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Full Length Article

Investigations on Texture Weed Invasion and Density Features of Some Cool Season Turf Grass Cultivars in Mediterranean Environment

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ABSTRACT

This study was conducted in 2003-2005 at Bornova experimental field in Ege University, Izmir-Turkey. Newly introduced and popular cultivars of perennial ryegrass (*Lolium perenne* L.)*,* tall fescue (*Festuca arundinaceae* Schreb.), kentucky bluegrass (*Poa pratensis* L.), colonial bentgrass (*Agrostis tenuis* Sibth)*,* sheep fescue (*F. ovina* L.), chewings red fescue (*F. rubra* spp. *rubra commutata* Gaud)*,* slender creeping red fescue (*F. rubra* L. spp. *trichophlylla* Gaud) and chewings red fescue *(F. rubra* spp. *rubra commutata* Gaud) were tested for turf texture, weed invasion and density features for the aim of generating information for further investigations in the area and resembling Mediterranean ecologies and turf specialists in turf grass cultivar selection and recommendation. All of the *F. arundinaceae* cultivars (Mustang, Houndog, Finelawn & Cochise) with outstanding density and weed invasion scores were the best performers. The *L. perenne* cultivars with an acceptable level of texture scores and relatively high density and invasion scores ranked second among all cultivars tested. Ovation and Delaware were the outstanding genotypes. All other cultivars of *F. ovina, Agrostis tenuis* and *F. rubra* subspecies, having had very limited turf scores, were found to be not recommendable for Mediterranean ecologies. © 2011 Friends Science Publishers

Key Words: Turf grass; Texture; Weed invasion; Density; Mediterranean environment

INTRODUCTION

Turf and turf grasses are fundamental components of green spaces, sport fields and also vital agents for safeguarding the environment by different techniques, e.g. in controlling erosion in roadsides, rivers, grazing lands and problematic agricultural areas (Tallarino & Argenti, 2001). However, since the water is becoming scarce and expensive throughout the world, turf culture must be water-economized (Beard, 1973; Avcioglu, 1997; Acikgoz, 1994). Recently, increased competition for water has fostered interest in responses of cool season turf grasses in Mediterranean environments of which dry summers and high temperatures, as well as low temperatures in winter are of tremendous significance in terms of turfgrass and proper medium growing selection.

Cool season turfgrasses such as *Lolium perenne* different subspecies of *Festuca rubra* and *F. arundinaceae*, *Poa pratensis* are widely used depending on very old data and tradition on turf sector in Mediterranean countries (Spain, Italy, Greece, Turkey & resembling environments in Northern Africa). Another factor dictating the widespread use of cool season, C-3 turfgrasses instead of C-4, warm season turfgrasses consuming lower rate of water in such environments can be ascribed to their availability on the seed market (Salman, 2010), while readily available vegetative production sources of warm season turfgrasses 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. It is a fact that the appropriate use of C-3 turfgrasses for implanting lawns require field evaluation of the genotypes in sites with Mediterranean climate to assess the behaviour of cultivars in heat and drought resistance, which can be diagnosed by turf traits such as turf texture, weed competition and density during the growing period (Martinello & D'Andrea, 2006).

In turf grass evaluation and selection, there are various criteria described by Beard (1973). Morris and Sherman (2000) pointed out the National Turf grass Evaluation Program (NTEP) as a leader in evaluation and selection of Turf grass species. In the present study, turf texture, density and weed invasion features (NTEP) of 36 cultivars from 8 different species and subspecies were tested in a Mediterranean environment for three years, aiming to generate information for further studies in the area and resembling Mediterranean ecologies and turf specialists in heat and drought resistant and adaptable C-3 turf grass

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cultivar selection and recommendations.

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 & 28 m above see level), Ege University, Izmir, Turkey. Meteorological data were summarized in Table I. The native root zone was composed of 80.2% sand, 18.1% silt and 1.7% clay. The soil was loamy sand with pH 8.1; total ($CaCO_3$) 2400 mg kg $^{-1}$; total nitrogen, 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 prepared by disrupting a cereal fallow with a mould board 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, phosphorus and potassium fertilizers were applied at 75 and 50 kg ha^{-1} N, P_2O_5 and K_2O, respectively before leveling the soil with a cultivator and harrow (Kacar, 1986). In the first week of November, 2002 seed of Taya, Belida, Capri, Sakini, Ovation, Delaware cultivars of perennial ryegrass (*L. perenne* L.), Geronimo, Conni, Sobra, Emprima of Kentucky bluegrass (*P. pratensis* L.) and Highland, Highlandband, Denso, Tracenta of colonial bentgrass (*Agrostis tenuis* Sibth), Eldorado Wrangler, Apache, Debussy cultivars of tall fescue (*F. arundinacea* Schreb.); Pamela, Ridu, Nordic, Pintor cultivars of sheep's fescue (*F. ovina* L.); Pernille, Picnic, Victor, Engina, Franklin, Bargena cultivars of creeping red fescue (*F. rubra* spp *rubra* L.); Mocassin, Suzette, Libano, Napoli cultivars of slender creeping red fescue (*F. rubra* spp. *trichophylla* Gaud.) and Enjoy, Ivalo, Tamara, Bargreen cultivars of chewings fescue (*F. rubra* spp. *commutata* Gaud.) were hand sown in plots measuring 2 m x 1m at the seed rate of 35 g m^{-2} for *F. arundinaceae* and *L. perenne* 25 g m^{-2} for the cultivars of other turf grass species. Plots were arranged in a randomized complete block design with four replicates. 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 & August) in succeeding years. The plots were mown at a height of 25-30 mm, when the turf grass was 50-60 mm tall by using a rotary mover (Massport, Maxicatch 500), recovering and discarding the clippings.

