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Comparison of tall fescue (*Festuca arundinacea* Schreb.) and common bermudagrass (*Cynodon dactylon* [L.] Pers.) turfgrasses and their seed mixtures

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Abstract: With dense shoots above ground, a well-developed root system and large amounts of biomass underground, turfgrass provides many environmental benefits, including moderating soil erosion, water runoff and leaching, contributing to carbon sequestration, moderating temperatures, and reducing noise, glare, and visual pollution. In this investigation, (*Cynodon dactylon* [L.] Pers.) tall fescue (*Festuca arundinacea* Schreb.) and common bermudagrass were compared in monoculture and different mixtures of 0 to 100%, based on the number of seeds used. Perennial ryegrass (*Lolium perenne* L.), a common lawn in Shiraz, was used as control. The experiment was conducted in a split block design (season as main plot and turfgrass types as subplot) and each treatment had four replications. Data were analyzed with MSTATC software and means were compared using Tukey's test at 5% level. Turfgrasses were compared by measuring visual quality after winter and summer, rooting depth, verdure and/ or root fresh and dry weight, tiller density, and clippings fresh and dry weight. Results showed that, with the exception of mean rooting depth and chlorophyll index after summer, spring sowing is better than fall sowing. However, it can be concluded that the 80% tall fescue and 20% bermudagrass treatment is the best treatment, or has not significant differences with the other good treatments, except with regard to tiller density. This type can be used alternatively in overseeding programs in areas with soil and environmental conditions similar to the present investigation site.

1. Introduction

There are four main methods to establish turfgrasses from seeds: monoculture, seed blend, seed mixture and overseeding. In seed mixture, the species or genera of turfs are mixed together (Salehi, 2008). Mixture of species has long been used for turf seedlings (Newell *et al.*, 1996). Turf mixture, as opposed to a single species, broadens the genetic base, and thus increases the probability of providing pest resistance and tolerance to environmental extremes (Newell *et al.*, 1996). A turf consisting of a mixture may not be as uniform as single species in appearance or texture. However, when disease or other injuries affect one species in the mixture, the resulting injury is generally not as severe as when affecting a lawn with a single species (Corman, 1955; Daniel *et al.*, 1955; DeFrance, 1951).This method consists of three types of mixing including cool-cool season turf, cold-warm season turf and rarely warm-warm season turf seed mixtures. Mixture of cool-warm season turf may be useful for areas with inconsistent environmental conditions because each component in the mixture excels in a specific environment (Davis, 1958), especially in a transition zone (Akbari *et al.*, 2011; Salehi, 2008). For example, in Missouri (classified as a transition zone) bermudagrass and Kentucky bluegrass are grown together (Dunn *et al.*, 1994). Bermudagrass dominates in the summer, while Kentucky bluegrass in the cooler months of fall and spring (Daniel *et al.*, 1955). Early investigations to mix bermudagrass with cool season species were often unsuccessful because of the dominance of bermudagrass during summer months (Beard, 1973; Davis, 1958). This problem could be solved by:

i) Using warm season grasses with lower dominance in order to get a lower competition between the species. There is no known report on this method (Salehi, 2008).
ii) Using more aggressive cool-season turf may lessen the advantage for bermudagrass in summer and may make a permanent, balanced, cool-warm season mixture more practical than in past years (Davis, 1958; Turgeon, 1991).
iii) Using growth inhibitors for warm-season turfs in the first summer after planting to prevent exceeding growth or using accelerator hormones in the first spring and fall after planting for more growth of cool season turfs (Salehi, 2008).

