AN EVALUATION OF SEVERAL GRASS AND LEGUME CULTIVARS UNDER DRYLAND AND IRRIGATION IN NORTH OTAGO

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Abstract

The performance of six grass and seven legume cultivars was evaluated over a two-year period under dryland and irrigated conditions in North Otago. In contrast to the strong summer and subsequent annual production of Nui ryegrass, S170 tall fescue, and Apanui cocksfoot under irrigation, that recorded for Ruanui ryegrass, Currie cocksfoot, and Sirocco *Phalaris tuberosa* was poor. Under dryland conditions the most persistent and hence productive grasses were Nui, S170, and Currie. Only in spring did Pawera red clover clearly outproduce Turoa red clover. Both red clovers when combined with Apanui cocksfoot produced similar total sward yields to those recorded for Wairau lucerne. All three lotus cultivars, Maku, G4712, and Empire, produced poorly at both sites compared with Huia white clover.

INTRODUCTION

ALTHOUGH vastly different in production patterns and potentials, both dryland and irrigated pastures in drought-prone areas such as North Otago are often far from satisfactory.

Persistence of improved pasture cultivars is poor under dryland conditions and the subsequent ingress of low-producing species such as hairgrass (*Vulpia bromoides*), sweet vernal (*Anthoxanthum odoratum*), and barley grass (*Hordeum murinum*) is common. Drought-tolerant cocksfoot (*Dactylis glomerata*) and tall fescue (*Festuca arundinacea*) have long been considered promising pasture species for dry conditions (Douglas, 1966), yet little agronomic development and use have occurred with these species. Drought avoidance through complete or partial summer dormancy may also be an alternative means of improving the persistence of pasture plants under dryland conditions (Knight, 1960).

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Even with irrigation, potential pasture production is not being achieved by existing pasture components such as ryegrass and white clover. Particularly during summer, such pastures are prone to white clover dominance, often resulting in lower and undesirable seasonal production patterns (Brown, 1974).

Newly developed material from Grasslands Division, DSIR, along with some introduced overseas cultivars, provided a range of plants with different genetic backgrounds and production characteristics. This paper presents the production performance of six grass and seven legume cultivars grown under dryland and irrigated conditions in North Otago for the two-year period, 1974-5 inclusive.

EXPERIMENTAL

Both the dryland and irrigated sites were situated in the Duntroon-Kurow area of the Waitaki Valley on the same terrace level of a dry sub-hygrous yellow-grey earth, an Otiake silt loam. The two sites were previously in lucerne and existing soil fertility and pH were high (P Truog: 40, 39; pH: 6.5, 6.8; for irrigated and dryland, respectively).

Two separate trials were established at each site and were of a randomized block design with four replicates. The grass cultivar trials included five cultivars cut frequently (F) and infrequently (I) and one cultivar cut infrequently, namely, *Phalaris tuberosa,* cv. Sirocco. For the legume trials, only the infrequent cutting regime was used. Although three- (F) and six- (I) weekly intervals were generally used, this increased to four and eight weeks, respectively, when little growth occurred dur-

TABLE 1: SOWN CULTIVARS AND VIABLE SEEDING RATES (kg/ha)

Grass Cultivars		*Legume Cultivars*	
Lolium perenne, cv. Grasslands Ruanui	13.0	*Trifolium repens,* cv. Grasslands Huia	4.0
L. perenne, cv. Grasslands Nui	13.0	*T. pratense,* cv. Grasslands Turoa	4.0
Dactylis glomerata, cv. Grasslands Apanui	7 .	0 *T. pratense,* cv. Grasslands Pawera	8.0
D. glomerata, cv. Currie	6.0	*Lotus pedunculatus,* cv. Grasslands Maku	5.0
Festuca arundinacea, cv. S170	18.0	*L. corniculatus,* cv. Empire	6.0
Phalaris fuberosa, cv. Sirocco	10.0	*L. pedunculatus* × *L. corniculatus hybrid,* cv. Grasslands 4712	4.0
		Medicago sativa, cv. Wairau	12.0

ing cool winter and dry summer conditions. Broadcast sowings were made on September 4 and 11, 1973, for the dryland and irrigated sites, respectively. The sown cultivars and associated viable seeding rates are listed in Table 1.

All grass cultivars were sown with 2.0 kg/ha Huia and all legumes, except Wan-au, with 3.0 kg/ha Apanui. Appropriate inoculums were used for all sown legumes.

