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GROWTH, HERBAGE YIELD AND QUALITY EVALUATION OF TURFGRASSES SPECIES UNDER AGRO-ECOLOGICAL CONDITIONS OF IĞDIR, TURKEY

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Abstract

The agro-botanical and qualitative testing of indigenous turfgrass species have remained neglected despite their enormous potential to provide nutritional herbage for dairy animals. A multi-year research was conducted to appraise the growth, herbage yield and nutritional quality performance of eight turfgrass species (*Lolium perenne, Festuca arundinacea, Poa pratensis, Festuca rubra rubra, Festuca rubra comutata, Festuca rubra trichophylla, Festuca ovina, Agrostis tenuis*) during 2015 and 2016 under the agro-ecological conditions of Iğdır, Turkey. The experiment was carried out in a factorial design with three replications, while response variables included different agro-botanical traits and green herbage potential of turfgrasses under investigation. The results revealed that *Festuca arundinacea* remained superior for canopy covering rate, green herbage yield, plant height, root depth, leaf width, grass quality and greenness of leaf color.It was followed by *Lolium perenne* and *Festuca rubra rubra*. However, *Festuca ovina* and *Agrostis tenuis* performed below par to other turfgrass species during all seasons of both years. Therefore, turfgrass species '*Festuca arundinacea*', *Lolium perenne* and *Festuca rubra rubra* may be recommended for obtaining significantly higher green herbage yield and quality in all three seasons (spring, summer and autumn) in Iğdır, Turkey and in other regions of having similar agro-climatic conditions globally.

Key words: Cool climate grass species; Canopy cover; Root depth; Grass performances.

Introduction

All grasses are members of Gramineae family, however, only 40 species have been found suited for turf use owing to their tolerance and persistence to mowing and compactions caused by vehicles traffic (Emmons & Rossi, 2015; Zanelli *et al.,* 2021; Iqbal *et al.,* 2022a). The term turfgrass refers to the plant itself, whereas turf donates the medium in which the grass is grown (Turgeon, 1985). All turfgrass species belong to three primary subfamilies of Festucoideae, Panicoideae and Eragrostoideae. The Festucoideae turfgrasses are cool-season grasses while turfgrasses in the Panicoideae and Eragrostoideae subfamilies are called warm-season grasses (Patel *et al.,* 2016).

Although there has been very little documentation on the role of perennial grasses in the evolution of sport and ball-games, but pasture grasses constitute a key component of games requiring turfs (Casler *et al.,* 2003; Iqbal *et al.,* 2022b). Historically, wild animals and livestock were largely responsible for mowing management of turf areas until the 20th century, suggesting that evolution of form, function and fitness of perennial turfgrasses continued to be influenced by grazing livestock (Patel *et al.,* 2016; Iqbal *et al.,* 2018a). However, cool climate-loving turfgrass species are well-preferred in a wide range of transitional areas such as city parks, sports and recreation areas, children's playgrounds and site gardens, fair and exhibition areas, and middle refuges (Patel *et al.,* 2016; Iqbal *et al.,* 2018b). Cool-season grass plants have been better adapted to the cooler regions of the northern latitudes and the warmer regions of the southern latitudes (Christians, 2011). The prerequisite of grasses for parks and gardens, picnic and caravan areas, sports and playgrounds is the strong structure and architecture which can resist compaction and press along with having short regrowth time.

The adaptations, evolution and eco-physiological aspects of the grass plants are pivotal for their robust growth in a specified region having peculiar agro-climatic conditions. The visual quality of the lawns especially during summer and autumn, chlorophyll indexes in winter and after summer, root depths, green residence times, unit weights and re-growth after mowing, and quickly covering the area by being structured in a short period are considered as quality characteristics (Zanelli *et al.,* 2021). For this purpose, fresh research was needed pertaining to the adaptation of grass species which are rarely studied in Iğdır region encompassinghot and dry summers and cold in winter (Iqbal *et al.,* 2018b).Thus, it was postulated that some turfgrass outperforms others due to genetic diversity under the same management system. The present multi-year research was, therefore undertaken to comparatively assess the growth, herbage yield and quality performance of eight turfgrass species (*Lolium perenne, Festuca arundinacea, Poa pratensis, Festuca rubra rubra, Festuca rubra comutata, Festuca rubra trichophylla, Festuca ovina, Agrostis tenuis*) during two consecutive years under the agro-ecological conditions of the Iğdır, Turkey.