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Misiha (1991) compared different turfgrass seed mixtures and demonstrated that the mixture of *Poa pratensis* L. 'Entopper' with *Festuca rubra* L. 'Hareld' had the best establishment rate and highest chlorophyll content, plant density, and clipping dry weight. Newell *et al.* (1996) indicated that *Lolium perenne* L. and *Festuca rubra* L. seed mixture had the best wear tolerance. Salehi and Khosh-Khui (2004) used *Lolium perenne* L., *Cynodon dactylon* (L.) Pers., *Poa pratensis* L. and *Festuca rubra* L. in mixtures of 1:1 (by weight) and a 1:1:1:1 (by weight) and two sport turfgrass cultivars, BAR11 (Barenbrug Co.) and MM (Mommersteeg Co.). The seeds were sown in March and October in two years. The turfgrasses were compared by measuring visual quality, chlorophyll index after winter and summer, rooting depth, verdure and/or root fresh and dry weight, tiller density, and clippings fresh and dry weight. They showed that fall sowing was superior to spring sowing and resulted in greater root growth, clippings yield, and chlorophyll content. *Poa+Cynodon* seed mixture was the best treatment and showed high tiller density, root growth, and chlorophyll content. They concluded that the cool-warm season seed mixture (*Poa+Cynodon*) can be used alternatively in overseeding programs in transition zone areas similar to Shiraz, Iran.

Following the study by Salehi and Khosh-Khui (2004), Akbari *et al.* (2011) compared *Poa* and *Cynodon* turfgrasses and their seed mixtures. In this research turfgrasses Kentucky bluegrass (*Poa pratensis* L. 'Merion') and common bermudagrass (*Cynodon dactylon* [L.] Pers.), in monoculture or in mixtures of 0 to 100%, based on number of seeds, were used. Perennial ryegrass (*Lolium perenne* L. 'Barball'), a common turf in the campus of Shiraz University, was used as control. The seeds were sown in October in two years. The turfgrasses were compared by measuring visual quality after winter and summer, chlorophyll index after winter and summer, rooting depth, verdure and/or root fresh and dry weight, tiller density, and clippings fresh and dry weight. *Poa* monoculture showed high tiller density, root fresh and dry weight and total fresh and dry weight. *Lolium* monoculture showed high rooting depth after winter and clippings fresh and dry weights. *Cynodon* monoculture quality was poor with regard to many characteristics, mainly due to fall sowing. The seed mixture composed of 20% *Cynodon* + 80% *Poa* was the best treatment and resulted in the highest rooting depth after summer, verdure fresh and dry weights, chlorophyll index after winter and summer, visual quality after winter and summer, and a good turf according to the other characteristics. Based on good characteristics of recently coming cool season *Festuca arundinacea* Schreb. cultivars to Shiraz, we proposed to test the performance of cool-warm season seed mixtures of a cultivar of this species with common bermudagrass in the same location as previous report. To the best of our knowledge there is no report of testing the seed mixture of this species with bermudagrass.

2. Materials and Methods

Characteristics of experimental location

Studies were conducted at the experimental farm of the Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, Iran, at Bajgah, 1810 m above mean sea level, 52°32' E and 29°36' N, with Daneshkadeh soil series (fine, mixed, mesic, Calcixerollic Xerochrepts, pH=8), from 2007 to 2008. The meteorological data for the experimental site is shown in Table 1. Long-term averages of maximum and minimum temperatures are 38°C and -9°C, respectively and yearly precipitation at this site is 400 mm.

Treatments

The species used in this study were *Festuca arundinacea* Schreb. 'Starlet' and *Cynodon dactylon* [L.] Pers. (California origin) in monoculture or in different mixture (by number of seed) and *Lolium perenne* L. cultivar Squire in monostand. In this investigation perennial ryegrass was used as control (Table 2). Turfgrass plots were established by directly sowing the seeds at two times, April and October, in 2007.

Management practices during investigation

Turfgrasses were irrigated every week in spring, every four days in summer, and every ten days in fall and every month in winter. It was enough to moisten the soil without overwatering. Turfgrasses were mowed at 5 cm height with an electrical mower. Weeds were manually removed. In this study no fertilizer was used.

