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PERFORMANCES OF NEWLY INTRODUCED *Festuca arundinacea* Schreb. CULTIVARS VERSUS *Lolium perenne* L. IN A MEDITERRANEAN ENVIRONMENT

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ABSTRACT

This study was conducted to evaluate the adaptability and turf quality of newly introduced Tall Fescue (*Festuca arundinacea* Schreb.) cultivars in comparison with Perennial Ryegrass (*Lolium perenne* L.) under Mediterranean environmental conditions of experimental fields of Bayindir Training College Aegean University, Izmir, Turkey in 2008-2010. Six cultivars of tall fescue (*Festuca arundinacea* Schreb.) were compared with the most popular perennial ryegrass (*Lolium perenne* L.) cultivar in the area for two years in a replicated experimental design (randomized complete block). On the cultivars of both species, turf colour, texture, weed invasion and quality traits were determined by using a visual score (1-9) assessed monthly from January to December, during 2008 - 2010. All tall fescue cultivars were better than perennial ryegrass to cope with climatic condition and achieved higher scores in all traits almost in all seasons, and cultivar Turbo and SR8600 performed far better than perennial ryegrass cultivar Henrietta.

Key Words: Cool-Season turf grassess, turf quality, adaptability, Mediterranean environment

INTRODUCTION

That is a fact that considerable amount of technical and scientific information has accumulated concerning turf grass agronomy and performance in sector, yet many questions and problems still exist in developing Mediterranean countries (Kir et al., 2010). Paulsen (1994) indicated that heat and drought stress which are the main characteristics of Mediterranean ecological conditions represent two of the major abiotic stress factors limiting the growth and development of cool season turf grasses. Cool season turf grasses exhibit optimal growth at 16-24 ^{o}C with reduction of impaired growth when the temperature reaches 33 ^{o}C (Beard, 1973; Van Huylenbroect et al., 1999). The weather conditions during the summer months in locations with a typical Mediterranean climate entail a prolonged period of drought stress which reduces the physiological activity of turf grass and hence the quality of lawn (Beard and Sifers, 1997; Jiang and Huang, 2001).

As a paradox, C_3-cool season turfgrasses are widely used depending on very old data and tradition on turf sector in Mediterranean countries such as Turkey and similar regions of neighbouring countries (Volterrani et. all., 2001; Demiroglu et.all., 2011) and objection to the warm season turfgrasses which occurs generally in the Mediterranean region is the lack of green colour during the winter dormancy period (Kir et al., 2010).

It is a fact that cool season turfgrasses adaptability and physiologically enduring to cope with the conditions of Mediterranean environments are the major question of vital significance. Thus, knowledge on adaptability to weather conditions allows us to identify turfgrass species and genotypes better able to tolerate and exploit the resources of the environments (Daget, 1985; Beard, 1989; Shearman et al., 2001). Genetic information on the environmental adaptability of the most popular varieties of cool season species may be determined by direct field comparison in targeted environments (Sifers and Beard, 1993). Many researchers investigated the adaptability of wide range of cool season turf grasses in Mediterranean environments and quality traits of cultivars in their countries (Greece, Italy, Spain, France and Turkey) in last decades. They all suggested that tall fescue (*Festuca arundinaceae* Schreb.) was the most adaptable species for dry and hot ecological conditions (Van Huylenbroect et al., 1999; Annicchiarico et al., 2000; Yilmaz and Avcioglu, 2000; Russi et al., 2004; Avcioglu et al., 2009). Martinello (2005) and Martinello and D' Andrea, (2006), also stated perennial ryegrass (*Lolium perenne* L.) and some other cool season turf grasses as widely used turf crops in addition to tall fescue in Mediterranean countries.

In this study, concidering the *Festuca arundinaceae* as most adaptable cool season turf species to Mediterranean environments, colour, texture, weed invasion and turf quality

traits of various newly tall fescue cultivars were tested and compared with a widely used perennial ryegrass cultivar Henrietta under Mediterranean ecological conditions.

