Establishment and Turf Qualities of Warm-season Turfgrasses in the Mediterranean Region

S. Severmutlu^{1,8}, N. Mutlu², R.C. Shearman³, E. Gurbuz⁴, O. Gulsen⁵, M. Hocagil⁶, O. Karaguzel¹, T. Heng-Moss⁷, T.P. Riordan³, and R.E. Gaussoin³

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SUMMARY. Warm-season turfgrasses are grown throughout the warm humid, sub-humid, and semiarid regions. The objective of this study was to determine the adaptation of six warm-season turfgrass species and several of their cultivars to Mediterranean growing conditions of Turkey by evaluating turfgrass establishment rate, quality, color, and percentage of turfgrass cover. Information of this nature is lacking and would be helpful to turfgrass managers and advisers working in the region. A study was conducted over a 2-year period in two locations of the Mediterranean region of Turkey. The warm-season turfgrass species studied were bermudagrass (*Cynodon dactylon*), buffalograss (*Buchloe dactyloides*), zoysiagrass (*Zoysia japonica*), bahiagrass (*Paspalum notatum*), seashore paspalum (*Paspalum vaginatum*), and centipedegrass (*Eremochloa ophiurioides*). Tall fescue (*Festuca arundinacea*) was included as a cool-season turfgrass species for comparison. Twenty cultivars belonging to these species were evaluated for their establishment, turfgrass color and quality, spring green-up, and fall color retention. Bermudagrass, bahiagrass, and seashore paspalum established 95% or better coverage at 1095 growing degree days [GDD (5 °C base temperature)], buffalograss and centipedegrass at 1436 GDD, and ‘Zenith’ and ‘Companion’ Zoysiagrass had 90% and 84% coverage at Antalya after accumulating 2031 GDD. ‘Sea Spray’ seashore paspalum; ‘SWI-1044’, ‘SWI-1045’, ‘Princess 77’, and ‘Riviera’ bermudagrass; ‘Cody’ buffalograss; and ‘Zenith’ zoysiagrass exhibited acceptable turfgrass quality for 7 months throughout the growing season. ‘Argentine’ and ‘Pensacola’ bahiagrass; ‘Sea Spray’ seashore paspalum; and ‘SWI-1044’ and ‘SWI-1045’ bermudagrass extended their growing season by retaining their green color 15 days or longer than the rest of the warm-season cultivars and/or species in the fall. The warm-season species stayed fully dormant throughout January and February. Zoysiagrass and buffalograss cultivars showed early spring green-up compared to the other warm-season species studied. Results from this study support the use of warm-season turfgrass species in this Mediterranean region, especially when heat stress and water limitations exist. Tall fescue did not survive summer heat stress necessitating reseeding in fall.

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¹Department of Landscape Architecture, University of Akdeniz, Antalya, Turkey

²Department of Agricultural Biotechnology, University of Akdeniz, Antalya, Turkey

³Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE

⁴Bati Akdeniz Agricultural Research Institute, Antalya, Turkey

⁵Department of Horticulture, Erciyes University, Kayseri, Turkey

⁶Alata Horticultural Research Institute, Mersin, Turkey

⁷Department of Entomology, University of Nebraska, Lincoln, NE

⁸Corresponding author. E-mail: songulmutlu@akdeniz.edu.tr.

Traditionally cool-season turfgrasses such as perennial ryegrass (*Lolium perenne*), tall fescue, and kentucky bluegrass (*Poa pratensis*) are the dominant species used as turf in the Mediterranean region of Turkey and in similar regions of neighboring countries (Croce et al., 2001; Volterrani et al., 1997). The

cool-season species, like tall fescue, require significant amounts of water and fertilizer for a green, dense stand (Bormann and Balmori, 1993). There is a dearth of information available in the literature on warm-season turfgrass species adaptation and use in this region. Urbanization, tourism, intensive agricultural use, and global warming have strained available water resources on a worldwide basis (Isendahl and Schmidt, 2006), often necessitating the selection and use of water-use efficient warm-season turfgrass species. The warm-season species require ≈45% less water (Brian et al., 1981), exhibit greater drought tolerance (Beard, 1989), and possess a higher nitrogen (N) use efficiency under a wide range of adaptation to soil conditions, ranging from sand to clay soils, depending on the species (Moore et al., 2004; Wedin, 2004). Many warm-season grasses including bermudagrass, buffalograss, zoysiagrass, centipedegrass, seashore paspalum, bahiagrass, and st. augustinegrass are used as turfgrasses, and they may be well adapted for use in the Mediterranean region. However, limited studies have been conducted regarding warm-season turfgrass adaptation to the Mediterranean region (Croce et al., 2001; Geren et al., 2009; Volterrani et al., 1997), and more information on warm-season turfgrass species and cultivar adaption is needed. In these studies, contrasting results were reported for some species depending on the place and experimental conditions. Geren et al. (2009) reported performance of zoysiagrass to be poor in western Turkey, whereas Volterrani et al. (1997) declared a good adaptability of this species in central Italy.

With these aspects in mind, this study was conducted to determine the adaptation of six warm-season turfgrass species and several of their cultivars to Mediterranean growing conditions by evaluating turfgrass establishment rate, quality, color, and

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
25.4	inch(es)	mm	0.0394
1	mmho/cm	dS·m ⁻¹	1
0.4470	mph	m·s ⁻¹	2.2369
305.1517	oz/ft ²	g·m ⁻²	0.0033
1	ppm	mg·kg ⁻¹	1
(°F - 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

percentage of turfgrass cover. Tall fescue, a commonly used cool-season turfgrass species, was included for comparison purposes.

Materials and methods

The study was conducted at two locations in Turkey, the West Mediterranean Agricultural Research Institute in Antalya (lat. 36°52'N, long. 30°43'E) and the Alata Horticultural Research Institute in Mersin provinces (lat. 36°37'N, long. 34°42'E). Soil on the Antalya site was a silty clay loam (Paralithic Xerortent) with a 1.4% organic matter (OM) content, electrical conductivity (EC) of 0.24 dS·m⁻¹, pH 8.4, phosphorus (P) level of 22 mg·kg⁻¹, and potassium (K) level of 117 mg·kg⁻¹. The Mersin site was a sandy soil (Typic Xerofluvent) with a 1.2% OM, EC of 0.17 dS·m⁻¹, pH 8.3, P level of 12 mg·kg⁻¹, and K level of 102 mg·kg⁻¹. Warm-season turfgrass species and cultivars studied were bermudagrass cultivars SWI-1044, Contessa (SWI-1045), Princess 77, Riviera, Mohawk, Sultan, NuMex Sahara, and Blackjack; buffalograss cultivars Cody, Bowie, SWI-2000, Bison and Texoka; zoysiagrass cultivars Zenith and Companion; bahiagrass cultivars Argentina and Pensacola; seashore paspalum cultivar Sea Spray; and centipedegrass cultivar Tifblair. 'Eldorado' tall fescue was included as a cool-season species.

The seeding rates of the species were 15 g·m⁻² for bermudagrass and buffalograss, 5 g·m⁻² for centipedegrass and seashore paspalum, 10 g·m⁻² for zoysiagrass, and 30 g·m⁻² for bahiagrass. The seeding dates were 15 July and 12 Aug. 2005 for the Mersin and Antalya locations, respectively. Tall fescue was seeded at 50 g·m⁻² on 15 Oct. at both locations. The experimental sites were raked and then rolled with a cultipacker after seeding to improve seed-to-soil contact. Irrigation was provided three times daily for 4 weeks at 7 mm to encourage germination and enhance establishment. Subsequently, turf was irrigated to prevent visual wilt symptoms. Starter fertilizer (15N-6.6P-12.5K) was applied at 5 g·m⁻² N at the time of seeding. After establishment, turfs received 17.5 g·m⁻² N per growing season with applications made as 5 g·m⁻² N in May, June, and July and 2.5 g·m⁻² N in August using a slow release (33N-0P-0K) fertilizer in both locations. In addition, 17.5 g·m⁻² K per season was applied along with the N for

the Mersin location. For tall fescue, applications were made as 5 g·m⁻² N in May, 2.5 g·m⁻² N in June, and 5 g·m⁻² N in October and November. Soil samples were taken in Apr. 2006 and 2007 before fertilizer applications, and soil tests indicated P (41 and 38 mg·kg⁻¹, respectively) and K (102 and 108 mg·kg⁻¹, respectively) levels in Antalya and P (12 and 28 mg·kg⁻¹, respectively) levels in Mersin were sufficient, whereas K (44 and 81 mg·kg⁻¹, respectively) levels in Mersin were not sufficient. Foliar sprays of 0.6 g·m⁻² ferrous sulfate (FeSO₄) were applied from mid-April to mid-October with a backpack sprayer in both locations to alleviate iron chlorosis. Plots were hand-weeded in both locations. Turfs were mowed weekly at 50 mm with clippings removed.

