INTERNATİONAL JOURNAL OF AGRİCULTURE & BİOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
10–694/SBC/2011/13–4–529–534
http://www.fspublishers.org

Full Length Article

Performances of Different Cool Season Turf Grasses and Some Mixtures under Mediterranean Environmental Condition

ALI SALMAN[1], RIZA AVCIOĞLU†, HALIL ÖZTARHAN†, A. CENAP CEVHERI‡ AND HÜLYA OKKAOĞLU¶
Ege University, Bayindir Training Collage, Landscape and Ornamental Plants Program, Izmir, Turkey
†Ege University, Faculty of Agriculture, Department of Field Crops, 35100, Izmir, Turkey
‡Harran University, Faculty of Arts and Sciences Department of Biology, 63300, Sanliurfa, Turkey
¶Cukurova University, Karaisali Vocational Training School, Medicinal Plants Program, Adana, Turkey
[1]Corresponding author's e-mail: ali.salman@ege.edu.tr

ABSTRACT

In the present study, turf color, cover, weed invasion and quality traits of different turf alternatives pure sowings of *Lolium perenne*, *Festuca arundinacea*, *F. rubra spp. trichophylla, F. rubra spp. commutata* and different types of mixtures (mixture 1: 75% *F. arundinacea* + 25% *L. perenne*; mixture 2: 50% *L. perenne* + 50% *F. ovina*; mixture 3: 50% *L. perenne* + 25% *F. rubra spp. commutata* + 25% *F. rubra spp. trichophylla* & mixture 4: 40% *L. perenne* + 25% *F. rubra spp. commutata* + 25% *F. rubra spp. trichophylla* + 10% *Poa pratensis*) were tested in acidic soils under Mediterranean climatic conditions. Results indicated the outstanding performances of *F. arundinacea* and partially *L. perenne,* which displayed quite high scores of color, cover, weed invasion and quality. *F. rubra spp. commutata* and *spp. trichophylla* had very limited scores of tested traits under summer heat and drought stress conditions of experimental area. The mixture including *L. perenne* and *F. arundinacea* had also satisfactory performance, with the exception of mixtures containing *F. rubra subspecies*, *F. ovina* and *P. pratensis*.

Key Words: Cool-season turf grasses and mixtures; Adaptability; Mediterranean environment

INTRODUCTION

Turfs were developed by contemporary man to enhance his environment. The more technologically advanced the civilization, the more widely turfs are used (Beard, 1973). Turfs are significant in human activities from the functional, recreational and ornamental standpoint.

A turf provides beauty and attractiveness for human activities. The clean, cool and natural greenness of turf provides a pleasant environment in which to live and work. It is unfortunate that cool season turf grass maintenance require considerable amount of irrigation water in Mediterranean environments, even in the continental parts of the Middle East countries. Since the water is becoming scarce and expensive throughout the world, it should be emphasized that turf culture must be directed toward practices that will lower water requirements as competition for water use increases in different sectors of daily life (Beard, 1973; Açıkgöz, 1994; Avcıoğlu, 1997). Under those circumstances, efficient selection of turf grasses resistant to heat and drought stresses is becoming a major step to achieve a successful turf establishment.

Paulsen (1994) displayed that heat and drought stress, which are the main characteristics of Mediterranean ecological conditions is becoming two of the major abiotic stress factors limiting the growth and development of cool-season grasses, especially, when predicted increases in mean temperatures of 1, 5-6^{o}C in future climates (global warming!), which can lead to inhibition of physiological activities of cool season turf grasses under hot climatic conditions.

It is obvious that turf experts need to know when and why, as well as how, various turf grass cultural practices are utilized and selecting a turf grass successfully requires knowing how the turf will be used, where it will be grown and what appearance and maintenance level will be acceptable (Paulsen, 1994). Because each cool and warm season turf grass species has good and bad features, one must know the strengths and weakness of each of the species in order to choose the one best adapted to a particular environment (Harivandi *et al.*, 1984).

