'Grasslands Maku' lotus (*Lotus pedunculatus* Cav.) seed production. 3. Effect of time of closing and severity of defoliation on seed yields.[1]

M.D. Hare[2]

ABSTRACT

'Grasslands Maku' (*Lotus pedunculatus* Cav.),syn. *L. uliginosus* (Schkuhr) seed yields of 47 g m^{-2} were harvested from treatments left uncut from the start of spring growth. Cutting to a ground level before bud appearance, in September and October, significantly reduced seed yields to 28 g m^{-2} and 14 g m^{-2} respectively and after bud appearance did not significantly affect seed yields but topping after bud appearance reduced seed yields to 26 g m^{-2}.

INTRODUCTION

Many farmers close 'Grasslands Maku' lotus (*Lotus pedunculatus* Cav.), syn. *L. uliginosus* (Schkuhr), from early spring to early summer according to their experiences with clover and lucerne seed crops. It is normal practice for farmers to cut established lucerne stands for hay and then harvest for seed later in the same season (Kowithayakorn and Hill, 1982). White clover seed crops grazed until mid-November and red clover seed crops closed in early December after grazing will give high seed yields (Clifford, 1980; Clifford and Anderson, 1980).

Research by Clifford (1975, reported by Lancashire et al., 1980) found that marked reductions in Maku lotus seed yields occurred when crops were closed later than October 1st. Neal (1983) also reports that by closing in mid-October, after close grazing or cutting, seed yields are decreased, compared with earlier closing dates. However, Neal (1983) preferred October closing, as there was less vegetative bulk at harvest and pod shattering was reduced by harvesting under cooler conditions in March.

By allowing an initial attack on Maku lotus flowerheads by potato mirids (*Calocoris norvegicus*) and then spraying with an insecticide, Clifford et al., (1983) increased stem branching and potential seed yields of Maku lotus. They concluded that the increased stem branching was because the early apical dominance of the primary stems was impaired, either by way of physical mirid damage or some hormonal effect induced by the injection of mirid saliva. They also found that flowerheads when protected with an insecticide application following a mirid attack, shortened the period of flowering, thereby ensuring minimum seed losses at harvest. Maku lotus has been found to have a long flowering period, flowering from mid-November until April, (Armstrong 1974), making harvesting difficult (Neal, 1983). Clifford et al., (1983) also suggested, that in the absence of a mirid attack, some form of high topping management with a mower to remove only primary apical meristems, might promote stem branching in Maku lotus.

The objective of this study was to impose a range of closing dates and different intensities of defoliation in order to test the following hypotheses that:

(i) any severe cutting treatment after the start of spring growth may be detrimental to seed yield.

(ii) a high topping may simulate mirid damage and concentrate flowering time allowing for easier harvest management.

MATERIALS AND METHODS

The study was conducted over two seasons (1981-83) on a 0.75 ha Maku lotus field at Lincoln College, Canterbury, New Zealand (43°S). The soil type was a Wakanui soil complex (Hare and Lucas, 1984) containing adequate nutrients. Maku lotus was sown on 5 November 1980 in 0.45 m rows, at a sowing rate of 3 kg ha^{-1}. Each plot over the two seasons averaged six plants m^{-2}.

Trial 1: Effect of time of defoliation, 1981-82

The field was sprayed with paraquat at 0.5 a.i. ha^{-1} in July 1981, to control grass weeds.

There were five treatments, a check and four cutting dates:

(a) left uncut until seed harvest in January.

(b) cut to ground level (30-50 mm above the ground) with a sickle-bar mower, 1.2 m wide, on 12 November, (c) 24 November, (d) 4 December, and (e) 15 December, 1981.

Each plot was 15 m x 2.5 m, and there were six replicates.

Dry matter yield measurements: At closing, material the length of each plot was harvested, fresh weighed and dry weight determined. At seed harvest, 10 stems from each plot were dried and the average stem dry weight multiplied by the average stem number m^{-2}.

