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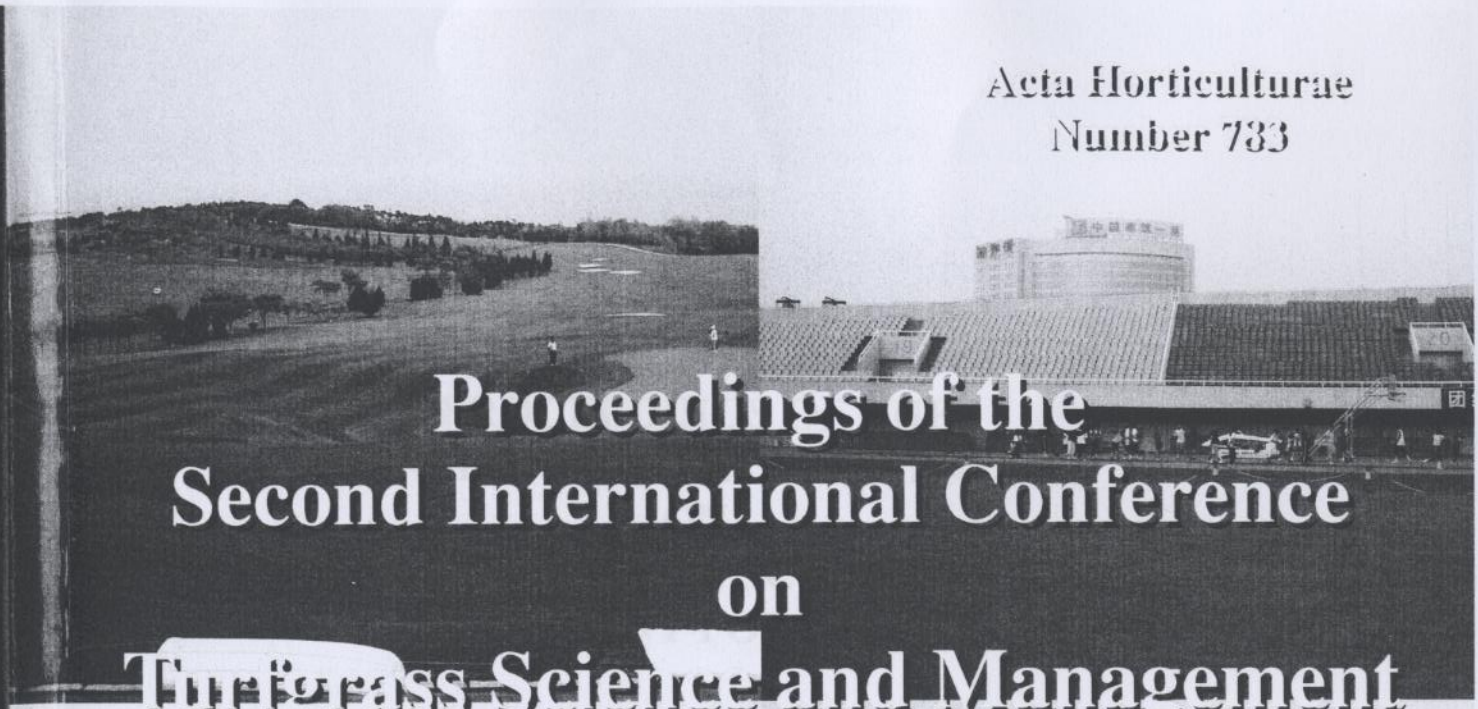

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1. Golf course
2. Beijing Fengtai Stadium
3. Turfgrass Experiment Station of Beijing Forestry University
4. Visit to Tianjin Honggang Sod Farm
5. The campus of Beijing Forestry University
6. Beijing Olympic Center Stadium

Two Years of Studies into Native Bermudagrass (*Cynodon* spp.) Germplasm from Sicily (Italy) for the Constitution of Turf Cultivars

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Keywords: warm season species, genetic resources, test field, quality ratings, bio-agronomic evaluation

Abstract

Bermudagrass (*Cynodon* spp.) is the most widely used warm season turf species in the world for sport, lawn and utility turfs. The species is widespread in Sicily (Italy) where it exhibits a large range of diverse morphological characteristics due to a long process of adaptation to varying climatic and soil conditions of the island. In order to exploit the bermudagrass genetic resources and establish a germplasm bank for use in various plant breeding programmes, bio-agronomic evaluation tests were carried out on the 40 Sicilian biotypes of *Cynodon* spp. from 2002 to 2004 at the experimental farm "Orleans", University of Palermo. The accessions were compared to the standard cultivar 'Savannah', as a reference. The main biometric and qualitative parameters (leaf texture, shoot density, turf colour and quality, etc.) of bermudagrass turf were monitored and, for each parameter, the biotypes exhibited significant differences.