Table 1 - Monthly average of temperature and precipitation (from April 2007 to August 2008)

Year	Month	Precipitation (mm)	Minimum T (°C)	Maximum T (°C)	Average T (°C)
2007	April	138.5	-3	24.5	11.56
	May	3	2	30.5	17.37
	June	0	7.8	38	22.07
	July	2.5	12.4	38	25.86
	August	0	9	36	24.16
	September	0	6	36	21.26
	October	0	3	29.5	15.79
	November	0	-5	26.5	11.34
	December	0	-12.3	18.5	3.4
2008	January	34	-14.8	12.6	0.5
	February	35	-13.7	20	3.5
	March	0	-9.6	22.2	7.5
	April	3.5	-3	29	14
	May	0	1.4	32.5	17.3
	June	0	5	38	22.4
	July	0	10.6	39	25.1
	August	0	13	38	24.2

Table 2 - Seeding rate of turfgrasses used (by percentage and weight)

Treatment number	*Cynodon* (%)	*Lolium* (%)	*Festuca* (%)	*Cynodon* (g m^{-2})	*Lolium* (g m^{-2})	*Festuca* (g m^{-2})
1	0	0	100	0.0	0	46.0
2	10	0	90	0.7	0	41.4
3	20	0	80	1.4	0	36.8
4	30	0	70	2.1	0	32.2
5	40	0	60	2.8	0	27.6
6	50	0	50	3.5	0	23.0
7	60	0	40	4.2	0	18.4
8	70	0	30	4.9	0	13.8
9	80	0	20	5.6	0	9.2
10	90	0	10	6.3	0	4.6
11	100	0	0	7.0	0	0.0
12	0	100	0	0.0	50	0.0

Measurements

Tiller density, verdure fresh and dry weight, clippings fresh and dry weight, root fresh and dry weight and total fresh and dry weight were measured after summer (October). Chlorophyll index and mean root depth and visual quality were measured after summer and winter (October and March, respectively).

Visual quality was assessed periodically throughout and after each growing season using a ranking scale from 0 to 9, 0= no live turf; 9= ideal shoot density, winter and summer color, and uniformity. Clippings and verdures were collected 20 days after mowing from 5 cm above the ground.

To measure dry weight, the materials were dried out at 60°C for 48 h. All data were measured for 100 cm^2 subsamples in each plot. A random subsample 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. After cleaning and air drying, plant samples were transferred to the laboratory for further measurements. Chlorophyll index (mg 100 cm^{-2}) was measured by spectrophotometric methods (by Spectronic 20D device) at 645 and 663 nm wavelengths (Salehi and Khosh-Khui, 2004).

Experimental design and data analysis

Experiments were conducted in 2×12 split block design with factorial arrangements, sowing season (spring and fall) as main plot and seed mixtures as subplot, and four replications in each treatment. Individual plots measured 4 m^2 (1×4 m). Data were analyzed using MSTAT-C program and the mean comparisons were made following Tukey's test at $p \leq 0.05$.

3. Results

Average root depth after summer

Results show that with spring sowing, there was no significant difference among all the seed mixtures' average root depth after summer. However, with fall sowing, the increase of tall fescue percentage led to greater root depth in the soil. The deepest root system was observed in treatment 1 with fall sowing composed of 100% seeds of tall fescue. Comparing averages of spring and fall sowing data, it is clear that the average root depth with fall sowing is greater than spring sowing (Table 3).

Average root depth after winter

With spring sowing the deepest root system belonged to the treatment composed of 100% tall fescue seed; decreasing the percentage of tall fescue seed, the root depth decreased. The deepest root system with fall sowing was found in *Lolium* monoculture, followed by the mixture with 90% tall fescue and 10% bermudagrass. By decreasing the percentage of tall fescue seeds, root depth decreased, except between treatments 4 and 5, in fall sowing and after winter. Averages of spring and fall sowing data indicate that the highest proportion of the root system grows near the soil surface with fall sowing (Table 3).

Tiller density

The average tiller density with spring sowing was found to be higher than with fall sowing. In spring, the mixture composed of 60% tall fescue and 40% bermudagrass had the highest tiller density and bermudagrass monoculture had the lowest; in fall, *Lolium* monoculture had the highest and bermudagrass monoculture had the lowest (Table 3).

Root fresh and dry weight

According to the results obtained, with the spring sowing, the mixture composed of 70% tall fescue and 30% bermudagrass produced the heaviest root system. With a decreasing percentage of tall fescue seeds, root system weights decreased. Therefore, the lowest root weight with spring sowing was observed in bermudagrass monoculture. With the fall sowing, the mixture composed of 80% tall fescue and 20% bermudagrass produced the heaviest and the 10% tall fescue and 90% bermudagrass mixture produced the lightest root systems (Table 3).

Clippings fresh and dry weight

Maximum values for clippings fresh and dry weights were found with the spring sowing of 60% tall fescue and 40% bermudagrass mixture. However, there was no significant difference ($p \leq 0.05$) for treatments 1 to 6. Furthermore, increasing the percentage of bermudagrass seeds (up to 40%), clippings weight increased and then decreased. With the fall sowing, the maximum clippings weight belonged to the mixture with 90% tall fescue and 10% bermudagrass. However, by decreasing the percentage of tall fescue seeds the weight decreased. Indeed, the lowest clippings weight was found with bermudagrass monoculture. Averages of spring and fall sowings data showed that clipping weights (both fresh and dry) of fall sowing was more than spring sowing (Table 4).

Verdure fresh and dry weight

Spring sowing results reveal that the maximum verdure fresh and dry weights belonging to the mixture composed of 60% tall fescue and 40% bermudagrass. However, it was not significantly different in treatments 4 and 6. With fall sowing, the 70% tall fescue and 30% bermudagrass mixture produced the maximum verdure weight. However, it was not significantly different in treatments 2 to 7 and 12 and tall fescue monoculture. Furthermore, averages of spring and fall sowing data show that verdure fresh and dry weights were greater in spring sowing than fall sowing (Table 4).

Total fresh and dry weight

The maximum total fresh and dry weights with spring sowing were found in treatment 5 (60% tall fescue and 40% bermudagrass). However, the values were not significantly different from treatment 4. The minimum total weight with spring sowing was observed in bermudagrass monoculture. With fall sowing, maximum and minimum total weights were noted in treatments composed of 80% tall fescue and 20% bermudagrass and bermudagrass monoculture, respectively. Furthermore, the average total weight of spring sowing was more than fall sowing (Tables 4 and 5).

Chlorophyll index after winter

With regard to chlorophyll, results showed that with spring sowing, the maximum index belonged to the 70% tall fescue and 30% bermudagrass mixture. A decrease in tall fescue seeds percentage led to a decrease in chlorophyll index. With fall sowing, the maximum index was found with the 90% tall fescue and 10% bermudagrass mixture (treatment 2). However, there was no significant difference between this treatment and treatments 3 and 4 (Table 5).

Chlorophyll index after summer

As for the chlorophyll index after summer, with spring sowing, treatment 3 gave the maximum chlorophyll index, however there was no significant difference between this treatment and treatments 1 and 2; the minimum index was

Table 3 - Effects of different seed mixtures and sowing times on some biological characteristics of the turfgrasses used

Sowing season	Treatment number	Average root depth after summer (cm)	Average root depth after winter (cm)	Tiller density (no 100 cm^{-2})	Root fresh weight (g)	Root dry weight (g)
Spring	1	26.25 c-f*	33.37 a	175 de	53.75 cd	22.40 bc
	2	25.37 c-f	33.25 a	180 cd	52.50 cd	21.00 c
	3	23.75 e-h	31.50 ab	186 bcd	51.80 cde	20.34 cd
	4	23.25 e-h	29.62 bc	193 ab	59.75 bc	22.98 bc
	5	22.50 fgh	29.00 bcd	194 ab	57.87 bc	22.26 bc
	6	25.00 c-g	28.75 bcd	179 cde	44.60 def	16.86 de
	7	23.25 e-h	28.75 bcd	155 fg	42.50 efg	15.74 ef
	8	24.75 d-g	26.87 c-f	141 hi	40.75 fg	14.87 efg
	9	24.62 d-g	27.12 cde	129 ij	34.25 gh	12.32 fgh
	10	24.50 d-g	25.87 def	124 jk	22.75 ij	7.84 ij
	11	23.75 e-h	24.12 efg	116 kl	19.87 ij	6.56 j
	12	26.75 cde	32.25 ab	178 cde	35.70 fgh	11.57 gh
	Average	24.48 B	29.21 A	162.8 A	43.02 A	16.22 A
Fall	1	33.62 a	23.50 fg	183 bcd	66.00 ab	27.50 a
	2	33.25 a	24.50 efg	185 bcd	66.87 ab	26.96 a
	3	31.75 ab	24.12 efg	190 abc	69.87 a	27.95 a
	4	31.75 ab	22.12 gh	177 de	64.12 ab	24.85 ab
	5	28.75 bc	24.00 efg	167 ef	57.62 bc	21.83 bc
	6	27.75 cd	19.62 hi	152 gh	35.60 fgh	13.49 e-h
	7	25.00 c-g	19.37 hi	148 gh	34.37 gh	12.88 fgh
	8	24.00 c-g	16.87 ij	130 ij	29.12 hi	10.48 hi
	9	23.37 e-h	14.12 jk	105 lm	19.00 j	6.78 j
	10	21.12 gh	12.75 k	96 m	13.75 j	4.79 j
	11	20.00 h	11.62 k	77 n	14.37 j	4.79 j
	12	31.75 ab	25.12 efg	198 a	42.32 fg	12.81 fgh
	Average	27.68 A	19.81 B	151 B	42.75 B	15.27 B

* In each column, means followed by the same letter(s) (small letters for means and capital letters for main averages) are not significantly different at 5% level according to Tukey's test.

found with treatment 11. With fall sowing, maximum and minimum chlorophyll indices were found with treatments 2 and 11, respectively. Averages of spring and fall sowing data showed that the chlorophyll index for spring sowing is significantly greater than fall sowing (Table 5).

Visual quality after summer

With spring sowing, treatment 5 gave grasses with the best visual quality. However, there was no significant difference between treatments 2 to 7, and tall fescue, bermudagrass and *Lolium* monocultures. With fall sowing, treatment 3 gave the best visual quality; there was no significant difference between this treatment and treatments 2 to 5, and tall fescue and *Lolium* monocultures. Furthermore, the average visual quality of spring sowing was greater than fall sowing (Table 5).

Visual quality after winter

The best average of visual quality with spring sowing was found with the treatment composed of 100% *Lolium* and, generally, by decreasing the percentage of tall fescue seeds the visual quality decreased. However, visual quality after winter increased between treatments 2 and 3, and also between 4 and 5. With fall sowing, *Lolium* monoculture gave the best average visual quality. In the mixtures, the 80% tall fescue and 20% bermudagrass mixture gave the best visual quality and the worst was found with bermudagrass monoculture. Averages of spring and fall sowings data showed that visual quality with spring sowing is more than fall sowing (Table 5).

4. Discussion and Conclusions

Average root depth after summer

There were no significant differences among different seed mixtures' root depth with spring sowing, maybe because their growth took place at the same time in spring. Maximum root depth in spring belonged to *Lolium*, based on its powerful germination and growth at the beginning of culture (Christians 2004; Salehi 2008; Akbari *et al.*, 2011). With fall sowing, by increasing the tall fescue seed per-

Table 4 - Effects of different seed mixtures and sowing times on some biological characteristics of the turfgrasses used

Sowing season	Treatment number	Clippings fresh weight (g)	Clippings dry weight (g)	Verdure fresh weight (g)	Verdure dry weight (g)	Total fresh weight (g)
Spring	1	8.00 de*	1.68 efg	16.75 d-g	5.46 def	78.50 de
	2	7.95 def	1.69 efg	23.37 b	7.30 ab	83.82 cd
	3	7.95 def	1.69 efg	21.62 bc	6.36 bcd	81.45 d
	4	8.17 de	1.77 def	24.87 ab	7.23 ab	92.80 abc
	5	8.60 cd	1.91 cde	27.00 a	7.71 a	93.47 abc
	6	7.90 def	1.76 d-g	23.75 ab	6.74 abc	76.27 de
	7	6.97 efg	1.58 fgh	19.12 cde	5.31 def	68.60 efg
	8	6.42 gh	1.48 gh	16.87 d-g	4.60 f-i	64.05 fgh
	9	5.00 ij	1.18 ij	15.50 fgh	4.17 g-j	54.75 hi
	10	4.17 ijk	1.01 jk	14.50 ghi	3.87 h-k	41.42 jk
	11	3.20 kl	0.80 kl	10.77 jk	2.83 kl	33.85 kl
	12	6.90 efg	1.37 hi	17.37 d-g	4.96 efg	60.02 fgh
	Average	6.77 B	1.49 B	19.29 A	5.54 A	69.08 A
Fall	1	10.65 ab	2.26 ab	16.25 e-h	5.41 def	92.60 abc
	2	11.20 a	2.38 a	17.12 d-g	5.38 def	95.20 ab
	3	11.15 a	2.36 a	18.62 c-f	5.85 cde	99.65 a
	4	9.75 bc	2.13 abc	19.62 cde	5.85 cde	93.50 abc
	5	9.12 cd	1.99 bcd	18.62 c-f	5.46 def	85.37 bcd
	6	8.37 d	1.88 cde	18.62 c-f	5.46 def	62.62 fgh
	7	6.60 fg	1.50 fgh	17.00 d-g	4.83 e-h	57.97 ghi
	8	5.12 hi	1.19 ij	13.12 hij	3.70 ijk	47.37 ij
	9	3.75 jkl	0.88 kl	11.75 ij	3.25 jk	34.50 kl
	10	2.52 lm	0.61 lm	10.87 jk	2.93 kl	27.15 l
	11	1.72 m	0.43 m	8.10 k	2.16 l	24.20 l
	12	7.95 def	1.59 fgh	19.77 cd	5.63 def	70.05 ef
	Average	7.32 A	1.60 A	15.79 B	4.58 B	65.87 B

* In each column, means followed by the same letter(s) (small letters for means and capital letters for main averages) are not significantly different at 5% level according to Tukey's test.

centage, the average root depth increased because tall fescue had good growth in early autumn while at the same time bermudagrass growth was very weak as it is a warm-season turfgrass.

Average root depth after winter

With spring sowing, maximum root depth belonged to tall fescue monoculture. Moreover, with increased tall fescue seed percentage in spring sowing, the growth of bermudagrass became slow with the beginning of the fall season, however *Lolium* and tall fescue grew continuously. With fall sowing, maximum root depth was found with *Lolium* because of its power to germinate. An increase in tall fescue seed percentage led to root depth increases because tall fescue goes into dormancy slowly and with increased temperature growth starts early.

Tiller density

With both sowing times, minimum tiller density was found with bermudagrass, which confirms the results of Akbari *et al.* (2011). Furthermore, with increasing tall fescue seed percentage, tiller density increased, which may refer to its power of tiller production.

Root fresh and dry weight

Increasing bermudagrass seed percentage led to decreases in root weight for both the sowing times, confirming the results of Akbari *et al.* (2011).

Clippings and verdure fresh and dry weight

With spring and fall sowing times, maximum weight was found in treatment 5 (60% tall fescue) and treatment 2 (90% tall fescue), respectively for clippings; and treatment 5 60% (tall fescue) and treatment 4 (70% tall fescue), respectively for verdure weight. Because tall fescue has good shoot growth, increasing its seed percentage increases clippings weight. However, this character is not suitable because it means increased mowing.

Total fresh and dry weight

Maximum total weights were found among treatments composed of higher percentages of tall fescue seeds; with

Table 5 - Effects of different seed mixtures and sowing times on some biological characteristics of the turfgrasses used

Sowing season	Treatment number	Total dry weight (g)	Chloropyll index after winter**	Chlorophyll index after summer**	Visual quality after summer	Visual quality after winter
Spring	1	29.53 cd*	2.10 cd	9.38 ab	8.25 ab	8.00 a-d
	2	29.99 cd	2.07 cd	9.41 a	7.75 a-d	7.75 a-e
	3	28.40 de	2.07 cd	9.47 a	8.37 ab	8.12 a-d
	4	31.99 bcd	2.28 abc	9.05 b	8.37 ab	8.12 a-d
	5	31.89 bcd	1.94 def	8.60 c	8.87 a	8.37 abc
	6	25.35 ef	1.74 fg	8.27 cde	8.37 ab	7.00 b-f
	7	22.64 fg	1.41 h	8.00 ef	8.00 ab	6.37 def
	8	20.97 gh	1.07 i	7.79 fg	7.12 b-e	6.00 efg
	9	17.67 hi	0.74 j	7.54 gh	6.62 cde	5.25 fg
	10	12.73 hi	0.45 k	7.29 hij	7.12 b-e	2.87 hi
	11	10.19 kl	0.09 l	7.04 j	7.75 a-d	0.00 k
	12	17.90 hi	1.61 gh	8.19 de	8.62 a	8.87 a
	Average	23.27 A	1.47 B	8.34 A	7.93 A	6.39 A
Fall	1	35.17 ab	2.24 bc	9.32 ab	8.50 a	8.37 abc
	2	34.74 ab	2.47 a	9.36 ab	8.50 a	8.50 abc
	3	36.12 a	2.37 ab	9.30 ab	8.87 a	8.75 ab
	4	32.84 abc	2.32 ab	8.60 c	8.50 a	8.12 a-d
	5	29.84 cd	2.00 de	8.41 cd	7.87 abc	7.87 a-d
	6	20.74 gh	1.79 efg	8.06 def	6.25 ef	6.75 c-f
	7	19.20 ghi	1.52 h	7.83 fg	5.87 efg	5.37 fg
	8	15.38 ij	1.05 i	7.53 gh	5.00 fgh	4.50 gh
	9	10.39 kl	0.84 j	7.39 hi	4.87 gh	1.87 ij
	10	8.34 l	0.35 k	7.16 ij	4.37 h	1.00 jk
	11	7.38 l	0.03 l	6.54 k	6.50 de	0.00 k
	12	20.03 gh	1.82 ef	8.22 de	8.78 a	9.00 a
	Average	22.51 B	1.57 A	8.14 B	6.99 B	5.84 B

* In each column, means followed by the same letter(s) (small letters for means and capital letters for main averages) are not significantly different at 5% level according to Tukey's test. ** mg 100 cm^{-2}.

increasing bermudagrass seed percentage, total weight decreases, especially with fall sowing.

Chlorophyll index after winter and summer

After winter, the chlorophyll index in bermudagrass was very low because it is a warm season turf and in winter its shoots become chlorotic. However, tall fescue and *Lolium* shoots remain green during winter. After summer, all the mixtures increased the chlorophyll index of shoots in all the seed mixtures. Furthermore, by lowering the plant density of tall fescue, light can penetrate more easily and thus the chlorophyll index becomes greater than tall fescue monoculture.

Visual quality after summer and winter

Visual quality has a direct correlation with chlorophyll index: as chlorophyll index increases, so does visual quality. Furthermore, visual quality depends on weed density and in mixtures with more bermudagrass the number of weeds increases, particularly with fall sowing.

Among *Festuca* and *Cynodon* seed mixtures, 80%F + 20%C was selected as an excellent turfgrass mixture in this study, with regard to all the positive characteristics except tiller density. This seed mixture established a fine, green color throughout the year. Furthermore it can be used alternatively in overseeding programs in areas with soil and environmental conditions similar to the present investigation site. Additional studies are needed to investigate the best cultural conditions of this selected seed mixture.

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