Seed yield measurements: Optimum harvest time was determined when approximately 5% of the pods had shattered, 80% of the pods were light brown, 10% of the pods were green or purple and 5% of the umbels were still in the yellow flower stage (Hare and Lucas, 1984).

[1]A contribution of the Plant Science Department, Lincoln College Canterbury, New Zealand. Received for publication 11 February 1985.

[2]Present address: Grasslands Division, DSIR, Private Bag, Palmerston North, New Zealand.

Just before seed harvest 20 stems were randomly cut from each plot for measurement of components of seed yield. Seeds per pod were not measured. At seed harvest two 2 x 1 m areas per plot were cut, oven dried for four days at 35 C, threshed and cleaned to determine total seed yield. The harvested areas were vacuumed to calculate shattered seed yield. To calculate the effect of delay of harvest upon seed yield, two more 2 x 1 m areas were harvested one week after the main harvest in the uncut treatment. All seed yields were corrected to 12% moisture content. Vacuumed seed was not added to final harvested seed yields in the results.

Trial 2: Effect of time and severity of defoliation, 1982-83

The field was mown on 4 May, 1982 and the cut material removed. Ioxynil ('Totril') was sprayed twice, two weeks apart, at 1.6 kg a.i. ha^{-1} in August to control broad leaved weeds. Carbetamide, ('Carbetamex 70') at 1.5 kg a.i. ha^{-1}, was applied twice, two weeks apart, in September to control *Poa annua* and barley grass (*Hordeum murinum*).

Two hives of honey-bees were placed in the field in November 1982. No hives were in the field for the previous trial.

Bromophos ('Nexion') at 0.4 a.i. ha^{-1}, was applied on 16 December to control potato mirids (*Calocoris norvegicus*) when mirid populations in the field reached 15-20 per 20 net sweeps with a 400 mm sweep net (Clifford et al., 1983).

The trial was a factorial design with three closing dates by two cutting heights, plus one uncut treatment, with four replicates. Closing dates were 29 September, 20 October, and 11 November, 1982, and cutting heights were (a) ground level with a sickle-bar mower and trimmed with rotary mower, and (b) 50-100 mm off the top of Maku lotus with a sickle-bar mower. The uncut treatment plots were not cut until seed harvest in February 1983.

Dry matter yield measurements: At closing two 2 x 1 m areas were cut from the ground level plots, fresh weighed and dry weight determined. Dry matter cuts were not taken from topped plots. At seed harvest two 0.5 m^{-2} areas were cut from each plot and all the material was dried and weighed.

Seed yield measurements: Two 2 x 1 m areas were hand harvested from each plot at the optimum seed harvest time and slowly air dried over a period of four to six weeks. The material was then threshed and the seed cleaned. Ten stems were randomly cut from each plot for measurement of components of seed yield. As shattering was minimal sample areas were not vacuumed. All seed yields were corrected to 12% moisture content.

RESULTS

Meteorological Data

1981-82 was a hot dry season with higher average maximum temperatures, higher average vapor pressure deficits and less total rainfall than the 1982-83 season (Table 1).

Heavy hail fell on 19 January, 1983, before any seed was harvested, causing approximately 10% seed loss in all plots. Estimates of hail damage were made by taking 10 stems randomly from each plot and counting total pods, broken pods and broken stems.

Flowering at Defoliation

At closing dates in September and October no flower buds were visible. By mid-November green buds were forming, becoming orange by late November. In early December yellow flowers were forming, reaching maximum bloom in mid-December.

Defoliation at closing caused harvest dates to be delayed up to two months later than the uncut treatment harvest time. When uncut plots were harvested other plots were still flowering.

