) who reported tall fescue mowed at 5.1 and 7.6 cm had consistently greater turf quality than when mowed at 2.5 cm. The lower quality at shorter heights is expected as recommendations are to mow tall at a height $\geq$ 4 cm (Turgeon 2005). Recommended mowing heights for perennial ryegrass and fine fescue are 4 to 5 cm (Turgeon 2005). Our results confirm this recommendation because mowing at a height of 3.5 cm resulted in below acceptable turfgrass quality. The recommended mowing height for Kentucky bluegrass is 2 to 6 cm (Turgeon 2005); however, both Kentucky bluegrass cultivars tested had less than acceptable quality when cut at 3.5 cm.

Weed Abundance. The most abundant broadleaf weed in this study was common dandelion. Grassy weeds such as tall fescue, creeping bentgrass (*Agrostis stolonifera* L.), annual bluegrass (*Poa annua* L.), and smooth crabgrass [*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl] were also prominent. Tall fescue turf had the lowest weed abundance of 3% at all nitrogen rates (Table 3). Kenblue Kentucky bluegrass had the greatest weed abundance at all three nitrogen application rates: 26% at 0 kg ha^{-1} yr^{-1}, 20% at 98 kg ha^{-1} yr^{-1}, and 15% at kg ha^{-1} yr^{-1}. A decrease in weed abundance with increasing nitrogen rate was observed for all turfgrass species, except tall fescue and common Kentucky bluegrass, which

Table 2. The effect of turfgrass species, nitrogen rate, and height of cut on quality of five turfgrasses as measured on average over the study period. Standard error of the mean for nitrogen rate is 0.4 and for height of cut is 0.3.

Species	Turfgrass quality[a]					
	Nitrogen rate			Height of cut		
	0	98	196	3.5	6.0	8.5
	kg ha^{-1} yr^{-1}			cm		
	1–9					
'Grande II' tall fescue	6.5 DE	7.2 AB	7.5 A	6.6 BC	7.2 A	7.3 A
'Victory II' chewings fine fescue	5.6 F	6.4 E	6.8 DC	5.6 EF	6.6 BCD	6.7 B
'Jiffe II' perennial ryegrass	5.2 G	6.5 E	6.9 BC	5.9 E	6.5 BCD	6.2 D
'Kingfisher' Kentucky bluegrass (improved)	5.1 G	6.4 E	7.1 BC	5.5 F	6.7 B	6.4 BCD
'Kenblue' Kentucky bluegrass (common)	5.3 GF	6.2 E	6.4 E	5.3 F	6.3 CD	6.4 BCD

[a] Means followed by a different letter are significantly different ($P < 0.05$) and can be compared across columns and rows within nitrogen rate and height of cut.

