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PERFORMANCES OF SOME COOL SEASON TURFGRASS SPECIES IN MEDITERRANEAN ENVIRONMENT: I. *Lolium perenne* L., *Festuca arundinacea* Schreb., *Poa pratensis* L., and *Agrostis tenuis* Sibth

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ABSTRACT

The commitment to turf research is more recent and is challenged by the diversity of climatic conditions occurring throughout the Anatolian peninsula in Turkey, thereby complicating the recommendation of species and cultivars. Assessing the peculiarities of turfs during the growing period and the efficient use of turf for establishing lawns requires field evaluation of the existing cultivars particularly in the sites with a Mediterranean climate. Our study is aimed at evaluating the adaptability and quality of the popular cultivars (introductions) of cool season turfgrass species in a Mediterranean site in western Turkey, Bornova/IZMIR. Six cultivars of perennial ryegrass (*Lolium perenne* L.), four cultivars of tall fescue (*Festuca arundinacea* Schreb.), four cultivars of Kentucky bluegrass (*Poa pratensis* L.) and four cultivars of colonial bentgrass (*Agrostis tenuis* Sibth) were tested for 3 years in a replicated experimental block group design. Turf cover, colour and quality traits of each cultivar in each species were evaluated by using a visual score (1-9) and assessed in each season from 2003 to 2005. Cultivars of tall fescue and to some extent perennial ryegrass species were better able than those of Kentucky bluegrass and colonial bentgrass to cope with the existing Mediterranean climatic condition. All species performed better in winter, spring and autumn than summer season, except for tall fescue. Kentucky bluegrass and colonial bentgrass cultivars were not found recommendable for Mediterranean environment.

Key words: Cool-season turfgrasses (*Lolium perenne* L., *Festuca arundinacea* Schreb., *Poa pratensis* L.and *Agrostis tenuis* Sibth), assessment, adaptability, Mediterranean environment.

INTRODUCTION

Turfs increase the aesthetic, economic and environmental value of the landscape and provides recreational vegetation, erosion control and other ecological benefits, when established consciously. There is a still continuing debate among the specialists about the turf crop material selection for Mediterranean ecologies. Mediterranean regimes are considered as transition zones. Dry summer and high temperatures as well as low temperatures in winter are of tremendous significance in terms of turfgrass and proper medium growing selection (Croce et al., 2001). For the time being, holiday houses and some touristic settlements, public and private turf areas are largely based on cool-season grasses in developing Mediterranean countries.

C_3, cool season turfgrasses such as *Lolium perenne, Festuca arundinecaea, Poa pratensis* and *Agrostis tenuis* are widely used depending on very old data and tradition on turf sector in a Mediterranean part of Turkey and similar regions of neighbouring countries (Geren et al., 2009). Another factor dictating the widespread use of cool season turfgrasses in such environments can be ascribed to their availability on the seed market, while readily available vegetative production sources of C_4, warm season grasses are quite limited. Another objection to the warm-season turfgrasses which occurs generally in the Mediterranean region is the lack of green colour during the winter dormancy period.

The large number of cool-season cultivars of all turf species are generally released in northern Europe and the USA. It is a fact that the appropriate use of turf for implanting lawns requires field evaluation of the genotypes in sites with a Mediterranean climate to assess the behaviour of cultivars during the growing period (Martiniello and D'Andrea, 2006). Accordingly, objective of the present study was to investigate the adaptability and establishment of many popular cultivars of the four cool-season turfgrass species in a site with a typical Mediterranean climate. Field evaluation aimed to assess the performance and adaptability of turf quality, turf colour and turf cover parameters of widely used turfgrasses over the 3 years of evaluation.

MATERIALS AND METHODS

The experiment was established in November 2002 at the experimental site, located at Bornova (38^0 27. 236 N, $27^{\,0}$ 13. 576 E and 28 m above sea level), Ege University, Izmir, Turkey. During the study period the site with a Mediterranean climate had a mean of annual rainfall of 658 mm, a daily mean temperature from October to June 18.2º C, in the remaining months the amount of rainfall might be considered erratic. The native root zone was composed of

80.2 % sand, 18.1 % silt and 1.7 % clay. The soil was silty sand with the following characteristics: pH (water) 8.1; total ($CaCO_3$) 2400 mg kg^{-1}; total nitrogen (Kjeldahl) 0.2 g kg^{-1}; organic matter 2.27 g kg^{-1}; available phosphorus 2.54 mg kg^{-1}; exchangeable potassium 150 mg kg^{-1}. The seedbed was made by disrupting a legume fallow with a mouldboard ploughed 35 cm deep at the beginning of September. Before seedbed preparation, the experimental plots was equipped with a permanent water pipeline system based on rotary sprinklers. Supplemental irrigations were applied as needed to prevent visual wilt of the turf by sprinkling during summer season.