Turfgrass establishment, quality, color, and green cover were rated weekly from Aug. 2005 to May 2008. Turfgrass establishment, spring green-up, and percentage of turfgrass ground-cover were based on a visual estimate scale of 0% to 100%, where 0% = no green vegetation cover and 100% = 100% green vegetation cover. Spring green-up was measured until all species reached 100% green cover in the spring from March through May. Turfgrass quality ratings were based on National Turfgrass Evaluation Program (NTEP) guidelines using a 1–9 visual rating scale, where 1 = poorest, 6 = acceptable, and 9 = best (NTEP, 2010). Turfgrass color was based on a 1–9 visual rating scale, where 1 = straw brown, 6 = light green, and 9 = dark green. Quality ratings were based on combination of color, density, uniformity, texture, weed, and disease infestation or sensitivity to environmental stress. Each species had its own standard.

The climate for both locations was strongly Mediterranean with dry, hot summers and mild, wet winters. Mean monthly maximum and minimum air temperatures in °C were determined for each location (Table 1). Daily GDD were calculated for 18 weeks beginning with seeding days for both the Antalya and Mersin locations by subtracting a 5 °C base temperature from the difference of daily maximum and minimum temperatures (Frank et al., 1998; Gilmore and Rogers, 1958; Patton et al., 2004; Pruess, 1983; Unruh et al., 1996).

The experimental design was a split plot with species as whole-plot

treatments arranged in a randomized complete block and cultivars within species as subplots (Federer, 1955). Species within a replicate were randomized and cultivars were nested and randomized within species. The main plots were 5.5 × 12.5 m and subplots were 1.5 × 1.5 m with a 0.3 m bare soil alleyway between each plot. Hartley's F max test (Hartley, 1950) was performed to determine homogeneity of variance between the first and second year and between the Antalya and Mersin locations. Treatment differences were tested using analysis of variance procedures with PROC MIXED (SAS release 8.0; SAS Institute, Cary, NC). Means were separated using Fisher's protected least significant difference procedure at $P \leq 0.05$.

Results and discussion

Hartley's F max test (Hartley, 1950) between the Antalya and Mersin locations indicated that variance is different at the two locations and so are analyzed separately. There were significant interactions for turfgrass color, quality, and green cover between years and species on some evaluation dates at both locations (Table 2). However, the warm-season species showed similar trends for both years and therefore data are not reported separately.

Significant differences were detected in establishment among species and cultivars at both locations (Table 3). Bermudagrass, bahiagrass, and seashore paspalum reached 95% coverage at 1095 GDD (Table 3); buffalograss and centipedegrass at 1436 GDD in Antalya; and 'Zenith' and 'Companion' zoysiagrass had 90% and 84% coverage at Antalya after accumulating 2031 GDD. Although, zoysiagrass was established with 25% less GDD in Mersin than that of in Antalya, bermudagrass showed a similar establishment at both locations. However, buffalograss, seashore paspalum, and centipedegrass established (>80% coverage) within 3 weeks and bahiagrass 11 weeks later in Mersin than in Antalya, which could be due to the differences in soil type, GDD, or the factors that influence GDD for the two locations (Table 3). The establishment rate of bermudagrass and seashore paspalum was more rapid than that of buffalograss, zoysiagrass, and centipedegrass in both locations. Croce et al. (2001) also found that bermudagrass and seashore paspalum cultivars established

Table 1. Meteorological parameters during the study period in 2006 and 2007 from weather stations located ≈ 1200 and 200 m (3937.0 and 656.2 ft) from the field sites in Antalya and Mersin, Turkey, respectively.

Location	Month	Mean maximum air temp ($^{\circ}\text{C}$)		Mean minimum air temp ($^{\circ}\text{C}$)		Mean relative humidity (%)		Mean wind speed ($\text{m}\cdot\text{s}^{-1}$)		Mean precipitation (mm)	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Antalya	January	14.2	16.2	5.4	8.3	55.1	57.3	2.9	2.1	319	136.8
	February	15.9	16.0	6.9	9.0	63.3	67.1	3.0	4.1	84.5	182.6
	March	18.2	18.7	9.1	11.1	71.4	59.9	2.6	7.4	78.2	10.2
	April	22.4	2.2	12.6	13.8	63.7	50.8	2.5	4.4	87.3	1.6
	May	26.9	25.6	15.4	18.9	64.2	69.4	2.2	1.9	12.3	5.2
	June	31.5	31.7	20.4	23.8	57.9	55.7	4.1	2.1	21.9	1.4
	July	35.2	34.8	23.3	26.3	55.6	54.2	2.3	2.0	0.3	0.2
	August	33.9	32.6	24.1	25.9	66.9	68.1	1.8	1.9	3.4	1.0
	September	31.8	30.9	19.8	22.9	60.8	52.0	2.5	2.0	29.9	0.0
	October	25.9	27.1	15.5	19.9	68.5	55.2	2.2	2.0	494.7	16.6
	November	20.2	20.1	8.7	13.2	60.7	68.2	2.2	1.7	126.4	58.2
	December	17.6	18.0	8.3	10.1	56.2	49.1	2.7	2.0	66.4	154.5
Mersin	January	15.0	15.8	4.9	3.6	48.9	50.4	1.6	1.4	46.6	14.1
	February	15.6	16.3	5.6	6.4	59.3	62.6	1.4	1.4	81.3	76.3
	March	18.5	18.9	7.9	7.4	68.5	61.1	1.6	1.6	30.2	62.1
	April	22.5	21.2	12.9	9.3	65.6	48.9	1.4	1.7	9.7	3.7
	May	25.5	26.9	15.1	17.2	60.4	62.1	1.6	1.4	2.5	46.8
	June	28.8	36.1	20.1	16.5	65.6	57.6	1.7	1.7	3.4	26.6
	July	31.3	38.2	24.2	18.2	60.2	57.5	1.7	1.7	0.7	0.6
	August	32.3	33.8	24.6	19.6	66.1	61.9	1.6	1.8	0	0
	September	30.7	34.0	20.2	14.6	54.4	54.2	1.5	1.6	13.6	0
	October	26.4	35.3	15.8	10.0	63.4	54.5	1.4	1.4	68.2	75.9
	November	20.5	28.5	8.4	5.4	51.6	53.8	1.4	1.5	202.8	78.2
	December	17.5	19.5	4.4	1.8	43.1	57.8	1.5	1.4	0	136.5

Table 2. Analysis of variance for turfgrass color, quality, and green cover in Antalya and Mersin, Turkey, for combined data of 2006 and 2007.

Source of variation	df	Antalya			Mersin		
		Color	Quality	Green cover	Color	Quality	Green cover
Block (B)	2	NS	21	NS	NS	1	NS
Species (S)	6	22	23	23	23	23	23
Whole-plot error (B $\times$ S)	12						
Cultivar [C(S)]	12	20	20	9	23	23	13
Split-plot error [B $\times$ C(S)]	24						
Year (Y)	1	20	19	19	21	15	22
B $\times$ Y	2	11	19	10	12	9	12
Y $\times$ S	6	23	23	23	23	23	23
B $\times$ Y $\times$ S	12	9	16	7	10	7	9
Y $\times$ C(S)	12	18	14	12	14	7	4
Residual	30						

Each of 23 weeks of data were analyzed separately. The species and cultivars were as follows: bermudagrass [cultivars SWI-1044, SWI-1045 (Contessa), Princess 77, Riviera, Mohawk, Sultan, NuMex Sahara, and Blackjack], buffalograss (cultivars Cody, Bowie, SWI-2000, Bison, and Texoka), zoysiagrass [cultivars Zenith and Companion (Compadre)], seashore paspalum (cultivar Sea Spray), centipedegrass (cultivar Tifblair), bahiagrass (cultivars Argentine and Pensacola), and tall fescue (cultivar Eldorado).

^{NS}Nonsignificant at the $P \leq 0.05$.

faster than zoysiagrass and buffalograss cultivars in Italy. Bermudagrass establishment was faster than zoysiagrass requiring 1100 and 1900 GDD, respectively, to reach 95% coverage.

