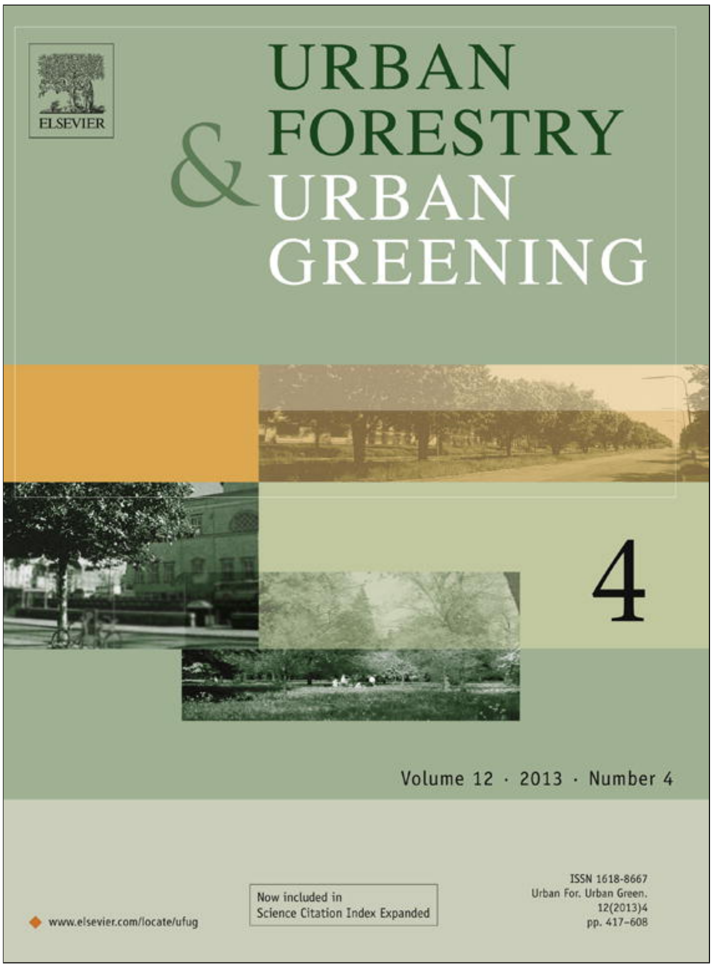
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The use of native turf mixtures to approach sustainable lawn in urban landscapes

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ABSTRACT

Native grasses are excellent candidate species for manipulation to produce dwarf and turf type varieties as well as for producing cultivars with higher attractiveness and requiring less maintenance to be used as a turf grass in arid and semi-arid regions of the world. This investigation was conducted to explore visual qualities of native grasses and their mixtures compared to commercial turf. The field experiment was set out in a split-plot in time based on a randomized experimental design with three replications. We used two native monoculture accessions, perennial ryegrass (*Lolium perenne* L. 'Yarand') and (*Lolium perenne* L. 'Shadegan'), Native low-variety Mixture (NM1): consisting of 50% *Lolium multiflorum* 'Shadegan', 50% *Festuca* spp. 'Shadegan', Native high-variety Mixture (NM2): consisting of 55% *Lolium perenne* L. 'Yarand', 35% *Lolium perenne* L. 'Shadegan', 5% *L. multiflorum* 'Shadegan' and 5% *Festuca* spp. 'Shadegan' and compared this with one commercial turf mixture that is commonly used in landscaping. Results indicated the effects of seasons and turf grass types and their interaction had significant effects on most variables including quality, season color, leaf texture, density, quality after clipping ($p < 0.01$). The visual quality measurements indicated the superiority of *L. perenne* 'Shadegan' over other native monoculture and polyculture and its ablility to compete with the commercial turf. The native turf mixture of NM2 showed several good characteristics. *L. perenne* 'Yarand' had statistically the lowest score for visual appeal as compared with the other turf types. This research suggests that the use of native grass species of *L. perenne* 'Shadegan' is worth investigating for better performance of the native landscape.

