COMPARISON OF HUIA WHITE CLOVER AND MAKU LOTUS OVERSOWN SEPARATELY OR AS A MIXTURE

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Abstract

Results are given from two experiments comparing the establishment and production of 'Grasslands Huia' white clover (*Trifolium repens*) and 'Grasslands Maku' lotus (*Lotus pedunculatus*). These were oversown alone or as a mixture on to a low-fertility, acid, tussock grassland soil (pH 4.6) near Berwick, Otago. Establishment of both species was slow and in the second year there were only small differences in yield between white clover and lotus. However, in the third year lotus markedly outyielded white clover in the presence and absence of lime; at four levels of P from 7.5 to 60 kg/ha; and at seeding rates from 2 to 10 kg/ha. Lotus also outyielded the lotus/white clover mixture at the 5 and 10 kg/ha seeding rate.

INTRODUCTION

Lotus pedunculatus is considered to be a suitable legume for sowing on low-fertility hill country soils (Levy, 1970). This is supported by *L. pedunculatus* outyielding white clover (*Trifolium repens*) under conditions of low phosphate (Brock, 1973) and by its lower lime requirements than white clover for nodulation on acid soils (Greenwood, 1961).

This paper compares the establishment and growth of *L. pedunculatus* and white clover on an acid, low-fertility soil in Otago. The effects of lime, phosphate, seeding rate, and of the two species sown separately or together on legume dry matter production were investigated.

EXPERIMENTAL

Two experiments were laid down near Rerwick, in the coastal margin of the Otago plateau approximately 40 km SW of Dunedin, at an altitude of 420 m. The annual rainfall, recorded at the nearby Berwick Forest, is 725 mm. The soil, a Waipori upland yellow-brown earth with a pH of 4.6 (0.3 cm), had a thick vegetative cover of snow tussock (*Chionochloa* sp.), browntop (*Agrostis tenuis*), sweet vernal (*Anthoxanthum odoratum*) and snow berries (*Pernettya macrostigma*).

The experiments compared the growth and establishment of 'Grasslands Maku' *L. pedunculatus* (lotus) and 'Grasslands Huia' *T. repens* (white clover). In addition to legume dry matter production, total dry matter production was recorded in one experiment. Seeding rates were adjusted to supply the same number of viable seeds per unit area.

The treatments, arranged in four randomized blocks, were as follows:

Experiment 1:

Species: Lotus vs white clover
Seeding rate: Equivalent to 2 or 10 kg/ha white clover
Mixture: Alone or as a 50:50 lotus: white clover mixture
Lime: 0 or 1250 kg/ha

Experiment 2 :

Species: Lotus or white clover (seeding rate equivalent to 5 kg/ha white clover)
Mixture: Alone or as 50:50 mixture
Phosphorus: 7.5, 15, 30, 60 kg/ha P as monocalcium phosphate.

Experiment 1 received a basal dressing of 300 kg/ha molybdic superphosphate, while Experiment 2 received 200 g/ha sodium molybdate, and 50 kg/ha elemental sulphur. Basal fertilizers were applied 2 days before sowing. Seed was inoculated with the respective commercial inoculants at the recommended rate, pelleted with rock-phosphate + dolomite and broadcast on September 9, 1973. Experiment 1 received an annual maintenance dressing of 300 kg/ha superphosphate and 100 kg/ha KCl. Experiment 2 received 50 kg/ha elemental sulphur, 100 kg/ha KCl, and the respective phosphorus levels.

The establishment of seedlings in Experiment 1 was assessed by quadrat counts in March 1974. Both experiments were then trimmed by a rotary mower and the clippings removed. In the 1974-5 season, dry matter production was assessed by one cut with a sickle bar mower on June 4, 1975. In the 1975-6 season. the experiments were cut on February 7 and April 29, 1976.

RESULTS

ESTABLISHMENT

Experiment 1

Far fewer lotus plants established than those of white clover and at the low seeding rate there were very few lotus seedlings present (Table 1). The addition of lime irxreased the establishment of both lotus and white clover.