Turf grass texture, weed invasion and density were assessed by a visual score (Morris & Sherman, 2000; Anonymous, 2001). 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 & January).

Statistical analyses were conducted by using TOTEMSTAT statistical program (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

Texture: The average texture scores of cultivars of eight different turf grass species in each season and year of evaluation were shown in Table II. Main effects of year, cultivar and season were significant in *L. perenne, F. arundinaceae, A. tenuis* and *F. rubra rubra.* Two and three factor interaction effects were not significant in all species and subspecies except year x cultivar interaction effect in *L. perenne, F. arundinaceae, A. tenuis* and *P. pratensis*.

Cultivars Delaware and Ovation had significantly higher scores than other cultivars during the three experimental years. Although *F. arundinaceae* had generally lower texture scores than *L. perenne* as an indication of fine texture, cultivar Finelawn was the genotype having highest texture score among all other cultivars in this group for three succeeding years (Table II).

Cultivars Geronimo and Conni having similar texture scores in succeeding years and medium texture, were the most favorable cultivars compared to Sobra and Emprima. There were significantly different texture scores among cultivars of *A. tenuis*, however all had quite similar scores in different years (Table II).

All *F. ovina* cultivars had very high texture scores representing fine texture compared to previous genera and cultivars Ridu and Nordic having same and higher average texture scores in succeeding experimental years were the comparably successful genotypes. Cultivar Picnic displayed the highest average scores in *F. rubra rubra* subspecies in the experimental period of three years. The cultivars of *F. rubra trichophylla* subspecies had also highly similar texture scores with *F. rubra commutata* cultivar and cultivar Mocassin were the outstanding cultivar in this subspecies. The average texture scores of cultivar Enjoy was higher than other cultivars of *F. rubra commutata* subspecies.

Weed invasion: There were great variations among the turf grass species cultivars in relation to weed invasion scores in different seasons and years (Table III). Main effects of cultivar, season and year were significant in all materials tested, except *F. ovina*, while two and three factor interaction effects were not, except year x cultivar interaction in *L. perenne, F. arundinaceae, P. pratensis, A. tenuis, F. ovina, F. rubra rubra* and *F. rubra commutata.* The year x season interaction effect was also significant in *P. pratensis, A. tenuis*, *F. rubra trichophylla* and *F. rubra commutata.*

Table I: Monthly average temperatures and total precipitations recorded in different yars at experimental area

Months	Temperature (°C)				Precipitation (mm)			
	2003	2004	2005	1980-2000	2003	2004	2005	1980-2000
January	12.0	8.3	9.9	8.1	102.7	228.5	124.0	109.7
February	5.6	9.4	8.7	8.6	201.0	27.9	287.4	89.8
March	9.4	12.9	12.1	10.8	25.3	21.3	90.5	72.3
April	13.6	16.6	16.4	15.0	104.5	30.3	17.3	48.9
May	22.4	20.4	21.5	20.2	10.3	11.3	35.8	32.2
June	27.5	26.1	25.0	25.0	0.1	3.7	21.0	8.2
July	28.5	28.6	28.8	27.6	-	1.2	-	3.6
August	29.0	27.4	28.5	27.0	-	-	0.2	2.1
September	23.4	24.1	24.1	22.2	0.0	0.0	6.6	17.0
October	20.4	21.0	17.9	18.0	66.5	1.7	22.8	46.8
November	14.2	14.4	12.9	13.2	15.6	100.0	155.9	80.3
December	10.3	11.1	11.3	9.9	116.3	77.7	67.5	122.3
X-∑	18.0	18.3	18.1	17.1	642.3	503.6	829.0	633.2

Cultivar Capri displayed the highest average weed invasion scores during the three experimental years, whereas cultivar Delaware had lower scores, which were the indication of lesser weed invasion in the plots. Although seasonal variations were also significant in all genotypes, all cultivars of *L. perenne* displayed higher weed encroachments in summer compared to other seasons. This inclination was also evident in all other species and subspecies. Cultivar Cochise was the outstanding genotype among all other cultivars in *F. arundinaceae* (Kamal-uddin *et al*., 2009). As a whole, *F. arundinaceae* cultivars were the outstanding genotypes with lower scores than all cultivars of other species and subspecies.

Among the cultivars of *P. pratensis* tested, cultivar Geronimo had lower weed invasion scores, namely, best performing genotype with regard to weed infestation. Increasing scores by years were also evident in *P. pratensis* and *A. tenuis,* which weed invasion score trends of these species were almost similar to each other. Weed invasion scores of *F. ovina* cultivars indicated a decreasing trend by years and cultivar Ridu was the best performer among other genotypes in the species. Weed invasion scores of all *F. rubra* species cultivars were extremely higher than other species tested in the experiment (Lower competitive ability). Similar results were monitored in *F. rubra trichophylla* and *F. rubra commutate.*

The mean density scores of the cultivars of eight turf grass species in each season and year of evaluation were shown in Table IV. Variation analysis of turf density scores mirrored the significant main effects of cultivar, year and season in all species and subspecies, except in all *Festuca* species. All two and three factor interactions were not significant, except year x cultivar interaction effect in all turf grass material tested.

