doi: 10.17221/78/2015-CJGPB

Morphological Characterization and Turf Performance of Paula Hard Fescue and Casero Colonial Bentgrass Selections under Low Maintenance Conditions

Jose Alberto OLIVEIRA PRENDES and Pedro PALENCIA

Plant Production Area, Department of Organisms and Systems Biology, Mieres Polytechnic School, University of Oviedo, Mieres, Asturias, Spain

Abstract

Oliveira Prendes J.A., Palencia P. (2015): Morphological characterization and turf performance of Paula hard fescue and Casero colonial bentgrass selections under low maintenance conditions. Czech J. Genet. Plant Breed., 51: 117–122.

Planting grasses that require low maintenance is a good option for reducing the management input required. The objective of this study was to obtain information about turfgrass characteristics based on spaced-plant characterization and turf performance in turf plots of two selections (Paula hard fescue and Casero colonial bentgrass) recently released for public distribution by the Plant Production Area of the University of Oviedo. The plants were grown under conditions of no irrigation, no fertilizer, no pesticide application and minimal mowing over a 3-year period (2012–2014). The following morphological measurements were done in a spaced-plant nursery: heading date, plant height, inflorescence length and flag leaf length and width. The turf plots were evaluated for several traits including overall turfgrass quality (turf score), leaf texture and genetic colour. In both the spaced-plant nursery and turf trials, hard fescue genotypes displayed better morphological characteristics (narrow leaves, reduced plant height) and performed better (overall high turfgrass quality, fine leaf texture, dark green colour) than bentgrass genotypes under conditions of low maintenance. For areas in which climate, soil characteristics and management conditions are similar to those encountered in this trial, the selection of Paula hard fescue is recommended for use in low-maintenance turf settings because of the good turfgrass performance and morphological characteristics of this selection.

Keywords: *Agrostis*; *Festuca*; spaced-plant nursery; turf plots

The changing climate conditions (global warming, temperature fluctuations, incidence of extreme conditions, etc.) are intensifying the need to reduce water consumption, and emphasis has been placed on selecting species and cultivars for establishment of high-quality turf in cities and in the countryside (Svobodová *et al.* 2013). The use of grasses that require less management inputs would provide advantages over conventional turf blends by reducing the need for fertilization, pest control, irrigation and mowing. The quality expectations of a low maintenance turf should not be high, since minimal inputs can be expected to produce only a turf of minimal quality. Proper selection of species and/or cultivar is important, since some species do not persist under low maintenance conditions (Koski 2011).

The hard fescue (*Festuca ovina* L.) Paula (PII-2011-0026) was selected by the Plant Production Area of the University of Oviedo in 2011 for public release with free distribution. The plant material was selected from a collection (project RF99-018-C2) of 28 accessions of fine fescues (*Festuca rubra*, *Festuca ovina*, etc.) collected in the Cantabrian mountain range (Oliveira *et al.* 2001). Agronomic characterization of the accessions was carried out during a two-year period (2001–2003) in the Centro de Investigaciones Agrarias de Mabegondo (A Coruña) by analysis of 14 agromorphological characteristics,

doi: 10.17221/78/2015-CJGPB

in a plot of spaced plants including 30 plants per accession under low maintenance conditions. Based on this work, a plot of 100 spaced plants of one of the accessions that performed well was established in Asturias in autumn 2011. Fifty plants of similar appearance were selected and allowed to multiply in the open air by polycrossing (plantation spacing, 0.5 × 0.5 m) in Candás (Asturias), to obtain the pre-base seed in summer 2012; the plants were isolated from others of the same species to prevent contamination from extraneous pollen. In the summer of 2013, the base seed was obtained from multiplication of the pre-base seed, again in an open-air plot in Candás, isolated from all sources of pollen from other plants of the same species. This is the first time that a hard fescue from Asturias and with good agronomic characteristics (low maintenance throughout the year, dark green colour, fine leaves and good tolerance to foliar fungal diseases) has been made available for use in low maintenance lawns, as a component of seed mixtures for landscape restoration in poorly fertile soils, sloping areas, road edges, vegetation under fruit trees and, in general, in zones that are not usually trampled.