This data agrees with earlier research by Patton et al. (2004), with 950 and 1750 GDD for bermudagrass and zoysiagrass, respectively. Frank et al. (1998) reported that buffalograss required at

least 1000 GDD for successful establishment. However, in this study, buffalograss required 1436 and 1928 GDD for establishment in Antalya and Mersin, respectively. The higher mean daily temperatures in Antalya and Mersin locations than the species requirement for germination and establishment may have led to the higher GDD values for establishment in our study compared with the sites of the reported studies during establishments.

Mean percentage of turfgrass cover values among bermudagrass cultivars differed in the first 5 weeks in Antalya and in the first 7 weeks in Mersin. 'Blackjack', 'Sultan', 'Sahara', and 'Mohawk' established significantly faster than 'SWI-1044', 'SWI-1045', 'Princess 77', and 'Riviera' (Table 3). The buffalograss cultivars were significantly different for their establishment rate throughout the establishment period. Overall, 'SWI-2000' established faster than other cultivars and 'Cody' was the second best. 'Bison' established relatively slowly in the sandy soil in Mersin (Table 3). Zoysiagrass and bahiagrass cultivars did not show significant intralocation variation (Table 3).

Table 3. Mean percentage of turfgrass coverage (establishment) for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya and Mersin, Turkey, taken after seeding in 2005.

Species/cultivars	Coverage (%) ^z													
	Time after seeding (weeks)													
	Antalya							Mersin						
	3	5	7	10	13	16	18	3	5	7	10	13	16	18
Bermudagrass														
SWI-1044	26	73	94	100	100	100	100	32	77	86	97	99	100	100
SWI-1045	44	79	95	100	100	100	100	47	80	88	96	99	100	100
Princess	53	84	96	100	100	100	100	45	80	90	98	99	100	100
Riviera	24	78	97	100	100	100	100	25	86	91	97	98	99	100
Mohawk	77	89	96	100	100	100	100	73	95	99	100	100	100	100
Sultan	77	89	91	98	100	100	100	77	93	98	100	100	100	100
Sahara	79	91	96	99	100	100	100	77	95	98	100	100	100	100
Blackjack	78	87	93	99	100	100	100	82	96	100	100	100	100	100
Mean	57	84	95	100	100	100	100	57	88	94	98	99	100	100
LSD _(bermudagrass)	10.1	7.0	NS	NS	NS	NS	NS	20.5	7.0	5.6	NS	NS	NS	NS
Buffalograss														
Cody	26	58	81	95	98	100	100	28	66	77	90	94	97	99
Bowie	17	44	74	92	93	100	100	17	55	70	88	95	96	98
SWI-2000	36	68	87	99	100	100	100	33	67	77	89	96	98	99
Bison	18	46	71	93	95	100	100	22	55	68	83	88	92	95
Texoka	5	18	65	90	92	95	96	11	47	70	90	96	97	97
Mean	20	47	76	94	96	99	99	22	58	72	88	94	96	98
LSD _(buffalograss)	5.2	8.6	7.5	5.0	4.8	4.5	4.0	10.2	7.3	7.8	4.9	4.1	4.0	NS
Zoysiagrass														
Zenith	14	49	70	81	83	87	90	17	62	78	91	95	96	98
Companion	13	43	65	76	79	84	84	12	66	80	90	93	95	97
Mean	14	46	68	78	81	86	87	15	64	79	91	94	96	98
LSD _(zoysiagrass)	NS	NS	NS	4.7	NS	NS	NS	2.9	NS	NS	NS	NS	NS	NS
Bahiagrass														
Argentine	34	79	96	99	100	100	100	28	65	72	82	88	91	95
Pensacola	56	86	98	100	100	100	100	38	76	80	86	90	93	96
Mean	45	83	97	99	100	100	100	33	71	76	84	89	92	96
LSD _(bahiagrass)	7.5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seashore paspalum														
Seaspray	20	74	97	100	100	100	100	20	77	88	95	97	99	100
Centipedegrass														
Tifblair	19	64	90	100	100	100	100	20	62	72	88	95	96	98
Tall fescue														
Eldorado	0	0	0	61	95	99	100	0	0	0	0	0	45	88
LSD _(species)	9.2	13.4	8.8	8.3	6.5	3.8	4.0	15.4	7.4	7.5	5.6	4.5	4.6	3.3
LSD _(cultivars)	7.7	8.7	6.4	5.6	4.3	3.5	3.2	14.3	6.8	7.0	NS	NS	NS	NS
Growing degree days (GDD)^y	507	819	1095	1436	1683	1885	2031	488	819	1136	1557	1928	2177	2312

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.

^zTurfgrass coverage ratings were based on a 0% to 100% visual rating scale, where 0% = no coverage and 100% = full coverage over the whole plot area.

^yGDD = [(maximum temperature °C + minimum temperature °C) ÷ 2] – 5 °C.

^{ns}Nonsignificant at $P \leq 0.05$.

Using the growing degree model (Unruh et al., 1996), bermudagrass, bahiagrass, and seashore paspalum could be seeded as late as 1 Sept.;

centipedegrass and buffalograss on 15 Aug.; and zoysiagrass on 1 Aug. in Antalya and still have acceptable establishment. In Mersin, bermudagrass

could be seeded as late as 1 Sept.; seashore paspalum on 10 Aug.; centipedegrass on 1 Aug.; and bahiagrass, buffalograss, and zoysiagrass on 15 July

in the Mediterranean region and still achieve >95% coverage before winter dormancy.

Significant differences in turfgrass quality and color throughout the growing season were detected among the turfgrass species (Table 2) and cultivars (Tables 4–7). The mean turfgrass quality of the species from May to December ranked from highest to lowest was as follows: seashore paspalum > bermudagrass > zoysiagrass > buffalograss = centipedegrass > bahiagrass > tall fescue. Volterrani et al. (1997) in Italy and Geren et al. (2009) in Turkey reported similar results, where seashore paspalum exhibited the greater turfgrass quality, but zoysiagrass had the lowest quality rating among the warm-season species tested (Geren et al., 2009).

Zoysiagrass and buffalograss cultivars exceeded the acceptable turfgrass quality of 6 by mid-April at Mersin. By mid-May, all species except bahiagrass were above the acceptable quality level at both locations. The duration of mean turfgrass quality of the species above the acceptable level varied from 6 to 7.5 months (from mid-April to December). Bermudagrass maintained acceptable turfgrass quality for 6 months, centipedegrass for 6.5 months, seashore paspalum for 7 months, and zoysiagrass for 7.5 months at both locations. Buffalograss maintained above-acceptable quality for 6 months at Antalya and 7 months at Mersin. Bahiagrass failed to provide acceptable quality on most of the evaluation dates and tall fescue had the lowest quality throughout the study. Significant differences in turfgrass quality and color were detected among the bermudagrass cultivars throughout the growing season (Tables 4–7). Seasonal color and quality ratings of the bermudagrass cultivars SWI-1044, SWI-1045, Princess 77, and Riviera were significantly higher than the cultivars Mohawk, Sultan, Sahara, and Blackjack during most of the growing seasons. These differences were due to a substantially finer leaf, denser turfgrass stand, and darker green color of the former group of cultivars.

Of the buffalograss cultivars, Cody was the first to reach to acceptable quality by mid-April and provided the highest quality throughout growing season, followed by cultivars Bowie, SWI-2000, Bison, and Texoka (Tables 4–5). In the NTEP trial (2000), ‘Cody’ demonstrated the best color and quality throughout the growing season. All

the buffalograss cultivars declined in quality below the acceptable level by early November in both locations. Buffalograss is adapted to a wide range of soil types and exhibits a high alkaline soil tolerance (Turgeon, 1999). Wenger (1943) reported that buffalograss preferred heavy, not sandy soil types; however, results indicate that turf-type buffalograss cultivars performed equally well in the sandy soil at Mersin.

‘Zenith’ zoysiagrass exhibited superior color and quality when compared with ‘Companion’ throughout the growing season at both locations. Similarly, ‘Zenith’ had better color and a higher quality than ‘Companion’ in the southeastern United States (NTEP, 2006a).

‘Argentine’ bahiagrass exhibited a darker green color but similar quality to ‘Pensacola’. These cultivars rarely reached acceptable quality, with a mean rating of 5.5 during their active growth period. Busey (2003) reported that bahiagrass turfs exhibited a relatively open growth habit, had a poor ability to survive in high (over 7.5) soil pH, and showed iron chlorosis in the spring under such conditions in Florida. We observed open growth habit and such chlorosis at both locations on ‘Argentine’ and ‘Pensacola’ bahiagrass post-green up in spring and summer months. The poor density and chlorosis contributed to the lower quality ratings of bahiagrass.

