

Forage potential of wild populations of perennial ryegrass collected from southern New Zealand farms

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Abstract

A ryegrass breeding programme to improve the cool season activity and summer quality of perennial ryegrass (*Lolium perenne* L.) in southern regions was initiated in 1986. One of the strategies assessed wild ryegrass populations from 50 dairy and sheep farms in Southland, West Otago and Westland. The plants were collected and evaluated as spaced plants in a high and low fertility site at DSIR Grasslands Gore in comparison with current ryegrass cultivars. Principal Component Analysis was used to order the performance of the ryegrass populations in relation to the observed characters of seasonal growth, tillering, crown rust infection, recurrent ear emergence and endophyte presence. The collection consisted of many short-leaved densely tillered prostrate plants with high levels of crown rust infection and recurrent flowering. In comparison the cultivars had fewer, but larger tillers, rapid leaf extension and good rust tolerance. There were no strong distinguishing features between plants from dairy and sheep farms and 30% of plants had no endophyte. Selected ecotypes hybridised with New Zealand and European cultivars produced plants with better cool season growth and summer quality than standard cultivars. The ecotype germplasm is an important source in the development of new cultivars suited to the southern region.

Keywords plant evaluation, *Lolium perenne*, ryegrass hybrids, southern New Zealand ecotypes

Introduction

Perennial ryegrass (*Lolium perenne* L.) is the most important grass species in southern New Zealand pastures. It is well adapted to the cool, moist temperate climate and intensive grazing practices of the region. Growth potential and persistence of ryegrass are limited by low soil fertility conditions which are becoming more widespread as fertiliser inputs are reduced. The shortage of grass during winter/early spring restricts animal carrying capacity and affects animal performance. The decline in the quality of ryegrass during its seed-head phase and recurrent flowering is a major reason for

reduced lamb growth rates (Ulyatt 1981).

Hence a breeding programme was initiated at DSIR Grasslands Gore to improve these limiting factors within perennial ryegrass. One of the strategies was to collect wild populations (ecotypes) of ryegrass from old pastures on farms of southern New Zealand. This paper describes the results of an evaluation of 50 farm populations. The survey compared this wild ecotype material with current ryegrass cultivars to identify ryegrass plants with cool-season growth, less recurrent flowering, resistance to crown rust (*Puccinia coronata*) and absence of endophyte (*Acremonium lolii*).

Materials and methods

Fifty ryegrass populations were collected from farms within the cool moist climatic regions of Southland and West Otago; (annual rainfall 900 mm to 1500 mm) and Westland (1800 to 4800mm) during the spring of 1986. Within these regions ryegrass populations were collected from four types of farm. Seven populations came from low fertility sheep farms (Olsen P soil test 8 to 11); 28 from high fertility sheep farms; (Olsen P range 15-35); 6 from cattle/sheep farms (Olsen P 15-23) and 9 from dairy farms (Olsen P 20-60).

At each farm, a pasture considered productive and greater than 25 years old was sampled. Sixty 50 mm diameter pasture cores were removed at random across the pasture. Each core was dissected and a single ryegrass plant removed. This plant was separated into individual tillers and two tillers of equal size were planted into separate soil pots to encourage further plant development before transplanting to the field. At the same time, seed from nine current ryegrass cultivars was sown in pots.

The first set of plants from the 50 populations was planted in a high fertility site with pH 5.8 and Olsen P 18; potassium (K) and sulphur (S) were 6 and 5 ppm respectively. The second set were planted in a low fertility site with pH 5.3, Olsen P 8, K and S 3 and 2 ppm, respectively, at AgResearch, Gore in November 1986. Each site had previously been treated with glyphosphate to remove resident ryegrasses while leaving the legume base intact. The high fertility site was maintained with an annual dressing of 300 kg/ha potassic superphosphate (O-7-15-7); the low fertility site received no fertiliser. At

each site the **50** wild populations and the **9** current **cultivars** were **randomised** in 6 blocks. Each population and **cultivar** in a block consisted of a row with 10 plants at **50 cm** spacings.