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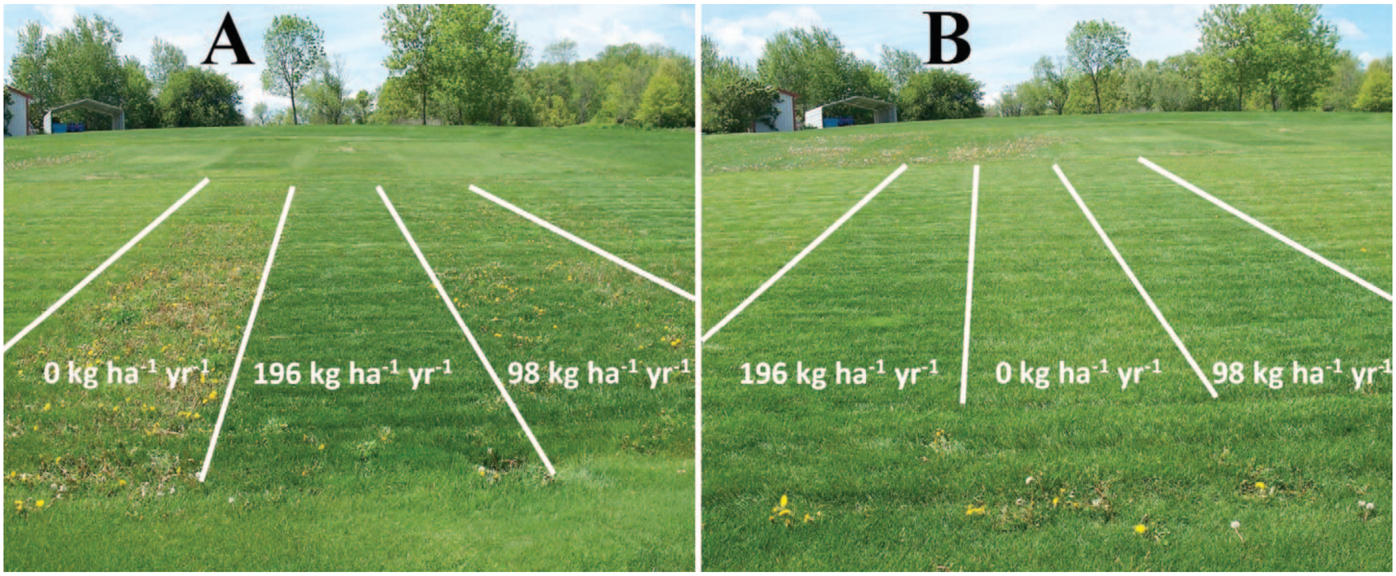

Figure 1. The influence of increasing nitrogen fertilizer application on a low-fertility Dresden silt loam for improved Kentucky bluegrass (A) and tall fescue (B).

both showed no fertilizer effect. The improved Kentucky bluegrass had the most dramatic response to increased nitrogen application rate. At 0 kg N ha^{-1} yr^{-1} 20% of the plot, at 98 kg N ha^{-1} yr^{-1} 7% of the plot, and at 196 kg N ha^{-1} yr^{-1} only 3% of the plot was covered by weeds, paralleling visual quality ratings.

Mowing height also had a significant impact on weed abundance (Table 3). At the 3.5-cm height of cut, tall fescue had 8% and chewings fine fescue had 16% weed cover while Kenblue Kentucky bluegrass had the greatest weed abundance of 44%. Even though the Kenblue Kentucky bluegrass had the greatest weed abundance at each height of cut, weed abundance fell by 32% between the 3.5- and 6.0-cm height of cut. Overall, the 3.5-cm height of cut had the greatest weed abundance for all species. Increasing the height of cut to 6.0 cm decreased weed abundance for all species except perennial ryegrass. However, increasing height of cut from 6.0 to 8.5 cm did not decrease weed abundance. Similarly, Davis (1958) found mowing at 5.1 cm compared to 1.9 cm decreased common dandelion, white clover, and smooth crabgrass abundance in fine fescue and Kentucky bluegrass. In this study, overall smooth crabgrass populations were decreased by 74% when mowing at 6.0 instead of 3.5 cm (data not shown). Annual bluegrass infestation on perennial ryegrass was decreased by 11% when mowing at 7.5 cm instead of 2.5 cm (Adams 1980). In general, we observed that increasing mowing height has a more dramatic effect on weed abundance than increasing fertilizer rates when returning clippings. However, both methods (along with proper species selection) should be used as tools to reduce the need for weed control in lawns.

Common dandelion is a common broadleaf weed in cool season home lawns of Wisconsin and are highly visible during flowering. Using digital image analysis of common dandelion flowers (Figure 2), we observed significant species and nitrogen rate main effects interactions (Table 4). Kenblue Kentucky bluegrass had 3% common dandelion flower head cover averaged over all mowing heights and nitrogen rates, significantly greater than the common dandelion head cover found for perennial ryegrass, tall fescue, and chewings fine

Table 3. The effect of turfgrass species, nitrogen rate and height of cut on percent weed cover of five turfgrasses as measured on average over the study period. Standard error of the mean for nitrogen rate is 5 and for height of cut is 6.