Material and Methods

Location and trial's duration: The research was carried out during spring, summer and autumn seasons under the ecological condition at the experimental condition of Faculty of Agriculture in the Iğdır University, Turkey (39.8148° N, 44.0768° E) during two consecutive years of 2015 and 2016.

Soil properties in experimental sites: In the experimental soil area, soil texture was clayey with the lime ratio, pH, and electrical conductivity were 6.53%, 7.98 and 1.8 dS m^{-1}, respectively. The nutrients like potassium and phosphorus

were 0.3, 0.008 t/ha, respectively with a very low organic matter content (1.6%). Before planting, all experimental units were given 8 and 5 kg/da of P_2O_5 as triple super-phosphate fertilizer and nitrogen as urea, respectively.

Plant materials and experimental design: In the experiment eight turfgrass species such as *Lolium perenne, Poa pratensis, Festuca rubra rubra, Festuca rubra comutata, Festuca rubra trichophylla, Festuca arundinacea, Festuca ovina, Agrostis tenuis* were used as plant materials. All plant materials were arranged in a randomized completely block design with three replications in both years.

Unit plots size were in 2m x 1m = 2 m^2 area, 0.5 m gap between the experimental units and 1 m between the block/replication. Before seeds sowing, soils in each unit plots were manually spread in both years. After seeds soing, 1 cm thick covering soil was spread out by hand and pressed with the soil cylinder and the plots were irrigated immediately by sprinkle centre pivot. The weeds were removed by hand and the first clipping was done when the plants had attained 8-10 cm height.

Data collection: Data regarding canopy covering rate, green herbage yield, plant height, root depth, leaf width, grass quality, the greenness of leaf color three seasons of both years were recorded.

Turfgrass quality traits like the visual appearance in terms of grass uniformity, frequency and clearance from weeds were determined visually. Accordingly, 1: worst, 9: rated as best grass quality (Mehall *et al.,* 1983). The plant height (10 different points on each plot) degree of covering , green grass yield, root depth and grass quality were examined.

Statistical analysis: The recorded data of both years were subjected to the analysis of variance technique according to the randomized block design, and the differences among treatment means were determined by using statistical package of SPSS by employing Duncan's multiple range test (DMRT) at 5% probability level (Steel & Torrie, 1960) .

Results and Discussion

Seasonal covering rates variation of eight turfgrass species: The results pertaining to agro-botanical traits and nutritional value of different cool-climate grass species and the quality of grass during the years of 2015 and 2016 are presented in Tables 1 and 2. In the first year, the lowest covering rate (23.8%) was recorded for *Agrostis tenius* while the highest rate (82.6%) was recorded with *Festuca arundinaceae*. The covering rates (66-67%) of all sub-species of *Festuca rupra* were similar. In terms of seasons and the first-rate of establishing, *Lolium perenne and Festuca arundinacea*e (67% and 70%) have a higher rate than other species among the turfgrassess. These research findings are consistent with those of Watschke & Schmidt (1992) as far as covering ration and rate of *Lolium perenne* was concerned.

In terms of species and season interaction, the species, *L. perenne* reached 94% at the end of the second year, while in the summer season *Festuca arundinacea* completed the coating rate immediately (Table 1). In both years, *A. tenius* and *F. ovina* had the lowest covering ratio, while *Festuca ovina* was dormant in the summer period of two years, and even was be able to attain 50% in the second year. Under the influence of the season, the rate of grass covering for spring, summer and autumn of 2015 remained 48.6%, 53.6 and 65.5, respectively and there was statistically significant difference between them.