Seasonal growth, tiller density, growth habit, leaf extension, crown rust infection and recurrent ear emergence were noted for each plant on a visual scale. The presence or absence of endophyte was determined by sampling 30 plants of each population in summer. After each plant character assessment, at **4- to 6-weekly**

intervals during spring and summer, twice during the autumn and at the end of winter, the plants were grazed with sheep.

Principal Component Analysis (PCA) was used to arrange **ecotypes** and **cultivars** into **recognisable** groups based on overall performance in the trials. The analysis of the 50 **ecotypes** and cultivar means for the various measured characters allowed a multitude of related variables to be replaced by a few derived variables or principal components. When plotted the components

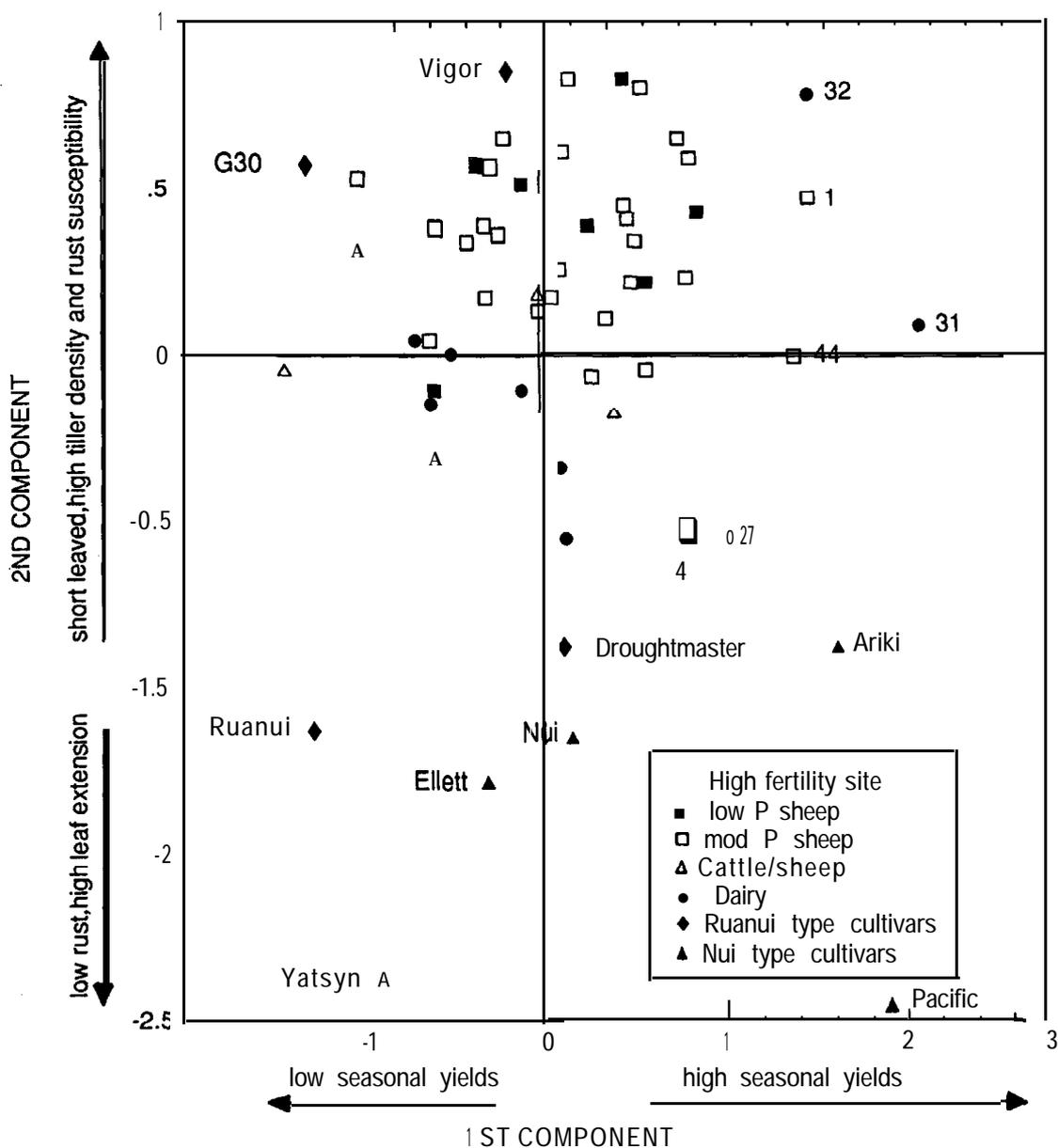


Figure 1 Position of the 50 wild populations of ryegrass and the 9 New Zealand cultivars as defined by the principal components 1 and 2 in the high fertility site.

portray the relative performance of all ryegrass populations.

Results

The seasonal herbage yields and morphological features of the ryegrass ecotypes and cultivars in the high and low fertility sites are presented in Figures 1 and 2 respectively. Under both fertility sites 80% of the total variation was explained by the first two principal components.

The first component (x-axis) in both figures was positively correlated to plants with consistent high yields in spring, summer and autumn in each of the 3 years that they were observed towards the right side of the graph and poor yielding plants on the left side of the graph. The second component (y-axis) represents densely tillered plants which were short-leaved and rust susceptible towards the top end of the graph. Plants with good leaf extension, larger leaved and rust tolerant were at the lower end of the axis.