INTRODUCTION

In Italy, and particularly in the Mediterranean area, the cultivars traditionally used to establish turfgrasses belong to cool season turf species and often form turfgrasses with a lower quality than the ones constituted in its place of origin (van Wijk, 1993).

In the Mediterranean area, the warm season turf species are of considerable interest due to their high temperatures and salt tolerance (Malcolm and Smith, 1971; Beard, 1973; Peacock et al., 2004). Furthermore, they show low water needs (Cereti, 2004) and an excellent recovery rate from biotic and abiotic stress (Croce et al., 2001; Turgeon, 2004).

The native populations of turf species represent an important source of genetic variability that can be used to support specific plant breeding programmes. Previous Italian research has shown that the germplasm of turf species selected from the areas of potential utilization or similar environments is much more likely to be successful (Romani et al., 2004). *Cynodon* spp. are the most commonly used warm species in the world for high quality turfs, such as golf courses and athletic fields (McCarty and Miller, 2002; Taliaferro, 2003; Richardson et al., 2004). The species is widespread in Sicily where it exhibits a wide range of diverse morphological characteristics due to a long process of adaptation to varying climatic and soil conditions across the island (Pignatti, 2003). Based on the apparent genetic diversity of bermudagrasses on Sicily, this research involved collecting and characterizing native bermudagrass germplasm in order to identify biotypes with good qualities for broad scale turf in the Mediterranean region.

MATERIALS AND METHODS

More than 80 accessions of *Cynodon* spp. were collected from various areas of Sicily, complete with a descriptor list and set of initials; the bio-agronomic evaluation was successively carried out on 40 biotypes owing to phenotypic selection. For each site several sods were collected and planted (spring-summer 2002) in a test field that was prepared at the experimental farm "Orleans", University of Palermo (31 m a.s.l. 38°06'26,2''N, 13°20'56,0''E – Reference frame WGS 84).

The soil was medium-sandy textured and flat (Table 1). The plots size was 1 m^2

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and spaced 50 cm apart: the inter-plot spaces were periodically treated with a non-selective herbicide (4 L glyphosate ha^{-1} $year^{-1}$) in order to avoid the spread of plants between plots. The testing area was equipped with a sprinkling irrigation system and was only irrigated in spring-summer to maintain active growth. The annual rate of nitrogen was 200 kg ha^{-1} and it was divided into 5 equal applications applied monthly from May to September. Phosphorus and potassium were applied at 240 kg ha^{-1} prior to planting. The turf was maintained at a mowing height ranging from 30 to 35 mm and it was mowed by a helicoidal mower during the bermudagrass vegetative stage. The mowing was carried out twice per week during intense growth periods with the subsequent removal of grass clippings.

From 2003 to 2004, the main biometrics and qualitative parameters of the 40 biotypes were compared to 'Savannah' (Fraser and Rose-Fricker, 1998) being used as a reference. The leaf texture of accessions was determined by randomly removing 100 flattened leaves per plot and measuring the leaf width at a distance of 1 cm from its ligule (Veronesi et al., 1992). Average stolon diameter was determined using 20 stolons of 100-150 mm in length and data were collected by measuring three different parts of plant: apical, medial and basal. On the same stolon, the internode length was also recorded (Leto et al., 2004). For each plot, the shoot density was calculated by counting the number of shoots in 60 mm diameter core (Croce et al., 2002). The turf quality was based on a 1 (= poorest or dead) to 9 (= outstanding or ideal) visual rating scale (National Turfgrass Evaluation Programme, 1997-2001). The turf colour was based on a 1 (= light green) to 9 (= dark green) visual rating scale after the mowing (National Turfgrass Evaluation Programme 1997-2001). The vertical leaf growth rate was determined by measuring the canopy height at three randomly selected locations in each plot. The difference between the average plant height before mowing and the mowing height, divided by the number of days between two successive mowings, provided the vertical leaf growth rate (Veronesi et al., 1992). The dormancy period of bermudagrass, as a percentage, was based on a 0 (= full vegetative activity and high colour intensity) to 100 (= full vegetative dormancy and low colour intensity) visual rating scale (Croce et al., 2002). The lateral growth rate of the bermudagrass was determined removing a circle 60 mm in diameter for each plot and visually estimating the percentage of regrowth that occupied the area at 60 days after the autumn removal and 30 days after the spring removal (Leto et al., 2004).

