THE IMPACT OF TURF COLORANTS AND OVERSEEDING PRACTICES ON THE DORMANT BERMUDA GRASS (*Cynodon dactylon* L.)

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Abstract. This research was carried out between May 2016 and February 2018 on the experimental field of Bayindir Vocational Training School at Ege University, Izmir, Turkey. The research study was a pioneer attempt in a Mediterranean area, conducted in two consecutive steps. In the first step, turf color performances of five different turf colorants were tested on a dormant Bermuda grass (*Cynodon dactylon* L.) stand. Dormant Bermuda grass was overseeded with eleven different varieties of cool-season turf grasses in the second step of the study and color, texture and turf quality traits together with the rate of weed invasion and cover were determined. As the results of the study, SP Green, Ecolor Koyu and Ecolor Acik were identified as the brands demonstrating the greatest visual impact on the plots where the turf colorants were applied. Additionally, *Poa pratensis* cultivars were found to be completely inadequate among the tested varieties to compete with Bermuda grass during the summer months, *Agrostis stolonifera* demonstrated the most successful performance in the second year compared to other cool-season turf cultivars tested in the research.
Keywords: *bermudagrass, cool-season turf grass, turf quality, dormancy, turf management, overseeding*

Introduction

In the Mediterranean climate zone, high temperatures and drought stresses affect cultivated plants significantly. The turf grass species used in landscape projects should be selected in accordance with the ecological requirements. *Cynodon dactylon*, *Cynodon transvaalensis*, *Zoysia japonica*, *Paspalum vaginatum*, *Stenotahrum secundatum* and *Buchleo dactyloides* turf species are often favoured for this purpose due to their high drought resilience and dense coverage. On the other hand, these species go into dormancy in winter and lose their green appearance until the arrival of spring, an aspect which is considered undesirable for aesthetic purposes (Salman and Avcioglu, 2010; Kir et al., 2019).

Turf managers have traditionally overseeded bermudagrass during the fall to maintain a playable desirable and aesthetically appealing turf surfaces throughout the dormancy. This goal, however, is achieved with some difficulty. Maintenance throughout the winter and transitioning the playing surface from a cool-season grass back to a warm-season grass can be challenging. However, overseeding is not the only way to maintain a green turf during the winter. Applying colorant to dormant Bermuda grass is an alternative to overseeding during winter. Although turf colorants are a cost-effective alternative to overseeding, in addition to providing green color, turf colorants absorb heat which helps Bermuda grass emerge from dormancy earlier in the spring. However, there is limited information available about colorant brands and appropriate application rates.

For turf managers in the transition zone, overseeding warm-season grasses with a cool-season species is a common practice to maintain aesthetics and playability during the winter season (Mazur and Rice, 1999). Many golf course superintendents and sports

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turf managers rely on this cool-season species for color while Bermuda grass is dormant in late fall, winter and early spring. In the spring, as soil temperatures warm and Bermuda grass resumes growth, cool-season turfgrass are removed by herbicide or by cultural practices such as low mowing, nitrogen fertilization, core aerification, dethatching, topdressing and dragging, which favour the growth and competitiveness of Bermuda grass.

One of the aims of this study was to investigate the effects of some different turf colorants on Bermuda grass stands, to evaluate the turf performances of some cool-season turf species practised in overseeding in autumn, winter and spring period and to determine which cultivars gave successful results in the second year as a result of cool-season grass competition with Bermuda grass (*Cynodon dactylon* L.) in the summer period.

Materials and Methods

The research was conducted in an open research field of Ege University’s Bayindir Vocational Training School situated in Izmir, Turkey, (38º20.12’N- 27º67.14’E) at an altitude of 105 metres. The study field was arranged in May 2016 and observations continued until February 2018. The research field was under the effect of typical Mediterranean ecology (*Table 1*). The climatic data indicates that the precipitation levels from May to September were insufficient for the development of turfgrasses. Before seedbed preparation, the experimental plots were equipped with a permanent water pipeline system based on rotary sprinklers. During the summer season, supplemental sprinkler irrigation has been carried out when necessary to prevent visual wilt of the turf. The irrigation was achieved every morning based on 7 – 10 mm/m^2 approximately.

