Journal of Applied Biological Sciences 8 (2): 86-90, 2014
ISSN: 1307-1130, E-ISSN: 2146-0108, www.nobel.gen.tr

An Evaluation of the Growth and Quality of Monoculture and Seed Mixtuers of Cool-Warm Season Turfgrasses in Temperate Area

Farzad NAZARI[1*] Taimoor JAVADI[1] Homayoun FARAHMAND[2] Mohsen AKBARI[3]
[1] Department of Horticultural Science, College of Agriculture, University of Kurdistan, Sanandaj, Iran
[2] Department of Horticultural Science, Shahid Bahonar University of Kerman, Kerman, Iran
[3] Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, Iran

*Corresponding author
E-mail: f.nazari433@gmail.com

Received: June 13, 2014
Accepted: July 24, 2014

Abstract
This study was conducted during 2009 and 2010 to compare different turfgrass species and their seed mixtures. In this reserch the turfgrasses Kentucky bluegrass (*Poa pratensis* L. 'Merion'), perennial ryegrass (*Lolium perenne* L. 'Barball'), common bermudagrass (*Cynodon dactylon* [L.] Pers.) and Tall fescue (*Festuca arundinacea* Schreb.) in monoculture or in mixtures of 1:1 and a 1:1:1:1 along with a sport turfgrass-DK (Douglass King Co.) based on seed number were used. The experiment was performed as a complete randomized block design with 12 treatments (turfgrass types) and four replications (individual plots). The turfgrasses were compared by measuring visual quality, chlorophyll index and mean rooting depth after winter and summer, verdure and/or root fresh and dry weight, tiller density, and clipping fresh weight. *Poa+Lolium* seed mixture was the best treatment and had high visual quality, chlorophyll index and mean rooting depth after winter and summer and tiller density. *Poa* monoculture had high root fresh and dry weight. The highest verdure fresh and dry weight was, obtained in *Cynodon+Festuca* seed mixture. Although according to measured characteristics, P+L seed mixture was better than other treatments, but in some parameters no significant differences were found between this mixtures with *Festuca* monoculture and L+F and P+F mixtures. Therefore, additional researches are needed to evaluate these mixtures with different seed ratio in same places.
Key words: *Cynodon*, *Festuca*, *Lolium*, *Poa*, seed mixture, turfgrass

INTRODUCTION

Turfgrasses, agriculturally and economically important perennial crops. One of the most critical decisions made during the establishment of a turf, is the proper selection of seed or seed mixtures. Turfgrasses must be selected according to their adaptation to the particular site and intended use [2]. Turfgrass seed can be sown individually, in seed mixtures and seed blends to provide green color and uniform surfaces in all the seasons [4]. Turfgrass is often sown in mixtures consisting of different species and cultivars. Mixtures of turfgrass species ensures genetic diversity and higher adaptive potential [1]. There are several reports on the comparison and selection between different genotypes of turfgrasses for color, uniformity, wear tolerance and coverage [5-11]. Juska and Hanson [7] blended 'Merion' the only bluegrass cultivar at the time, with common bluegrass and recorded higher turf quality scores in 'Merion' monoculture than blends, but were unwilling to recommended 'Merion' alone because of its known susceptibility to strip smut disease. The following factors have been shown to affect strongly the density and frequency of grass species in mixtures: seeding rates, mowing height and frequency, germination inhibition and combinations of the above [6]. Akbari et al. [5] with investigating cool-warm season *Poa-Cynodon* seed mixtures in subtropical region reported that, seed mixture composed of 40% *Cynodon* + 60% *Poa* was the best treatment and resulted in the highest verdure fresh weight, chlorophyll index after winter and summer, visual quality after winter and summer, and established a good turf. Therefore the present study was planned, to evaluate the growth and quality of monoculture and seed mixtures of cool-warm season turfgrasses in a temperate area and recommending the best seed mixture ratio.

MATERIALS AND METHODS

This research was conducted at the experimental farm of the Department of Horticultural Science, College of Agriculture, Kurdistan University, Kurdistan, Iran, located in Sanandaj (in the west of Iran with a temperate climate), 1540 m above the mean sea level, 35˚ 20′E and 47˚ 1′N, with clay-sandy soil (pH = 7.2), from August 2009 to September 2010. The meteorological data of the experimental site is shown in Table 1. Average daily maximum and minimum temperature are 40.6˚C and -10.2˚C, respectively and yearly precipitation at this site is 500 mm. This study was conducted in a shade-free area without fertility program. The experiment was performed in a complete randomized block design with 12 treatments (turfgrass types) and four replications (individual plots). Individual plots measured 2 m² (1×2 m). Turfgrasses were Kentucky bluegrass (*Poa pratensis* L. 'Merion'), perennial ryegrass (*Lolium perenne* L. 'Barball'), common bermudagrass [*Cynodon dactylon* [L.] Pers. (California origin)] and tall fescue (*Festuca arundinacea* Schreb.) in monoculture or in mixtures of 1:1 and a 1:1:1:1 and one sport turfgrass- DK [consisting 40% *lolium prenne* 'Taya', 23% *Poa pratensis* 'Platini', 7% *Poa pratensis* 'Conni', 20% *Festuca rubra* L. 'Maxima 1' and 10% *Poa pratensis* 'Balin' (Douglass King Co.)]. Seeds were obtained from seed companies on a weight basis, and composition was calculated on a seed number basis. Thus, turfgrass treatments were abbreviated as, *Cynodon*= C, *Poa*= P, *Festuca*= F, *Lolium*= L, C+P, C+L, C+F, P+L, P+F, L+F, C+P+L+F and sport turfgrass- DK (Douglass King Co.) The rate of seeding based on number of seeds 30 $g.m^{-2}$ for small seeds (P and C) and 74 $g.m^{-2}$ for large seeds (F and L). Because, sport turf consist 40% small seeds and 60% large seeds the rate of seeding was 56.5 $g.m^{-2}$. The rate of

seeding for each treatment is shown in Table 2. Turfgrass plots were established by directly sowing the seeds in August 2009. The soil was plowed, disked, and stones removed by hand prior to seeding. After raking, roll the soil with a roller to firm the soil. The plots were hand-seeded and immediately covered with a thin layer (about 0.5 cm) of decomposed livestock manure. Irrigation was applied regularly during establishment stage and then only during soil surface drought periods thereafter. During the experiment period, all plots were clipped when needed, from 3 cm above the ground by an electrical mower. The grass clippings were not returned to the plots. Visual quality [1] was assessed after winter and summer using ranking scale of 1 to 9, 1 = no live turf; 9: ideal shoot density, winter and summer color, and uniformity [4]. Tiller density, verdure and/or root fresh and dry weight at August, and chlorophyll index after winter and summer (March and September, respectively), mean rooting depth (average length of roots), all were measured in 100 cm² sub samples in each plot. Clipping fresh and dry weight was measured after each mowing, and their average during the year were subjected to statistical analysis. For measuring the dry weight, the materials were dried at 70˚C for 48h. Random sub sample of each plot was collected using a 10 × 10 × 50 cm metal block inserted into the soil. Then, the samples were soaked in tap water and soil was removed. Cleaned and ambient-air dried samples of plants were transferred to the laboratory for further measurements. Chlorophyll index was measured by spectrophotometric method at 645 and 663 nm wavelengths. All data (except visual quality data) were subjected to an analysis of variance (ANOVA) using MSTATC software program. Tucky's test at 5% level was used for mean separation.

RESSULTS

Time to seed emergence and winter weed number

In this study, time to seedling emergence was 6 d for *Lolium*, 7 d for *Festuca*, 8 d for *Poa* and 13 d for *Cynodon*. After counting the number of weeds in each plot in late winter, *Cynodon* monoculture and C+P mixture had the highest number of winter weeds, respectively. The lowest winter weed number was observed in P+L mixture (data not shown).