Prior to seeding, nitrogen and phosphorus fertilizers were applied at a rate of 75 kg ha^{-1} of N and 75 kg ha^{-1} P_2O_5, and 50 kg ha^{-1} K_2O respectively, before levelling the soil with a cultivator and harrow. In the first week of November 2002, seed of Taya, Belida, Capri, Sakini, Ovation, Delaware cultivars of perennial ryegrass (***Lolium perenne* L.**), Houndog, Mustang, Finelawn, Cochise of tall fescue (***Festuca arundinacea* Schreb.**), Geronimo, Conni, Sobra, Emprima of Kentucky bluegrass (***Poa pratensis* L.**) and Highland, Highlandband, Denso, Tracenta of colonial bentgrass (***Agrostis tenuis* Sibth**) were hand sown in plots of 2 m^2 (2m x 1m) at the seed rate of 20 g m^{-2} for Kentucky bluegrass, 35 g m^{-2} for the varieties of other turfgrass species tested. Plots were arranged in a group block design randomly with four replicates. Invading weeds were hand removed during the establishment period, later on, dicotyledonous weed encroachment was controlled by herbicide. Nitrogen, phosphorus and potassium fertilizers were manually applied in all entries at a rate of 10 g m^{-2} in five rounds (early April, May, June, July and August) The plots were mown at a height of 25-30 mm when the turfgrass was 50-60 mm tall by using a rotary mover (Massport Maxicatch 500), recovering and discarding the clippings.

Turfgrass quality was assessed by a visual score based on a 1-9 scale, as used in the National Turfgrass Evaluation Program in the USA. The lowest level (1) defines very poor turf quality, light green turf and bare soil while the highest level (9) indicates outstanding turf quality, dark green turf and very dense cover. Observations were maintained on a monthly basis whereas scoring was carried out on a seasonal basis, in the middle of each season (April, June, July, October, January).

Statistical analysis was conducted by using TOTEMSTAT (Acikgoz et al., 2004). Probabilities equal to or less than 0,05 were considered significant. If, TOTEMSTAT indicated differences between treatments means, a LSD test was performed to separate them.

RESULTS

Turf Cover

Mediterranean climatic parameters (rainfall, temperature, air humidity, etc.) occurring in the seasons during the period of turf growth had significant impact on turf cover traits of the cultivars of turf species tested in the experiment (Table 1).