Table 1. *Climatic data of research years and long year averages*

Months	2016			2017			2018			1980-2016		
	TP (mm)	MT (ºC)	ARH (%)	TP (mm)	MT (ºC)	ARH (%)	TP (mm)	MT (ºC)	ARH (%)	TP (mm)	MT (ºC)	ARH (%)
Jan.	-	-	-	206.4	5.4	80.5	106.5	7.3	83.7	125.0	8.4	69.3
Feb.	-	-	-	20.6	8.9	77.0	103.8	10.9	86.7	72.5	8.5	64.4
Mar.	-	-	-	38.9	12.4	76.2	90.1	14.1	75.6	100.9	11.4	60.6
Apr.	-	-	-	56.8	16.0	65.5	12.6	20.0	62.6	64.0	15.0	57.2
May	-	-	-	18.1	21.2	59.6	63.8	23.2	61.8	42.1	20.0	52.1
June	-	-	-	44.7	26.0	57.0	-	-	-	5.2	25.6	40.9
July	-	-	-	0.0	29.8	44.7	-	-	-	6.8	27.4	37.9
Aug.	2.1	29.5	52.4	2.8	29.5	48.8	-	-	-	1.4	27.0	40.9
Sep.	38.7	24.3	54.3	1.2	24.1	54.8	-	-	-	4.8	24.1	4.6
Oct.	0.4	18.4	64.3	43.5	17.8	64.9	-	-	-	21.5	20.3	49.6
Nov.	70.2	12.1	73.1	59.2	11.8	78.7	-	-	-	89.4	13.5	58.9
Jan.	12.7	5.2	72.7	95.3	10.3	85.0	-	-	-	176.1	10.6	67.4
X/∑				587.5	17.8	66.1				709.7	17.7	53.7

TP: total precipitation MT: mean temperature; ARH: average relative humidity; X/∑: mean/total

The research field soil was analysed in terms of physical and chemical properties through the soil analysis laboratory of Ege University, Plant Nutrition and Soil Department Laboratory (*Table 2*). The results indicated that the soil characteristics were aligned with most specifications for grass growth except K, Ca, Mg and Zn content which were at amounts slightly below the required concentrations.

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Table 2. *Soil characteristics of the research field*

Soil Characteristics	Sample Depth (cm)		Soil Characteristics (ppm)	Sample Depth (cm)	
	0-20	**20-40**		**0-20**	**20-40**
pH	5.83	7.43	Available P	2.54	0.88
Total Salinity (%)	0.030	0.030	Available K	40	150
$CaCO_3$ (%)	0.82	2.27	Available Ca	1300	2400
Sand (%)	80.16	73.84	Available Mg	34	174
Silt (%)	18.00	20.72	Available Na	60	40
Clay (%)	1.84	5.44	Available Fe	12.75	11.6
Texture	Loam	Loam	Available Cu	0.35	0.54
Org. Material (%)	2.27	0.83	Available Zn	0.28	0.74
Total N (%)	0.092	0.050	Available Mn	6.84	5.04

The base warm-season turfgrass for the research was Bermuda grass (*Cynodon dactylon* L.) cultivar 'Tifsport'. Over seeded cool-season turfgrasses were *Lolium perenne* 'Sun', 'Double', 'Stolawn', 'Ringles' and 'Strawinsky'; *Festuca arundinacea* 'Lexington' and 'Titanium LS'; *Poa pratensis* 'SR 2100' and 'Evora' and *Agrostis stolonifera* '007' and 'Cobronova' were sown. The overseeding research pattern was a randomized block design with four replications. In total 44 (11×4) plots were arranged; each plot was 2 m^2 (1 m × 2 m), totalling 88 m^2. There was 50 cm distance between the plots; the total research area being 178.5 m^2.

The soil was prepared and Bermuda sod was laid in May 2016. In October, the turf was deeply mowed and verticutting was applied before overseeding. Sowing rates were 50 g/m^2 for *Lolium perenne* and *Festuca arundinacea*, 20 g/m^2 for *Poa pratensis* and 10 g/m^2 for *Agrostis stolonifera*. *Poa pratensis* and *Agrostis stolonifera* due to their small seed sizes they were sown with sand without top dressing, while *L. perenne* and *F. arundinacea* seeds were top dressed and rolled firmly. For ant control, Pestban 2 Dust (2% chlorpyrifos) was applied. The plots were irrigated by sprinkling when necessary.

The turf colorants practised on the turf plots included both foreign (SP Green, Ever Green, Grassline) and domestic (Ecolor Koyu, Ecolor Acik) brands. The turf colorant experiment was conducted in a randomized block design with four replications; composed of 24 (6×4) plots including control plots. Each plot was 1 m × 2 m = 2 m^2, totalling 48 m^2.

The turf colorants were applied in 03 December 2016 when the Bermuda grass was fully dormant. The consistencies of the colorants were arranged in accordance with the brand instructions for 8 m^2. Grassline (1.5 liter colorant + 7.5 liter water + surfactant = 9 liter), SP Green (1.5 liter colorant + 6 liter water + surfactant = 7.5 liter), Ecolor Koyu (1 liter colorant + 6 liter water + surfactant = 7 liter), Ecolor Acik (1 liter colorant + 6 liter water + surfactant = 7 liter) and Ever Green (1 liter colorant + 7 liter water + surfactant = 8 liter) were used as indicated.

Before the overseeding, Inpul 75 WG herbicide (60 g/ha dose + 45 L water) was applied to the Nut Grass (*Cyperus rotundus*). After the overseeding, Entec 26 (26% N – 31% S) fertilizer was added (5 g/m^2 N) monthly. Finally, from May onwards, Malvin XL 035 FS fungicide was used (2500 cc/ha) to control *Pythium* infection. Mowing was carried out weekly to a height of 2.5 cm while paths were cut to 1 cm. Throughout the research study, the following traits were determined on both the individual plants and plots as a whole.

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FieldScout GreenIndex+ Turf App was used to monitor the effects of turf colorants between December and March. For the overseeding experiment, color tests were carried out on a scale of 1 to 9 with 1 indicating yellow, 3 light yellowish-green, 5 green, 7 dark green and 9 very dark green (Morris and Shearman, 1998). The observations were repeated monthly between December and April, and again in July, October and February.

By examining leaf texture, measurements were taken monthly between December and April, then again in July and October. The visual rating of texture was based on a 1 to 9 rating scale with 1 equalling fine and 9 equalling coarse. General appearance scores were classified on a scale of 1-9 with 1 being very unpleasant and 9 very pleasant (Morris and Shearman, 1998). Weeds were scored on a scale of 1 to 9, with 1 indicating an excessive amount of weed invasion and 9 complete absences (Beard, 1973). Covers were scored on a scale of 1 to 9, with 1 being very sparse and 9 very dense.

Statistical analysis was conducted by using TOTEM STAT Statistical program (Acikgoz et al., 2004). The randomised complete block design of the overseeding experiment was evaluated with two replications and with a single replication for the turf colorant experiment. Probabilities equal to or less than 0.05 were considered significant. If, TOTEM STAT indicated differences between treatment means an LSD test was performed to separate them.

Results and Discussion

Color

The color values of each turf colorant are given below (*Table 3*). The turf colorant, month and turf colorant x month interactions were statistically significant.

Table 3. *Color values (1-9 point scale) of turf colorants on dormant Bermuda grass*

Turf Colorants	Color (2016 – 2017)				
	December	**January**	**February**	**March**	**Mean**
Grassline	7.6 d	4.7 e	4.5 d	4.8 c	5.41 e
SP Green	10.0 b	9.9 a	8.7 a	9.1 a	9.22 a
Ecolor Koyu	10.4 a	8.7 b	8.3 b	8.3 b	8.93 b
Ecolor Acik	9.8c	8.1 c	7.8 c	8.3 b	8.51 c
Control plot	1.6 e	1.5 f	1.4 f	3.4 e	1.97 f
Ever Green	10.2 b	5.0 d	3.5 e	3.9 d	5.66 d
Mean	8.27 a	6.32 b	5.70 b	6.30 c	
LSD (5%)	turf colorant: 0.07 month: 0.06 turf colorant x month: 0.15				

The results showed that mean highest color value was reached in December (8.27), with SP Green (9.22) and followed by Ecolor Koyu (8.93) displaying the highest scores for individual turf colorants. In comparison, the lowest mean color value was recorded in February (5.70) while the control plot means (1.97) showed a significantly lower score than plots with turf colorants. In the study, color values of the plots applied turf colorants were higher than those of control plots in March (*Table 3*).

Ratings for colorant-treated turf plots declined with time but were always better than the untreated control (Younger and Fuchigami, 1958) observed a similar response on Bermuda grass (*Cynodon dactylon*) colorant studies conducted in California. Untreated control Bermuda grass remained straw brown during the study. Turfgrass colorant

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treatments improved visual quality ratings when compared to the untreated control. The color value is a significant criterion for turf swards, whereas due to the agronomical and physiological features visual quality is also important (Williems et al., 1993; Braun et al., 2015). The turf colorants practised in this experiment was successful in improving the visual appearance of the turf surfaces although some color degradation did take place by the time. These findings were similar to the results of studies of (Sherman et al., 2005; Briscoe et al., 2010; Braun et al., 2017; Biber and Gokkus, 2020).

Bermuda grass is usually overseeded in the fall with perennial ryegrass or other cool-season grasses to provide green color, a uniform surface, and tolerance to wear while it is dormant. The color values of 11 different cool-season turfgrass cultivars overseeded on Bermuda grass is given in *Table 4* and *Figure 1*. The results indicated that the cultivar, month and cultivar x month interaction were statistically significant. The highest mean color value was achieved equally by the *Lolium perenne* cultivars, 'Sun', 'Ringles' and 'Strawinsky' (7.0), whereas the lowest mean color value was detected on the *Poa pratensis* cv. 'Evora' (6.1). The highest color value was also obtained in April (9.0) and the lowest in February in the second year (2.6).

Table 4. *Color values (1-9 point scale) of cool-season turfgrass cultivars overseeded on Bermuda grass*

		2016			**2017**				**2018**	
	Cultivars	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**July**	**Oct.**	**Feb.**	**Mean**
Lolium perenne	Sun	8.0 a	7.7 b	7.9 b	8.7 b	9.0 a	7.8 a	6.0 e	1.2 f	7.0 a
	Double	7.9 b	7.8 a	7.8 c	7.8 g	7.8 f	7.6 c	6.0 e	1.2 f	6.7 b
	Stolawn	7.3 e	7.5 c	7.5 d	7.6 h	7.0 g	7.6 c	6.0 e	1.2 f	6.4 d
	Ringles	7.8 c	7.4 d	8.0 a	8.8 a	9.0 a	7.7 b	6.0 e	1.2 f	7.0 a
	Strawinsky	8.0 a	7.7 b	8.0 a	8.2 d	8.6 b	7.8 a	6.0 e	1.6 d	7.0 a
Festuca arundinacea	Lexington	7.6 d	4.6 i	7.2 e	8.4 c	9.0 a	7.5 d	6.2 d	1.2 f	6.5 c
	Titanium LS	7.3 e	4.3 j	7.0 f	8.0 e	8.5 c	7.5 d	6.4 c	1.4 e	6.3 e
Poa pratensis	SR 2100	6.0 f	5.4 e	7.5 d	7.9 f	8.2 d	7.6 c	6.2 d	3.0 c	6.5 c
	Evora	6.0 f	5.3 g	7.2 e	7.6 h	8.0 e	7.6 c	6.0 e	1.0 g	6.1 f
Agrostis stolonifera	007	5.0 g	5.0 g	6.8 g	6.8 I	6.6 h	7.8 a	6.8 a	8.2 a	6.6 c
	Cobronova	5.0 g	4.9 h	6.5 h	6.4 j	6.4 i	7.7 b	6.5 b	7.0 b	6.3 e
	Mean	6.9 e	6.1 f	7.4 d	7.8 b	8.0 a	7.7 c	6.2 g	2.6 h	-
	LSD (5%)	cultivar: 0.02			month: 0.02		cultivar x month: 0.06			

Figure 1. *General view of the overseeded trial area in March 2017*

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The weather temperature rising above 10 ºC breaks winter dormancy and encourages green tissue development of Bermuda grass (Beard, 1973; Acikgoz, 1994; Avcioglu, 1997). The Bermuda grass emerging from dormancy in May affected the results obtained in July and October. The cool-season turfgrasses were less capable of competing with Bermuda grass during the summer season and by winter in the second year; many cultivars had been rendered almost absent in their plots. However, the average score for *Agrostis stolonifera* '007' (8.2) and 'Cobronova' (7.0) appeared to demonstrate that they were the most resilient of the cultivars surviving the competition period and performing the highest color values in October and February.

Turf color, being indicative of the healthy development of turf crops and the ratio of high photosynthetic activity, is a convenient feature for evaluating the turfs (Martiniello and Andrea, 2006). For this reason, the green color tone increases rapidly in the plants that are able to perform optimum growth and development, which is especially important for turf grasses (Beard, 1973; Avcioglu, 1997). Our turf color results were confirmed by Rossini et al. (2019) and Volterrani and Magni (2004a,b)'s findings.

Texture

The "texture" feature of turfs is symbolized by the width of the leaf blades of turf grasses (Beard, 1973), is a feature that enhances the appearance of the turf plots and exhibits the "fine" texture structure in narrow-leaved grasses. A medium-fine to medium texture, ranging from 1.5 to 3 mm in width is generally preferred for most turf grass uses (Beard, 1973). The texture scores of eleven different cool-season turfgrass cultivars overseeded on Bermuda grass are given in *Table 5*. The results indicated that the cultivar, month and cultivar x month interactions were statistically significant. The highest texture value was observed on *Festuca arundinacea* 'Lexington' and 'Titanium LS' (6.5) plots which compared to the considerably lowest texture value of *Agrostis stolonifera* cultivars (4.1-4.2). The peak mean value was obtained in March and April (6.3) as a result of this favourable vegetation season, while the lowest mean value was recorded in July (3.1) and October (2.4) due to the influence of Bermuda grass which was dominantly present throughout the summer season.

Table 5. *Texture values (1-9 point scale) of cool-season turfgrass cultivars overseeded on Bermuda grass*

		2016	2017						
	Cultivars	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**July**	**Oct.**	**Mean**
Lolium perenne	Sun	4.3 d	4.4 c	5.2 f	5.3 g	5.3 g	3.0 c	2.5 a	4.3 c
	Double	4.5 b	4.5 b	5.4 e	5.4 f	5.5 f	3.0 c	2.5 a	4.4 b
	Stolawn	4.4 c	4.4 c	5.2 f	5.3 g	5.3 g	3.0 c	2.5 a	4.3 c
	Ringles	4.2 e	4.4 c	5.0 g	5.1 h	5.1 h	3.0 c	2.5 a	4.2 d
	Strawinsky	4.2 e	4.4 c	4.9 h	5.1 h	5.1 h	3.0 c	2.5 a	4.2 d
Festuca arundinacea	Lexington	6.5 a	7.2 a	8.0 a	8.9 a	9.0 a	3.4 a	2.5 a	6.5 a
	Titanium LS	6.5 a	7.2 a	8.0 a	8.9 a	8.9 b	3.4 a	2.5 a	6.5 a
Poa pratensis	SR 2100	3.2 f	4.3 d	5.5 d	6.1 e	6.2 e	3.2 b	2.5 a	4.4 b
	Evora	3.0 g	4.1 e	5.5 d	6.2 d	6.2 e	3.2b	2.5 a	4.4 b
Agrostis stolonifera	007	2.3 h	2.8 f	6.0 c	6.4 c	6.4 d	2.8 d	2.0 c	4.1 e
	Cobronova	2.3 h	2.8 f	6.2 b	6.6 b	6.6 c	3.0 c	2.3 b	4.2 d
	Mean	4.1 d	4.6 c	5.9 b	6.3 a	6.3 a	3.1 e	2.4 f	-
	LSD (5%)	cultivar: 0.03		month: 0.02		cultivar x month: 0.07			

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It was concluded that there are texture differences among the varieties of different cool-season turfgrass types tested in the study. *Festuca arundinacea* has genetically a rough or moderately rough texture depending on the different cultivars. It is a coarse or rough textured grass which displayed clearly these characteristics mentioned in this part of our study. Avcioglu (1997) and Volterrani and Magni (2004a) stated that new *Festuca arundinacea* cultivars with fine texture were improved in many countries since old rough-textured *Festuca arundinacea* cultivars were not being required by customers. Our texture score results were similar to the results of Baker and Jung (1968), Avcioglu (1997) and Salman et al. (2019).

Turf Quality

Since the warm-season turfgrasses are in yellowish-brown-coloured during dormancy period in winter, only the data collected in autumn-winter-spring seasons. The turf quality trait as the composite of colour, uniformity and texture traits is a widely used criterion to define the overall performances of turfs in turf management practices. The turf quality values of eleven different cool-season turfgrass cultivars overseeded on Bermuda grass are given in *Table 6*. The results indicated that the cultivar, month and cultivar x month interaction were statistically significant.

Table 6. *Turf quality (1-9 point scale) values of cool-season turfgrass cultivars overseeded on Bermuda grass*

		2016	**2017**						**2018**	
	Cultivars	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**July**	**Oct.**	**Feb.**	**Mean**
Lolium perenne	Sun	7.4 a	7.5 b	8.0 a	8.7 a	9.0 a	8.4 b	7.2 c	1.2 e	7.2 a
	Double	7.4 a	7.6 a	7.8 b	8.7 a	9.0 a	8.2 c	7.2 c	1.2 e	7.1 b
	Stolawn	7.4 a	7.6 a	7.8 b	8.5 c	8.7 c	8.2 c	7.2 c	1.2 e	7.1 b
	Ringles	7.3 b	7.5 b	8.0 a	8.7 a	9.0 a	8.2 c	7.2 c	1.4 d	7.2 a
	Strawinsky	7.4 a	7.6 a	8.0 a	8.6 b	8.3 d	8.4 b	7.2 c	1.4 d	7.1 b
Festuca arundinacea	Lexington	5.6 c	5.8 c	6.7 c	8.2 d	9.0 a	8.0 d	7.2 c	1.2 e	6.5 e
	Titanium LS	5.5 d	5.7 d	6.6 d	8.2 d	8.9 b	8.0 d	7.2 c	1.2 e	6.4 f
Poa pratensis	SR 2100	4.3 g	4.5 g	4.5 g	6.6 g	7.2 g	8.0 d	7.2 c	2.5 c	5.6 g
	Evora	4.0 h	4.1 h	4.2 h	6.0 h	6.2 h	8.0 d	7.2 c	1.1 f	5.1 h
Agrostis stolonifera	007	4.4 f	4.6 f	5.4 f	7.7 e	8.2 e	8.5 a	8.0 a	7.8 a	6.8 c
	Cobronova	4.6 e	4.8 e	5.6 e	7.5 f	7.6 f	8.4 b	7.6 b	6.5 b	6.6 d
	Mean	5.9 g	6.1 f	6.6 e	7.9 c	8.3 a	8.2 b	7.3 d	2.4 h	-
	LSD (5%)	cultivar: 0.03			month: 0.03			cultivar x month: 0.08		

The results revealed that the highest value was obtained in *Lolium perenne* 'Sun' (7.2) and 'Ringles' (7.2) compared to the lowest valued *Poa pratensis* 'Evora' (5.1) and 'SR 2100' (5.6) both of which displayed scores below the acceptable level. Similarly, the appearance value peaked in April (8.3) and decreased in February (2.4) in the second year.

In December 2016, the turf quality values of the varieties of *Lolium perenne* and *Festuca arundinacea*, which had larger seeds, were higher than the varieties of other species. Turf quality values of all varieties increased until April while Bermuda grass became dormant in July, the grass quality values of all plots were close to each other. In February 2018, highest quality values were recorded in *Agrostis stolonifera* varieties. All overseeded cool-season grasses lost competition with Bermuda grass during the summer

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period and could not exist in plots by the second year, except *Agrostis stolonifera* cultivars.

When the total turf quality data of the first year of the study were evaluated, *Lolium perenne* cv. and *Festuca arundinacea* cv. displayed much better performance than the *Poa pratensis* cultivars.

Weed Invasion

The weed invasion scores of cool-season turf cultivars overseeded on Bermuda grass is given in *Table 7*. The results indicated that the cultivar, month and cultivar x month interactions were statistically significant.

Table 7. *Weed invasion (1-9 point scale) values on cool-season turfgrass cultivars on Bermuda grass stand*

		2016	2017					2018	
	Cultivars	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**July**	**Oct.**	**Feb.**	**Mean**
Lolium perenne	Sun	9.0 a	9.0 a	8.8 b	9.0 a	9.0 a	8.9 b	9.0 a	8.8 c	8.9 b
	Double	9.0 a	9.0 a	8.9 a	9.0 a	9.0 a	8.9 b	9.0 a	8.8 c	8.9 b
	Stolawn	9.0 a	9.0 a	8.9 a	9.0 a	9.0 a	8.9 b	9.0 a	8.9 b	9.0 a
	Ringles	9.0 a	9.0 a	8.8 b	9.0 a	9.0 a	8.9 b	9.0 a	8.8 c	8.9 b
	Strawinsky	9.0 a	9.0 a	8.5 e	8.9b	8.8 b	9.0 a	9.0 a	8.8 c	8.9 b
Festuca arundinacea	Lexington	9.0 a	9.0 a	8.9 a	9.0 a	9.0 a	9.0 a	9.0 a	8.8 c	9.0 a
	Titanium LS	9.0 a	9.0 a	8.9 a	9.0 a	9.0 a	9.0 a	9.0 a	8.8 c	9.0 a
Poa pratensis	SR 2100	9.0 a	9,0 a	8.6 d	8.5 c	8.3 c	9.0 a	9.0 a	8.8 c	8.7 c
	Evora	9.0 a	9.0 a	8.2 f	7.9 d	6.1 d	9.0 a	9.0 a	8.8 c	8.4 d
Agrostis stolonifera	007	9.0 a	9.0 a	8.9 a	9.0 a	9.0 a	8.9 b	9.0 a	9.0 a	9.0 a
	Cobronova	9.0 a	9.0 a	8.7 c	9.0 a	9.0 a	9.0 a	9.0 a	8.9 b	8.9 b
	Mean	9.0 a	9.0 a	8.7 d	8.8 c	8.7 d	8.9 b	9.0 a	8.8 c	-
	LSD (5%)	cultivar: 0.02			month: 0.02		cultivar x month: 0.07			

The mean weed invasion value (8.4-9.0) of cool-season grass cultivars was significant. *Lolium perenne* ‘Stolawn’, *Festuca arundinacea* ‘Lexington’ and ‘Titanium LS’ and *Agrostis stolonifera* ‘007’ plots contained the highest weed invasion scores (9.0) while *Poa pratensis* ‘Evora’ had the lowest (8.4). The peak mean value (9.0) was reached in December, February and October while the lowest mean value was recorded in February and April (8.7). Overall results were found to be rather high. Since the weed presence on lawns is an undesirable trait, only turf species capable of competing successfully with weeds can sustain the desirable turf appearance (Avcioglu, 1997; Salman et al., 2011). The weed infestation data of the cultivars used in the study were generally high. The dense texture of bermudagrass during summer period and its high competitive capacity contributed these results. Cover data of different cool-season grass cultivars tested in the study also supports our findings here.

Cover

The cover scores of 11 different cool-season turfgrass cultivars overseeded on Bermuda grass are given in *Table 8*. The results displayed that the cultivar, month factors and the cultivar x month interaction were statistically significant.

The cover scores were recorded for 8 different months. *Lolium perenne* ‘Sun’, ‘Double’ and ‘Stolown’ cultivars reached the highest value as 7.7, while *Poa pratensis* ‘Evora’ (5.7) and ‘SR 2100’ (6.0) demonstrated the lowest.