That is a fact that considerable amount of knowledge has accumulated concerning the culture of turf grasses in this discipline, yet many questions and problems still exist in developing Mediterranean countries (Kir *et al.*, 2010a; Demiroğlu *et al.*, 2010a). Recently, increased competition for water has fostered interest in responses of cool season turf grasses to drought and heat, which can be viewed in as number of ways. Drought and heat stresses will affect visual quality, growth rate and recuperative ability of especially

To cite this paper: Salman, A., R. Avcioğlu, H. Öztarhan, A.C. Cevheri and H. Okkaoğlu, 2011. Performances of different cool season turf grasses and some mixtures under mediterranean environmental condition. *Int. J. Agric. Biol.*, 13: 529–534

cool season grasses (Aronson *et al.*, 1987).

Russi *et al.* (2004) displayed that turf quality is a complex character of fundamental importance in turf grass evaluation. It takes into account aesthetic and functional aspects and depends on several individual components, which may wary with time. The use of a synthetic and simple quality score is necessary, when evaluating large number of cultivars.

The visual evaluation of turf quality, which is based on a combination of color, density, uniformity, disease or environmental stress, cover and weed invasion traits usually assessed monthly on a scale ranging from 1 to 9 are highly regarded variables in USA and European national tests (Morris & Sherman, 2000).

Despite their limitations, the turf quality score, color, cover and weed invasion traits of turf remain as fundamental characteristics used by turf researchers because the process is much less time-consuming than alternative options based on individual traits and can, therefore, be easily assessed several times a year (Russi *et al.*, 2004).

In this study, considering the previous studies conducted in the region and resembling ecologies, new accessions of tall fescue (*Festuca arundinacea* Shreb.), perennial ryegrass (*Lolium perenne* L.) *F. rubra subsp. commutata* and *F. rubra subsp. trichophylla* cultivars and some mixtures were tested for quality, cover, color and weed invasion traits to generate information for their adaptability to Mediterranean environment.

MATERIALS AND METHODS

The research was conducted between October, 2004 and November, 2006 on the experimental field of the Bayindir Training College (38º 20′ 26 N - 27º 67′ 22 E), Ege University, Izmir, Turkey, at about 107 m a.s.l. with typical Mediterranean climate characteristic. Average annual temperature and precipitation data through experimental years (16.9, 18.8ºC & 548.5, 554.9 mm in 2005 to 2006, respectively) were generally in accordance with long term average (16.6ºC & 623.8 mm). The native root zone was composed of 78.4% sand, 17.6% silt and 4.0% clay. The soil was silty sand with the following characteristics: pH 5.8; $CaCO_3$ 0.82%; total nitrogen 0.09%; organic matter 2.3%; available phosphorus 2.54 mg kg^{-1}; exchangeable potassium 40 mg kg^{-1}. The seedbed was made by disrupting a vegetable 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.

The following turf grass species and cultivars entries and some traditional turf mixtures were tested (Table I). A randomized complete block design arranged with four replications was used. Plot size was 2 m long by 1 m wide. A 0.5 m bare soil corridor was maintained between blocks. All cultivars were hand sown with traditional amount of seed per unit area in plots in autumn. Invaded weeds were hand removed during the establishment period; later on weed encroachment didn't controlled by any mean. A combined fertilizer (12-12-12 NPK) was manually applied in all entries at a rate of 10 gm^{-2} in five rounds (early April, May, June, July & August). The plots were mown at a height of 25-30 mm, when the sward was 50-60 mm tall by using a rotary mover (Massport, Maxicatch 500), recovering and discarding the clippings. Supplemental irrigation was applied as needed to prevent visual wilt of the turf by sprinkling during summer season. Turf grass cover, color, weed invasion and quality traits were assessed by a visual score based on a 1-9 scale, as used in the National Turf grass Evaluation Program in the USA (Morris & Sherman, 2000). Observations were maintained on a monthly basis, while scoring was carried out on a seasonal (Sp:Spring, Su:Summer, Au:Autumn, Wi:Winter) basis, in the middle of each season (April, June, October & January).

Statistical analysis was 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 color: Mediterranean climatic parameters prevailing during the period of turf growth in different seasons of the experimental years and two years average had significant impact on turf color traits of the turf alternatives tested in the experiment (Table II). Variation analysis indicated that there were significant influences of year, season and turf alternatives on the turf color trait. The effect of three and two factor interaction was also significant with the exception of year x season interaction.

