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Comparison of Native Turf grass Monoculture and Polycultures with Commercial Turf Mixture

Elham Saeedi Pooya[1], Ali Tehranifar[2], Mahmoud Shoor[3], Yahya Selahvarzi[4], Hossein Ansari[5]

1- Msc., Student of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.
2- Associate Professor, Department of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.
3- Assistant Professor, Department of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.
4- Lecturer, Department of Horticultural Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.
5- Assistant Professor, Department of Water and Soil Engineering, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.

Corresponding author: Elham Saeedi Pooya

Abstract

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. This investigation was conducted to explore visual qualities and growth parameters between native grasses and their mixtures compared to commercial mixture turf. The field experiment was set out in a randomized complete design with four replicates. We used two native monoculture accessions, perennial ryegrass (*Lolium perenne* L. 'Yarand') and (*Lolium perenne* L. 'Shadegan'), Native low- variety Mixture (NM1): consisting 50% *Lolium multiflurom* 'Shadegan', 50% *Festuca* spp. 'Shadegan', Native high-variety Mixture (NM2): consisting 55% *Lolium perenne* L. 'Yarand', 35% *Lolium perenne* L. 'Shadegan', 5% *Lolium multiflurom* 'Shadegan' and 5% *Festuca* spp. 'Shadegan' in compared to one commercial turf. It can be concluded that, there was significant difference among the turf grass types in all measured traits including genetic color, establishment rate, smoothness, uniformity, weed suppression, frost tolerance, leaf width, plant height and clipping weight. The visual quality measurements indicated the superiority of *Lolium perenne* L. 'Shadegan' over other native monoculture and polyculture and it is able to compete with the commercial turf. This native species was aesthetically pleasing, slow growing, require less maintenance and mowing. *Lolium perenne* L. 'Yarand' had a statistically lowest score for visual appeal than the other turf types. This research suggests that the use of native grass species of *Lolium perenne* L. 'Shadegan' is worth investigating for performance of the native landscape.

***Key words*:** accession, *Festuca, Lolium multiflurom, Lolium perenne*.

Introduction

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 (www.rainscapingiowa.org). Native plants are aesthetically pleasing and require less maintenance and don't need watering or much fertilization, and mowing may be reduced. There is significant short-term maintenance cost compared to high maintenance turf grass systems (www.rainscapingiowa.org). In general, native plants have two advantages. First, they may have more potential to be adapted to a wide range of habitats. Secondly, native genetic material is lost daily to urban development and other land conversions (Pfaff, 2002). Therefore, there has been more attention to select and propagate the native turf grasses which have beneficial traits (Simmon, 2011). Some native grasses have introduced noticeable potential as turf grasses because of high leaf density and drought resistance, and performed as well if not better than some commonly used non-natives (McKernan et al., 2001; Mintenko et al., 2002; Romani et al., 2002). Several grass species native to North America had examined for turf grass applications, including warm season grasses such as *Bouteloua dactyloides, Bouteloua gracilis, Bouteloua curtipendula, Paspalum* spp. and *Eragrostis* spp. as well as cool season grasses including *Festuca rubra* L., *Agrostis canina* L. and *Poa* spp. (Frank et al., 2004; Jenkins et al., 2004; Mintenko et al., 2002).

The selection of the proper turf grass species for playing surface or recreational area is one of the most important decisions to be made (Turgeon, 1985). Each grass species has relative advantages and disadvantages and no grass species is perfect. As a rule, if one type of grass is chosen, it is best to blend three to five its cultivars. If a mix of grass is desired (e.g. *Poa pratensis* and *Lolium perenne* mix), two cultivars of each are best. This offers the best diversity and possible resistance to certain disease or insect problems. Variation in performance among cultivars of different grass species was further investigated by Newell et al. (1996). Newell and wood (2000) compared a wide range of cultivars and a number of grass mixtures.

There has not been extensively investigated the use of native turf grasses polycultures (Simmon, 2011).

The mixture of native species with similar traits (appearance and habitats) may have noticeable advantages to create lawns while requiring fewer maintenance costs (Simmon, 2011). We suggest that this principle should be tested by exploring the performance of native and non-native species and as selected multi-species mixes.

This study tests the following items:

a. Aesthetic qualities such as color, smoothness, uniformity and homogeneity (attractiveness)
b. Frost tolerance, and weed density
c. Establishment rate, plant height, leaf width and growth among native and non-native grasses.