Days From Cutting to Seed Harvest

Seed harvest dates and days from cutting to seed harvest are given in Table 2. The cool weather caused pods to ripen very slowly (Hare and Lucas, 1984) making optimum harvest time very difficult to determine. From stem analysis at harvesting, there was a large proportion of small green pods and a very small proportion of shattered pods (light brown pods 55%, purple pods 9%, green pods 34%, shattered pods 2%). The heavy December rainfall caused a mass of new vegetative growth to appear with new flowers forming in

Table 1. Mean monthly temperatures, mean monthly vapor pressure deficits and total monthly rainfall for the 1981-82 and 1982-83 seasons.

Month	Mean temperatures		Mean vapor pressure deficits		Total rainfall	
	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83
	(C)		(k pa)		(mm)	
August	5.6	8.2	0.20	0.41	122.5	23.4
September	8.7	8.6	0.43	0.25	15.0	20.8
October	11.5	9.9	0.52	0.48	94.4	87.6
November	13.5	15.0	0.48	0.87	34.6	52.2
December	17.1	13.7	0.72	0.59	15.1	94.2
January	17.2	15.7	1.02	0.82	28.2	30.8
February	17.4	14.8	0.93	0.55	15.5	18.5
March	16.0	15.2	0.67	0.81	12.2	24.0
April	10.1	11.6	0.30	0.42	46.6	101.4

Table 2. Harvest dates and days from cutting to seed harvest.

Time of closing and method of cutting at closing	Seed harvest date	Days from cutting to seed harvest
1981-82		
Uncut	21 January	
12 November	9 February	89
Cut to ground level		
24 November	18 February	86
Cut to ground level		
4 December	16 March	102
Cut to ground level		
15 December	22 March	97
Cut to ground level		
1982-83		
Uncut	8 February	-
29 September	1-16 February	125-140
Cut to ground level		
Topped	1-16 February	125-140
20 October	16-24 February	119-127
Cut to ground level		
Topped	1-24 February	104-127
11 November	2 March	111
Cut to ground level		
Topped	16-24 February	97-105

January. It was not possible to delay harvesting until the green pods were ripe, as the brown pods, which were in larger proportion, would have shattered.

Dry Matter Yields

Dry matter at closing increased with the lateness of closing dates (Table 3). The maximum dry matter yield at seed harvest in 1982 was from the uncut treatment. This was three to four times greater than the defoliated treatments which averaged 330 g m^{-2} of dry matter at harvest.

Cutting to ground level on 11 November, 1982 significantly reduced dry matter at seed harvest in 1983 compared with the topped treatment (Table 3). There were no significant differences in dry matter at seed harvest in 1983 between methods of cutting at the two earlier closing dates.

Stem Length at Seed Harvest

In 1981-82 cutting at closing reduced stem length at seed harvest by one half or more than the uncut treatments (Table 4). Stem lengths were significantly reduced at harvest, by closing in mid-December.

In 1983 cutting at closing did not affect stem lengths at harvest except for the ground level cutting on 11 November which was approximately 100 mm shorter in length.

Seed Yield

Maximum seed yields in both years were from the uncut treatments; 47 g m^{-2} in 1981-82 (Table 5) and 48.8 g m^{-2} in 1982-83 (Table 6).

Seed yields in 1981-82 were significantly reduced by cutting (Table 5). Plots cut in November and December 1981, produced none or very little seed at all, as the very dry conditions caused the pods to shrivel and produce no harvestable seed.

Later closing with cutting to ground level decreased seed yields in 1982-83 (Table 6). There was no significant difference in seed yield between closing dates when crops were simply topped. However, crops that were topped yielded significantly less seed than those that were uncut (Table 6).

Table 3. Effect of closing date upon Maku lotus dry matter yields at closing, harvest and post-harvest in 1981-82.

Treatments	Dry Matter g m^{-2}	
Closing date	Closing	Harvest
1981-82		
Uncut		1135
12 November	263	416
24 November	406	330
4 December	480	365
15 December	408	208
SE (mean)	55	164
1982-83		
Uncut		1044
29 September		
Ground	204	905
Topped		943
20 October		
Ground	288	1034
Topped		999
11 November		
Ground	350	806*
Topped		1112
SE (mean)		

Table 4. Effect of closing date upon stem length at harvest.

Closing Date	Method of cutting	Stem length
1981-82		(mm)
Uncut		860
12 November	Ground level	460
24 November	Ground level	420
4 December	Ground level	330
15 December	Ground level	280
SE (mean)		103
1982-83		
Uncut		710
29 September	Ground level	760
	Topped	730
20 October	Ground level	730
	Topped	730
11 November	Ground level	620
	Topped	710
SE (mean)		16.7

Table 5. Effect of time of closing on Maku lotus seed yields in 1981-82.

Treatment (Closing date 1981)	Seed yield g m^{-2} (12% moisture)
Uncut	47
SE (mean)	(4.8)
12 November	1.2
SE (mean)	(0.25)
24 November	0
4 December	0
15 December	1.5
SE (mean)	(0.47)

Table 6. Effect of time of closing and method of cutting at closing on Maku lotus seed yields in 1982-83.

Treatment	Seed yield g m^{-2} (12% moisture)	
(Time of closing, 1982)	Cut to ground level	Topped
29 September 1982	28.2	39.9
20 October 1982	13.6	41.1
11 November 1982	6.7	25.9
SE (mean)	4.24	7.39
Significance	[1]L**	[2]N.S.
Uncut	48.8	
Mean of 6 cut treatments	25.8	
SE (mean)	5.8	
Significance	**	

[1]Linear [2]Non-significant
** Significance 1% level.

Topping produced significantly higher yields, than cutting at all closing dates.

Pod shatter was rapid in 1981-82 as a result of hot dry conditions when harvesting was delayed. Uncut plots harvested on 21 January 1982, had 11% of total seed on the ground and eight days later 47% of total seed was on the ground. Pod shattering was minimal in 1982-83 with only 2% pod shatter in the uncut plots at harvest.

Components of Seed Yield

In 1981-82 cutting reduced the number of umbels per stem and pods per umbel (Table 7). In 1982-83 seed yield per stem and seeds per pod when both topped and cut to ground level, showed highly significant ($P<0.01$) decreases from September to November closing dates (Table 8). Cutting at ground level significantly ($P<0.01$) reduced umbels per stem. Pods per umbel and 1,000 seed weight were not affected by successively later closings and severity of defoliation (Table 8).

DISCUSSION

Delaying the date of closing and increasing severity of defoliation at closing depressed seed yields of Maku lotus. This pattern of reductions in seed yield following either lax or severe defoliations, particularly after bud formation, has also been reported in other herbage legumes e.g., *Lotus corniculatus* (Anderson and Metcalfe, 1957; Bader and Anderson, 1962), *Medicago sativa* (Kowithayakorn and Hill, 1982), *Stylosanthes guianensis* (Loch et al., 1976), *S. humilis* (Loch and Humphreys, 1970; Fisher, 1973), *Trifolium subterraneum* (Rossiter, 1961; Collins, 1978) and *Trifolium pratense* (Dade, 1966).

Closing Maku lotus seed crops from November onwards significantly reduced seed yields as previously observed by Clifford (1975; reported by Lancashire et al., 1980). However, closing even earlier, in late September and October, with a close ground cutting, also decreased seed yields. These decreases of Maku lotus seed yields may be caused by either slow recovery from severe defoliation, (Sheath, 1980) or slow growth under cool early spring temperatures (Charlton, 1977). In both trials warm spring temperatures above 15°C were not reached until November.

Both lucerne and white clover recover rapidly from defoliation and grow in the early spring when the average daily temperatures are still about 10-15 C. Grazing can therefore be practiced before closing crops for seed production. However, Maku lotus has relatively little winter or early spring growth and therefore, spring grazing cannot be carried out if maximum seed yields are to be produced.

Topping did not simulate mirid damage, as the stems did not branch and produce more umbels per stem (Table 8) and concentrate flowering. Instead there was a decrease in seeds per pod following topping. Clifford et al., (1983) found that mirids only damaged the umbels. Topping in this study removed the umbels and 50-100 mm of stem, and this may have been too severe to allow Maku lotus to recover, branch, and produce more umbels per stem. However, it is impractical for farmers to remove any less stem by topping in November or December, because of the height and uneven growth of Maku lotus stands. There is a need, however, for more detailed study of the effect on seed yield on removing

Table 7. Effect of time of closing on components of seed yield of Maku lotus in 1981-82.

Treatment	Stems m^{-2}	Umbels $stem^{-1}$	Pods $umbel^{-1}$	1000 seed wt (12% moisture)
Uncut	325	8.5	8.0	0.930
Cut to ground level				
12 Nov	427	4.2	5.2	0.918
24 Nov	345	-	-	-
4 Dec	373	-	-	-
15 Dec	343	1.9	2.6	0.938
SE (mean)	17.8			

Table 8. Effect of time of closing and method of cutting at closing on components of seed yield of Maku lotus in 1982-83.

Treatment	Stems m^{-2}	Seed Yield $stem^{-1}$ (g)	Umbels $stem^{-1}$	Pods $umbel^{-1}$	Seeds pod^{-1}	1000 seed weight (g) 12% moisture
Cut to ground level						
29 Sept	452	0.18	6.2	5.5	5.6	0.970
20 Oct	476	0.09	5.5	6.0	2.7	0.977
11 Nov	502	0.02	2.9	6.7	1.2	0.912
Significance	N.S.	[1]L**	L**	[2]N.S.	L**	N.S.
SE (mean)	30	0.03	0.8	0.3	0.7	0.019
Topped						
29 Sept	449	0.24	6.4	5.7	6.9	0.944
20 Oct	447	0.19	6.3	5.7	5.6	0.929
11 Nov	374	0.08	5.6	5.5	2.6	0.994
Significance	N.S.	L**	N.S.	N.S.	L**	N.S.
SE (mean)	30	0.03	0.8	0.3	0.7	0.019
Contrast						
Uncut	481	0.18	5.3	5.1	7.5	0.926
Mean of 6	450	0.13	5.6	5.8	4.1	0.954
Cut treatments						
Significance	N.S.	N.S.	N.S.	N.S.	**	N.S.
SE (mean)	30	0.03	0.8	0.4	0.7	0.027

[1]Linear [2]Non-significant
**Significance 1% level.

only umbels as this may stimulate mirid damage more closely. The possibility of hormonal effects of mirids saliva (Clifford et al., 1983) needs further study as some growth regulatory substance may be involved.

The main problem with Maku lotus at harvest is to dry the mass of vegetation, especially the stems, before pods shatter. Neal (1983) closed fields late in order to have less vegetation and shorter stems to dry at harvest and to reduce pod shatter, although this meant a loss in potential seed yield. However, Neal (1983) maintained that it was better to be sure of a low seed yield in the bag rather than risk a high seed yield with most on the ground. It was found in this study that vegetation and stem length at harvest could only be significantly reduced by cutting to ground level from November onwards, but little seed was produced. In order, therefore, to get high seed yields, large amounts of vegetation and long stems are unavoidable and must be coped with at harvest. Harvesting at the optimum time (Hare and Lucas, 1984) will allow sufficient time for the vegetation and stems to dry, either after mowing or chemical desiccation, before combine harvesting. After mowing, the stems should be turned upmost with a hay rake in order to dry quickly. The pods will be protected from shattering under the stems (Lancashire et al., 1980).

Flowering and seed ripening were not concentrated by later closing dates as reported by Neal (1983). There were no observed differences in length of flowering and seed ripening between treatments cut to ground level or topped.

CONCLUSION

Seed yields of Maku lotus in Canterbury were significantly reduced by cutting to ground level after spring growth started. Topping only reduced seed yields when it was carried out after bud appearance in November. A light topping can therefore take place in the spring without detrimental effects on seed yields, but it is of no practical value.

ACKNOWLEDGEMENTS

Appreciation is expressed to the Leonard Condell Farming Scholarship Trust for awarding the author a scholarship in 1982 and 1983, the Lincoln College Research Committee for providing funds for the field research, Mr. R.J. Lucas for assistance in preparing the trial and advice in analyzing the data, Mr. B.G. Love for statistical analysis and Mr. P.T.P. Clifford for advice throughout the research program.

REFERENCES

1. Anderson, S.R., and D.S. Metcalfe, 1957. Seed yields of Birdsfoot Trefoil (*Lotus corniculatus* L.) as affected by preharvest clipping and by growing in association with three adapted grasses. Agron. J. 49:52-55.
2. Armstrong, C.S. 1974. 'Grasslands Maku' tetraploid lotus (*Lotus pedunculatus* Cav.). N.Z. J. of Exp. Agric. 2:333-6.
3. Bader, K.L., and S.R. Anderson. 1962. Seed yields of Birds-

foot Trefoil, *Lotus corniculatus* L., as affected by preharvest clipping combined with control of injurious insects. Agron. J. 54:306-309.
4. Charlton, J.F.L. 1977. Establishment of pasture legumes in North Island hill country. N.Z. J. of Exp. Agric. 5:385-390.
5. Clifford, P.T.P. 1980. Research in white clover seed production. pp. 64-67. *In* Lancashire, J.A. (ed.) Herbage seed production. N.Z. Grassl. Assoc., Palmerston North.
6. Clifford, P.T.P., and A.C. Anderson. 1980. Red clover seed production. Research and practice. pp. 76-79. *In* Lancashire, J.A. (ed.) Herbage seed production. N.Z. Grassl. Assoc. Palmerston North.
7. Clifford, P.T.P., J.A. Wightman, and D.N.J. Whitford 1983. Mirids in 'Grassland Maku' lotus seed crops: friends or foes? Proc. N.Z. Grassl. Assoc. 44:42-46.
8. Collins, W.J. 1978. The effect of defoliation on inflorescence production, seed yield and hard-seededness in swards of subterranean clover. Australian J. of Agric. Res. 29:789-801.
9. Dade, E. 1966. Effects of clipping on red clover seed yields and seed-yield components. Crop Sci. 6:348-350.
10. Fisher, M.J. 1973. Effects of times, height and frequency of defoliation on the growth and development of Townsville stylo in pure ungrazed swards at Katherine, N.T. Australian J. of Exp. Agric. and Animal Husb. 13:389-397.
11. Hare, M.D., and R.J. Lucas 1984. 'Grasslands Maku' lotus (*Lotus pedunculatus* Cav.) seed production. 1. Development of Maku lotus seed and the determination of time of harvest for maximum seed yields. J. of Applied Seed Prod. 2:58-64.
12. Kowithayakorn, L., and M.J. Hill, 1982. A study of seed production of lucerne (*Medicago sativa*) under different plant spacing and cutting treatments in the seeding year. Seed Sci. and Technol. 10:3-12.
13. Lancashire, J.A., J.S. Gomez, and A. McKellar. 1980. 'Grasslands Maku' lotus seed production: Research and practice. pp. 80-86. *In* Lancashire, J.A. (ed.) Herbage seed production. N.Z. Grassl. Assoc., Palmerston North.
14. Loch, D.S., and L.R. Humphreys 1970. Effects of stage of defoliation on seed production and growth of *Stylosanthes humilis*. Australian J. of Exp. Agric. and Animal Husb. 10: 577-581.
15. Loch, D.S., J.M. Hopkinson, and B.H. English 1976. Seed production of *Stylosanthes guyanensis* 2. The consequences of defoliation. Australian J. of Exp. Agric. and Animal Husb. 16:226-230.
16. