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Low-Input Turfgrass Species for the North Central United States

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Abstract

Public attention is being increasingly focused on the environmental impact and management costs of turfgrass areas such as lawns for schools, parks, and homes. The objectives of this study were to: (i) identify grass species adapted to low-input environments (limited water, no fertilizer or pesticides after establishment) in the North Central Region (NCR) of the USA; and (ii) evaluate these species for turfgrass quality under mowed and non-mowed conditions. Low-input turf trials of 12 grass species were established at eight locations and evaluated for turf quality over two years. Plots were mowed monthly at either 5.1 or 10.2 cm or not mowed. Hard fescue (*Festuca brevipila* Tracey), colonial bentgrass (*Agrostis capillaris* L.), tall fescue (*Festuca arundinacea* Schreb.), and sheep fescue (*Festuca ovina* L.) performed well at most locations at the 5.1 and 10.2-cm mowing heights. Several other species were also evaluated: tufted hairgrass [*Deschampsia cespitosa* (L.) P. Beauv.], hybrid bluegrass (*Poa arachnifera* Torr. × *Poa pratensis* L.), meadow fescue [*Schedonorus pratensis* (Huds.) P. Beauv.], prairie junegrass [*Koeleria macrantha* (Ledeb.) Schult], crested wheatgrass [*Agropyron cristatum* (L.) Gaertn.], alkaligrass [*Puccinellia distans* (Jacq.) Parl.], blue grama [*Bouteloua gracilis* (Willd. Ex Kunth) Lag. Ex Griffiths], and crested dogstail (*Cynosurus cristatus* L.).

Introduction

At present, Kentucky bluegrass (*Poa pratensis* L.), perennial ryegrass (*Lolium perenne* L.), and tall fescue are the primary species used for turf in the North Central Region (NCR). Recently-developed Kentucky bluegrass and perennial ryegrass cultivars provide high quality turf when managed with sufficient amounts of fertilizers, water, and pesticides (21). However, there has been increasing attention drawn to the negative aspects of higher input turfs (15) which has resulted in changes such as fertilizer use restrictions in Minnesota (19), cosmetic pesticide restrictions in Canada (9), and water use restrictions set by the Environmental Protection Agency (23). Current turf management options and some of the species and cultivars commonly used for turf may be inadequate for use in the USA in the future due to potential negative impacts of high-input turfgrass management on the environment. One way to reduce inputs is by identifying and planting low-input turfgrass species that require less mowing, fertilization, and irrigation in order to achieve adequate visual quality. In order to use low-input species and make them attractive to the public, it is critical to properly assess low-input adaptation across multiple environments.

Diesburg et al. (6) evaluated twelve grass species as low-input turf at seven sites in the NCR for three years. Overall, the best performing species, as determined by plot uniformity and cover, were tall fescue, colonial bentgrass, redtop bentgrass (*Agrostis gigantea* Roth), and sheep fescue. We decided to compare the performance of some species that did well in the study by Diesburg et al. (tall fescue, colonial bentgrass, sheep fescue) with other grasses that have been shown to be effective in climates similar to the NCR and with grasses that have not been extensively tested for low-input turf but have shown the potential to perform adequately in the NCR.

Hard fescue is a bunch-type grass native to central Europe known to perform well in reduced-input shady environments, under full-sun conditions, and in situations where reduced mowing frequency is desirable (10,17). Tufted hairgrass is a cool-season bunch grass that can thrive in both sun and shade when moisture is not limiting (3). Prairie junegrass is native to the Great Plains and has performed adequately in low-input turf evaluations in Canada (16). Blue grama is a warm-season bunchgrass found throughout the Great Plains that has shown potential for use as a turf in low-nitrogen and arid environments (13,16). In recent years, a number of Texas bluegrass × Kentucky bluegrass hybrid cultivars have been released; these cultivars can exhibit improved heat tolerance compared to Kentucky bluegrass (20). Other species that have not been tested on a wide-scale in the NCR include alkaligrass, which can be an effective turf when grown in areas with high salt levels in the soil (21); meadow fescue, which is similar in appearance to coarse-textured tall fescue cultivars (1); crested wheatgrass, a grass that has been the focus of germplasm improvement efforts for use in arid environments (11); and crested dogstail, which has been shown to be adapted to shady environments (14).

The objectives of this study were to: (i) identify grass species adapted to low-input environments (limited water, no fertilizer or pesticides after establishment) in the NCR of the USA; and (ii) evaluate these species for turfgrass quality under mowed and non-mowed conditions. These low-input grasses could potentially be utilized on home lawns, school grounds, parks, golf course roughs, and other turf areas. Furthermore, the identification of species with potential low-input use will give plant breeders information to help focus germplasm improvement programs.

Establishment and Treatments

In fall 2004, 12 grass species (Table 1) were seeded at eight sites in the NCR (Table 2). The experimental design for each location was a split plot with mowing height as the main plot and species as the sub-plot. Individual sub-plots were 1.52 m × 0.91 m, with no border between plots, and seeded at a generally-accepted rate for each species (Table 1). Plots were established by either dormant seeding or a typical late summer seeding on bare soil (Table 2). Dormant seeding was done late-fall once soil temperatures were below 5°C to ensure that seed would not germinate until temperatures warmed in the spring. After seed was applied and lightly raked into the soil, the dormant-seeded trials were covered with Futerra blankets (Profile Products LLC, Buffalo Grove, IL). Late summer-seeded plots were seeded in late August/early September and a starter fertilizer was used at time of seeding at a rate of approximately 49 kg N/ha and 43 kg P_2O_5/ha. Plots were irrigated during the fall establishment period. Following establishment, no irrigation or fertilizer was applied. For both establishment methods, during the first spring after seeding, broadleaf weeds were controlled with a single application of an herbicide mixture of 2,4-D, MCPP, and dicamba (Trimec Classic, PBI/Gordon Corp., Kansas City, MO) at all sites with the exception of Wisconsin (no herbicide applied), North Dakota (no herbicide applied), and Ohio [single application of an herbicide mixture of 2,4-D, clopyralid, and dicamba (Millennium Ultra 2, Nufarm Americas Inc., Burr Ridge, IL)]. No other pesticides were ever applied at any location. Beginning in spring 2005, three mowing treatments were applied: (i) once per month at

5.1 cm; (ii) once per month at 10.2 cm; and (iii) no mowing. Plots were mowed with a rotary mower and clippings were returned.

Table 1. Turfgrass entries planted at 8 locations in the North Central United States in 2004 for the low-input turfgrass study.

Common name	**Scientific name**	**Cultivar or selection**	**Seeding rate** (g/m²)
Alkaligrass	*Puccinellia distans*	Fults	7.3
Blue grama	*Bouteloua gracilis*	Bad river	14.7
Colonial bentgrass	*Agrostis tenuis*	SR 7150	4.9
Crested dogstail	*Cynosurus cristatus*	ShadeStar	4.9
Crested wheatgrass	*Agropyron cristatum*	Roadcrest	24.4
Hard fescue	*Festuca trachyphylla*	Berkshire	29.3
Meadow fescue	*Schedonorus pratensis*	LMC-1122	34.2
Prairie junegrass	*Koeleria macrantha*	LMC-5000	9.8
Sheep fescue	*Festuca ovina*	Blacksheep	34.2
Tall fescue	*Festuca arundinacea*	Grande II	34.2
Texas bluegrass hybrid	*Poa arachnifera* × *Poa pratensis*	DuraBlue	9.8
Texas bluegrass hybrid	*Poa arachnifera* × *Poa pratensis*	HB 342	9.8
Tufted hairgrass	*Deschampsia cespitosa*	Spike	4.9

Table 2. Seeding method, weather information, soil type, and pH for research sites.