Materials and Methods

Experimental design and site description

This research was carried out at the experimental fields of Ferdowsi University of Mashhad, Iran, in 2011. The experimental area (59º 38′ E and 36º 16 ′ N) has an altitude of 989 m, with a total annual precipitation of 255.2 mm on average. Long term averages of maximum and minimum temperature are 22ºC and 8.9 ºC, respectively. The meteorological data of the experimental site is shown in Table 1. The experiment was set out in a randomized complete design with four replicates.

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	11.71	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

Plant material

Turf grass were consisting; Native monoculture: perennial ryegrass (*Lolium perenne* L. ‘Yarand’) (LPY) and (*Lolium perenne* L. ‘Shadegan’) (LPS), which are two regionally native accessions from Yarand and Shadegan, respectively in Esfahan province, Iran.

Native low-diversity mixture (NM1): consisting 50% *Lolium multiflurom* 'Shadegan', 50% *Festuca* spp. 'Shadegan'.

Native high-diversity mixture (NM2): consisting 55% *Lolium perenne* L. 'Yarand', 35% *Lolium perenne* L. 'Shadegan', 5% *Lolium multiflurom* 'Shadegan' and 5% *Festuca* spp. 'Shadegan'. One Commercial Mixture (CM): 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= Native low-diversity mixture, NM2= Native high-diversity mixture and CM= Commercial Mixture.

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 ds m^{-1}, 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 (1m×1.2m) 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 only during soil surface drought periods thereafter. During the experiment periods, all plants were clipped when needed and all weed species, both grasses and forbs, were hand pulled. 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 (3g/m^{-2}) was applied to each plot in spring.

Data collection

The visual field assessment (VFA) of turf grass quality is a visual rating that combines characteristics such as color, smoothness, texture and uniformity, weed density, establishment and etc. VFA varies with turf grass species, cultural management, climate, season and etc. In each season 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, 2004). The lowest level (1) defines very poor turf quality and highest level (9) defines very ideal visual quality. A rating of 6 or greater in all visual quality was considered to be acceptable. For example, genetic color reflects the inherent color of the genotype. It is based on a visual rating scale with 1 being light green and 9 being dark green. Genetic color ratings were collected when the turf was actively growing and was not under stress. Chlorosis and browning from necrosis are not a part of genetic color. Establishment, Smoothness, Uniformity, Weed suppression and frost tolerance have also evaluated using rated on 1 to 9 scale (1=poorest, 9=best).

Uniformity was measured 2 times in autumn and spring and mean of them was calculated and analyzed. Frost injury can comprise winter injury symptoms. Turf grass species and cultivars differ in their responses to this stress. Frost injury is generally expressed on a 1 to 9 rating scale with 1 equaling 100% leaf injury and 9 equaling no injury. Frost tolerance was measured 2 times in autumn and winter and mean of them was analyzed.

Turf grass texture is a measure of leaf width. Leaf widths (mm) were measured for random plants per plot to estimate texture of the turf. This assessment has done when the turf grass was actively growing and was not under stress. The clipping weight was measured after moving and clipping weight of all surface of each plot was recorded.

Statistical analysis

The JMP software was used for all data analysis (ver. 8.0) and LSD test was used to separate means ($P < 0.05$).

Results and Discussion

The results of analysis of variance indicated that among the turf grass types, there was significant difference in all measured traits ($p<0.01$) (Table 2). Comparison between different turf grass types is shown in Table 3 and Figure 1.

Establishment rate

The Figure 1a showed that the establishment rate of all species were highest during fall season (sowing season) and there was no significant difference between turf types except significant decrease was showed in establishment rate of NM1. In other word, of the five turf types tested only NM1 appeared to be weaker to the others. Establishment rate was based on 90 percentage of ground cover.

Poor establishment rate of NM1 was due to slow seedling emergence of *Festuca* in this native mixture. *Festuca* had weak established when sown in turf grass seed mixtures in comparison to *Lolium multiflorum.* Tall Fescue has been shown to be a poor competitor against Italian Ryegrass *(Lolium multiflorum)* (Brede and Brede, 1988)**.**

Smoothness

There was a statistical difference between LPS, CM with three other turf types in smoothness trait. LPS and CM showed the most smoothness in leaf tissue and there were no significant difference between three other types (Figure. 1b).

Genetic color

Differences were detected among turf type for visual color assessments, the darkest green color was observed in CM and LPS, which had similar color. The regularity of color quality based on scale of 1-9 was CM (8.31) ≥ LPS> NM1> NM2≥ LPY (7.06) (Figure. 1c).

