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# VARIETIES OF ITALIAN RYEGRASS IN NEW ZEALAND

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**Abstract**

To assist farmers and their advisers in becoming familiar with the many different varieties of Italian ryegrass currently available, this paper compares morphological. physiological and biochemical characteristics of Concord, Ceres Progrow, Lemtal (Belgium), Grasslands Tama, Grasslands Paroa, Grasslands Moata, Te Puna, Te Rahu, Bradley, Rakaia and also Grasslands Manawa, a hybrid cultivar which behaves as a persistent Italian ryegrass.

In trials at Palmerston North in 1986/87, Moata stood out for its size in comparison to all other lines. Rakaia and Progrow from the South Island were short-lived and early heading, went directly to head after spring sowing and had large heads and many florets per spikelet. despite small size of leaves and plants. By contrast, Concord and Te Rahu from North Island dairy pastures were persistent, later heading and large in both vegetative and reproductive characteristics. All the varieties based on NZ material were quicker to germinate than any of the cultivars bred from overseas material, and, except Bradley, contained *Acremonium* endophyte.

**Keywords:** *Lolium multiflorum* Lam., crown rust, germination, vernalisation, electrophoresis, seed protein banding. vegetative and reproductive characteristics, *Acremonium* endophyte.

## INTRODUCTION

The aim of this paper is to present and compare some of the morphological, physiological and biochemical characteristics of all varieties of Italian and Westerwolds ryegrass (*Lolium multiflorum* Lam.) currently or occasionally sold in New Zealand, many of which are based on New Zealand material. Grasslands Manawa hybrid ryegrass, which behaves as a persistent Italian ryegrass, is also included in the comparison.

## THE RYEGRASSES STUDIED

Eleven varieties were included in the study:

**Grasslands** Paroa Bred by Grasslands Dwision, DSIR, from New Zealand and overseas material. First certified 1936 (as NZ Certified Italian Ryegrass). Renamed 1964.

**Grasslands Manawa** Bred by Grasslands Division, DSIR, from artificial hybrids between Ruanui perennial ryegrass and Paroa Italian ryegrass, as well as natural hybrids collected from pasture. First certified 1943 (as Short Rotation ryegrass). Renamed 1964.

**Grasslands Tama** Bred by Grasslands Division, DSIR, from induced tetraploids of imported Westerwolds ryegrass. First certified 1966.

Grasslands **Moata** Bred by Grasslands Division, DSIR, from induced tetraploids of Paroa Italian ryegrass. First certified 1960.

**Lemtal RvP** Bred by Rijksstation voor Plantenveredeling, Merelbeke, Belgium. Has been imported and sold in New Zealand as a persistent variety.

Concord Bred by Wrightson NMA from a local ecotype in dairy pastures at Orini, Waikato. First certified 1965.

**Ceres Progrow** Westerwolds ryegrass bred by Pyne Gould Guinness Ltd from a local ecotype in the Blenheim district. First certified 1986.

**Te Puna** Local ecotype from old dairy pastures in the Tauranga region, Bay of Plenty. Not currently commercialised.

**Te Rahu Local** ecotype from dairy pastures in the Edgscumbe district, Say of Plenty. Not currently mmmercialised.

**Rakaia** Local ecotype from Rakaia region, Canterbury. Not currently commercialised.

Bradley Short-lived strain developed as cover for white clover seed crops, sold by A. W. and W. Bradley, Courtenay, Canterbury, trading as Bradcorp International. This variety did not become available in time to be included in the field trial or the vernalisation experiments.

## METHODS

### Field trial

A randomised spaced-plant trial with 50 plants per variety was started at Grasslands

Division, Palmerston North, in autumn 1986. From this were obtained measurements of heading date, morphological characteristics, spring growth and autumn vigour. All culm, flagleaf and spike measurements were based on one well-developed culm chosen at random per plant. Leaf measurements were based on one well-developed tiller leaf per plant, similarly chosen. Plants were not grazed at any stage in the 12 months of the trial, and cut only once in mid summer following flowering to determine degree of aftermath heading and autumn vigour.

