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Performance of nitrogen fertilised temperate grasses and temperate grass-clover mixtures in coastal south-east Queensland

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Summary

Dry matter production of nitrogen fertilised temperate grasses, including ryegrasses (*Lolium* spp.) and oats (*Avena strigosa* cv. Saia), was compared at two planting rates. Kangaroo Valley ryegrass (*L. perenne*) was also grown without nitrogen and in mixtures with various clovers (*Trifolium* spp.). The experiments were conducted at four sites, two raingrown and two irrigated, in coastal south east Queensland from 1972 to 1975.

Raingrown Saia oats produced the most forage, especially early in the season, but reacted unfavourably to the cutting height and frequency possible with irrigation. When irrigated, the annual ryegrasses (*L. rigidum* and *L. multiflorum*) gave the best early production. The late season production of the perennial ryegrasses was best. There were no consistent differences between cultivars within the two ryegrass groupings, although Kangaroo Valley was the outstanding cultivar over the full season.

Inclusion of various clovers or mixing oats with Kangaroo Valley ryegrass did not improve the yield. Clovers did not compensate for the lack of nitrogen application although the mixtures outyielded unfertilised Kangaroo Valley. When nitrogen was applied to the ryegrass—clover mixture clover yields were drastically reduced.

Increasing ryegrass planting rate above 22 kg/ha suggested higher yields could be achieved only early in the season, especially under raingrown conditions.

INTRODUCTION

The near north coast district of south-east Queensland has a moderately high but variable rainfall. Cooroy for example receives a mean annual rainfall of 1620 mm with a range in 4 out of 5 years of from 1070 to 2180 mm and Gympie 1140 mm (range 750 to 1600 mm). Some 70% of these amounts are received over the six summer months. The remainder, falling variably in the cooler months, can be quite substantial in some years.

Native pastures and sown tropical species occupy the majority of the grazing lands and provide the main sources of animal feed. However, they suffer from cool season dormancy and are of very poor quality over late autumn, winter and early spring. Spring rains are also the most erratic and dry springs are frequent.

There is, therefore, a considerable need for high quality feed over the cool season, especially from plants which can take advantage of winter rains when these occur. This particularly applies to the highly intensive dairying industry and especially for whole milk production.

Pastures based on white clover (*Trifolium repens*) provide one source of winter-spring feed. However, the performance of white clover, which is widely naturalised, is quite variable from year to year (Ostrowski 1972). In the past substantial areas of forage oats have been grown, utilising both stored fallow moisture and rainfall to improve the quality of the winter nutrition of dairy cows.

There is also substantial scope for the use of irrigation in this reasonably well watered area, pumping both from local streams and farm dams, and its use is increasing substantially. When irrigation is intended it is desirable that full use is made of the water applied.

It is likely, therefore, that nitrogen fertilisers will also be required, especially on pure grass pastures.

This paper reports a series of preliminary experiments, designed over 12 years ago to assess the role of oats and various temperate grasses under both raingrown and irrigated conditions with and without applied nitrogen. Planting rates were also varied and the ability of various clovers to supply some of the nitrogen to Kangaroo Valley ryegrass was tested.

MATERIALS AND METHODS

Sites

Four field experiments were sown from 1972 to 1975 in the near north coast district using the most promising ryegrasses from preliminary evaluations in 1970-71. Experiments 1 and 2 were raingrown and 3 and 4 were irrigated. Experiment 4 perenniated into 1975 and was again irrigated. Details of the experimental sites are shown in Table 1, and rainfall for all experiments in Table 2.

Table 1. Details of experimental sites

Experiment	Sowing date	Location	Soil type	pH (1:2)	Acid extract P (ppm)	Exchangeable K (meq %)
Raingrown						
1	11 Apr 72	Kin Kin	Alluvial clay loam	5.1	40	0.24
2	21 Apr 75	Tuchekoi	Sandy clay loam Prairie alluvial	5.4	30	0.20
Irrigated						
3	27 Mar 73	Kandanga	Sandy clay loam Prairie alluvial	6.1	25	0.13
4	27 Mar 74	Kandanga	Sandy clay loam Prairie alluvial	6.0	21	0.17
		Kandanga*	Sandy clay loam Prairie alluvial	5.9	30	0.20

*Perenniated into 1975.