Species	Percent weed cover[a]					
	Nitrogen rate			Height of cut		
	0	98	196	3.5	6.0	8.5
	kg ha^{-1} yr^{-1}			cm		
	%					
'Grande II' tall fescue	3 F	3 F	3 F	8 DEFG	2 HI	1 I
'Victory II' chewings fine fescue	12 BCD	10 CDE	5 EF	16 BCD	6 FG	7 EFG
'Jiffe II' perennial ryegrass	25 AB	9 DE	10 CDE	21 B	12 BCDEF	9 CDEF
'Kingfisher' Kentucky bluegrass (improved)	20 ABC	7 DE	3 F	20 BC	4 GH	5 FGH
'Kenblue' Kentucky bluegrass (common)	26 A	20 ABC	15 ABCD	44 A	12 BCDEF	15 BCDE

[a] Means followed by a different letter are significantly different ($P < 0.05$) and can be compared across columns and rows within nitrogen rate and height of cut.

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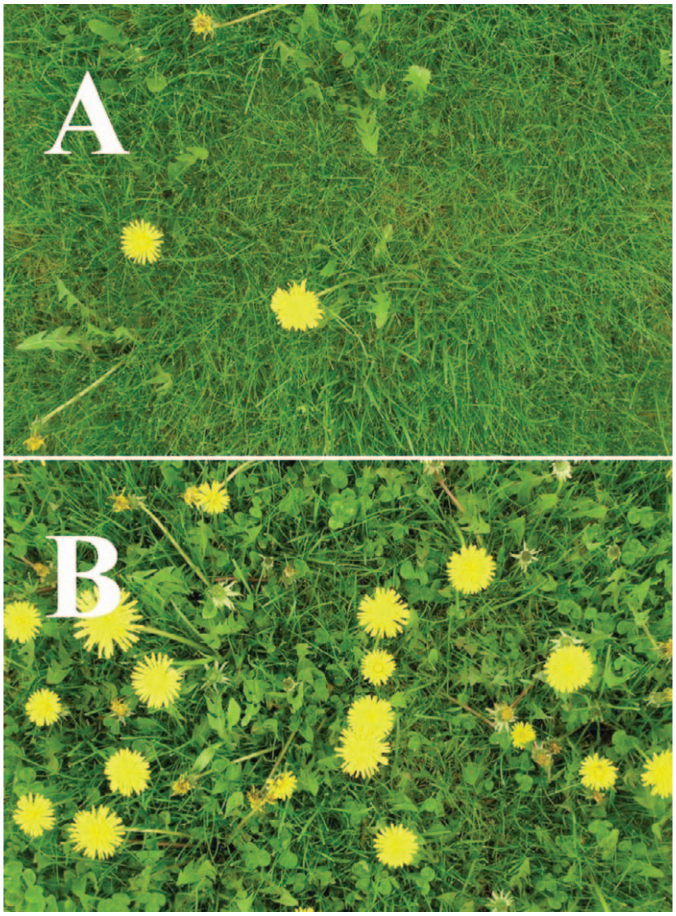

Figure 2. Example of digital images used to assess common dandelion flower cover. Results indicate that there is 1.1% common dandelion flower cover in fine fescue (A) mowed at 3.5-cm height of cut, and 8.6% common dandelion cover in common Kentucky bluegrass (B) mowed at 3.5-cm height of cut.

fescue, but not different from the improved Kentucky bluegrass Similar to our observations of total weed cover, a 40% reduction in common dandelion flower head cover occurred as fertilization rate increased from 0 to 98 kg N ha^{-1} yr^{-1}. Averaged across species, increasing nitrogen fertilizer application to 196 kg ha^{-1} yr^{-1} did not further reduce common dandelion cover (Table 4). Callahan and Overton (1978) reported that common dandelion cover in bermudagrass was reduced 21% with an increase from 95 to 190 kg N ha^{-1} yr^{-1}. In a review of cultural management of turfgrass weeds, Busey (2003) suggests fertilization with 100 to 300 kg N ha^{-1} yr^{-1} to reduce common dandelion weed populations. Returning clippings also was found to reduce weed populations in Kentucky bluegrass (Heckman et al. 2000), likely because of increased nitrogen availability. Though we found no main effect for height of cut for common dandelion flower cover (data not shown), Calhoun et al. (2005) found that decreasing height of cut from 10 to 5 cm increased common dandelion cover in a mixed stand of cool-season grasses. Similar to common dandelion cover, crabgrass cover has been shown to decrease with higher rates of fertilization in chewings fescue (Jagshitz and Ebdon 1985), tall fescue (Dernoeden et al. 1993; Voigt et al. 2001), and Kentucky bluegrass (Dunn et al. 1981). In our study smooth crabgrass populations decreased by 36% when nitrogen rates were increased from 0 to 98 kg ha^{-1} yr^{-1} (data not shown).

Table 4. Effect of turfgrass species and nitrogen rate on percent common dandelion cover on May 12, 2011, by digital image analysis. Standard error of the mean for species is 0.6 and nitrogen rate is 0.5.

Species	Common dandelion cover (%)[a]
'Kenblue' Kentucky bluegrass (common)	3.4 A
'Kingfisher' Kentucky bluegrass (improved)	2.9 AB
'Jiffe II' perennial ryegrass	2.1 BC
'Grande II' tall fescue	1.4 C
'Victory II' chewings fine fescue	1.1 C
Nitrogen rate (kg ha^{-1} yr^{-1})	
0	3.2 A
98	1.9 B
196	1.5 B

[a] Means followed by a different letter are significantly different ($P < 0.05$) and can be compared within a column for species and nitrogen rate.

Influence of Soil Fertility. New home lawns are often established on a thin layer of nutrient-rich topsoil overlying subsoil compacted during residential construction or directly on exposed subsoil (Craul 1992). A similar situation was mimicked in this study by differences in soil properties across blocks. These differences significantly impacted visual quality and weed cover (Table 1). The Dresden silt loam was located on a highly eroded hillside from previous agricultural activity. However, the Troxel silt loam was located at the foot of the hill, where much of the eroded topsoil was deposited. Soil analysis revealed that there was no difference in soil organic matter content in the top 15 cm of each block; however, significant differences were found from 15 to 30 cm (Table 1). To highlight the differences between soil types, the estimated annual nitrogen mineralization from organic matter decomposition was calculated. Results reveal that an additional 24 kg N ha^{-1} yr^{-1} potentially mineralized in the Troxel silt loam. Therefore, every 2 yr the difference in natural soil fertility would account for the equivalent of an additional fertilizer application, or approximately 44 kg N ha^{-1}.

This additional fertility was most noticeable for the improved Kentucky bluegrass. Average turf quality for improved Kentucky bluegrass on the low-fertility Dresden silt loam (6.0-cm height of cut) was 4.0 at 0 kg N ha^{-1} yr^{-1} and 6.3 at 98 kg N ha^{-1} yr^{-1}. On the Troxel silt loam, improved Kentucky bluegrass quality (6.0-cm height of cut) was 6.4 at 0 kg N ha^{-1} yr^{-1} and 7.1 at 98 kg N ha^{-1} yr^{-1}. The same result was not observed for turf species with lower nitrogen fertility requirements, including tall fescue (Figure 1). Therefore, soil fertility needs to be a primary consideration in turf species selection for new establishments. High maintenance varieties should be avoided on low fertility soils unless management intensity matches turfgrass requirements.

In conclusion, tall fescue provided the greatest turfgrass quality, and was among the best species in limiting weed invasion across fertilizer rates and mowing heights. Kingfisher Kentucky bluegrass showed the greatest response to applied nitrogen fertilizer but did not provide acceptable turf quality when not fertilized. Low mowing heights can increase weed pressure and thereby decrease turf visual quality. Tall fescue is an alternative turfgrass for home lawns that had minimal weed invasion and provided acceptable quality at low fertilizer rates over a variety of mowing heights.

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