Plant counts, made three months after sowing, ranged from 130 to 160 plants/m* for the grass cultivars and 180 to 230 for the legume cultivars. Turoa and Pawera were the exceptions, their range being 70 to 80 plants/m'.

From 2 X 4 m plots, a central 4 m^2 area, mown down to a 3.0 cm height, was taken on each harvest day. Approximately 30% of clippings were returned to both the grass and legume trials and nitrogen, at a rate of 17.5 kg N/1000 kg dry matter removed, was applied as nitrolime after each cut to the grass cultivar trials only. Molybdenized superphosphate and muriate of potash, both at 375 kg/ha, were applied at sowing and then annually as two split dressings to all trial areas.

Irrigation was conducted as part of the farmer's irrigation schedule and the number of applications, each of approximately 75 mm, were three and six for 1974-5 and 1975-6, respectively. Mean rainfall for the period 1941-70, and that recorded during

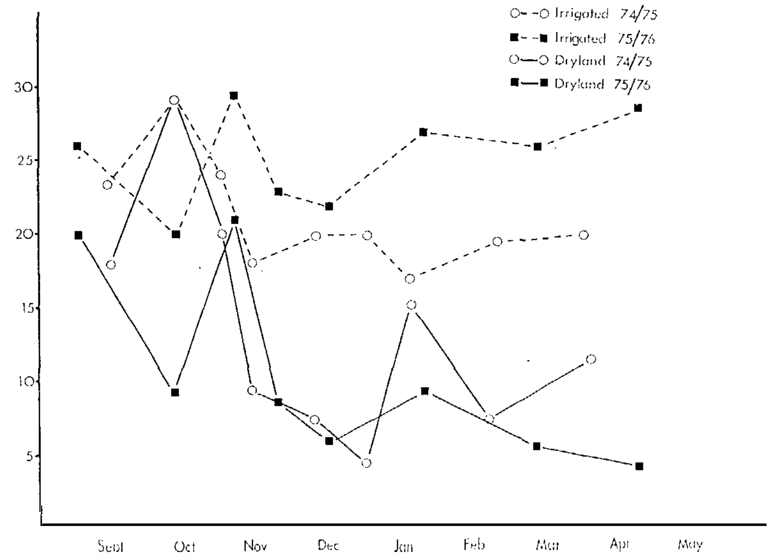

FIG. 1: ***Percentage soil moisture (O-1 5 cm depth).***

the experimental period at a site 4 km from the trial areas are presented in Table 2. Soil moisture values for the O-15 cm profile were determined gravimetrically and are expressed as a percentage of oven dry weight (ODW) in Fig. 1 for the mid-spring to mid-autumn periods.

TABLE 2: SEASONAL RAINFALL (mm)

	Autumn	*Winter*	*Spring*	*Summer*	*Total*
1974-5	161	121	122	156	560
1975-6	125	101	135	135	495
Normal (1941-70)	135	107	137	183	562

RESULTS

Results are presented as histograms (see Figs. 2 to 5) and are the means for the two experimental years. Seasonal yields indicated in these figures are applicable to only that component of the sward appropriately designated below each histogram ("sown cultivar"). However, total annual sward production — *i.e.,* "sown cultivar" plus companion — is indicated by the appropriate "open caps". For the grass cultivars the balance of production was from white clover under irrigation and white plus suckling clover under dryland. Apanui cocksfoot was the principal contributor to the balance of the red and white clover swards and both Apanui and volunteer white clover for the lotus cultivars.

Standard error bars are presented for each seasonal period and for the annual production of the "sown cultivar".

IRRIGATED GRASS CULTIVARS (see Fig. 2)

Relative to Nui, the production of Ruanui was low for all seasons, particularly during the summer, and was continuing to decline with time. Considerable Ruanui tiller death occurred each summer, especially under the strongly white clover dominant, infrequent cutting regime.

For both years, S170 tall fescue was superior to Nui as a "sown cultivar"; however, total sward yields were similar. Summer production of S170 was greater than recorded for Nui and it was over this period that tall fescue benefited most from the infrequent cutting regime.