Salehi and Khosh-Khoi (2004) used visual quality for shoot density, color and uniformity measurements. Garling and Boehm (2001) measured turf color by visual quality measurements. Cooper and Spokas (1991) declared that turf color is the most important characteristics of visual quality.

Table 2. Analysis of variance for visual quality assessment in 2011

S.O.V	df	Establishment rate	Genetic color	leaf width	Plant height	Smoothness	Uniformity	Weed suppression	Frost tolerance	clipping weight
turf grass types	4	0.898**	1.222**	2.205**	121.944**	1.394**	1.833**	6.630**	2.801**	184222.7**
Error	15	0.109375	0.05	0.06297	9.986	0.075	0.10260	0.38542	0.07448	5463

ns,**,* Non significant and significant of 1 and 5 percent of probability, respectively.

Table 3. Quantity comparison of different turf grass types

S.O.V	leaf width (mm)	Plant height (cm)	clipping weight (gr)
LPY	2.76 a	21.91 a	582.26 a
LPS	1.24 c	13.46 b	167.05 b
NM1	2.05 b	10.84 b	220.57 b
NM2	2.95 a	19.51 a	518.71 a
CM	1.55 c	9.16 b	113.42 b

Means in the same column followed by the same letter were not significantly different at the 5% level. LPY= *Lolium perenne* L. ‘Yarand’, LPS= *Lolium perenne* L. ‘Shadegan’, NM1= Native low-variety mixture, NM2= Native high-variety mixture, CM= Commercial mixture.

