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Improving aesthetic and diversity of bermudagrass lawn in its dormancy period

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ABSTRACT

Among warm season grasses, *Cynodon dactylon* (L.) Pers, commonly called bermudagrass, is one of the species that better tolerates drought stress and is the most widely employed for turf in Italy.

When temperatures drop below 0 °C, bermudagrass plants enter dormancy and eventually leaves turn brown. In spring, exit from dormancy occurs when soil temperatures persist for several days with an average above 10 °C. The management of an ornamental turf during dormancy could include the use of other herbaceous species able to enhance aesthetic quality, although no study has so far been carried out on the potential for combined planting of warm season grasses, wildflowers and/or bulbous species. The present study was carried out to (a) evaluate the possibility of integrating into the dormant *Cynodon dactylon* x *C. Transvaalensis* cv. Tifway 419 lawn some plants able to enhance the ornamental aspect and biodiversity, (b) attempt to identify the best species, (c) observe phenomena of competition, and (d) define the protocol for cultivation of a lawn composed of hybrid bermudagrass, bulbous, annual and perennial herbaceous plant species.

The experiment was carried out on a mature (over 5 years-old) sward of hybrid bermudagrass on which eight bulbous species (geophytes) were planted and eight species of native forbs (wildflowers) were sown. Forbs that could coexist after two years with bermudagrass were *B. perennis* and *G. molle*. Concerning the bulbous species *C. pulchellus*, *M. neglectum*, *G. nivalis* and *N. minor* were suitable to be planted in a Bermuda grass. The presence of these species on a dormant bermudagrass turf improved the aesthetical quality and the diversity of the vegetation; as the studied species are able to attract pollinating insects therefore, support a habitat. Further studies will be required to test the most suitable forbs as a mix in combination with bulbous species.

1. Introduction

Warm season grasses are commonly used for turfgrass areas as they have many advantages: good wear resistance, ornamental quality, and high tolerance to summer drought and heat stress (Beard, 1989). The low summer rainfall of the Mediterranean regions, along with an increasingly limited water supply, mean that drought-tolerant warm-season turfgrass are mandatory (Croce et al., 2001). However, during winter, low temperatures reduce the green colour of warm season turfgrass species, which turn an unattractive brown (Croce et al., 2004; Volterrani and Magni, 2004).

Cynodon dactylon (L.) Pers, commonly called bermudagrass, is one of the warm season grasses that best tolerates drought stress (Beard, 1989) and it is widely used in Italy (Volterrani and Magni, 2004). In the Italian peninsula, areas at latitudes between the Po Valley to Sicily are defined as "the transition zone" i.e. areas where temperatures are too low in winter for the vegetative activity of the warm season grasses, but too hot in summer for the biology of cool season turfgrasses (Dunn and Diesburg, 2004). The dormancy of *C. dactylon* begins when temperatures fall below 10 °C during autumn or early winter (Double, 1996). At this stage, plants stop growing and carbohydrate reserves are accumulated in the nodes of the rhizomes, stolons and roots. When temperatures drop below

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0 °C, plants enter dormancy and finally the turf turns brown. In spring, exit from dormancy occurs when soil temperatures persist for several days with an average above 10 °C (Double, 1996). During winter dormancy the high maintenance sport turfgrasses are overseeded with a cool season grass. This requires specific agronomic practices for both fall overseeding and spring transition management, and is not always financially viable for ornamental lawns. Another method commonly adopted in the U.S., but not in Italy, is turf painting with non-toxic dyes. Both solutions are expensive.

The coexistence of forbs and grasses has been investigated. Early studies highlighted the characteristics, introduction and the survival of native species in grasslands, for ornamental and conservation purposes (Fenner, 1978a; Wathern and Gilbert, 1978). In addition, the establishment of different species after being seeded in tall and short turf has been studied, in terms of the ecological strategies of ruderality and competitiveness (Fenner, 1978b). Some species, such as *Bellis perennis* (L), are able to survive in lawns and cope with frequent mowing, thanks to their phenotypic plasticity (Warwick and Briggs, 1980).

The composition of lawns in terms of volunteer species is strongly determined by the local climate and intensity of use (Thompson et al., 2004). Tinsley et al. (2006) compared mixes of native versus non-native species, including bermudagrass mixed with other grasses, in the revegetation of roadsides. Hitchmough and Woudstra (1999) reviewed the ecology of herbaceous perennials growing in grassy vegetation, focusing on exotic species. However as they report, the tradition of using "native grasses and flowering broadleaves into which are planted non-native bulbs and herbaceous perennials" dates back as far into the Middle Ages.

More recent studies have focused on the reintroduction of grasslands to urban degraded soils as a conservation practice (Fischer et al., 2013). Other studies have investigated the diversification of grasslands in urban parks in order to create a more interesting landscape from an aesthetical point of view (Hitchmough, 2009), the creation of lawns with perennial flowering species only (Smith and Fellowes, 2014) and the incorporation of early spring bulbs into dormant *Zoysia japonica* (Richardson et al., 2015).