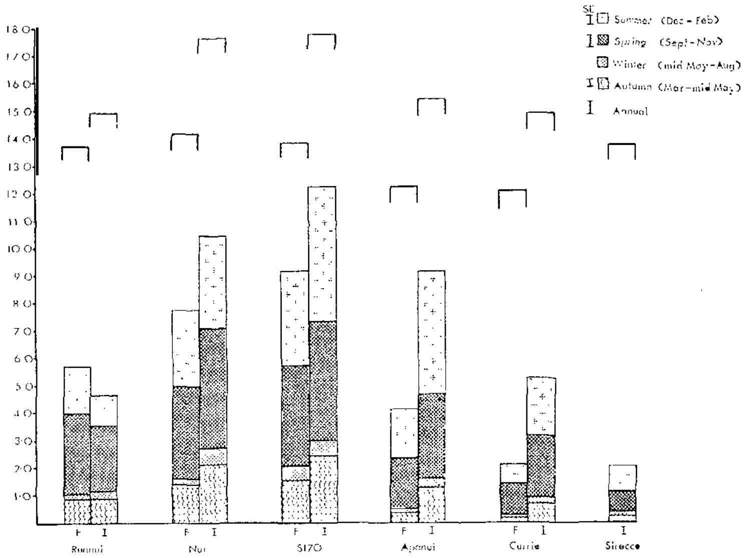

FIG. *2: Irrigated grass cultivar yields (tonnes DM/ha).*

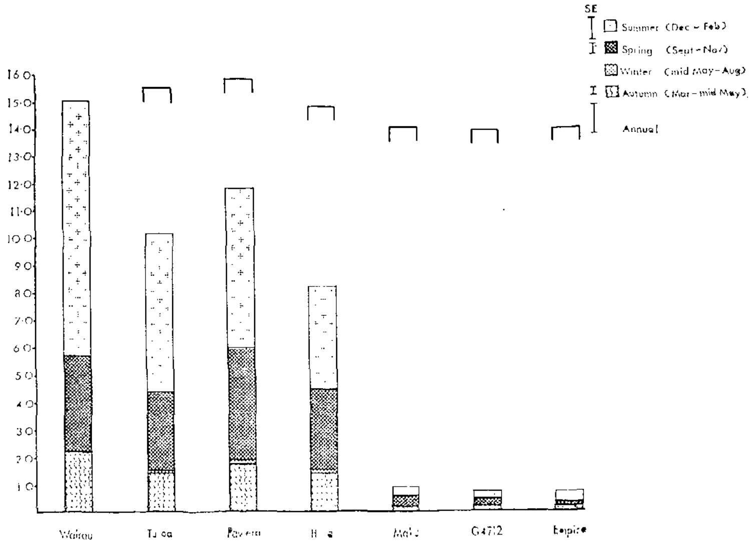

FIG. *3: Irrigated legume cultivar yield; (tonnes DM/ha).*

Apanui cocksfoot was superior in yield to Currie cocksfoot, particularly in the summer and under infrequent cutting. The poor summer growth of Currie cocksfoot, like that of Sirocco, resulted in the development of a strong white clover dominant sward with a poor grass component throughout all seasons.

IRRIGATED LEGUME CULTIVARS (see Fig. 3)

Owing mainly to a large summer component, Wairau lucerne production was far superior to that of the red clover component of both Turoa and Pawera swards. However, when Apanui production is included in the latter two, total production is very similar.

Only in spring did Pawera red clover significantly out-produce Turoa. This production advantage was the result of an earlier commencement and greater level of early spring production over the September-October period; Over this period, however, Apanui growth was greater within the Turoa swards and as a result total yields were similar in all seasons for the two red clover swards.

Compared with Huia white clover, all three lotus cultivars produced poorly. The large non-lotus component of total sward production was from the sown companion Apanui and volunteer white clover.

DRYLAND GRASS CULTIVARS (see Fig. 4)

Soil moisture during both summers fell to very low levels, particularly during the 1975-6 dry period when it was well below wilting point, a level of approximately 9% ODW for this soil (Fig. 1) .

The ability of Nui to continue growth into and then recommence growth following dry summer conditions was far superior to that of Ruanui. Furthermore, the survival of Nui under drought conditions was greater than for Ruanui, as is illustrated by tiller counts taken in September 1976, following an extended dry period over the summer, autumn and winter of 1976 (Table 3). As a result, Nui outproduced Ruanui in all seasons, but most notably during the highly productive spring period.

Although S170 summer production was similar to that of Nui, subsequent autumn and winter production was inferior. Furthermore, only the frequently cut S170 matched the spring production of Nui as the former cultivar did not significantly respond to the infrequent cutting regime over this production period. Nevertheless, the survival of S170 over the severe 1976 drought was

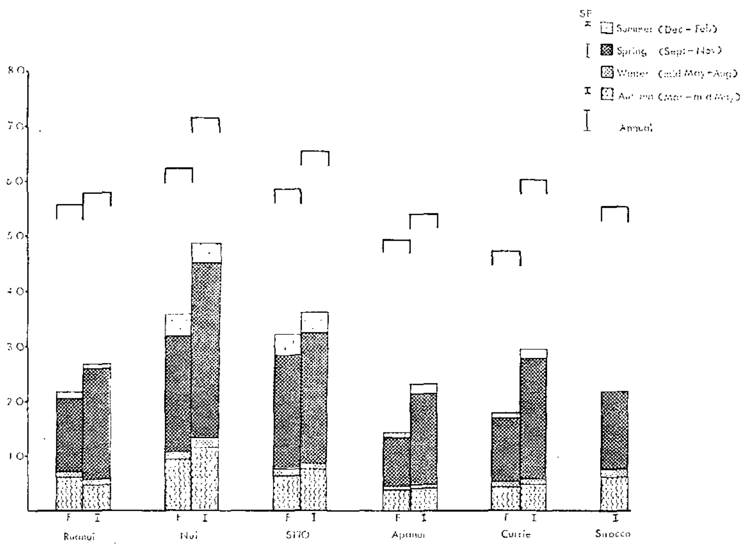

FIG. 4: *Dryland grass cultivar yields (tonnes DM/ha).*

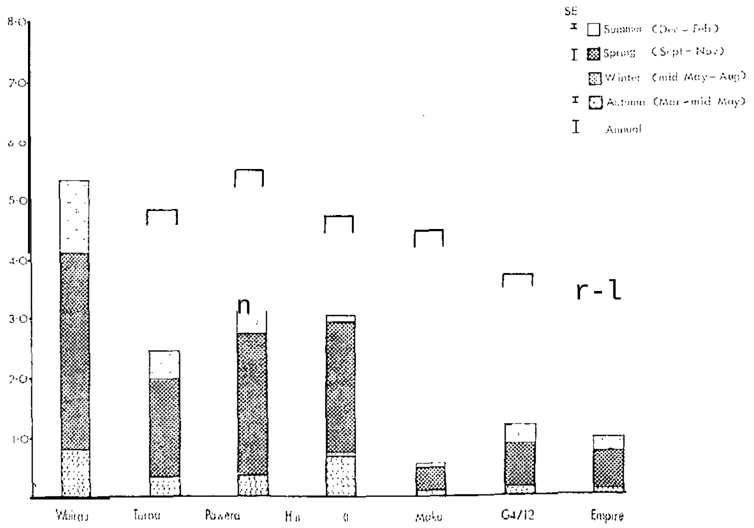

FIG. 5: ***Dryland legume cultivar yields (tonnes DM/ha).***

TABLE 3: DRYLAND TILLER DENSITIES ON 9/9/76 (100 tillers/m')

	F	I
Ruanui	86	84
Nui	184	194
S170	148	182
Apanui	48	79
Currie	254	290

SE: 24; CV: 27.7%

greater than that recorded for Ruanui and similar to that for Nui (Table 3).

Owing mainly to its greater spring production, annual dry matter yield of Currie was superior to that of Apanui. This superiority was increasing with time and each dry spell experienced. This greater ability of Currie cocksfoot to survive drought conditions is also shown in Table 3.

Summer-dormant Sirocco was the lowest yielding cultivar evaluated in this trial. Strong and rapidly developing white clover growth Following improved autumn moisture restricted the regeneration of previously dormant Sirocco plants and as a result it was a weak and diminishing component of the sward throughout the remainder of each year. Furthermore, winter frosting limited production over a period in which Sirocco is supposedly at its greatest advantage.

DRYLAND LEGUME CULTIVARS (see Fig. 5)

Relative to Turoa, superior Pawera production was recorded in spring and summer but not in autumn. With the inclusion of the Apanui component, total sward yields again favoured Pawera and were similar to those recorded for the pure Wairau stands.

Although near complete desiccation of Huia occurred during the dry summer spells, some stolons did manage to survive. The most notable feature of Huia's performance was the rapid re-establishment from the remaining stolons, in response to autumn rains, resulting in a relatively high autumn production.

Except for the summer performance of Empire and the hybrid G4712, all lotus production was markedly inferior to the other legumes. The deeper rooting Empire was the most persistent lotus cultivar, followed by G4712 and Maku. The respective plant densities recorded in March 1976 at the end of the experimental period were 19, 9 and $1/m^2$. The degree of desiccation of aerial growth over the summer was greatest in Maku, although of the three lotus cultivars it retained the greatest amount of viable growth during winter frosting.