Experimental

All experiments were randomised block designs with three replications of 4.6 ×2.7 m plots. In March-April the grasses and legumes (Tables 5 and 8) were hand sown into prepared seedbeds. Legume species were inoculated with the appropriate strain of *Rhizobium*. Fertiliser applications and sowing rates are shown in Tables 3 and 4 respectively.

Experiments 3 and 4 were irrigated at planting and then at 21 to 26 day intervals until late November. The perenniated growth of Experiment 4 was irrigated in May 1975 after slashing summer grass growth, resowing the Grasslands Ariki ryegrass (which had failed to established in 1974) and oats treatments, and applying nitrogen.

Irrigated experiments were sampled for dry matter yield at about 3 week intervals, and raingrown experiments whenever sufficient growth warranted cutting (grass about 25 cm high). On some occasions ryegrass-clover treatments were not harvested at the same time as the grasses growing alone because of insufficient growth. The growth missed was picked up at the next harvest.

At each harvest a 2.7×0.8 m strip was cut from the centre of the plot with an autoscythe to a height of 5 cm. The sampled material was weighed green, subsampled and separated into sown grass, legume and weed for dry matter determinations. Where present, grass and legume components were analysed for nitrogen content. After sampling, plots were mown to 5 cm, the surplus material raked off and nitrogen treatments applied.

Table 2. Monthly and total rainfalls in millimetres during the growing periods each year at the various sites

Month	Experiment				
	1 Kin Kin 1972	2 Tuchekoi* 1975	3 Kandanga 1973	4 Kandanga 1974	4 Kandanga 1975
March	5	82	75	252	86
April	10	50	25	66	62
May	8	12	40	149	12
June	3	62	35	13	58
July	..	33	545	4	32
August	..	66	35	65	31
September	..	66	75	35	71
October	7	91	150	119	102
November	7	105	94	166	118
Total	40	567	1074	869	572

*Nearest recording centre Imbil.

RESULTS

Grass species and cultivars

Total dry matter yields (Table 5)

Under raingrown conditions with nitrogen fertiliser applied, Kangaroo Valley ryegrass was significantly exceeded ($P<0.01$) in total dry matter yield only by Wimmera ryegrass and Saia oats in Experiment 1. However, the cutting frequency used in Experiment 2 did not suit the regrowth pattern of Saia. Here, Kangaroo Valley outyielded all other lines. Grasslands Manawa and Ariki ryegrasses also yielded well in both raingrown experiments (Table 5).

When irrigated, the perennial ryegrasses were generally higher yielding than the annuals, with Kangaroo Valley again being the highest yielding cultivar. In Experiment 3, Kangaroo Valley gave the highest yield, but did not significantly ($P=0.05$) exceed Grasslands Ariki, Priebe prairie or Mansfield ryegrass (Table 5). Wimmera equalled Kangaroo Valley in the first year of Experiment 4. Priebe prairie and Mansfield also yielded well in the second year of Experiment 4 as did Grasslands Ariki which had failed to establish the first year (Table 5).

Mixing oats with a ryegrass cultivar gave no yield advantage. In both years of Experiment 4 the mixture was outyielded ($P<0.01$) by the pure sward of Kangaroo Valley and in the first year by Wimmera (Tables 5 and 8).

Seasonal growth rates (Table 6)

Over the establishment period, up to 100 days after planting, Saia oats and the annual ryegrasses, especially Wimmera and Grasslands Manawa, grew faster than the perennials. The annuals' daily growth rates were up to double those of the perennials. However, once established the perennials grew faster, especially under irrigation. Kangaroo Valley had the most consistently high daily growth rates (Table 6).

Table 3. Schedule of fertiliser applications

Site	Treatment	Basal planting fertiliser (kg/ha)			Maintenance nitrogen fertiliser		Total nitrogen applied (kg/ha)
		N	P	K	Number of applications	Amount per application (kg/ha)	
1. Kin Kin 1972	Pure grasses	112	25	63	1*	25	137
2. Tuchekoi 1975	Pure grasses	0;112†	25	63	4	48	0;304†
	Oats+ryegrass+clover	112	25	63	4	48	304
	Kangaroo Valley ryegrass+clover (28N)	28	25	63	. .	. .	28
	Kangaroo Valley ryegrass+clover (256N)	112	25	63	3‡	48	256
	Kangaroo Valley ryegrass+clover (304N)	112	25	63	4	48	304
3. Kandanga 1973	Pure grasses	0;112†	49	63	7	48	0;448†
	Ryegrass—clover	28	49	63	. .	. .	28
4. Kandanga 1974	Pure grasses	0;112†	49	63	6	48	0;400†
	Ryegrass—clover mixture	28	49	63	. .	. .	28
4. Kandanga 1975§	Pure grasses	0;112	25	. .	6	48	0;400†
	Ryegrass—clover mixtures	28	25	. .	. .	. .	28

Source of nitrogen was urea (at Kin Kin ammonium nitrate).

