WARM-SEASON TURFGRASS SPECIES AND CULTIVAR CHARACTERIZATIONS FOR A MEDITERRANEAN CLIMATE

P. Croce*, A. De Luca, M. Mocioni, M. Volterrani, and J.B Beard

ABSTRACT

In many regions of the northern Mediterranean the low rainfall and limited water availability are major developing concerns. Traditionally C_3 cool-season turfgrasses have been used in Italy and other similar regions. However, certain of the C_4 warm-season turfgrass species have a much lower water use rate and superior drought resistance and dehydration avoidance. Thus, the objective of this investigation was to evaluate the adaptation of four warm-season turfgrass species to the Mediterranean environment of Italy. Included in the study were 5 vegetative propagated and 11 seeded cultivars of *Cynodon,* 5 vegetatively propagated and 4 seeded cultivars of *Zoysia*, 2 vegetatively propagated *Paspalum vaginatum* cultivars, and 3 seeded *Buchloe dactyloides* cultivars. The experiment was conducted over a six-year period with the cultural conditions being representative of golf course fairways and sports fields, including a 13 mm cutting height. The findings from this study revealed the vegetatively propagated cultivars as a group were much better than the seeded cultivars of *Cynodon, Zoysia, Paspalum,* and *Buchloe* in terms of turfgrass quality, shoot density, and leaf blade width. The seed propagated *Zoysia japonica* cultivars were damaged because of significant *Puccinia* species problems in the fifth and sixth years, while De Anza and Victoria were severely damaged by *Rhizoctonia solani* Kuhn in 1999. Princess *C. dactylon* var. *dactylon* ranked considerably higher and acceptable in turfgrass performance compared to the remainder of the seeded *Cynodon* cultivars.

Keywords

Leaf blade width; mole crickets; seeded; shoot density; turfgrass quality; vegetative

INTRODUCTION

The C_3 cool-season grasses have been the dominant species used for turfs in the Mediterranean climate of Italy, as well as in many other countries surrounding the northern Mediterranean Sea. A contributing factor to this situation has been the ready seed availability of cool-season turfgrasses from northern Europe, while vegetative production sources for warm-season species have been lacking in the Mediterranean region. However, the low summer rainfall of the Mediterranean regions along with an increasingly limited water supply are dictating the need to use the low water use rate, drought tolerant warm-season turfgrasses. Among the warm-season turfgrasses, the *Cynodon* species and *Paspalum vaginatum* are characterized by superior drought resistance and dehydration avoidance, which are related to extensive deep root systems [Beard, 1989; Beard and Sifers, 1997]. Another objection to the warm-season turfgrasses which occurs in the Mediterranean region is the lack of green color during the winter dormancy period, when compared to the cool-season turfgrasses. However, this can be countered with a winter overseeding program in those areas where green winter turfs are desired, such as on sports fields and resort destination golf courses [Beard, 1973, 1982]. Accordingly, the objective of this research was to assess the turfgrass performance and adaptation of four species and a total of 29 cultivars of C_4, warm-season turfgrass species under Mediterranean climatic conditions in Italy.

P. Croce, A. De Luca, and M. Mocioni,Italian Golf Federation - National School of Golf – Green Section, Via di Monte Topino, SS Cassia km 44.500, Sutri, Viterbo, Italy. M. Volterrani, Dipartimento di Agronomia e Gestione dell'Agroecosistema, University of Pisa, Italy. J.B Beard, International Sport Turf Institute Inc., College Station, Texas, USA.
*Corresponding author: crocep@tin.it

MATERIALS AND METHODS

Establishment

The experimental site was just west of Rome near Casalpalocco, Italy at 4l°40'N and 10°15'E. The native root zone was composed of 83.5% sand with 95% above 0.25 mm in diameter, 10.8% silt, and 5.7% clay. The infiltration rate was 89 mm h^{-1}, and the organic matter content was 4.7%. The plot size was 3 by 2 m, in a randomized block design with 4 replications. There was a 0.5 m bare-soil alleyway between each plot. The *Cynodon* L. C. Rich. entries included 11 seeded and 5 vegetative cultivars, the *Zoysia* Willd. entries included 4 seeded and 5 vegetative cultivars, the *Paspalum vaginatum* Swartz entries included 2 vegetative cultivars, and the *Buchloe dactyloides* (Nutt.) Engeln.] entries included 3 seeded cultivars (Table 1). The hybrid *C. dactylon* x *C. transvaalensis* included Santa Ana,

Table 1. Comparative turfgrass characteristics among 3 species with a total of 27 cultivars during the third through sixth years at Casalpalocco, Italy.