All turf alternatives, even in pure sowing or in mixtures, were best adapted to humid seasons (winter, spring & autumn) with regard to all turf trait scores tested, whereas those scores were extremely lower in summer seasons in both years and two years average. On the contrary, in summer season, the best adaptabilities for mean turf color were monitored in Delaware (*L. perenne*) and Starlet (*F. arundinacea*) and highest score in the mixture 1 (75% Starlet + 25% Delaware) in succeeding experimental years and in two years average. The mixture 2 (50% Delaware + 50% Triana) and mixture 3 (50% Delaware + 25% Wilma + 25% Suzette) had the lowest and declining scores in the duration of experimental years (Table II), mixture 2 having lowest score in two years average. Accordingly, pure sowings of Wilma and Suzette had also limited color scores compared to Delaware and Starlet in both years. The mixture 4 (40% Delaware + 25% Wilma + 25% Suzette + 10% Balin) ranked intermediately among all other turf alternatives.

Turf cover: Turf cover, being an indication of rapid and healthy growth and development in addition to higher rate

Table I: Cool season turf grass species and cultivars and mixtures tested

No.	Turfgrass species	Cultivar	Establishment
1	*Lolium perenne* L.	Delaware	Autumn-2004
2	*Festuca arundinacea* Schreb.	Starlet	Autumn-2004
3	*F. rubra spp. commutata* Gaud.	Wilma	Autumn-2004
4	*F. rubra spp. trichophylla* Gaud.	Suzette	Autumn-2004
Mixture 1	%75 *F. arundinacea* Schreb. %25 *L. perenne* L.	Starlet Delaware	Autumn-2004
Mixture 2	%50 *L. perenne* L. %50 *F. ovina* L.	Delaware Triana	Autumn-2004
Mixture 3	%50 *L. perenne* L. %25 *F. rubra spp. commutata* Gaud. %25 *F. rubra spp. trichophylla* Gaud	Delaware Wilma Suzette	Autumn-2004
Mixture 4	%40 *L. perenne* L. %25 *F. rubra spp. commutata* Gaud. %25 *F. rubra spp. trichophlla* Gaud %10 *P. pratensis* L.	Delaware Wilma Suzette Balin	Autumn-2004

of metabolic activity and tillering, is a favorable feature to observe and evaluate the turf alternatives (Martinello, 2005). The evaluation of average turf cover scores of turf alternatives tested in the experiment in different seasons for two years were summarized in Table II. The effects of two and three factor interactions were significant in addition to significant main effects of year, season and turf alternative.

Cover scores of Deleware were higher in different seasons of the first year (8.9, 8.9, 8.3, 8.1, respectively), while Starlet had also comparable scores (7.3, 7.9, 9.0, 8.6, respectively) in same period of growth. However, Starl-et displayed extremely high cover scores (9.0, 9.0, 8.3, 8.2, respectively) in four different seasons of the second experimental year and possessed also higher scores in two years average (Table II) compared to declining scores of Delaware in succeeding experimental year. Turf cover scores of mixture 1, containing higher rate of Delaware and Starlet had higher turf cover scores than other turf alternatives in both years where decreasing values of cover rates of other mixtures by seasons and years were evident. Wilma and Suzette displayed extremely low scores in the second half of the first experimental year and declining scores were monitored particularly succeeding seasons of the second year.

Although, Delaware mixed with Triana (mixture 2) or with Suzette and Wilma (mixture 3) or with Suzette, Wilma and Balin (mixture 4) indicated a rapid and high cover scores at the beginning of the first experimental year, all scores of these mixtures declined continuously throughout the rest of the experimental period, displaying also very limited scores in two years average.