The mean density scores of *L. perenne* cultivars increased with succeeding three experimental years. Since all cultivars responded differently in different years (year x cultivar interaction), the cultivars having highest scores varied by years. Cultivar Capri, having highest score in the first year, while Sakini in second and Delaware in the last experimental year were the best performers. There were remarkable differences among *F. arundinaceae* cultivars and to distinguish cultivars with highest or lowest density scores in different seasons and years was easier than *Lolium* genus. Cultivar Mustang was the most promising cultivar compared to cultivar Cochise, which had also very dense canopy in the plots in the duration of succeeding years. On the contrary, all cultivars of *P. pratensis* had very limited density scores, displaying very poor tillering and individual crops in the plots. Cultivar Geronimo was the genotype with highest scores. As a result of significant year x cultivar interaction and differentiating characteristics of *A. tenuis* cultivars according to seasons and years, profiling the group and quoting a cultivar was difficult, the mean density scores of *F. ovina* cultivars were highly limited like previous species and cultivar Pintor displayed the highest scores.

The density scores of *F. rubra subspecies* were quite lower than other species tested and cultivar Bargena was the outstanding genotype compared the other material tested in *F. rubra rubra*. Cultivar Mocassin performed far better than other cultivars in *F. rubra trichophylla* while Cultivar Enjoy of *F. rubra commutata* ranked first in this subspecies.

DISCUSSION

The results obtained from the three year field experiment indicated a wide range of variation of the eight cool season turf grasses under existing Mediterranean weather conditions. The variation in adaptation to prevailing seasonal and yearly effect of climatic factors was also evident. Remarkable differences of texture, weed invasion and density scores of various cultivars of species tested proved the better growth adaptability of all turf grass material to climatic conditions of the winter, autumn and spring seasons rather than summer. Van Huylenberg *et al*. (1999) and Salman and Avcioglu (2010) also stated that better growth activities of cool season turf grasses in cool seasons (winter, spring & autumn) of Mediterranean environments may be ascribed to more efficient biological mechanisms during these seasons. All tested species cultivars, except *F. arundinaceae* and to some extent *L. perenne*, displayed extremely reduced adaptability in summer almost in all succeeding three experimental years. Many turf researchers revealed that reduced adaptability observed in summer season may be attributed to the negative effects of heat and drought stress, as well as susceptibility to pathogen injuries occurring in summer period of Mediterranean environments (Avcioglu, 1997; Belisario *et al*., 2001; Volterani *et al*., 2001; Kusvuran, 2009). Our results were also in agreement with the statements of Russi *et al*. (2001).

The high and increasing density and lower weed invasion scores of *F. arundinaceae* cultivars, particularly cultivar Finelawn and cultivar Cochise were attributed to the

Table II: Leaf texture scores of turf grass species by seasons in different years

	Leaf texture														
	2003					2004					2005				
Turfgrass	**Wi**	**Si**	**Su**	**Au**	**M**	**Wi**	**Si**	**Su**	**Au**	**M**	**Wi**	**Si**	**Su**	**Au**	**M**
Lolium perenne															
Taya	6.5	6.4	5.5	6.5	6.2	6.1	6.0	5.1	6.0	5.8	6.0	6.0	5.0	6.0	5.8
Belida	6.3	6.2	5.3	6.2	6.0	6.0	6.0	5.0	6.0	5.8	5.9	6.0	4.9	5.9	5.7
Capri	6.4	6.4	5.4	6.5	6.2	6.2	6.2	5.0	6.0	5.9	6.1	6.1	5.1	6.1	5.9
Sakini	6.8	6.9	5.8	6.9	6.6	6.5	6.5	5.5	6.6	6.3	6.3	6.4	5.3	6.5	6.1
Ovation	6.9	6.9	5.9	6.9	6.7	6.8	6.9	5.8	6.8	6.6	6.5	6.4	5.5	6.5	6.2
Delaware	7.0	7.1	6.0	7.1	6.8	7.0	7.0	6.0	7.0	6.8	6.9	7.0	5.9	6.9	6.7
Mean	6.7	6.7	5.7	6.7	6.4	6.4	6.4	5.4	6.4	6.2	6.3	6.3	5.3	6.3	6.1
	LSD:%5	Y: 0.04	S: 0.05	C: 0.06	YxS: ns	YxC: 0.1	SxC: ns	YxSxC: ns							
Festuca arundiinaceae															
Houndog	3.9	4.0	4.9	4.1	4.2	2.7	2.8	3.7	2.8	3.0	2.5	2.4	3.5	2.4	2.7
Mustang	4.0	4.0	5.0	4.1	4.3	2.9	2.9	3.9	2.8	3.1	2.5	2.5	3.5	2.5	2.8
Finelawn	4.5	4.6	5.5	4.5	4.8	3.5	3.5	4.5	3.5	3.8	2.9	3.0	3.9	3.0	3.2
Cochise	4.2	4.2	5.2	4.2	4.5	3.0	3.1	4.0	3.1	3.3	2.7	2.7	3.7	2.7	3.0
Mean	4.2	4.2	5.2	4.2	4.4	3.0	3.1	4.0	3.1	3.3	2.7	2.7	3.7	2.7	2.9
	LSD: %5	Y: 0.04	S:0.07	C: 0.07	YxS : ns	YxC:0.12	SxC: ns	YxSxC: ns							
Poa pratensis															
Geronimo	6.0	6.1	5.0	5.0	5.5	5.9	6.0	4.9	4.9	5.4	5.5	5.6	4.8	4.9	5.2
Conni	5.8	5.8	4.8	4.8	5.3	5.9	6.0	4.8	4.8	5.4	5.8	5.8	4.8	4.9	5.3
Sobra	5.5	5.6	4.5	4.5	5.0	5.6	5.4	4.5	4.5	5.0	5.5	5.6	4.5	4.4	5.0
Emprima	5.5	5.4	4.5	4.5	5.0	5.4	5.4	4.5	5.4	5.2	5.4	5.4	4.4	4.4	4.9
Mean	5.7	5.7	4.7	4.7	5.2	5.7	5.7	4.7	4.9	5.2	5.6	5.6	4.6	4.7	5.1
	LSD %5	Y: 0.07	S:0.08	C: 0.08	YxS: ns	YxC: 0.13	SxC: ns	YxSxC: ns							
Agrostis tenuis															
Highland	6.5	6.6	5.5	5.6	6.1	6.3	6.3	5.3	5.2	5.8	6.2	6.2	5.2	5.2	5.7
Highlandbend	6.0	6.0	5.0	5.0	5.5	6.0	6.0	5.0	5.0	5.5	6.0	6.0	5.0	5.0	5.5
Denso	6.6	6.6	5.6	5.6	6.1	6.1	6.1	5.1	5.2	5.6	6.1	6.1	5.1	5.2	5.6
Tracenta	6.7	6.7	5.7	5.7	6.2	6.1	6.1	5.2	5.0	5.6	6.0	6.0	5.0	5.0	5.5
Mean	6.5	6.5	5.5	5.5	6.0	6.1	6.1	5.2	5.1	5.6	6.1	6.1	5.1	5.1	5.6
	LSD %5	Y: 0.07	S: 0.09	C: 0.09	YxS: ns	YxC: 0.15	SxC: ns	YxSxC: ns							
Festuca ovina															
Pamela	8.6	8.5	8.7	8.8	8.7	8.6	8.5	8.6	8.6	8.6	8.5	8.6	8.5	8.6	8.6
Ridu	9.0	9.0	8.9	9.0	9.0	8.8	8.7	8.9	8.8	8.8	8.8	8.9	8.9	8.8	8.9
Nordic	9.0	9.0	9.0	9.0	9.0	8.8	8.7	8.9	8.8	8.8	8.8	8.9	8.9	8.8	8.9
Pintor	8.8	8.8	8.9	8.0	8.6	8.7	8.6	8.8	8.8	8.7	8.6	8.6	8.7	8.6	8.6
Mean	8.9	8.8	8.9	8.7	8.8	8.7	8.6	8.8	8.8	8.7	8.7	8.8	8.8	8.7	8.7
	LSD %5	Y: 0.06	S: ns	C: 0.07	YxS: ns	YxC: ns	SxC: ns	YxSxC: ns							
Festuca rubra rubra															
Pernille	8.4	8.4	8.9	9.0	8.7	8.3	8.3	8.8	8.8	8.6	8.3	8.3	8.8	8.8	8.6
Picnic	8.5	8.6	9.0	9.0	8.8	8.5	8.6	9.0	9.0	8.8	8.4	8.5	8.9	9.0	8.7
Victor	8.4	8.4	8.9	8.9	8.7	8.3	8.3	8.8	8.9	8.6	8.3	8.2	8.8	8.8	8.5
Engina	8.3	8.2	8.8	8.8	8.5	8.3	8.2	8.8	8.8	8.5	8.2	8.3	8.7	8.8	8.5
Franklin	8.3	8.2	8.8	8.7	8.5	8.2	8.1	8.7	8.6	8.4	8.2	8.2	8.7	8.7	8.5
Bargena	8.3	8.2	8.8	8.8	8.5	8.2	8.1	8.7	8.6	8.4	8.1	8.1	8.6	8.6	8.4
Mean	8.4	8.3	8.9	8.9	8.6	8.3	8.3	8.8	8.8	8.5	8.3	8.3	8.8	8.8	8.5
	LSD %5	Y: 0.07	S: 0.08	C: 0.10	YxS: ns	YxC: ns	SxC: ns	YxSxC: ns							
Festuca rubra trichophylla															
Mocassin	8.5	8.5	9.0	9.0	8.8	8.5	8.3	9.0	9.0	8.7	8.5	8.5	9.0	9.0	8.8
Suzette	8.5	8.5	9.0	9.0	8.8	8.5	8.8	9.0	9.0	8.8	8.5	8.5	8.9	8.9	8.7
Libano	8.4	8.3	8.9	8.9	8.6	8.4	8.3	8.9	8.9	8.6	8.5	8.4	8.9	8.9	8.7
Napoli	8.5	8.5	9.0	9.0	8.8	8.4	8.3	8.8	8.8	8.6	8.5	8.4	8.9	8.9	8.7
Mean	8.5	8.5	9.0	9.0	8.7	8.5	8.4	8.9	8.9	8.7	8.5	8.5	8.9	8.9	8.7
	LSD %5	Y: ns	S: 0.06	C: 0.06	YxS: ns	YxC: ns	SxC: ns	YxSxC: ns							
Festuca rubra commutata															
Enjoy	8.5	8.5	9.0	9.0	8.8	8.5	8.5	9.0	9.0	8.8	8.5	8.5	9.0	9.0	8.8
Ivalo	8.4	8.4	8.9	8.9	8.7	8.2	8.2	8.7	8.7	8.5	8.3	8.3	8.8	8.8	8.6
Tamara	8.3	8.3	8.8	8.8	8.6	8.4	8.3	8.9	8.9	8.6	8.4	8.4	8.9	8.9	8.7
Bargreen	8.2	8.2	8.7	8.7	8.5	8.2	8.2	8.7	8.7	8.5	8.2	8.3	8.7	8.7	8.5
Mean	8.4	8.4	8.9	8.9	8.6	8.3	8.3	8.8	8.8	8.6	8.4	8.4	8.9	8.9	8.6
	LSD %5	Y: ns	S: 0.06	C:0.06	YxS: ns	YxC: ns	SxC: ns	YxSxC: ns							

Abbreviations: Wi (winter), Si (spring), Su (summer), Au (autumn), M(mean)

Table III: Weed Invasion Scores of Turf grass Species by Seasons in Different Years

	Weed ınvasıon														
	2003					2004					2005				
Turfgrass	**Wi**	**Si**	**Su**	**Au**	**M**	**Wi**	**Si**	**Su**	**Au**	**M**	**Wi**	**Si**	**Su**	**Au**	**M**
Lolium perenne															
Taya	2.3	2.4	3.3	2.2	2.6	2.3	2.3	3.2	2.4	2.6	2.5	2.7	3.5	2.5	2.8
Belida	2.5	2.4	3.5	2.5	2.7	2.6	2.6	3.6	2.6	2.9	2.9	2.8	3.9	2.8	3.1
Capri	2.8	2.8	3.8	2.7	3.0	2.7	2.6	3.6	2.7	2.9	2.7	2.7	3.7	2.8	3.0
Sakini	2.2	2.1	3.2	2.3	2.5	2.2	2.3	3.2	2.3	2.5	2.2	2.2	3.2	2.2	2.5
Ovation	2.8	2.8	3.8	2.8	3.1	2.5	2.5	3.5	2.5	2.8	2.5	2.6	3.5	2.5	2.8
Delaware	2.2	2.1	3.2	2.3	2.5	2.1	2.0	3.1	2.3	2.4	2.2	2.2	3.2	2.3	2.5
Mean	2.5	2.4	3.5	2.5	2.7	2.4	2.4	3.4	2.5	2.7	2.5	2.5	3.5	2.5	2.8
	LSD:%5 Y:0.07 S:0.08 C: 0.09 YxS: ns YxC: 0.16 SxÇ: ns YxSxC: ns														
Festuca arundiinaceae															
Houndog	1.0	1.0	1.0	1.1	1.0	0.8	0.9	0.9	0.9	0.9	0.6	0.6	0.6	0.7	0.6
Mustang	0.8	0.9	1.0	1.1	1.0	0.8	1.0	1.1	1.1	1.0	0.4	0.4	0.5	0.5	0.5
Finelawn	1.2	1.3	1.3	1.3	1.3	1.0	1.0	1.0	1.1	1.0	0.9	1.0	1.2	1.2	1.1
Cochise	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.6	0.5	0.4	0.6	0.6	0.7	0.6
Mean	0.9	0.9	1.0	1.0	0.9	0.8	0.8	0.9	0.9	0.8	0.6	0.7	0.7	0.8	0.7
	LSD: %5 Y: 0.07 S:0.08 C: 0.08 YxS : ns YxC:0.13 SxC: ns YxSxC: ns														
Poa pratensis															
Geronimo	5..2	5..3	5.7	4.3	5.1	7.7	7.7	6.7	6.7	7.2	8.6	8.5	7.6	7.6	8.1
Conni	5.4	5.4	5.9	4.5	5.3	7.9	7.9	6.9	7.0	7.4	8.7	8.8	7.7	7.7	8.2
Sobra	5.9	6.0	6.4	4.9	5.8	8.5	8.6	7..5	7.7	8.1	9.0	9.0	8.7	8.8	8.9
Emprima	6.0	6.0	6..5	5.0	5.9	8.5	8.6	7..5	7..5	8.0	9.0	9.0	8.6	8.7	8.8
Mean	5.6	5.7	6.1	4.7	5.5	8.2	8.2	7.2	7.2	7.7	8.8	8.8	8.2	8.2	8.5
	LSD %5 : Y: 0.07 S:0.09 C: 0.09 YxS: 0.15 YxC: 0.15 SxC: ns YxSxC: ns														
Agrostis tenuis															
Highland	4.8	5.0	5.4	4.8	5.0	6.0	6.0	5.9	5.9	6.0	6.8	7.0	7.0	7.0	7.0
Highlandbend	4.8	5.0	5.5	4.8	5.0	6.0	6.0	5.9	5.9	6.0	6.8	7.0	6.8	6.8	6.9
Denso	5.1	5.1	5.7	5.2	5.3	5.8	5.6	5.6	5.6	5.7	7.8	7.7	7.9	7.9	7.8
Tracenta	5.3	5.3	5.8	5.3	5.4	5.8	5.8	5.8	5.8	5.8	7.8	7.8	8.0	8.0	7.9