Visual quality after winter and summer

The results indicated that P+L mixture and *Cynodon* monoculture had the highest and lowest visual quality after winter, respectively (Table 3). But visual quality after winter in P+L mixture had no significant difference with some monocultures (L and F) and mixtures (C+L, L+F, C+P+L+F and Sport). The highest visual quality after summer belonged to P+L mixture and *Poa* monoculture; not significantly different compared with other treatments except *Cynodon* monoculture. *Cynodon* monoculture had the lowest visual quality after summer (Table 3).

Table 1. Monthly average precipitation and temperatures at the experimental site for August 2009 to September 2010.

	2009		Month	2010	
Month	Precipitation (mm)	Temp. (˚C)		Precipitation (mm)	Temp. (˚C)
August	0	26.0	January	49.0	6.0
September	7.0	21.0	February	49.9	5.9
October	62.5	15.3	March	50.9	12.1
November	89.3	8.8	April	94.2	13.6
December	35.1	5.8	May	28.0	17.9
–	–	–	June	1.0	24.8
–	–	–	July	0	28.3
–	–	–	August	0	27.6
–	–	–	September	0	24.0

Table 2. Seeding rate for each treatment.

	Turfgrass types (monoculture or mixtures)				Seeding rate (g m^{-2})			
Treat.	*Cynodon*	*Poa*	*Lolium*	*Festuca*	*Cynodon*	*Poa*	*Lolium*	*Festuca*
C	100%	0	0	0	30	0	0	0
P	0	100%	0	0	0	30	0	0
L	0	0	100%	0	0	0	74	0
F	0	0	0	100%	0	0	0	74
C+P	50%	50%	0	0	15	15	0	0
C+L	50%	0	50%	0	15	0	37	0
C+F	50%	0	0	50%	15	0	0	37
P+L	0	50%	50%	0	0	15	37	0
P+F	0	50%	0	50%	0	15	0	37
L+F	0	0	50%	50%	0	0	37	37
C+P+L+F	25%	25%	25%	25%	7.5	7.5	18.5	18.5
Sport	–	–	–	–	–	–	–	–

C: *Cynodon dactylon* [L.] Pers., P: *Poa pratensis* L. 'Merion', L: *Lolium perenne* L. 'Barball', F: *Festuca arundinacea* Schreb. Sport turfgrass-AAA [consisting 40% *lolium prenne* 'Taya', 23% *Poa pratensis* 'Platini', 7% *Poa pratensis* 'Conni', 20% *Festuca rubra* L. 'Maxima 1' and 10% *Poa pratensis* 'Balin'].

Table 3. The comparison of turfgrass types according to visual quality (9=ideal shoot density, winter and summer colour and uniformity; 0: no live turf), chlorophyll index and mean rooting depth after winter and summer.

Turfgrass types	Variables					
(monoculture or mixtures)	Visual quality		Chlorophyll index		Mean rooting depth (cm)	
	After winter	After summer	After winter	After summer	After winter	After summer
C*	0.00e	4.50b	0.10e	6.18f	10.20h	17.67d
P	5.80bc	8.60a	1.78ab	8.30bcd	18.30c	27.30a
L	7.30ab	7.50a	1.23cd	9.50ab	18.15c	24.48bc
F	8.00a	8.00a	1.08d	7.32def	16.31d	26.21ab
C+P	4.62d	7.80a	1.48bc	7.16def	18.43c	22.80c
C+L	7.50ab	8.13a	1.17cd	6.71ef	14.50e	24.00c
C+F	5.50bc	8.50a	1.21cd	6.21f	16.00d	24.17c
P+L	8.70a	8.60a	1.93a	10.20a	21.50a	27.30a
P+F	6.17bc	7.60a	1.43bcd	8.20b-e	13.50f	22.68c
L+F	8.20a	7.00a	1.24cd	7.84cde	12.31g	19.50d
C+P+L+F	8.00a	7.81a	1.22cd	8.96abc	20.08b	27.48a
Sport	7.85ab	8.50a	1.37cd	8.60bcd	16.70d	24.25c

C: *Cynodon dactylon* [L.] Pers., P: *Poa pratensis* L. 'Merion', L: *Lolium perenne* L. 'Barball', F: *Festuca arundinacea* Schreb. *In each column, means followed by the same letter (s) are not significantly different according to Tucky's test at 5% level.

Chlorophyll index after summer and winter

Observations indicated that P+L mixture and *Cynodon* monoculture had the highest and lowest chlorophyll index after winter and summer respectively. *Cynodon* monoculture loses its chlorophyll as it goes dormant, and remains brown until spring (Table 3). After winter, chlorophyll index in P+L had significant difference compared to other treatments except *Poa* monoculture, but after summer chlorophyll index in P+L had no significant difference with *Lolium* monoculture and C+P+L+F mixture (Table 3).

Mean rooting depth after winter and summer

The P+L mixture showed the greatest mean rooting depth after winter, while the highest mean rooting depth after summer related to P+L mixture and *Poa* monoculture although had no significant difference with *Festuca* monoculture and C+P+L+F mixture. *Cynodon* monoculture had the lowest mean rooting depth after winter and summer (Table 3).

Verdure fresh and dry weight

The results indicated that significant differences between treatments in term of verdure fresh and dry weight (Table 4). Higher verdure fresh and dry weights were observed in C+F mixture compared to the other treatments. Although the verdure fresh weight in C+F mixture had no significant difference with *Festuca* monoculture, also the verdure dry weight of this mixture had no significant difference with some other treatments (Table 4).

Root fresh and dry weight

The highest root fresh and dry weights were observed in *Poa* monoculture, compared to the other treatments. Root fresh weight in *Poa* monoculture had no significant difference with C+P mixture and Sport turf. Lowest root fresh and dry weights were obtained in *Cynodon* monoculture (Table 4).

Tiller density and clipping fresh weight

C+P and P+L mixtures had the highest tiller density and significant differences were observed between these mixtures and the other treatments. The lowest tiller density was observed in *Cynodon* monoculture. *Lolium* monoculture had the highest clipping fresh weight, although the difference was significant only with *Cynodon* monoculture, C+F and P+F mixtures (Table 4).

Table 4. The comparison of turfgrass types according to mean rooting depth, and root, verdure, clippings and total fresh weights in 100 cm^2 area, tiller density in 100 cm^2 area.

Turfgrass types	Variables					
(monoculture or mixtures)	Verdure fresh wt (g)	Verdure dry wt (g)	Root fresh wt (g)	Root dry wt (g)	Clipping fresh wt (g)	Tiller density (no. 100 cm^{-2})
C*	12.90fg	2.03cd	7.50i	1.67e	1.60d	75.00e
P	21.95bc	2.47bcd	36.30a	11.00a	3.92abc	220.00bc
L	12.01g	1.89d	29.50e	4.23d	4.90a	225.00b
F	26.07a	3.22abc	23.60h	4.95d	4.67abc	200.00bcd
C+P	20.25cd	3.10a-d	35.30ab	10.45a	3.80abc	270.00a
C+L	15.98e	1.84d	28.17fg	4.00d	4.01abc	175.00d
C+F	27.22a	4.34a	33.40c	7.87b	3.31bc	190.00cd
P+L	21.38bc	3.38ab	29.00ef	5.45cd	3.53abc	270.00a
P+F	22.45b	3.45ab	27.30g	5.50cd	3.10cd	175.00d
L+F	18.85d	3.23abc	31.50d	4.80d	3.78abc	230.00b
C+P+L+F	22.05bc	3.50ab	35.00b	7.05bc	4.80ab	225.00b
Sport	14.10ef	2.60bcd	35.15ab	8.60b	4.50abc	205.00bcd

C: *Cynodon dactylon* [L.] Pers., P: *Poa pratensis* L. 'Merion', L: *Lolium perenne* L. 'Barball', F: *Festuca arundinacea* Schreb. *In each column, means followed by the same letter (s) are not significantly different according to Tucky's test at 5% level.

DISCUSSION

The use of turfgrass mixtures is an important tool in turf management. Blending or mixtures three or more turfgrass cultivars to induce several desirable characteristics such as stress tolerance and disease resistance has become a common practice [12]. Perennial ryegrass germinates rapidly (5 to 7 days) and establishes quickly. In this study, time to seedling emergence was 6 d for *Lolium*, 7 d for *Festuca*, 8 d for *Poa* and 13 d for *Cynodon*. This is in agreement with Pommer [13] and Skired [10]. Because *Lolium*, germinated very fast and covered the ground, no weed was observed in its plots after winter. The quality of rapid germination and superior seedling growth of *Lolium* has led to frequent use as nurse crops for other desirable turfgrass seed mixtures. In this research, *Cynodon* monoculture and C+P mixture had the highest number of winter weeds, respectively. The lowest winter weed number was observed in P+L seed mixture. Warm-season species emerge from dormancy more slowly and do not reach maximum growth rate until midsummer. Their growth rate slows in the fall, and they go into dormancy in regions where soil temperatures are below 10 °C [1]. Poorly established species are more susceptible to weed invasions and require more intense maintenance than well- established species (P+L seed mixture). *Poa+Lolium* seed mixture was the best treatment and had high visual quality, chlorophyll index and mean rooting depth after winter and summer and tiller density, because both species are cool season grasses hence, emerge from dormancy sooner and do reach maximum growth rate until late spring [14]. This mixture can be used alternatively in overseeding programmes in areas with soil and environmental conditions similar to the present research site, wherein warm-season grasses and/or warm-season grasses mixed with cool-season grasses planted. *Cynodon* monoculture had the lowest chlorophyll index after winter and summer, becacuse is sensitive to cool temperatures and will stop growing, lose its chlorophyll, and take on a brown-tan color when soil temperatures fall below 10 °C [14]. *Lolium* monoculture had poor visual quality following mowing due to several physiological factor such as tough vascular bundles [14]. The highest root fresh and dry weights were observed in *Poa* monoculture, compared to the other treatments. It is in accordance with Akbari et al. [5] results, which with investigating *Poa-Cynodon* seed mixtures reported the *Poa* monoculture had the highest root fresh and dry weights compared to other treatments. Rooting depth is affected by several factors, such as environment, mowing height, fertility level, and soil-related factors. It is clear that warm-season grasses will usually have a deeper root system than cool-season grasses [14]. Since in this study, *Cynodon* was planted in summer; winter injury occurred in monoculture treatment. Winter injury is a term commonly used to represent any injury occurring to a turf during the winter period [3]. Although winterkill is typically defined as a gradual loss or thinning of bermudagrass turf caused by low temperature injury, Chalmers [15] reported winter injury includes any number of factors acting alone or in combination to injure dormant bermudagrass turf. These factors include low temperature, length of dormancy, winter moisture availability, cultivar selection, traffic, timing and use of cultural practices, and age of dormant turfgrass. C+P and P+L mixtures had the highest tiller density and significant differences were observed between these mixtures and the other treatments. This result is not in agreement with finding of Akbari et al. [5], that reported *Poa* monoculture have the highest tiller density among *Poa* and *Cynodon* seed mixtures and monoculture. These contradictory results may be due to differences in genotypes, geographical location and environmental condition [4]. The lowest tiller density was observed in *Cynodon* monoculture corresponding with finding of Akbari et al. [5]. *Lolium* monoculture had the highest clipping fresh weight; which can be due to its rapid growth in this region. Perennial ryegrass is known for its rapid germination and establishment. It is useful for quickly reestablishing damaged areas on lawns, athletic fields, and golf courses [14]. Although, now day one can be used of chemical agent such as paclobutrazol for retardant growth of turfgrasses [16]. In temperate areas, turfgrass seed mixtures often include the species slender creeping red fescue, perennial ryegrass, and Kentucky bluegrass in various proportions [17].

CONCLUSION

Mixing turfgrass varieties to combine desirable characteristics is a common management strategy. Although in this study *Poa+Lolium* seed mixture was partly the best treatment, but *Festuca* monoculture, L+F and P+F mixtures had some similar characteristics with this mixture therefore, additional studies are needed to evaluate different seed mixtures in these three species and their tolerance level to wear, mowing height, disease and pests, etc.

Acknowledgements

The authors wish to express thanks to the Research Council of University of Kurdistan (Sanandaj, Iran) for funding support of this research project.

REFERENCES

[1] Beard JB. 1973. Turfgrass: Science and Culture. Prentice-Hall: Englewood Cliffs, NJ., U.S.A. 704p.

[2] Murphy JA. 1995. Turfgrass seed selection for home. Lawns Rutgers Cooperative Research and Extension, NJAES, Rutgers, The State University of New Jersey.

[3] Turgeon AJ. 2002. Turfgrass Management. Prentice-Hall, Englewood Clifs, NJ., U.S.A. 400 p.

[4] Salehi H, Khosh-Khui M. 2004. Turfgrass monoculture, cool-cool, and cool- warm season seed mixture establishment and growth responses. HortScience 39:1732- 1735.

[5] Akbari M, Salehi H, Khosh-Khui M. 2011. Cool-warm season *Poa-Cynodon* seed mixtures and their turf growth and quality. Acta Agri Scandinavica Section B - Soil and Plant Sci. 61:559-564.

[6] Hsiang T, Carey K, He B, Eggens JL. 1997. Composition of mixtures of four turfgrass species four years after seeding under non-wear conditions. International Turfgrass Society Research J. 8: 671-679.

[7] Juska FV, Hanson AA. 1959. Evaluation of cool-season turfgrasses alone and in mixtures. Agron. J. 51:597-600.

[8] Misiha A. 1991. Effect of cool season turfgrasses seed mixtures on lawn characteristics. Bulletin Faculty of Agriculture Cairo University 42:401-414.

[9] Newell AJ, Crossley FEM, Jones AC. 1996. Selection of grass species, cultivars and mixtures for lawn tennis courts. Journal Sports Turf Research Institute 72: 42-60.

[10] Skirde W. 1989. Verhalten neuer sorten von rohrschwingel, *Festuca arundinacea*, in reinsaat und mischungen. Zeitschrift fur vegetations technic 4: 135-140.

[11] Tyson J, Grigsby B. 1952. Growing beautiful lawns. Michigan Ext. Bul. MI., U.S.A. 224 p.

[12] Lickfeldt DW, Voigt TB, Hamblin AM. 2002. Composition and characteristics of blended Kentucky bluegrass stands. HortScience 37: 822–825.

[13] Pommer G. 1972. Art-rund sortenbedingte variation von rasengrasen. Rasen-Turf-Gazen 3: 89-93.

[14] Christians N. 2004. Fundamentals of Turfgrass Management. John Wiley andS Inc., NJ, U.S.A. 359 p.

[15] Chalmers DR. 1978. Winter survival of bermudagrasses (*Cynodon* sp.) as influenced by deacclimation, low temperatures, and dormancy periods. M.S. Thesis, Virginia Tech, Blacksburg, Virginia.

[16] Nazari F, Javadi T. 2012. Growth and development of *Lolium perenne* L. 'Barbal' in response to different concentrations of paclobutrazol. J. Biol. Environ. Sci. 6: 195-198.

[17] Larsen SO, Andreason C, Kristofferson P. 2004. Differential sowing time of turfgrass species affects the establishment of mixtures. Crop Sci. 44: 1315–1322.