*Applied 2 August 1972.

†Applies to two pure Kangaroo Valley ryegrass planting rates only. These did not receive maintenance N applications either.

‡Applied until end of August 1975.

§Perenniated growth from 1974.

Table 4. Sowing rates of pure stands and grass-legume mixtures in kilograms per hectare

	Experiment			
	1	2	3	4
Lolium spp.	17;34*	22;45	22;45	22;45
Phalaris tuberosa cv. Sirocco	. .	17	. .	. .
Phalaris tuberosa cv. Australian	. .	17	3	. .
Bromus unioloides cv. Priebe (prairie grass)	. .	22	11;22	11;22
Avena strigosa cv. Saia (oats)	45	45;90	. .	22;45
Lolium perenne cv. Kangaroo Valley+*Trifolium semipilosum* cv. Safari	. .	. .	9+7	9+7
L. perenne cv. Kangaroo Valley+*T. repens* cv. Ladino	. .	. .	9+7	9+7
L. perenne cv. Kangaroo Valley+*T. repens* cv. Louisiana	. .	. .	9+7	9+7
L. perenne cv. Kangaroo Valley+*T. repens* cv. Haifa	. .	. .	9+7	. .
L. perenne cv. Kangaroo Valley+*T. subterranean* cv. Yarloop	. .	. .	9+7	. .
L. perenne cv. Kangaroo Valley+clover mixture (28N)†	. .	11+12†	. .	. .
L. perenne cv. Kangaroo Valley+clover mixture (256N)†	. .	11+12†	. .	. .
L. perenne cv. Kangaroo Valley+clover mixture (304N)†	. .	11+12†	. .	. .
Avena strigosa cv. Saia+*L. perenne* cv. Kangaroo Valley+clover mixture†	. .	11+6+12†	. .	. .
Avena strigosa cv. Saia oats+*L. multiflorum* Grasslands Tama	45+17	. .	. .	. .
Avena strigosa cv. Saia+*L. perenne* cv. Kangaroo Valley	. .	22+11	. .	11+9

*Grasslands Tama ryegrass also planted at 8.4 and 67 kg/ha.
†Clover mixture=Ladino white clover 3 kg/ha+Louisiana white clover 3 kg/ha+Grasslands Huia white clover 3 kg/ha +Grasslands Turoa red clover 3 kg/ha.

Priebe prairie grass was very slow to start in both irrigated trials but grew particularly well in the late spring early-summer period. At no stage in the second year of Experiment 4 did the annual ryegrasses equal the perennials in growth rates. As well, only in the autumn-early winter did Priebe prairie grow rapidly (Table 6).

Nitrogen content and recovery (Table 7)

Nitrogen content of the dry matter was increased by applying nitrogen fertiliser. While the annual ryegrasses showed a tendency to higher nitrogen contents than the perennials this was not consistent. In the first year harvests, the lower yielding Experiments 1 and 4 tended to have higher nitrogen contents. The second year of Experiment 4 also showed depressed nitrogen contents compared to the first year (Table 7).

Apparent nitrogen recovery from Kangaroo Valley ryegrass was 46% in Experiment 2, 89% in the high yielding Experiment 3, 75% in the first year of Experiment 4 but only 43% in the second year.

Clover mixtures

Total dry matter yields (Table 8)

The inclusion of clovers with a low (28 kg/ha) nitrogen rate at planting gave substantially lower yields than the nitrogen fertilised ryegrasses, especially in the high yielding, irrigated Experiment 3. Here, clover-ryegrass yields were only about 50% of those of nitrogen fertilised Kangaroo Valley ryegrass (compare Table 8 with Table 5).

Only in the raingrown Experiment 2 was there any consistent, significant increase in yield as a result of including clovers over that of the unfertilised Kangaroo Valley ryegrass. In Experiment 2, the inclusion of the clover mixture, without extra fertiliser nitrogen, resulted in some 870 kg/ha of clover dry matter plus a non-significant increase in ryegrass yield. Louisiana white clover, which tended to be the best clover, increased total dry matter yield in the second year of Experiment 4. Safari Kenya white clover gave significantly lower yields in its mixtures than did *T. repens* cultivars in Experiment 3 and in the second year of Experiment 4 (Table 8).