Mean	5.0	5.1	5.6	5.0	5.2	5.9	5.9	5.8	5.8	5.8	7.3	7.4	7.4	7.4	7.4
	LSD %5 Y: 0.11 S: 0.12 C: 0.12 YxS: 0.22 YxC: 0.22 SxC: ns YxSxC: ns														
Festuca ovina															
Pamela	5.7	5.8	5.8	6.0	5.8	4.9	4.8	4.8	4.9	4.9	4.4	4.4	4.5	4.5	4.5
Ridu	5.5	5.5	5.5	5.5	5.5	4.6	4.6	4.5	4.7	4.6	4.1	4.0	4.1	4.0	4.1
Nordic	5.6	5.6	5.7	5.7	5.7	4.7	4.7	4.5	4.5	4.6	4.3	4.4	4.4	4.1	4.3
Pintor	5.9	6.0	6.1	6.0	6.0	5.3	5.4	5.4	5.4	5.4	4.8	4.8	4.8	4.8	4.8
Mean	5.7	5.7	5.8	5.8	5.7	4.9	4.9	4.8	4.9	4.9	4.4	4.4	4.5	4.4	4.4
	LSD %5 Y: 0.08 S: ns C:0.09 YxS:ns YxC: 0.16 SxC: ns YxSxC: ns														
Festuca rubra rubra															
Pernille	5.3	8.4	8.9	9.0	8.7	8.3	8.3	8.8	8.8	8.6	8.3	8.3	8.8	8.8	8.6
Picnic	8.5	8.6	9.0	9.0	8.8	8.5	8.6	9.0	9.0	8.8	8.4	8.5	8.9	9.0	8.7
Victor	8.4	8.4	8.9	8.9	8.7	8.3	8.3	8.8	8.9	8.6	8.3	8.2	8.8	8.8	8.5
Engina	8.3	8.2	8.8	8.8	8.5	8.3	8.2	8.8	8.8	8.5	8.2	8.3	8.7	8.8	8.5
Franklin	8.3	8.2	8.8	8.7	8.5	8.2	8.1	8.7	8.6	8.4	8.2	8.2	8.7	8.7	8.5
Bargena	8.3	8.2	8.8	8.8	8.5	8.2	8.1	8.7	8.6	8.4	8.1	8.1	8.6	8.6	8.4
Mean	8.4	8.3	8.9	8.9	8.6	8.3	8.3	8.8	8.8	8.5	8.3	8.3	8.8	8.8	8.5
	LSD %5 Y: 0.07 S: 0.08 C: 0.10 YxS: 0.14 YxC: 0.17 SxC: ns YxSxC: ns														
Festuca rubra trichophylla															
Mocassin	5.6	5.6	6.0	5.3	5.6	6.8	7.5	7.7	7.6	7.4	7.5	7.9	8.0	7.9	7.8
Suzette	5.8	5.9	6.5	6.0	6.1	7.0	7.5	7.7	7.6	7.5	7.5	7.9	7.9	7.9	7.8
Libano	6.2	6.0	6.5	6.0	6.2	7.6	8.4	8.5	8.8	8.3	7.9	8.4	8.6	8.6	8.4
Napoli	6.0	5.8	6.4	5.8	6.0	7.5	8.0	8.0	8.0	7.9	7.6	8.2	8.2	8.4	8.1
Mean	5.9	5.8	6.4	5.8	6.0	7.2	7.9	8.0	8.0	7.8	7.6	8.1	8.2	8.2	8.0
	LSD %5 Y: 0.09 S: 0.10 C: 0.10 YxS: 0.18 YxC: ns SxC: ns YxSxC: ns														
Festuca rubra commutata															
Enjoy	6.4	8.5	9.0	9.0	8.8	8.5	8.5	9.0	9.0	8.8	8.5	8.5	9.0	9.0	8.8
Ivalo	8.4	8.4	8.9	8.9	8.7	8.2	8.2	8.7	8.7	8.5	8.3	8.3	8.8	8.8	8.6
Tamara	8.3	8.3	8.8	8.8	8.6	8.4	8.3	8.9	8.9	8.6	8.4	8.4	8.9	8.9	8.7
Bargreen	8.2	8.2	8.7	8.7	8.5	8.2	8.2	8.7	8.7	8.5	8.2	8.3	8.7	8.7	8.5
Mean	8.4	8.4	8.9	8.9	8.6	8.3	8.3	8.8	8.8	8.6	8.4	8.4	8.9	8.9	8.6
	LSD %5 Y: 0.08 S: 0.09 C:0.09 YxS: 0.16 YxC: 0.16 SxC: ns YxSxC: ns														

Table IV: Density Scores of Turf grass Species by Seasons in Different Years

	Density														
	2003					2004					2005				
Turfgrass	Wi	Si	Su	Au	M	Wi	Si	Su	Au	M	Wi	Si	Su	Au	M
Lolium perenne															
Taya	7.5	7.5	6.5	7.3	7.2	7.7	7.8	6.7	7.8	7.5	7.9	8.0	7.0	8.1	7.8
Belida	7.0	7.2	6.0	7.2	6.9	7.9	7.6	6.9	7.7	7.5	7.8	8.1	7.0	8.1	7.8
Capri	7.7	7.7	6.7	7.8	7.5	7.8	7.8	7.0	7.7	7.6	7.9	7.9	6.9	7.8	7.6
Sakini	7.5	7.6	6.5	7.5	7.2	7.6	7.7	7.2	7.7	7.7	7.9	7.8	6.9	7.6	7.6
Ovation	7.4	7.5	6.4	7.0	7.1	7.8	7.0	6.1	7.0	7.0	8.0	8.0	7.0	8.1	7.8
Delaware	7.0	7.0	6.8	7.6	7.1	7.9	7.6	7.0	7.8	7.6	8.1	8.0	7.1	8.3	7.9
Mean	7.4	7.4	6.5	7.4	7.1	7.8	7.6	6.8	7.6	7.5	7.9	7.9	7.0	8.0	7.7
	LSD:%5	Y: 0.07	S:0.08	C: 0.10	YxS: ns	YxC: 0.17	SxC: ns	YxSxC: ns							
Festuca arundinaceae															
Houndog	8.0	8.2	8.3	8.1	8.2	8.5	8.6	8.7	8.6	8.6	8.9	9.0	8.9	8.9	8.9
Mustang	8.8	8.8	8.8	8.8	8.8	8.9	9.0	9.0	8.9	9.0	8.9	9.0	9.0	8.9	9.0
Finelawn	8.5	8.6	8.7	8.6	8.6	8.7	8.7	8.7	8.8	8.7	8.5	8.5	8.6	8.4	8.5
Cochise	8.2	8.2	8.3	8.2	8.2	8.5	8.6	8.5	8.6	8.6	8.7	8.8	8.9	8.8	8.8
Mean	8.4	8.5	8.5	8.4	8.4	8.7	8.7	8.7	8.7	8.7	8.8	8.8	8.9	8.8	8.8
	LSD: %5	Y: 0.09	S: ns	C: 0.07	YxS : ns	YxC: 0.17	SxC: ns	YxSxC: ns							
Poa pratensis															
Geronimo	2.1	2.2	1.5	2.1	2.0	1.9	1.8	1.4	1.9	1.8	1.5	1.7	1.0	1.7	1.5
Conni	1.8	1.9	1.3	1.7	1.7	1.6	1.6	1.1	1.6	1.5	1.5	1.7	1.0	1.5	1.4
Sobra	1.8	1.8	1.3	1.7	1.7	1.4	1.3	0.9	1.3	1.2	1.0	1.1	0.7	1.2	1.0
Emprima	1.7	1.8	1.2	1.5	1.6	1.3	1.3	0.8	1.3	1.2	1.1	1.1	0.6	1.1	1.0
Mean	1.9	1.9	1.3	1.8	1.7	1.6	1.5	1.1	1.5	1.4	1.3	1.4	0.8	1.4	1.2
	LSD %5	Y: 0.06	S: 0.07	C: 0.07	YxS: ns	YxC: 0.12	SxC: ns	YxSxC: ns							
Agrostis tenuis															
Highland	2.5	2.5	2.0	2.6	2.4	2.4	2.5	2.0	2.4	2.3	2.8	2.9	2.3	3.1	2.8
Highlandbend	2.5	2.6	2.0	2.5	2.4	2.6	2.7	2.1	2.6	2.5	2.7	2.7	2.2	2.8	2.6
Denso	2.9	3.0	2.4	3.0	2.8	2.8	2.9	2.3	3.0	2.8	2.8	2.9	2.3	2.9	2.7
Tracenta	2.8	2.7	2.3	2.8	2.7	2.4	2.5	2.0	2.5	2.4	2.7	2.6	2.2	2.6	2.5
Mean	2.7	2.7	2.2	2.7	2.6	2.6	2.7	2.1	2.6	2.5	2.8	2.8	2.3	2.9	2.7
	LSD %5	Y: 0.12	S: 0.14	C: 0.14	YxS: ns	YxC: 0.24	SxC: ns	YxSxC: ns							
Festuca ovina															
Pamela	3.5	3.4	3.5	3.6	3.5	2.6	2.5	2.5	2.7	2.6	2.0	2.0	1.9	1.8	1.9
Ridu	3.7	3.8	3.7	3.7	3.7	2.8	2.8	2.9	3.3	3.0	2.2	2.2	2.2	2.0	2.2
Nordic	3.8	3.8	3.7	3.9	3.8	2.5	2.5	2.6	2.6	2.6	2.3	2.4	2.5	2.3	2.4
Pintor	3.9	3.9	4.1	4.1	4.0	3.0	3.1	3.0	3.0	3.0	2.4	2.6	2.5	2.3	2.5
Mean	3.7	3.7	3.8	3.8	3.8	2.7	2.7	2.8	2.9	2.8	2.2	2.3	2.3	2.1	2.2
	LSD %5	Y: 0.09	S: ns	C: 0.11	YxS: ns	YxC: 0.19	SxC: ns	YxSxC: ns							
Festuca rubra rubra															
Pernille	2.0	2.0	2.0	2.1	2.0	2.0	2.0	2.2	1.9	2.0	1.9	1.8	1.6	1.9	1.8
Picnic	2.2	2.2	2.3	2.2	2.2	2.1	2.1	2.3	2.0	2.1	1.8	1.8	1.7	1.7	1.8
Victor	2.5	2.6	2.5	2.7	2.6	2.6	2.4	2.4	2.3	2.4	2.0	2.0	1.9	1.9	2.0
Engina	2.1	2.2	2.3	2.0	2.2	2.0	2.0	2.2	2.0	2.1	2.0	2.0	1.9	1.9	2.0
Franklin	2.4	2.4	2.4	2.4	2.4	2.2	2.2	2.3	2.2	2.2	2.1	2.2	2.2	2.1	2.2
Bargena	3.0	3.0	3.0	3.0	3.0	2.7	2.9	3.1	2.9	2.9	2.3	2.3	2.4	2.4	2.4
Mean	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.4	2.2	2.3	2.0	2.0	2.0	2.0	2.0
	LSD %5	Y: 0.07	S: ns	C: 0.10	YxS: ns	YxC: 0.17	SxC: ns	YxSxC: ns							
Festuca rubra trichophylla															
Mocassin	2.7	2.9	2.9	3.1	2.9	2.3	2.5	2.6	2.8	2.6	2.0	2.3	2.5	2.6	2.4
Suzette	2.6	2.6	2.5	2.4	2.5	2.0	2.0	2.2	2.2	2.1	1.9	1.9	1.9	1.9	1.9
Libano	2.5	2.4	2.5	2.5	2.5	2.2	2.2	2.2	2.3	2.2	1.9	1.9	1.7	1.8	1.8
Napoli	2.5	2.5	2.4	2.3	2.4	2.1	2.0	2.0	2.1	2.1	2.1	2.2	2.1	2.1	2.1
Mean	2.6	2.6	2.6	2.6	2.6	2.2	2.2	2.3	2.4	2.2	2.0	2.1	2.1	2.1	2.1
	LSD %5	Y: 0.07	S: ns	C: 0.09	YxS: ns	YxC: 0.15	SxC: 0.17	YxSxC: ns							
Festuca rubra commutata															
Enjoy	2.8	3.0	2.8	2.9	2.9	2.8	2.8	2.9	2.7	2.8	2.5	2.3	2.2	2.2	2.3
Ivalo	2.5	2.5	2.4	2.5	2.5	2.6	2.7	2.7	2.6	2.7	2.0	2.0	2.0	2.0	2.0
Tamara	2.5	2.5	2.5	2.4	2.5	2.7	2.7	2.8	2.6	2.7	2.1	2.0	2.1	2.0	2.1
Bargreen	2.3	2.2	2.1	2.1	2.2	2.5	2.5	2.4	2.3	2.4	2.2	2.2	2.3	2.0	2.2
Mean	2.5	2.6	2.5	2.5	2.5	2.7	2.7	2.7	2.6	2.6	2.2	2.1	2.2	2.1	2.1
	LSD %5 :	Y:0.10	S: ns	C: 0.11	YxS: ns	YxC :0.19	SxC: ns	YxSxC: ns							