The experimental design was a randomised complete block with three replications (Gomez and Gomez, 1984). Data were processed applying the analysis of variance in order to calculate the F-test. For each treatment, the separation of means was carried out using the Test of Tukey.

RESULTS AND DISCUSSION

Rainfall and temperatures charts for the test period are shown in Figures 1-2.

The collection sites for *Cynodon* spp. biotypes were situated throughout the Sicily region and differed not only according to their geographical position, but also to their soil (Fig. 3) and climatic conditions and vegetation associations.

In each site, the De Martonne's index of aridity was applied in order to have a more definite climatic characterization. Most of sites (57.5%) were located in warm-temperate zone, 5% in humid-temperate zone and 37.5% in semi-arid zone (Fig. 4).

The accessions were collected from hilly, flat and mountain areas which were situated from 4 to 700 m a.s.l. and were characterized by clayey, sandy and low fertile soils. The native bermudagrasses were found in different vegetation associations such as Mediterranean maquis, garigue, dune and pasture.

The results of bio-agronomic evaluation of 40 biotypes of *Cynodon* spp. from 2003 to 2004 are shown in Tables 2-3.

The 'biotype' caused significant difference in each of the tested parameter when subjecting them to analysis of variance. For simplicity, the results for each parameter have been analysed separately.

Leaf Texture

The average leaf texture was 2.27 mm with a difference of 1.99 mm between the highest leaf width value [3.14 mm (CYND9)] and the lowest one [1.15 mm (CYND4)]. Most of biotypes showed values lower than 3 mm. The average leaf width of 'Savannah' was 1.72 mm. CYND21, CYND29, CYND30, CYND31, CYND32, CYND35, CYND36, CYND37, CYND40 did not exhibit different values in comparison with 'Savannah'.

No significant differences were recorded between test years.

Stolon Diameter

CYND4 and CYND19 showed the finest stolons, while the thickest ones were recorded in CYND7, CYND10, CYND14, CYND20, CYND39 and CYND40 exhibited extremely interesting values due to their fine stolons. The average diameter of the 'Savannah' stolon was 1.07 mm.

Stolon Internode Length

In 65% of biotypes, the average values of stolon internode length ranged from 30.1 (CYND40) to 34.8 (CYND11) mm, while in 32.5% of them, they varied from 29.6 (CYND17) to 26.3 (CYND5) mm. CYND4 exhibited the best value (20.3 mm) and differed greatly from the other biotypes. The average 'Savannah' stolon internode length was 27.5 mm; the value was higher than CYND4 but lower than 90% of other bermudagrasses. No significant differences were recorded between test years.

Shoot Density

The average shoot density was 1.63 shoots cm^{-2} with a difference of 1.29 shoots cm^{-2} between the highest density value [2.40 shoots cm^{-2} (CYND4)] and the lowest [1.11 shoots cm^{-2} (CYND11)]. CYND4 had the highest shoot density (2.40 shoots cm^{-2}) of the biotypes and was not significantly different from 'Savannah' (2.43 shoots cm^{-2}). Values higher than 2 shoots cm^{-2} were also recorded in CYND19 and CYND29. Shoot density was lower than 2 shoots cm^{-2} in 92.5% of the biotypes.

Vertical Leaf Growth Rate

The highest grass clipping rate was recorded in summer because of the higher rate of vegetative growth of bermudagrass; in this period, the number of mowings was increased in order to control the vegetative growth and maintain the turf at mowing heights ranging from 30 to 35 mm. CYND4 showed the lowest value (0.33 cm d^{-1}), while CYND14 and CYND31 exhibited the highest one (0.41 cm d^{-1}). The value for 'Savannah' was 0.35 cm d^{-1}. In 2003 the turf growth rate (0.38 cm d^{-1}) was higher than 2004 because of the more favourable climatic conditions.

Turf Quality

All biotypes exhibited the best visual turf quality in spring and summer, but differed in quality ratings in autumn and winter. From 2003 to 2004, the highest value (6.40) was recorded in CYND4 which had the highest quality ratings in every season. During autumn and winter, 97.5% of biotypes showed values lower than 5 but only 37.5% of them were subject to a significant decline in quality, with values lower than 3. CYND4 and CYND11 rated higher than 'Savannah' and showed the best results in every season. Also CYND10, CYND12, CYND25, CYND30 exhibited higher turf quality values than 'Savannah' in summer and autumn.

Turf Colour

The best turf colour performances were recorded in spring and summer. CYND4, CYND10, CYND11, CYND12, CYND30 and CYND31 showed the darkest green colour and were different from 'Savannah', especially during the coldest months.