Species	Cultivar	Leaf Blade Width (mm)	Shoot Density (cm^{-2})	Visual Turfgrass Quality (9 = best & 1 = poorest)			
				1997	1998	1999	2000
Cynodon spp.	Tifway*	1.2	11.7	7.32	7.74	7.30	8.06
	Tifdwarf*	1.2	9.0	7.20	7.76	7.33	8.00
	Tifway II*	1.2	10.8	7.20	7.90	8.08	7.31
	Santa Ana*	1.1	11.2	6.02	7.07	7.15	7.06
	Tifgreen*	1.2	8.6	7.18	7.21	7.15	6.97
	Princess	1.4	8.7	6.72	6.81	6.83	6.66
	Az. common	1.9	4.8	5.84	5.65	5.10	4.94
	Sultan	1.8	4.8	6.23	6.04	5.60	4.28
	Sonesta	1.8	4.3	6.12	5.82	5.25	4.81
	Mirage	1.9	4.5	6.13	5.76	5.13	4.50
	Pyramid	1.8	5.3	6.29	5.78	5.13	4.50
	Jackpot	1.6	5.3	5.95	5.81	5.10	4.31
	Cheyenne	1.7	3.6	5.84	5.55	5.10	4.75
	Primavera	1.9	4.6	5.98	5.75	5.03	4.44
	NuMex Sahara	1.8	5.2	5.99	6.08	5.35	4.84
	Guymon	1.9	4.0	6.02	5.67	4.73	4.25
LSD 5%		0.3	2.2	0.37	0.83	0.47	0.86
Zoysia spp.	Emerald*	1.4	9.9	6.38	8.29	8.40	8.16
	El Toro*	2.6	4.4	7.03	6.93	7.10	8.00
	De Anza*	2.2	4.8	6.93	7.13	6.20	7.75
	Victoria*	1.9	6.6	6.97	7.40	6.40	7.59
	Meyer*	2.2	5.0	6.72	6.97	7.10	6.63
	China common (Sunrise®)	2.8	2.5	6.24	6.10	5.20	4.94
	T-1 Meyer	2.0	5.4	6.13	6.54	6.30	4.31
	J-36	2.6	3.3	-	4.74	2.70	3.13
	W 3-2	2.4	4.1	-	5.24	4.90	2.19
LSD 5%		0.3	2.1	0.77	0.84	0.66	1.65
Paspalum vaginatum	Adalayd*	1.8	5.8	7.08	7.04	7.20	7.88
	Bindi*	1.5	8.5	7.43	7.06	7.00	6.97
LSD 5%		NS	NS	NS	NS	NS	NS
LSD 5%							1.17

*** Vegetatively propagated, with all others being seeded.**

Tifdwarf, Tifgreen, Tifway, and Tifway II, with the other 11 cultivars being *C. dactylon* [(L.) Pers.] var. *dactylon*. Among the *Zoysia* species *Z. japonica* Steud. is represented by Chinese common, El Toro, J-36, Meyer, T-1 Meyer, and W 3-2. De Anza and Victoria are hybrids of *Z. japonica* x *Zoysia* species, while Emerald is a hybrid of *Z. japonica* x *Z.matrella* var. *tenuifolia.*

The site was tilled, and phosphorus and potassium were incorporated into the seedbed at rates based on a chemical soil test. The soil pH was 7.1. The site was fumigated with methyl bromide on 14 July 1995. The planting date for the seeded cultivars was 21 July 1995, and for the vegetatively planted cultivars it was 17 August 1995, with the exception of a few entries which were planted on 5 August 1996. These included the seeded W 3-2 and the vegetatively planted Santa Ana. The vegetative plantings were sprig planted in rows, followed by rolling to firm the soil around the lateral stems. The seeding rate was at 0.5 kg 100 m^{-2} for the *Cynodon* cultivars, 1 kg 100 m^{-2} for the *Zoysia* cultivars, and 0.5 kg 100^{-2} for the *Buchloe* cultivars.

Cultural Practices

During the initial establishment year the turfs were mowed twice per week at a cutting height of 50 mm using a triplex reel mower. For subsequent growing season, the cutting height was lowered to 13 mm, with a mowing frequency of 2 to 3 times per week, depending on the vertical shoot growth rate. A total of 2.41 kg 100 m^{-2} of nitrogen was applied during the 1996 growing season, divided into 4 equal applications. In 1997 the annual nitrogen fertilization rate was 1.53 kg 100 m^{-2}, divided into 5 equal applications, and in 1998 thru 2000 it was 2.25 kg 100 m^{-2}, divided into 5 equal applications. The two exceptions to this nitrogen fertilization program were the *B.*

Table 2. Comparative spring greenup, fall color retention, scalping tendency, and pest susceptibility among 3 species with a total of 27 cultivars at Casalpalocco, Italy.

Species	Cultivar	Percent Green Color		Midsummer Scalping Tendency	Mole Cricket Susceptibility
		Spring Greenup	Fall Color Retention		
Cynodon spp.	Tifway*	79	77	x	x
	Tifdwarf*	89	31	x	x
	Tifway II*	61	79	xxx	x
	Santa Ana*	80	76	xxx	
	Tifgreen*	86	29	x	xx
	Princess	27	70	xx	xxx
	Az. common	76	20		x
	Sultan	64	19	x	
	Sonesta	79	14		xx
	Mirage	72	11		xx
	Pyramid	69	10		xx
	Jackpot	77	12		
	Cheyenne	55	10		x
	Primavera	61	14	x	x
	NuMex Sahara	77	16		x
	Guymon	64	6		x
LSD 5%		15.9	9		
Zoysia spp.	Emerald*	89	84	x	
	El Toro*	22	61	xx	
	De Anza*	79	84		
	Victoria*	72	86	x	x
	Meyer*	80	15	x	x
	China common (Sunrise®)	77	4		
	T-1 Meyer	79	17		
	J-36	57	14		
	W 3-2	50	7		
LSD 5%		13.1	9.6		
Paspalum vaginatum	Adalayd*	17	66	xxx	
	Bindi*	14	57	xxx	x
LSD 5%		NS	NS		

*** Vegetatively propagated, with all others being seeded.**

dactyloides cultivars that received a total of 0.5 kg 100^{-2} of nitrogen in 2 equal applications. Phosphorus and potassium were applied twice annually as needed based on a chemical soil test. Supplemental irrigations were applied as needed to prevent visual wilt of the turf. No turf cultivation or vertical cutting was practiced on the experimental area in order to avoid interplot contamination. Invading weeds were hand removed during the establishment period, but after the turfs were fully established the weeds were allowed to invade. Some occasional, sporadic disease injury were evident in the turfed plots, while a significant mole cricket infestation occurred in 1999 and 2000.

Assessments

Both turfgrass quality and morphological assessments were made during the 1996 thru 2000 seasons. Visual turfgrass quality estimates were made at 15- to 30-day intervals throughout the growing season. These ratings were based primarily on a composite of two components: uniformity of appearance and shoot density. The rating scale used was 9 = best and 1 = poorest. A rating of 6.5 or higher represented an acceptable quality turf surface for golf fairways, sports fields, and high-quality lawns. Visual assessments of spring greenup and fall color retention were made, along with scalping and pest injury as they occur.

The morphological assessments were made in September of 1998 following the summer heat stress period. They included (a) leaf blade width measurements involving the midpoint of the second-youngest, fully expanded leaf and (b) shoot density counts assessed on a 70 mm diameter turf plug. The data were processed and statistically analyzed using analysis of variance.

RESULTS

The establishment rates of the 16 *Cynodon* and 2 *P. vaginatum* cultivars were much more rapid than for the 9 *Zoysia* and 3 *B. dactyloides* cultivars. Detailed turfgrass quality and morphological characterizations were initiated in the third year following planting after all cultivars were fully stabilized. The results of the third through sixth growing seasons following planting are summarized in Table 1. There was a general increase in the turfgrass quality, shoot density and leaf width between 1997 and 1998, which probably was in response to an increased annual nitrogen fertilization rate from 1.53 to 2.25 kg 100 m^{-2}.

Cynodon Cultivars

Seasonal turfgrass quality data through six years indicate that the five vegetatively propagated hybrid *Cynodon* cultivars, plus Princess *C. dactylon* var. *dactylon*, performed at a much higher level than the remainder of the 10 *C. dactylon* var. *dactylon* cultivars, when maintained at a 13 mm cutting height (Table 1). Associated with the lower than acceptable turfgrass quality for the 10 seeded *C. dactylon* var. *dactylon* cultivars were a substantially lower shoot density and wider leaf width. Those *Cynodon* cultivars with slow spring greenup rates included Princess, Cheyenne, Tifway II, Primavera, Guymon, and Sultan (Table 2). Ranking highest in autumn color retention were Tifway II, Tifway, Santa Ana, and Princess. No significant disease problems were observed during this experimental evaluation period. However, one significant pest insect problem did occur, that being European mole crickets (*Gryllotalpa gryllotalpa* L.) which caused up to 35% damage in both 1999 and 2000. Those cultivars exhibiting substantial mole cricket damage included Tifgreen and Princess (Table 2).

Zoysia Cultivars

The five vegetatively propagated *Zoysia* cultivars, ranked substantially higher in turfgrass quality than the four seeded *Z. japonica* cultivars (Table 1). In terms of shoot density, the hybrid Emerald was far superior to the other cultivars, and also was the finest in leaf width, with Victoria ranking second in both morphological characteristics. All Zoysia cultivars exhibited poor leaf mowing quality in the autumn season, except for De Anza. A significant disease problem appeared during 1998 that was caused by rust (*Puccinia* spp.), and that occurred principally on the *Z. japonica* cultivars propagated by seed: De Anza and Victoria were severely damaged by *Rhizoctonia solani* Kuhn in spring 1999. Those *Zoysia* cultivars with a slow spring greenup rate were El Toro, W 3-2, and J-36 (Table 2). Ranking highest in autumn color retention were Victoria, De Anza, and Emerald.

Paspalum vaginatum Cultivars

Both vegetative propagated cultivars of *P. vaginatum*, Adalayd and Bindi, performed quite high in overall turfgrass quality, ranking with the best of the vegetatively propagated *Cynodon* and *Zoysia* cultivars (Table 1). Neither cultivar exhibited visually significant disease or insect pest problems during the six-year experimental period under the conditions near Rome, Italy. Both cultivars had poor spring greenup rates and medium-good fall color retention (Table 2).

Buchloe dactyloides Cultivars

The three seeded cultivars of *B. dactyloides* evaluated in this study were Bison, Cody, and Tanaka. Satisfactory stands of these three cultivars were initially established in 1996 and 1997 with some weed invasion evident in the summer of 1997. Subsequently, a severe invasion of *Digitaria* species, *Eleusine indica* [(L.) Gaertn.], *Poa annua* L., *Portulaca oleracea* L., and *Pennisetum clandestinum* Hochst. ex Chiox. weeds resulted in a rapid decline in the density of all three *B. dactyloides* cultivars during the summer of 1998. There was a lack of sufficient recovery of these weed infested turfs during 1998 and 1999. Consequently, all three cultivars performed unacceptably as turfs under the conditions of this study near Rome, Italy.

DISCUSSION

These results indicate that as a group of vegetatively propagated cultivars of *Cynodon* and *Zoysia* species performed better than the seeded cultivars. These results were based on a cutting height of 13 mm which is typical of mowing practices on sports fields and golf course fairways composed of these warm-season species. Perhaps the seeded *C. dactylon* var. *dactylon* cultivars would have performed somewhat better if mowed at a higher height of 25 mm or more, as is typical of golf course roughs and minimal use areas. The seed propagated *Z. japonica* cultivars declined substantially in turfgrass quality in 1999 due to a significant rust disease problem caused by *Puccinia* species that occurred under the environmental-soil conditions near Rome, Italy, while De Anza and Victoria were badly thinned by *Rhizoctonia solani* Kuhn in 1999.

The selection and development of vegetatively propagated cultivars of both the *Cynodon* and *Zoysia* species has been underway for a number of decades. In contrast, the development of seeded cultivars of these same species has received emphasis only in recent years. Thus, it is not surprising that this differential between the two groups was evident. It can be anticipated that there will be further improvements in the seeded types through continued breeding efforts such that the gap in turf quality between the two groups will be narrowed.

While only two cultivars *P. vaginatum* were available for use in this study, both exhibited turfgrass quality and shoot density characteristics that ranked with the best of the *Cynodon* and *Zoysia* cultivars over the six-year duration of the study. In contrast, the three *B. dactyloides* cultivars performed far below the minimum acceptable stan-

dard for turf use under the conditions of this study in Italy.

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REFERENCES

Beard, J.B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 658 pp.

Beard, J.B. 1982. Turfgrass Management for Golf Courses. Burgess Publishing Company, Minneapolis, Minnesota, USA. 642 pp.

Beard, J.B. 1989. Turfgrass water stress: drought resistance components, physiological mechanisms, and species-genotype diversity. Proceedings of the International Turfgrass Research Conference. 6:23-28.

Beard, J.B. and S.I.Sifers. 1997. Genetic diversity in dehydration avoidance and drought resistance within the *Cynodon* and *Zoysia* species. International Turfgrass Society Research Journal. 8:603-610.