The buffalograss cultivars Bison and Cody were reported to have a satisfactory establishment in the first 2 years of establishment in Italy (Croce et al., 2001). However, weed invasion reduced the quality and made them unacceptable as a turf in the same study. We observed a very successful establishment and satisfactory color and quality of the buffalograsses over the 2-year period at both locations. Vegetatively propagated seashore paspalum cultivars are reported to have comparable quality levels with the best of vegetatively propagated bermudagrass and zoysiagrass cultivars in Italy (Croce et al., 2001). Although all the cultivars used in our study were seeded types, we also observed that seeded-type ‘Sea Spray’ seashore paspalum performed better in overall quality and ranked with the best bermudagrass cultivars.

Differences in fall color retention among species and cultivars were

detected (Tables 6–9). Turfgrass color retention for warm-season grasses in the fall is a desirable character. Growth of the warm-season species slowed in November. All the warm-season species began to show significant color decline when the mean minimum air temperatures dropped below 10 °C (Table 1). Overall fall color retention of the warm-season species was ≈15 d longer at Antalya than at Mersin. This delay was likely due to differences in mean minimum air temperatures ranging from 9 to 13 °C in Antalya and 5 to 8 °C in Mersin during November (Table 1). The green cover of buffalograss cultivars at both locations and the bermudagrass and zoysiagrass cultivars in Mersin was less than 50% by the end of November. Centipedegrass dropped below 50% by mid-December and seashore paspalum by late-December. Bahiagrass exhibited the best fall color retention with greater than 50% green cover until the end of December at both locations. The species order for fall color retention was buffalograss < zoysiagrass < centipedegrass < bermudagrass < seashore paspalum < bahiagrass. Geren et al. (2009) reported a similar order for fall color retention of the species in western Turkey.

There were differences among the cultivars of bermudagrass for fall color retention with ‘SWI-1044’, ‘SWI-1045’, and ‘Princess 77’ retaining their color longer than the other bermudagrass cultivars (Tables 6–7). ‘SWI-1044’ and ‘SWI-1045’ provided over 50% and 40% green cover on 15 Dec. in Antalya and Mersin, respectively (Tables 8–9). ‘SWI-1044’ and ‘SWI-1045’ exhibited superior fall color retention compared with the other bermudagrass cultivars in the southeastern United States from 2002 to 2006 (NTEP, 2006b). Dudeck and Peacock (1985) and White and Schmidt (1989) also reported growth cessation and discoloration responses among bermudagrasses to chilling temperatures (0 to 10 °C). Buffalograss cultivars responded similarly to declines in air temperature with a loss of 50% to 66% of their green color and green cover in November at both locations. No differences were detected for fall color among the zoysiagrass cultivars. The zoysiagrass cultivars performed similarly to most of the bermudagrass cultivars. All species and cultivars

Table 4. Mean turfgrass quality throughout the growing period for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass quality (1-9 scale) ^z																					
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.	30 Dec.	
Bermudagrass																						
SWI-1044	1.5	2.5	4.6	5.3	6.5	7.6	8.3	8.4	8.2	8.2	7.8	7.9	8.2	7.5	8.4	8.0	8.0	6.3	5.3	4.4	3.3	
SWI-1045	1.6	2.6	4.6	4.8	6.2	7.5	8.0	8.3	8.1	8.0	8.1	7.7	8.2	7.6	8.5	8.1	8.0	6.1	5.6	4.5	3.5	
Princess	1.6	2.5	4.2	4.8	6.7	7.6	8.2	8.3	8.1	7.9	7.3	7.3	7.7	7.3	8.2	7.7	7.8	6.2	5.2	4.2	3.4	
Riviera	1.8	3.4	5.3	5.6	6.4	7.1	7.4	7.9	7.8	7.7	7.4	7.8	7.9	7.3	8.1	7.6	7.5	5.8	4.9	3.5	2.4	
Mohawk	1.6	2.4	4.0	4.4	5.6	6.0	6.6	6.8	7.0	6.9	6.4	6.7	6.8	6.6	7.0	6.4	6.7	5.6	4.5	3.4	3.0	
Sultan	1.5	2.6	3.9	4.3	5.3	5.8	6.3	6.6	6.6	6.4	6.4	6.8	6.5	6.4	6.7	6.1	6.5	5.3	4.4	2.6	2.6	
Sahara	1.5	2.7	4.0	4.8	5.6	6.2	6.7	6.7	6.8	5.5	6.4	6.6	6.9	6.6	6.7	6.2	6.6	5.2	4.3	3.0	2.5	
Blackjack	1.5	2.5	3.9	4.4	5.2	5.8	6.3	6.6	6.9	6.6	6.3	6.7	7.0	6.5	6.7	6.5	6.7	5.5	4.7	3.5	2.9	
MMean	1.6	2.7	4.3	4.8	5.9	6.7	7.2	7.5	7.4	7.2	7.0	7.2	7.4	7.0	7.5	7.1	7.2	5.8	4.9	3.6	3.0	
LSD(bermudagrass)	NS	0.5	0.5	0.4	0.4	0.5	0.3	0.4	0.5	1.2	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.5	0.4	0.4	0.4	
Buffalograss																						
Cody	1.3	4.0	5.9	6.3	6.4	6.5	7.0	7.5	7.6	7.5	7.8	7.7	7.8	7.3	7.4	7.5	6.9	5.5	3.5	1.3	1.1	
Bowie	1.3	4.1	5.7	5.8	6.0	6.2	6.6	7.0	7.1	7.3	7.3	7.5	7.3	7.3	7.1	6.8	6.6	5.0	3.1	1.2	1.0	
SWI-2000	1.3	3.9	5.4	5.6	5.9	6.1	6.6	7.1	7.2	7.4	7.3	7.1	7.0	7.0	7.2	6.7	6.7	4.7	3.2	1.3	1.0	
Bison	1.2	3.7	5.0	5.5	5.4	6.0	6.2	6.3	6.3	6.6	6.8	6.9	6.8	6.7	6.8	6.8	6.6	4.9	3.4	1.4	1.3	
Texoka	1.7	3.3	4.7	4.8	4.9	5.3	5.8	6.2	6.5	6.9	6.9	7.1	7.0	6.8	6.9	6.9	6.6	5.3	3.7	1.8	1.2	
MMean	1.4	3.8	5.3	5.6	5.7	6.0	6.4	6.8	6.9	7.1	7.2	7.3	7.2	7.0	7.1	6.9	6.7	5.1	3.4	1.4	1.1	
LSD(buffalograss)	0.3	0.4	0.6	0.6	0.6	0.6	0.4	0.6	0.5	0.3	0.4	0.5	0.4	0.3	0.4	0.3	0.3	0.4	0.4	NS	0.2	
Zoysiagrass																						
Zenith	2.0	3.8	5.5	6.0	6.2	6.3	6.8	7.4	7.3	7.3	7.1	7.0	7.0	6.8	7.3	6.9	6.7	6.2	5.1	2.6	2.3	
Companion	2.2	3.8	5.4	5.9	6.0	6.3	6.6	6.9	6.8	6.9	6.6	6.7	6.7	6.6	6.9	6.6	6.5	5.8	4.8	2.4	1.8	
MMean	2.1	3.8	5.5	6.0	6.1	6.3	6.7	7.2	7.1	7.1	6.9	6.9	6.9	6.7	7.1	6.8	6.6	6.0	5.0	2.5	2.1	
LSD(zoysiagrass)	NS	NS	NS	NS	NS	NS	NS	0.3	NS	NS	0.5	NS	NS	NS	0.3	0.3	NS	NS	NS	NS	0.3	
Bahiaagrass																						
Argentine	1.3	2.6	4.0	4.3	5.3	5.8	5.6	5.5	5.5	5.6	5.5	5.5	5.4	5.3	5.5	5.6	5.9	5.5	5.1	4.4	3.6	
Pensacola	1.8	2.7	4.5	4.7	5.4	5.3	5.4	5.3	5.3	5.5	5.5	5.5	5.5	5.3	5.5	5.3	6.0	5.8	5.6	4.8	4.5	
MMean	1.6	2.7	4.3	4.5	5.4	5.6	5.5	5.4	5.4	5.6	5.5	5.5	5.5	5.3	5.5	5.5	6.0	5.7	5.4	4.6	4.1	
LSD(bahiaagrass)	0.3	NS	NS	NS	NS	NS	NS	0.3	NS	NS	NS	NS	NS	NS	NS	NS	0.1	0.2	0.4	NS	0.8	
Seashore paspalum																						
Seaspray	1.8	3.2	5.3	5.7	7.2	7.9	8.1	8.3	8.2	8.2	7.8	8.0	7.8	7.5	8.1	8.7	8.4	6.0	5.6	4.4	3.5	
Centipedegrass																						
Tifblair	1.7	3.7	5.3	5.6	6.0	6.5	6.5	6.9	6.8	6.8	6.9	7.0	7.1	6.5	7.0	7.2	7.2	4.9	4.2	2.5	1.9	