Introduction

Turf grass plays a vital role in human life adding elegance to the environment and providing the foundation for many recreational sports and comprises a large portion of residential and commercial landscapes. One of the native landscaping options is the use of native turf, a blend of low-growing native grasses that provide a lawn-like appearance (Sauer, 1999; www.rainscapingiowa.org). Native plants are hardy because they have adapted to local conditions (Butler et al., 2012). Because maintaining native plants requires less work, they provide excellent choices for large commercial landscapes as well as residential gardens (Lady Bird Johnson Wildflower Center, 2013; www.wildflower.org). Turf breeders are searching to develop turf grass cultivars that can implement satisfactory growth in a wide range of climates, soils, and environmental conditions (Pessarakli and Kopec, 2008). These grasses are excellent candidate species for manipulation to produce dwarf and turf type varieties as well as producing cultivars which have more attractiveness and require less maintenance to be used as a turf grass in arid and semi-arid regions of the world. For these reasons there has been increasing attention toward the selection and propagation of native turf grasses which have demonstrated a variety of other beneficial traits (Bormann et al., 2001). Because of different growth patterns, a mixture of two or more grasses types may complement each other to provide both functional and esthetic improvements in turf quality.

There are several reports on the comparison and selection between different genotypes of turf grasses for color uniformity, wear tolerance and coverage (Skirde, 1989; Dunn et al., 1994; Newell et al., 1996; Salehi and Khosh-Khui, 2004). Salehi and Khosh-Khui (2004) compared different seed mixtures in the experimental field in Shiraz and reported that mixture of *Poa* with *Cynodon* had highest tiller density, root growth and chlorophyll content. They also showed that *Lolium* monoculture was not suitable in regard to low tiller density. Newell et al. (1996)

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Table 1
Monthly average precipitation and temperatures at the experimental site for January 2011 to December 2012.

	2011			2012		
Month	Max. average Temp (°C)	Min. average Temp (°C)	Precipitation (mm)	Max. average Temp (°C)	Min. average Temp (°C)	Precipitation (mm)
January	8.7	0.5	0	6.3	3.2	28
February	1.1	0.1	150	3	0.5	18
March	10.5	1.6	9.5	2.2	1.2	291.5
April	23.21	9.27	1.5	21.04	9.28	21
May	25.52	15	27.5	24.37	12.6	10.5
June	27.22	14.9	4.5	22.25	12.5	8.5
July	29.51	18.1	0	21.92	17.5	0
August	27.39	17.4	0	26.8	14.2	0
September	28.85	11.1	0	19.86	15.6	0.5
October	18.72	9.19	19.5	19.03	9.96	7.5
November	7	1.99	47.5	6.93	3.28	0.5
December	7.4	-1.55	0	0.11	0.01	0

recommended seed mixtures of *Lolium* and *Festuca* for having best wear tolerance. Skirde (1989) reported that *Festuca* had poor competitiveness against *Lolium* and *Poa*. Perennial ryegrass and tall fescue genotype were better than Kentucky bluegrass in coping with the Mediterranean environmental conditions (Martiniello and D'Andrea, 2006). Salehi and Khosh-Khui (2004) compared monoculture and mixture of different turfgrasses and showed that visual quality of mixture of *Festuca*, *Poa*, *Lolium* and *Cynodon* was better than individual species. The advantage of mixing species of *Festuca*, *Poa* and *Lolium* compared with individual species to reduce disease occurrence was evident on several occasions (Dunn et al., 2002).

The use of polycultures of native turfgrasses has not been extensively investigated (Simmons et al., 2011). Preliminary tests of any native turf grasses under real conditions would produce valuable results for breeders and urban landscape designers. So, the objectives of this investigation were to compare growth responses of native accessions in monoculture and their mixtures compared to commercial turf mixture and evaluate esthetic qualities, homogeneity (attractiveness) and yield among native grasses.

Materials and method

Experimental design and site description

This research project was conducted at the experimental farm of the Department of Horticultural Science, Agricultural College, Ferdowsi University of Mashhad, Mashhad, Iran, during 2011 and 2012 (59° 38′ E and 36° 16′ N; elevation 989 m; mean annual rainfall 255.2 mm). The local climate is arid and semi-arid. Long term averages of maximum and minimum temperature are 22 °C and 8.9 °C, respectively. The meteorological data of the experimental site is shown in Table 1. This research project was conducted in a split-plot in time based on completely randomized experimental design with three replications. Year seasons (autumn, winter, spring, summer) were considered as main plot and turf grass types as subplot.