The second-year data (Table 2), depicted the covering rate of69.4, 74.1 and 81.6% according to the same seasons, respectively and showed an increasing trend. The average covering rate of 45-50% was recorded in the first year and it was increased to 80% in the second year. However, the lowest level of covering rate was recorded by *F. ovina* in the first year and *A. Tenuis* in the second year.Previously, it has been reported that turfgrass species having larger seed size tend to germinate earlier and have considerably higher covering rate compared to small-seeded turfgrasses (Ateş & Tekeli, 2004] . These results of the trial were guilty consisted with the data of the effects on plant cover rate, plant height, fresh grass yield, plant cover level, colour, turfgrass quality, mixtures consisted of creeping bentgrass and colonial bentgrass (*Agrostis tenuis*), had the worst results in terms of all values (Çelebi *et al.,* 2009).

Green herbage yield variation of eight turfgrass species: The green herbage yields of cool climatic turfgrass species during three seasons of two consecutive years have been given in Table 2. The lowest green yield was obtained from the Kentucky bluegrass (*Poa pratensis*), during the Spring period of both years. In the first year of investigation, the highest green yield was obtained from perennial ryegrass (*Lolium perenne*), tall fescue (*Festuca arundinacea*) in Autumn season. Herbage yields continued to increase across seasons while the maximum herbage yield was recorded during the spring season of the second year which remained statistically at par to herbage yield during the summer of the first year. The highest green yield was obtained from *Festuca arundinaceae* in two years, the lowest yield from *Poa pratensis* and *Festuca ovina* in two years. These results are comparable with the research findings of Akdeniz *et al*., (2018), who reported that Kentucky bluegrass (*Poa pratensis* Geronimo), remained unmatched by recording the highest herbage yield as well as covering rate which was obtained during the autumn season in Iğdır and finally 25 g m^{-2} seed of Kentucky bluegrass was recommended for general adaptation in the region. Except for the green yield and covering ratio of grasses, the quality scores were found to be 7.69-7.87 and the texture values were similar to 2.61-2.98 mm (Gül, 2015).

Seasonal plant height variation of eight turfgrass species: The results of plant heigh of all turfgrass species are presented in Table 3. The lowest value was measured for *Poa prantensis* and *Festuca ovina* species in the spring and summer period of the first year of 2015. The plant length of perennial ryegrass (*Lolium perenne*) were highest among species, *F. rubra rubra* followed by *L. perenne* in respect of the leaf length. Besides, all turfgrass species recorded the increasing trend from spring to autumn except sheep's fescue (*Festuca ovina*). As far as plant height of turfgrasses is concerned, (Hubbard, 1992) previously revealed the same trend as that of ours except for Lolium perenne which exhibited inconsistant growth across seasons during both years. Some other researchers have also found the plant height of *Lolium perenne* similar to *P. pratensis* (Akdeniz *et al.,* 2018).

Table 1.The seasonal covering rates variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species means	
L. perenne	67.0 gh	88.0 cde	75.0 de	86.3 de	88.3 ab	94.3 abc	76.8 b	90.0 b
P. pratensis	16.3 m	49.3 j	26.0 kl	67.7 h	43.3 j	67.3 h	28.6 e	61.4 e
F. rubra rubra	58.0 i	75.7 fg	64.0 hi	91.7 bcd	80.3 cd	95.7 ab	67.4 c	87.7 b
F. rubra comutata	58.0 i	71.7 gh	66.3 gh	78.0 fg	76.7 de	82.7 ef	67.0 c	77.4 d
F. rubra trichophylla	59.0 i	76.7 fg	67.3 fgh	78.7 fg	73.7 ef	92.0 bcd	66.7 c	82.4 c
F. arundinacea	70.7efg	89.3 b-e	84.7 bc	100 a	92.3 a	100 a	82.6 a	96.4 a
F. ovina	43.3 j	52.3 j	21.7 lm	30.3 k	38.7 j	53.7 ij	34.6 d	45.4 f
A. tenuis	16.3 m	52.3 j	24.0 l	60.0 i	31.0 k	67.3 h	23.8 f	60.0 e
Means of seasons	48.6 c	69.4 c	53.6 b	74.1 b	65.5 a	81.6 a		