Table 1. Turf Cover Scores of Four Cool Season Turfgrass Species in 2003-2005

	Turf Cover														
	2003					2004					2005				
	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Lolium perenne															
Taya	7.6	8.4	7.3	7.6	7.7	7.8	8.1	7.1	7.8	7.7	7.4	8.0	6.9	7.6	7.5
Belida	7.0	8.2	7.0	7.6	7.5	7.3	7.8	7.0	7.4	7.4	6.9	7.6	6.8	7.0	7.1
Capri	6.9	7.9	6.9	7.1	7.2	7.1	8.1	6.7	7.5	7.3	7.2	7.5	6.9	7.7	7.3
Sakini	7.7	8.3	7.4	7.8	7.8	8.1	8.0	7.1	8.1	7.8	7.8	8.1	7.2	8.0	7.8
Ovation	7.1	7.8	7.1	6.9	7.2	7.6	7.8	7.0	7.4	7.5	7.8	7.6	6.8	7.6	7.5
Delaware	7.8	8.4	7.5	7.5	7.8	7.9	8.2	7.4	8.2	7.9	7.9	8.0	7.1	8.1	7.8
M	7.3	8.2	7.2	7.4	7.5	7.6	8.0	7.1	7.7	7.6	7.5	7.8	7.0	7.7	7.5
LSD %5 Y: ns	S: 0.1		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca arundinaceae															
Houndog	7.3	8.4	8.1	8.4	8.0	7.8	8.5	8.3	8.2	8.2	8.1	8.6	8.1	8.6	8.4
Mustang	7.8	8.6	7.9	8.5	8.2	8.1	8.5	7.8	8.6	8.2	8.4	8.7	8.4	8.8	8.6
Finelawn	7.6	8.1	7.8	7.9	7.8	7.5	8.5	7.9	7.9	8.0	8.0	8.5	7.8	8.3	8.1
Cochise	8.1	8.6	8.4	8.8	8.5	8.2	8.8	8.5	8.8	8.6	8.4	8.8	8.4	8.8	8.6
M	7.7	8.4	8.0	8.4	8.1	7.9	8.6	8.1	8.4	8.3	8.2	8.7	8.2	8.6	8.4
LSD %5 Y: 0.2	S: 0.2		C:0.2		YxS: ns		YxC: ns		SxC: ns		YxSxC: ns				
Poa pratensis															
Geronimo	7.2	7.1	4.6	4.3	5.8	4.1	4.2	2.4	2.5	3.3	3.1	3.1	1.8	1.6	2.4
Conni	6.6	6.8	4.7	4.4	5.6	3.8	3.6	2.2	2.8	3.1	2.9	3.1	1.9	1.4	2.3
Sobra	6.1	6.4	4.1	3.9	5.1	3.1	2.9	1.9	2.1	2.5	1.7	1.9	0.7	0.9	1.3
Emprima	5.9	6.1	4.1	3.8	5.0	3.4	2.8	1.8	2.1	2.5	1.7	2.1	0.7	1.1	1.4
M	6.5	6.6	4.4	4.1	5.4	3.6	3.4	2.1	2.4	2.9	2.4	2.6	1.3	1.3	1.9
LSD %5 Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Agrostis tenuis															
Highland	6.4	6.1	4.1	4.1	5.2	5.2	4.9	3.2	2.8	4.0	3.4	3.6	2.9	2.4	3.2
Highlandbend	6.5	6.1	4.1	4.1	5.2	5.1	4.9	3.3	2.6	4.0	3.8	3.4	3.1	2.4	3.2
Denso	5.9	6.2	3.9	3.6	4.9	4.3	4.1	2.3	2.0	3.2	2.2	2.6	2.4	1.7	2.2
Tracenta	5.9	5.8	3.8	3.3	4.7	4.3	4.0	2.3	2.0	3.2	2.2	2.6	2.4	1.7	2.2
M	6.2	6.0	4.0	3.8	5.0	4.7	4.5	2.7	2.4	3.6	3.0	3.1	2.7	2.0	2.7
LSD %5 Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: 0.3		SxC: ns		YxSxC: ns				

Y: Year S: Season C: Cultivar ns: not significant Wi:Winter Sp: Spring Su:Summer Au:Autumn M: Mean

Variation analysis indicated that there was a significant influence of year, season and cultivar in all cultivars of turfgrass species, except year in perennial ryegrass. The three- and two-factor interactions were not significant, while YxS (two factor) interaction had significant impact on cover traits of cultivars of perennial ryegrass, Kentucky bluegrass and colonial bentgrass, except for tall fescue cultivars. Year, season, cultivar and YxS interaction was the main source of the variation which created significant differences among the cultivars almost all in turf species.

All cultivars of turf species were best adapted to humid seasons (winter, spring, autumn) for the turf cover trait, whereas the scores were extremely lower in summer. In this season, the best adaptability for mean turf cover was observed in all tall fescue cultivars for the succeeding three years (8.0-8.1-8.2, respectively) and perennial ryegrass cultivars also maintained acceptable levels of scores (7.2-7.1-7.0, respectively) in summer season throughout the experimental years and in three years average (Figure 1).

