Proceedings of the New Zealand Grassland Association 44: 81–90 (1983)

A COMPARISON OF PERENNIAL GRASSES UNDER SHEEP GRAZING ON THE CENTRAL PLATEAU

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Abstract

Details are given on the production and survival over four years of five perennial grasses under rotational sheep-grazing on a pumice soil. The comparison involved three perennial ryegrasses ('Grasslands Nui and Ruanui', and Yates Ellett), and mixtures of Ellett with 'Grasslands Roa' tall fescue and Ellett with 'Grasslands Maru' phalaris. All pastures were sown with white and red clovers.

Annual dry matter yields from Nui and Ellett pastures were similar, at about 6,500 kg/ha. Ruanui pastures were on average 800 kg/ha lower. The pastures containing tall fescue and phalaris were similar to Ellett. The major seasonal yield effects were in autumn and winter, when Ruanui pastures *were* substantially poorer than those with Nui and Ellett.

Ryegrass yield of Ellett pasture was greater than Nui, and Nui was greater than Ruanui at all seasons. Ellett ryegrass was a higher proportion of the total yield at all times, and had higher tiller populations than Nui and Ruanui. Neither tall fescue or phalaris *were,* able to compete with Ellett ryegrass. It is suggested that neither of these be sown with ryegrass. Clover yields were higher in Ruanui than Ellett pastures, with Nui intermediate.

The use of Nui, Ellett and Ruanui ryegrasses is related to the problems of seasonal distribution and total annual yields of pastures on the Central Plateau. It is suggested using Nui or Ellett as the base for perennial pastures will give substantial increases in production. Ellett ryegrass had higher survival than Nui which was considered an advantage, though this was achieved at the expense of a small reduction in clover yields.

Keywords: Perennial ryegrass, Ellett, Nui, Ruanui, Roa tall fescue, Maru phalaris, canary grass, sheep grazing, central North Island, Central Plateau, grass grub, Argentine stem weevil, *Lolium endophyte.*

INTRODUCTION

Since the 1930's about 350,000 ha of pumice soils have been developed for farming in the Bay of Plenty and Central North Island. Much of this land was developed by government departments, and a typical seed mixture included perennial and hybrid ryegrasses *(Lolium spp),* cocksfoot *(Dactylis glomerata),* timothy *(Phleum pratense),* crested dogstail *(Cynosurus cristatus),* white clover *(Trifolium repens),* and red clover *(T. pratense)* (R.G.Ashton *pers comm).* Most of the grass components have persisted poorly, and are present only as sub-dominants. Currently, the major grass components of pastures on the Central Plateau are browntop *(Agrostis tenuis),* Yorkshire Fog *(Holcus lanatus),* sweet vernal *(Anthoxanthum odoratum),* and goose grass *(Bromus mollis)* (N.S. Percival, unpublished data). The comparatively low content of cool season active grasses such as perennial ryegrass *(Lolium perenne)* results in a seasonal distribution of growth that is poorly matched to the feed requirements of most farms. The dominance of the lower fertility/annual grasses is considered a major constraint to farmers increasing livestock numbers.

In some districts the pasture problems have been accentuated by severe infestations of grass grub *(Costelytra zealandica)* (Gordon & Kain 1972). In the absence of economically viable insecticides for control, the use of grasses and legumes tolerant to grass grub is an attractive option. An extensive programme of pot and field trials showed that tall fescue *(Festuca arundinacea)* and phalaris *(Phalaris aquatica)* were relatively tolerant of high grass grub populations (Kain & Atkinson 1977, East *et a/* 1979). The major response by farmers to the problems of low yields from pasture and its seasonal distribution has been sowing large areas in lucerne (Mace 1979). Lucerne yields are high compared with pasture (McQueen & Baars 1979), and it is also resistant to grass grub (Kain & Atkinson 1970). However, a major limitation of lucerne is the poor cool season growth of most cultivars.