TABLE 1: EXPERIMENT 1: EFFECT OF LIME ON LEGUME SEEDLING ESTABLISHMENT
(Plants/m*)

Species	Lime (kg/ha)	Seeding Rate (kg/ha) 2	10	Mean
White Clover	0	11	40	26
	1250	22	63	43
Lotus	0	2	20	11
	1250	7	39	23
LSD $P<0.05$			13	9
$P<0.01$			18	12

Species × lime interaction not significant ($P<0.05$)

DRY MATTER PRODUCTJON

Experiment 1

Legume dry matter production was low in 1974-5, although some significant treatment effects emerged (Table 2). Increasing the seeding rate markedly increased the yield of lotus and increased the yield of the mixture in the absence of lime. The apparent higher yield of the mixture in the presence of lime was not significant. At the high seeding rates, lotus outyielded white clover in both the absence and presence of lime. There was a non-significant trend for lotus to outyield the mixture at the high seeding rate.

In 1975-6 (Table 3), increasing the seeding rate markedly increased the dry matter of lotus but in contrast to 1974-5 had no

TABLE 2: EXPERIMENT 1: TREATMENT EFFECTS ON LEGUME DRY MATTER PRODUCTION IN 1974-5
(kg/ha)
(and log transformed values)

Species	Lime	Seeding Rate (kg/ha) 2	10
White clover	0	76 (4.25)	108 (4.59)
	1250	163 (4.76)	196 (5.26)
Lotus	0	118 (4.61)	625 (6.16)
	1250	164 (5.08)	512 (6.22)
Mixture	0	99 (4.56)	288 (5.63)
		25 %*	44 %
	1250	128 (4.76)	243 (5.46)
		9 %	19 %
LSD (dry matter)		$P<0.05$ = (0.78) ;	$P<0.01$ = (1.04)
(% lotus)		=32	=47

*% of dry matter made up of lotus

effect on the yield of the mixture. Lime increased the yield of white clover at both seeding rates but had no significant effect on lotus; there was a suggestion of an increase at the low seeding rate, but the difference failed to reach significance. Although the addition of lime did not increase the yield of the mixture, it markedly reduced the percentage of lotus in the dry matter.

In 1975-6, the highest yield of legume dry matter was obtained from lotus at the high seeding rate. At the low seeding rate in the absence of lime, lotus and the mixture had similar yields; both outyielded white clover. The non-significant increase in yield of lotus from the addition of lime resulted in significantly higher dry matter production from lotus than from either white clover or the mixture in the presence of lime.

There were no significant treatment effects on total dry matter production in 1974-5 as legumes made up only a small proportion of the total dry matter. The mean total dry matter was 2655 kg/ha.

In 1975-6, there was a species × seeding rate interaction and the highest total yields were obtained from the treatments with lotus at the high seeding rate (Table 4).

Experiment 2

Increasing the P level resulted in only a small increase in white clover yield but markedly increased the yield of lotus (Table 5). In both years, lotus outyielded white clover at all levels of P.

TABLE 3: EXPERIMENT 1: TREATMENT EFFECTS ON LEGUME DRY MATTER PRODUCTION IN 1974-5
(kg/ha)
(and log transformed values)

Species	*Lime*	*Seeding Kate (kg/ha)* 2	10
White clover	0	313 (5.67)	362 (5.85)
	1250	842 (6.70)	766 (6.63)
Lotus	0	1184 (7.04)	3019 (7.92)
	1250	1628 (7.35)	2656 (7.86)
Mixture	0	1021 (6.90)	950 (6.77)
		74 %*	67 %
	1250	898 (6.80)	944 (6.78)
		18 %	24 %
LSD (dry matter)		$P<0.05 = (0.49)$;	$P<0.01 = (0.66)$
(% lotus)		$=21$	$=30$