Weed invasion: The variation analysis of weed invasion scores of turf alternatives tested in the experiment revealed the significant main effects of season, cultivar, year and all two and three factor interaction (Table II). Weed invasion scores of mixture 1 (75% Starlet + 25% Delawere) and pure Starlet turf plots were higher than other alternatives in different seasons of the first experimental year and also consistent in the succeeding year. Two years averages of higher weed invasion scores (low weed infestation) of these turf alternatives were another indication of the superiority of these turf grasses to resist weed infestation (Table II). Weed invasion scores of Wilma (5.4) and Suzette (4.7) were significantly lower than other alternatives and declined extremely in second experimental year, displaying heavy weed infestations in these experimental plots. Weed invasion scores of mixture 2, 3 and 4 declined significantly in the second experimental year, while four crop mixture turf alternative mixture 4 (40% Deleware + 25% Wilma + 25% Suzette + 10% Balin) had also extremely lower weed invasion scores, which were the indication of higher weed infestation, almost in all seasons of the first experimental year. Two years average values of different seasons evidenced the extremely limited performances of these mixtures in terms of competition with to weed encroachment.

Turf quality: The mean turf quality scores of various turf alternatives tested in the experiment in each season and year of evaluation were reported in Table II. Variation analysis of quality score displayed the significant main effects of season, year and turf alternatives in addition to the significant effect of two and three factor interactions.

Mean scores of Delaware, *L. perenne* cultivar, in different seasons of the first experimental year (8.9, 8.5, 8.8, 8.0, respectively) were in quite acceptable level, whereas these scores declined extremely in the second experimental year. Starlet, *F. arundinacea* cultivar had respectively lower quality scores than Deleware in the first experimental year, however those scores were highest among all other turf alternatives in all seasons of the second year and in two years average. The mixture 1 (75% Starlet + 25% Delaware) were the only mixture alternative to have the ability to maintain quite high quality scores throughout the experimental years, possessing also very high quality scores in two year average.

Wilma and Suzette, although having very high quality scores in the spring season of the first experimental year, had rapidly declining scores in following experimental seasons and years. These two turf alternatives had also extremely minimum scores in different seasons in two years average (Table II). The mixture 2 (50% Delaware + 50% Triana), mixture 3 (50% Delaware + 25% Wilma + 25% Suzette) and mixture 4 (40% Delaware + 25% Wilma + 25% Suzette + 10% Balin) had reasonably high quality scores in first two seasons of the first experimental year, but those scores of all three mixtures declined gradually by second year and displayed quite lower scores than other promising turf alternatives in two years average.

DISCUSSION

Turf alternatives performed differently in Mediterranean environmental condition prevailing in the experimental area. The great variation occurring among the seasons in terms of color, cover, weed invasion and quality scores proved the better adaptability of all turf alternatives to the weather conditions of spring, winter and autumn seasons during, which heat or drought stresses didn't exist.

Table II: Color, cover, weed invasion and quality traits of different turf alternatives

