Title: Establishment and winter management of MiniVerde bermudagrass for putting greens in Italy

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Introduction

Many areas of the Mediterranean climate combine mild winters with drought and high temperatures during summer, representing a transition zone for turfgrasses (Dunn and Diesburg, 2004). While hybrid and seeded bermuda-grass cultivars are currently adopted on golf fairways in Italy, the use of dwarf cultivars of *Cynodon* on greens still needs to be accepted. The lack of information on establishment, playing quality and winter management is a major concern for their diffusion in Italy. In particular, as to winter management, previous research carried out in Italy on autumn overseeding of putting surfaces (Volterrani et al., 2009) highlighted some changes in playing quality during fall and spring transition that could be perceived by players as negatively affecting the game. In other countries turf painting is becoming increasingly popular also for dormant putting greens (Briscoe et al., 2010). The use of turf colorants could provide an effective tool for winter management and facilitate the use of dwarf bermudagrass in Italy.

Materials and methods

Sprigs of hybrid bermudagrass *Cynodon dactylon x transvaalensis* cv. MiniVerde were raised in the green house in peat-filled seed trays with plugs of 5 cm^3. Subsequently, plants were manually transplanted at a density of 30 plants m^{-2} on mid July 2012 in three different Italian locations: Montecchia Golf Course, in Padova (45°24' N, 11°52' E), Golf Village Golf club, in Porto Recanati (Macerata) (43°25' N, 13°39' E) and Le Costiere Persano Royal Golf, in Serre (Salerno) (40°34' N, 15°08' E). In each location four 50 m^2 plots were set up. Water was applied as needed to encourage establishment. Diammonium phosphate was applied at planting at 20 g m^{-2} rate. Top dressing fertilization was carried out from July to September with 10 g m^{-2} of urea per week and 10 g m^{-2} of potassium sulphate every other week. During establishment plants were left unmown. Mowing was started from August 2012 and cutting height gradually brought to 4 mm. Where necessary, weeds were manually removed. In order to monitor establishment, from 31 July to 20 September (every ten days) digital images of plots were taken and processed by digital image analysis to determine percent green ground cover. Data were subject to statistical analysis and standard error was calculated for mean comparison.
Following full establishment, at Padova location, a turf painting trial was carried out. The product Green Lawnger was applied at 4.1 L ha^{-1} and 12.3 L ha^{-1} application rates of pure colorant in a mix having a 1:7 colorant:water ratio. An untreated control was included as a reference. Treatments were arranged in a randomized complete block experimental design with three replication. Plot size was 13 m^2.
In order to determine color persistence, green color was visually assessed from 1 November 2012 to 13 April 2013 on a 1 to 9 scale (1 = brown turf, 5 = acceptable green, 9 = dark green). In three occasions during the bermudagrass dormant period, color dropped below the acceptable value of 5 in some of the plots. In order to restore an acceptable color intensity treatments were repeated for all plots on 2 and 26 November 2012 and 4 February 2013. Core samples with a 86.4 cm^2 surface area and 15 cm depth were collected on 19 April and 17 October 2013 in order to detect any effects of painting treatments on turf characteristics at spring green up and at the end of the following growing season. Shoot density, root dry biomass, stolon dry biomass and stolon density were measured. On 4 January 2013 in

Padova location, green speed was determined by stimpmeter readings. Data were subject to ANOVA and Least Significant Difference calculated for P≤0.05 level.

Results

Despite the expectations based on latitude of the three locations included in the trial, on 20 September 2012 full ground cover was reached in Salerno and Padova while in the Recanati location a slight delay in establishment was observed (Table 1).

Winter color management with the use of turf painting provided a good color during the dormant period of MiniVerde bermudagrass assumed that multiple applications were carried out with the highest application rate and every time that the exposure to atmospheric factors causes a decline in color (Table 2).

At spring green up, following winter application of painting, some of the turf characteristics were affected by the treatments. When the lower application rate was used, differences from the untreated control were barely noticeable. The application of the higher rate of painting, caused an increase in turf density, root and stolon specific biomass as well as in stolon length (Table 3) suggesting some positive effects of turf painting on bermudagrass green-up after winter. On 17 october 2013, none of those differences were significant and untreated plots had similar turf characteristics compared to plots treated with high and low rates of painting (data not shown).

As expected, the dormant turf provided good playing conditions and the application of turf painting did not affect this characteristic of the putting surface. Stimpmeter readings did not detect significant differences in green speed between treated and control plots with a mean value of 2.6 m being recorded.

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Table 1. Green ground cover during establishment of MiniVerde bermudagrass in three locations in Italy. Standard error is reported in brackets.

Location	31 Jul.	1 Aug.	11 Aug.	21 Aug.	1 Sept.	11 Sept	20 Sept.
	Green ground cover (%)						
Padova	5 (±0.1)	12 (±2.6)	37 (±3.6)	58 (±4.1)	76 (±3.1)	85 (±3.5)	95 (±2.9)
Recanati	5 (±0.1)	9 (±3.1)	23 (±3.5)	42 (±4.2)	61 (±4.0)	75 (±4.1)	86 (±3.1)
Salerno	5 (±0.2)	21 (±3.5)	43 (±4.1)	64 (±3.8)	80 (±4.0)	90 (±3.9)	98 (±1.1)

Table 2. Winter color of dormant and painted turf of MiniVerde bermudagrass in Padova (1 = brown turf, 5 = acceptable green, 9 = dark green).

Pure colorant application rate (L ha^{-1})	1 Nov 2012	2 Nov. 2012[(1)]	25 Nov. 2012	26 Nov. 2012[(1)]	4 Feb. 2013	5 Feb. 2013[(1)]	12 Apr. 2013
No paint	4	4	2.5	2.5	1	1	2.5
4.1	4	5.5	4.5	5	4.5	6.0	4.5
12.3	4	7.5	6.5	8.0	6.5	8.0	6.5
LSD (0.05)	-	*1.0*	*1.3*	*1.2*	*1.0*	*1.5*	*1.5*

[(1)] Assessment made after paint application

Table 3. Effect of turf painting on shoot density, root and stolon specific biomass and stolon density of Miniverde bermudagrass in Padova (19 April 2013).

Pure colorant application rate (L ha^{-1})	Shoot density (n° cm^{-2})	Root dry biomass (mg cm^{-2})	Stolon dry biomass (mg cm^{-2})	Stolon density (cm cm^{-2})
No paint	4.4	6.0	37.2	6.2
4.1	5.7	6.5	38.2	6.8
12.3	7.8	7.3	41.7	7.5
LSD (0.05)	*0.6*	*0.4*	*0.8*	*0.3*