Dormancy Period as Percentage

In November 2003, due to a fall in temperatures, fewer than half the biotypes exhibited values of 60-80% and showed significant colour retention. From January to February 2004, all biotypes became completely dormant. Vegetative growth resumed in March and complete greening occurred by May when the climatic conditions were ideal. CYND4, CYND11 and CYND31 had the shortest dormancy period, performing comparably to 'Savannah' (Fig. 5).

Vegetative Regrowth Rate

In autumn, 60 days after removing a circle of 60 mm diameter from each plot, CYND7, CYND8, CYND12, CYND22, CYND27, CYND30 and CYND31 exhibited a vegetative regrowth percentages (75%) similar to 'Savannah'. Most of biotypes (42.5%) also showed good performance (50%). In spring excellent results were recorded in half the biotypes, which exhibited values of 75%. In fact, 30 days after removing a circle of the same size, almost 30% of accessions showed a similar behaviour to 'Savannah' and covered the surface totally (100%). The vegetative regrowth percentages were 75% and 50% for 50% and 20% of biotypes respectively (Fig. 6).

CONCLUSIONS

The bio-agronomic evaluation of 40 Sicilian biotypes of *Cynodon* spp. showed high variability in the collected germplasm, as far as the biometric and qualitative parameters were concerned. The biotype CYND4 exhibited the best results of the native bermudagrasses and showed the same or higher values than 'Savannah' cultivar, used as reference plant. The research project was of particular interest in increasing knowledge on bermudagrass germplasm in Sicily. For some parameters, several biotypes (CYND10, CYND11, CYND12, CYND25, CYND30, etc.) showed higher biometric and qualitative performances than 'Savannah' and could result in being of great interest for future bermudagrass cultivars plant breeding activity.

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Tables

Table 1. Main chemical and physical soil characteristics of "Orleans" test field (Palermo, Italy).

Soil characteristics	Values
Sand	55.92%
Silt	20.65%
Clay	23.43%
Total Carbonates (De Astis)	5.80%
Active Carbonates (Drouneau)	3.70%
Organic matter (Lotti)	1.90%
Total Nitrogen (Kjeldal)	1.32%
Assimilable Phosphorus (Olsen)	18.1 p.p.m.
Exchangeable Potassium (International method)	320 p.p.m.
pH (in water)	7.91

Table 2. Main biometric parameters that were monitored for 40 Sicilian biotypes of *Cynodon* spp. from 2003 to 2004.