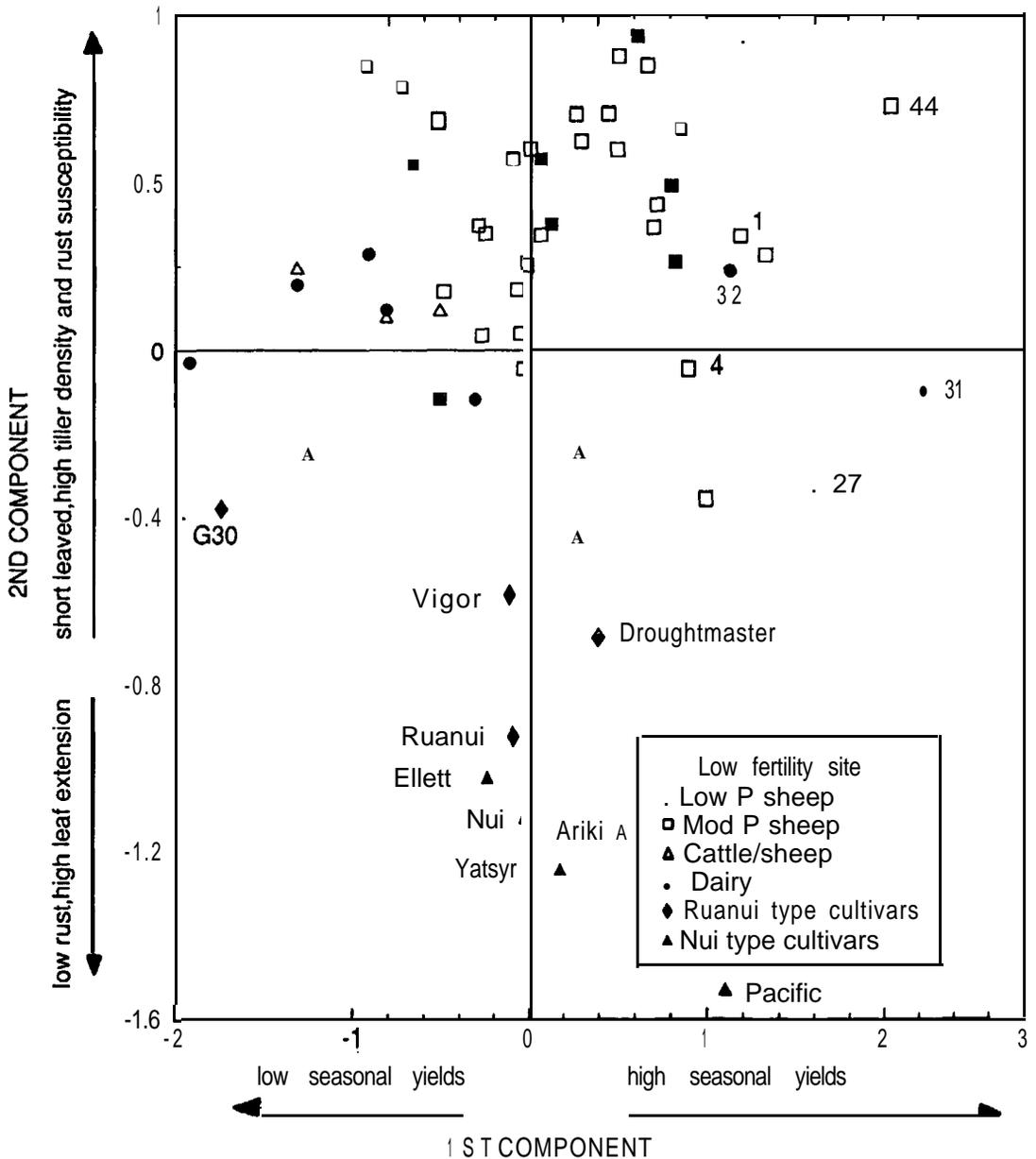


Figure 2 Position of the 50 wild populations of ryegrass and 9 New Zealand cultivars as defined by the principal components 1 and 2 in the low fertility site.

The ecotypes formed a distinct set, different to the **New Zealand bred cultivars (Figures 1 and 2). They were** densely **tillered** plants which were short leaved and susceptible to crown rust. The ecotypes were uniformly early heading and all developed reproductive heads between 9 and 20 November which is similar to the heading time of standard New Zealand cultivars. However 62% of the ecotype plants had recurrent flowering into summer compared with forty percent of the cultivar plants. Vigor (a European cultivar) and G30 (North Island hill country selection) had similar features to the ecotypes. The remaining seven New Zealand cultivars had fewer but larger tillers, rapid leaf extension and good rust tolerance compared with the ecotypes.

In both the high and low fertility sites the four groups of ecotypes showed little differentiation when plotted (Figures 1 and 2) and merged together regardless of where they originated. There was no interaction between the high and low fertility evaluation sites as those **ecotypes with high growth (Lines 1, 4, 27, 31, 32 and 44)** were the best at either fertility site. The four groups of ecotypes were also represented by high and low **yielding** populations which were consistent in both fertility sites.

