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TURF AND PLAYING QUALITY TRAITS OF SOME NEW TURFGRASS ALTERNATIVES IN A MEDITERRANEAN ENVIRONMENT

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ABSTRACT

In an attempt to investigate the turfgrass and playing quality characteristics of some newly introduced warm season turf grasses and traditional cool season sports turf mixture, classical and contemporary techniques were imposed on the turfgrass experimental plots of the research area of Department of Field Crops, Agriculture Faculty of Ege University, Bornova/Izmir/Turkey. Some warm season turfgrasses (*Cynodon dactylon* cv. SR9554, *Cynodon dactylon x Cynodon transvaalensis* cv. Tifway-419, *Paspalum vaginatum* cv. Sea Spray and *Zoysia japonica* cv. Zenith) and traditional cool season sports turf mixture were tested in terms of visual turf quality and playing quality traits (ball rebound, ball roll and shock absorption) on a monthly and seasonal bases for three years under Mediterranean environmental conditions. Significant variations were determined among the turfgrass alternatives in all traits except years. It was concluded that Tifway-419 and Sea Spray turf grasses were the most successful and promising alternatives compared to the other options under Mediterranean environmental conditions.

Keywords: Ball rebound, ball roll, playing quality, shock absorption, visual turf quality

INTRODUCTION

In the modern world, in addition to the turf quality traits in sports turf, it is an important part of the turf researches in the tests related to the playing quality, unless a particular experimental treatment or new product can be shown to enhance enjoyment or safety of players during a game (Baker and Canaway, 1993). There has also been an increasing interest in the using of performance standards, including measurement of playing quality on turf areas (Lulli et al., 2004). The main objectives of sports turf research are to provide a playground that can be managed with an affordable and acceptable budget, but we must also try to produce a turf surface that minimizes the risk of injury and allows maximum enjoying a game of player (Baker and Canaway, 1993). In researches on sports turf made in athletic fields, the quality and security of the playing area constitute two important characteristics (Bell et al., 1985). Firstly, some of the most important characters in the interaction between ball and turfgrass surface are ball rebound and ball roll. Second, the players are also sensitive to quality of the turfgrass and the evenness of the sport surface which is significant in bumps and hallows (Baker and Canaway, 1993). Although Turkey has many sophisticated sport fields (such as soccer, horse racing, golf etc.), there is not any systematic research study on the turf and surface quality characteristics of the sport fields of those establishments. As far as depending on the collected information, this study project was the first turf field investigation in this area and was supported by TUBITAK-TOVAG for three years. Data obtained from the field studies by new devices developed for this type of measurements for contemporary turf sport surfaces and imported from a specialist company Netherlands, Europe (Deltec Metaal-Club Set for FIFA standards).

The aim of the study was to evaluate the newly introduced turfgrass surface and playing quality characteristics of SR9554, Tifway-419, Sea Spray and Zenith warm season turf grasses and additionally to compare their performances with the traditional cool season sports turf mixture alternative.

MATERIALS AND METHODS

The trial was conducted in between November 2012-November 2014 on the experimental area located in Bornova (38°27'05.76" N, 27°13'28.59" E and 26 m above sea level) experimental fields of Field Crops Department, Agriculture Faculty, Ege University, Izmir, Turkey. Typical Mediterranean climate was observed during the experimental years and the average for long years was 17.1ºC at temperature and 633.2 mm at rainfall, it was

considered that the amount of rain in different months were irregular.

The soil of the turf experimental area was loamy sand (previously prepared for turf experiments) in texture with following characteristics; ph 7.8, total ($CaCO_3$) 2450 mg kg^{-1}, total nitrogen 0.22 g kg^{-1}, organic matter 2.439 g kg^{-1}, available phosphorus 2.39 mg kg^{-1} and exchangeable potassium 127 mg kg^{-1}. At the beginning of September, the seedbed was sprayed twice to control weeds and cultivated with rototiller and rolled. Before this preparation, the experimental plots were equipped with a permanent pipeline system using rotary sprinklers. During the summer season, supplemental sprinkler irrigation has been carried out when necessary to prevent visual wilt of the turf. In the first week of November in 2012, nitrogen, 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 seeding and levelling the soil with the roller again.

The experiment was conducted in a factorial randomised complete block design with four replications. Five turfgrass alternatives (*Cynodon dactylon cv. SR9554, Cynodon dactylon x Cynodon transvaalensis cv. Tifway-419, Paspalum vaginatum cv. Sea Spray and Zoysia japonica cv. Zenith)* and traditional cool season sports turf mixture (50% *Lolium perenne* cv. Hawkeye, 20% *Festuca rubra rubra* cv. Corail, 10% *Festuca rubra commutate* cv. Maritza, 10% *Festuca ovina* cv. Ridu, 10% *Poa pratensis* cv. Platini) were tested in the trial. Plot size was 2 m wide by 12 m long and no bare soil corridor was maintained between plots. Invading weeds were removed during the establishment period by hand-hoeing when necessary. However, after the turfs were fully established the area, weeds were allowed to invade as the competition evolved better with grass cultivars.