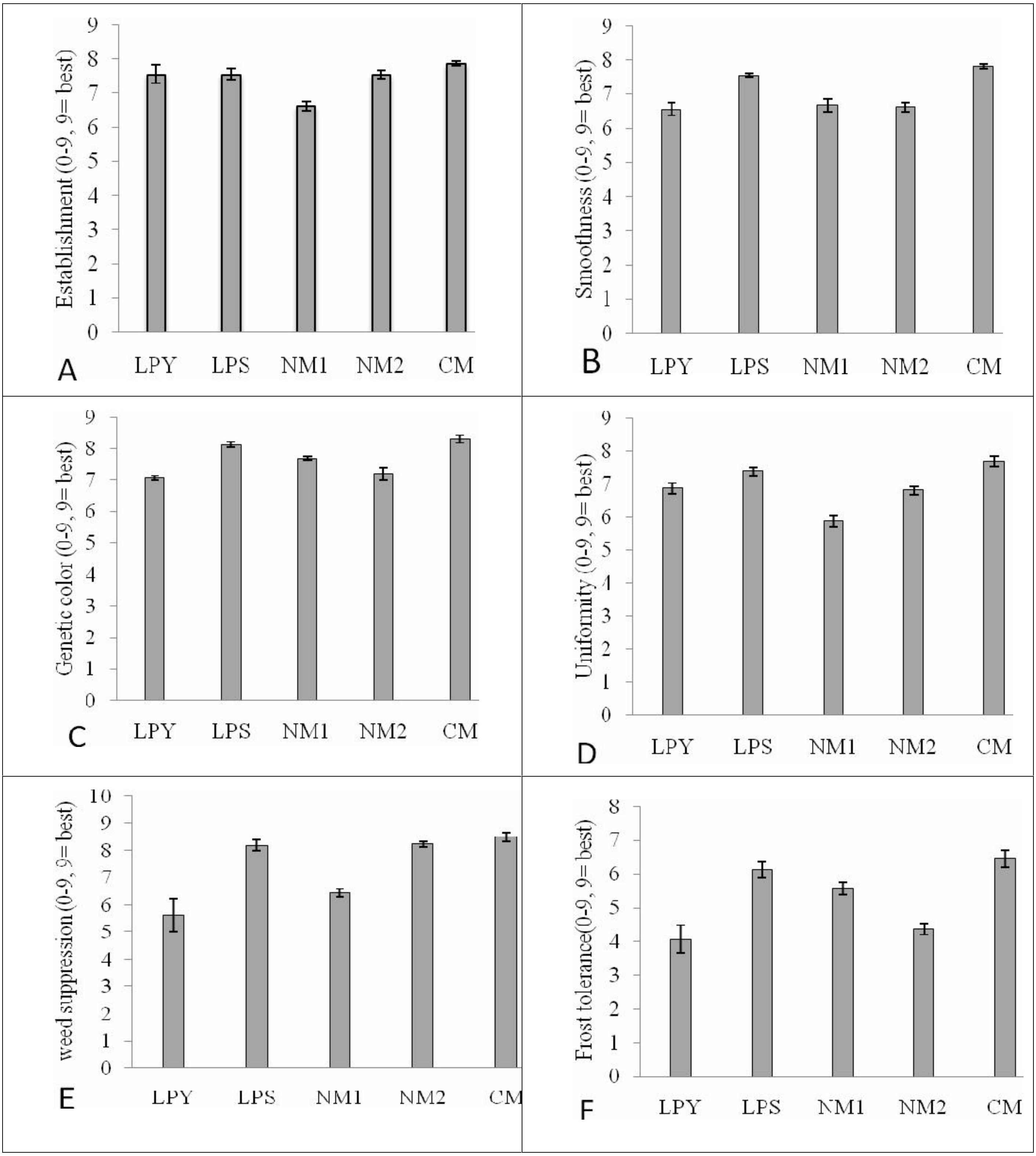

Figure 1. Visual merit scores (1= poor, 9= best) according to NTEP in 2011. LPY= *Lolium perenne* L. 'Yarand', LPS= *Lolium perenne* L. 'Shadegan', NM1= Native low-variety mixture, NM2= Native high-variety mixture, CM= Commercial mixture. A: Establishment rate, B: Smoothness, C: Genetic color, D: Uniformity, E: Weed suppression, F: Frost tolerance. Error bars represent standard error.

Uniformity

Comparing the different turf grass showed the best quality in viewpoint of uniformity in CM and LPS, 7.68 and 7.59, respectively but poorest uniformity in NM1 (6.25) (Figure. 1d). Poor establishment of *Festuca* and the coarse texture of *Lolium multiflurom* compared to *Festuca*, and their different growth rate, result in a non-uniform and patchy appearance in NM1 that was not very acceptable. No difference was observed between LPY and NM2 in uniformity because of very similarity of NM2 with LPY. This mixture was including nearly 55 percentage of LPY. Uniformity cannot be measured accurately; it is influenced by many features of the turf. Differences in texture, density, species composition, color, moving height, and other features determine uniformity and, therefore, visual quality of a turf (Turgeon, 1985). There are several reports on the comparison between different genotypes of turf for coverage, color and uniformity (Salehi and khosh-khui, 2004; Dunn et al., 1994; Newell et al., 1996; Skirde, 1989).

Weeds suppression

LPY and NM1 had significantly more weeds than other turf plots. The difference between three other grasses was not significant (Figure. 1e).

Except of NM1 other multi-species mixes showed significant effect on suppress of weeds. Weed cover represents that turf leaf densities were highest for CM, NM2 and monoculture of LPS. Mckernan et al. (2001) reported that grass mixture were better at weed resistance than one species due to a proposed ‘synergistic effect’.

Simmons et al. (2011) showed weed cover was lower in the native compared to non-native turf. The precise mechanisms of weed suppression were not examined here, but could be attributed to multiple ecological processes including diminution of the soil surface light and above- and belowground competition related to increased turf canopy density (Simmons et al., 2011).

Frost tolerance

LPS and CM showed high degree of resistance to environmental cold during autumn and winter and LPY and NM2 had lowest resistance. The regularity of frost resistance was CM ≥ LPS≥ NM1> NM2≥ LPY (Figure. 1f).

The frost tolerance is the most important limiting factor for cultivation of grasses in temperate regions, so using frost tolerant cultivars is essential for grasses successful cultivation (Nezami et al., 2010).

Leaf texture

Variations between grass types were obvious. The most slender leaves were belonged to LPS and CM whereas the coarsest leaves attained in NM2. In other word, the order of texture was NM2 (2.95 mm) ≥ LPY (2.76 mm)> NM1 (2.05 mm) > CM (1.55 mm) ≥ LPS (1.24 mm) (Table 3). In this respect, as fescue leaves are much finer than ryegrass leaves, it would be expected in a mixture of these two grasses that more ryegrasses would be identified than fescues due to the difference in size (Newell et al., 1996).

Plant height

The most plant height was recorded in LPY (21.91 cm) and NM2 (19.51 cm) (different not significant between both of them) and lowest height showed in CM (9.16 cm) whereas there was no significant difference between CM, LPS and NM1 (Table 3).