MATERIALS AND METHODS

This study was conducted during the 2008-2009 and 2009-2010 growing season on the experimental fields of Bayindir Training College (38 20´12N – 27 67´ 14 E), Ege University- Izmir, Turkey, at about 105 m a.s.l. with typical Mediterranean climatic conditions. Average annual data of temperature through experimental years in 2009-2010 (17.3–18.1 ^{o}C, respectively), were generally in accordance with long term average (18.8 ^{o}C), but precipitation (768.7–742.6 mm in succeeding experimental years, respectively) compared to long term average (554.9). The native root zone was composed of 80.1 % sand, 15.3 % silt and 4.6 % clay. The experimental area soil was silty sand with following characteristics; pH 6.0; $CaCO_3$ 1.02%; total nitrogen 0.08%; organic matter 2.7%, available phosphorus 2.31 mg kg^{-1}; exchangeable potassium 36 mg kg^{-1}. The seedbed was made by disrupting a vegetable fallow with mouldboard ploughed 30-35 cm deep at the beginning of October in 2008. Prior to seedbed preparation, the experimental plots were equipped with a permanent water pipeline system based on rotary sprinklers.

Four newly introduced (Turbo, Firaces, Merida, SR8600) and two conventional (Apache, Eldorado) cultivars of tall fescue (*Festuca arundinaceae* Schreb.) and a popular perennial ryegrass cultivar (Henrietta) were tested and compared in the experiment. A randomised complete block design arranged with four replications was used. Plot size was 2 m long by 1 m wide. Half a meter bare soil corridors were maintained between blocks. All cultivars were hand sown with traditional amount of seed per unit area in plots in late October. Invaded weeds were hand removed during the establishment period and further weed encroachment wasn't controlled by any mean. Ammonium nitrate (NH_4NO_3) were used as N fertilizer and manually applied in all entries at rate of 10 g m^{-2} in fourteen rounds (twice in early April, May, June, July, August, September, October). 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 and early fall. Turf grass colour, texture (Beard, 1973), weed invasion and quality traits were assessed by a visual score based on a 1-9 scale, as recommended in the National Turfgrass Evaluation Program in the USA (Morris and Sherman, 2000). Observations were maintained on a monthly basis, while scoring was carried out on a seasonal (Sp: Spring, Su: Summer, Fa: Fall, Wi: Winter) basis in the middle of each season (April, June, October, January).

Statistical analyses were conducted by using TOTEMSTAT Statistical Program (Acikgöz et al., 2004). Probabilities equal to or less than 5% were considered significant. If TOTEMSTAT indicated significant differences between treatment means a LSD test was performed to separate them.

RESULTS

The variation analysis of data in 2009, 2010 and two years average were summarised in Table 1.

Turf Colour

The average turf colour scores and the statistical evaluations of six different tall fescue cultivars and perennial ryegrass in each season and succeeding two years and two years average were summarized in Table 1.

Main effects of year, cultivar and season were significant while two and tree factor interactions were also significant indicating differentiating performances of cultivars according to the seasons and years. Turf colour scores of all tall fescue cultivars were higher almost on all seasons and Turbo and SR8600 cultivars (8.2 and 8.2, respectively) displayed better growth adaptability compared to the tested cultivars including ryegrass cultivar Henrietta in 2009. Average colour scores of cultivars increased in second year depending on the maturation of grasses, while Turbo and SR8600 cultivars maintained highest average scores also in second experimental year. Apache cultivar had the lowest colour scores in succeeding seasons of both years, while all grass material tested in the experiment possessed lower average scores in winter and spring than summer and fall. Turbo and SR8600 displayed higher colour scores in summer and fall seasons in two years average (9.0-9.0 and 9.0-9.0, respectively) and the performance of ryegrass cultivar Henrietta was also restricted and not comparable to these tall fescue cultivars during the same period.

Turf Texture

There was great variation among the different cultivars of tall fescue and perennial ryegrass with regard to turf texture scores in different seasons and years. Main effects of those factors and two and three factor interactions (year x season, cultivar x year, season x year and year x cultivar x season) were significant.

