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PERFORMANCES OF SOME COOL SEASON TURFGRASS CULTIVARS IN MEDITERRANEAN ENVIRONMENT: II. *Festuca arundinacea* Schreb., *Festuca ovina* L., *Festuca rubra* spp. *rubra* L., *Festuca rubra* spp. *trichophylla* Gaud and *Festuca rubra* spp. *commutata* Gaud

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ABSTRACT

The commitment to turf research is more recent and is challenged by the diversity of climatic conditions occurring in Anatolian peninsula of Turkey. These differences in climatic factors and environmental variation may determine the specific adaptation of species to certain areas and complicate the species and cultivar recommendations. In this present study, aiming to evaluate the adaptability and quality of newly introduced cultivars of different cool season turfgrass species in a Mediterranean environment in western Turkey, Bornova-İzmir, four cultivars of Tall fescue (*Festuca arundinacea* Schreb), Sheep fescue *(Festuca ovina* L), *Festuca rubra* L. spp. *trichophlylla* Gaud (Slender creeping red fescue) and *Festuca rubra* spp. *rubra commutata* Gaud (Chewings red fescue) and six cultivars of *Festuca rubra* spp. *rubra* L. (Creeping red fescue) were tested for 3 years (2003-2005) in a replicated experimental block group design. Turf cover, colour and quality traits of these cool season turfgrass cultivars were evaluated by using a visual score (1-9) and the target of the generated information was the support turfgrass specialist in turfgrass cultivars selection and recommendations and research institutions for their breeding programs. Results indicated that tall fescue cultivars were the only genotypes maintaining high scores of cover, colour and quality in different seasons and years. Sheep fescue cultivars were also consistent throughout the experimental years, although their colour, cover and quality scores were not high. We also suggested that all red fescue sub-species were not fully adaptable to Mediterranean conditions and their usage had to be limited in turf mixtures.

Key words: Cool-season turfgrass, tall fescue, sheep fescue, creeping red fescue slender creeping red fescue, chewings red fescue, adaptability, Mediterranean environment.

INTRODUCTION

Modern society wants to be close in touch with nature and demands to benefit from its physical and physiological health advantages. This approach is raising the significance of turfs and turfgrasses which are the fundamental segments of green spaces, sport fields, parks and other recreational areas.

Turf and turfgrasses are also fundamental agents for safeguarding the environment by different techniques, e.g. in controlling erosion in roadsides, rivers, grazing lands and problematic agricultural areas (Tallarico and Argenti, 2001).

Turf industry is a consolidated sector of the economy in some countries, such as USA, UK, Netherland and Denmark. The common varieties of cool season turfgrass species have been developed from public institutions and breeding companies in Northern Europe and the USA (Martiniello and D'Andrea, 2006). The commitment to turf research is more recent and is challenged by the diversity of climatic conditions occurring in Anatolian peninsula of Turkey. These differences in climatic factors and environmental variation may determine the specific adaptation of species to certain areas and complicate the species and cultivar recommendations. As an example, cool-season turfgrasses exhibit optimal growth at 16-24°C, with reduction of impaired growth when the temperature reaches 33 °C, (Beard, 1973; Van Huylenbroeck, et al. 1999). The atmospheric parameters during the summer months in locations with a typical Mediterranean climate may dictate a prolonged period of drought and heat stress which reduce the physiological activity of turf growth and hence the quality of the lawn (Martiniello and D'Andrea, 2006). Under those circumstances, turf specialists always need to have the detailed knowledge on adaptability of turf material to weather conditions which allows them to identify turfgrass species and genotypes better able to tolerate and exploit the resources of the existing environments (Daget, 1985; Beard, 1989).

Although the cultivars of *Festuca arundinacea* (Tall fescue), *Festuca ovina* L. (Sheep fescue), *Festuca rubra* spp. *rubra* L. (Creeping red fescue), *Festuca rubra* L. spp. *trichophlylla* Gaud (Slender creeping red fescue) and *Festuca rubra* spp. *rubra commutata* Gaud (Chewings red fescue) turfgrass species present large performance variability and different responses to diversifying weather conditions (Acikgöz,1994, Avcioglu, 1997), it is a fact that those cool season turfgrasses' adaptability and physiologically enduring to cope with the conditions of

Mediterranean environments are the major question of vital significance.

Many researchers investigated the adaptability of wide range of cool season turfgrasses in Mediterranean environments and quality traits of cultivars in Mediterranean areas of their countries, such as Greece, Italy, Spain, France and Turkey in last decades (Daget, 1985; Van Huylenbroeck, et al. 1999; Annicchiarico et al. 2000; Yılmaz, 2000; Russi et al. 2001; Volterrani et al. 2001; Martiniello, 2005; Martiniello and D'Andrea, 2006, Bilgili and Acikgöz, 2007; Zorer et al. 2009; Avcıoglu et al. 2009). All of them aimed to determine the fundamentals of species adaptation and selection of cool-season turfgrasses for Mediterranean environments.

In the present study, turf quality, colour and cover traits of 22 different cool season turfgrass cultivars belonging to five species were evaluated under Mediterranean climatic conditions of west cost of Turkey for 3 years and the aim of the generated information was to support turf specialists in turfgrass cultivars selection and recommendations and research institutions for their breeding programs.

MATERIALS AND METHODS

The experiment was established in November 2002 on the experimental farm, located in Bornova (38° 27. 236 N, 27° 13. 576 E and 28 m above see level), Ege University, Izmir, Turkey. During the study period the site with a Mediterranean climate had a long year average rainfall of 658 mm, a daily mean temperature 18.2°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 cereal fallow with a mouldboard ploughed 35 cm deep at the beginning of September. Before seedbed preparation, the experimental plots were 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 and potassium 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, seeds of Eldorado Wrangler, Apache, Debussy cultivars of tall fescue (*Festuca arundinacea* Schreb.); Pamela, Ridu, Nordic, Pintor cultivars of sheeps fescue (*Festuca ovina* L.); Pernille, Picnic, Victor, Engina, Franklin, Bargena cultivars of creeping red fescue (*Festuca rubra* spp *rubra* L.); Mocassin, Suzette, Libano, Napoli cultivars of slender creeping red fescue (*Festuca rubra* spp. *trichophylla* Gaud.) and Enjoy, Ivalo, Tamara, Bargreen cultivars of chewings fescue (*Festuca rubra* spp. *commutata* Gaud.) were hand sown in plots of 2 m^2 (2m x 1m) at the seed rate of 35 g m^{-2} for tall fescue, 25 g m^{-2} for the cultivars of other turfgrass species. Plots were arranged in a group block design with four replicates. Invaded weeds were hand removed during the establishment period, later on dicotyledonous weed encroachment was controlled by herbicide. Nitrogen, phosphorus and potassium fertilizer was 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, while scoring was carried out on a seasonal basis, in the middle of each season (April, June, July, October, and January).

Statistical analysis were conducted by using TOTEMSTAT statistical program (Açıkgöz 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

The average turf cover scores of cultivars of five turfgrass species in each year and season of evaluation were summarized in Table 1. Effect of year, season and cultivar were significant in all species. Year x season (YxS) interaction effect was also significant in all species, except tall fescue, while all other two and three factor interactions were not significant.

The cover scores of tall fescue cultivars were quite high in all seasons and largely consistent across the experimental years. Eldorado (8.3-8.5-8.7 respectively) and Apache (8.5-8.7-8.7 respectively) cultivars of tall fescue species had higher cover scores than all other cultivars in the species and other tested material in the experiment during three years. Sheep fescue cultivars displayed an acceptable performance and all cultivars were consistent in the stands in different years, although the mean cover scores were lower than tall fescue species particularly in three years average (Figure 1).

The mean scores of slender creeping red fescue (5.1-3.3-1.9, respectively) creeping red fescue (5.5-4.0-2.4, respectively) and chewings red fescue species (4.6-2.9-1.6, respectively) for turf cover were lower than those of tall fescue (scores) and sheep fescue (scores) in succeeding experimental years. The adaptability of these 3 subspecies was extremely limited in summer seasons in each year and sheep fescue cover scores also declined (5.5-5.4-5.1, respectively) in this hot and dry period of Mediterranean environment during the experimental years.