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Table 8. *Cover values (1-9 point scale) of cool-season turfgrass cultivars overseeded on Bermuda grass*

		2016			2017				2018	
	Cultivars	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**July**	**Oct.**	**Feb.**	**Mean**
Lolium perenne	Sun	8.1 b	8.2 b	8.3 c	8.6 b	9.0 a	9.0 a	9.0 a	1.2 e	7.7 a
	Double	8.4 a	8.4 a	8.4 b	8.6 b	9.0 a	9.0 a	9.0 a	1.2 e	7.7 a
	Stolawn	8.0 c	8.4 a	8.5 a	8.7 a	9.0 a	9.0 a	9.0 a	1.2 e	7.7 a
	Ringles	7.7 d	8.2 b	7.7 e	8.6 b	9.0 a	9.0 a	9.0 a	1.4 d	7.6 b
	Strawinsky	7.5 e	7.7 c	8.0 d	8.6 b	9.0 a	9.0 a	9.0 a	1.4 d	7.5 c
Festuca arundinacea	Lexington	5.5 g	6.7 e	6.9 g	8.2 d	9.0 a	9.0 a	9.0 a	1.2 e	6.9 d
	Titanium LS	5.6 f	6.7 e	6.9 g	8.2 d	9.0 a	9.0 a	9.0 a	1.2 e	6.9 d
Poa pratensis	SR 2100	2.5 j	4.8 g	5.6 h	7.2 e	7.5 d	9.0 a	9.0 a	2.4 c	6.0 e
	Evora	2.5 j	4.6 h	5.3 i	7.1 f	7.2 e	9.0 a	9.0 a	1.0 f	5.7 f
Agrostis stolonifera	007	3.5 i	6.2 f	7.3 f	8.4 c	8.8 b	9.0 a	9.0 a	8.0 a	7.5 c
	Cobronova	5.0 h	6.8 d	7.7 e	8.2 d	8.6 c	9.0 a	9.0 a	6.5 b	7.6 b
	Mean	5.8 f	7.0 e	7.4 d	8.2 c	8.6 b	9.0 a	9.0 a	2.4 g	-
	LSD (5%)	cultivar: 0.03			month: 0.03		cultivar x month: 0.09			

The cover scores varied between 2.4 and 9.0 during 8 months while only *Agrostis stolonifera* was able to compete with Bermuda grass during summer and produce sufficient cover for the second year of the experiment. *Lolium perenne* and *Festuca arundinacea* cultivars with their large seeds were advanced in early sprouting and high tillering stage which allowed them to cover the ground rather rapidly (Salman et al., 2019). These findings were similar to the comments of Acikgoz (1994), Deniz (2018) and Salman et al. (2019). Barton (1997) stated that *Lolium perenne* establishes very rapidly and is included in grass mixtures to provide a quick cover. Many research workers, studying under Mediterranean conditions reported that *Lolium perenne* is a proper turf grass to be included in mixtures (Beard, 1973; Acikgoz, 1994; Avcioglu, 1997; Biber and Gokkus, 2020).

In the first year of the study, the development of *Poa pratensis* cv. and *Agrostis stolonifera* cv. were slow to develop, so they maintained low levels of cover trait. While varieties of *Poa pratensis* exceeded 7 points in March, *Agrostis stolonifera* cultivars reached these scores in February. When the cover data of February in the second year of the study were examined, we determined that all other varieties except *Agrostis stolonifera* were very low in performance. In the second year of the study, cultivar 007 variety of *Agrostis stolonifera* showed much better cover score.

Conclusions

The color values of all turf colorants were sufficient when compared to the control plots and they (SP Green, Ecolor Koyu and Ecolor Acik) all sustained their color successfully. The color values of *Festuca arundinacea*, *Lolium perenne* and *Poa pratensis* were higher than *Agrostis stolonifera* which was more successful in spring than in winter. The textures of all the cool-season turfgrasses were found to be coarse, showing the highest value with *Festuca arundinacea* cultivars. Turf quality value was high in spring, except *Poa pratensis* cultivars. *Lolium perenne* and *Festuca arundinacea* demonstrated the most successful cover in spring while *Poa pratensis* cultivars had limited performance. *Lolium perenne* and *Festuca arundinacea* cultivars demonstrated

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the most successful recovery performance. *Agrostis stolonifera* cultivars performed well at competing with Bermuda grass over the summer and had higher thinning scores.

We are suggesting applying turf colorant will reduce costs and increase the performance of coloring in harsh conditions and growth difficulties. Besides, we recommend performing *Agrostis stolonifera* cultivation could enhance covering and decrease numerous times of cultivations and application costs annually.

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