

Annual and hybrid ryegrass cultivars in New Zealand

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Abstract

Results are presented for 16 National Forage Variety Trials of annual and short-term hybrid ryegrass cultivars conducted in Waikato, Taranaki, Manawatu, Canterbury and Southland. In all, 30 cultivars (17 named, 13 experimental) were included. Cultivar effects were significant in all seasons, and for the annual totals. Cultivar differences were greatest in summer. Spring production accounted for over 40% of annual totals and summer production less than 20%, but it was summer production that was more closely correlated with the individual cultivar annual total. Over all trials and cultivars, regrowth in the second autumn accounted for 11% of the total for 12 months beginning in the winter following sowing. Comparing North Island sites with Canterbury sites, there was some indication of cultivar × region interaction, particularly in summer. Patterns of interaction of cultivars with trials were examined, and indicated that some cultivars can be grouped as having similar responses. Repeated trials at the same site were sometimes but not always consistent in ranking cultivars. The results indicate that some cultivars do perform consistently better than others, for particular seasons or for annual totals, so that the trials are a reliable indicator of which new experimental cultivars should be released to the market. The results also indicate that several trials are necessary to determine the merit of a well-

performing cultivar. The error associated with the mean of cultivars present in only one or two trials is high (standard deviation approaching 20% of the mean in some seasons). This may, however, be sufficient to eliminate poorer experimental lines from further consideration.

Keywords: Italian ryegrass, hybrid ryegrass, cultivars, *Lolium* × *boucheanum*, *Lolium multiflorum*, pasture agronomy

Introduction

Italian ryegrass (*Lolium multiflorum* Lam.) has been used in New Zealand since pastures were first sown. Short-term hybrid ryegrasses (*L.* × *boucheanum* Kunth.) were identified among New Zealand seed stocks in the 1920s (Levy & Davies 1929). Just under 3000 tonnes of seed of these two groups together are currently certified annually in New Zealand (MAF 1997), compared with nearly 12 000 tonnes of perennial ryegrass. They are sown either in specialist short-term pastures, or included in perennial pasture seed mixtures, to provide a good bulk of quality feed in the first winter.

Levy and colleagues studied seed sources of pasture species available in New Zealand in the 1920s. Almost no genuine Italian ryegrass lines were found in commerce (Corkill 1949). Imported varieties of Italian ryegrass proved to be superior to material then available in New Zealand (Levy & Saxby 1933), and after the introduction of a certification system in 1929/30, the best imported

varieties were multiplied under certification. A selected pedigree strain of Italian ryegrass was first certified in New Zealand in 1938, and it proved to be superior to existing certified commercial strains (Corkill 1949).

Levy and co-workers did not identify any naturally evolved populations of Italian ryegrass in commerce, but noted that good populations persisted by natural reseeded in some New Zealand pastures (Levy 1932). Valuable sources have more recently been shown to exist (Burgess & Easton 1986), and cultivar (cv.) Concord was the first Italian ryegrass cultivar to be developed from material naturally adapted to New Zealand conditions.

Natural populations of ryegrass in New Zealand show varying degrees of hybrid origin between the Italian and perennial species (Levy & Davies 1929). Forde *et al.* (1988) compared descriptive traits of Italian ryegrass cultivars. They found the Te Puna ecotype (from which cv. Corvette was derived) to be similar in most descriptive characters to Grasslands Manawa hybrid ryegrass. They also noted, however, that their results showed no clear discontinuities in the range of cultivars examined. While some sources and cultivars are clearly distinct from Italian ryegrass, the classification of others as either Italian or hybrid ryegrass does not secure unanimity.

Italian ryegrass cultivars from overseas were compared by Rumball & Armstrong (1975) who concluded that none were superior to New Zealand cultivars. This situation remains generally true (unpublished data), and only one imported cultivar is currently marketed in New Zealand.

Forde *et al.* (1988) found that New Zealand ecotypes and cultivars developed from them tended to be faster to germinate and establish than cultivars developed from imported material. These same ecotypes and cultivars were infected with the Italian ryegrass endophyte (Latch *et al.* 1988). Examination of old seed of Grasslands Paroa showed that this cultivar had also once been infected with endophyte.

Hickey & Baxter (1989), Hume & Hickey (1989) and Hickey & Hume (1994) compared cultivars grown at Gore and Palmerston North. All cultivars persisted better in the summer-moist conditions of Southland, but the yield and persistence of cv. Concord and cv. Corvette (classified as hybrid by these authors) relative to

those of Paroa and Grasslands Moata were greater at Palmerston North than at Gore.