Table 1. Turf Cover Scores of Turfgrass Species by Seasons in Different Years

		Turf Cover														
		2003					2004					2005				
		Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Festuca arundinaceae																
Wrangler		7.1	8.2	8.0	8.3	7.9	7.6	8.3	8.0	8.1	8.0	8.0	8.6	8.0	8.3	8.2
Eldorado		7.9	8.8	8.2	8.5	8.3	8.4	8.6	8.1	8.7	8.5	8.6	8.7	8.5	8.8	8.7
Debussy		7.3	7.7	7.6	7.7	7.6	7.5	8.0	7.7	7.7	7.7	7.7	8.0	7.6	8.0	7.8
Apache		8.2	8.6	8.5	8.8	8.5	8.3	8.9	8.7	8.8	8.7	8.3	8.8	8.7	8.9	8.7
M		7.6	8.3	8.1	8.3	8.1	8.0	8.5	8.1	8.3	8.2	8.1	8.5	8.2	8.5	8.3
LSD %5	Y: ns	S: 0.1		C:0.1		YxS: ns		YxC: ns		SxC: 0.2		YxSxC: ns				
Festuca ovina																
Pamela		6.5	7.1	5.4	6.1	6.3	6.4	7.0	5.1	5.8	6.1	6.0	6.6	4.9	4.8	5.6
Ridu		6.8	7.4	5.8	6.0	6.5	6.4	7.2	5.7	6.1	6.4	5.9	6.9	5.4	5.3	5.9
Nordic		6.7	6.9	5.9	5.9	6.4	6.6	6.7	5.7	6.0	6.3	5.3	7.0	5.3	5.0	5.7
Pintor		6.1	7.1	5.1	5.9	6.1	6.1	6.4	5.0	5.4	5.7	5.3	6.3	4.8	4.6	5.2
M		6.5	7.2	5.5	6.0	6.3	6.4	6.8	5.4	5.8	6.1	5.6	6.7	5.1	5.0	5.6
LSD %5	Y: 0.1	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra rubra																
Pernille		6.1	6.4	5.1	5.1	5.7	5.4	4.6	3.6	4.0	4.4	3.6	3.5	2.1	1.9	2.8
Picnic		5.9	6.4	4.8	5.3	5.6	4.9	4.7	3.7	4.0	4.4	3.9	3.7	1.9	1.9	2.9
Victor		5.4	5.8	4.6	4.9	5.2	4.7	4.1	2.9	3.2	3.7	2.7	2.6	1.8	1.4	2.2
Engina		6.1	6.5	4.3	5.0	5.5	5.1	4.2	2.7	3.1	3.8	2.8	2.6	1.6	1.4	2.1
Franklin		6..3	6.6	5.2	5.3	5.5	5.5	4.8	3.5	3.4	4.3	3.1	2.8	1.7	1.8	2.3
Bargena		5.8	5.7	4.2	4.6	5.1	4.8	3.9	3.0	2.9	3.7	2.9	2.4	1.4	1.4	2.1
M		5.9	6.2	4.7	5.0	5.5	5.1	4.4	3.2	3.4	4.0	3.2	2.9	1.7	1.7	2.4
LSD %5	Y: 0.1	S: 0.1		C:0.2		YxS: 0.2		YxC: 0.3		SxC: ns		YxSxC: ns				
Festuca rubra trichophylla																
Mocassin		6.1	5.9	4.8	4.7	5.4	4.8	4.6	2.8	2.4	3.7	2.3	1.8	1.9	2.1	2.0
Suzette		5.3	5.7	4.4	4.7	5.2	4.7	4.3	2.8	2.4	3.5	2.1	1.6	2.1	2.1	2.0
Libano		5.4	5.6	3.9	4.1	4.8	3.9	3.8	1.9	1.8	2.9	1.6	1.4	1.6	1.6	1.6
Napoli		5.3	5.9	4.6	4.2	5.0	4.2	3.6	2.1	2.1	3.0	1.7	2.1	1.7	1.9	1.9
M		5.7	5.8	4.5	4.5	5.1	4.4	4.1	2.4	2.2	3.3	1.9	1.7	1.8	1.9	1.9
LSD %5	Y: 0.1	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra commutata																
Enjoy		5.4	4.9	4.1	3.9	4.6	4.0	4.1	1.9	1.9	3.0	2.1	1.6	1.4	1.3	1.6
Ivalo		5.6	5.2	4.6	3.8	4.8	3.6	4.0	1.8	1.9	2.9	2.1	1.6	1.3	1.5	1.6
Tamara		6.1	5.3	3.8	4.1	4.8	3.8	4.3	2.1	1.4	2.9	1.6	2.0	1.5	2.1	1.8
Bargreen		5.0	5.2	3.2	3.7	4.3	4.1	3.6	1.6	1.4	2.7	1.6	1.4	1.2	1.3	1.4
M		5.5	5.2	3.9	3.9	4.6	3.9	4.0	1.9	1.7	2.9	1.8	1.6	1.4	1.5	1.6
LSD %5	Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: 0.6				