Table 2. The seasonal green herbage yield variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three seasons	
L. perenne	330 d	640 cde	440 c	537 fg	690 a	697 abc	487 b	624 b
P. pratensis	43 j	150 kl	100 i	193 jkl	117 hi	243 hij	86.7 f	196 d
F. rubra rubra	277 de	670 bcd	423 c	707 abc	683 a	743 a	461 b	707 a
F. rubra comutata	307 de	503 g	313 de	683 abcd	563 b	657 cde	394 c	614 b
F. rubra trichophylla	190 fg	530 fg	267 e	617 de	517 b	700 abc	324 d	616 b
F. arundinacea	320 de	593 ef	560 b	727 ab	680 a	730 ab	520 a	683 a
F. ovina	140 ghi	197 jkl	87 ij	133 l	117 hi	217 ijk	114 f	182 d
A. tenuis	157 fgh	227 ij	187 fg	270 hi	200 f	303 h	181 e	267 c
Means of seasons	220 c	439 c	297 b	483 b	446 a	536 a		

Table 3.The seasonal plant height variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three seasons	
L. perenne	16.3 cd	18.3 e	15.3 de	17.3 ef	21.7 a	24.0 a	17.8 a	19.9 b
P. pratensis	6.7 l	11.0 j	7.7 kl	12.0 ij	9.0 k	13.7 gh	7.8 e	12.2 e
F. rubra rubra	12.0 ij	21.3 bcd	13.7 fgh	20.0 d	20.0 b	22.7 ab	15.2 b	21.3 a
F. rubra comutata	11.0 j	16.3 f	13.0 ghi	17.7 ef	16.7 cd	18.0 e	13.5 c	17.3 cd
F. rubra trichophylla	10.7 j	17.0 ef	12.7 hi	17.7 ef	16.3 cd	18.3 e	13.2 cd	17.7 c
F. arundinacea	14.7 ef	17.7 ef	17.3 c	20.7 cd	19.3 b	22.0 bc	17.1 a	20.1 b
F. ovina	8.3 k	11.0 j	6.3 l	9.0 k	9.0 k	13.0 hi	7.9 e	11.0 f
A. tenuis	11.0 j	14.7 g	12.7 hi	17.0 ef	14.3 efg	18.0 e	12.7 d	16.6 d
Means of seasons	11.3 c	15.9 c	12.3 b	16.4 b	15.8 a	18.7 a		

Table 4.The seasonal root-depth variation of eight turfgrass species during both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three seasons	
L. perenne	8.7 gh	20.0 b	15.0 cd	19.7 bc	19.0 b	19.0 bc	14.2 b	19.5 b
P. pratensis	2.3 mn	4.3 m	3.0 lmn	4.0 m	4.3 jklm	4.3 m	3.2 f	4.2 g
F. rubra rubra	7.0 hi	16.3 de	13.0 de	14.7 efg	15.3 c	17.7 cd	11.8 c	16.2 c
F. rubra comutata	4.0 klmn	6.7 kl	5.0 ijkl	6.0 lm	6.7 hi	7.7 kl	5.2 e	6.8 f
F. rubra trichophylla	5.3 ijk	12.3 hi	10.0 fg	14.7 efg	12.0 ef	15.7 de	9.1 d	14.2 d
F. arundinacea	13.7 cde	23.0 a	23.0 a	23.0 a	24.3 a	22.7 a	20.3 a	22.9 a
F. ovina	6.3 ij	13.3 fgh	10.0 fg	12.7 ghi	13.0 de	15.3 ef	9.8 d	13.8 d
A. tenuis	2.0 n	8.7 jk	6.0 ijk	10.7 ij	9.3 g	13.0 gh	5.8 e	10.8 e
Means of seasons	6.2 c	13.1 b	10.6 b	13.2 b	13.0 a	14.4 a		