The New Zealand Plant Breeding and Research Association co-ordinates co-operative trials (National Forage Variety Trials) comparing commercial and experimental cultivars of Italian and short-lived hybrid ryegrasses at a range of sites throughout New Zealand. This paper presents results from 16 trials carried out from 1990 to 1996.

Materials and methods

Trials are listed in Table 1 with location, sowing date, number of entries and management.

Trials were sown into well prepared seed-beds on land immediately out of a non-ryegrass crop, or which had been rigorously controlled over the previous season to prevent any return of ryegrass seed to the soil. Base fertiliser was applied to each trial as indicated by soil analysis. Plot size varied between trials, being largest in trials grazed by cattle, but was at least 3.6m × 0.75m in all trials. Where necessary, volunteer species were controlled by herbicide. All trials were laid out as randomised complete blocks, with cultivar the only factor.

Table 1 List of trials with management details.

Trial	Location	Sowing date	No harvests	Management	No entries
A291 HOD	Canterbury	13.3.91	6	mown	7
A291 PAL	Manawatu	13.3.91	6	mown	10
A291 PGG	Canterbury	18.3.91	8	mown	10
A291 RUK	Waikato	21.3.91	10	mown	7
A292PGG	Canterbury	12.3.92	8	mown	13
A292RUA	Waikato	13.3.92	13	mown	11
A293GOR	Southland	10.3.93	19*	mown	9
A293 PGG	Canterbury	17.3.93	7	mown	12
A293RUA	Waikato	23.3.93	12	mown	11
A294KIM	Canterbury	1.3.94	10	mown	11
A294NOR	Taranaki	21.4.94	9	mown	8
A294RUA	Waikato	14.3.94	12	grazed cattle	12
A295GOR	Southland	7.3.95	11	mown	4
A295KIM	Canterbury	22.2.95	12	mown	11
A295NOR	Taranaki	23.3.95	8	mown	5
A295RUA	Waikato	14.3.95	10	mown	12

1 Trial ran for two years

Table 2 Cultivars tested, with number of trials in which each was present.

Cultivar	No. trials	Cultivar	No. trials	Cultivar	No. trials	Cultivar	No. trials
AGR902	4	Cordura	8	Flanker	7	Moata	9
AGR906	3	Corvette	15	Galaxy	8	NZALM28	5
Atlantis	3	CS3566	2	Geyser	12	NZALM37	3
Concord	16	Decanter	2	12	2	PG19	1
Conker	7	Eclipse	4	Maverick Gold	1	PG201	1
Conquest	6	Exalta	16	Maxima	1	PG202	1
						VP61	1

A total of 30 cultivars (some in commerce, others experimental) were examined in the trials (Table 2). In North Island and Canterbury trials, but not in Southland, Ceres Geyser and Ceres Galaxy were infected with the endophyte, *Neotyphodium lolii*, typically associated with perennial ryegrass. Two cultivars were present in all trials, and another 9 were present in 6 or more trials. Seven cultivars were present in only one trial.

Seed was supplied by owners or licensees of the cultivars. Seed was drilled into plots or broadcast and covered. Trials were visited by representatives of interested parties soon after establishment to maintain confidence that emergence was satisfactory.

A standard management protocol was followed, requiring adjustment of sowing rate to give equivalent weight of viable seed per m², with a 30% increase for tetraploid cultivars. Trials were harvested when heaviest plots carried between 2000 and 3000 kg DM/ha, and nitrogen was applied after each harvest at 3% of mean dry matter removed from the highest-yielding cultivar at the time. Plots in one Waikato trial were grazed as quickly as possible by fasted animals. Elsewhere, they were mown off. All trials were sown in autumn and ran for 15 months, except for one trial at Gore, Southland, which ran for an extra year. Data from the second year were not included in the analysis presented here. Dry matter production was measured directly by cutting, or assessed by appropriately calibrated capacitance probes.

Each trial was analysed using GENSTAT, analysing first for harvest and replicate, and then for cultivar within harvest. Data were then combined and analysed across all trials, with estimation of adjusted means for cultivars. Harvests were combined within seasons to give an establishment total and four seasonal totals. Yields for harvest periods straddling seasons were assigned according to the number of days in each season. Trials were assigned to three regions (North Island, Canterbury, Southland) and data were analysed for interactions between cultivar and region. Finally, cultivars and trials were clustered into dendrogrammes to indicate which cultivars were most similar in their performance across trials, and which trials were most similar in their annual and seasonal ranking of cultivars.