Location	**Establishment method**	**Rainfall** (mm)x		**Soil Type**	**pH**
		2005	**2006**		
Ames, IA	fall	566	735	loam	7.6
West Lafayette, IN	fall	480	763	silt loam	7.8
East Lansing, MI	fall	388	544	fine loam	7.8
St. Paul, MN	dormant	832	681	silt loam	7.6
Fargo, ND	fall	571	341	silty clay	7.8
Columbus, OH	dormant	547	776	loam	7.4
Brookings, SD	dormant	773	561	clay loam	7.7
Madison, WI	dormant	390	746	silt loam	7.5

x Total precipitation from 1 April through 31 October.

Data Collection and Analysis

Turfgrass quality was assessed monthly during each growing season using visual ratings on a 1 to 9 scale, with 9 representing the best turfgrass quality. Persistence (plot cover) and uniformity were the two primary criteria used to determine quality for each plot. Secondary criteria included freedom from disease and insect damage, color, and turf density. A rating of 5.0 was considered to be acceptable turf.

All data were subjected to analysis of variance according to the general linear models procedure of SAS (SAS Institute Inc., Cary, NC). The yearly turf quality averages for all locations and years were combined in an analysis of variance which showed that location and all year by interactions were significant at the $P \leq 0.0001$ level. Therefore, yearly turfgrass quality averages at each location were analyzed separately. Species turfgrass quality means (within mowing treatment at each location) were separated by Fisher's Least Significant Difference (LSD) test at $P \leq 0.05$. The effect of species (cultivar) was highly significant at all locations while the effect of mowing and the cultivar × mowing interaction was sometimes significant depending on location (Table 3). Cultivar data from each location were analyzed separately for each year at each location for each of the three mowing heights (Tables 4 to 6).

Table 3. Analysis of variance ($P > F$) for average turfgrass quality at eight locations in the North Central United States in 2005 and 2006.

	IA[x]	IN	MI	MN	ND	OH	SD	WI
Source of variation	***2005***							
mowing height (mow)	NS	NS	*	NS	**	**	**	**
cultivar (cult)	**	**	**	**	**	**	**	**
cult × mow	*	NS	NS	NS	NS	**	*	**
Source of variation	***2006***							
mowing height (mow)	NS	**	NS	**	**	**	**	**
cultivar (cult)	**	**	**	**	**	**	**	**
cult × mow	**	**	NS	NS	*	**	**	NS

*, ** , NS = significant at $P \leq 0.05$, $P \leq 0.01$, or not significant, respectively, according to Fischer's protected least significant difference test.

[x] Average of all turfgrass quality ratings in either 2005 or 2006 (1 to 9 scale, 9 = best turfgrass quality).
IA = Ames, Iowa; IN = West Lafayette, Indiana, MI = East Lansing, Michigan; MN = St. Paul, Minnesota; ND = Fargo, North Dakota; OH = Columbus, Ohio; SD = Brookings, South Dakota; WI = Madison, Wisconsin.

Table 4. Visual quality ratings of low-input turfgrass species in 2005 and 2006 maintained at 5.1 cm at eight locations in the North Central United States. Entries are listed in order by overall performance in 2006.

Species	2005 Quality[v]							
	IA[w]	IN	MI	MN	ND	OH	SD	WI
Hard fescue	8.5	7.2	6.3	7.5	7.0	5.3	7.7	4.5
Tall fescue	8.3	5.3	5.6	6.0	4.7	5.4	8.6	3.3
Sheep fescue	8.3	6.7	5.7	6.8	6.7	6.4	7.8	4.1
Colonial bentgrass	7.8	4.3	4.1	7.7	4.7	3.4	6.4	4.7
Tufted hairgrass	6.5	6.7	4.9	3.8	4.7	2.4	6.9	2.9
Hybrid bluegrass 1[x]	5.0	5.2	3.5	3.5	1.7	1.8	4.6	2.9
Hybrid bluegrass 2[y]	3.5	6.0	3.1	4.0	1.2	1.4	3.4	2.7
Meadow fescue	6.5	4.9	4.4	3.2	5.0	4.9	7.0	2.8
Blue grama	1.7	3.5	2.5	3.0	1.0	3.9	3.4	1.5
Crested dogstail	4.3	3.1	N/A	2.8	1.2	1.7	3.4	N/A
Prairie junegrass	5.5	3.4	2.7	4.5	4.8	3.2	4.7	3.3
Crested wheatgrass	4.7	4.4	2.4	1.3	4.7	3.0	3.0	2.8
Alkaligrass	5.3	5.1	3.5	1.2	5.5	2.4	5.2	2.1
LSD[z]	*1.3*	*3.1*	*2.8*	*1.4*	*1.3*	*1.3*	*1.4*	*1.4*
Species	**2006 Quality[v]**							
	IA	**IN**	**MI**	**MN**	**ND**	**OH**	**SD**	**WI**
Hard fescue	8.2	5.1	6.7	7.3	4.6	6.3	8.0	6.6
Tall fescue	7.9	6.5	6.0	7.0	5.6	6.7	8.3	3.8
Sheep fescue	7.6	4.7	6.1	6.7	3.6	6.7	8.1	5.8
Colonial bentgrass	7.2	4.3	4.7	7.0	4.2	6.3	6.4	5.4
Tufted hairgrass	4.6	3.4	3.8	2.3	3.6	2.5	7.6	4.2
Hybrid bluegrass 1	2.7	5.7	4.3	2.7	3.6	2.7	4.7	2.8
Hybrid bluegrass 2	3.9	5.7	N/A	2.7	4.5	3.3	4.7	2.4
Meadow fescue	6.0	3.1	2.7	3.0	4.3	2.5	5.3	2.7
Blue grama	3.2	4.9	N/A	2.0	2.8	5.3	4.7	2.5
Crested dogstail	3.6	3.3	N/A	2.0	2.7	3.8	3.9	N/A
Prairie junegrass	2.8	3.6	3.3	1.7	3.1	2.0	4.4	3.3
Crested wheatgrass	2.1	2.5	3.6	2.0	3.0	1.3	3.2	2.2
Alkaligrass	2.3	3.5	2.8	1.0	2.6	1.5	3.8	1.3
LSD[z]	*0.7*	*1.1*	*1.0*	*2.9*	*1.1*	*1.4*	*1.3*	*1.7*

N/A = data not available.

[v] Average of multiple quality ratings in 2005 and 2006 at each location (1 to 9 scale, 9 = best turfgrass quality). Quality components included plot cover, uniformity, color, density, and freedom from disease and insect damage.

[w] IA = Ames, Iowa; IN = West Lafayette, Indiana, MI = East Lansing, Michigan; MN = St. Paul, Minnesota; ND = Fargo, North Dakota; OH = Columbus, Ohio; SD = Brookings, South Dakota; WI = Madison, Wisconsin.

[x] DuraBlue hybrid bluegrass.

[y] HB 342 hybrid bluegrass.

[z] Least significant difference ($P \leq 0.05$) according to Fisher's Least Significant Difference (LSD) test.

Table 5. Visual quality ratings of low-input turfgrass species in 2005 and 2006 maintained at 10.2 cm at eight locations in the North Central United States. Entries are listed in order by overall performance in 2006.

Species	2005 Quality[v]							
	IA[w]	IN	MI	MN	ND	OH	SD	WI
Hard fescue	8.2	6.9	6.1	8.3	6.5	3.4	7.2	4.1
Tall fescue	8.3	4.9	6.6	6.0	4.5	3.9	8.4	2.7
Sheep fescue	8.2	6.1	5.9	6.2	6.5	4.7	7.9	4.6
Colonial bentgrass	7.5	5.8	5.9	6.8	3.3	2.0	6.3	3.3
Tufted hairgrass	7.7	6.6	4.3	4.5	4.8	2.1	7.0	3.5
Hybrid bluegrass 2[x]	3.5	4.9	3.7	2.8	1.0	1.4	4.4	2.9
Hybrid bluegrass 1[y]	4.0	3.8	3.9	3.2	2.7	1.6	4.1	3.0
Blue grama	1.5	5.6	2.3	3.0	1.0	3.2	4.2	1.3
Crested dogstail	5.7	5.5	N/A	1.8	1.0	1.6	3.4	N/A
Meadow fescue	7.7	6.1	5.7	2.8	4.3	6.1	7.4	3.7
Prairie junegrass	5.3	3.3	2.9	4.3	4.8	2.2	5.9	3.4
Crested wheatgrass	4.3	5.3	2.7	1.2	5.2	2.7	4.4	3.2
Alkaligrass	4.2	6.9	3.2	1.0	5.7	2.0	6.0	2.0
LSD[z]	*1.3*	*2.8*	*2.8*	*1.5*	*1.1*	*1.2*	*1.1*	*1.0*
Species	**2006 Quality[v]**							
	IA	**IN**	**MI**	**MN**	**ND**	**OH**	**SD**	**WI**
Hard fescue	6.2	6.0	6.9	7.3	5.3	7.8	8.0	5.5
Tall fescue	7.4	6.5	5.6	6.7	5.5	7.5	8.7	2.3
Sheep fescue	6.9	5.8	5.7	4.3	3.9	7.3	7.6	6.2
Colonial bentgrass	6.7	3.7	4.7	5.3	4.6	5.7	7.0	4.0
Tufted hairgrass	4.4	4.9	3.2	1.7	4.4	3.5	7.8	5.1
Hybrid bluegrass 2[x]	3.8	6.8	N/A	1.7	5.0	2.0	5.0	1.7
Hybrid bluegrass 1[y]	3.1	5.7	4.4	1.7	4.9	2.7	4.8	2.3
Blue grama	3.0	5.1	N/A	1.3	3.6	4.3	5.3	2.0
Crested dogstail	4.4	4.0	N/A	1.0	3.2	3.5	4.7	N/A
Meadow fescue	5.8	3.8	2.8	2.3	4.9	5.2	5.3	3.7
Prairie junegrass	3.6	4.6	3.5	1.3	3.7	3.3	4.1	3.2
Crested wheatgrass	2.2	3.5	3.5	1.3	3.2	1.3	4.0	2.6
Alkaligrass	2.1	2.5	2.6	1.0	2.8	1.3	4.6	1.7
LSD[z]	*1.2*	*1.0*	*0.9*	*1.2*	*1.1*	*1.4*	*1.2*	*1.6*

N/A = data not available.

[v] Average of multiple quality ratings in 2005 and 2006 at each location (1-9 scale, 9 = best turfgrass quality). Quality components included plot cover, uniformity, color, density, and freedom from disease and insect damage.

[w] IA = Ames, Iowa; IN = West Lafayette, Indiana, MI = East Lansing, Michigan; MN = St. Paul, Minnesota; ND = Fargo, North Dakota; OH = Columbus, Ohio; SD = Brookings, South Dakota; WI = Madison, Wisconsin.

[x] HB 342 hybrid bluegrass.

[y] DuraBlue hybrid bluegrass.

[z] Least significant difference ($P \leq 0.05$) according to Fisher's Least Significant Difference (LSD) test.

Table 6. Visual quality ratings of non-mowed, low-input turfgrass species in 2005 and 2006 at eight locations in the North Central United States. Entries are listed in order by overall performance in 2006.

