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Breeding of Rhizomatous Turf Tall Fescue

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Abstract. Breeding tall fescue with rhizomes has the potential to improve turf persistence and recovery from wear. Most northern European and North American tall fescue cultivars can produce a few short rhizomes although they are considered to be non-rhizomatous. In contrast, almost all tall fescue plants from north-west Spain and northern Portugal have a high number of long rhizomes. Use of this rhizomatous germplasm in New Zealand turf grass breeding has been shown to provide valuable features, including winter activity, wear recovery and the ability to maintain a desirable winter green colour under our mild winter climate. The extent of rhizomatous spread within this germplasm responds readily to selection.

Introduction

Development of the first rhizomatous tall fescue (*Festuca arundinacea*) turf cultivar occurred in New Zealand in the mid 1990s with the release of "Ceres Torpedo" (Anon. 1994; Stewart 1995, 1997). This cultivar was based on winter active germplasm from Galicia in north-west Spain.

This germplasm differs from cultivars of Northern European and American origin in a number of aspects including highly rhizomatous habit, active winter growth, adaptation to mild winter climates, late flowering and a light green colour. Some accessions from this region have a turf density similar to many of the USA turf cultivars. They display excellent resistance to stem rust *(Puccinia graminus)* and crown rust *(P. coronata)* in New Zealand and Australia. Interestingly hybrids between this germplasm and American cultivars have exhibited a high degree of F1 sterility.

Data is presented comparing turf density, winter growth, flowering date, stem rust resistance and observations on rhizomatous spread.

Rhizomes in tall fescue

The presence of extravaginal rhizomes within the tall fescue species has been recognized for many years (Cowan 1956, Porter 1958, Jernstedt & Bouton 1985). A few short rhizomes can occur in traditional cultivars considered to be non-rhizomatous (Hume and Brock 1997). Highly rhizomatous plants occur sporadically in many populations (D'Uva *et al.* 1983) but are present in almost all plants from northern Portugal and north-west Spain (Borrill *et al.* 1971, Gonzales-Bernaldez *et al*. 1969).

Rhizomes can emerge from seedling plants in New Zealand within 2 months of sowing, earlier than the 7 months reported in an overseas study with less rhizomatous germplasm (de Battista & Bouton 1990, Bouton *et al.* 1992). Rhizome buds form mainly in the late summer-autumn period and their outgrowth can occur any time through to the following spring (Lopez *et al.* 1967).

Rhizomatous development is unaffected by endophyte infection (de Battista *et al.* 1990), but is reduced by inter-specific plant competition (D'Uva 1982, Bouton *et al*. 1989). The number of rhizomes on a plant can vary with tiller base shading (Hume and Brock 1997) and the expression of rhizomes is reduced in compact soils (D'Uva *et al.*

1983). The number of rhizomes produced can also be reduced by the defoliation pressure applied to the plant (Brock *et al*, 1997).

In the USA, rhizomatous plants were found to be prevalent in collections from marginal environments for tall fescue. Bouton *et al.* (1989) concluded that the presence of rhizomes would be a valuable feature to enhance persistence.

In high fertility situations apical dominance of the rhizome is reduced and a shorter but highly branched rhizomatous system develops; a similar effect to that observed in rhizomatous clovers (Stewart 1979, de Kroon & Hutchings 1995).

The number of rhizomes is moderately heritable with minimal genotype - environment interaction (D'Uva 1982, Bouton *et al*. 1992). We have found that both number and length of rhizomes respond well to selection.

Torpedo Tall fescue

Torpedo originates from an ecotype collected in Galicia, Spain and is typical of rhizomatous populations from that region in having a strongly pigmented ligule and leaf sheath margin.

Populations from this region were studied by Hughes and Evans (1967) who found that they had a much higher rate of appearance of leaves and tillers than the UK forage cultivar S170, producing 34% more tillers after 39 days.

Turf trial results

Torpedo and other turf type tall fescues were sown in 1 metre square plots and evaluated for their turf qualities at Ceres Research Centre. Plots were mown with a rotary mower at a height of 22 mm. The plots were evaluated for turf qualities by scoring every two months. Winter growth was measured with a rising disc.

Torpedo was planted out as spaced plants with other turf type tall fescues in order to evaluate them as individual plants. Plants were spaced 50 cm apart and left to grow.

Torpedo exhibited similar turf density scores and significantly finer leaves than some USA bred turf tall fescue cultivars (Table 1 & 2). Winter growth, as measured by vertical growth after 14 days in winter, has been much greater than USA bred cultivars (Table1). Torpedo is a lighter green colour and has exhibited excellent resistance to stem rust (*Puccinia graminis* f. *sp*) (Table 2).

Table 1: Winter vertical growth, turf density and colour of turf tall fescue cultivars under mown turf conditions

	Winter growth Rising disc (mm)	Mean turf density score (9=high density)	Colour
Torpedo	50	7.7	light green
Winchester	28 ** (1)	7.6 NS (2)	dark green
Mini-Mustang	23 **	8.0 NS	dark green

(1) Significantly different from Torpedo at P = 0.01

(2) Not significantly different from Torpedo at P = 0.05

Table 2: Leaf width and stem rust resistance of turf tall fescue cultivars in spaced plants.

	Vegetative leaf width (mm)	Resistance to stem rust (9 = excellent resistance)
Torpedo	7.1	8.8
Rebel 2	8.0 *** (3)	6.7 ***
Tribute	8.3 ***	6.5 ***

(3) Significantly different from Torpedo at P = 0.001

Spaced plants of Torpedo can develop rhizomes up to 100 mm long (Table 3) and 3 year old plants can reach a diameter of 1 metre on sandy soil. However rhizome development is known to be reduced on hard, compact soils (d'Uva *et al.* 1983; Sheratt 2005). Torpedo 2 is an improved selection from crosses of Torpedo and a Portuguese rhizomatous accession. It has an increased rhizome production (Table 3) and improved turf qualities (Table 4). PG956 is an additional cycle of selection for even greater rhizome production.

Table 3: Rhizome growth of tall fescue cultivars grown in single rows

	Number of rhizomes (per metre of row)	Rhizome length (mm)
PG 956	137a	120a
Torpedo 2	120ab	112a
Torpedo	100b	100a
Coronado	0c	
Wolfpack	0c	
LSD P = 0.05	*29.5*	*37.4*

Table 4: Winter vertical growth and quality of turf tall fescue cultivars

	Turf growth (mm)	Turf Quality (9 = excellent)
Torpedo 2	30.0	4.0
Torpedo	29.3	3.7
Currawong	24.3	5.7
Tomahawk	22.3	5.0
Coronado	21.7	4.7
Pure gold	21.0	3.0
Olympic gold	24.0	3.7
Coronado gold	23.0	4.3
Coyote	26.7	4.0
Crossfire 2	22.0	5.0
Petite	21.3	3.7
LSD	*6.2*	*1.8*

A comparison of rhizomatous spread under high and low nitrogen fertiliser treatments showed that nitrogen increased both rhizome length and percentage of emerged rhizomes with more than one tiller by 12% and 10% respectively. Interestingly

the number of rhizomes was reduced by 20% (Table 5). It is clear that selections for greater rhizomatous spread react differently under different nitrogen treatments. The number of rhizomes responds to selection best under low nitrogen while rhizome length responds best under high nitrogen.

Table 5: Rhizome production from single plant rows under low and high nitrogen treatments

	No. of rhizomes per metre		Mean rhizome length (mm)		Emerged rhizomes with more than one tiller (%)	
	High N	Low N	High N	Low N	High N	Low N
PG 956	25	35	39	33	80	71
Torpedo 2	25	28	38	29	71	61
Torpedo	22	22	29	31	41	40

More selection needs to be done to bring the turf quality of the rhizomatous tall fescues into line with the best non-rhizomatous types, especially selection for darker green colour. This could be achieved by direct selection for turf quality within the pool of rhizomatous types or by crossing with top turf quality American tall fescues. Torpedo has been crossed with germplasm of American turf tall fescues and the progeny were found to be vigorous but almost completely male sterile. However, others have managed to select the few fertile hybrids by screening large numbers of plants. That way, it has been possible to develop viable populations exhibiting limited rhizomatous spread, fine leaves, better density, good turf quality and improved colour (Saulsbury pers comm.). The cultivar Labyrinth has been developed from crosses between these two sources of germplasm after considerable selection to recover plant fertility and other desirable turf features.

The behaviour and significance of rhizomes in tall fescue and other turf species is poorly understood and there is considerable potential for further research in this area. The potential to transfer the rhizomatous feature to turf ryegrass should also be explored (Harris *et al.* 1979*)*.

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