Turf Alternatives	2005 Sp	2005 Su	2005 Au	2005 Wi	2005 Mean	2006 Sp	2006 Su	2006 Au	2006 Wi	2006 Mean	Mean Sp	Mean Su	Mean Au	Mean Wi	Mean
Turf color															
Delaware	8.1	7.9	7.9	8.0	8.0	8.0	7.8	7.4	7.8	7.8	8.1	7.8	7.7	7.9	7.9
Starlet	8.2	7.6	7.9	7.5	7.8	8.3	8.2	8.3	7.1	8.0	8.3	7.9	8.1	7.3	7.9
Wilma	7.2	6.5	7.0	7.0	6.9	7.3	6.7	7.1	7.2	7.1	7.2	6.6	7.0	7.1	7.0
Suzette	7.0	6.6	7.2	7.2	7.0	7.0	6.5	7.7	7.1	7.1	7.0	6.6	7.5	7.1	7.0
Mixture 1	8.3	8.3	8.7	7.9	8.3	8.1	8.4	8.1	7.7	8.1	8.2	8.4	8.4	7.8	8.2
Mixture 2	6.6	6.9	7.1	7.0	6.9	6.2	6.5	6.5	6.6	6.4	6.4	6.7	6.8	6.8	6.7
Mixture 3	6.9	6.5	7.0	7.0	6.9	6.6	6.1	7.0	6.8	6.6	6.8	6.3	7.0	6.9	6.8
Mixture 4	7.6	6.9	7.8	8.1	7.6	7.5	7.0	7.7	7.9	7.5	7.5	7.0	7.8	8.0	7.6
Mean	7.5	7.2	7.6	7.5		7.4	7.1	7.5	7.3		7.4	7.2	7.5	7.4	
LSD %5			Y: 0.06	S: 0.08	C: 0.1		YxS: ns		YxC: 0.2	SxC: 0.2		YxSxC: 0.3			
Turf cover															
Delaware	8.9	8.9	8.3	8.1	8.6	8.3	7.2	6.3	6.8	7.1	8.6	8.0	7.3	7.4	7.9
Starlet	7.3	7.9	9.0	8.6	8.2	9.0	9.0	8.3	8.2	8.6	8.1	8.4	8.7	8.4	8.4
Wilma	7.9	7.8	2.9	3.0	5.4	3.6	1.4	1.3	1.3	1.9	5.8	4.6	2.1	2.2	3.7
Suzette	8.1	7.6	3.4	3.1	5.5	3.8	1.6	1.7	1.4	2.1	6.0	4.6	2.6	2.3	3.8
Mixture 1	7.5	8.0	8.6	7.9	8.0	8.0	8.4	8.0	7.4	7.9	7.8	8.2	8.3	7.6	8.0
Mixture 2	8.7	8.7	7.8	7.5	8.2	7.7	4.0	4.3	3.6	4.9	8.2	6.4	6.1	5.5	6.5
Mixture 3	8.0	8.0	7.1	6.8	7.5	6.8	5.6	5.7	5.7	6.0	7.4	6.8	6.4	6.3	6.7
Mixture 4	7.1	6.6	7.1	6.7	6.9	6.6	4.1	4.6	4.7	5.0	6.9	5.4	5.8	5.7	6.0
Mean	7.9	7.9	6.8	6.5		6.7	5.2	5.0	4.9		7.3	6.5	5.9	5.7	
LSD %5			Y: 0.08	S: 0.1	C: 0.1		YxS: 0.1		YxC: 0.2	SxC: 0.3		YxSxC: 0.4			
Weed invasion															
Delaware	7.8	6.4	7.1	7.3	7.1	7.0	6.2	6.6	6.4	6.5	7.4	6.3	6.8	6.8	6.8
Starlet	6.5	7.4	7.9	7.7	7.4	8.0	8.2	8.0	8.2	8.1	7.3	7.8	8.0	7.9	7.4
Wilma	7.6	4.6	4.3	5.1	5.4	3.3	2.1	2.4	2.8	2.7	5.5	3.4	3.4	4.0	4.0
Suzette	7.1	3.8	3.6	4.1	4.7	4.2	1.2	1.6	1.8	2.2	5.7	2.5	2.6	3.0	3.4
Mixture 1	7.8	8.2	7.8	8.3	8.0	7.9	8.6	8.2	8.2	8.2	7.9	8.4	8.0	8.3	8.1
Mixture 2	7.8	6.7	6.5	6.9	7.0	5.9	5.4	6.0	5.1	5.6	6.9	6.0	6.3	6.0	6.3
Mixture 3	6.2	5.9	6.6	6.1	6.2	5.8	5.1	5.7	4.9	5.4	6.0	5.5	6.1	5.5	5.8
Mixture 4	7.2	5.3	6.8	6.6	6.5	5.9	4.2	4.6	4.4	4.8	6.5	4.8	5.7	5.5	5.6
Mean	7.2	6.0	6.3	6.5		6.0	5.1	5.4	5.2		6.6	5.6	5.9	5.9	
LSD %5			Y: 0.02	S: 0.03	C: 0.05		YxS: 0.05		YxC: 0.07	SxC: 0.1		YxSxC: 0.1			
Turf quality															
Delaware	8.9	8.5	8.8	8.0	8.5	7.9	7.4	6.4	6.1	7.0	8.4	8.0	7.6	7.1	7.8
Starlet	7.7	8.2	8.7	7.9	8.1	8.9	9.0	8.1	8.4	8.6	8.3	8.6	8.4	8.2	8.4
Wilma	7.3	7.7	2.8	2.7	5.1	4.4	1.6	1.1	1.2	2.1	5.9	4.6	2.0	2.0	3.6
Suzette	8.0	6.8	3.3	3.2	5.3	5.0	2.5	2.4	1.6	2.9	6.5	4.7	2.8	2.4	4.1
Mixture 1	8.7	8.5	8.7	8.1	8.5	8.4	8.6	8.2	8.2	8.3	8.5	8.6	8.4	8.1	8.4
Mixture 2	8.0	8.1	7.8	7.0	7.7	7.5	5.3	4.5	3.6	5.2	7.7	6.7	6.2	5.3	6.5
Mixture 3	8.1	7.7	6.4	6.3	7.1	6.8	6.1	5.9	6.2	6.2	7.4	6.9	6.2	6.3	6.7
Mixture 4	7.1	6.2	6.7	7.0	6.8	6.8	4.1	3.7	3.9	4.6	7.0	5.2	5.2	5.4	5.7
Mean	8.0	7.7	6.7	6.3		7.0	5.6	5.0	4.9		7.5	6.6	5.8	5.6	
LSD %5	Y: 0.06	S: 0.09	C: 0.1	YxS: 0.1		YxC: 0.2		SxC: 0.3		YxSxC: 0.4					

In contrast, all turf alternatives, except *L. perenne* and *F. arundinacea* and their mixtures, had reduced adaptability during summer seasons of both years may be attributed to the heat and drought stresses arising from weather conditions of the summer season under Mediterranean environment, which generally has restrictive effect on plant growth and development especially for cool season grasses (Xu *et al.*, 2005; Demiroğlu *et al.*, 2010b).

The color scores of turfs may also help to define the most appropriate alternative to select, particularly in relation to the seasons in which turf color is considered of special significance (Morris & Sherman, 2000). The higher turf color scores of *F. arundinacea* and *L. perenne* and their mixtures during the summer season, which is the least favorable period of the year for cool season turf grass growth in Mediterranean environment were mainly due to the greater color retention and heat, drought resistance of above mentioned turf grasses (Russi *et al.*, 2004). Avcıoğlu *et al.* (2009)'s statements are in agreement with our findings. Among the cover scores of all turf alternatives, Starlet, *F. arundinacea* cultivar had highest scores in various seasons of different experimental years. The obtained results of quality scores also in summer revealed the greater performance of Starlet, which mirrored the adaptability of *F. arundinacea* to dry and hot environmental conditions of Mediterranean ecologies. Martinello and D'Andrea (2006) also stated that tall fescue had higher values of turf cover and quality in summer because of high drought and heat resistance capability of this species. Delaware, *L. perenne* cultivar performed respectively well in the duration of first experimental year, but had lower cover scores than Starlet in second year. These results might

be due to the intermediate level of drought and heat resistance of *L. perenne* under heat and drought stress conditions of Mediterranean environment (Beard, 1973; Açıkgöz, 1994; Avcıoğlu, 1997).

In turfs, weeds are a major problem and can reduce the growth of turf, be a host to the other pests, compete with turf for water, light, space, nutrient and become established more readily in thin and weak turf areas, instead of a vigorous and healthy turf (Gaussoin & Martin, 1994; Roberta *et al*., 2005). Since the presence of weeds in a turf grass community disrupts the uniformity and quality due to the variability in leaf width color and growth habit, competitive ability and aggressive growth behavior of turf grass is a major factor to establish and maintain a successful turf. Weed invasion scores of turf alternatives tested in the experiment differed ultimately in both years, including seasons. Starlet and Delaware were the cultivars highly resistant to weed infestation, that's because they possessed highest scores representing their abilities to compete with weeds. *F. rubra subsp*. and *F. ovina* and *P. pratensis* cultivars in mixtures decreased the performances of mixture 2, 3 and 4, although the other component, Delaware, *L. perenne* cultivar was the turf grass showing acceptable rate of adaptability to Mediterranean climatic condition. These results were most probably due to the acknowledged susceptibility of *F. rubra subsp*., *F. ovina* and *P. pratensis* to heat stress encountered by crops mainly in summer season in Mediterranean environments (Beard, 1973). Nevertheless, Yılmaz and Avcıoğlu (2000) and Zorer *et al*. (2009) also stated that these cool season grasses displayed very good performances particularly in cool climatic conditions of Tokat and Van locating in cooler zones of Turkey. Statements of Açıkgöz (1994) and Avcıoğlu (1997) are in accordance with our results. On the contrary, Russi *et al*. (2004)'s indications didn't confirm our findings.