In the early 1970's 'Grasslands Nui' and Yates Ellett perennial ryegrasses became commercially available. In a number of trials in other districts of New Zealand these have shown greater productivity than Grasslands Ruanui perennial ryegrass (Cumberland & Honore 1970, McLeod 1974, Goold 1982, F.R.Duder, unpublished data). Visual observations in the Taupo area from early sowings of both Nui and Ellett pastures indicated they were more productive than Ruanui (R.B.Gordon *perscomml.*

The trial was sown in spring 1977 to provide field data on the productivity and persistence under grazing of two new perennial ryegrass cultivars, and also the grass grub tolerant species, tall fescue and phalaris. A preliminary report of the trial was given by Brown (1979).

METHODS

Site

The trial was located at Tihoi (lat. 38° 35'S:490 m asl : 30 km north-west of Taupo) on Oruanui sand, a coarse rhyolitic pumice soil (typic Vitrandept). Mean annual rainfall recorded on the farm from 1977-81 was 1528 mm (1173-1767), of which 26% fell in spring, 21% in summer, 21% in autumn and 32% in winter. Mean daily temperatures between 1978 and 1981 from the two nearest climate stations (Taupo at 407 m asl and Pureora at 549 m asl) were 16.1°C maximum, 6.5°C minimum and 3.9°C grass minimum. The site had been developed by the Department of Lands and Survey from scrub around 1950, and subsequently settled as a private farm.

Establishment and Treatments

The trial was sown on September 20, 1977 into cultivated ground immediately out of a swede forage crop. The area had been in pasture for a number of years previously. Plots were 67.5 x 9.5 m. Five pasture mixtures were sown with a deep V ring roller drill. The following grasses were sown:

'Grasslands Ruanui' ryegrass (27 kg/ha)
'Grasslands Nui' ryegrass (19 kg/ha)
Yates Ellett ryegrass (23 kg/ha)
Ellett ryegrass (8 kg/ha) + 'Grasslands Roa' tall fescue (9 kg/ha)
Ellett ryegrass (8 kg/ha) + 'Grasslands Maru' phalaris (6 kg/ha)

All grasses were sown with 'Grasslands Huia' white clover (2 kg/ha) and 'Grasslands Hamua' red clover (1 kg/ha). In October 1977, the trial was top-dressed with 15% potassic serpentine superphosphate (1000 kg/ha) and lime

(1250 kg/ha) The area was treated with Lindane prills (11 kg/ha) for grass grub control during the establishment phase. A randomised block design with four replicates was used.

Management

Rotational grazing was practised throughout, mainly with ewes. The first grazing was in November 1977. Drought conditions prevailed through the summer of 1977/78, during which time there were three light grazings.

The grazing period was usually two days. Mob size was generally between 1500-2000 ewes, at a stock density of 300-400/ha/day. In most years there were eight grazings. The mean grazing intervals were: autumn 42, winter 106, spring 32, and summer 35 days, Pastures were generally grazed down to 3-4 cm. Plots, were not fenced individually. Selective grazing effects were minimised by the long rotations, short grazing duration and high utilisation.

Annual topdressing with 375 kg/ha 30% potassic serpentine superphosphate (applied in autumn) maintained soil fertility at a level comparable with the surrounding district. Mean levels from three soil tests were pH 5.2, Ca 3, K 6, P 34 and Mg 8. In addition the area received 250 kg/ha sulphate of ammonia in August 1978, 125 kg/ha calcium nitrate in July 1979 and 22 kg/ha calcined magnesite in January 1980.

Measurements

In the first year pasture yields were measured by cutting three or four $4.5m^2$ strips from each plot to 4 cm. The sampled areas were not pretrimmed to a standard height, and as such represented 'feed on offer'.

From April 1979 until May 1982 each plot was divided into two and an alternate cutting and grazing technique used (Lynch 1966). Yield sampling strips ($2 \times 5.4\ m^2$) were pretrimmed to 3.5 cm after grazing. Botanical composition of individual plots was determined on random samples taken from the side of the yield measurement strips with handshears. These were separated into the major botanical components.