Biotypes and cultivars	Leaf texture (mm)	Stolon diameter (mm)			Stolon internode lenght (mm)	Shoot density (shoots cm^{-2})	Vertical leaf growth rate (cm d^{-1})
		Apical	Medial	Basal			
CYND1	2.14 de	1.11 cd	1.20 d	1.51 bc	31.6 ab	1.55 ef	0.38 ab
CYND2	2.23 cd	1.09 cd	1.15 d	1.45 bc	32.5 ab	1.33 fg	0.38 ab
CYND3	2.54 bc	1.16 cd	1.38 bc	1.67 ab	27.0 c	1.93 cd	0.39 ab
CYND4	1.15 f	0.83 e	0.94 e	0.99 d	20.3 d	2.4 a	0.33 b
CYND5	1.98 de	1.40 ab	1.49 b	1.69 ab	26.3 c	1.73 de	0.38 ab
CYND6	2.54 bc	1.42 ab	1.62 a	1.78 ab	30.5 bc	1.34 fg	0.37 ab
CYND7	2.47 c	1.49 a	1.59 ab	1.80 a	32.3 ab	1.42 fg	0.40 ab
CYND8	2.18 d	1.26 bc	1.51 ab	1.67 ab	31.9 ab	1.52 ef	0.38 ab
CYND9	3.14 a	1.15 cd	1.37 c	1.46 bc	30.6 bc	1.64 e	0.39 ab
CYND10	3.08 a	1.09 cd	1.22 d	1.29 cd	31.4 b	1.64 e	0.40 ab
CYND11	3.00 a	1.18 bc	1.31 cd	1.39 c	34.8 a	1.11 h	0.40 ab
CYND12	2.38 cd	1.14 cd	1.20 d	1.35 c	28.0 c	1.99 cd	0.37 ab
CYND13	2.64 bc	1.11 cd	1.19 d	1.40 c	30.6 bc	1.64 e	0.38 ab
CYND14	2.32 cd	1.08 cd	1.16 d	1.27 cd	28.2 bc	1.97 cd	0.41 a
CYND15	2.71 bc	1.10 cd	1.21 d	1.36 c	29.0 bc	1.58 ef	0.38 ab
CYND16	1.99 de	1.12 cd	1.39 bc	1.58 bc	32.2 ab	1.5 ef	0.38 ab
CYND17	3.08 a	1.19 bc	1.33 c	1.56 bc	29.6 bc	1.86 cd	0.38 ab
CYND18	2.31 cd	1.15 cd	1.29 cd	1.73 ab	29.1 bc	1.86 cd	0.37 ab
CYND19	2.28 cd	1.05 d	1.18 d	1.29 cd	26.9 c	2.01 c	0.39 ab
CYND20	3.08 a	1.04 d	1.25 cd	1.37 c	32.5 ab	1.28 g	0.40 ab
CYND21	1.84 e	1.12 cd	1.36 c	1.54 bc	32.4 ab	1.49 ef	0.38 ab
CYND22	2.16 de	1.13 cd	1.27 cd	1.39 c	30.6 bc	1.55 ef	0.37 ab
CYND23	2.10 de	1.08 cd	1.20 d	1.26 cd	33.2 ab	1.26 gh	0.37 ab
CYND24	2.47 bc	1.08 cd	1.18 d	1.32 c	33.1 ab	1.34 fg	0.37 ab
CYND25	2.29 cd	1.21 bc	1.28 cd	1.47 bc	33.7 ab	1.23 gh	0.38 ab
CYND26	1.94 de	1.09 cd	1.26 cd	1.58 bc	32.6 ab	1.3 g	0.38 ab
CYND27	2.23 cd	1.10 cd	1.32 c	1.49 bc	28.4 bc	1.87 cd	0.39 ab
CYND28	2.57 bc	1.10 cd	1.25 cd	1.39 c	32.0 ab	1.55 ef	0.37 ab
CYND29	1.90 e	1.22 bc	1.37 c	1.59 bc	27.9 c	2.18 b	0.36 b
CYND30	1.81 e	1.14 cd	1.44 bc	1.73 ab	27.8 c	1.92 cd	0.38 ab
CYND31	1.87 e	1.09 cd	1.33 c	1.54 bc	32.6 ab	1.23 gh	0.41 a
CYND32	1.89 e	1.12 cd	1.25 cd	1.51 bc	31.8 ab	1.6 ef	0.38 ab
CYND33	2.39 cd	1.18 c	1.44 bc	1.61 b	28.0 c	1.92 cd	0.37ab
CYND34	3.00 a	1.10 cd	1.22 d	1.44 c	28.6 bc	1.96 cd	0.36 b
CYND35	1.82 e	1.23 bc	1.33 c	1.44 c	31.5 ab	1.57 ef	0.37 ab
CYND36	1.87 e	1.10 cd	1.30 cd	1.61 b	33.7 ab	1.19 gh	0.37 ab
CYND37	1.77 e	1.31 b	1.42 bc	1.68 ab	32.1 ab	1.47 f	0.37 ab
CYND38	2.11 de	1.08 cd	1.23 d	1.35 c	32.5 ab	1.4 fg	0.37 ab
CYND39	2.25 cd	1.06 d	1.16 d	1.29 cd	33.0 ab	1.32 fg	0.37 ab
CYND40	1.86 e	1.09 cd	1.29 cd	1.38 c	30.1 bc	1.83 d	0.36 b
Savannah	1.72 e	0.99 d	1.09 d	1.15 d	27.5 c	2.43 a	0.35 b
Year							
2003	2.27 a	1.14 a	1.29 a	1.49 a	30.3 a	1.59 b	0.39 a
2004	2.27 a	1.14 a	1.29 a	1.45 b	30.5 a	1.67 a	0.36 b

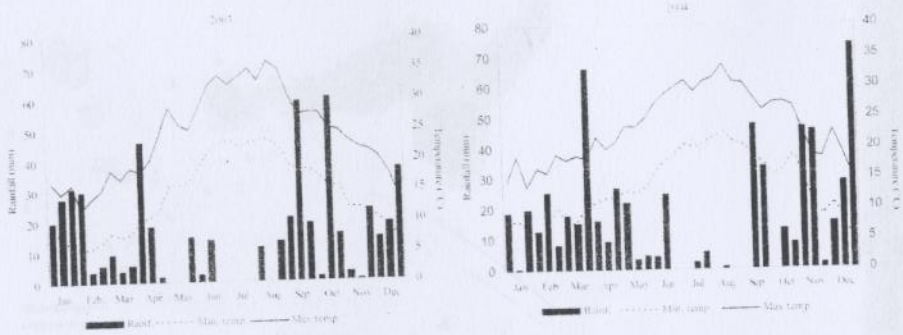
The values followed by the same letter are not significantly different for P = 0.05 according to Test of Tukey.