Root-depth variation: Turfgrass roots are fibrous, branching, and very slender while their growth gets restricted by suboptimal temperature, moisture and oxygen supplies. Cooler season turfgrasses tend to develop rigorous roots network at cooler temperatures and vary in their genetic potential for roots proliferation. The root depths of the turfgrass plants during two years are presented in Table 4. *F. arundinacea* developed the deepest roots during all seasons. Its roots depth varied between 13-24 m, while the maximum depth was recorded during the autumn season.

The root depth was 2.3 cm in the spring of the first year but it remained in the same depth of fall at 4.3 cm in the fall and the second year in *Poa pratensis*. *Poa pratensis, Festurca rupra comutata* and *Agrostis tenius* species have not been found to have too many deep-rooted plants. The deepest rooted plant was *Festuca arundinacea*, followed by *Lolium perenne* and *Festuca rupra rupra*. In general, the root depths of the plant species continued in both years depending on the seasons. The results of experiments of by some researcers found that *Festuca arundunaceae cultivers* were the most proper material and *Lolium perenne cultivars* were also successful and *Poa pratensis cultivars* failed in terms of many properties were agreement with our data from this trial (Cakmakci *et al.,* 2005], (Varoğlu *et al.,* 2015). A researcher who studied the warm and cool seasons species and their mixtures had high and fresh total fresh weight in the *Poa pratensis* L. 'Merion' monoculture (*Lolium perenne* L. 'Barball') and that the root depth after winter was higher than other species and 40% Cynodon + 60% (Akbari *et al.,* 2011). Various composts and their rations on *Poa pratensis*, has increased the root depth linearly as a result of the covering rate and grass quality is very superior (Mandal *et al.,* 2013).

The seasonal leaf-length variation of eight turfgrass species in both-year: The leaf width values of the grass species called texture are presented in Table 5. *Festuca arundinacea* recorded the highest leaf texture during the Summer season of 2015. During the second year of the field trial, it was observed that the interaction effect of season and grass species remained statistically insignificant. *F. arundinacea* was coarse leaf texture in 2016, followed by *P. Pratensis, L. Perenne, F. rubra rubra, F. rubra comutata*. It was found that the leaf texture of *F. arundinacea* was more than the other species. *F. rubra trichophylla* and *F. ovina* are thinner, and some researchers as (Hubbard, 1992) had earlier explained that tissues of some grasses tend to fold, which conforms with those our results.

Leaf-colour variation of eight turfgrass species: The colour values of the lawns are given in Table 6, the colour tone was not significant among the seasons, in three times, spring, summer and autumn periods in 2015 and 2016. However, *Festuca ovina* was the lowest of the season with 6.4 points and *Agrsostis tenius* with 7.3 points, while the colours of all other species varied between 8.2 and 8.6. While the colour in 2016 was insignificant during the first year, *Festuca ovina* was found to be lower in colour than other species, and the colour was statistically non-significant as per visual analysis (Table 6). No significant differences were found between seasons and turfgrass species. The colour of *Pao pratensis* were found to be quite compatible with the results of a previous study (Gül, 2015; Zanelli *et al.,* 2021).