Seasonal growth rates (Table 9)

Only late in the season in the two irrigated experiments did the inclusion of a clover improve the daily increments of total dry matter. Ladino white clover resulted in the highest yields at this stage (Table 9).

Nitrogen content (Table 7)

Relative to the nitrogen fertilised pure grass stand, nitrogen contents and yield from the total forage were reduced. With the better clovers, there was an improvement in nitrogen yield over the unfertilised Kangaroo Valley ryegrass (data not presented).

Table 5. Mean total oven dry grass yields in kilograms per hectare across sowing rates of nitrogen fertilised ryegrasses, phalaris, prairie grass and oats planted in pure swards

	Experiment				
	1 Kin Kin 1972	2 Tuchekoi 1975	3 Kandanga 1973	4 Kandanga 1974	4 Kandanga* 1975
Lolium perenne cv. Kangaroo Valley	4 080	7 263	15 645	9 467	9 698
L. perenne×(*L. multiflorum*×*L. perenne*) cv. Grasslands Ariki	4 653	5 910	14 705	0†	8 090
L. perenne cv. Tasmanian No. 1	1 738	. .	. .	. .	. .
L. perenne cv. Kangaroo Valley (late strain)	2 786	. .	. .	. .	. .
L. perenne cv. Kangaroo Valley (early strain)	3 548	. .	. .	. .	. .
L. perenne cv. Colac (Victorian perennial)	3 169	. .	14 187	6 735	6 368
L. perenne cv. Mansfield (Victorian perennial)	3 093	5 079	14 471	6 418	7 835
L. perenne cv. Grasslands Ruanui	3 476	. .	. .	. .	. .
L. perenne cv. Medea	1 823	. .	. .	. .	. .
L. perenne cv. Tasdale	3 978	. .	. .	. .	. .
L. perenne strain G.A. 40	1 055	. .	. .	. .	. .
L. perenne×*L. multiflorum* cv. Grasslands Manawa	4 686	6 181	13 956	7 221	6 046
L. multiflorum cv. Grasslands Paroa	3 192	4 211	13 393	8 529	6 035
L. multiflorum Grasslands Tama	3 690	5 116	12 838	6 705	2 132
L. rigidum cv. Wimmera	5 331	5 936	13 387	9 411	1 931
Bromus catharticus cv. Priebe prairie	. .	. .	14 510	5 443	7 823
Phalaris tuberosa cv. Sirocco	. .	5 757	. .	. .	. .
Phalaris tuberosa cv. Australian	. .	317	12 160	. .	. .
Avena strigosa cv. Saia (oats)	6 086	4 658	. .	4 006	4 786
l.s.d. (P=0.05)	892 (1 092)‡	798 (987)	1 382 (1 692)	812	1 238

* Perenniated growth from Experiment 4.

†Failed to germinate.

‡l.s.d. values shown in parenthesis are to be used for testing oats (1972) and *Phalaris tuberosa* (1973, 1975) against any other species.

Table 6. Interharvest mean daily growth rates in kilograms ODM per hectare per day of perennial and annual ryegrasses, Priebe prairie and Saia oats in each experiment

Experiment number Location Date planted	1 Kin Kin 11 Apr 72			2 Tuchekoi 21 Apr 75					3 Kandanga 27 Mar 73							
Date harvested	14 Jun	5 Jul	4 Sep	25 Jun	23 Jul	19 Aug	18 Sep	11 Nov	17 May	7 Jun	3 Jul	1 Aug	22 Aug	18 Sep	17 Oct	6 Nov
Growth interval (days)	64	21	61	65	28	27	30	54	51	21	26	29	21	27	29	20
Perennial ryegrasses																
Kangaroo Valley	15	53	33	0	35	57	80	44	27	58	91	80	84	103	114	26
Ariki	11	66	42	0	24	49	64	37	25	57	77	93	78	89	103	25
Mansfield	9	54	22	0	20	41	61	30	25	51	73	71	89	97	106	30
Colac	10	44	27	..	..	..	..	..	24	66	76	72	83	85	93	37
Mean perennials	11	54	31	0	26	49	68	37	25	58	79	79	84	94	104	30
Annual ryegrasses																
Manawa	23	66	30	3	45	56	61	26	31	51	75	68	88	84	95	25
Tama	12	52	30	1	33	45	64	19	33	57	77	57	77	76	72	27
Paroa	7	50	27	0	5	24	62	29	34	60	62	71	80	85	81	22
Wimmera	17	67	47	3	55	42	82	11	28	50	82	64	66	83	94	29
Mean annuals	15	59	34	2	35	42	67	21	32	55	74	65	78	82	86	26
Other species																
Priebe prairie	..	..	..	..	..	..	..	..	19	35§		55	79	108	169	40
Saia oats	35	93	31	16	46	7	48	13	..	..	..	..	..	..	..	..