Plant material

Turf grasses were comprising of:

1. Native monoculture: perennial ryegrass (*Lolium perenne* L. 'Yarand') and (*Lolium perenne* L. 'Shadegan'), which are two regionally native accessions from Yarand and Shadegan, respectively, in Esfahan Province, Iran.
2. Native low-variety mixture (NM1): consisting 50% *Lolium multiflorum* 'Shadegan', 50% *Festuca* spp.'Shadegan'.
3. Native high-variety mixture (NM2): consisting 55% *Lolium perenne* L. 'Yarand', 35% *Lolium perenne* L. 'Shadegan', 5% *L. multiflorum* 'Shadegan' and 5% *Festuca* spp. 'Shadegan'.These native seeds were supplied by Pakan Bazre Esfahan Ltd. Co.
4. Commercial mixture (CM) (NAk-Nederland): consisting 2% *Lolium perenne* BE, 33% *Lolium perenne* NL, 20% *Lolium perenne* DK, 35% *Poa pratensis* US and 10% *Festuca rubra* commutata FR.

Thus, turf grass treatments were abbreviated as *Lolium perenne* L. 'Yarand' = LPY, *Lolium perenne* L. 'Shadegan' = LPS and seed mixtures of NM1, NM2 and CM.

Culture and maintenance

Turf grass plots were established by directly sowing the seeds at autumn season in 2011. The rate of seedling was 40 g/m^{-2} for LPY, 25 g/m^{-2} for LPS, 28 g/m^{-2} for NM1, 33.5 g/m^{-2} for NM2 and CM according to seeds size and physical purity.

The soil characteristics was loamy texture, pH = 7.21, cation exchange capacity of 6.6 meq/100, organic matter of 0.9%.

Plots were prepared after plowing and leveling the soil. The plots were hand sown in plots of 1.2 m^2 (1 m × 1.2 m) and covered with a thin layer of leaf compost and manure. Irrigation was carried out daily (2 or 3 times a day) during establishment and then irrigation depths varied with daily reference evapotranspiration (ETo). Evaporation pan was used to estimate ETo; multiplying daily pan evaporation measurement by pan coefficient (K_p = 0.75 for the study area) yielded the reference evapotranspiration which equals to irrigation depth. Clippings number during experiment for single season is shown in Table 2. All weed species, both grasses and forbs, were hand pulled during the two years of study. In winter all plots were top dressed with a 3 to 6 mm mixed layer of sand and manure to increase cold tolerance and urea ($CO(NH_2)_2$) fertilizer (3 g/m^{-2}) was applied to each plot in spring.

Data collection

Visual quality was assessed using a visual score based on a 1–9 scale, as used in the National Turf grass Evaluation Program (NTEP) in the USA (Beard, 1973; Salehi and Khosh-Khui, 2004). The lowest level (1) defines very poor turf quality while the highest level (9) defines ideal visual quality. A rating of 6 or greater was considered

Table 2
Clippings number during experiment for single season.

clippings (no.)	
Autumn	2
Winter	0
Spring	5
Summer	5
Total cuts	12

to be acceptable. For example, season color is based on a visual rating scale with 1 being light green and 9 being dark green. Turfgrass health shows no disease, insect injury and environmental stress based on the turfgrass resistance, using the 1 to 9 rating scale with 1 equaling no resistance or 100% injury, and 9 equaling complete resistance or no injury. Density, quality, leaf texture, quality after clipping have also evaluated using rated on 1 to 9 scale (1 = poorest, 9 = best).

Statistical analysis

All data were subjected to analysis of variance (ANOVA) using JMP8 software and LSD test at 5% levels was used for mean separation.

Results

The results of analysis of variance indicated that season significantly affected all variables ($p < 0.01$) (Table 3). Effects of different turf grass types on all traits were significant ($p < 0.01$) except Turfgrass health trait (Table 3). Also, Interaction of season and Turf grass type had significant effects on all variables except Turfgrass health trait ($p < 0.01$) (Table 3). According to Fig. 1, interaction of season and turf grass type can be described as described below.