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Table 4. (*Continued*) Mean turfgrass quality throughout the growing period for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass quality (1–9 scale) ^z																					
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.	22 Dec.	
Tall fescue																						
Eldorado	4.8	4.9	5.2	5.3	5.4	5.6	5.7	6.0	5.2	4.3	2.9	1.8	1.6	1.2	2.5	3.2	3.6	4.1	4.1	3.8	3.7	
LSD (species)	0.4	0.6	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.9	0.5	0.5	0.6	0.4	0.6	0.9	1.0	1.1	1.1	1.0	0.8	
LSD (cultivars)	0.2	0.4	0.5	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.8	0.4	0.5	0.5	0.3	0.4	0.6	0.5	0.7	0.8	0.9	

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.
^zTurfgrass quality ratings were based on a 1–9 visual rating scale, where 1 = poorest, 6 = acceptable, and 9 = best.
^{ns}Nonsignificant at $P \leq 0.05$.

Table 5. Mean turfgrass quality for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass quality (1–9 scale) ^z																				
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.	
Bermudagrass																					
SWI-1044	1.3	2.8	3.6	4.8	6.0	7.6	8.1	8.2	8.5	8.4	8.4	8.4	8.3	8.3	8.0	7.5	7.2	6.2	4.8	3.8	
SWI-1045	1.2	2.6	3.6	5.1	5.7	7.0	7.9	8.0	8.5	8.5	8.3	8.3	8.4	8.3	8.0	7.7	7.3	6.3	5.2	4.2	
Princess	1.2	2.4	3.5	4.9	5.8	7.2	8.1	8.1	8.2	8.1	8.2	8.2	8.2	8.2	7.8	7.2	6.9	6.0	4.6	3.4	
Riviera	1.8	3.8	4.6	5.6	6.4	7.4	7.8	7.6	8.3	8.2	8.1	8.1	8.1	8.1	8.0	7.7	7.1	5.7	3.4	2.1	
Mohawk	2.3	3.7	4.2	5.0	5.9	6.8	6.8	6.9	7.0	7.2	7.2	7.5	7.6	7.6	7.6	7.1	6.8	5.4	3.4	2.5	
Sultan	2.1	3.6	4.1	4.8	5.6	6.3	6.7	7.0	6.7	7.1	7.3	7.4	7.5	7.3	7.1	6.4	6.4	5.2	3.3	2.3	
Sahara	2.2	3.9	4.3	5.1	5.8	6.6	6.9	6.8	7.0	7.3	7.3	7.3	7.5	7.4	7.3	6.8	6.7	5.4	3.5	2.5	
Blackjack	2.3	3.5	4.0	4.6	5.2	6.5	6.6	6.9	6.6	6.8	6.8	7.1	7.3	7.4	7.4	6.8	6.4	5.3	3.2	2.2	
Mean	1.8	3.3	4.0	5.0	5.8	6.9	7.3	7.4	7.6	7.7	7.7	7.8	7.8	7.8	7.6	7.1	6.8	5.7	3.9	2.9	
LSD(bermudagrass)	0.4	0.5	0.4	0.5	0.5	0.7	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.4	0.4	
Buffalograss																					
Cody	1.8	4.1	5.3	6.5	7.0	7.3	7.5	7.5	7.6	7.4	7.0	6.7	6.9	6.9	7.1	6.5	6.3	5.6	2.9	1.6	
Bowie	1.4	3.9	5.0	6.3	6.8	7.1	7.1	7.0	7.1	7.0	6.9	6.7	6.8	6.8	7.0	6.5	6.2	5.4	3.2	1.4	
SWI-2000	1.9	4.3	4.9	5.9	6.4	7.0	7.3	7.4	7.4	7.2	6.7	6.4	6.8	6.8	6.8	6.3	6.0	5.1	3.0	1.4	
Bison	1.8	4.3	5.1	6.0	6.1	6.6	6.8	7.0	7.1	7.0	6.6	6.3	6.7	6.7	6.6	6.3	6.1	5.4	3.8	2.3	
Texoka	1.7	3.9	4.9	5.7	6.2	6.4	6.6	6.7	6.8	6.4	6.3	6.2	6.5	6.5	6.5	6.3	6.0	5.1	3.0	1.3	
Mean	1.7	4.1	5.0	6.0	6.5	6.9	7.1	7.1	7.2	7.0	6.7	6.5	6.7	6.7	6.8	6.4	6.1	5.3	3.2	1.6	
LSD(buffalograss)	0.3	NS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.5	NS	0.2	0.3	0.5	0.3	
Zoysiagrass																					
Zenith	2.7	4.6	5.6	6.8	7.1	7.3	7.6	7.8	8.0	7.5	7.4	7.5	7.6	7.7	7.7	6.9	6.4	5.1	3.7	1.9	

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Table 5. (Continued) Mean turfgrass quality for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass quality (1–9 scale) ^z																			
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.
Companion	2.1	4.7	5.6	6.4	6.6	6.8	6.9	7.0	7.6	7.2	7.3	7.3	7.2	7.2	7.2	6.7	6.2	5.0	2.7	1.8
MMean	2.4	4.6	5.6	6.6	6.9	7.0	7.2	7.4	7.8	7.4	7.3	7.4	7.4	7.4	7.4	6.8	6.3	5.0	3.2	1.8
LSD(zoysiagrass)	0.5	NS	NS	NS	0.4	0.3	0.4	0.5	0.2	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.8	NS
Bahiagrass																				
Argentine	1.8	2.4	3.7	5.1	5.7	6.1	6.2	6.0	6.1	5.7	5.3	5.5	5.6	5.8	5.8	5.9	5.9	5.8	5.4	4.7
Pensacola	2.8	3.5	4.7	5.6	5.8	5.8	5.8	5.5	5.6	5.4	5.3	5.3	5.5	5.6	5.7	5.8	5.9	5.8	5.5	4.7
MMean	2.3	3.0	4.2	5.3	5.7	6.0	6.0	5.7	5.9	5.5	5.3	5.4	5.6	5.7	5.8	5.8	5.9	5.8	5.5	4.7
LSD(bahiagrass)	0.4	0.2	0.6	0.4	NS	NS	NS	0.1	0.3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seashore paspalum																				
Seaspray	1.3	2.0	3.4	5.6	6.8	7.8	8.2	8.0	8.3	8.0	8.0	7.8	7.8	8.1	8.4	8.2	8.0	7.1	5.4	4.6
Centipedegrass																				
Tifblair	2.4	4.1	5.1	5.9	6.4	6.8	6.8	6.9	7.1	6.8	7.1	7.3	7.4	7.5	7.5	7.0	6.4	5.7	5.1	2.8
Tall fescue																				
Eldorado	3.4	3.5	3.6	3.8	4.0	4.0	4.1	4.2	3.9	3.2	2.2	1.5	1.5	1.5	1.6	1.8	1.9	1.9	1.9	1.9
LSD(species)	0.5	0.5	0.4	0.5	0.5	0.6	0.5	0.5	0.5	0.8	0.7	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.6	0.6
LSD(cultivars)	0.4	0.5	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.5	0.6	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.^zTurfgrass quality ratings were based on a 1–9 visual rating scale, where 1 = poorest, 6 = acceptable, and 9 = best.^{ns}Not significant at $P \leq 0.05$.