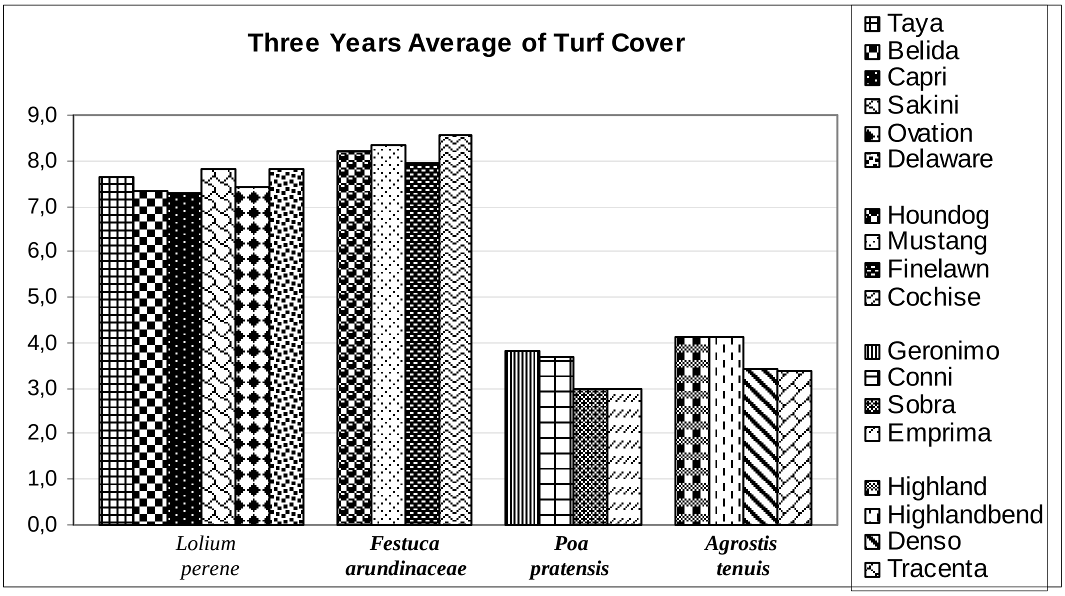

Figure 1. Turf Cover Scores of Four Cool Season Turfgrass Species

The Kentucky bluegrass cultivars had generally lower turf cover scores than other turfgrass cultivars and the declining values, displaying very poor turf cover in the stands, in the duration of experimental years were evident. Although the colonial bentgrass cultivars, with average scores of 6.4-6.5-5.9-5.9, respectively in winter and 6.1-6.1-6.2-5.8, respectively in spring, showed an average rate of adaptation to Mediterranean weather conditions in the first experimental year, the turf cover scores declined drastically almost in all seasons of the succeeding years.

Turf Colour

The turf colour, being an indication indicator of healthy development and higher rate of photosynthetic activity in turf crops, is a favourable trait to evaluate the turfs (Martinello, 2005). Variation analysis of the turf colour trait scores indicated the significance of the effects of season, cultivar and year x season (YxS) interaction in all turfgrass species and also year effect in Kentucky bluegrass and colonial bentgrass. The effect of three-factor and two-factor interactions was not significant (Table 2).

Perennial ryegrass cultivars maintained very high turf colour scores throughout the experimental years and Taya (8.3-8.4-8.3, respectively) and Delaware (8.3-8.4-8.4, respectively) were the most favourable cultivars in the succeeding years. The colour scores of all cultivars declined in summer season and were higher in winter. The colour trait scores of tall fescue cultivars were also among acceptable levels, while Houndog (7.8-7.8-7.5, respectively) and Cochice (8.0-7.7-8.1, respectively) cultivars performed better than other genotypes in the species. Unlike of other turf species, all cultivars of this species had also high colour scores in summer seasons throughout the experimental years and in three years average (Figure 2). The Kentucky bluegrass species displayed the highest colour scores in winter seasons of different years, Geronimo (8.1-8.2-8.0, respectively) and Conni (8.2-8.3-8.0, respectively) being the most successful cultivars, although the colour scores of all cultivars were the lowest in summer season. The colour scores of colonial bentgrass cultivars were lower than the scores of other species cultivars and summer season scores were the lowest in all experimental years while declining mean colour scores were evident in succeeding years as well. It was also recorded that Highland (7.2-7.2-6.9, respectively for different years) and Highlandband (7.1-7.1-6.9, respectively for different years) performed relatively better than other cultivars in the species.

Turf Quality

The turf quality trait is a widely used criterion to define the overall performances of turfs in turf management practices. The variation analysis of turf quality scores of turf species cultivars tested in the experiment revealed the significant effect of season, cultivar, year x season interaction

(YxS) and also year on the turf quality of all species tested, except for tall fescue. The effect of three and two factor interactions was not significant (Table 3).