Experiment number Location Date planted	4 Kandanga 27 Mar 74							4 Kandanga 1975 perenniated						
Date harvested	5 Jun	11 Jul	20 Aug	10 Sep	26 Sep	16 Oct	4 Nov	8 May*	11 Jun	17 Jul	12 Aug	15 Sep	27 Oct	26 Nov
Growth interval (days)	70	36	40	21	16	20	19		34	36	26	34	42	30
Perennial ryegrasses														
Kangaroo Valley	10	23	39	69	87	84	99		20	39	48	48	42	31
Ariki	†	†	†	†	†	†	†		44	45	58	51	25	22
Mansfield	2	6	18	41	88	69	91		23‡	33	41	45	30	43
Colac	6	8	21	39	84	70	87			32	31	27	27	32
Mean perennials	6	12	26	50	86	74	92		29	37	45	43	31	32
Annual ryegrasses														
Manawa	7	25	25	55	77	53	70		18‡	32	38	39	23	7
Tama	3	14	25	65	69	61	68				17	27	18	0
Paroa	10	27	36	58	89	64	77		13‡	35	36	37	19	26
Wimmera	36	19	26	71	72	59	72				15	18	21	0
Mean annuals	14	21	28	62	77	59	72		15	33	27	30	20	8
Other species														
Priebe	0	2	7	39	65	64	100		47‡	47	45	37	22	7
Saia oats	36	0	8	29	35	0	0		65	27	43	10	0	6

*Starting date 1975 calculations; over summer growth harvested and included in total yield Table 5.

†Planted but failed to established 1974; replanted May 75.

‡11 Jun growth rate based on one planting rate yields only.

§Not harvested 7 Jun 1973.

Table 7. Mean nitrogen concentration (%) of various groups of plants for the total pasture each year in each experiment compared with that of unfertilised Kangaroo Valley ryegrass

Experiment number	1	2	3	4	
Year	1972	1975	1973	1974	1975
Kangaroo Valley (unfertilised)	..	3.1	3.0	3.3	3.3
Perennial ryegrasses	4.0	3.9	3.95	4.7	3.75
Annual ryegrasses	4.2	4.3	4.1	4.6	3.7
Other grasses					
Priebe prairie	..	..	3.6	4.2	3.8
Sirocco phalaris	..	4.0	..	..	..
Australian phalaris	..	5.0	3.6	..	..
Saia oats	3.6	3.8	..	4.1	4.1
Kangaroo Valley+clovers	..	3.5	3.2	3.0	2.8
Kangaroo Valley+oats	..	3.8	..	5.4	4.2

Table 8. Mean total oven dry matter yields in kilograms per hectare of grass+legume and oat+ryegrass mixtures with unfertilised Kangaroo Valley ryegrass yields included for comparison

Species	1 Kin Kin 1972	2 Tuchekoi 1975	3 Kandanga 1973	4 Kandanga 1974	4 Kandanga 1975*
Lolium perenne cv. Kangaroo Valley unfertilised in pure stand	..	1 975	8 758	3 895+	5 029
Lolium perenne cv. Kangaroo Valley+*Trifolium semipilosum* cv. Safari	..	..	6 068	7 444φ	3 129
L. perenne cv. Kangaroo Valley+*T. repens* cv. Ladino	..	..	8 847	6 942φ	5 800
L. perenne cv. Kangaroo Valley+*T. repens* cv. Louisiana	..	..	9 484	5 942φ	7 241
L. perenne cv. Kangaroo Valley+*T. repens* cv. Haifa	..	..	8 851	..	..
L. perenne cv. Kangaroo Valley+*T. subterranean* cv. Yarloop	..	..	6 929	..	..
L. perenne cv. Kangaroo Valley+clover mixture (28N)	..	3 475	..	..	..
L. perenne cv. Kangaroo Valley+clover mixture (256N)	..	5 054	..	..	..
L. perenne cv. Kangaroo Valley+clover mixture (304N)	..	5 842	..	..	..
Avena strigosa cv. Saia+*L. perenne* cv. Kangaroo Valley+clover mixture	..	5 717	..	..	..
Avena strigosa cv. Saia oats+*L. multiflorum* Grasslands Tama	5 917	..	..	..	..
Avena strigosa cv. Saia oats+*L. perenne* cv. Kangaroo Valley	..	7 189	..	8 348φ	7 800
l.s.d. (P=0.05)		1 129	1 955	1 176	1 750