Table 3. Main qualitative parameters that were monitored for 40 Sicilian biotypes of *Cynodon* spp. from 2003 to 2004.

Biotypes and cultivars	Turf quality (1-9)				Turf colour (1-9)			
	Spring (monthly)	Summer (monthly)	Autumn (monthly)	Winter (monthly)	Spring (monthly)	Summer (monthly)	Autumn (monthly)	Winter (monthly)
CYND1	5.24 bc	6.27 cd	4.03 cd	3.06 de	5.33 bc	6.51 bc	4.03 cd	3.29 c
CYND2	5.14 bc	6.50 c	3.87 cd	2.69 e	4.89 cd	6.41 bc	4.04 c	2.70 cd
CYND3	5.28 bc	6.41 cd	4.13 cd	3.12 de	4.88 cd	6.10 cd	4.44 bc	2.92 cd
CYND4	6.70 a	7.69 a	6.04 a	5.18 a	6.58 ab	7.60 a	5.87 a	4.85 a
CYND5	5.47 bc	6.37 cd	4.22 cd	3.34 d	4.95 cd	6.12 cd	3.66 cd	2.79 cd
CYND6	5.31 bc	6.74 bc	4.04 cd	2.85 de	5.52 bc	6.55 bc	4.14 c	2.74 cd
CYND7	4.56 cd	5.71 de	3.73 cd	2.52 e	3.85 d	5.82 cd	3.24 d	2.18 d
CYND8	5.20 bc	6.00 cd	4.08 cd	3.18 de	4.80 cd	5.91 cd	3.55 cd	3.08 cd
CYND9	5.31 bc	6.96 bc	4.79 bc	3.31 d	5.19 c	6.44 bc	4.11 c	3.10 cd
CYND10	6.50 ab	7.17 ab	5.16 b	4.26 bc	6.41 ab	7.11 ab	5.60 ab	4.49 ab
CYND11	6.70 a	7.44 ab	5.78 ab	4.50 b	6.73 a	7.48 ab	6.00 a	4.93 a
CYND12	6.24 ab	7.04 bc	5.62 ab	4.33 bc	5.93 b	7.12 ab	4.95 bc	3.93 b
CYND13	5.25 bc	6.79 bc	4.16 cd	3.26 d	5.35 bc	6.79 bc	4.16 c	3.06 cd
CYND14	6.00 ab	6.66 bc	4.14 cd	3.82 cd	5.54 bc	6.49 bc	3.98 cd	3.57 c
CYND15	4.33 cd	6.27 cd	3.35 d	2.81 de	4.69 cd	6.12 cd	3.61 cd	2.69 cd
CYND16	4.27 cd	5.49 de	3.36 d	2.62 e	4.57 cd	5.71 d	3.16 d	2.22 d
CYND17	5.04 bc	6.05 cd	4.01 cd	3.21 de	5.03 cd	6.43 bc	4.08 c	3.10 cd
CYND18	6.03 ab	6.73 bc	4.79 bc	3.52 cd	5.63 bc	6.68 bc	4.36 bc	3.14 cd
CYND19	5.47 bc	6.45 cd	4.23 cd	3.12 de	5.20 c	6.09 cd	4.00 cd	3.09 cd
CYND20	5.31 bc	6.35 cd	3.77 cd	3.14 de	5.03 cd	6.51 bc	3.98 cd	2.80 cd
CYND21	4.83 cd	6.54 bc	3.72 cd	2.61 e	4.85 cd	6.53 bc	3.65 cd	2.63 d
CYND22	4.45 cd	6.01 cd	3.79 cd	3.00 de	4.51 cd	5.98 cd	3.63 cd	2.60 d
CYND23	4.98 bc	6.54 bc	3.98 cd	3.02 de	4.68 cd	6.02 cd	3.62 cd	2.62 d
CYND24	4.01 cd	5.63 de	3.26 d	2.65 e	4.22 d	5.78 d	3.44 cd	2.12 d
CYND25	6.31 ab	7.10 b	5.62 ab	3.93 c	5.87 bc	6.86 bc	4.48 bc	3.62 bc
CYND26	4.18 cd	5.91 d	3.56 cd	2.80 de	4.89 cd	6.24 cd	3.70 cd	2.95 cd
CYND27	5.47 bc	6.38 cd	4.27 c	3.19 de	5.52 bc	6.36 c	4.30 bc	2.83 cd
CYND28	5.41 bc	6.54 bc	4.30 c	3.01 de	5.43 bc	6.74 bc	4.10 c	2.73 cd
CYND29	5.50 bc	6.69 bc	4.86 bc	3.04 de	5.15 c	6.46 bc	4.31 bc	3.04 cd
CYND30	6.16 ab	7.32 ab	5.42 ab	4.08 bc	6.00 b	7.20 ab	4.98 b	3.65 bc
CYND31	6.24 ab	7.06 bc	5.69 ab	4.09 bc	6.19 ab	7.39 ab	5.41 ab	3.76 bc
CYND32	3.87 d	5.20 e	3.13 d	2.40 e	3.96 d	5.75 d	3.10 d	2.14 d
CYND33	4.22 cd	6.01 cd	3.45 d	2.97 de	4.18 d	5.70 d	3.51 cd	2.91 cd
CYND34	4.99 bc	5.89 d	3.91 cd	3.09 de	5.59 bc	6.33 cd	4.16 c	3.02 cd
CYND35	4.72 cd	5.85 d	4.23 cd	2.97 de	4.91 cd	6.01 cd	3.85 cd	2.75 cd
CYND36	4.60 cd	5.60 de	3.36 d	2.36 e	4.62 cd	5.65 d	3.41 cd	2.20 d
CYND37	4.32 cd	5.30 e	3.26 d	2.58 e	4.48 cd	5.37 d	3.38 cd	2.51 d
CYND38	4.84 c	6.27 cd	3.97 cd	3.41 cd	4.33 d	5.84 cd	3.82 cd	3.01 cd
CYND39	4.68 cd	5.65 de	4.12 cd	2.94 de	4.72 cd	6.01 cd	3.95 cd	2.86 cd
CYND40	4.71 cd	5.47 de	3.62 cd	2.88 de	4.65 cd	5.89 cd	3.68 cd	2.87 cd
Savannah	5.71 b	6.28 cd	4.31 c	3.85 cd	6.23 ab	6.95 b	5.36 ab	3.61 bc
Year								
2003	5.35 a	6.36 a	4.35 a	3.29 a	5.11 b	6.42 a	4.07 b	3.04 a
2004	5.06 b	6.34 a	4.10 b	3.18 b	5.19 a	6.31 b	4.16 a	3.06 a

The values followed by the same letter are not significantly different for P = 0.05 according toTest of Tukey.

Figures



Figs. 1-2. Rainfall and temperatures during the test period.

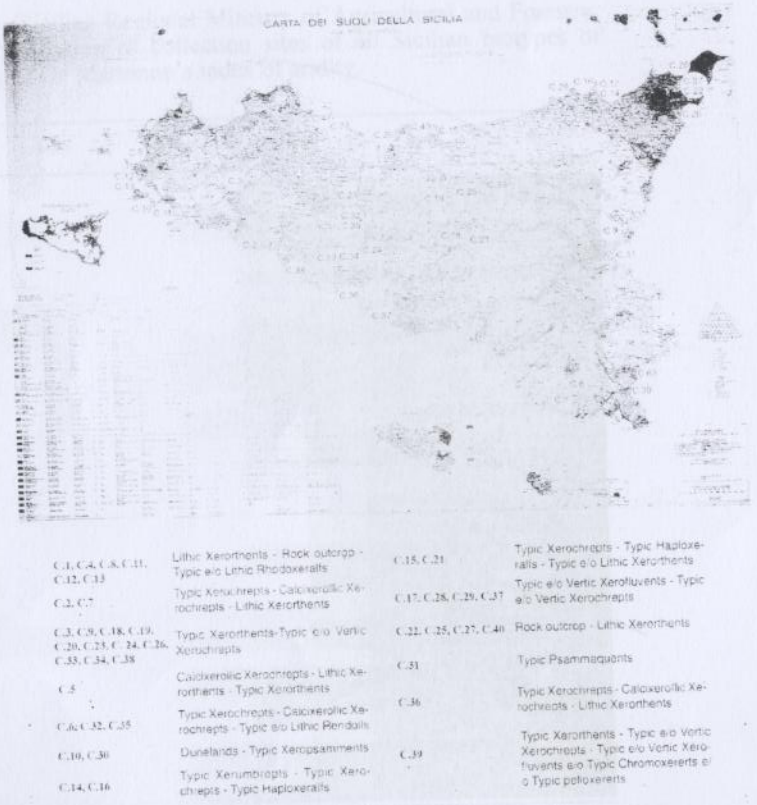


Fig. 3. Soil Map of Sicily (Fierotti, 1988). Soil classification of collection sites of 40 Sicilian biotypes of *Cynodon* spp. according to USDA-Soil Taxonomy.

Fig. 4. Climatic Map of Sicily (Sicilian Regional Ministry of Agricultural and Forestry, 2000). Geographical localization of collection sites of 40 Sicilian biotypes of *Cynodon* spp. according to De Martonne's index of aridity.

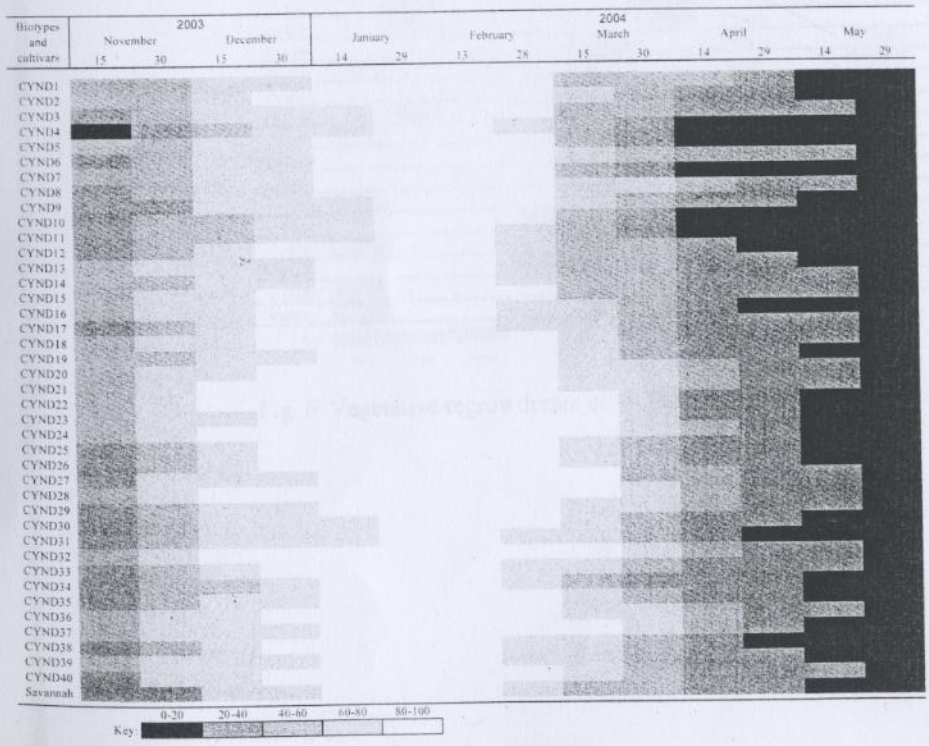


Fig. 5. Dormancy period as percentage of 40 Sicilian biotypes of *Cynodon* spp.

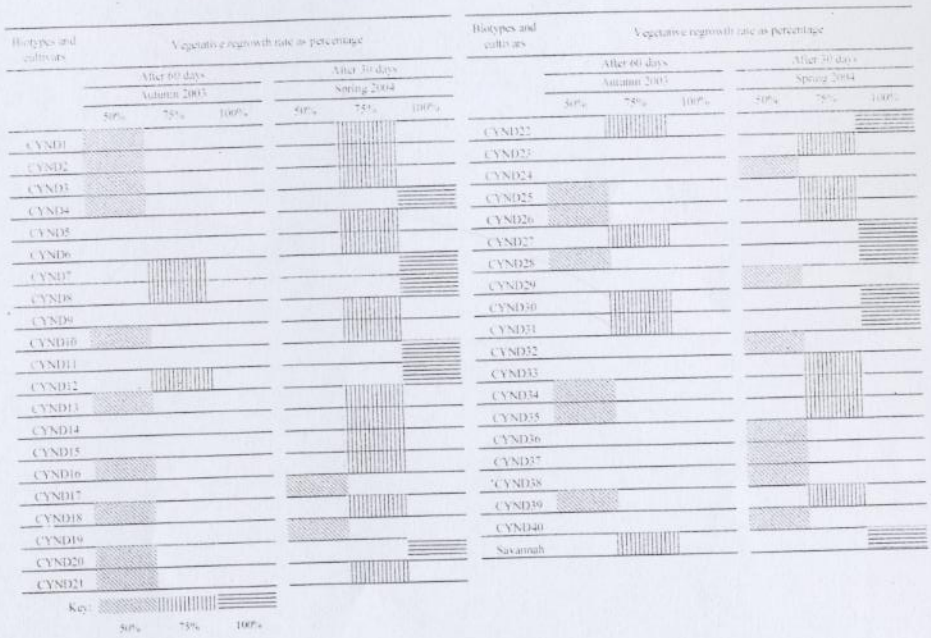


Fig. 6. Vegetative regrowth rate of 40 Sicilian biotypes of *Cynodon* spp.