The turf quality trait scores of perennial ryegrass cultivars were the highest in the winter of the first year and declined gradually in the course of the experimental years. Mean quality scores were always lower in summer unlike other seasons, Delaware (8.2-7.7-7.0, respectively) and Ovation (8.1-7.6-6.6, respectively) were the most successful cultivars tested in the three years. Tall fescue was the only species maintaining high quality scores in the succeeding three years including summer seasons. Mustang (8.2-8.2-8.1, respectively) and Cochise (8.4-8.4-8.3, respectively) proved to be the best performing cultivars almost in all seasons during the experimental years and in the three years averagely (Figure 3).

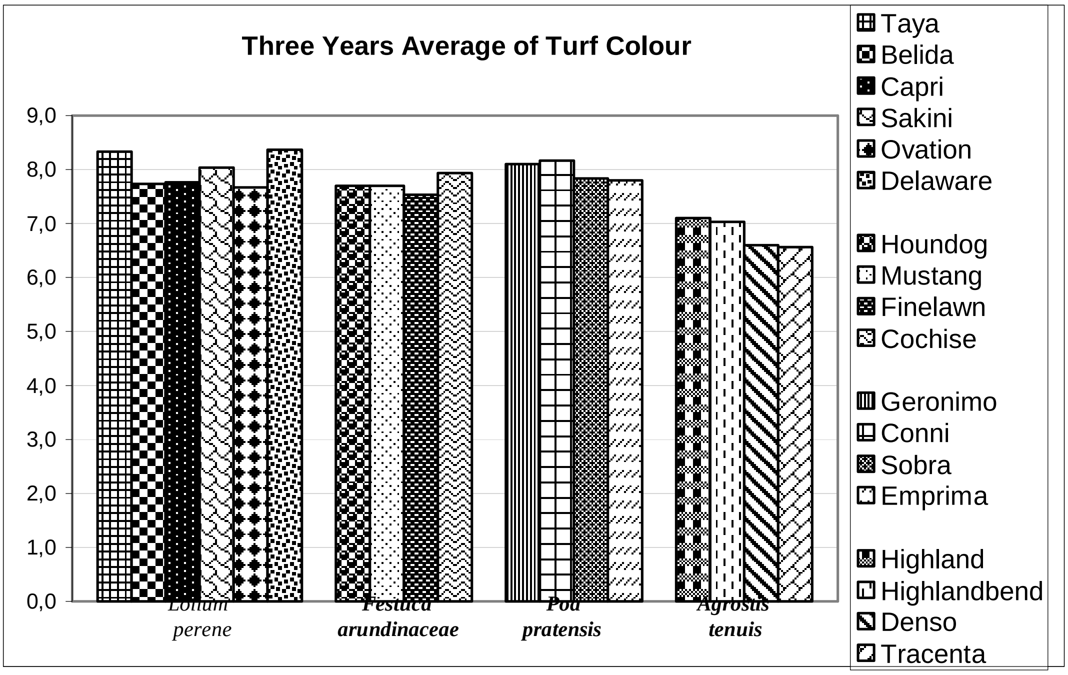

Figure 2. Turf Colour Scores of Four Cool Season Turfgrass Species

Table 2. Turf Colour Scores of Four Cool Season Turfgrass Species in 2003-2005

Turf Colour															
	2003					2004					2005				
	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Lolium perenne															
Taya	8.5	8.4	7.9	8.3	8.3	8.8	8.6	8.1	8.1	8.4	8.6	8.4	8.0	8.2	8.3
Belida	8.1	7.9	7.4	7.8	7.8	8.0	7.8	7.2	7.6	7.7	8.4	7.9	7.0	7.4	7.7
Capri	8.1	7.9	7.4	7.6	7.8	7.9	8.1	7.4	7.7	7.8	8.2	8.0	7.1	7.3	7.7
Sakini	8.2	7.9	8.0	8.3	8.1	8.5	8.1	7.8	8.0	8.1	8.6	8.0	7.3	7.6	7.9
Ovation	8.0	7.8	7.0	7.8	7.7	7.9	8.0	7.2	7.8	7.8	8.1	7.9	7.0	7.2	7.5
Delaware	8.6	8.4	7.8	8.3	8.3	8.9	8.3	8.0	8.2	8.4	8.8	8.4	8.2	8.2	8.4
M	8.3	8.1	7.6	8.0	8.0	8.3	8.2	7.6	7.9	8.0	8.5	8.1	7.4	7.7	7.9
LSD %5 Y: ns	S: 0.1		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca arundinaceae															
Houndog	7.7	7.7	7.9	7.6	7.8	7.8	8.3	7.3	7.8	7.8	7.4	7.8	7.1	7.7	7.5
Mustang	7.9	8.2	8.0	7.2	7.8	7.6	8.2	7.6	7.4	7.7	7.7	8.2	7.0	7.6	7.6
Finelawn	7.3	7.8	7.9	7.4	7.6	7.0	7.9	7.9	7.4	7.6	7.1	8.0	7.1	7.3	7.4
Cochise	7.9	8.1	8.2	7.9	8.0	7.8	7.4	7.4	8.1	7.7	8.4	8.5	7.8	7.9	8.1
M	7.7	8.0	8.0	7.5	7.8	7.5	8.0	7.7	7.7	7.7	7.6	8.1	7.3	7.6	7.7
LSD %5 Y: ns	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Poa pratensis															
Geronimo	8.7	8.6	6.9	8.2	8.1	8.9	8.8	7.1	8.1	8.2	9.0	8.4	6.7	7.9	8.0
Conni	8.7	8.8	7.1	8.4	8.2	8.8	8.7	7.3	8.3	8.3	8.8	8.8	6.1	8.2	8.0
Sobra	8.4	8.1	6.8	7.9	7.8	8.6	8.2	6.9	7.8	7.9	8.8	8.5	5.9	7.9	7.8
Emprima	8.4	8.1	6.4	7.9	7.7	8.6	8.2	6.9	7.9	7.9	8.8	8.5	5.9	7.9	7.8
M	8.5	8.4	6.8	8.1	8.0	8.7	8.5	7.1	8.1	8.1	8.9	8.5	6.2	8.0	7.9
LSD %5 Y: 0.1	S: 0.1		C:0.1		YxS: 0.2		YxC: ns		SxC: ns		YxSxC: ns				
Agrostis tenuis															
Highland	7.5	7.2	6.9	7.1	7.2	7.4	7.0	7.1	7.2	7.2	7.1	6.9	6.8	6.9	6.9
Highlandbend	7.1	7.4	6.7	7.2	7.1	7.4	7.0	6.9	7.2	7.1	7.2	6.9	6.7	6.8	6.9
Denso	6.8	7.1	6.3	6.9	6.8	6.4	6.9	6.2	6.8	6.6	6.8	6.5	6.0	6.1	6.4
Tracenta	6.8	7.1	6.3	7.0	6.8	6.4	6.9	6.2	6.6	6.5	6.9	6.5	6.0	6.1	6.4
M	7.1	7.2	6.6	7.1	7.0	6.9	7.0	6.6	6.9	6.9	7.0	6.7	6.4	6.5	6.7
LSD %5 Y: 0.1	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				

Table 3. Turf Quality Scores of Four Cool Season Turfgrass Species in 2003-2005

	Turf Quality														
	2003					2004					2005				
	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Lolium perenne															
Taya	8.3	8.1	6.1	6.9	7.4	7.8	7.8	5.7	7.0	7.1	6.2	6.0	5.5	6.2	6.0
Belida	7.2	7.9	5.9	6.2	6.8	6.6	7.2	5.0	6.2	6.3	5.1	6.1	4.5	5.7	5.4
Capri	7.6	7.7	5.9	7.1	7.1	6.9	7.3	5.1	6.3	6.4	5.4	6.6	5.0	5.9	5.7
Sakini	8.8	8.2	6.8	8.1	8.1	8.4	7.7	6.3	6.9	7.3	6.6	7.0	6.2	6.3	6.5
Ovation	8.8	8.9	6.8	7.9	8.1	8.2	7.9	6.9	7.4	7.6	6.7	7.1	5.9	6.7	6.6
Delaware	8.8	9.0	7.2	7.8	8.2	8.4	8.1	6.9	7.3	7.7	7.1	7.7	6.1	6.9	7.0
M	8.3	8.3	6.5	7.4	7.6	7.7	7.7	6.0	6.9	7.1	6.2	6.8	5.5	6.3	6.2
LSD %5 Y:0.1	S: 0.2		C:0.2	YxS: 0.3			YxC: ns		SxC: ns		YxSxC: ns				
Festuca arundinaceae															
Houndog	8.2	8.6	8.1	7.7	8.2	7.9	8.2	7.9	7.9	8.0	8.1	8.0	8.0	7.8	8.0
Mustang	8.0	8.7	8.2	8.0	8.2	7.7	9.0	7.8	8.2	8.2	7.9	8.5	7.9	8.0	8.1
Finelawn	8.1	8.8	7.9	8.1	8.2	8.0	9.0	8.1	7.9	8.3	8.4	8.7	8.3	8.1	8.4
Cochise	8.2	9.0	8.1	8.3	8.4	8.3	8.8	8.3	8.0	8.4	8.1	8.8	8.1	8.4	8.3
M	8.1	8.8	8.1	8.0	8.3	8.0	8.8	8.0	8.0	8.2	8.1	8.5	8.1	8.1	8.2
LSD %5 Y: ns	S: 0.2		C:0.2	YxS: 0.3			YxC: ns		SxC: ns		YxSxC: ns				
Poa pratensis															
Geronimo	7.8	7.1	3.2	6.6	6.2	6.5	6.6	2.9	5.5	5.4	5.6	5.0	2.1	2.8	3.9
Conni	7.5	7.2	3.6	6.4	6.2	6.0	6.6	2.9	5.2	5.2	5.9	5.4	2.4	2.9	4.2
Sobra	7.1	7.0	3.1	5.9	5.8	5.9	6.0	2.6	5.1	4.9	5.1	5.1	2.1	2.1	3.6
Emprima	7.5	7.2	3.4	5.2	5.8	6.1	6.1	2.5	4.8	4.9	4.8	4.9	2.0	2.3	3.5
M	7.5	7.1	3.3	6.0	6.0	6.2	6.3	2.7	5.1	5.1	5.4	5.1	2.2	2.5	3.8
LSD %5 Y: 0.4	S: 0.4		C:ns	YxS: 0.8			YxC: ns		SxC: ns		YxSxC: ns				
Agrostis tenuis															
Highland	7.3	6.9	5.8	5.9	6.5	6.5	6.6	2.9	5.5	5.4	5.6	5.0	2.1	2.8	3.9
Highlandbend	7.2	7.1	5.9	5.4	6.4	6.0	6.6	2.9	5.2	5.2	5.9	5.4	2.4	2.9	4.2
Denso	7.0	6.6	5.7	5.5	6.2	5.9	6.0	2.6	5.1	4.9	5.1	5.1	2.1	2.1	3.6
Tracenta	7.2	6.4	5.7	5.2	6.1	6.1	6.1	2.5	4.8	4.9	4.8	4.9	2.0	2.3	3.5
M	7.2	6.8	5.8	5.5	6.3	6.2	6.3	2.7	5.1	5.1	5.4	5.1	2.2	2.5	3.8
LSD %5 Y: 0.2	S: 0.2		C:0.2	YxS: 0.3			YxC: ns		SxC: ns		YxSxC: ns				