The turf texture scores of all cultivars of tall fescue species in different seasons and years were consistent and higher than ryegrass cultivar´s score in the duration of experimental years and two years average. Although, to some extent significant variation were detected among tall fescue cultivars, cultivar Turbo (5.1), Merida (5.1), SR8600 (4.9) and Firaces (4.9) displayed relatively lower scores as an indication of finer leaf blades in the first experimental year. Turbo and SR8600 tall fescue cultivars maintained similar texture scores in the second year, while ryegrass cultivar Henrietta had distinguished average texture score compared to the tall fescue cultivars and revealed same outstanding texture quality in succeeding year and two years average. Seasonal variation in average texture scores were also evident for all species and cultivars tested in the experiment in both years, while lower texture scores indicating higher texture quality of tested turf grasses were also evident in spring and summer seasons in both experimental years and two years average.

Weed Invasion

Ecological conditions of the experimental area had significant impact on weed invasion scores of all cultivars in

Table 1. Colour, texture, weed invasion and quality traits of tall fescue and ryegrass cultivars

Turf Colour															
Turf Cultivars	2008-2009					2009-2010					Mean				
	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean
Turbo	7.2	7.5	9.0	9.0	8.2	9.0	9.0	9.0	9.0	9.0	8.1	8.3	9.0	9.0	8.6
Firaces	6.8	7.1	8.1	9.0	7.7	7.7	9.0	8.4	8.7	8.4	7.2	8.0	8.2	8.8	8.1
Merida	6.2	7.1	9.0	9.0	7.8	9.0	8.4	9.0	8.6	8.7	7.6	7.7	9.0	8.8	8.3
Eldorado	6.8	7.1	9.0	9.0	8.0	9.0	8.7	7.7	8.6	8.5	7.9	7.9	8.3	8.8	8.2
SR8600	7.5	7.2	9.0	9.0	8.2	9.0	9.0	9.0	9.0	9.0	8.3	8.1	9.0	9.0	8.6
Apache	6.6	6.4	6.4	6.4	6.4	7.6	6.4	7.1	7.7	7.2	7.1	6.4	6.7	7.0	6.8
Henrietta	7.1	6.4	7.7	7.7	7.2	6.3	6.4	8.4	8.4	7.4	6.7	6.4	8.1	8.0	7.3
Mean	6.9	7.0	8.3	8.4	7.6	8.2	8.1	8.4	8.6	8.3	7.5	7.5	8.3	8.5	8.0
LSD %5	Y: 0.01		S: 0.01		C: 0.02	YxS:0.02			YxC: 0.02		SxC: 0.03			YxSxC: 0.05	

Turf Texture															
Turf Cultivars	2008-2009					2009-2010					Mean				
	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean
Turbo	5.1	5.2	5.0	5.2	5.1	5.0	5.1	4.8	5.1	5.0	5.1	5.1	4.9	5.2	5.1
Firaces	5.4	4.9	4.6	4.6	4.9	5.3	5.1	5.0	5.4	5.2	5.3	5.0	4.8	5.0	5.0
Merida	5.3	4.9	5.0	5.1	5.1	5.4	5.0	4.9	5.5	5.2	5.3	5.0	5.0	5.3	5.1
Eldorado	5.8	5.8	5.1	5.5	5.6	5.1	5.2	4.9	5.4	5.1	5.5	5.5	5.0	5.4	5.3
SR8600	5.1	5.0	4.6	5.1	4.9	5.1	4.9	4.8	5.0	5.0	5.1	5.0	4.7	5.0	4.9
Apache	5.9	5.6	4.8	5.4	5.4	5.3	5.3	4.8	5.6	5.2	5.6	5.4	4.8	5.5	5.3
Henrietta	3.3	1.9	2.3	2.5	2.5	2.9	2.5	2.0	2.4	2.5	3.1	2.2	2.2	2.4	2.5
Mean	5.1	4.7	4.5	4.8	4.8	4.9	4.7	4.5	4.9	4.7	5.0	4.7	4.7	4.8	4.7
LSD %5	Y: 0.02		S: 0.03		C: 0.04	YxS: 0.05			YxC: 0.06		SxC: 0.08			YxSxC: 0.12	

Weed Invasion															
Turf Cultivars	2008-2009					2009-2010					Mean				
	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean
Turbo	6.8	7.7	8.6	8.8	8.0	9.0	9.0	9.0	9.0	9.0	7.9	8.3	8.8	8.9	8.5
Firaces	6.3	7.0	7.7	8.6	7.4	8.5	8.6	8.8	8.6	8.6	7.4	7.8	8.2	8.6	8.0
Merida	7.2	7.2	7.9	9.0	7.8	9.0	8.5	8.8	8.5	8.7	8.1	7.9	8.4	8.8	8.3
Eldorado	7.2	6.8	7.7	9.0	7.7	9.0	8.3	8.6	8.3	8.5	8.1	7.5	8.1	8.7	8.1
SR8600	6.3	6.8	8.8	9.0	7.7	8.8	8.8	9.0	9.0	8.9	7.5	7.8	8.9	9.0	8.3
Apache	6.8	7.7	8.3	9.0	7.9	8.6	8.5	8.5	8.5	8.5	7.7	8.1	8.4	8.8	8.2
Henrietta	6.3	6.5	7.0	8.8	7.1	8.3	8.3	8.1	8.1	8.2	7.3	7.4	7.5	8.4	7.7
Mean	6.7	7.1	8.0	8.9	7.7	8.7	8.6	8.7	8.6	8.6	7.7	7.8	8.3	8.7	8.2
LSD %5	Y: 0.01		S: 0.01		C: 0.02	YxS: 0.02			YxC: 0.02		SxC: 0.03			YxSxC: 0.05	

Turf Quality															
Turf Cultivars	2008-2009					2009-2010					Mean				
	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean	Wi	Sp	Su	Fa	Mean
Turbo	4.0	6.5	8.6	9.0	7.0	7.8	8.4	9.0	9.0	8.5	5.9	7.4	8.8	9.0	7.8
Firaces	3.5	6.0	7.1	8.2	6.2	7.5	7.9	8.4	8.3	8.0	5.5	7.0	7.7	8.3	7.1
Merida	3.5	5.5	7.6	8.0	6.1	7.5	7.9	9.0	8.6	8.3	5.5	6.7	8.3	8.3	7.2
Eldorado	2.8	5.5	8.1	8.6	6.2	7.7	8.0	9.0	8.2	8.2	5.2	6.8	8.6	8.4	7.2
SR8600	4.4	6.5	8.5	8.9	7.1	8.0	8.1	9.0	8.8	8.5	6.2	7.3	8.7	8.8	7.8
Apache	4.8	6.8	7.5	8.5	6.9	6.7	7.0	8.0	7.5	7.3	5.8	6.9	7.8	8.0	7.1
Henrietta	3.0	5.8	6.3	7.8	5.7	6.1	7.0	7.3	6.8	6.8	4.6	6.4	6.8	7.3	6.3
Mean	3.7	6.1	7.7	8.4	6.5	7.3	7.8	8.5	8.2	7.9	5.5	6.9	8.1	8.3	7.2
LSD %5	Y: 0.01		S: 0.01		C: 0.02	YxS: 0.02			YxC: 0.02		SxC: 0.03			YxSxC: 0.04	

each season and year. Variation analysis of data of weed infestation mirrored the significant main effects of cultivar year and season (Table 1), while all two and three factor interactions were also significant.

The mean weed invasion scores of all cultivars of tall fescue and ryegrass were not high in winter and spring seasons of the first experimental year and afterwards increased indicating the decreased level of weed invasion in the plots in the other seasons of the first and succeeding year. There were also remarkable intra and interspecific differences among the turf grasses tested and cultivar Turbo and SR8600 were the distinguishing material among the tall fescue cultivars, with outstanding weed invasion scores in each season of first and second experimental years and two years average. On the contrary, ryegrass cultivar Henrietta had very limited weed invasion scores displaying poor tillering and limited individual crops per unit area and high

weed encroachment in the plots in the duration of the succeeding seasons of the both experimental years.

The weed invasion scores of two years average also proved that cultivar Turbo (8,5) and SR8600 (8,3) of tall fescue were highly promising turf grass material in terms of weed competition compared to other tall fescue cultivars and ryegrass cultivar Henrietta.

Turf Quality

The mean turf quality scores of various turf alternatives tested in the experiment in each season, year and two years average of evaluation were summarized in table 1. Variation analysis of quality scores indicated the significant main effects of season, year and cultivar in addition to the significant effect of two and three factor interactions.

The mean scores of all cultivars of tall fescue and ryegrass cultivar Henrietta were lower than summer and fall (3.7 and 6.1 respectively) in winter and spring (7.7 and 8.4 respectively) in the first experimental year, while all quality scores highly increased in all seasons of the second year. All cultivars of tall fescue displayed higher quality scores than cultivar Henrietta in the duration of entire experimental seasons and cultivar Turbo and SR8600 ranked first among all turfgrass cultivars tested. By contrast, ryegrass cultivar Henrietta had remarkably lower quality scores than all tall fescue cultivars throughout the experimental seasons and years and comparably lower performance of cultivar Henrietta was clearly observed in summer seasons of both years and two years average.

DISCUSSION

The cultivars of tall fescue and ryegrass adapted differently to Mediterranean environmental conditions occurring in the experimental site during the study years. The variation recorded in turf colour, texture, weed invasion and quality scores among the seasons and years almost for all tall fescue cultivars tested proved the reasonable adaptability of genotypes to weather conditions of the summer season as well as fall, winter and spring. The reduced adaptability of ryegrass cultivar Henrietta observed generally during summer season almost in all traits tested may be attributed to the restrictive effect of weather conditions prevailing during this period on plant development (Demiroglu et al., 2010; Kusvuran and Tansı, 2009). Kir et al. (2010) declared that colour scores in turf grass cultivars tests may help to define the most appropriate turf grasses 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 cultivars and relatively perennial ryegrass cultivar during the summer which usually is the least favourable season for cool season turf growth in Mediterranean environment were most probably due to the colour retention (Russi et al., 2004) of both grasses and acknowledged resistance of tall fescue to heat and drought stresses encountered by crops mainly in summer season in Mediterranean environments (Salman et al., 2011; Avcioglu, 1997, Russi et. all., 2004).

Although the turf texture of tall fescue cultivars were courser than perennial ryegrass cultivar Henrietta in all seasons and years in the experiment, higher scores of particularly weed invasion, quality and to some extent colour proved that all tall fescue cultivars were the most successful genotypes maintaining higher performance in different seasons of the succeeding years and their wide range of adaptability to Mediterranean environment. Many turf researchers also stated that tall fescue is the most adaptable turfgrass for the Mediterranean environment and confirmed our results (Russi et al., 2004; Beard, 1973; Yılmaz and Avcioglu, 2000; Martiniello and D'Andrea, 2006; Bilgili and Acikgöz, 2005).

Tall fescue cultivars Turbo and SR8600 were the outstanding and favourable genotypes for the experimental conditions. Oral and Acikgöz (1998) studied on cool season turf grasses and indicated the resembling behaviour of tall fescue under Sub-Mediterranean conditions and Salman and Avcioglu (2010) reported resembling findings. Russi et al. (2004)'s findings were in agreement with those statements and they also revealed that pure stands of tall fescue are often preferred, when adaptation to low-input or unfavourable conditions are targeted.

The lower and declining turf colour, weed invasion and quality scores of perennial ryegrass cultivar Henrietta in summer seasons of both years were particularly the indication of being physically worse endowed the cope with the ecological conditions of Mediterranean hot summers (Daget, 1985; Arslan & Cakmakci, 2004).

CONCLUSION

The results of the experiment confirmed the outstanding adaptability of tall fescue (*Festuca arundinaceae* Schreb.) species to the Mediterranean environment and higher performances of cultivar Turbo and SR8600 compared to other genotypes tested. It was also concluded that perennial ryegrass cultivar Henrietta's performance was not comparable with tall fescue cultivars. However, considering the reasonable and consistent levels of colour and texture scores of ryegrass cultivar in the duration of experiment, we suggested to include this grass in mixtures with tall fescue under Mediterranean conditions.

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