DISCUSSION

GRASS CULTIVARS

The vastly improved summer growth of Nui is a distinct advantage over Kuanui for irrigated conditions. This improvement results in a greater expression of the high production potential that exists with irrigation, particularly during the warm summer period. It is also evident that the problem of poor ryegrass persistence over the summer within irrigated white clover dominant swards is reduced with Nui. As a result, grass and total sward production is also improved during the cooler parts of the year.

The drought-tolerant characteristics of Nui have also been reported by Rumba11 (1969) and Armstrong (1977). Although later than for Ruanui, near complete desiccation of Nui leaf did occur during the dryland summer "burns". However, it was apparent that a greater number of Nui tillers and/or tiller buds remainder viable. As a result, the response of Nui to improved moisture was earlier and greater than for any of the other grass cultivars. Where ryegrass plant mortality has previously been a problem under dry conditions, Nui will undoubtedly be an improvement.

The high-producing, summer-active characteristics of S170 tall fescue under irrigation provide similar advantages to those forwarded for the improved summer activity of irrigated Nui. Furthermore, when irrigated pastures tend to become very lush in summer, the higher fibre content associated with tall fescue cultivars (Wilson, 1975) may also be of benefit.

Unlike the ryegrass cultivars, S170 did retain leaves during the dryland summer "burns", although they were of a rolled, xeromorphic character. Watkin (1975) has previously suggested improved water utilization or deeper roots as reasons for the drought-tolerant characteristics of S170 tall fescue, and Yeh et al. (1976) reported a summer dormancy in tiller bud release, particularly under dry conditions. From this drought-tolerant state in the summer, a delay in and restriction of autumn growth in response to improved moisture was evident for S170 compared with Nui. However, this autumn restriction was not experienced under irrigation where plant water stress was not apparent during the summer.

The superiority of Apanui over Currie as sown cultivars under irrigation was a reflection of the greater summer growth and competitiveness of the former. Reduced summer activity, inherent in Currie cocksfoot (Broue, 1965), was, however, of advantage under dry conditions, improving persistence and hence annual production.

The marked response by the two cocksfoots to the infrequent cutting regime again illustrates the large benefits gained by extending their regrowth period, as has previously been reported by Brougham (1960) .

The poor performance of Sirocco was due to its inability to successfully re-establish itself in the autumn from underground stem bases. Nevertheless, Sirocco is the most summer dormant of the available Australian P. *tuberosa* cultivars (Meakins, 1973) and a slightly more summer-active cultivar may swing the competitive balance more favourably towards successful re-establishment where strong autumn competition is experienced.

LEGUME CULTIVARS

At both sites, the production of Pawera was only clearly superior to Turoa in early- to mid-spring. This earlier production may be a reflection of higher carbohydrate reserves that were suggested by Anderson (1973) to exist over the cooler parts of the year in the tetraploid, Pawera. The greater persistency of Pawera (Anderson, 1973) was also evident in the irrigated trial. Initial plant densities were 73.7 and $76.3/m^2$ and, at June 1976, 22.0 and $36.5/m^2$ for Turoa and Pawera, respectively. However, at the dryland site, although Pawera summer production was slightly greater than that of Turoa, greater drought tolerance and persistence were not evident in the former. Similar plant densities of 25.5 and $24.0/m^2$ for Pawera and Turoa, respectively, were recorded in March 1976, and by August 1976 complete plant mortality had occurred for both cultivars.

For the dryland and irrigated Wairau lucerne stands, the average numbers of defoliations per year were four and seven. Although this management would not maximize lucerne production, it is interesting to note the similarity in dry matter production attained by both red clover/cocksfoot combinations and Wairau. This is of significance, particularly under irrigation, where problems of lucerne persistence are encountered.

Although lotus seedling numbers at the irrigated site were 210 to $230/m^2$ initially, almost complete lotus plant mortality occurred as a result of premature and subsequently too severe defoliation, plus competition from the sown companion Apanui and volunteer white clover.

At the dryland site reduced competition, particularly from white clover, improved the opportunity for lotus growth. However, dry conditions and nodulation problems with Empire and the G4712 hybrid restricted the performance of all three lotus cultivars. Nitrogen deficiency symptoms in Empire and G4712 first appeared one year after sowing and reinoculation of selected isolets from sparsely nodulated field plants (W. L. Lowther, pers. comm.) indicated that the rhizobium strains used were unable to maintain their effectiveness at this dryland site. With a more satisfactory rhizobium strain, the production of the more drought-tolerant lotus cultivars would most likely be greater than that recorded in this trial.

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