Results

Trials were run very satisfactorily, with coefficients of variation for individual harvests generally no larger

than 15%. Cultivars present in 6 or fewer trials had standard errors of overall mean at least twice those of cultivars present in most trials. Cultivars present in only one trial had standard errors of mean of 10% for winter and spring production, 20% for summer and 30% for autumn. Only cultivars present in 6 or more trials are shown in Tables 3 and 4.

Table 3 Cultivar mean total yields and seasonal means % of mean yield. All trials combined. Cultivars present in less than 6 trials not included.

Number of trials	Establishment	second				Total	Total
		winter	spring	summer	autumn		
Concord	16	110	96	94	97	103	12823
Conker	7	99	99	96	98	98	12977
Conquest	6	101	94	89	86	93	11965
Cordura	8	100	99	107	125	126	14848
Corvette	15	101	109	110	113	108	14706
Exalta	16	99	107	102	81	54	12456
Flanker	7	106	105	107	119	119	14732
Galaxy	8	91	103	107	127	140	15184
Geyser	12	89	92	98	114	121	13665
Moata	9	95	98	100	82	76	12393
Progrow	7	108	97	90	59	61	10830
Mean yield kg DM/ha		1960	3008	5970	2900	1448	13325
% of total		23	45	22	11		

Table 4 Relative mean summer yields of cultivars in different regions % of regional mean.

	Southland	Canterbury	Nth Island	Overall
Concord	101	112	79	98
Conker	93	107	78	94
Conquest		112	57	92
Cordura	111	113	138	120
Corvette	106	100	130	112
Exalta	103	73	73	82
Flanker		105	138	116
Galaxy	107	112	150	122
Geyser	88	108	140	113
Moata	90	89	77	85
Progrow		69	41	65

Cultivar effects were significant across harvests in all trials, and cultivar × harvest interactions were significant in all trials but one. When all trials were analysed together, cultivar effects were significant in each season (Table 3), and there was a significant cultivar × season interaction.

In the establishment period (up to the end of May in the year of sowing), in winter and in spring, the

range of performance was much the same, some cultivars producing 25% more than others. In summer and autumn, the stronger cultivars yielded twice as well as the weakest cultivars. Spring yield accounted for 45% of the total after the establishment period and summer only 22%, but cultivar spring yield was not as highly correlated with the annual total as was summer yield. Summer yield was correlated with spring and autumn yields, and these seasons were correlated with the annual total. Winter yield was correlated with spring yield. Yield in the establishment period was not correlated with any other season. Yield in the autumn 12 months after sowing accounted on average for 11% of total yield after the establishment period.

Region effects were significant in all seasons against residual error, but were greater than trial-within-region effects only in summer. Cultivar \times region effects were significant against residual error, only after removal of trial-within-region effects, in spring, summer (Table 4) and annual totals, but not for establishment, winter or the second autumn.

The dendrogramme of trials (Figure 1) produced by the clustering exercise did not clearly group trials within a region or consistently group trials at one site. It identified the single trial in Manawatu (Palmerston North) as the most distinct from all others. A peculiarity of this trial was very good performance by cv. Exalta, particularly in summer. The clustering of cultivars (Figure 2) separated the erect open cultivars Exalta and Grasslands Moata from the others and from each other, and placed the Westerwolds cultivar Ceres Progrow with an experimental line NZALM28 but distinct from others. Concord, Conquest and Eclipse were grouped together, while Corvette, Galaxy, Cordura and Flanker were identified as another group. Note, however, that no assessment of statistical significance can be made for these observations.

Discussion

Yield in agronomic trials is an indicator of the ability of a cultivar to provide nutrition for the maintenance, growth and milk production of livestock. Kilograms of dry matter per hectare do not necessarily translate into livestock production (Thom & Bryant 1996), and yield data must be interpreted according to the seasonal needs of a particular livestock enterprise.

The data show the value of a network of trials, in giving confidence in the seasonal and total yield of new cultivars about to be commercialised. Four to six trials could indicate a promising trend of a new cultivar to yield well relative to a control, and justify commercialisation. In a few cases, one or two trials were sufficient to indicate that an experimental cultivar did not merit further examination. Farmers should not

Figure 1 Dendrogramme grouping trials according to similarity of cultivar performance.