Table 6. Mean turfgrass color for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass color (1–9 scale) ^z																							
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.	22 Dec.			
Bermudagrass																								
SWI-1044	1.8	2.8	4.4	4.7	6.6	7.8	8.1	8.3	7.9	7.9	8.0	8.2	8.3	7.7	8.4	8.4	8.3	6.0	5.1	4.3	3.6			
SWI-1045	1.9	2.3	4.1	4.5	6.4	7.6	8.3	8.3	7.8	7.7	7.7	7.9	8.1	7.8	8.5	8.6	8.2	5.8	5.2	4.3	3.3			
Princess	1.8	2.4	4.3	5.1	6.9	7.9	8.2	8.1	7.9	7.6	7.5	7.8	7.7	7.7	8.0	8.0	8.0	5.9	4.9	4.2	3.3			
Riviera	2.2	3.5	4.9	5.2	6.6	7.3	7.6	7.7	8.0	7.6	7.4	8.0	8.0	7.4	8.1	7.8	7.6	5.4	4.3	3.3	2.8			
Mohawk	1.7	3.3	4.4	4.7	6.1	6.5	6.8	6.7	7.1	6.9	6.8	7.1	7.1	6.8	7.1	6.7	7.3	5.3	4.4	3.5	3.3			
Sultan	1.8	3.3	4.0	4.7	5.8	6.3	6.6	6.8	7.0	6.7	6.7	7.4	7.4	6.8	7.0	6.4	7.1	5.1	4.3	2.9	2.6			

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Table 6. (*Continued*) Mean turfgrass color for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass color (1–9 scale) ^z																							
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.	22 Dec.			
Sahara	1.8	3.3	4.4	4.8	6.1	6.5	6.7	6.9	7.1	6.7	6.7	6.8	7.1	6.9	6.9	6.4	7.0	5.3	4.3	3.2	2.8			
Blackjack	1.7	3.3	4.4	4.8	5.6	6.6	6.8	6.8	7.2	6.8	6.7	7.1	7.3	6.8	7.0	6.6	7.2	5.3	4.4	3.5	2.9			
Mean	1.8	3.0	4.4	4.8	6.3	7.1	7.4	7.5	7.5	7.2	7.2	7.5	7.6	7.2	7.6	7.4	7.6	5.5	4.6	3.7	3.1			
LSD (bermudagrass)	0.4	0.4	0.5	0.5	0.5	0.3	0.4	0.5	0.3	0.4	0.2	0.4	0.4	0.4	0.4	0.5	0.4	0.6	0.5	0.5	0.4			
Buffalograss																								
Cody	1.4	4.6	7.0	7.2	7.3	7.2	7.8	8.0	8.0	7.9	8.1	8.1	8.3	7.7	7.8	8.0	7.4	6.2	3.0	1.3	1.2			
Bowie	1.3	4.8	6.8	6.9	7.0	7.3	7.5	8.0	7.8	7.8	7.8	7.8	8.1	7.6	7.3	7.5	6.9	5.7	2.8	1.2	1.0			
SWI-2000	1.4	4.4	6.0	6.2	6.3	6.7	6.9	7.1	7.0	6.9	6.9	7.2	7.1	6.9	7.1	7.1	6.9	5.6	2.7	1.3	1.1			
Bison	1.6	4.6	6.2	6.2	6.7	6.8	7.0	7.8	7.9	7.9	7.6	7.6	7.6	7.4	7.6	7.6	7.0	5.9	3.8	1.5	1.3			
Texoka	1.9	4.8	5.9	5.9	6.0	6.3	6.7	7.0	7.6	7.7	7.6	7.7	7.5	7.1	7.2	7.3	7.0	6.1	3.7	1.5	1.3			
Mean	1.5	4.6	6.4	6.5	6.7	6.9	7.2	7.6	7.7	7.6	7.6	7.7	7.7	7.3	7.4	7.5	7.0	5.9	3.2	1.4	1.2			
LSD (buffalograss)	0.3	NS	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.4	0.3	0.5	0.4	0.1	0.1			
Zoysiagrass																								
Zenith	2.3	4.7	6.5	6.6	6.3	6.6	7.0	7.3	6.9	6.6	6.7	6.8	6.8	6.7	7.3	7.4	7.0	6.4	5.0	2.5	2.0			
Companion	2.3	5.2	6.2	6.4	6.3	6.3	6.5	6.7	6.6	6.5	6.3	6.4	6.4	6.4	6.9	6.8	6.7	6.1	4.6	2.0	1.7			
Mean	2.3	5.0	6.4	6.5	6.3	6.5	6.8	7.0	6.8	6.6	6.5	6.6	6.6	6.6	7.1	7.1	6.9	6.3	4.8	2.3	1.9			
LSD (zoysiagrass)	NS	NS	NS	NS	NS	NS	0.3	0.5	NS	NS	NS	0.2	NS	NS	0.1	0.2	0.2	0.2	NS	0.3	0.2			
Bahiagrass																								
Argentine	1.8	2.8	4.3	4.8	6.2	6.1	6.3	6.1	5.9	5.7	5.5	5.9	5.8	5.4	6.0	7.0	7.3	7.0	6.0	4.8	4.1			
Pensacola	2.2	3.5	3.9	4.5	5.4	5.3	5.5	5.4	5.1	5.5	5.3	5.5	5.6	5.3	5.4	6.0	6.7	6.4	5.6	5.1	4.9			
Mean	2.0	3.2	4.1	4.7	5.8	5.7	5.9	5.8	5.5	5.6	5.4	5.7	5.7	5.4	5.7	6.5	7.0	6.7	5.8	5.0	4.5			
LSD (bahiagrass)	0.2	NS	NS	NS	0.2	0.3	0.2	0.3	0.2	NS	NS	NS	NS	NS	0.5	0.3	0.3	0.2	0.2	NS	0.6			
Seashore paspalum																								
Seaspray	2.2	3.0	4.8	5.7	6.9	7.0	7.0	6.7	6.8	6.7	6.9	7.0	6.8	6.8	7.2	7.7	7.6	5.7	5.6	4.6	3.5			
Centipedegrass																								
Tifblair	2.0	4.2	4.7	5.2	5.7	6.1	6.1	6.2	5.9	6.1	6.5	6.7	6.9	6.2	6.8	6.9	7.3	5.2	4.3	2.5	2.0			
Tall fescue																								
Eldorado	5.3	5.6	6.3	6.5	6.6	6.6	6.8	7.3	6.3	6.0	3.7	2.9	2.5	2.1	2.9	4.8	5.5	5.8	5.7	5.7	5.5			
LSD (species)	0.7	0.8	0.8	1.0	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.4	0.6	1.1	1.0	NS	1.3	1.1	1.0			
LSD (cultivars)	0.3	0.5	0.7	0.6	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.7	0.6	0.9	0.8	0.8			

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.

^aTurfgrass color ratings were based on a 1–9 visual rating scale, where 1 = straw brown, 6 = light green, and 9 = dark green.

^{NS}Nonsignificant at $P \leq 0.05$.

Table 7. Mean turfgrass color for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass color (1–9 scale) ^z																					
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.		
Bermudagrass																						
SWI-1044	1.3	2.3	3.5	5.1	6.0	7.8	8.0	8.3	8.5	8.5	8.4	8.5	8.4	8.1	8.0	7.9	7.4	6.2	4.8	3.3		
SWI-1045	1.2	2.3	3.6	5.0	6.1	7.8	8.3	8.4	8.4	8.5	8.5	8.8	8.8	8.4	8.3	8.0	7.6	6.4	4.9	3.6		
Princess	1.2	2.1	3.3	4.9	6.0	7.5	8.1	8.2	8.2	8.3	8.3	8.5	8.5	8.5	8.5	8.0	7.6	6.3	4.7	3.2		
Riviera	1.6	3.4	4.7	5.8	6.4	7.1	7.5	7.8	8.3	8.3	8.3	8.1	8.2	8.2	8.3	7.8	7.3	5.3	3.5	2.5		
Mohawk	2.0	3.3	4.0	5.1	6.0	6.9	7.0	7.1	7.5	7.6	7.2	7.4	7.5	7.6	7.7	7.1	6.6	5.1	3.5	2.5		
Sultan	2.0	3.2	3.8	4.7	5.8	6.4	6.8	6.8	7.2	7.4	7.1	7.3	7.3	7.3	7.3	6.9	6.5	5.1	3.3	2.3		
Sahara	2.1	3.8	4.2	5.1	5.9	6.6	6.8	6.9	7.3	7.5	7.5	7.7	7.4	7.6	7.7	7.1	6.6	5.1	3.3	2.3		
Blackjack	2.0	3.2	3.8	4.6	5.3	6.6	6.8	6.8	7.0	7.3	7.4	7.3	6.7	7.2	7.3	6.7	6.3	4.9	3.2	2.4		
MMean	1.7	2.9	3.9	5.0	5.9	7.1	7.4	7.5	7.8	7.9	7.8	7.9	7.8	7.9	7.9	7.4	7.0	5.6	3.9	2.8		
LSD(bermudagrass)	0.3	0.5	0.5	0.4	0.5	0.6	0.4	0.4	0.5	0.2	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.6	0.4	0.4		
Buffalograss																						
Cody	1.4	4.5	5.8	6.8	7.2	7.7	8.3	8.3	8.3	8.1	7.6	7.5	7.8	7.8	7.8	7.7	7.3	5.8	2.8	1.5		
Bowie	1.3	4.3	5.9	6.8	7.3	7.7	8.0	8.2	8.2	7.9	7.2	7.4	7.5	7.6	7.7	7.3	6.8	5.6	2.9	1.5		
SWI-2000	1.7	4.1	5.2	5.8	6.3	6.8	7.2	7.4	7.4	7.3	7.0	7.0	7.0	7.2	7.1	6.8	6.4	5.2	3.1	1.5		
Bison	1.7	4.6	6.1	6.9	7.3	7.7	8.2	8.4	8.3	7.8	7.5	7.7	7.9	7.9	7.6	7.3	7.0	5.8	3.6	2.3		
Texoka	1.6	4.3	5.8	6.4	6.7	7.3	7.5	7.6	7.5	7.0	7.0	7.2	7.3	7.2	7.0	7.3	7.0	5.3	2.9	1.4		
MMean	1.5	4.4	5.7	6.5	6.9	7.4	7.8	8.0	7.9	7.6	7.3	7.4	7.5	7.5	7.4	7.3	6.9	5.5	3.1	1.6		
LSD(buffalograss)	0.2	0.3	0.5	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.5	0.5	0.5	0.7	0.3		
Zoysiagrass																						
Zenith	2.4	4.3	5.5	6.7	6.9	7.2	7.6	7.7	7.8	7.6	7.3	7.3	7.3	7.3	7.3	7.0	6.6	4.8	3.4	2.2		
Companion	2.2	4.5	5.8	6.5	6.7	6.8	6.9	6.9	7.0	7.0	6.9	7.3	7.3	7.1	7.0	6.8	6.5	4.7	2.6	1.8		
MMean	2.3	4.4	5.6	6.6	6.8	7.0	7.2	7.3	7.4	7.3	7.1	7.3	7.3	7.2	7.1	6.9	6.6	4.8	3.0	2.0		
LSD(zoysiagrass)	NS	NS	NS	NS	NS	0.1	0.2	0.2	0.3	0.5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		
Bahiaagrass																						
Argentine	1.8	2.9	4.2	5.6	6.7	7.2	7.2	6.6	6.3	5.8	5.3	5.4	5.3	5.6	6.1	6.3	6.1	6.0	5.5	4.8		
Pensacola	2.8	3.8	4.5	5.3	5.8	5.9	6.0	5.5	5.4	5.3	5.1	5.4	5.7	5.8	6.1	6.3	6.2	6.1	5.5	4.5		
MMean	2.3	3.4	4.3	5.4	6.2	6.6	6.6	6.0	5.8	5.5	5.2	5.4	5.5	5.7	6.1	6.3	6.2	6.0	5.5	4.7		
LSD(bahiaagrass)	0.7	0.3	NS	NS	NS	0.3	0.3	0.4	0.7	0.3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		
Seashore paspalum																						
Seaspray	1.3	2.2	3.8	6.3	7.2	7.4	7.5	7.6	7.8	7.7	7.6	7.6	7.5	7.7	7.8	7.7	7.5	6.7	5.2	4.3		
Centipedegrass																						
Tifblair	2.3	3.9	4.8	5.6	6.4	6.5	6.8	7.1	7.3	7.2	7.3	7.5	7.6	7.5	7.3	7.4	6.5	5.8	4.9	2.9		

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Table 7. (Continued) Mean turfgrass color for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Turfgrass color (1–9 scale) ^z																	
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.
Tall fescue																		
Eldorado	4.0	4.1	4.3	4.8	5.4	5.6	5.9	6.3	6.2	4.5	3.2	2.7	2.2	2.3	2.5	2.6	2.6	2.5
LSD(species)	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.5	0.6	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.7
LSD(cultivars)	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.

^zTurfgrass color ratings were based on a 1–9 visual rating scale, where 1 = straw brown, 6 = light green, and 9 = dark green.

^{ns}Nonsignificant at $P \leq 0.05$.

Table 8. Mean percentage of turfgrass green cover for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivars	Green cover (%) ^z																	
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.
Bermudagrass																		
SWI-1044	15	35	73	80	97	100	100	100	100	100	100	100	100	100	100	100	100	100
SWI-1045	16	36	68	79	92	100	100	100	100	100	100	100	100	100	100	100	100	100
Princess	13	33	69	80	93	100	100	100	100	100	100	100	100	100	100	100	100	100
Riviera	20	49	80	89	99	100	100	100	100	100	100	100	100	100	100	100	100	100
Mohawk	15	39	71	79	95	97	99	100	100	100	100	100	100	100	100	100	100	100
Sultan	13	38	68	78	93	97	99	100	100	100	100	100	100	98	99	100	100	100
Sahara	15	41	72	84	96	98	99	100	100	100	100	100	100	99	99	100	100	100
Blackjack	12	39	67	80	90	94	98	100	100	100	100	100	100	99	99	100	100	100
Mean	15	39	71	81	94	98	99	100	100	100	100	100	100	100	100	100	100	100
LSD(bermudagrass)	4	8	6	6	4	2	1	NS	NS	NS	NS	NS	NS	1	NS	NS	8	6
Buffalograss																		
Cody	10	73	92	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100
Bowie	9	68	90	95	99	100	100	100	100	100	100	100	100	99	98	98	98	98
SWI-2000	10	68	89	93	99	100	100	100	100	100	100	100	100	100	100	100	100	100
Bison	10	68	84	89	96	100	100	100	100	100	100	98	98	98	98	98	98	98
Texoka	18	77	87	92	98	100	100	100	100	100	100	98	98	99	99	99	99	99
Mean	11	71	88	93	98	100	100	100	100	100	100	99	99	99	99	99	99	99
LSD(buffalograss)	5	7	3	3	2	NS	NS	NS	NS	NS	NS	1	2	2	3	7	6	4
Zoysiagrass																		
Zenith	23	77	93	96	99	100	100	100	100	100	100	100	100	100	100	100	100	100

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Table 8. (*Continued*) Mean percentage of turfgrass green cover for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Antalya, Turkey, averaged over 2006 and 2007.

Species/ cultivars	Green cover (%) ^z															
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	15 July	15 Aug.	15 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.
Companion	26	80	94	96	99	100	100	100	100	100	100	100	100	77	61	27
Mean	25	78	94	96	99	100	100	100	100	100	100	100	100	81	63	31
LSD (zoysiagrass)	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5	NS	6
Bahiagrass																
Argentine	14	55	79	87	93	100	99	100	98	97	97	96	93	95	82	72
Pensacola	22	71	88	93	98	100	100	100	96	96	96	95	96	96	89	84
Mean	18	63	84	90	95	100	100	100	97	96	96	95	95	95	85	78
LSD(bahiagrass)	NS	8	7	5	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	16
Seashore paspalum																
Seaspray	19	50	83	89	100	100	100	100	100	100	100	100	100	79	79	63
Centipedegrass																
Tiflair	20	70	88	96	99	100	100	100	100	100	100	100	100	64	51	31
Tall fescue																
Eldorado	78	78	83	83	87	89	90	90	83	35	16	47	53	70	75	68
LSD(species)	9	10	10	9	8	5	4	4	3	3	4	13	14	19	20	16
LSD(cultivars)	6.4	8.0	7.4	6.7	5.6	3.1	2.6	2.4	2.4	2.7	2.1	5.5	5.8	11.81	11.7	9.6

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.

^zTurfgrass green cover ratings were based on a 0% to 100% visual rating scale, where 0% = no green cover and 100% = full green cover over the whole plot area.

^{ns}Non-significant at $P \leq 0.05$.

Table 9. Mean percentage of turfgrass green cover for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Green cover (%) ^z															
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	15 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.
Bermudagrass																
SWT-1044	11	37	52	77	90	98	100	100	100	100	100	100	100	100	100	92
SWT-1045	8	35	48	75	85	96	100	100	100	100	100	100	100	100	100	93
Princess	9	40	55	73	83	97	100	100	100	100	100	100	100	100	100	88
Riviera	22	70	82	94	98	100	100	100	100	100	100	100	100	100	95	82
Mohawk	37	72	82	93	97	100	100	100	100	100	100	100	100	100	97	82
Sultan	27	63	77	88	94	100	100	100	100	100	100	100	100	100	95	78

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Table 9. (Continued) Mean percentage of turfgrass green cover for bermudagrass, buffalograss, zoysiagrass, seashore paspalum, centipedegrass, bahiagrass, and tall fescue species and their cultivars in Mersin, Turkey, averaged over 2006 and 2007.