In the ecotype populations, 70% of the plants were endophytic and 30% of plants had nil endophyte. In one

Table 1 **Percentage** of endophytic plants in the **ecotype** population

Endophyte Level %	0-20	21 - 40	41-60	61-80	81-100
number of populations	2	6	13	13	16

quarter of the populations less than 50% of the plants were endophytic (Table 1). The most productive ecotype populations (Lines 1, 4, 27, **31, 32** and 44) showed variable numbers of endophytic plants: 87%, 96%, 26%, 37%, 52% and 66% respectively. Plant growth was compared during the second summer in the high fertility site (Table 2). The infected **and** uninfected plants followed a normal distribution for growth with a similar percentage of plants at each growth score.

Selected ecotype plants were hybridised with plants from New Zealand and **European** cultivars which had

Table 2 **Summer growth in the second year of ecotype plants with or without endophyte**

Summer growth score	% Endophytic plants	% non endophytic plants
1 poor	11	10
2	17	17
3 average	33	35
4	25	23
5 excellent	13	14

rust resistance and less recurrent heading. The hybrid lines were evaluated as spaced plants and showed **improved growth** in all seasons when compared to standard **cultivars** (Table 3). The hybrids with European parentage had better summer growth, were **more** leafy and densely **tillered** than other **hybrids. Hybrids** with New Zealand parentage had superior **autumn/winter** and spring growth compared to the standard cultivars.