*% of dry matter made up of lotus

TABLE 4: EXPERIMENT 1: TREATMENT EFFECTS ON TOTAL DRY MATTER PRODUCTION IN 1975/76* (kg/ha)

Species	*Seeding Rate (kg/ha)* 2	10
White clover	2191	1978
Lotus	2811	5122
Mixture	2377	2490
LSD $P<0.05=839$; $P<0.01=1127$		

*Mean of 2 lime treatments. Lime effect and interactions not significant ($P<0.05$)

At the lower levels of P, legume yield of the mixture was similar to that from white clover. However, at the higher levels of P, the legume yield of the mixture was much greater than that from clover. Overall the yield of lotus was significantly greater than that of the mixture ($P < 0.01$) and the trend was apparent at all levels of P.

DISCUSSION

Although lotus was capable of outyielding white clover in the second growing season, differences in general were small owing to the slow establishment of the legumes. The high production of lotus and its influence on total dry matter production was most evident in the third season. In contrast to white clover, yield of lotus was markedly influenced by seeding rate, indicating that, though lotus can spread by stolons and shallow rhizomes (Armstrong, 1974), this spread is relatively slow and it is important to obtain good establishment.

In contrast to white clover, the addition of lime did not appear to increase the growth of lotus as it had no effect on the production of the latter at the high seeding rate. However, lime increased the establishment of lotus seedlings, which may be causal in the tendency for the greater production of lotus with lime at the low seeding rate.

The response to P reported here differs from Brock's (1973) results where lotus outyielded white clover only under conditions of low P. In the present experiment, the yield advantage of lotus increased with increasing P levels. Even though the levels of P used in this experiment are much lower than those used by Brock, it appears that white clover growth is limited by some factor other than P on these soils as there was only a small in-

TABLE 5: EXPERIMENT 2: EFFECT OF P LEVEL ON LEGUME DRY MATTER PRODUCTION (kg/ha)
(and log transformed values)

P (kg/ha)	*19745* White Clover	*Lotus*	*Mixture*	*19756* White Clover	*Lotus*	*Mixture*
7.5	46 (3.49)	114 (4.54)	24 (2.75)	328 (5.41)	600 (6.32)	311 (5.63)
15	22 (2.90)	112 (4.35)	64 (3.87)	415 (5.99)	1090 (6.75)	509 (6.11)
30	42 (3.67)	192 (5.22)	88 (4.39)	550 (6.29)	1665 (7.39)	1199 (7.08)
60	163 (4.10)	552 (6.17)	419 (5.98)	561 (6.29)	3275 (8.07)	1718 (7.42)
LSD $P<0.05$ =		(1.03)			(0.70)	
$P<0.01$ =		(1.39)			(0.95)	
Mean *	43 (3.54)	242 (5.07)	149 (4.25)	463 (6.00)	1658 (7.13)	934 (6.56)
LSD $P<0.05$ =		(0.52)			(0.35)	
$P<0.01$ =		(0.69)			(0.47)	

*Species/mixture x P level interaction not significant ($P < 0.05$).

crease in white clover dry matter when P was increased from 7.5 to 60 kg/ha.

In the present experiments, the highest yields of legume dry matter were obtained from lotus sown alone. The legume yield of the mixture was generally higher than white clover in the absence of lime but similar to white clover in the presence of lime. The addition of lime had no effect on the total legume yield of the mixture but markedly reduced the percentage of lotus in the mixture. It therefore appears that the incorporation of lotus with white clover can increase legume yield on acid soils where white clover growth is limited. However, on higher pH soils, competition from white clover may reduce the contribution of lotus to total legume yields as happened when lime was applied in the present experiment.

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REFERENCES

Armstrong, C. S., 1974. *N.Z. Jl exp. Agric., 2*: 333-6.
Brock, J. L., 1973. *N.Z. Jl agric. Res., 16*: 483-91.
Greenwood, R. M., 1961. *Ibid., 4*: 375-89.
Levy, E. B., 1970. *Grasslands of New Zealand,* 3rd ed. Government Printer, Wellington.