**Rate of heading in controlled photoperiods following vernalisation**

Seed was vernalised at 0°C for 10 weeks, after which 36 plants per variety were grown until they headed in 14-hour days at 20°/15°C in growth rooms at the Controlled Climate Laboratory, Plant Physiology Division, DSIR, Palmerston North. This work is more fully described by Halligan ef al. (in prep).

**Heading after spring sowing**

Sixty-four seedlings of each variety were sown in boxes in a glasshouse at Grasslands Division, DSIR, Palmerston North, in September 1986. Plants were scored as they headed and removed when the tip of the first spike was visible. The experiment was terminated at the end of January 1987 although additional plants were still slowly coming to head.

**Seed characteristics**

Percentage germination was determined at constant temperatures of 5°C, 20°C and 30°C. One hundred and fifty seeds per line at each temperature were germinated and seedlings counted and removed regularly for 25, 16 and 8 days at 5, 20 and 30°C respectively. Germination profiles (% germination over time) and, from these, time to reach an arbitrary 80% germination were determined for each ryegrass seed line. The proportion of seedlings with fluorescent roots under UV illumination was determined using 100 seeds per variety at 20°C.

Percentage of seeds infected with *Acremonium* was determined by scoring 50 seeds per line for the presence of mycelium, following the method described by Latch et al. (1987a). One or more recent lines of each variety were tested. Viability of the endophyte was not examined.

**Electrophoresis of seed proteins**

Sodium dodecylsulphate (SDS) gel electrophoresis of ground bulked seed samples was used to prepare protein banding patterns that characterised each variety. The general procedure for extraction of proteins from a seed meal and then separation by SDS gel electrophoresis has been described in detail by Gardiner et *al.* (1986), and the modifications to the method used in the present study are outlined in Forde and Gardiner (this Proceedings).

## RESULTS AND DISCUSSION

**Heading after spring sowing**

Table 1 clearly confirms Tama, Progrow, Rakaia and Bradley to be Westerwolds varieties, although none headed completely before the experiment was terminated. Low % heading in other varieties show that Westerwolds and non-Westerwolds varieties are not sharply differentiated, and that given time all Italian ryegrasses will begin to head without vernsalisation.

**Field trial**

Discontinuous groupings of NZ-based Italian ryegrasses were not apparent on this single spaced plant block (tables 2 and 3). Rakaia and Progrow, from the South Island, behaved as Westerwolds varieties and most plants died after heading. The other Westerwolds variety (Tama) was also at the lower end of the range for aftermath heading and autumn vigour, but did not differ significantly from either Lemtal or Manawa (tables 2 and 3).

The only other character for which Tama, Rakaia and Progrow were grouped at the extreme of the range was for number of florets per spikelet (table 3).

Table I: Indoor heading behaviour of NZ varieties of Italian ryegrass, first following spring sowing and second under 14h photoperiod at 20/15°C following 10 weeks vernalisation.

| | Following spring sowing | Under 14h photoperiod following vernalisation | | | |
|---|---|---|---|---|---|
| | % plants heading | Mean (and SD) days to heading | | Days to 50% heading | Days to 100% heading |
| Rakaia | 62 | 28.6 | (8.5) | 27 | 49 |
| Progrow | 58 | 29.2 | (5.2) | 28 | 41 |
| Tama | 73 | 29.9 | (5.8) | 29 | 42 |
| Bradley | 46 | - | | | |
| Te Rahu | 12 | 35.4 | (5.4) | 35 | 46 |
| Lemtal | 6 | 39.8 | (7.2) | 39 | 64 |
| Te Puna | 12 | 41.6 | (8.2) | 42 | 66 |
| Concord | 3 | 43.6 | (6.1) | 42 | 62 |
| Manawa | | 45.7 | (7.2) | 47 | 58 |
| Paroa | | 52.8 | (10.2) | 54 | 78 |