Species	2005 Quality[v]							
	IA[w]	IN	MI	MN	ND	OH	SD	WI
Sheep fescue	8.3	5.5	6.3	5.8	6.3	3.8	7.7	2.7
Hard fescue	7.7	6.1	6.2	6.7	6.0	2.9	6.8	3.4
Tall fescue	8.5	6.4	6.4	5.2	3.3	3.7	8.8	2.8
Tufted hairgrass	5.7	4.9	4.7	4.5	3.5	2.0	7.2	2.4
Meadow fescue	8.2	6.4	6.4	4.0	4.5	5.2	8.8	2.7
Hybrid bluegrass 1[x]	3.7	3.3	3.3	2.2	1.3	1.7	5.8	2.9
Hybrid bluegrass 2[y]	3.7	5.4	3.0	2.5	1.5	1.6	4.3	2.3
Colonial bentgrass	7.8	6.7	4.8	7.3	1.3	2.1	6.3	2.5
Crested wheatgrass	5.0	4.1	3.1	1.7	5.0	2.6	6.1	4.4
Blue grama	2.3	3.3	N/A	3.2	1.2	2.8	4.1	1.3
Crested dogstail	4.3	3.3	N/A	1.8	1.0	1.8	3.2	N/A
Prairie junegrass	5.0	4.7	3.1	3.7	4.7	2.1	4.9	1.9
Alkaligrass	4.8	5.9	3.7	1.8	5.0	2.1	7.3	2.4
LSD[z]	*1.0*	*3.1*	*2.5*	*1.3*	*1.3*	*0.5*	*1.5*	*0.6*
Species	**2006 Quality[v]**							
	IA	**IN**	**MI**	**MN**	**ND**	**OH**	**SD**	**WI**
Sheep fescue	7.0	6.4	6.1	N/A	2.4	6.3	7.0	3.9
Hard fescue	6.2	4.9	6.7	N/A	2.8	3.8	6.9	4.6
Tall fescue	5.6	3.6	5.0	N/A	2.6	4.8	6.6	2.3
Tufted hairgrass	4.6	5.1	4.3	N/A	2.2	2.5	7.4	3.2
Meadow fescue	5.6	2.8	3.8	N/A	2.8	4.0	4.2	3.2
Hybrid bluegrass 1[x]	3.4	5.3	4.0	N/A	2.4	2.7	5.8	1.8
Hybrid bluegrass 2[y]	5.7	5.4	N/A	N/A	2.2	1.2	5.1	2.0
Colonial bentgrass	6.1	1.3	4.1	N/A	2.1	3.2	4.4	3.2
Crested wheatgrass	2.8	4.1	4.0	N/A	2.7	1.5	4.8	2.9
Blue grama	2.6	4.5	N/A	N/A	2.4	1.3	3.3	1.3
Crested dogstail	3.8	2.8	N/A	N/A	2.1	1.2	2.4	N/A
Prairie junegrass	2.9	2.9	3.0	N/A	2.0	1.3	2.4	1.9
Alkaligrass	2.4	1.7	3.4	N/A	1.9	1.0	2.9	1.5
LSD[z]	*1.4*	*2.2*	*0.9*	N/A	*0.6*	*1.7*	*1.3*	*1.1*

N/A = data not available.

[v] Average of multiple quality ratings in 2005 and 2006 at each location (1-9 scale, 9 = best quality). Quality components included plot cover, uniformity, color, density, and freedom from disease and insect damage.

[w] IA = Ames, Iowa; IN = West Lafayette, Indiana, MI = East Lansing, Michigan; MN = St. Paul, Minnesota; ND = Fargo, North Dakota; OH = Columbus, Ohio; SD = Brookings, South Dakota; WI = Madison, Wisconsin.

[x] DuraBlue hybrid bluegrass.

[y] HB 342 hybrid bluegrass.

[z] Least significant difference ($P \le 0.05$) according to Fisher's Least Significant Difference (LSD) test.

Results and Recommendations

Species were identified, based on performance across the region at the two mowing heights (5.1 and 10.2 cm), which could be recommended as low-input species in the NCR. Those species that performed well at only a few locations may need to be developed further by plant breeders for more extensive low-input turf use.

Best Options for Mowed, Low-Input Turf Areas

Hard fescue performed well (≥ 5.0) in both years at both mowing heights at most locations with the exception of 2005 in Wisconsin (both mowing heights), 2005 in Ohio (10.2 cm), and 2006 in North Dakota (5.1 cm). Interestingly, in all of these situations, rainfall was quite low compared to the other testing year (Table 2). At Wisconsin in 2005, no other species rated greater than 5.0 at either the 5.1-cm or 10.2-cm mowing height, and at North Dakota in 2006 at 5.1 cm, only tall fescue rated greater than 5.0. In both cases, hard fescue was not statistically different than the other top performing species at either 5.1 or 10.2 cm. In Ohio, when plots were mowed at 10.2 cm, only two species had average turf quality ratings significantly higher than hard fescue in 2005 (meadow fescue and sheep fescue); additionally, although hard fescue averaged only 3.4 in 2005, it recovered to average 7.8 the following year. This indicates that hard fescue is just as good an option as the other tested species in environments that experience reduced precipitation. Diesburg et al. (6) tested 'Durar' hard fescue and suggested that the species was adapted to an area from Iowa through central Illinois to Indiana, while not being adapted to more southern testing locations such as southern Illinois and Missouri. We found that 'Berkshire' hard fescue did well in most sites in both years.

Tall fescue has previously been suggested for use as a low-input turf in the NCR (6). One of the major barriers to use of this species on a wider scale in the NCR is a perceived lack of winterhardiness (21). Previous research has suggested that new seedings of tall fescue are more susceptible to winter damage than mature stands (12). In our study, tall fescue performed adequately in all locations except Wisconsin in both years and in North Dakota in 2005. The Wisconsin location was a dormant seeding, and lack of moisture during 2005 seemed to affect growth more than any potential winter injury. Seed that did not germinate in spring 2005 would have been unlikely to survive until more favorable conditions arose (7). In North Dakota, the trial was seeded in the early fall, and first year quality was inadequate (4.7), which may have been caused by stand loss caused by the death of young tall fescue plants during the winter of 2005-2006.

Sheep fescue showed acceptable turfgrass quality at several locations in both years when mowed at either 5.1 cm or 10.2 cm; in fact, the species had average quality ratings over 5.0 in at least one year at all locations at both mowing heights. Similar wide-adaptation for this species was found by Diesburg et al. (6). Dernoeden et al. (5) compared 'Bighorn' sheep fescue with 'Aurora' hard fescue and two turf-type tall fescue cultivars. They found that after three years without fertilization or irrigation in Maryland, sheep fescue and hard fescue outperformed the tall fescue cultivars under several mowing regimes.

Colonial bentgrass was best adapted to Iowa, Minnesota, and South Dakota. Recently, this species has been evaluated as a golf course fairway grass under reduced levels of water, fertilizer, and pesticide inputs (28). With the exception of work by Diesburg et al. (6), who showed that the species can perform well in low-input environments, limited research has been conducted to evaluate colonial bentgrass as a higher-cut, low-input turf. In our study, at the 10.2-cm mowing height, colonial bentgrass had an acceptable turfgrass quality rating at five sites in 2005 and four sites in 2006. The overall turfgrass quality of this species in our trial suggests that further testing should be pursued.

Potential Future Options for Low-Input Turf

Several grass species had turfgrass quality ratings at a level that indicated they need to be further evaluated for use as low-input turf and as targets of plant breeding programs. These species often had acceptable turfgrass quality ratings at some test locations and poor ratings at others. Some of these species, such as tufted hairgrass, hybrid bluegrass, blue grama, and prairie junegrass, are already being improved for use as low-input turf, while others have not yet gained enough breeder interest.

Tufted hairgrass had variable turfgrass quality ratings throughout the region. Average quality for this species was greater than 6.0 for at least one of the years at Iowa (2005, both mowing heights), Indiana (2005, both mowing heights), and South Dakota (both years, both mowing heights). In both Iowa and Indiana, performance declined from 2005 to 2006, which is not surprising given the fact that the species can experience reduced quality due to several summer stresses including heat, drought, and rust disease (25,27). In areas that receive adequate moisture and where billbug damage is not a problem, the species can do quite well with minimal fertilization. Tufted hairgrass can also be used as a turf in areas where heavy metal contamination is a concern (4,24). The cultivar used in our study was not developed specifically for turf which may have affected its performance. There are several public and private breeding programs developing new cultivars of this species for turf use (2).

The ***hybrid bluegrass*** cultivars showed mixed results throughout the region. Because these hybrids were developed for use in areas that experience significant heat stress, the use of these species in cooler regions may not be appropriate. Further testing under similar low-input conditions in areas that experience severe heat stress may be warranted.

Despite having a coarse leaf texture which may limit its use in turf situations, ***meadow fescue*** had acceptable turfgrass quality at several locations. At the 5.1-cm mowing height, it had acceptable turfgrass quality in Iowa (2005, 2006), North Dakota (2005), and South Dakota (2005, 2006). At the 10.2-cm mowing heights, the species performed at an acceptable level in Iowa (2005, 2006), Michigan (2005), Ohio (2005, 2006), South Dakota (2005, 2006), and Wisconsin (2005). Performance at the higher mowing height might indicate potential use on higher-cut utility turfs, which would not require grasses with more fine leaf texture.

Blue grama generally had poor turfgrass quality at both 5.1 and 10.2 cm with the exception of the higher mowing height in Indiana (2005 and 2006) and South Dakota (2006). The selection used in our study is an ecotype collection that was made in South Dakota in 1988 (22); therefore, its poor performance at many of the sites with different climatic condition is not surprising. Additionally, fall establishment of warm-season grasses can be difficult in colder climates, such as are found in many parts of the NCR. Although there have not been any cultivars of this species released specifically for turf use, researchers at South Dakota State University have initiated a research program focused on this species.

Prairie junegrass had acceptable turfgrass quality during 2005 in Iowa at both mowing heights and in 2005 in South Dakota at 10.2 cm. Prairie junegrass persisted at all sites in both years with quality ratings typically between 2.0 and 4.5 at both mowing heights during both years. The selection used in this study was not developed for turf use. Overall, the species showed promise and may have use for low-input turf in the NCR. The University of Minnesota has initiated a germplasm improvement program for this species and has identified mowing quality, establishment rate, and rust resistance as the primary issues that must be addressed in a breeding program (26).

The turfgrass quality ratings of ***crested dogstail*** and ***crested wheatgrass*** indicated these species could be further evaluated for use in specific environments. In our trial, both of these species had acceptable turfgrass quality in only a few locations in individual mowing treatments, while they performed well below average at most locations.

Not Recommended

Alkaligrass did not have turfgrass quality ratings that would indicate potential use as a low-input turfgrass species. At many sites, this species had a turfgrass quality below 2.5 during both years, and in sites where it did well in year one, the second year performance declined sharply. This species is known for its salt-tolerance; however, its lack of other important low-input attributes suggests that the species does not provide a suitable turf.

Best Options for No-Mow Areas

Evaluations for no-mow grasses are difficult because there are no widely-accepted criteria. In this study, we based quality on the following factors: lack of weed pressure, freedom from disease, plot density, and lack of lodging. Overall, both sheep and hard fescue had high quality ratings in both years at most sites, with the exception of Ohio and Wisconsin. Meadow fescue did very well at both Iowa and South Dakota in 2005 (8.2 and 8.8, respectively), but declined in 2006 (5.6 and 4.2, respectively). A similar decline was observed for most species at most testing locations. Burrowing animals (*Marmota monax* and *Spermophilus tridecemlineatus*) occasionally resided in the no-mow plots and disrupted the turf surface with soil mounds surrounding their burrow entrances. Poor performance of non-mowed plots suggests that more information is needed about proper vegetation management for low-input situations (burning, fall mowing, etc.). Ultimately, some level of mowing or grazing may be important to long-term survival of turfgrasses as the defoliation reduces encroachment of other species and certain mowing heights may promote tillering of turfgrasses (8,18).

Conclusions

Hard fescue, tall fescue, sheep fescue, and colonial bentgrass all showed adequate to superior turfgrass quality under low-input conditions in multiple environments. Additionally, these field studies demonstrated that several other grass species (tufted hairgrass, meadow fescue, blue grama, and prairie junegrass) could potentially provide turfgrass managers with a living turf stand when managed under low-input conditions. Based on this and previous research, practitioners in the NCR should consider the use of these species; however, additional local data need to be generated and should be consulted in order to determine the best possible species for use in a given environment (e.g., 5.1-cm mowing vs. non-mowed). Additionally, longer-term research trials are needed to determine species performance over periods of time greater than two years, which would allow evaluation for additional stress tolerances. Future low-input turfgrass studies should include multiple cultivars of the aforementioned species in order to determine intraspecific differences for adaptability in the region.

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