Season color

The darkest green color was observed in summer and there was no significant difference between turf grass types, except for NM1, which color was significantly lighter in summer. In this study, color quality measurements indicated the superiority of summer over spring> autumn > winter. The lower color quality was shown in winter, in LPY and NM2. The rank of color quality in winter was LPS> CM> NM1> NM2 ≥ LPY (Fig. 1A).

Leaf texture

The coarsest and finest leaf texture is observed in winter and spring season, respectively and no differences were observed between spring and summer (Table 4). Results showed finer textures were related to CM, NM1 and LPS, the difference between these turfs grasses was not significant (Table 4). In summer and spring, NM1 had finer foliage texture than other turf grasses. The coarsest texture was observed in LPY in winter (Fig. 1B).

Turf density

Fig. 1C shows that the highest turf density was related to LPS and CM as compared to the other turf grass in summer and spring. The lowest density belonged to LPY in winter.

Turf quality after clipping

The maximum quality after clipping was observed in summer and spring but winter had lowest quality. In winter CM and LPS had best quality after clipping (Fig. 1D).

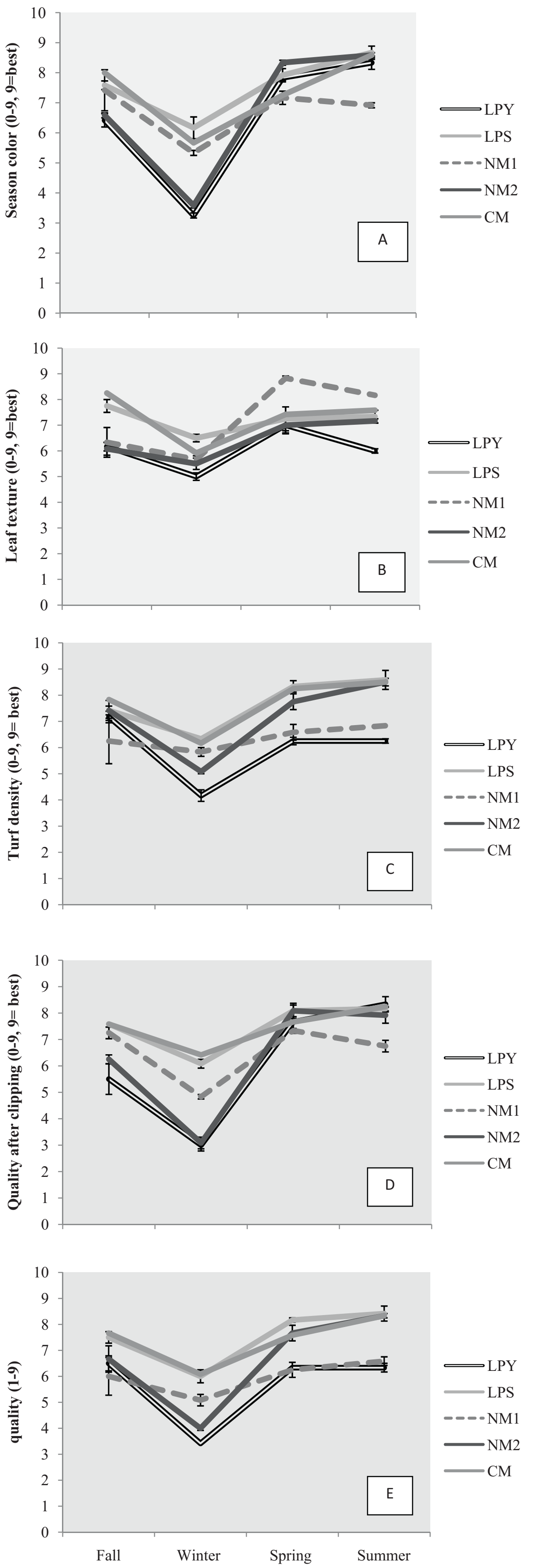

Fig. 1. Interaction effect of different season and turf grass types on season color (A), leaf texture (B), turf density (C), quality after clipping (D), quality (E) of turf grasses. Visual merit scores (1 = poorest, 9 = best) according to NTEP and during 2011 and 2012. LPY = *Lolium perenne* L. 'Yarand', LPS = *Lolium perenne* L. 'Shadegan', NM1 = Native low-variety mixture, NM2 = Native high-variety mixture, CM = Commercial mixture. Error bars represent standard error.

Table 3
Analysis of variance for visual quality assessment during 2011 and 2012.

Source	df	SC	LT	DE	QC	Turfgrass health	Quality
Season	3	34.243**	9.357**	14.851**	32.946**	1.350**	21.282**
Error A	8	0.067	0.152	0.354	0.195	0.013	0.343
Grass	4	2.729**	3.921**	7.274**	4.987**	0.045	8.414**
Grass × Season	12	2.026**	1.233**	0.877**	2.315**	0.045	0.934**
Error B	32	0.16562	0.19115	0.20182	0.18047	0.035938	0.18646

ns,**,* Non significant and significant of 1 and 5 percent of probability, respectively; SC = Season color, LT = Leaf texture, DE = Density, QC = Turf quality after clipping.

Table 4
Comparison between different season and turfgrass types according to visual quality assessment during 2011 and 2012.

		Turf grass quality (1–9)					
S.O.V		SC	LT	DE	QC	Turfgrass health	Quality
Season	Autumn	7.2 c	6.92 b	7.22 b	6.83 b	9 a	6.87 c
	Winter	4.8 d	5.72c	5.52 c	4.68 c	8.4 b	4.92 d
	Spring	7.7 b	7.50 a	7.43 ab	7.77 a	9 a	7.20 b
	Summer	8.22 a	7.25 a	7.73 a	7.88 a	9 a	7.60 a
Grass	LPY	6.46 b	6.04 c	5.96 d	6.13 c	8.75 a	5.65 c
	LPS	7.58 a	7.21a	7.67 a	7.48 a	8.85 a	7.52 a
	NM1	6.71 b	7.25 a	6.38 c	6.54 b	8.92 a	5.98 c
	NM2	6.77 b	6.44 b	7.19 b	6.33 bc	8.85 a	6.67 b
	CM	7.38 a	7.29 a	7.69 a	7.48 a	8.88 a	7.42 a

Means based on scale of 1 to 9, 9 = best quality and 1 = poorest quality. Means in the same column followed by the same letter were not significantly different at the 5% level. SC = Season color, LT = Leaf texture, DE = Density, QC = Turf quality after clipping. LPY = *Lolium perenne* L. 'Yarand', LPS = *Lolium perenne* L. 'Shadegan', NM1 = Native low-variety mixture, NM2 = Native high-variety mixture, CM = Commercial mixture turf.

Turfgrass health

Turfgrass health was not significantly influenced by different turf grass types and interaction between season and turf grass type (Table 3). Only the effect of season was significant (Table 4) and a significant decrease was observed during winter.

General quality

Quality was generally greater in LPS and CM. Turf quality followed the sequence LPS ≥ CM> NM2> NM1 ≥ LPY (Table 4). Generally, summer was superior to other seasons. Season effect on quality followed the sequence summer> spring> autumn > winter (Table 4). Results indicated that LPS, CM and NM2 had a higher visual quality in summer. All turf grass types had lowest turf quality in winter, and the regularity of quality in winter was LPS ≥ CM> NM1> NM2 ≥ LPY (Fig. 1E).

Discussion

In this study, visual quality measurements indicated the superiority of LPS over other native accessions. However, further experiments are needed to better understand of their reactions to some environmental stress. Beard (1973) is convinced that visual qualifying is the best procedure for selection between turf grasses. Salehi and Khosh-Khui (2004) used visual quality for shoot density, color and uniformity measurements of some cool and warm season grass species. Garling and Boehm (2001) measured turf color by visual quality measurements.

In the present investigation, turf color was lighter in winter and turned greener after winter. These results are consistent with Salehi and Khosh-Khui (2004) for fall sowing. The highest color quality in winter was shown, in LPS. Beard (1973) stated that most individuals prefer a dark green turf. It was obvious that all visual quality was great in summer and poorest in winter (Table 4).

In our study, LPY did not have good characteristics, especially regarding quality after cutting. It only had good growth because of adaptation to cold weather. The high density observed in LPS and CM may be due to compact growth of this turf grass (Beard, 1973).

Among turf mixtures, CM and LPS were excellent turf grasses and appear quite similar in all measured traits. They were well adapted to the environment and management conditions of the test conditions.

Mixture plots with NM1 did not possess good characteristics probably because of inappropriate mixing percentage and species in a mixture. Poor establishment of *Festuca* and the coarse texture of *L. multiflorum* compared to *Festuca* may prevent their mixture being acceptable. *L. multiflorum* was fast growing from October 2011 in early stage of establishment. Its volume increased by May 2012, but decreased until *Festuca* became dominant species. The different growth rate resulted in a non-uniform and patchy appearance that was not acceptable. Different growth rates between *Festuca* and buffalograss have been reported by Johnson (2003) in mixture of *Festuca* and buffalograss, *Festuca* dominated the buffalograss until the plots were 100% *Festuca*.

In the mixture of NM2, results suggest that because of the good quality of the LPS among other native accessions, an increased share of LPS over LPY would improve the quality of the mixture. However, the used share in the NM2 showed good potential of perennial mixture of these grasses.

Conclusions

LPS as a native turf was found to be able to compete with commercial mixtures. We recommend it to for urban landscapes and Iran and other areas with soil and environmental conditions similar to our research site. The native turf mixture of NM2 showed several good characteristic and should be preferred over the native mixture of NM1. Native accession of LPY had the lowest quality in all variables.

Further study of native species especially concerning their resistance to different environmental stresses such as salt, drought, cold and etc. is clearly needed. The present can contribute to more efficient use of native species in urban landscape.

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References

Beard, J.B., 1973. Turf Grass: Science and Culture. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Bormann, F.H., Balmori, D., Geballe, G.T., 2001. Redesigning the American Lawn: A Search for Environmental Harmony. Yale University Press.

Butler, C., Butler, E., Orians, M.C., 2012. Native plant enthusiasm reaches new heights: perceptions, evidence, and the future of green roofs. Urban Forestry & Urban Greening 11, 1–10.

Dunn, J.H., Ervin, E.H., fresenburg, B.S., 2002. Turf performance of mixtures and blends of tall fescue, kentuky bluegrass and perennial ryegrass. HortScience 37 (1), 214–217.

Dunn, J.H., Minner, D.D., Freenburg, B.F., Bughrara, S.S., 1994. Bermudgrass and cool season turf grass mixtures: response to simulated traffic. Agronomy 86, 10–16.

Garling, D.C., Boehm, M.J., 2001. Temporal effects of compost and fertilizer applications on nitrogen fertility of golf course turf grass. Agronomy 93, 548–555.

Johnson, P.G., 2003. Mixtures of buffalograss and fine fescue or streambank wheatgrass as a low-maintenance turf. HortScience 38 (6), 1214–1217.

Lady Bird Johnson Wildflower Center, 2013. Austin, Texas, http://www.wildflower.org (15.04.2013).

Martiniello, P., D'Andrea, E., 2006. Cool-season turf grass species adaptability in Mediterranean environments and quality traits of varieties. European Journal of Agronomy 25, 234–242.

Newell, A.J., Crossley, F.E.M., Jone, A.C., 1996. Selection of grass species, cultivars and Mixtures for lawn tennis court. Journal of Sport Turf Research Institution 72, 42–60.

Pessarakli, M., Kopec, D.M., 2008. Comparing growth responses of selected cool-season turf grasses under salinity and drought stresses. Turf Trass, Landscape and Urban IPM Research Summary, 55–60.

Salehi, H., Khosh-Khui, M., 2004. Turf monoculture cool-cool and cool-warm season seed mixture establishment and growth responses. HortScience 39 (7), 1732–1735.

Sauer, P., 1999. Rainscaping Iowa, http://www.rainscapingiowa.org/index.php/practiceslink/nativeturf (13.01.2013).

Simmons, M., Bertelsen, M., Windhager, S., Zafian, H., 2011. The performance of native and non-native turf grass monocultures and native turf grass polycultures: an ecological approach to sustainable lawns. Ecological Engineering 37, 1095–1103.

Skirde, W., 1989. Performance of new cultivars of tall fescue (*Festuca arundinacea*) in pure sowings and mixtures. Zeitschrift fur Vegetationstechnik im Landschafts und Sportstattenbau 12 (4), 135–140.