Species/ cultivar	Green cover (%) ^z																			
	28 Feb.	15 Mar.	30 Mar.	15 Apr.	30 Apr.	15 May	30 May	15 June	30 June	15 July	30 July	15 Aug.	30 Aug.	15 Sept.	30 Sept.	15 Oct.	30 Oct.	15 Nov.	30 Nov.	15 Dec.
Sahara	35	76	84	93	98	100	100	100	100	100	100	100	100	100	100	100	98	77	33	25
Blackjack	28	65	77	85	93	100	100	100	100	100	100	100	100	100	100	95	93	73	35	25
Mean	22	57	70	85	92	99	100	100	100	100	100	100	100	100	100	100	97	83	45	32
LSD(bermudagrass)	5	12	14	8	6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	10	16	13
Buffalograss																				
Cody	19	76	95	100	100	100	100	100	100	100	100	95	100	100	100	100	100	80	38	22
Bowie	16	72	87	98	100	100	100	100	100	100	100	97	100	100	100	100	97	78	43	20
SWI-2000	22	75	90	98	100	100	100	100	100	100	100	100	100	100	100	100	97	67	35	20
Bison	23	75	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	83	48	33
Texoka	23	73	85	100	100	100	100	100	100	100	100	93	100	100	100	95	93	77	40	18
Mean	21	74	89	99	100	100	100	100	100	100	100	97	100	100	100	100	97	77	41	23
LSD(buffalograss)	5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zoysiagrass																				
Zenith	33	85	99	100	100	100	100	100	100	100	100	100	100	100	100	98	93	67	38	28
Companion	32	87	97	100	100	100	100	100	100	100	100	100	100	100	100	95	90	63	42	32
Mean	33	86	98	100	100	100	100	100	100	100	100	100	100	100	100	95	92	65	40	30
LSD(zoysiagrass)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bahiagrass																				
Argentine	22	55	73	98	100	100	100	100	100	100	100	100	100	100	100	100	100	97	85	75
Pensacola	45	80	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	87	75
Mean	33	68	82	99	100	100	100	100	100	100	100	100	100	100	100	100	100	98	86	75
LSD(bahiagrass)	NS	NS	7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seashore paspalum																				
Seaspray	13	40	65	90	97	100	100	100	100	100	100	100	100	100	100	100	100	98	70	58
Centipedegrass																				
Tiflair	35	82	92	100	100	100	100	100	100	100	100	100	100	100	100	100	100	97	73	45
Tall fescue																				
Eldorado	49	50	54	55	58	58	62	63	33	22	14	13	14	17	18	19	19	20	21	21
LSD(species)	9	10	10	5	3	2	2	2	2	2	2	2	2	2	2	2	6	11	16	19
LSD(cultivars)	7	7	7	5	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	8	12	13

Fisher's protected least significant difference (LSD) values ($P \leq 0.05$) are for comparing within or between species.^zTurfgrass green cover ratings were based on a 0% to 100% visual rating scale, with 0% = no green cover and 100% = full green cover over the whole plot area.^{ns}Non-significant at $P \leq 0.05$.

demonstrated a turfgrass color measurement of 6 or above at the end of October in both locations, but by the end of November, Argentine bahiagrass was the only cultivar with a color value of 6 in Antalya (Tables 6–7). Of all the warm-season cultivars, ‘Argentine’ and ‘Pensacola’ bahiagrass demonstrated the best fall color retention, followed by ‘Sea Spray’ seashore and ‘SWI-1044’ and ‘SWI-1045’ bermudagrass in mid-December (Tables 6–7). ‘Pensacola’ is reported to have better frost tolerance than ‘Argentine’ (Burton, 1946), which may help to explain the better winter color of ‘Pensacola’ in both locations.

All the warm-season species stayed fully dormant with a straw brown color for ≈ 6 to 8 weeks from mid-December to the end of February at both locations. The buffalograsses and zoysiagrasses entered dormancy in early December, followed by bermudagrass and centipedegrass, then seashore paspalum, and finally bahiagrass. Tall fescue did not go dormant at any time but discolored during summer heat stress.

The turfgrass species and cultivars differed in their spring green-up response at both locations (Tables 8–9). Intra and interspecific variations have been reported to exist in base spring green-up temperatures for growth in warm-season turfgrass species (Madakadze et al., 2003; Unruh et al., 1996). Spring green-up began in mid-to late February and was completed in late April in both locations. Zoysiagrass exhibited the best spring green-up at 80%, followed by buffalograss and centipedegrass at 70% by mid-March. Centipedegrass has been reported to have a higher basal temperature requirement and higher growth rate constant than other warm-season turfgrasses (Unruh et al., 1996). However, centipedegrass had a similar green-up to zoysiagrass and buffalograss and greened up earlier than seashore paspalum and bermudagrass in our study. All the species exceeded 90% green cover by the end of April with a mean GDD of 983. Seashore paspalum and bermudagrass exhibited the slowest spring green-up among the warm-season species. However, Geren et al. (2009) reported that ‘Sea Spray’ seashore paspalum and ‘Bowie’ buffalograss exhibited the earliest and latest spring green up in another study conducted at Izmir, located at western Turkey. The species order for spring green-up was zoysiagrass >

buffalograss > centipedegrass > bahiagrass > seashore paspalum > bermudagrass.

Bermudagrass cultivars differed in their spring green-up response between the two locations, with ‘Riviera’ at both locations and ‘Mohawk’ and ‘Sahara’ in Mersin demonstrating better spring green-up than the other bermudagrass cultivars. They exhibited a superior spring green-up with over 80% green cover when compared with ‘Princess 77’, ‘SWI-1044’, and ‘SWI-1045’, which had less than 55% green cover at the end of March. Our results agree with that of NTEP (2006b), in which ‘Riviera’ showed better spring green-up than ‘SWI-1045’. Croce et al. (2001) reported a relatively slow spring green-up rate for ‘Princess 77’ in Italy. In general, bermudagrass cultivars with better fall color retention demonstrated delayed spring green-up (Tables 8–9).

Buffalograss cultivars began spring green-up in late February and completed it by mid-April in Mersin and late April in Antalya. ‘Cody’ was superior to the other buffalograss cultivars in both locations throughout the spring green-up period. ‘Cody’ also showed superior early-spring green-up in NTEP trials (2000). The zoysiagrass cultivars Zenith and Companion showed similar spring green-up. The bahiagrass cultivar Pensacola exhibited better spring green-up than ‘Argentine’. When all the cultivars were evaluated, ‘Companion’ and ‘Zenith’ zoysiagrass, ‘Pensacola’ bahiagrass, and ‘Tifblair’ centipedegrass initiated the earliest spring green-up in both locations, with a 20% to 26% green cover at Antalya and 32% to 45% at Mersin by the end of February. By the end of March, the zoysiagrass cultivars Companion and Zenith and the buffalograss cultivar Cody demonstrated over 90% green cover at Antalya and over 95% at Mersin. All the cultivars, except SWI-1045 and Princess 77 bermudagrass at Mersin showed over 90% spring green-up by the end of April in both locations (Tables 8–9).

The warm-season species retained 95% to 100% green cover throughout the summer (Tables 8–9). Tall fescue had the poorest color and quality ratings and lowest percentage of green cover when all warm-season grasses were actively growing during the summer and early fall. Cool-season turfgrasses showed reduced turfgrass quality

and green cover in response to high temperature stress in previous studies (Baker and Jung, 1968; Wehner and Watschke, 1981). Tall fescue’s green cover declined after 15 July until October and recovered only partially to reach 70% in December at Antalya, while it failed to recover at Mersin, requiring reseeding in fall (Tables 8–9). Surviving tall fescue plants in the plots retained their green color during winter months with a turfgrass color measurement of 5 or better in Antalya.

In conclusion, this research identified several warm-season species and cultivars that have great potential for summer and fall utilization in the Mediterranean region. Based upon our research findings, these warm-season turfgrasses may perform better than cool-season species that are commonly used in this region and provide a quality turf with reduced water-use requirements. These results will be helpful to turfgrass managers and advisers seeking to manage and recommend suitable warm-season turfgrass species and cultivars for the Mediterranean region. Turfgrass breeders and companies would also have a better understanding of response of their cultivars in the target environment. Future research on the long-term performance of the species under different fertilization, mowing height, and irrigation regimes should also be considered to develop specific maintenance recommendations for a given species under a Mediterranean environment.

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