'Measurement years' ran from June to May, divided into 'seasons' with 'summer' from mid-December to mid-March, 'autumn' from mid-March to May, 'winter' from June to mid-September and 'spring' from mid-September to mid-December. Total ryegrass and white clover component yields for each 'season' were averaged over the three years 1979-1982.

The cutting method understated actual yields because the pretrimming often removed fresh regrowth. Also the pretrimming height was slightly lower (0.4 cm) than the cutting height. The overall effect of these is estimated at 15-20%.

In December 1979, 1980 and 1981 plant populations were measured using 20, 5.08 cm diameter cores taken at equi-distant points on a diagonal line transect in each plot. Data were averaged over the three samplings.

Argentine stem weevil (ASW; *Listronotus bonariensis)* populations and tiller damage were determined in March and December 1979 and February 1981 from ten, 7.5 cm diameter cores of the Ruanui, Nui and Ellett plots (2 replicates only). Grass grub larval numbers were determined in autumn 1980, 1981 and 1982 from 4, 1 m x 14 cm plough furrows per plot. *Lolium endophyte* infection of plant tissue was assessed on five tiller clumps per plot of Ruanui, Nui and Ellett ryegrasses in June 1982 (2 replicates only).

All data was analysed by analysis of variance using a split plot in time method (Steel & Torrie 1960).

Table 1: ANNUAL DRY MATTER YIELDS (kg/ha) OF FIVE PERENNIAL PASTU R ES

Pasture	Part 1977178'	1978/79	1979180	1980181	1981182
Ruanui	1230	5330	5660	6760	5140
Nui	1500	5710	6500	7650	6260
Ellett	1210	5750	6140	7700	6430
Ellett + Fescue	1300	6790	6130	7540	6120
Ellett + Phalaris	1280	6220	6230	7760	6170
Level of significance	ns	*	ns	ns	***
LSD CO.05	210	690	730	770	530

[1] Period December 1977 to April 1978

RESULTS

Total Yields

(a) ***Annual*** **(Table 1). All three** ryegrass **pastures established well. From the** three cuts during the establishment period there were no significant effects on **total dry matter yield. In the subsequent four years, dry matter yields were similar for Nui and Ellett pastures, with mean production being 6,500 kg/ha. Yield of the Ruanui pasture was on average 13% lower than Nui, but the dif-** ference was only significant in 1981-82. Yields of the treatments containing tall fescue and phalaris were similar to Nui and Ellett in all years except in 1978/79, when the Ellett plus fescue treatment was superior to Nui.

Table 2: MEAN SEASONAL TOTAL DRY MATTER YIELDS (kg/ha) OF FIVE PERENNIAL PASTURES FROM 1979-82 (relative yields in parenthesis)

Pasture	'Autumn'	Winter	'Spring'	'Summer'
Ruanui	620 (63)	175 (65)	2590 (91)	2390 (92)
Nui	990 (100)	270 (100)	2840 (100)	2600 (100)
Ellett	1010 (102)	300 (111)	2880 (101)	2520 (97)
Ellett + Fescue	1020 (103)	300 (111)	2710 (95)	2540 (98)
Ellett + Phalaris	980 (99)	305 (113)	2810 (99)	2570 (99)
Level of significance	***	***	ns	ns
LSD <0.05	80	40	240	280

(b) *Seasonal* (Table 2). The distribution of pasture yields was for strong spring and summer growth (>80% of annual yield), with a relatively minor proportion of annual yield in autumn and winter. There was some variation between years mainly due to drought or insect predation.

Over the period 1979-82, mean spring and summer yields were similar for all treatments, except that yield of the Ruanui pasture was lower in the final spring and summer. During autumn and winter Ruanui pasture was consistently poorer (65% of Nui) than all other pastures, which were similar in yield.

Table 3: MEAN SEASONAL 'RYEGRASS' YIELDS (kg DM/ha) OF FIVE PERENNIAL PASTURES FROM 1979-82 (relative yields in parenthesis)

Pasture	'Autumn'	Winter'	'Spring'	'Summer'
Ruanui	330 (43)	130 (55)	760 (65)	670 (50)
Nui	760 (100)	235 (100)	1170 (100)	1330 (100)
Ellett	870 (114)	280 (119)	1390 (119)	1450 (109)
Ellett + Fescue	830' (109)	260 (111)	1280 (109)	1260 (95)
Ellett + Phalaris	800' (105)	270 (115)	1220 (104)	1260 (95)
Level of significance	***	***	***	***
LSD <0.05	100	40	170	180

[1] Values estimated for autumn 1982

Ryegrass Component Yields (Table 3)

Ryegrass was the dominant component of all pastures in all seasons. The only exception was the Ruanui pasture in summer 1980/81 when white clover was the major component. Ruanui ryegrass was markedly poorer than Nui and Ellett at all seasons, at about 50% of Nui. The yield of Ellett was greater than Nui in autumn, winter and spring. This pattern was consistent in all years. During summer, Nui and Ellett were not significantly different, but in no single summer was Ellett inferior to Nui. Yields of Ellett in association with tall fescue and phalaris were intermediate between those of Nui and Ellett (except in summer), being not significantly different from either.

Table 4: MEAN SEASONAL CLOVER YIELDS (kg DM/ha) OF FIVE PERENNIAL PASTURES FROM 1979-82 (relative yields in parenthesis)

Pasture	'Autumn'	Winter'	'Spring'	'Summer'
Ruanui	155 (103)	23 (121)	686 (114)	714 (126)
Nui	150 (100)	19 (100)	600 (100)	565 (100)
Ellett	91 (61)	14 (74)	576 (96)	513 (91)
Ellett + Fescue	a	20 (105)	529 (88)	a
Ellett + Phalaris	a	18 (95)	625 (104)	a
Level of significance	**	*	ns	ns
LSD <0.05	30	5	119	182

a Data incomplete

Clover Yields (Table 4)

White clover was the dominant legume throughout the trial. Red clover made a significant contribution from 1979/81, mainly in spring and summer. On an annual basis clovers were 27, 20 and 18% of total yield in the Ruanui, Nui and Ellett pastures respectively. There was a pattern in all seasons for highest clover growth in the Ruanui and least in the Ellett pastures, though these differences diminished with time. Clover content of Nui and the tall fescue and phalaris mixtures was generally intermediate.

Phalaris and Tall Fescue

Maru phalaris established well over the first summer and was evident as a minor component throughout the trial. Roa tall fescue was slow to establish and was suppressed by ryegrass competition. As neither was more than 5% of the total dry matter at any cut yields have not been presented.

Plant Populations (Table 5)

The mean ryegrass tiller population of Ellett was 31% higherthan Nui pastures, which in turn were 36% greater than Ruanui pastures. Ryegrass tiller numbers in tall fescue and phalaris were intermediate of Nui and Ellett treatments. Although overall there were no significant differences, the 'other grasses' *(Poa spp.,* Yorkshire Fog, browntop), broadleaf weeds, and white clover were considerably higher than Ruanui than in Ellett pastures (significant with 'other grasses' in December 1980).

Insect Pest Populations

(a) *Grass* grub. There was grass grub present in all pastures from 1979-1982. Larval populations rose with time to a mean of 130 per m^2 by April 1982, resulting in moderate pasture damage. Although numbers were higher in the Nui pastures in 1980 there were no subsequent differences between the five pastures (R .East *pers comm).*

(b) Argentine *stem weevil.* ASW was present at each of the three samplings. At each assessment there was a higher larval infestation of individual tillers on Ruanui than Ellett, with Nui intermediate (data not presented). However, because of differences in tiller population between pastures, when expressed on an area basis there was a higher population on Ellett than Ruanui pastures (P.J. Addison, G.M.Barker and R.P.Pottinger pers comm).