Herbage quality variation: The turfgrasses quality values were recorded during all seasons of both years (Table 7). *F. arundinacea* and *L. perenne* created uniform images, a clean area of weeds and a common grass cover during the entire development period in 2016. In terms of seasonal variation, the quality of turfgrass in the Autumn season was higher than those of Spring and Summer seasons. In the Spring of the second year, quality values of *L. Perenne, F. rubra comutata* and *F. ovina* species were slightly lower during the Summer and continued to stabilize other species stabilizers. By the end of the second year *F. arundinacea* and *F. rubra trichophylla, F. rubra rubra* were found to be superior to other turfgrass species. *A. tenuis* and *Festuca pratensis* exhibited the lowest quality compared to rest of species. It was probably because cool-season grasses were better adapted to the cooler regions of the northern latitudes of the world and the warmer regions of the southern latitudes and exhibit superior quality in cooler regions only (Christians, 2011). Similarly, in Diyarbakır conditions (Gül, 2015), the quality scores with 7.69-7.87, were found to be quite similar to the two-year scores of the trial. The significant variations among crops and their interaction with environment concerning production and nutritive value was reported by different investigations (Barutcular *et al.,* 2016; Barutcular *et al.,* 2017; Akdeniz *et al.,* 2018a), while these findings have also been in agreement with few of recent studies (Akdeniz *et al.,* 2018b; Yıldırım *et al.,* 2018; Akdeniz *et al.,* 2019; EL Sabagh *et al.,* 2019).

Correlation between characters of turfgrass species: In the Pearson correlation analyses between the characters considered among the different types of grasses for two years, significant correlations were found in terms of average plant yield, root depth, plating ratio and grass quality between age yield and leaf width as the average of grass species (Table 8). However, the relationship between the covering ratio and plant height with the grass quality and the plant height and plating ratio with green biomass yield was observed to be quite significant (r^2=.899**) (Table 8). A positive correlation was found between the rooting depth and the grass yield (r^2 = 0.94), indicating a strong and direct relationship between the root system and general green grass yield.

Perennial ryegrass (*Lolium perenne* L.), which is widely used in the world, is medium-textured, fringe-rooted, resistant to temperature,however, *Lolium perenne* L. and *Festuca rubra* L. thrive well in cooler climates.Arslan and Çakmakçı, 2004) inferred that *L. Perenne* Belrawo and Ovation varieties of different grass *Lolium perenne* species, *Festuca rubra* L. subsp. *rubra* Sch Franklin a and *Festuca arundinacea. Poa pratensis* and *Festuca rubra* new varieties are not similar in terms of numerous agro-botanical traits (Varoğlu *et al.,* 2015). Besides, in order to be acceptable in terms of color tone and grass quality in the grass plants, it has been pointed out that60 or 90 g m^2 of slow soluble nitrogen sources might be helpful (Bilgili & Acikgoz, 2005; Zanelli *et al.,* 2021).

Table 5. The seasonal leaf-length variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three seasons	
L. perenne	1.11 ghi	2.34	2.20 e	2.25	2.27 de	2.20	1.86 c	2.26 c
P. pratensis	1.47 fg	2.29	2.68 cd	2.58	3.01 bc	2.63	2.39 b	2.50 b
F. rubra rubra	0.98 hi	1.74	1.45 fg	1.58	1.61 f	1.47	1.35 de	1.60 d
F. rubra comutata	1.23 fghi	1.48	1.63 f	1.50	1.45 fg	1.71	1.44 de	1.56 d
F. rubra trichophylla	0.84 i	1.28	1.21 fghi	1.15	1.10 ghi	1.01	1.05 f	1.14 e
F. arundinacea	2.48 de	3.37	3.49 a	3.24	3.26 ab	3.06	3.07 a	3.22 a
F. ovina	1.12 ghi	1.31	1.28 fghi	1.25	1.30 fgh	1.25	1.23 ef	1.27 e
A. tenuis	1.13 ghi	2.27	1.25 fghi	2.24	2.26 de	2.34	1.54 d	2.28 bc
Means of seasons	1.30 b	2.01	1.90 a	1.97	2.03 a	1.96		