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

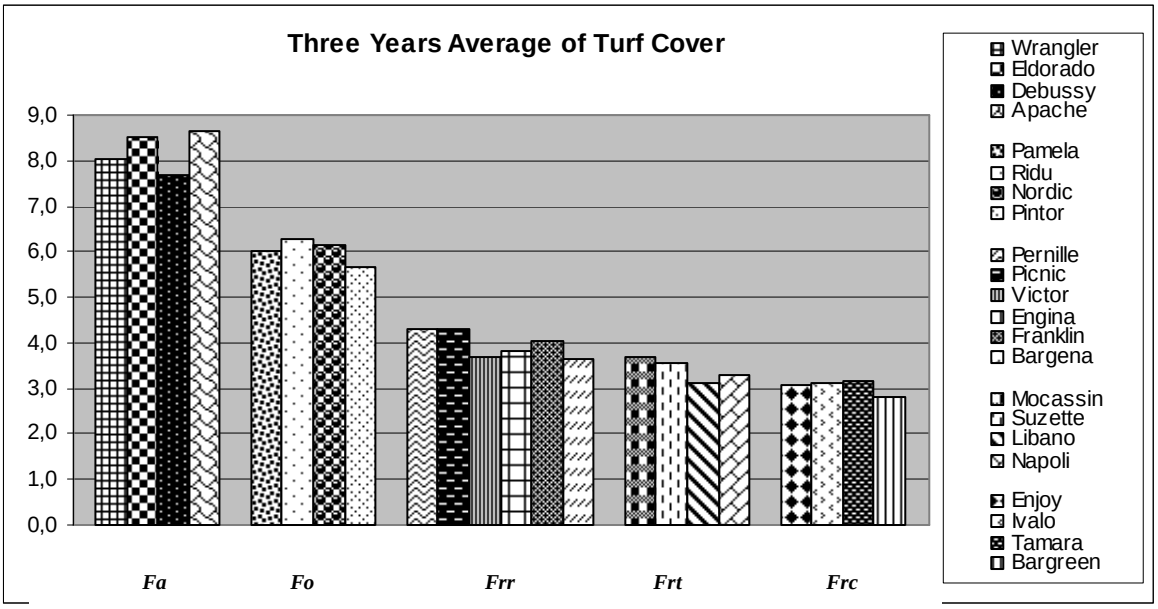

Figure 1. Turf Cover Scores of Five Cool Season Turfgrass Species
Fa: *Festuca arundinacea* Fo: *Festuca ovina* Frr: *Festuca rubra rubra* Frt:*Festuca rubra trichophylla* Frc:*Festuca rubra commutata*

Turf Colour

There was great variation among the different cultivars of turfgrass species with regard to turf colour scores in different seasons and years. Main effects of those factors and year x season (YxS) interaction were significant while all other two and three factor interaction effects were not significant.

The turf colour scores of tall fescue species in different seasons were consistent and higher than other species' scores in the duration of experimental years (Table 2) and three years average (Figure 2), although to some extent, significant variation were detected among the cultivars within the species. Apache cultivar with higher mean scores than other cultivars of tall fescue species in succeeding years (8.2-8.2-8.3, respectively) displayed also distinguished and outstanding colour characteristics compared to all other cultivars of tested species.

Average colour scores of sheep fescue were lower than the scores of all other species in the experiment over the experimental seasons and years, and only Ridu cultivar indicated a remarkably higher colour scores (5.8-5.8-5.7, respectively) compared to other cultivars tested within the sheep fescue species.

Creeping red, slender creeping red and chewings red fescue species showed similar trends in turf colour score variation in humid seasons (winter, spring, autumn) of different years, while the performances of all above mentioned species were lowest in summer seasons in the duration of experiment. The average colour scores were 6.7-7.0-6.3, respectively for creeping red fescue, 6.5-6.7-6.8, respectively for slender creeping red fescue and 6.9-7.0-6.8, respectively for chewings red fescue in summer season of all years. Pernille and Picnic cultivars were the remarkable turfgrass material compared to other cultivars within creeping red fescue species, whereas Suzette cultivar of slender creeping red fescue species and Tamara cultivar of chewings red fescue species had relatively higher colour scores than other cultivars tested.