The colonial bentgrass (*Agrostis capillaris* L.) Casero (PII-2013-0025) was selected by the Plant Production Area of the University of Oviedo in 2013 for public release and free distribution. The plant material was selected on the basis of the findings of a research project carried out in Asturias between 2002 and 2005 (project RF02-025-C2-1) in which 14 Asturian accessions of *Agrostis capillaris* were agronomically characterized and classified in four groups with distinctive characteristics (Oliveira *et al*. 2010). From a group comprising four accessions that displayed the best agronomic characteristics (good appearance throughout the year, dark green colour, fine leaves and good resistance to the fungal disease caused by *Sclerotina homoecarpa* (dollar spot), plants of the three most promising accessions, Ac1265 (25 plants), Ac1266 (25 plants) and Ac1275 (15 plants), were selected. At the end of 2009, these 65 plants were allowed to grow in the open air, by polycrossing (plantation spacing, 0.5 × 0.5 m), in a plot isolated from any source of pollen from other *Agrostis capillaris* plants, to produce the pre-base seed in the summer of 2010. The base seed was finally obtained from multiplication of the pre-base seed in the summer of 2013 in an open air plot in Candás isolated from all sources of pollen of other plants of the same species.

This is the first Asturian material of *Agrostis capillaris* displaying good agronomic characteristics (good appearance throughout the year, dark green colour, fine leaves and good resistance to infection by the fungus *Sclerotina homoecarpa*) that has been made available for use in low maintenance lawns and as a component of seed mixture for landscape restoration.

The objective of this study was to provide information about turfgrass characteristics based on spaced-plant characterization and turf performance in turf plots of two selections of hard fescue and colonial bentgrass (released by the Plant Production Area of the University of Oviedo) under low maintenance conditions over a 3-year period.

MATERIAL AND METHODS

Characteristics of the study areas. The study areas (Candás and Mieres) are included in the Euro-Siberian region in the Atlantic-European province in Northern Spain. Candás is further included in the phytogeographical Cantabrian-Atlantic subprovince. By contrast, Mieres is included in the Oro-Cantabric phytogeographical subprovince, characterised by higher continentality (Díaz González & Fernández Prieto 1994). The influence of the oceanic fronts is attenuated by the high relief, and although the winter conditions in the lowest areas of the Oro-Cantabric subprovince prevent growth of cold-sensitive flora, the same flora is maintained in low-lying areas in the Cantabrian-Atlantic subprovince. The meteorological stations closest to the trial plots in Candás and Mieres were in Gijón and Oviedo, respectively.

The average annual temperature and precipitation values were similar during the study period, although in 2012 and 2014 precipitation was higher in Oviedo than in Gijón (Table 1). Soil analysis was carried out at the beginning of the trial in the Agroforestry Engineering Laboratory of the Polytechnic School in Mieres. The analysis of general properties of the Mieres soil, in 2011, revealed the following characteristics (Table 2): neutral pH, low electrical conductivity (non-saline soil), low contents of organic matter and total nitrogen, adequate C/N ratio, and higher levels of available P extracted with Mehlich 3 reagent than the level considered critical for this extractant (> 30 mg P/kg) (Buondonno *et al*. 1992).

The concentrations of exchangeable K and Ca in the soil were within the range considered adequate (Junta de Extremadura 1992). The concentration of exchangeable Mg in the soil was below the level con-

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sidered adequate (Junta de Extremadura 1992). The concentration of Na was within the recommended levels (Junta de Extremadura 1992).

The Ca/Mg ratio was higher than 10 (value 49.6), which indicates a possible deficiency of Mg (Junta de Extremadura 1992). The cation exchange capacity was high due to the high concentrations of exchangeable Ca.

The analysis of general properties of the soil in Candás, in 2011, revealed the following characteristics (Table 2): low (acidic) pH, low electrical conductivity, high contents of organic matter and total nitrogen, adequate C/N ratio and higher levels of available P extracted with Mehlich 3 reagent than the level considered critical for this extractant (>30 mg P/kg) (Buondonno *et al*. 1992).

The concentration of exchangeable K was high and that of exchangeable Ca was low (Junta de Extremadura 1992). The concentration of exchangeable Mg in the soil was below the levels considered adequate for this element (Junta de Extremadura 1992). The concentration of Na was within recommended levels (Junta de Extremadura 1992).

The cationic exchange capacity was high due to the high concentration of exchangeable K. The Ca/Mg ratio (9.75) was adequate (Junta de Extremadura 1992).

Spaced-plant study. In November 2011, plants of the following hard fescue and bentgrass cultivars and selections were established in a spaced-plant nursery at Oviedo University's Polytechnic School in Mieres (inland area of Asturias, 43°15'00''N latitude, 5°46'00''W longitude, 207 m a.s.l.): the hard fescue cultivars Aurora Gold (Turf Seed Europe Ltd, Dublin, Ireland) and Ridu/Triana (DLF Trifolium Seeds and Science, Roskilde, Denmark), the dryland bentgrass cultivar Highland (Semillas Fitó, Barcelona, Spain), the colonial bentgrass cultivar Golfin/Golf (Plant Breeding Station, Hladke Zivotice, Czech Republic), and two selections (hard fescue Paula and colonial bentgrass Casero) released by the University of Oviedo (Table 3). The trial was carried out as a randomized complete block design with five replications, each of which included 10 plants of each cultivar or selection. The plants were fertilized with 5 g/m^2 of N per growing season year in March.

Morphological measurements were done in 2012, 2013 and 2014. Spaced plants were cut twice a year, once after measurements were taken every year and again in autumn at a height of 60 mm with a rotary mower that returned clippings. The spaces between

Table 1. Summary of average annual temperature and precipitation in the study area

Year	Gijón	Oviedo
Average temperature (°C)		
2012	13.5	13.2
2013	13.5	12.6
2014	14.6	14.0
Year average	14.0	13.3
Precipitation (mm)		
2012	714	848
2013	1397	988
2014	875	1112
Year average	1017	960

Data were obtained from the weather stations closest to the study sites, in Gijón (latitude 43°32'17''N, longitude 5°37'26''W, elevation 30 m a.s.l.) and Oviedo (latitude 43°21'12''N, longitude 5°52'27''W, elevation 336 m a.s.l.); year averages were calculated considering the period of 20 and 30 years for Gijón and Oviedo, respectively

Table 2. Soil chemical and physical characteristics at the beginning of the trial (2011) in the Mieres and Candás trial plots

Soil characteristics	Mieres	Candás
Bulk density (g/cm^3)	1.50	1.37
pH (water 1:2.5)	7.70	5.30
Electrical conductivity (dS/m)	0.55	0.01
Sand (%)	65	53
Silt (%)	29	16
Clay (%)	6	31
Texture	sandy loam	sandy clay loam
Organic matter (%)	1.34	7.50
Total N (%)	0.07	0.30
C (%)	0.78	4.36
C/N	11.14	14.53
Extractable P (mg/kg)	33.60	74.10
Extractable K (cmol$_c$/kg)	0.40	1.40
Extractable Ca (cmol$_c$/kg)	12.40	7.80
Extractable Mg (cmol$_c$/kg)	0.25	0.80
Extractable Na (cmol$_c$/kg)	0.17	1.90
Extractable Al (cmol$_c$/kg)	0.00	2.20
Effective cation exchange capacity (cmol$_c$/kg)	13.22	14.10

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Table 3. Species and cultivars used in this study

Species	Cultivar/Selection
Hard fescue	Paula (selection)
	Aurora Gold
	Ridu/Triana
Colonial bentgrass	Casero (selection)
	Golfin/Golf
Dryland bentgrass	Highland

and around plants were maintained weed free by mowing with a brush cutter.

Morphological measurements (NTEP 1998; UPOV 1990, 2006) were done 10 days after anthesis. Heading date was determined as the day when the first five seed heads per plant were completely emerged and was recorded as days after 1 January of each year. Plant height was measured from the base of the crown to the top of the inflorescence. Inflorescence length of three inflorescences per plant was measured from flag leaf to top inflorescence. Flag leaf length (from the beginning of the ligule to the end of the tip of the leaf) and flag leaf width (the widest part of the flag leaf) were measured in three flag leaves per plant.

In spaced plants, the incidence of diseases was not taken into account because reliable field characterization methods require even distribution of inoculum and predictable environmental conditions for consistent disease expression (Moss & Trevathan 1987).

Turf plots. A turf trial was established in October 2011 on a farm (Casero farm) that collaborates with the Plant Production Area of the University of Oviedo, in Candás (coastal area of Asturias, latitude 43°35'03" N; longitude 5°46'56"W; elevation 80 m a.s.l.). The trial included the same cultivars and selections of the spaced-plant study replicated three times in a randomized complete block design. Plots (1 × 1 m) were seeded at rates of 15 g/m^2 (bentgrass) and 30 g/m^2 (hard fescue). Plots were fertilized with 5 g/m^2 of N per growing season, half of which was applied in spring and half in autumn.

Turf data was collected during 2012, 2013 and 2014. Ratings for several turf characteristics were scored visually: turf score, leaf width and genetic colour. Turf score was calculated as the average of four turf quality ratings (based on a combination of colour, density, uniformity, leaf texture, and disease, weeds or environmental stress) ranging between 1 and 9, where 1 = poorest turf quality or dead turf and 9 = best possible quality; turf score was measured in autumn (November), winter (February), spring (April) and summer (August). The leaf width rate was also evaluated on a scale ranging from 1 (= narrow) to 9 (= broad). The genetic colour refers to the inherent colour of the genotype when the turf is actively growing and is not under stress and ranged from 1 (= light green) to 9 (= dark green); this parameter was measured in April.

The plot was not irrigated and was not treated with herbicide. Plots were mowed four times a year, one week after each quality rating, to a height of 60 mm, with a rotary mower, and clippings were returned to the plot.

Data analysis. Analysis of variance of the traits was first performed for each year: after confirmation of the similarity of errors in each year, a combined analysis was carried out for the data collected during the whole study period (three years). Means were separated using Fisher's protected least significant difference (LSD), at the 5% significance level. Statistical analysis was performed with SPSS version 22 (SPSS 2013).

RESULTS AND DISCUSSION

Spaced-plant study. The bentgrass genotypes showed the highest combined 3-year mean values for heading date, plant height, flag leaf length and width and inflorescence length (Table 4). The Casero bentgrass selection displayed intermediate values for these characters relative to the other bentgrass genotypes, except for flag leaf width, which was highest in this selection and in Golfin.

Hard fescue genotypes showed the lowest combined 3-year mean values for heading date, plant height, flag leaf length and width and inflorescence length.

In the hard fescues, heading was latest in the Paula selection. Heading date is probably the single most important character that determines the growth rhythm of plants (Tyler *et al*. 1987). This may be an advantage on roadsides and other less frequently mown sites (Corkill & Rumball 1980), as a slow growth rate yields low herbage yield, which is a desirable trait for turf cultivars (Hazard *et al*. 2006).

Plant height is an important consideration in low maintenance grasses as mowing frequency is dependent on height (McKernan *et al*. 2001). The Paula and Aurora Gold fescues grow to a low height and would be the most suitable for a low maintenance grass seed mixture.

Flag leaf length was higher and flag leaf width was lower in Paula than in the other hard fescue cultivars. Several authors have shown that flag leaf area is directly related to grain yield in cereals like wheat

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Table 4. Combined 3-year (2012–2104) means (M) and standard deviations (SD) for heading date, plant height, flag leaf length and width, and inflorescence length of hard fescue and bentgrass cultivars and selections planted in a spaced--plant nursery at Mieres Polytechnic School

Cultivars	Heading date (days after January 1)		Plant height (cm)		Flag leaf length (cm)		Flag leaf width (mm)		Inflorescence length (cm)	
	M	SD	M	SD	M	SD	M	SD	M	SD
Paula	106^{d}	12.9	25.1^{e}	6.3	8.0^{d}	2.8	0.8^{d}	0.2	5.2^{d}	2.2
Aurora Gold	87^{e}	13.6	26.9^{de}	14.2	5.6^{e}	2.4	1.2^{c}	0.4	4.9^{d}	2.4
Ridu/Triana	83^{f}	8.3	28.9^{d}	17.4	5.2^{e}	1.5	1.1^{c}	0.3	4.8^{d}	2.7
Casero	157^{b}	8.9	53.1^{b}	18.3	10.6^{b}	3.1	5.3^{a}	1.4	13.8^{b}	4.7
Golfin/Golf	170^{a}	7.8	44.7^{c}	10.9	9.0^{c}	2.6	5.3^{a}	1.2	12.2^{c}	4.7
Highland	142^{c}	8.8	64.1^{a}	12.9	11.3^{a}	2.8	4.9^{b}	1.3	19.7^{a}	2.5
LSD (0.05)	3.8		3.7		0.7		0.3		1.5	

LSD (0.05) – Fisher's protected least significant difference at the 5% significance level; in each column, mean values indicated by the same letter are not significantly different (at $P = 0.05$)

(Monyo & Whittington 1973; Riaz & Chowdhry 2003).

Inflorescence length was similar in all hard fescue genotypes, but was higher in Highland than in the other bentgrass cultivars. Bean (1970) showed that inflorescence length is positively correlated with seed yield per plant in *Phleum pratense*.

Turfgrass performance. Data on the performance criteria are presented in Table 5. The results of this trial reflect cultivar performance for the management regime applied at this site and for the environmental conditions prevailing on the northern coast of Asturias (Spain).

The Paula hard fescue selection was awarded the highest combined turf score between 2012 and 2014. Although turf score takes into account several factors, this cultivar ranked higher than others mainly due to its superior density, uniformity and lack of disease susceptibility. The leaf texture was also finest (lower leaf width) in this selection.

Only one colonial bentgrass cultivar, Golfin, performed poorly throughout the trial. The Casero and Highland colonial bentgrasses displayed the coarsest leaf texture (highest leaf width).

The turfgrass genetic colour ratings in spring showed that hard fescues were the darkest green of the plants considered and the Highland dryland bentgrass the lightest green.

The suitability of grasses for turf is partly determined by maintenance of a green colour between spring and autumn. This mainly depends on the susceptibility of plants to leaf diseases (Stukonis *et al*. 2010) and on drought susceptibility (McKernan *et al*. 2001). No leaf disease was evident in any of the entries in the course of the study.

Hard fescues are generally considered to be particularly drought tolerant (Turgeon 1999) and plants with a superior colour rating, therefore they show no obvious stress or colour loss and have good drought tolerance.

Table 5. Combined 3-year (2012–2104) means (M) and standard deviations (SD) for overall turf quality (turf scores 1–9 scale with 9 representing outstanding cultivars), leaf width (1 = narrow to 9 = broad), genetic colour (1 = light green to 9 = dark green) for hard fescue and bentgrass cultivars and selections in a trial on Casero farm in Candás, which collaborates with the Plant Production Area of the University of Oviedo

Cultivars	Turf score (1–9 scale)		Leaf width (1–9 scale)		Colour (1–9 scale)	
	M	SD	M	SD	M	SD
Paula	5.1^{a}	1.5	1.8^{d}	0.8	6.6^{a}	1.9
Aurora Gold	4.7^{c}	1.9	2.2^{c}	0.9	6.7^{a}	1.7
Ridu/Triana	4.6^{c}	1.7	2.2^{c}	0.8	6.8^{a}	1.5
Casero	4.9^{b}	1.5	4.9^{a}	1.3	4.5^{b}	1.7
Golfin/Golf	3.9^{d}	1.9	4.8^{a}	1.6	4.3^{b}	1.6
Highland	4.9^{b}	1.7	3.4^{b}	1.5	4.0^{c}	1.6
LSD (0.05)	0.2		0.4		0.3	

LSD (0.05) – Fisher's protected least significant difference at the 5% significance level; in each column, mean values indicated by the same letter are not significantly different (at $P = 0.05$)

doi: 10.17221/78/2015-CJGPB

CONCLUSIONS

The results brought the following conclusions:

– hard fescue varieties are more useful (like a component in the mixture) for low maintenance turfs compared with colonial and dryland bentgrass,
– the domestic varieties, selected from indigenous genotypes, are most useful in the country of their origin,
– cv. Paula is recommended for low maintenance turfs in the specific conditions of northern Spain.

Acknowledgements. The authors are grateful for support from the Department of Organisms and Systems Biology, the Office of the Vice-Rector for Research and Campus of International Excellence, and the Agroforestry Engineering Laboratory (Dr. E. Afif Khouri) of the Polytechnic School in Mieres, University of Oviedo.

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Received for publication June 1, 2015
Accepted after correction September 2, 2015

Corresponding author:

Prof. Jose Alberto Oliveira Prendes, University of Oviedo, Mieres Polytechnic School, Department of Organisms and Systems Biology, Plant Production Area, 33600 Mieres, Asturias, Spain; e-mail: oliveira@uniovi.es