Table 6. The seasonal leaf-colour variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three seasons	
L. perenne	8.7	8.7	8.3	8.3	8.3	8.3	8.4 a	8.4 ab
P. pratensis	8.3	8.0	8.0	7.7	8.3	7.3	8.2 a	7.7 bc
F. rubra rubra	8.6	8.3	8.7	8.3	8.0	8.0	8.4 a	8.2 ab
F. rubra comutata	8.3	8.3	8.7	8.0	8.3	8.0	8.4 a	8.1 abc
F. rubra trichophylla	8.7	8.3	8.7	8.0	7.7	8.0	8.3 a	8.1 abc
F. arundinacea	9.0	8.7	8.7	8.7	8.0	9.0	8.6 a	8.8 a
F. ovina	6.7	6.7	6.3	6.0	6.3	6.7	6.4 c	6.4 d
A. tenuis	7.7	7.0	7.3	7.7	7.0	7.0	7.3 b	7.2 cd
Means of seasons	8.3	8.0	8.1	7.8	8.1	7.8		

Table 7. The seasonal herbage quality variation of eight turfgrass species in both-year (2015-2016).

Turfgrass species	2015	2016	2015	2016	2015	2016	2015	2016
	Spring		Summer		Autumn		Species mean in all three season	
L. perenne	5.67 fg	9.00 a	7.00 cd	7.67 c	9.00 a	9.00 a	7.22 b	8.56 b
P. pratensis	3.33 kl	7.67 c	4.67 hi	8.00 bc	5.67 fg	7.67 c	4.56 de	7.78 c
F. rubra rubra	4.67 fg	8.67 ab	6.00 ef	8.67 ab	7.67 bc	9.00 a	6.11 c	8.78 ab
F. rubra comutata	5.00 gh	9.00 a	5.67 fg	7.67 c	7.67 bc	9.00 a	6.11 c	8.56 b
F. rubra trichophylla	4.67 hi	8.67 ab	5.67 fg	9.00 a	8.00 b	8.67 ab	6.11 c	8.78 ab
F. arundinacea	6.00 ef	9.00 a	9.00 a	9.00 a	9.00 a	9.00 a	8.00 a	9.00 a
F. ovina	3.67 jkl	7.33 c	4.33 hij	5.33 d	6.67 de	8.00 bc	4.89 d	6.89 d
A. tenuis	3.00 l	7.67 c	4.00 ijk	7.67 c	5.67 fg	7.67 c	4.22 e	7.67 c
Means of seasons	4.50 c	8.38 a	5.80 b	7.88 b	7.40 a	8.50 a		

Table 8. The correlation between characters of turfgrass species.

Studied characters	Turfgrass quality (1-9)	Leaf width (mm)	Plant height (cm)	Root depth (cm)	Covering ratio (%)	Green herbage yield (kg)
Leaf width (mm)	0.381**					
Plant height (cm)	0.782**	0.280**				
Root depth (cm)	0.647**	0.420**	0.670**			
Covering ratio (%)	0.813**	0.309**	0.851**	0.671**		
Green herbage yield (kg)	0.768**	0.205*	0.899**	0.667**	0.667**	
Leaf color (1-9)	0.165	0.147	0.252**	0.124	0.124	0.321**

** The correlation is important at the level of 0.01, * The correlation is important at the level of 0.05

Conclusion

The research findings of field trials were in accordance with the research hypothesis as results revealed that performance of the turfgrass *Festuca arundinacea* was superior in terms of the canopy covering rate, green herbage yield, plant height, root depth, leaf width, grass quality and greenness of leaf colour during three seasons of two consecutive years. It was followed by turfgrass species *Lolium perenne* and *Festuca rubra rubra*. While turfgrass species of *Festuca ovina* and *Agrostis tenuis* were found to be inferior concerning all parameters under study. Based on recorded findings, turfgrass species of *Festuca arundinacea*, *Lolium perenne* and *Festuca rubra rubra* may be recommended for obtaining higher green herbage yield and quality during all three seasons (spring, summer and autumn) under the agro-ecological condition of Iğdır, Turkey and other regions of the world having similar agro-climatic conditions.

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