Discussion

The southern New Zealand perennial ryegrass collection showed little discrete differentiation between ecotypes in plant morphology and during the reproductive phase. Even though the collection came from both dairy and sheep farms under high and low fertility soil conditions, the four groups of ecotypes had no strong distinguishing features. This result is consistent with collections made in the **North Island (Suckling & Forde 1978; Wedderburn et al. 1989)** where sampling **from** a wide range of environments did not reveal distinct **ryegrass** ecotypes.

The **ecotype** plants when viewed as a whole collection, were densely tillered, prostrate growing type plants with relatively short leaves. During summer a **large** proportion of the collection put a significant amount of **energy** into the reproductive phase with continuous recurrent flowering and seed setting. **These morphological and reproductive characteristics** are adaptive mechanisms to ensure plant survival under intense grazing management practices and other harsh environmental conditions. The **standard** cultivars contrasted strongly with the ecotypes. They had fewer tillers, grew more upright and were longer leaved, flowering was **confined** hugely to a narrower time span and less recurrent flowering occurred. These features are seen by plant breeders as desirable for animal production under rotational grazing conditions.

The **ecotype** populations showed differences in **herbage** yield potential. These differences were not specifically linked to any one of the four stock and fertility groupings, previously outlined. The response pattern for **herbage** yields showed a **number** of ecotype populations (Figures 1 and 2) which were inherently high yielding in both high and low soil fertility. The converse was also true, with consistently low yielding ecotype populations under both fertility conditions. Superior plants were selected mainly from the numbered populations (Figures 1 and 2) which had inherently the highest yielding response pattern.

The varying numbers of endophytic plants within the ecotype populations contrasts sharply with the **North Island hill country collection of Wedderburn et al. (1989)** and the North Island collection of Cooper (**pers. comm.**) where 85-100% of their plants contained **endo-**

Table 3 Performance of selected ecotypes hybridised with New Zealand and European ryegrass cultivars. (mean of two years).

Hybrids	Number of lines	Growth Score			Morphology		
		Spring	Summer	Aut/Wint	Tillering	Leafiness	Leaf length
Ecotype X European cultivars	6	3.2	3.3	3.3	3.0	3.3	2.6
Ecotype X Ecotype	13	3.1	3.0	3.2	2.6	2.7	3.0
Ecotype X NZ cultivars	22	3.2	3.0	3.3	2.4	2.5	3.0
Control cultivars							
Nul types	7	2.7	2.6	2.6	1.6	1.6	3.2
Ruanul types	4	2.4	2.3	2.4	2.0	2.0	2.2
LSD (5%)		0.4	0.4	0.4	0.4	0.4	0.3

phyte. The presence of endophyte ensures the survival of a plant by conferring resistance to the pest Argentine stem weevil (*Listronotus bonariensis* (Kuschel)). The cooler and wetter summer conditions of the southern regions do not favour the development of significant population levels of Argentine stem weevil and therefore allows a significant number of nil endophyte plants to persist. If the vigour of the nil endophyte plants was being hindered, a skewed distribution to lower growth scores would be expected. This result indicates that selecting high yielding nil-endophyte plants will have a distinct advantage for producing high lamb growth rates in southern regions (Eerens et al. 1992; Fletcher et al. 1990).

Many ecotype plants with good cool-season growth, high tiller numbers and absence of endophyte were identified; however, most were highly rust susceptible and had recurrent ear emergence. Both these factors are detrimental to ryegrass quality over summer when there is a need for high quality forage to sustain high lamb growth rates. Germplasm with leafy summer growth and little recurrent flowering has been identified in European cultivars (Widdup & Ryan 1993). New Zealand cultivars contain plants with good cool season growth and rust resistance.

The hybridisation of superior ecotypes with superior New Zealand and European plant material produced plants with improved cool season yields and summer quality factors compared to the standard cultivars. The ecotype collection has proved to be an interesting and valuable source in the development of new genetic material. This material will form the basis of cultivars adapted to the climate, topography and grazing management systems of the region.

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