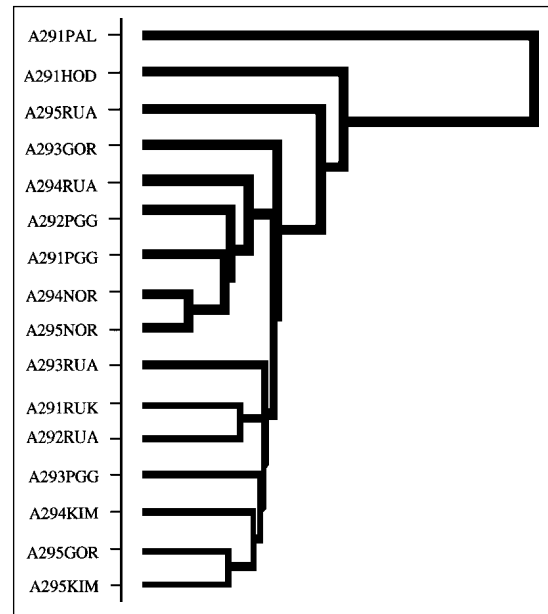
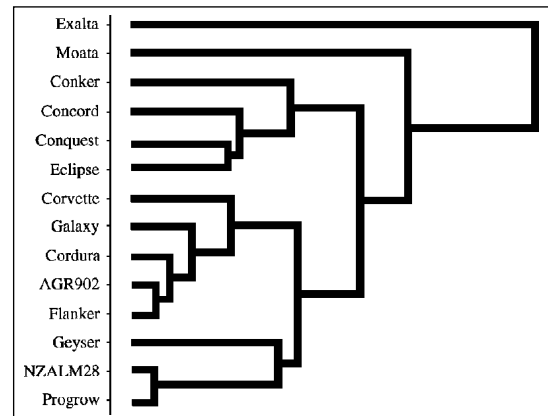


Figure 2 Dendrogramme grouping cultivars according to performance across trials.



accept the value of a cultivar on the basis of one or two trials.

The failure of the clustering analysis to clearly associate trials from the same region indicates that the national mean performance may be of more value to a farmer in indicating performance than a small number of trials within a district.

The data also indicate that progress has been made in improving Italian and short-term hybrid ryegrasses. When Moata was developed it was clearly superior to

any other Italian ryegrass material available (Armstrong & Rumball 1975, who refer to it as G4709). Almost all cultivars in Table 3 out-yielded Moata, with most of the improvement in summer and autumn. Corkill (1950) reported seasonal yields of pedigree strains of Italian ryegrass, and showed summer yield as less than one third of that in the spring. Table 3 indicates that there has been significant progress in this respect.

The interaction of cultivar and season is seen in the relative seasonal performance of different cultivars. Conker yielded close to the mean in all seasons. Exalta, Moata and especially the Westerwolds cultivar Ceres Progrow, performed relatively better in winter and spring than in summer and autumn, whereas Cordura, Flanker, Ceres Galaxy and Ceres Geysler yielded relatively much better in summer and autumn than they did in the earlier seasons. Endophyte infection of these last two may have afforded resistance to insect pressure (Prestidge *et al.* 1994) and contributed to their summer and autumn performance. A choice of infected or uninfected seed lines of these cultivars is available in commerce. Corvette yielded well in all seasons, but while it was top of the trial in winter and spring, it was outperformed by four other cultivars in summer and autumn. In absolute terms, all cultivars produced more herbage in spring than in other seasons.

There is a range of nearly 20% between cultivars in mean spring yield over all trials. Yields in other seasons are lower than in spring, but there is a greater range, particularly in summer and the second autumn. Cultivars should be chosen for the strengths which meet the needs of a particular farm operation. In this set of data, Concord showed particularly good establishment and Exalta performed better in winter than in other seasons. Generally, however, summer and autumn were the seasons which separated the cultivars.

Some differences in regional adaptation for summer production are evident (Table 4), with Concord, Conker and Conquest performing relatively better in Canterbury, while Cordura, Corvette, Flanker, Galaxy and Geysler performed relatively better in the North Island.

The clustering of cultivars (Figure 2) is of interest. Concord, Conquest and Eclipse are related. Cordura is derived from Corvette and, like Corvette, Flanker is derived from ecotype material from the Waikato–Bay of Plenty area. These common origins are reflected in similar patterns of performance across the trials.

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