Clipping weight

It was evident that the highest and lowest clipping weight was belonged to LPY and CM, 582.26 (gr) and 113.42 (gr), respectively. LPY and NM2 had faster growth than other turf grasses. The regularity of clipping weight was LPY (582.26) ≥ NM2 (518.71) >NM1 (220.57) ≥ LPS (167.05) ≥ CM (113.42) (gr) (Table 3).

Perennial ryegrass is known as a “starter grass” because of its rapid germination and provides quick green cover (Turgeon, 2002). Therefore, height weight in NM2 is likely a result of the combination of high percentage of *Lolium perenne* with other native species. In fact, relative growth of native species was more rather than the commercial turf. Fast growth rate increase mowing frequency and costs of other management activities. Any turf that reduces cost of management such as mowing, irrigation, fertilizer and pesticide application could have a significant positive effect on the economic costs of landscape.

There was marked variation among accession of individual grasses. Monoculture of LPS showed highest visual quality whereas LPY had lowest quality. We feel that is also reasonable to assume that the high proportions of LPY in mixture of NM2 decreased its quality. Looking at the ranking of the turf types overall, it does appear that the choice of ryegrass had a greater influence on the performance of the mixture than the grass or grasses that it was sown with. Newell et al. (1996) reported that mixtures which contained one of the better perennial ryegrass cultivars (Lorina) certainly performed better than similar mixtures which contained lower ranking perennial ryegrasses.

There was significant difference between NM1 which contained two species and CM and NM2 turf which contained some different ryegrass cultivars and accessions, respectively.

In order to provide a uniform-appearing turf, each blend component should be compatible in leaf texture, growth habit, density, and vertical shoot growth rate (Beard, 1973). The compatibility was more in CM and NM2, and low compatibility was in NM1. A further demonstration of the value of careful selection of cultivars for use in mixtures is shown by comparing mixtures NM1 and NM2.

Using annual ryegrass (*Lolium multiflurom* 'Shadegan') in mixture NM1 accelerated ground cover of this mixture and gradually the proportion of it declined. The use of *Lolium multiflurom* instead of *Lolium perenne* resulted in unacceptable lawn turf. Perennial ryegrass in a mixture, especially for best turf type selections, creates a much more desirable lawn than annual ryegrass. They also germinate nearly as fast to provide quick soil stabilization. In temperate climates, annual ryegrass is occasionally used for establishing temporary lawns (Turgeon, 1985). There are not many reasons to put annual ryegrass into a lawn mixture except to plant a temporary groundcover, or to keep the price of the mixture cheap.

Turf that was initially composed of several cultivars may eventually become a monostand due to an imbalance in the competitive aggressiveness of component cultivars (Vargas and Turgeon, 1978). This phenomenon was observed in NM1. At the beginning of the experiment *Lolium multiflurom* was dominant and then gradually decline and *Festuca* spp. increased.

The Comparison of the visual merit scores for the three different mixtures supports the findings described earlier by Newell et al. (1996) who reported the choice of perennial ryegrass cultivar had the largest influence on mixture performance. There were no differences noted among NM2 with LPY, except for weeds suppression and uniformity. Likeness of CM and NM2 was using of some genotypes of ryegrass in both of them. Newell and wood (2000) declared the precision of the visual assessment, in terms of separating grasses in to performance groups, was as good if not better than the objective measurement of grass cover. Beard (1973) is convinced that visual qualifying is the best procedure for selection between turf grasses.

Conclusion

Some caution is needed when viewing these data, it is apparent that there were large differences from one turf type to another. Generally, turf grass types can be described as follows:

LPY: This type had good establishment and color, acceptance smoothness and uniformity, low resistance to frost and weeds. In viewpoint of quantity values, it had high clipping yield, great height and broad leaves.

LPS and CM: These turf grasses were very similar and had excellent color and resistance to weeds, good establishment, smoothness and uniformity and acceptance frost resistance. They had low height and clipping yield and slender leaves.

NM1: This type had good color, acceptance smoothness, establishment and weeds resistance, low uniformity and frost resistance. Other traits such as clipping yield and height was low and had medium width leaves.

NM2: This turf grass had excellent resistance to weeds, good color and establishment, acceptance smoothness and uniformity and low resistance to frost. It's clipping yield and height was high and had wide leaves.

Generally, of the four native turf type tested only LPS appeared to be superior to the others. It was not possible to distinguish statistically between the LPS and CM. An important finding from this work was that choice of one native species (LPS) which was very similar with used commercial turf (CM).

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