high competitive ability and greater adaptability to heat and drought stress conditions of Mediterranean environment. Yilmaz and Avcioglu (2000) indicated the superiority of *F. arundinaceae* also under the conditions of transitional zone of Anatolian Peninsula. Barton (1997) declared very similar statements for *F. arundinaceae* under very hot summer conditions. Youngner *et al*. (1981) compared *F. arundinaceae* with *P. pratensis* and found that former turf grass performed for better than latter with regard to weed competition, root depth, establishment and drought resistance. Our results of texture, weed invasion and density scores confirmed this statement and the findings of Kir *et al*. (2010) and Demiroglu *et al*. (2010). Acikgoz (1994) and Avcioglu (1997) clearly stated that *P. pratensis* is a cold resistant cool season turf grass and not a proper turf grass for hot and dry environments. Intermediate level of texture and reasonable density and weed invasion scores of *L. perenne* cultivars ranked this turf grass second among all other turf grasses tested in the experiment. Sustainable performance of Delaware and Ovation cultivars throughout the three years proved the relatively reasonable adaptability of this turf grass species to Mediterranean environment. Barton (1997) stated that *L. perenne* establishes very rapidly and is included in grass mixtures to provide a quick cover. Many research workers, studying under Mediterranean conditions reported that *L. perenne* is a proper turf grass to be included in mixtures. (Beard, 1973; Harivandi *et al*., 1984; Acikgoz, 1994; Avcioglu, 1997; Barton, 1997; Kir *et al*., 2010).

Although the inter-and intra-species variations were highly significant in *P. pratensis, A. tenuis* and *F. ovina*, limited performances of those species in terms of density and weed competition made it clear that they are not favorable turf grasses for Mediterranean conditions of the experimental area. Our results were confirmed by Beard (1973) and Kir *et al*. (2010)'s statements, while Russi *et al*. (2001)'s results were not compatible with our findings. However, high texture scores of *F. ovina* cultivars were not negligible and confirmed the statements of Acikgoz (1994) and Avcioglu (1997), advising this turf grass to use in limited rates mixtures to obtain a relatively fine textured turf.

Very limited performances of three *F. rubra* subspecies cultivars, although their texture scores were favourable proved that those turf grasses were not proper turf components for Mediterranean environments. In another word, low competitive ability and density scores of those cultivars were the indication of being physiologically worse endowed to cope with the ecological conditions of Mediterranean climate (Daget, 1985; Zorer *et al*., 2009).

CONCLUSION

All *F. arundinaceae* cultivars (Finelawn, Mustang, Cochise & Houndog) performed best under Mediterranean conditions although the texture scores were quite limited. The cultivars of *L. perenne* ranked second among all cultivars tested in the experiment and cultivars Ovation and Delaware were promising genotypes in this group. Cultivars Geronimo and Conni displayed relatively recommendable texture scores. All cultivars of *A. tenuis, F. ovina* and *F. rubra* subspecies indicated very limited capacity to cope with the Mediterranean environmental conditions.

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