The turf quality is a widely used criterion to define the overall performances of turf in turf management practices (Kir *et al.*, 2010b). The results of the turf quality scores obtained from the experiment also revealed that *F. arundinacea* and to some extent *L. perenne* cultivars were the outstanding genotypes under our experimental conditions. The mixture 1, containing these components, possessed also high scores and confirmed the adaptability of above mentioned crop material to the Mediterranean environment. Oral and Açıkgöz (1998) studied on cool season turf grass adaptability and indicated the resembling behavior of these species under sub - Mediterranean conditions. Salman and Avcıoğlu (2010) reported resembling findings. Russi *et al*. (2004) also stated that pure stands of tall fescue are often preferred, when adaptation to low-input or un-favorable condition is targeted. Our findings in *F. ovina, F. rubra* subspecies and *P. pratensis* containing mixtures (Misture 2, 3, 4, respectively) were not in agreement with the indications of Van Huylenbroeck *et al*. (1999) and Martinello and D'Andrea (2006). The Lower and declining turf color, cover, weed invasion and quality scores of above mentioned turf alternatives were particularly the indication of being physiologically worse endowed to cope with the ecological conditions of Mediterranean summers (Daget, 1985; Arslan & Çakmakçı, 2004).

CONCLUSION

We concluded that results of the experiment confirmed the outstanding adaptability of *F. arundinacea* cultivar Starlet and partially perennial ryegrass cultivar Delaware to Mediterranean environment. Mixture 1, composed of 75% *F. arundinacea* + 25% *L. perenne* was the only tested mixture to recommend for a satisfactory and sustainable turf establishment under Mediterranean and resembling climate conditions. Mixture 2 (50% *L. perenne* + 50% *F. ovina*), mixture 3 (50% *L. perenne* + 25% *F. rubra spp. commutata* + 25% *F. rubra spp. trichophylla*) and mixture 4 (40% *L. perenne* + (25% *F. rubra spp. commutata* + 25% *F. rubra spp. trichophylla* + 10% *P. pratensis*) were not found to be recommendable for the existing environmental conditions.

REFERENCES

Açıkgöz, E., 1994. *Turf Areas, Techniques of Establishment and Maintenance*. Çevre Peyzaj Mimarlığı Publish, Bursa

Açıkgöz, N., E. İlker and A. Gökçöl, 2004. Assessment of biological research on the computer. *Eu Totem,* 2: 236

Aronson, L.J., A.J. Gold and R.J. Hull, 1987. Cool Season Turfgrass Responses to Drought Stress. *Crop Sci*., 27: 1261–1266

Arslan, M. and S. Çakmakçı, 2004. Determination of Adaptation Ability and Performance of Different Grass Species and Cultivars in Coastal Conditions of Antalya Province. *J. Agric. Akdeniz Uni.*, 17: 31–42

Avcıoğlu, R., 1997. *Turf Technique (Turf Establishment & Management)*. Ege University Press, Izmir, Turkey

Avcıoğlu, R., R. Hatipoğlu and Y. Karadağ, 2009. *Grass and Other Family Forage Crops*, p: 856. Ministry of Agriculture and Rural Affairs, İzmir/Turkey

Beard, J.B., 1973. *Turf Grass: Science and Culture*. Prentice-Hall Inc., Englewood Cliffs, NJ, USA

Daget, P., 1985. The Mediterranean Bio Climates and Some of Their Consequences on Vegetation. *Int. Turf Grass Soc. Res. J*., 5: 25–35

Demiroğlu, G., H. Geren, B. Kir and R. Avcioglu, 2010a. Performances of Some Cool Season Turf Grass Cultivars in Mediterranean Environment: II. *Festuca arundinacea* Scherb., *Festuca ovina* L., *Festuca rubra spp. rubra* L., *Festuca rubra spp. trichophylla* Gaud and *Festuca rubra spp. commutata* Gaud. *Turkish J. Field Crops*, 15: 180-187

Demiroğlu, G., B. Kir, R. Avcioglu and H. Geren, 2010b. An Investigation on the Yield and Quality Performances of Some Rotation Pasture Mixtures under Different Harvest Treatments. *African J. Biotechnol.*, 9: 7877–7884