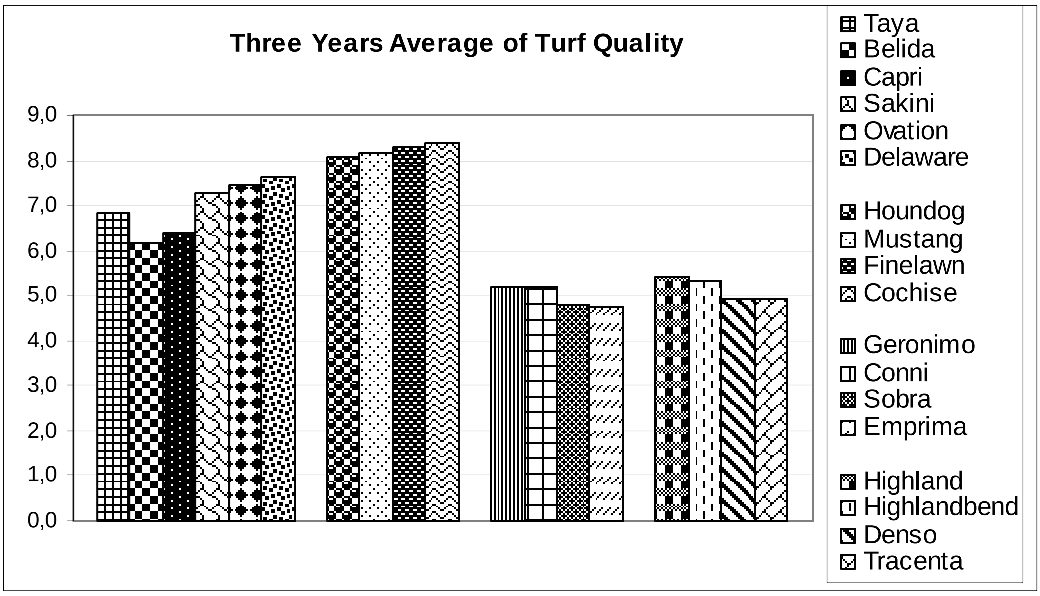

Figure 3. Turf Quality Scores of Four Cool Season Turfgrass Species

The cultivars of Kentucky bluegrass and colonial bentgrass species displaying the indications of very limited adaptability to experimental conditions of Mediterranean environment scored significantly lower than perennial ryegrass and tall fescue. Year by year, gradually decreasing mean scores of quality trait of the most adaptable cultivars in Kentucky bluegrass (Geronimo; 6.2-5.4-3.9 and Conni; 6.2-5.2-4.2, respectively) and bentgrass species (Highland; 6.5-5.4-3.9 and Highlandband; 6.4-5.2-4.2, respectively) were the clear evidences of declining performances of these two species.

DISCUSSION

The obtained results showed a wide range of adaptability of the cool season turfgrass species cultivars to the existing weather conditions. The genotypes of all species were differently adapted to the weather conditions of the Mediterranean experimental area, occurring across the seasons of the years evaluated. The variation in scores observed among seasons in turf cover, colour and quality traits of all species proved the better growth adaptability of genotypes to climatic conditions of the winter, autumn and spring seasons rather than summer. Van Huylenbroeck et al. (1999) stated that better growth activities of turfgrasses in cool seasons (winter, spring and autumn) may be ascribed to more efficient biological mechanisms in these seasons. All species, except tall fescue, had reduced adaptability in summer seasons almost in all experimental years. According to Belisario et al. (2001) and Volterrani et al. (2001), reduced adaptability observed in summer season may be attributed to the negative effects of climatic parameters and susceptibility to pathogen agents occurring in summer period on plant development. Our results were also in agreement with results of Russi et al. (2001) and Kuşvuran (2009). In all turfgrass species, turf cover, because of evaluated plant development, was the most affected parameter by weather conditions (Russi et al., 2004). The high and increasing values of turf cover scores in tall fescue cultivars were attributed to greater adaptability to dry and hot environmental conditions. Yılmaz and Avcioglu (2000) indicated the superiority of similar tall fescue cultivar under transitional climatic conditions of Tokat. Martinello and D'Andrea (2006) also stated that tall fescue and Kentucky bluegrass had higher values of turf cover in summer because of drought resistance in tall fescue and reduction in pathogen injury in Kentucky bluegrass. Our findings in Kentucky bluegrass were not in agreement with the indications of Martinello and D'Andrea (2006), Volterrani et al. (2001) and Van Huylenbroeck et al. (1999). But our results for Kentucky bluegrass species were in agreement with results of Arslan and Çakmakçı (2004), obtained under typical Mediterranean environmental conditions of Antalya, Southern Turkey.

Tall fescue and perennial ryegrass cultivars, unlike cultivars of Kentucky bluegrass and colonial bentgrass scored more highly in all turf parameters. The perennial ryegrass was the species with some cultivars showing acceptable rate of adaptability of the genotypes to Mediterranean climatic conditions. Sakini and Delaware cultivars of perennial ryegrass and Cochise and Mustang cultivars of tall fescue performed better than other genotypes tested. Throughout the experimental years, the declining turf cover scores and deeply poor performances of Kentucky bluegrass and colonial bentgrass cultivars were the indication of being physiologically worse endowed to cope with the ecological conditions of Mediterranean environment (Daget, 1985). Zorer et al. (2009) also reported that cultivars of bentgrass species were not adaptable to the dry continental climatic conditions of Van region.

CONCLUSION

This evaluation experiment described in this study, although not providing information for identification of ideal components for possible mixtures, confirmed the outstanding value of tall fescue and partially perennial ryegrass cultivars for Mediterranean environments. Kentucky bluegrass and colonial bentgrass species including all cultivars were not found recommendable for Mediterranean ecological conditions of the experimental area.

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