Table 2. Turf Colour Scores of Turfgrass Species by Seasons in Different Years

		Turf Colour														
		2003					2004					2005				
		Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Festuca arundinaceae																
Wrangler		7.6	7.6	7.6	7.5	7.6	7.7	8.0	7.4	7.7	7.7	7.4	7.7	7.0	7.6	7.4
Eldorado		8.0	8.3	8.1	7.5	8.0	7.8	8.3	7.7	7.6	7.9	7.8	8.3	7.1	7.8	7.8
Debussy		7.2	7.7	7.8	7.3	7.5	7.0	7.8	7.8	7.3	7.5	7.0	7.9	7.0	7.2	7.3
Apache		8.0	8.2	8.5	8.0	8.2	7.6	8.6	8.2	8.3	8.2	8.6	8.6	7.9	8.1	8.3
M		7.7	8.0	8.0	7.6	7.8	7.5	8.2	7.8	7.7	7.8	7.6	8.1	7.3	7.7	7.7
LSD %5	Y: ns	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: 0.3		YxSxC: ns				
Festuca ovina																
Pamela		5.9	5.6	4.7	5.3	5.4	5.8	5.2	4.8	5.6	5.4	6.1	5.3	4.5	5.2	5.3
Ridu		6.3	5.9	5.1	5.9	5.8	6.0	5.7	5.2	6.1	5.8	6.5	5.8	4.9	5.8	5.7
Nordic		6.1	5.4	4.9	5.3	5.4	6.0	5.0	4.6	5.7	5.3	5.9	5.4	4.1	5.1	5.1
Pintor		5.9	5.4	4.6	5.1	5.3	5.9	5.3	4.6	5.4	5.3	5.7	5.1	4.1	5.1	5.0
M		6.0	5.6	4.8	5.4	5.5	5.9	5.3	4.8	5.7	5.5	6.1	5.4	4.4	5.3	5.3
LSD %5	Y: ns	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra rubra																
Pernille		7.6	6.9	6.9	7.2	7.2	7.3	7.4	7.1	7.4	7.3	7.1	7.2	6.6	7.6	7.1
Picnic		7.4	7.0	6.9	7.0	7.1	7.0	7.2	7.3	7.1	7.2	7.1	7.1	6.4	7.5	7.0
Victor		7.1	7.0	6.5	7.1	6.9	6.9	7.4	6.8	6.9	7.0	7.2	7.1	6.2	7.1	6.9
Engina		6.9	7.2	6.6	6.9	6.9	7.1	7.0	6.9	7.1	7.0	7.2	6.9	6.2	7.0	6.8
Franklin		6.9	7.0	7.0	6.9	7.0	7.1	7.0	6.9	7.2	7.0	6.8	6.9	6.0	7.0	6.7
Bargena		7.1	6.8	6.5	7.2	6.9	6.8	6.9	6.9	6.9	6.9	6.0	7.2	6.1	7.2	6.6
M		7.2	7.0	6.7	7.1	7.0	7.0	7.2	7.0	7.1	7.1	6.9	7.1	6.3	7.2	6.9
LSD %5	Y: 0.1	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra trichophylla																
Mocassin		7.1	7.1	6.4	7.2	7.0	7.3	7.4	7.0	7.3	7.3	7.3	7.1	7.0	7.0	7.1
Suzette		7.3	7.4	6.9	7.8	7.3	7.4	7.2	7.2	7.8	7.4	7.4	6.9	7.2	7.6	7.3
Libano		7.0	7.1	6.4	7.1	6.9	7.0	7.4	6.2	6.9	6.9	6.9	7.2	6.4	7.1	6.9
Napoli		7.0	7.0	6.3	7.3	6.9	7.1	7.5	6.2	7.2	7.0	6.9	7.0	6.4	7.0	6.8
M		7.1	7.1	6.5	7.3	7.0	7.2	7.4	6.7	7.3	7.2	7.1	7.1	6.8	7.2	7.0
LSD %5	Y: ns	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra commutata																
Enjoy		7.6	7.6	6.9	7.1	7.3	7.7	7.6	6.9	7.1	7.3	7.6	7.4	6.7	6.9	7.1
Ivalo		7.4	7.0	6.7	7.2	7.1	7.2	7.2	6.9	7.2	7.1	7.6	7.4	6.6	7.0	7.2
Tamara		7.8	7.4	7.1	7.4	7.4	7.9	7.4	6.8	7.3	7.3	7.7	7.2	7.2	7.3	7.3
Bargreen		7.1	7.0	6.8	6.9	7.0	7.3	7.3	7.0	7.1	7.2	7.1	7.1	6.6	6.8	7.0
M		7.5	7.3	6.9	7.2	7.2	7.5	7.4	7.0	7.1	7.2	7.5	7.3	6.8	7.0	7.2
LSD %5	Y: ns	S: 0.2		C:0.2		YxS: ns		YxC: ns		SxC: ns		YxSxC: ns				

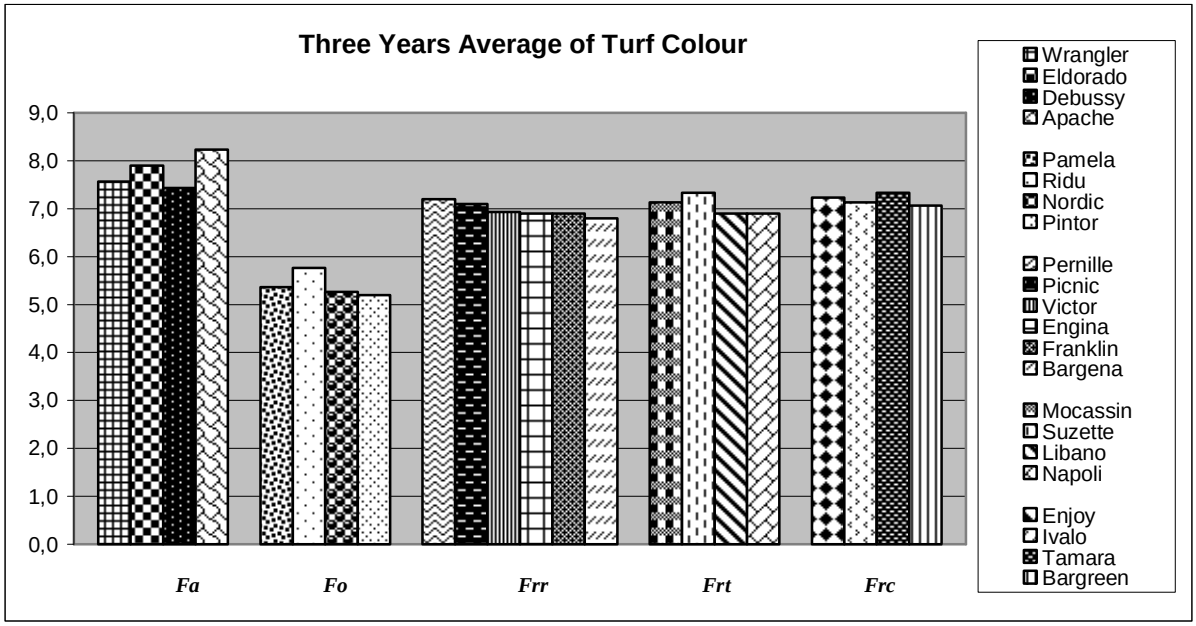

Figure 2. Turf Colour Scores of Five Cool Season Turfgrass Species

Table 3. Turf Quality Scores of Turfgrass Species by Seasons in Different Years

		Turf Quality														
		2003					2004					2005				
		Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M	Wi	Sp	Su	Au	M
Festuca arundinaceae																
Wrangler		8.0	8.5	8.0	7.6	8.0	7.9	8.1	7.6	7.8	7.9	8.0	8.0	7.8	7.7	7.9
Eldorado		8.1	8.8	8.3	8.1	8.3	8.0	9.0	8.0	8.4	8.3	7.9	8.7	8.0	8.3	8.2
Debussy		8.1	8.8	7.8	8.0	8.2	8.0	9.0	8.0	7.8	8.2	8.4	8.7	8.3	8.0	8.4
Apache		8.3	9.0	8.2	8.4	8.5	8.4	8.8	8.4	8.2	8.5	8.3	8.9	8.3	8.5	8.5
M		8.1	8.8	8.1	8.0	8.3	8.1	8.7	8.0	8.1	8.2	8.2	8.6	8.1	8.1	8.3
LSD %5	Y: ns	S: 0.1		C:0.1		YxS: ns		YxC: ns		SxC:0.3		YxSxC: ns				
Festuca ovina																
Pamela		7.3	7.0	5.7	6.9	6.7	7.7	6.7	5.1	6.5	6.5	7.1	6.9	5.4	6.2	6.4
Ridu		7.6	7.3	6.1	7.4	7.1	7.7	7.1	5.8	6.9	6.9	7.5	7.1	5.9	6.3	6.7
Nordic		7.9	7.5	5.9	7.0	7.1	8.0	6.8	5.8	7.0	6.9	7.2	7.1	5.3	6.9	6.6
Pintor		7.0	7.0	5.8	7.4	6.8	7.1	6.9	5.4	7.0	6.6	6.8	7.0	5.7	7.1	6.7
M		7.5	7.2	5.9	7.2	6.9	7.6	6.9	5.5	6.9	6.7	7.1	7.0	5.6	6.6	6.6
LSD %5	Y: 0.2	S: 0.2		C:0.2		YxS: ns		YxC: ns		SxC: 0.4		YxSxC: ns				
Festuca rubra rubra																
Pernille		8.1	7.4	4.2	6.6	6.6	6.7	5.9	3.8	5.1	5.4	4.3	4.8	2.6	3.7	3.9
Picnic		7.9	7.5	4.4	6.7	6.6	6.0	5.5	3.5	5.1	5.0	4.2	4.9	2.7	3.8	3.9
Victor		7.4	7.7	3.8	5.9	6.2	5.8	5.3	3.5	4.9	4.9	3.9	4.2	2.1	2.9	3.3
Engina		7.3	7.1	3.8	6.3	6.1	5.4	5.1	3.3	4.7	4.6	3.8	4.4	2.4	3.4	3.5
Franklin		7.8	7.4	3.5	5.8	6.1	5.9	4.9	3.0	5.1	4.7	4.1	4.1	2.3	3.3	3.5
Bargena		7.4	6.9	3.2	5.7	5.8	5.7	4.8	3.2	4.6	4.6	3.7	4.1	2.2	3.7	3.4
M		7.7	7.3	3.8	6.2	6.2	5.9	5.2	3.4	4.9	4.9	4.0	4.4	2.4	3.5	3.6
LSD %5	Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra trichophylla																
Mocassin		7.6	6.9	3.6	6.3	6.1	5.9	5.5	3.5	4.9	4.9	4.0	4.7	2.8	3.1	3.7
Suzette		7.6	7.1	3.7	6.7	6.3	6.0	5.5	3.0	5.0	5.0	4.4	4.7	3.1	3.6	3.9
Libano		7.0	7.2	3.1	5.8	5.8	5.4	4.8	3.1	4.4	4.4	3.9	4.4	3.3	3.3	3.7
Napoli		7.1	6.8	3.0	6.1	5.7	5.5	4.9	3.0	4.4	4.5	3.9	4.1	2.9	3.6	3.6
M		7.3	7.0	3.3	6.2	6.0	5.7	5.2	3.2	4.7	4.7	4.0	4.5	3.0	3.4	3.7
LSD %5	Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				
Festuca rubra commutata																
Enjoy		7.4	6.7	3.5	5.8	5.8	5.6	5.5	3.2	4.5	4.7	4.4	4.7	2.6	3.2	3.7
Ivalo		7.1	6.4	3.1	5.4	5.5	6.0	4.9	3.2	4.4	4.6	4.6	4.2	2.4	3.0	3.5
Tamara		6.9	6.4	3.0	5.4	5.4	5.7	5.3	3.1	4.4	4.6	3.9	4.1	2.8	3.4	3.5
Bargreen		7.2	6.1	2.9	5.3	5.4	5.7	5.5	2.6	4.1	4.5	3.6	4.2	2.1	3.1	3.3
M		7.2	6.4	3.1	5.5	5.6	5.8	5.3	3.0	4.4	4.6	4.1	4.3	2.5	3.2	3.5
LSD %5	Y: 0.2	S: 0.2		C:0.2		YxS: 0.3		YxC: ns		SxC: ns		YxSxC: ns				

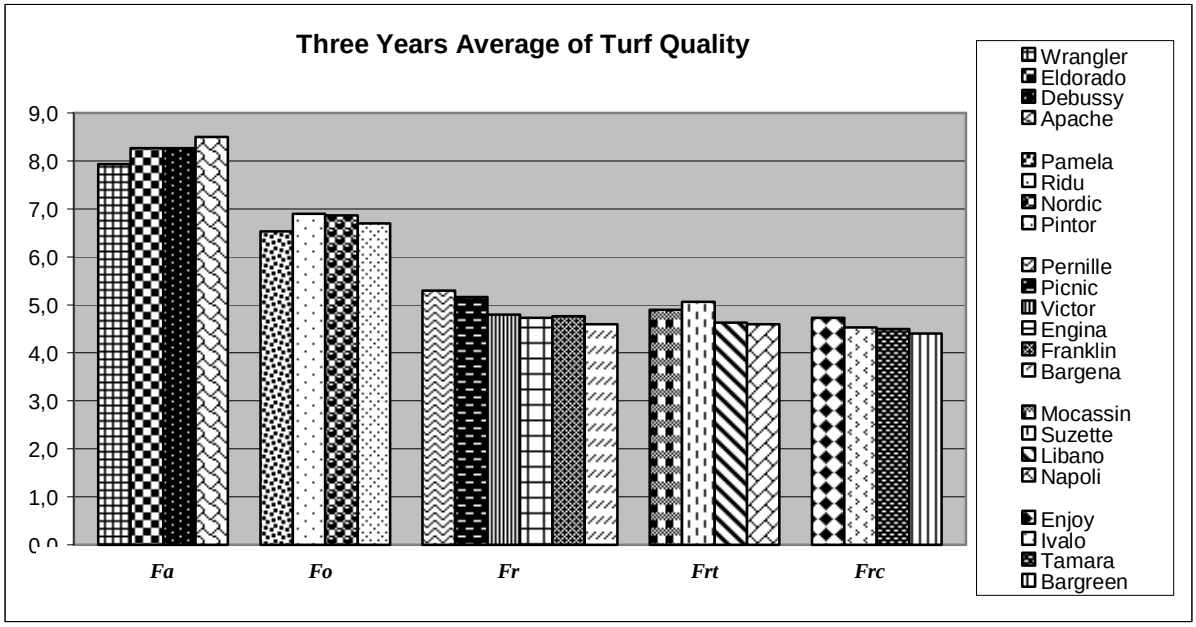

Figure 3. Turf Quality Scores of Five Cool Season Turfgrass Species

Turf Quality

The mean turf quality scores of the five turfgrass species in each season and year of evaluation were reported in Table 3. Variation analysis of turf quality scores displayed the significant effects of only season and cultivar in tall fescue species, but season, cultivar and year effects in sheep fescue, creeping red fescue, slender creping red fescue and chewings fescue. All two or three factor interaction effects were not significant in these species.

The mean turf quality scores of tall fescue species were highest (8.3-8.2-8.3, respectively) for turf quality in three years than those of other turfgrass species tested in the experiment and the cultivars of this species maintained highest turf quality scores throughout and three year average (Figure 3). Apache and Eldorado cultivars had outstanding turf quality scores compared to others.

The turf quality scores of sheep fescue cultivars were not comparable to tall fescue species, but all sheep fescue cultivars maintained an acceptable level of quality scores in succeeding years. The significant variation of mean turf quality scores among the seasons were also evident while performances of all of this species cultivars (5.9-5.5-5.6, respectively for species mean in succeeding years) were lowest in summer seasons.

The mean turf quality scores of creeping red fescue species were quite high in winter and spring (7.7-7.3, respectively) in the first experimental year, but rapid decreases were observed in following seasons and years. Resembling behaviours of cultivars of chewings red fescue and slender creeping red fescue species were also recorded in same periods of experiment during which their turf quality scores declined drastically, indicating extremely poor adaptability to Mediterranean environment of the experimental site. As an example, mean turf quality scores of creeping red, slender creeping red and chewings red fescue species were 6.2-6.0-5.6 respectively, for the first experimental year, while those quality scores declined extremely in the last experimental year being 3.6-3.7-3.5 respectively.

DISCUSSION

The cultivars of five cool-season turfgrass species adapted differently to Mediterranean environmental conditions occurring in the experimental site during the study years. The differences in turf colour, cover and quality scores among the seasons almost for all species tested proved the better adaptability of genotypes (cultivars) to weather conditions of the winter and autumn months rather than those of other seasons. The reduced adaptability observed during summer season in all traits of all species, except tall fescue, may be attributed to the restrictive effect of weather conditions occurring in this period on plant development (Sandal and Hızal, 2002; Öztürk and Tansı, 2004). Our approach was also confirmed by Kuşvuran and Tansı (2009)'s findings.

Turf colour is of particular significance in intensive care turf evaluation and an indication of higher photosynthetic activity and chlorophyll accumulation in turfgrass tissues, particularly in leaf cells. Since it is a characteristic determined mainly by genetically controlled mechanisms (Demir, 1990), green crops have the ability to behave highly consistent in maintaining a reliable degree of colour intensity during their life period. Environmental factors are also effective to some extent on this qualitative trait and a variation due to the differentiating ecological factors must be expected in different environments (Salisburry and Ross, 1992). The colour scores of turfgrass species in the experiment may also help define the most appropriate species to use, particularly in relation to the seasons in which turf colour is considered of special significance. The higher turf colour scores of tall fescue and relatively sheep fescue cultivars during the summer which usually is the least

favourable season for cool season turf growth in Mediterranean environment were mainly due to the greater colour retention (Russi et al., 2004) and higher drought and heat resistance of these two species (Avcıoglu et al., 2009). The distinctly low cover and quality scores of all red fescue species in first experimental year declined throughout the succeeding years and displayed the very limited adaptability of tested genotypes to Mediterranean environment, although the colour scores of cultivars were at an acceptable level and consistent . These results were most probably due to the acknowledged susceptibility of red fescues to heat stress encountered by crops mainly in summer season in Mediterranean environments (Beard, 1973). Nevertheless Zorer et al. (2009) reported that creeping red fescue and chewings red fescue species were highly adaptable to the dry and cold continental climatic conditions of Van, Eastern Turkey. Yılmaz (2000) also stated that creeping red fescue and chewings fescue species displayed very high quality scores in cool climatic conditions of Tokat locating in transition zone in the region and maintained this performance also in summer season. Our results are also in agreement with Beard (1989) and Martiniello and D'Andrea (2006)'s statements. Bilgili and Acikgöz (2005) reported the superiority of tall fescue in adaptation to sub-Mediterranean conditions of Marmara region. On the contrary, Russi et al. (2004)'s report didn't confirm our findings.

Tall fescue cultivars were the only genotype maintaining relatively high scores of cover, colour and quality in different seasons of the succeeding years and proved the wide range of adaptability to Mediterranean environment. Russi et al. (2004) also stated that pure stands of tall fescue are often preferred when adaptation to low-input or unfavourable conditions are targeted. Oral and Açıkgöz (1998), studying with cool-season turfgrasses, indicated the resembling behaviour of cultivars under Sub-Mediterranean conditions.

Sheep fescue cultivars, having highly limited scores of colour, cover and quality, were consistent in all seasons of the three experimental years and proved to be used in limited rates in mixtures aiming for low-care lawns under Mediterranean conditions.

For tall fescue species Apache and Eldorado, and Ridu and Nordic for sheep fescue species were identified to support experts in recommendations for Mediterranean ecologies. Pernille and Picnic for creeping red fescue, Suzette for Slender creeping red fescue and Enjoy for chewings red fescue were also identified to intimate experts to benefit in limited rates for turf mixtures in Mediterranean environment.

CONCLUSION

Different cool season turf species tested in the studies displayed differentiating abilities to adapt to Mediterranean ecological conditions of the experimental area. Tall fescue cultivars were the only genotypes maintaining high scores of cover, colour and quality in different seasons and years. Sheep fescue cultivars were also consistent throughout the experimental years, although their colour, cover and quality scores were not high. We also suggested that all red fescue sub-species were not fully adaptable to Mediterranean conditions and their usage had to be limited in turf mixtures.

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