Lolium Endophyte

Examination in September 1982 of the ryegrass seed used in the trial indicated that when originally harvested, the percentage of seed infected with *Lolium endophyte* was 15, 40 and 100% for Ruanui, Nui and Ellett respectively. Because the age of the seed at sowing is not known, the actual percentage of seed infected with viable endophyte at sowing can only be speculated on. In June 1982, between 80 and 100% of the surviving ryegrass plants of all three ryegrass cultivars contained endophyte (M diMenna *pers comm.)*

DISCUSSION

This trial was sown to investigate the performance of five pastures in a practical grazing situation. It was monitored under a variety of climatic and management stresses that occurred over almost five years. These included drought,

insect predation, rotational grazing and weed ingress.

There was a number of significant effects attributable to the performance of the ryegrass cultivars used. A major effect was the higher annual production from Nui and Ellett based pastures. This was due to the greater productivity of their ryegrass components. On an annual basis the extra 800 kg DM/ha (mean of four years) from Nui and Ellett pastures should support over one additional stock unit per ha, or substantially improve feeding levels of existing stock.

The other major treatment effect was a change in the seasonal distribution of yield. There were relatively large increases in autumn and winter yields from Nui and Ellett based pastures. As slow pasture growth during autumn and winter is a major barrier to increased stocking rates on the Central Plateau, the use of Nui or Ellett should be of considerable benefit over this period.

Although continuous yield measurements ceased in May 1982 there will be annual assessments of species composition and insect populations for a further *3-4* years.

Ruanui Ryegrass

The lower annual production from Ruanui was due to its poor survival. This was apparent within 12 months from sowing. Initially the poorer Ruanui ryegrass survival was partly compensated for by greater clover (both red and white) growth. However, with time the poorer ryegrass survival also resulted in ingress by volunteer grasses, such as browntop, Yorkshire Fog and *Poa spp* (yield data for these are not presented). By summer 1981/82 clover yields in all five pastures were similar, the extra white clover in Ruanui pastures having been replaced by the volunteer grasses, and composition of the Ruanui pastures was approaching that of typical runout pasture of the Central Plateau. This had not occurred with the Nui and Ellett pastures.

Nui and Ellett Ryegrasses

While the total annual and seasonal yields of Nui and Ellett pastures were similar, the survival of Ellett was superior to Nui. This resulted in the ryegrass component of Ellett pastures performing significantly better than Nui in the autumn to spring period. Conversely, annual clover yields from Nui pasture were slightly greater than for Ellett, which may confer some advantage to Nui for fattening young stock (Rattray & Joyce 1970, Ulyatt 1971). However, for the Central Plateau it is likely that the higher survival of Ellett ryegrass over Nui more than offsets any gain due to differences in clover content. The relative differences between Ellett and Nui have also occurred in other trials. Goold (1982) found Ellett had a 9% higher cattle carrying capacity than Nui on peat soils, and on a yellow brown loam under sheep grazing gave substantially greater autumn to spring ryegrass yields. Perhaps more importantly, the same pattern between Ellett and Nui has occurred in another grazing trial (sown in 1979) on the Central Plateau (Percival and East, *pers comm).* The collective evidence from all these trials suggests Ellett is the preferred perennial ryegrass component for pastures both in the Waikato and the Central Plateau.

Grazing Management

Bearing in mind the dynamic nature of grazed grass-legume pastures, it is important to consider to what extent the results were affected by the trial management. Conceivably, rotation length, intensity of grazing and grazing preference are all important. There were some differences in residual grazing

Table 5: PLANT POPULATION DENSITY OF FIVE PERENNIAL PASTURES AVERAGED FROM 1979-81 (relative values in parenthesis).

Pasture	Pasture Components			
	Ryegrass Tillers/m^2	'Other Grasses' Tillers/m^2	Broadleaf Weeds % Frequency	White Clover Rooted nodes/m^2
Ruanui	2850 (74)	1060 (141)	10.6 (128)	1550 117)
Nui	3870 (100)	750 (100)	8.3 (100)	1330 100)
Ellett	5070 (131)	570 (76)	9.5 (114)	1110 (83)
Ellett t Fescue	4460 (115)	850 (113)	9.0 (108)	1230 (92)
Ellett + Phalaris	4710 (122)	960 (128)	10.5 (127)	1350 102)
Level of significance	**	ns	ns	ns
LSD CO.05	1070	580	2.6	470

height. The plots with higher ryegrass content were not grazed as low as those with lower ryegrass content. The main difference was between Ruanui and the other four pastures. Whether this was due to preference or for the higher selection against the Ellett and Nui ryegrasses is unclear. It was also unclear whether the higher clover content of Ruanui pastures was due to the lower survival of Ruanui ryegrass or to the differences in grazing intensity. There was little grazing preference between Nui and Ellett pastures. The use of long intervals between grazing served to reduce any effect of selective grazing by giving individual components sufficient recovery time to express their growth potential. As a matter of policy, grazing duration and stocking rate was left up to the farmer, so as to reflect a realistic grazing intensity according to feed requirements. Stubble height was usually 3-4 cm, though on some occasions it varied from this.

Insect Pests and Ryegrass Survival

(a) Grass *grub.* Numbers built up steadily and their effects became more marked with time, being similar among the five pastures. The latter years of the trial were relatively wet. A study by East (1981) showed that in wet years the effects of grass grub are less severe. Also the trial was treated with lindane at establishment, which prevented larval numbers building up. Taken together, these probably resulted in the effects of grass grub being less severe than may have otherwise occurred.

(b) *Argentine stem weevil.* The lower yields and survival of Ruanui may have been due to higher susceptibility to ASW. Whether differences between Ellett and Nui were due to ASW susceptibility is unclear, as these occurred before ASW sampling commenced. Kain *et al* (1982) found Ellett was less susceptible than Nui to ASW in Hawkes Bay. A more recent study by Prestidge et al (1982) suggested susceptibility to ASW is related to *Lolium endophyte* levels. While the actual levels of endophyte infection of the three ryegrasses at sowing is unknown, examination of seed retrospectively indicated maximum endophyte levels of 15, 40, and 100% for Ruanui, Nui and Ellett. The higher ASW infection of Ruanui tillers than on Ellett suggests that Ruanui ryegrass had a lower level of viable endophyte than Ellett at sowing. Further, the high endophyte infestation in tillers of all three ryegrasses in 1982 suggests that the only tillers to survive were those derived from seeds with viable endophyte at sowing.

Role of Tall Fescue and Phalaris

Under the management of the trial and at the sowing rates used, tall fescue and phalaris were unable to compete with Ellett. Under the grass fence that divided the trial in half, both tall fescue and phalaris were more evident, indicating a probable effect of management on their expression. In 1978/79 the high total yields of the tall fescue and phalaris mixturesover 'Ellett only' pastures was probably due to the lower sowing rate of Ellett in these treatments. Both tall fescue and phalaris may have a niche as special purpose pastures, particularly in areas with high grass grub populations. It is suggested that neither be sown with ryegrass as a companion species.

CONCLUSIONS

* The trial reinforces the importance of perennial ryegrass in cool season production on the Central Plateau.
* The large advantage of Nui and Ellett pastures over Ruanui in autumn and

winter is largely due to higher ryegrass yields. Ruanui ryegrass is not recommended for new pastures on the Central Plateau.

* The greater survival and productivity of Ellett ryegrass over Nui is considered an advantage for long term perennial pastures, though this occurs at the expense of a small reduction in white clover.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge Mr G.A. Brown for provision of the site and stock, co-operation with trial management and recording of rainfall, Mr L.J. Cranshaw (MAF, Rotorua) for technical assistance, Mr R.B.Gordon (MAF, Taupo) for assistance and advice throughout the trial, Mr N.Cameron (Yates Research, Darfield) for statistical analyses and the Rukuhia Herbage Laboratory for herbage analyses.

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