Research has also been carried out on the use of Mediterranean wildflowers for anthropic landscape management, especially when low-input maintenance is required (Bretzel et al., 2009, 2012). In terms of fauna diversity, arthropods found in flowers growing adjacent to turfgrasses, suggest that floral plantings may attract beneficial parasitoid species and generalist predators, able to contain bermudagrass pests (Braman et al., 2002).

However, in order to utilise the opportunities offered by this type of coexistence in overcoming the aesthetic issues related to the winter dormancy of warm season grasses no test has been carried out on a possible association between warm season grasses and wildflowers and/or bulbous species. The aim of the present study was thus to identify plant species that can grow and co-exist within bermudagrass, to provide an aesthetically pleasing ground cover during its winter dormancy, and withstand mowing schedules under the traditional maintenance requirements carried out for ornamental lawns, during the growing season.

2. Material and methods

The experiment was carried out from October 2011 to March 2013 at the Experimental Research Station of Rottaia (43°40′N, 10°18′E, 6 m asl.), of the Department of Agriculture, Food and Environment (DAFE), University of Pisa, in S. Piero a Grado – Pisa (Tuscany, Italy). The site is level and exposed to full sun. The total annual precipitation was 521 mm in 2011 and 898 mm in 2012 (last 35-year average = 905 mm). Monthly mean, maximum and minimum temperatures recorded at the trial site are reported in Table 1.

Table 1
Monthly mean aerial temperatures and mean rainfall during trial period (source: Consorzio LAMMA: www.Lamma.rete.Toscana.it).

Month	Mean Minimum (°C)	Mean Maximum (°C)	Mean rainfall (mm)
2011			
October	10.5	21.8	22.3
November	6.6	17.5	31.2
December	4.7	13.3	119.8
2012			
January	1.3	11.4	21
February	−0.6	9.3	24.2
March	4.1	17.9	20.8
April	9.3	18.1	154.6
May	10.7	20.8	82.8
June	15.7	27.3	18.4
July	18.5	29.6	0
August	19.3	31.3	57.6
September	16.3	26.0	35.8
October	13.2	21.7	181.4
November	9.5	16.2	229
December	3.1	10.7	151.4
2013			
January	3.6	10.1	189.2
February	1.2	9.7	104.2
March	5.9	12.9	222

The physical and chemical properties of the soil were as follows: texture silty-loam, pH 7.7, total N 1.3 g kg^{-1}, Olsen P 17.5 mg kg^{-1}, total K 24.8 g kg^{-1}, organic matter 1.88% (ASA-SSSA, 1996).

The trial was carried out on a mature (over 5 years-old) sward of hybrid bermudagrass *Cynodon dactylon* x *Cynodon transvaalensis* cv. "Tifway 419" (hereafter Cdxt), on which eight species of native forbs (wildflowers) were sown and eight bulbous species (geophytes) were planted. During the first year Cdxt dormancy length ranged from January to mid March 2012, and from mid December 2012 to mid April 2013 in the second year.

All the species were chosen according to direct observation of their adaptability to grow in grassy swards and on their time of flowering. The species were also chosen according to the following criteria: limited production of aboveground biomass or creeping habit, availability of commercial germplasm, number, colour and shape of flowers. The species evaluated in the trial are listed in Tables 2 and 3, defined for their origin and, according to Pignatti (1982), for life cycle, family, common name, biological form and anthesis.

The experimental design used was a randomized block with three replications. Plots (1.5×1.5 m = 2.25 m^2) were separated by a pathway of 0.5 m. Turf scalping was carried out with a flail lawn mower before sowing and transplanting. Fertilization was performed by distributing 50 kg ha^{-1} of N and 120 kg ha^{-1} of P_2O_5 over the entire turf surface. Cast sowing was carried out on November 2, 2011. The seeding and the bulb planting densities were determined on the basis of the plants characteristics (habit, germinability, establishment capacity) and cost. For a more uniform distribution, the seeds were mixed with 700 ml of silica sand, and the broadcast seeding was carried out in the absence of wind and close to the soil surface to prevent seed drifting into adjacent plots. Manual transplanting of bulbous species took place on November 10, 2011. A not transplanted or seeded turf control was included in the trial.

Once sowing and planting had been carried out, the area was covered with geotextile with a density of 17 g m^{-2} to avoid seed predation by granivorous birds or arthropods, and to increase soil temperature, maintain moisture and prevent seed runoff due to rain (Volterrani and Magni, 2004). The area was then irrigated with approximately 5 mm of water which also helped to promote the release of seed dormancy.

From June 11, 2012 and until October 2, 2012, the plots containing forbs were managed with two different mowing programs.