Table 2: Performance of NZ varieties of Italian ryegrass: vegetative characters in the field

| | Tiller leaf | | Plant | | Spring | Growth habit | | Rust | Autumn |
|---|---|---|---|---|---|---|---|---|---|
| | length (cm) | width (mm) | diam. (cm) | height (cm) | growth (0-5) | Pre-heading (1-5) | Post heading (1-5) | score (0-4) | Vigour (0-5) |
| Moata | 23.6 | 7.6 | 25.0 | 23.3 | 3.7 | 2.4 | 3.3 | 2.5 | 3.6 |
| Concord | 18.7 | 6.8 | 24.1 | 26.5 | 3.3 | 2.8 | 3.7 | 1.7 | 3.3 |
| Te Rahu | 19.2 | 6.6 | 25.5 | 26.4 | 3.6 | 2.8 | 3.6 | I.2 | 3.0 |
| Paroa | 18.5 | 7.0 | 22.8 | 22.7 | 3.4 | 2.6 | 3.2 | 2.8 | 2.4 |
| Te Puna | 16.3 | 6.4 | 22.9 | 18.8 | 3.1 | 2.5 | 3.1 | I.o | 2.8 |
| Manawa | 15.6 | 5.5 | 22.7 | 16.6 | 2.9 | 2.2 | 2.9 | 1.0 | 2.2 |
| Lemtal | 17.6 | 6.2 | 17.2 | 23.4 | 2.9 | 2.4 | 3.7 | 2.7 | 1.9 |
| Tama | 18.0 | 6.9 | 22.9 | 26.4 | 3.5 | 2.7 | 3.8 | 2.8 | 2.2 |
| Progrow | 17.0 | 6.2 | 25.6 | 20 .a | 3.5 | 2.2 | 3.1 | 3.1 | 0.4 |
| Rakaia | 1 7 . 2 | 6.3 | 25.2 | 19.5 | 3.2 | 2.2 | 3.2 | 4.2 | 0.0 |
| LSD | I.5 | 0.5 | 2.3 | 2.8 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 |

Table 3: Performance of NZ varieties of Italian ryegrass: reproductive characters in the field

| | Flag leaf | | Culm | Nodes | Spike | Spikelets | Florets | Heading | Aftermath |
|---|---|---|---|---|---|---|---|---|---|
| | length (cm) | width (mm) | length (cm) | /culm | length (cm) | /spike | /spikelet | date[1] | heading % |
| Moata | 23.2 | 9.6 | 78 | 6.2 | 36.5 | 33.6 | 10.0 | 21.4 | 76 |
| Concord | 16.9 | 7.3 | 77 | 5.4 | 29.9 | 31.3 | 10.2 | 19.0 | 62 |
| Te Rahu | 16.9 | 7.0 | 67 | 5.1 | 29.0 | 29.6 | 9.8 | 16.9 | 88 |
| Paroa | 18.1 | 8.0 | 66 | 5 6 | 26.8 | 28.3 | 10.5 | 18.4 | 76 |
| Te Puna | 17.1 | 7.3 | 63 | 4.5 | 28.2 | 27.8 | 9.9 | 12.9 | 98 |
| Manawa | 17.3 | 6.7 | 62 | 4.6 | 29.3 | 27.9 | 10.4 | 15.5 | 68 |
| Lemtal | 16.8 | 6.6 | 60 | 4.9 | 25.8 | 24.8 | 8.6 | 18.8 | 68 |
| Tama | 18.6 | 7.8 | 73 | 6.1 | 28.4 | 30 0 | 11.8 | 18.1 | 58 |
| Progrow | 17.9 | 6.8 | 66 | 4.6 | 29.6 | 28.1 | 10.6 | 13.1 | 30 |
| Rakaia | 17.6 | 7.3 | 68 | 4.8 | 29.5 | 29.2 | II.3 | 10.3 | 16 |
| LSD | 1.78 | 0.63 | 5 | 0.69 | 2.6 | 2.4 | 1.o | 2.3 | 16 |

[1] Days from 31 October

Lemtal and Manawa, both considered to be persistent ryegrasses, are notable in that they fell into the lowest groupings of lines for all vegetative and floral characters. These two lines differed significantly in that Lemtal was more erect, taller and more susceptible to crown rust *(Puccinia coronata)* than Manawa, the most prostrate and shortest of all lines tested

(table 2). Te Puna, despite its similarity to Manawa for all characters throughout the experiment, was more vigorous at the end of the trial (autumn) and had a greater degree of aftermath heading, compared with Manawa.

At the other extreme, Moata stood out as having significantly longer and broader tiller and flag leaves, and longer spikes than any other variety. It also had longer culms, more leaves/culm and spikelets/spike and greater spring growth than most other lines (tables 2 and 3). However, the two North Island varieties, Te Rahu and Concord, were more erect and significantly taller and freer of crown rust than Moata.

The other variety tested, Paroa, fell into the groupings for larger plant size, leaf size and number of leaves/culm and florets/spikelet but like its derivative Moata was only semi-erect, of medium height and moderate rust susceptibility.

The degree of crown rust infection in early summer sorted the Italian ryegrasses into four distinct categories: relatively rust free (Te Puna, Manawa and Te Rahu), some rust (Concord), moderately rusty (Moata, Lemtal, Tama, Paroa, Progrow) and very rusty (Rakaia) (table 2). The lines originating in the Waikato/Bay of Plenty were significantly freer from rust in this trial than the South Island lines.

Heading date in the field for the bred cultivars fits the established pattern (Anon 1982): Moata was later than all other Italian ryegrasses, 3 or 4 days after Paroa, which was slightly later (here 3 days) than Manawa (table 3). Rakaia stood out from all others as earliest to head, with heading date (early November) comparable with the early perennial ryegrasses, Nui and Ruanui. Between Moata and Rakaia are three overlapping groups: Te Puna and Progrow were early to flower, followed by Manawa and Te Rahu, and then a later group comprising Tama, Paroa, Lemtal and Concord.

It must be emphasised that these data are derived from spaced plants in experimental situations, and that persistence, rust infection, heading time and morphological characteristics will vary according to season, area and conditions of growth.

**Electrophoresis of seed proteins**

All the varieties shown in figure 1 are distinguishable by differences in the occurrence of one or more seed protein bands. The three South Island varieties (Progrow, Rakaia and Bradley) have very similar banding patterns, however, as do Concord and Te Puna. Paroa and Lemtal are clearly distinct from all the New Zealand-based varieties. The "perennial band" characteristic of perennial ryegrass is particularly prominent in Lemtal, Manawa and Te Rahu but faintly present in all varieties except Paroa, Moata, Tama and Bradley, attesting to the long history of deliberate or accidental hybridism between the two species (and perhaps to the frequent inclusion of Manawa in pasture mixes). Its presence may be interpreted as an indicator of persistence (eg in Manawa) but the correspondence is not perfect; for example, despite a fairly strong perennial band, Progrow behaves as a Westerwolds ryegrass.

**Rate of heading in controlled photoperiods following vernalisation**

The heading behaviour of the NZ Italian ryegrasses in the growth room differed from that in the field. First, the range in mean heading date was extended to 26 days (table 1) compared with only 11 days in the field. Second, rank order of heading differed. Under the controlled conditions (14h photoperiod at 20/15°C), Rakaia, Progrow and Tama headed early. The remainder were intermediate between Tama and Paroa, the last to reach 50% heading, but did not form discontinuous groupings. Mean and 50% heading were similar, but changes in ranking of varieties for 100% heading indicate that late-heading stragglers occurred in some varieties. Three plants of Paroa completely failed to head and were excluded.

**Seed characteristics**

At all three temperatures, Concord and Te Rahu were first to germinate (table 4). Grasslands Division cultivars based on overseas material were consistently slow at all

MAN CON TE P TE R PAR LEM MOA RAK PRO BRA TAMA

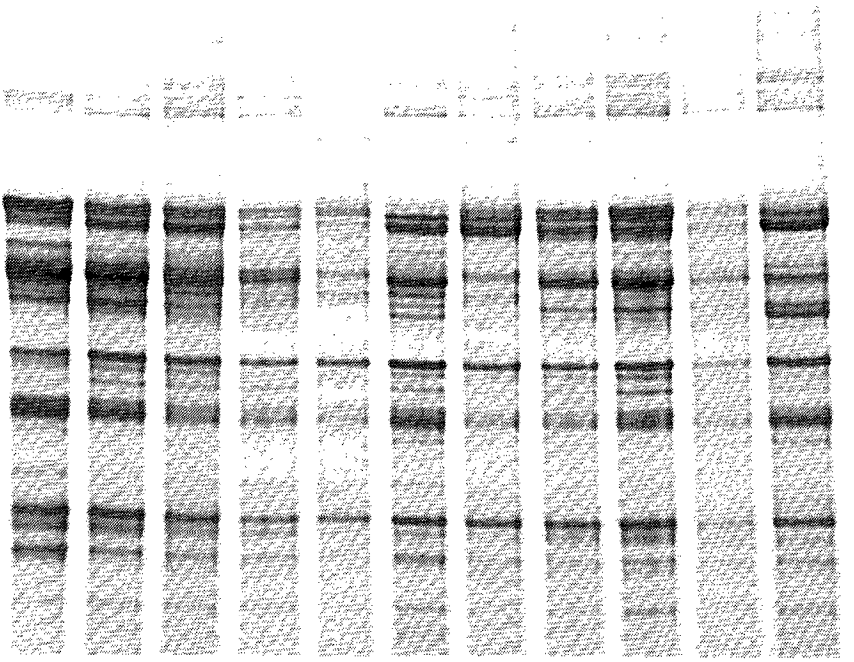

Figure 1' Seed protein banding patterns of different varieties of Italian ryegrass following SDS-polyacrylamide gel electorphoresis. Varieties shown are Man, Manawa; Con, Concord; Te P, Te Puna; Te R, Te Rahu; Par, Paroa; Lem, Lemtal; Moa, Moata; Rak, Rakaia; Pro, Progrow; Bra, Bradley; Tama.

Table 4: Seed characteristics of NZ varieties of Italian ryegrass

| | Hours to 80% germination at 3 temperatures | | | Fluorescent seedlings | Endophyte infection % seeds infected |
|---|---|---|---|---|---|
| | 8°C | 20°C | 30°C | % | |
| Moata | 285 | 94 | 74 | 97 | 0 |
| Te Puna | 263 | 72 | 91 | 98 | 35 |
| Paroa | 358 | 71 | 62 | 97 | 0 |
| Manawa | 316 | 69 | 56 | 99 | 47 |
| Tama | 389 | 68 | 72 | 100 | 0 |
| Lemtal | 246 | 56 | 47 | 100 | 0 |
| Rakaia | 252 | 52 | 48 | 95 | 20 |
| Progrow | 277 | 51 | 48 | 100 | 80 |
| Bradley | 224 | 49 | 48 | 100 | 0 |
| Concord | 196 | 44 | 38 | 98 | 61 |
| Te Rahu | 162 | 41 | 35 | 99 | 40 |
| Ruanui | — | — | — | 0 | — |
| Nui | | | | 0 | |

— not included

' 1960s nucleus lines of Paroa have 20-55% infection

temperatures. The South Island lines (Progrow, Bradley and Rakaia) and Lemtal were intermediate between these two groups. Te Puna varied in its response, being amongst the slowest at the higher temperatures and intermediate at 8°C.

All NZ Italian ryegrasses, including the hybrid Manawa, have a very high proportion of seedlings with fluorescent roots, in contrast to the perennial ryegrass lines included as controls.

Table 4 shows that seeds of Paroa, Moata, Tama, Lemtal and Bradley are totally free from *Acremonium* endophyte. Examination of older seed lines of Paroa show that this variety originally contained endophyte however, and has presumably lost it during seed storage. The same is probably true of Bradley, as all other varieties based on local NZ material are infected. The *Acremonium* endophyte in Italian ryegrasses is different from A. *lolii* in perennial ryegrasses. A comparison of the two fungi is made by Latch *et al.* 1987b.

## CONCLUSIONS

South Island varieties are short lived, do not require vernalisation for high % heading and head early.

Two varieties from dairy pastures in the North Island from which hay crops have been regularly taken tend to be erect, tall and large with large leaves, are relatively free of rust, have high levels of aftermath heading and very rapid seed germination. A third does not conform to this pattern, however.

Moata tetraploid Italian ryegrass stands out for the size of both plants and leaves and for its spring and autumn vigour. It was consistently larger than Tama, the other tetraploid variety.

Varieties of NZ origin, except Bradley, are high in *Acremonium* endophyte whereas those bred from overseas material are without endophyte.

All varieties studied can be identified by their seed protein banding patterns and most show evidence of introgression from perennial ryegrass.

Manawa hybrid ryegrass is not markedly different from some of the persistent Italian varieties.

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