Gaussoin, R. and A. Martin, 1994. *Turf grass Weed Prevention and Management*. http://ianrpubs.unl.edu/Weeds/g1045.htm

Harivandi, M.A., W. Davis, V.A. Gibeault, M. Henry, J.V. Dam and Lin Wu, 1984. Selecting The Best Turfgrass. *California Turfgrass Culture*, 34: 17-24

Kır, B., R. Avcioglu, G. Demiroglu and S. Aleksandar, 2010a. Performances of Some Cool Season Turfgrass Species in Mediterranean Environment: I. *Lolium perenne* L., *Festuca arundinacea* Schreb., *Poa pratensis* L. and *Agrostis tenuis* Sibth. *Turkish J. Field Crops*, 15: 174-179

Kır, B., G. Demiroglu, R. Avcioglu and H. Geren, 2010b. Effect of Sowing Techniques and Harvesting Treatments on the Performances of Some Rotation Pasture Mixtures. *African J. Biotechnol.*, 9: 6666–6669

Martinello, P., 2005. Variability of Turf Quality and Phytocoenoses in Areas of Play in Football Grounds in Mediterranean Environments. *Agric. Med.*, 135: 209–220

Martinello, P. and E. D'Andrea, 2006. Cool-season Turf grass Species Adaptability in Mediterranean Environments and Quality Traits of Varieties. *European J. Agron.,* 25: 234–242

Morris, K.N. and R.C. Sherman, 2000. The National Turfgrass Evaluation Program: Assessing New and Improved Varieties. *Diversity*, 16: 19–22

Oral, N. and E. Açıkgöz, 1998. The Investigations on the Seed Mixtures, Seeding Rate, N-fertilization in the Turfs Established in Bursa Region. *Ph. D Thesis*, Uludağ University Department of Field Crops, Bursa, Turkey

Paulsen, G.M., 1994. High Temperature Responses of Crop Plants. *In*: Boote, K.J., J.M. Bennett, T.R. Sinclair and G.M. Paulsen (eds.), *Physiology and Determination of Crop Yield*, pp: 365–389. ASA, CSSA and SSSA, Madison, WI

Roberta, M., C.Z. Maria, W.A. David and Z. Giuseppe, 2005. Weed Turf: A Predictive Model to Aid Control of Annual Summer Weeds in Turf. *Weed Sci.*, 53: 193–201

Russi, L., P. Annicchiarico, P. Martiniello, C. Tomasoni, E. Piano and F. Veronesi, 2004. Turf Quality and Reliability in Varieties of Four Turfgrass Species in Contrasting Italian Environments. *Grass Forage Sci.*,59: 233–239

Salman, A. and R. Avcıoğlu, 2010. Performances of Some Cool Season Turf Grasses in Different Fertilizer Doses. *J. Ege Uni. Facul. Agric.*, 47: 309-319

Van Huylenbroeck, J.M., P. Lootens and E. Van Bockstaele, 1999. Photosynthetic Characteristics of Perennial Ryegrass and Red Fescue Turf-grass Cultivars. *Grass Forage Sci*., 54: 267–274

Xu, Sheng, Li Jianlong, Zhang Xinquan, Wei Hong and Cui Langjun, 2005. Effects of Heat Acclimation Pretreatment on Changes of Membrane Lipid Peroxidation, Antioxidant Metabolites and Ultrastructure of Chloroplasts in Two Cool-Season Turfgrass Species under Heat Stress. *Environ. Expt. Bot.*, 56: 274–285

Yılmaz, M. and R. Avcıoglu, 2000. Investigation on seed yield and turf properties of some grasses grown for turfgrass and erosion control purposes in Tokat, Turkey. Ege University Faculty of Agriculture, Dept. of Field Crops, (Unpublished PhD Thesis), p. 220.

Zorer, Ş., N. Andiç and İ.H. Yılmaz, 2009. Determination of Proper Species Mixtures for Established Turf grass Field in Van Region. *YYU J. Agric. Sci.*, 19: 91–101

(Received 20 December 2010; Accepted 19 January 2011)