* Perenniated growth from 1974; .. not sown; +One harvest omitted (23 Dec); φc. 3000 kg of these yields from the harvest on 23 Dec.

Application of nitrogen

There was no measure of the effect of applied nitrogen in the low yielding Experiment 1, but in the remaining plantings substantial and highly significant ($P<0.01$) increases in yield of Kangaroo Valley ryegrass were obtained (Figure 1). As well, nitrogen content was increased in each experiment by nitrogen application (Table 7).

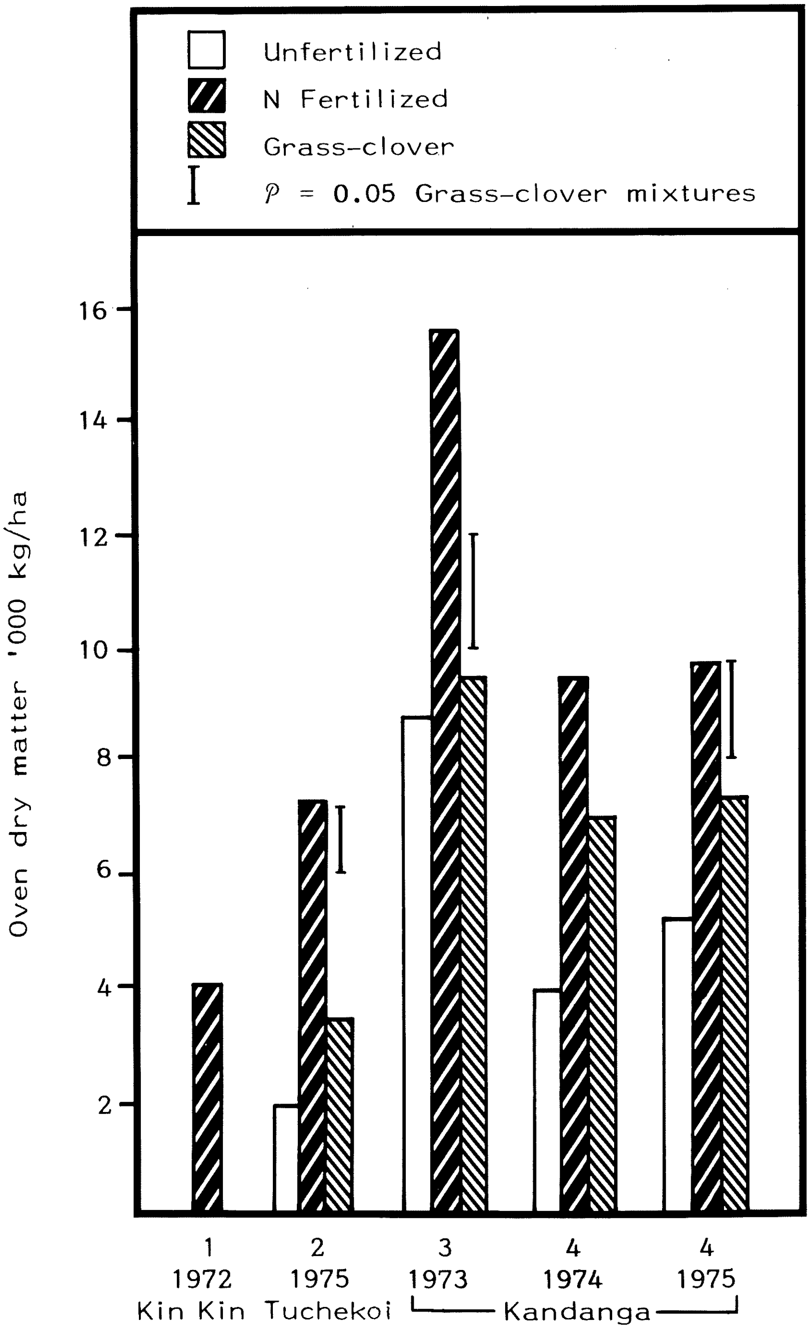

Figure 1. The effect of nitrogen fertiliser on the total oven dry matter yields of Kangaroo Valley ryegrass in pure swards compared with the best grass-clover mixture and unfertilised Kangaroo Valley ryegrass swards.

Table 9. Interharvest mean daily growth rates in kilograms ODM per hectare per day of total pasture yield and the clover component compared with unfertilised Kangaroo Valley ryegrass in the Kangaroo Valley ryegrass clover mixtures under irrigation in Experiments 3 and 4 in the first year

Experiment number Location Date planted	3 Kandanga 27 Mar 73								4 Kandanga 27 Mar 74							
Date harvested Growth interval (days)	17 May 51	7 Jun 21	3 Jul 26	1 Aug 29	22 Aug 21	18 Sep 27	17 Oct 29	6 Nov 20	5 Jun 70	11 Jul 36	20 Aug 40	10 Sep 21	26 Sep 16	16 Oct 20	4 Nov 19	23 Dec 49
Total growth: Grass +Clover																
+Ladino	12		23	37		54	90	44	1	3	7	27	37	58	62	61
+Louisiana	18		21	42		63	93	34	1	4	9	28	33	35	53	53
+Haifa	16		23	41		54	89	31	..	..	..	..	..	..	..	..
+Yarloop	19		21	35		36	63	19	..	..	..	..	..	..	..	..
+Safari	20		17	31		32	50	19	2	5	11	28	49	53	46	46
Kangaroo Valley ryegrass−N	22	40	28	41	49	60	61	25	4	7	8	29	40	40	53	1.5
Clover growth																
Ladino	0.9		3.6	6.7		18	44	22	0.1	0.1	0.4	3.0	5.0	14	13	22
Louisiana	0.5		1.5	5.3		17	34	11	0.0	0.0	0.0	0.4	0.3	1	2	4
Haifa	0.2		1.6	6.3		21	41	9	..	..	..	..	..	..	..	..
Yarloop	1.5		2.5	4.0		7	6	0	..	..	..	..	..	..	..	..
Safari	0.8		0.5	0.4		0	1	0	0.0	0.1	0.0	2.4	9.3	11	4	12

In Experiment 2, where differential nitrogen rates were applied to the Kangaroo Valley-clover mixture, a severe depression in total clover yield resulted from the increasing use of nitrogen. Clover yields fell from 870 kg/ha with only 28 kg/ha N at planting to 159 kg/ha when 304 kg/ha N was applied over the full growing season. However, when Saia oats was also included in the mixture and 304 kg/ha N applied, clover yield was 376 kg/ha.

Variation of grass seeding rate (Table 10)

At the seeding rates chosen, effects on dry matter yields were variable and inconclusive. Where present, positive effects from increasing seeding rate only lasted for about the first 130 days. On 6 out of 30 harvests the cultivar by seeding rate interaction was significant ($P<0.05$) (Table 10) but there was no consistent size or order in the differences measured.

Diseases

Leaf rust (*Puccinia coronata*) was prevalent under warm humid conditions. The ryegrasses *L. perenne* cvv. Mansfield and Tasdale, and *L. multiflorum* cv. Grassland Tama appeared the most susceptible to rust.

DISCUSSION

A wide range of conditions was experienced from the droughted Experiment 1 to an excellent season (Experiment 3, irrigated). The second raingrown Experiment 2 received average rainfall, while Experiment 4 received inadequate irrigation and experienced a drier and colder winter in its first year. This range of conditions resulted in large variations in yield, the irrigated yields in 1974, for example, being less than 50% of the 1973 yields for some cultivars. Maintaining Experiment 4 for a second year also gave an indication of the potential of lines to perenniate.

Table 10. Main effects of seeding rate of grasses on mean oven dry matter production across all grass treatments in kilograms per hectare

Experiment Seeding rate (kg/ha)	1. Kin Kin 1972		2. Tuchekoi 1975φ		3. Kandanga 1973ˣ		4. Kandanga 1974ˣ		4. Kandanga 1975	
	17	34	22	45	22	45	22	45	22	45
Harvest number										
1	536	648‡*	121	244**	1 304	1 479	793	910#	778	859
2	1 150	993‡*	827	1 021**	987	1 112*	464	539	643	570
3	1 460	1 919**	1 039	1 131	1 892	2 013	905	913	1 008	1 084
4			1 878	2 023*	1 916	2 158*	1 055	1 125#	949	983
5			1 427	1 377	1 672	1 711	1 123	1 246*	1 177	1 131
6					2 444	2 427	1 133	1 194#	961	964
7					3 327	2 641**	1 401	1 406	569	474
8					634	524				
Total	3 146	3 560*	5 291	5 797*	14 178	14 065	6 874	7 333*	6 084	6 065