Observations and scoring for visual turf quality trait and measurements for playing quality traits of tested turf grasses were maintained on a monthly basis on the plots and summarized as average of season and years. The visual turf quality was determined by observing turf canopy in terms of color, uniformity and weed infestation. Visual turf quality estimates were made at 15 to 30 day intervals throughout the growing seasons. Rating scale used 1=poorest and 9=highest quality, being 6 or above is considered acceptable, NTEP. Ball rebound (Football FIFA 2009, Playing Quality Standard 5, inflated to 0.9 bar released from a height of 2 m) data were given as cm for ball roll, ball rebound and shock absorption were measured as FIFA standards (FIFA, 2005; Saunders et al., 2011) using "Club Set Device" of Deltec Metaal. All data except visual turf quality were analysed statistically (Acikgoz et al., 2004) and significant means were compared by the LSD test at 5% probability level as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The visual turf quality trait as the composite of color, uniformity and weed infestation traits is a widely used criterion to define the overall performances of turfs in turf management practices (Ozkan et al., 2014; Demiroglu et al., 2010; Grossi et al., 2004).

Since, the warm season turf grasses are in yellowish-brown-coloured during dormancy period in winter, only the data collected in spring-summer-autumn seasons were statistically analysed, whereas the traditional cool season sports turf mixture alternative was compared in four different seasons in two years (Table 1). In terms of this character, turf alternative Tifway-419 was highest quality score in both years and 2 year average ranked first and it was followed by Sea Spray. It has also been concluded that the advantages of both turf alternatives were their success in color, cover and weed invasion properties, as well as the superiority of their texture. Some researchers (Zhou and Abaraha, 2007; Volterrani and Magni, 2004; Watschke and Schmidt, 1992) described that the determining of turf quality is based on the color, uniformity, texture and weed invasion. Despite, it was not directly scored in our study; we observed that Tifway-419 plots, also having very fine leaf texture, have reached the highest quality scores. Avcioglu et al. (2007) and Trenholm and Unruh (2002) reported that Tifway-419 and Sea Spray had very high turf quality. In addition, Salman and Avcioglu (2008) also described the high turf quality of Sea Spray which could successfully sustain this feature year by year.

Table 1. Visual turf quality of some new warm season turfgrasses and traditional cool season sports turf mixture (1-9)

Turf Alternatives	2013					2014					2013-2014				
	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn
C. dactylon	0	7.47	7.93	7.13	7.51	0	7.37	8.03	6.93	7.44	0	7.42	7.98	7.03	7.48
C. dactylon x *C. transvaalensis*	0	8.17	8.43	7.83	8.14	0	8.43	8.57	8.03	8.34	0	8.30	8.50	7.93	8.24
Paspalum vaginatum	0	7.97	8.23	7.63	7.94	0	8.20	8.45	7.85	8.17	0	8.08	8.34	7.74	8.06
Zoysia japonica	0	7.40	7.87	7.10	7.46	0	7.42	7.73	7.20	7.45	0	7.41	7.80	7.15	7.45
Traditional cool season sports turf mixture	0	7.23	6.80	7.27	7.10	0	7.03	6.60	7.48	7.04	0	7.13	6.70	7.38	7.07
Mean	0	7.65	7.85	7.39	7.63	0	7.69	7.88	7.50	7.69	0	7.67	7.87	7.40	7.66

Wi: Winter, Sp: Spring, Su: Summer, Au: autumn, Mn: Mean

In terms of turfgrass quality, SR9554 and Zenith had similar average scores in all seasons and these results were confirmed by Salman and Avcioglu (2008). However, the traditional cool season sports turf mixture had low turf quality scores, mainly showing poor adaptability of perennial ryegrass (*Lolium perenne* L.) in addition to Kentucky bluegrass and fescue species to Mediterranean environmental conditions of the research area. Avcioglu et al. (2013), Bilgili and Acikgoz (2011), Uzun and Bilgili (2011), Kir et al. (2010), Volterrani and Magni (2004) also revealed similar findings.

Ball rebound character is expressed as the ratio of height bounced/height dropped as cm (FIFA, 2009a, 2009b) (Table 2). The ball rebound feature is required to be within certain boundary limits as it is important for players to dominate the ball during playing process. Ball rebound determined as percentage of the fall height in the British system, has become a reliable and easily measurable criterion since it is determined to be the highest point (60-85 cm interval) that the ball can rise after bouncing in FIFA standards.

Table 2. Ball rebound trait of some new warm season turfgrasses and traditional cool season sports turf mixture (cm)

Turf	**2013**					**2014**					**2013-2014**				
Alternatives	**Wi**	**Sp**	**Su**	**Au**	**Mn**	**Wi**	**Sp**	**Su**	**Au**	**Mn**	**Wi**	**Sp**	**Su**	**Au**	**Mn**
C. dactylon	62.7	70.0	102.0	70.7	76.3	68.0	67.3	98.3	71.3	76.3	65.3	68.7	100.2	71.0	76.3
C. dactylon x *C. transvaalensis*	58.0	54.7	77.7	62.0	63.1	55.3	53.3	72.7	63.0	61.1	56.7	54.0	75.2	62.5	62.1
Paspalum vaginatum	61.0	54.0	76.3	61.7	63.3	58.0	53.0	71.3	63.7	61.5	59.5	53.5	73.8	62.6	62.4
Zoysia japonica	69.7	67.7	91.0	69.3	74.4	64.7	66.0	84.7	71.0	71.6	67.2	66.8	87.8	70.2	73.0
Traditional cool season sports turf mixture	77.7	74.3	108.3	75.7	84.0	72.7	75.0	104.0	74.0	81.4	75.2	74.7	106.2	74.8	82.7
Mean	65.8	64.1	91.07	67.9	72.2	63.7	62.93	86.2	68.6	70.4	64.8	63.5	88.6	68.2	71.3
LSD (%5): TA: 2,2 S: 2,0 Y: 1,4 TAxS: 4,5 TAxY: ns SxY: 2,8 TAxSxY: ns															

TA: Turf Alternatives S: Seasons, Y:Years, ns: none significant

Ball rebound statistical analysis indicated that, the triple interaction was not significant but because other dual interactions were significant except for the TAxY, the turfgrass alternatives values were significantly variable among the treatments (turfgrasses) and seasons. In this respect, Tifway-419 and Sea Spray turf options have created ball rebound values below 60 cm in spring, but close to ideal scores in the other seasons, most probably due to the very dense and strong grass coverings. In contrast, the measurement values of 108.3, 104.0 and 106.1 cm were detected in the traditional cool season sports turf mixture, being affected negatively by Mediterranean climatic conditions (Trenholm et al., 2007; Zhou and Abaraha, 2007; Volterrani and Magni, 2004), have exceeded the standards. In particular, due to the soil hardening effect of heat and drought in summer, traditional cool season sports turf mixture was laid out a very weak cover, revealing high rebound values which were unfavourable scores (Avcioglu et al., 2013; Grossi et al., 2004). Generally, all other turf options had high ball rebound features exceeding standards in summer season. Unfavourable values were also detected in Standard Bermuda as it was in the traditional cool season sports turf mixture especially during the summer. Depending on the acceptable level of coverage, Japanese grass (*Zoysia japonica*) maintained reasonable ball rebound values between the upper and lower limits (Zhou and Abaraha, 2007; Miller, 2004; Orchard, 2002).

Ball roll trait is basically the function of rolling and rolling resistance which is regarded as a force acting at the point of contact between the ball and turf surface whose direction is the inverse of the direction of movement and therefore causes the ball to slow down while moving along the surface and generally expressed in terms of distance rolling by the ball indirectly (Baker and Bell, 1986). Ball roll measurements displayed limited values overall in treatments (Table 3). Although significant differences were recorded between experimental factor and related interaction effects, all scores were in between the standards. The ball roll trait is required to be within the certain limits because of the speed of the game and the players' domination of the ball in the process of playing on turfgrass (Baker and Canaway, 1993). At the beginning, these limits have been identified as 4-14 m in the United Kingdom, but later on those were adapted as the most ideal of the 4-10 m range according to FIFA's international investigations (FIFA, 2009a). Some researchers like Grossi et al. (2004), Miller (2004) and Orchard (2002) revealed that factors such as soil dryness and turfgrass cover weakness or vegetation deprivation, moisture condition of the soil, and especially the cutting height are the most important factors affecting the ball rolling feature.

Especially, Tifway-419 and Sea Spray were notable in all seasons and had a stable ball roll score. In contrast, the traditional cool season sports turf mixture that created sparse and weak vegetation with low turf quality (Cockerham et al., 1989) and had much higher and significantly different ball roll score than other warm season turf grasses in all seasons. However, these values remained between the highest and lowest ball roll standards in Bermudagrass. SR9554 and Zenith ranked after Tifway-419 and Sea Spray.

Table 3. Ball roll trait of some new warm season turfgrasses and traditional cool season sports turf mixture (cm)

Turf Alternatives	2013					2014					2013-2014				
	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn
C. dactylon	603	690	677	750	680	598	660	667	760	671	601	675	672	755	676
C. dactylon x *C. transvaalensis*	560	528	568	612	567	510	508	555	623	549	535	518	562	618	558
Paspalum vaginatum	537	553	558	540	547	508	543	558	575	546	523	548	558	558	547
Zoysia japonica	582	590	558	610	585	553	592	577	668	598	568	591	568	639	591
Traditional cool season sports turf mixture	645	687	705	688	681	647	698	722	720	697	646	693	713	704	689
Mean	585	610	613	640	612	563	600	616	669	621	574	605	615	655	612
LSD (%5): TA: 11,91 S: 10,66 Y: ns TAxS: 23,83 TAxY: 16,85 SxY: 15,07 TAxSxY: ns															

In terms of ball roll characteristic; there were significant variations among the turfgrass alternatives and season averages over the years and dual interactions were significant, but all values were between lowest and higher limits of ball roll standards indicating that all turf alternatives displayed appropriate values.

Shock absorption is a measure of the ability of the turfgrass canopy surface to absorb a part of the force on it, which is related to the hardness or softness of the turf stand. As it is well known, hard surface can crush joints (ankle, hip and spine) and cartilages and cause soft tissues to bruise in the living body's muscles (Baker and Canaway, 1993; Saunders et al., 2011). The human body also acts as a spring on the surface in which it touches (Orchard, 2002), and the athlete who moves on the surface of the grass is applying a certain force to this surface and a significant portion of the ability to absorb the effect is defined as "Shock Absorption" (FIFA, 2009a, 2009b; Orchard, 2002). This character, also referred to as the "Force Reduction" of the turfgrass surface, is expressed in units of "%". For example, the high force reduction value (%) means "Soft Surface" and the absorbing force value of the ideal natural turfgrass reaches 60-70% (Brosnan et al., 2009).

Statistical analysis of data related to the shock absorption collected in the experiment indicated that TAxSxY triple interaction, SxY dual interaction and year effect were not significant. Accordingly, Sea Spray turf alternative had the highest shock absorption values decreasing in summer in both years (Table 4). This result was due to the superior vegetative properties of this turf grass in terms of turf cover and the turf quality. The strong and dense turfgrass cover largely absorbs the pressure forces (Lulli et al., 2004; Cockerham et al., 1989). Therefore, the most successful turf alternative in terms of shock absorption was Sea Spray. Tifway-419 turfgrass ranked second with shock absorption values close to Sea Spray and once again confirmed that shock absorption will be favourable on the dense and strong turfgrass covers with high quality (Cockerham et al., 1989).

Table 4. Shock absorption trait of some new warm season turfgrasses and traditional cool season sports turf mixture (%)

Turf Alternatives	2013					2014					2013-2014				
	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn	Wi	Sp	Su	Au	Mn
C. dactylon	64,33	61,33	61,00	58,33	61,25	64.00	62.67	61.00	54.67	60.58	64.17	62.00	61.00	56.50	60.92
C. dactylon x *C. transvaalensis*	73,00	71,33	65,00	68,67	69,50	73.67	71.33	67.67	69.67	70.58	73.33	71.33	66.33	69.17	70.04
Paspalum vaginatum	76,67	74,67	68,00	70,00	72,33	78.00	75.67	71.33	71.33	74.08	77.33	75.17	69.67	70.67	73.21
Zoysia japonica	69,00	66,33	65,67	68,67	67,42	65.67	66.33	62.00	68.00	65.50	67.33	66.33	63.83	68.33	66.46
Traditional cool season sports turf mixture	65,67	62,33	59,00	65,67	63,17	62.33	57.67	54.33	62.67	59.25	64.00	60.00	56.67	64.17	61.21
Mean	69,73	67,20	63,73	66,27	66,73	68.73	66.73	63.27	65.27	66.00	69.23	66.97	63.50	65.77	66.37
LSD (%5): TA: 1,75 S: 1,57 Y: ns TAxS: 3,51 TAxY: 2,48 SxY: ns TAxSxY: ns															

Traditional cool season sports turf mixture, having upper limits of the shock absorption standards during winter season, had lower scores depending on the vegetation cover which is weakened due to the hot and arid climatic conditions especially during summer seasons (Salman et al., 2011). Zenith followed the high ranking turfgrass choices and was often attracted as a successful turf choice with the shock absorption values remaining between the standards (Table 4).

Results of the experiment revealed that Tifway419 and Sea Spray turf grasses were the most successful alternatives compared to the other options under Mediterranean environmental conditions. Traditional cool season sports turf mixture was the poorest alternative most probably due to the heat and drought stress conditions of Mediterranean climatic parameters existing generally in summer season.

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