* Differences significant $P<0.05$
** Differences significant $P<0.01$
φoats seeding rate 44 and 88 kg/ha.
ˣ prairie seeding rates 11, 22 kg/ha.
‡cultivar×rate interaction significant $P<0.01$ (H1) and $P<0.05$ (H2)
#cultivar×rate interaction significant $P<0.05$ (H1, 4 and 6)
Considerable lack of consistency between grasses at different harvests.

Even with this variation the mean total annual yields of the irrigated and nitrogen fertilised grass pasture (7.1 to 14.2 t/ha dry matter: 6 t/ha perenniated) are within the range recorded for nitrogen fertilised ryegrasses for similar growth periods in temperate environments (Hunt 1971; Harris 1973). The mean total yield of 14.2 t/ha dry matter at Kandanga in 1973 is lower, but not substantially so, than the maximum attainable in subtropical areas (Lowe, Bowdler, Ostrowski and Stillman 1983).

While the ryegrasses showed consistent and considerable promise under irrigation their value under raingrown conditions, especially in the 1972 drought, indicated that they are poorly adapted. If the ryegrasses are to be used raingrown then the earlier growing annuals appear superior, especially Wimmera and Grasslands Manawa.

As is to be expected, the annual ryegrasses performed best early in the season, with the perennials doing much better in late winter and spring. In an annual pasture a mixture of annuals and perennials is indicated. This should give the longest period of high yields. However, where it is intended to carry the stand through into the second year, and this is sometimes possible in south-east Queensland, then the perennial cultivars should be the dominant component of the planting. This strategem has some merit in savings in replanting costs and in earlier second season grazing but, to be successful, summer management is important in maintaining sward density.

Kangaroo Valley was the most consistently high yielding ryegrass. It also showed good rust tolerance and this confirms previous experience with it elsewhere in south-east Queensland (Lowe *et al.* 1983). However, overall the results show few differences between the ryegrass cultivars in total dry matter yields with the annuals Wimmera, Grasslands Paroa and Manawa, and the perennials Mansfield, Colac and Grasslands Ariki all providing excellent alternatives if Kangaroo Valley seed is unavailable.

Plant type did not appear to influence yield greatly. Although the tetraploid Grasslands Tama had a broader and larger leaf Tama showed no yield advantage over the narrower leaved diploids. This agrees with Harkess (1966) who found the major difference was that the tetraploids had a higher moisture content.

Saia oats was the best species in the drought of 1972 but was not able to sustain production under close constant defoliation. This agrees with the findings of Lowe and Bowdler (pers. comm.) and was particularly obvious in mixtures with ryegrasses.

The only other grass species to show promise was prairie grass (cv. Priebe) which yielded very well in late spring and then early in the autumn in the second year. It did not, however, persist well in the second winter but warrants consideration in warmer areas.

Within the range of *Trifolium* spp. and cultivars planted, there was almost no benefit from their inclusion in mixtures with Kangaroo Valley ryegrass, especially in annual plantings, when very high yields are being sought. They only yielded well late in the spring and had little effect on the associated ryegrass. This agrees with other results in south-east Queensland (Bowdler and Lowe 1980). When nitrogen was applied to the mixture the clover yield was reduced to insignificance. The ryegrass planted in these mixtures at a reduced rate was also unable to make up the leeway in total yield achieved from pure fertilised stands. Overall these clovers did not stand up to the competition from fertilised ryegrass and made little contribution to the nitrogen nutrition of unfertilised ryegrass in the first season. However, there was merit in the species used, especially the *T. repens* and *T. semipilosum* cultivars, where it is intended to carry the planting over into the second winter. They begin to make a useful contribution in this second season and could substitute for applied nitrogen in these cases.

Doubling ryegrass seeding rates from 17 kg/ha in Experiment 1 and from 22 kg/ha in the remaining plantings had little effect on yield. Therefore, it would appear that, with pure swards planted on well prepared seedbeds, 22 kg/ha is an adequate seeding rate for the ryegrass. The appropriate lower rate for other species also applies.

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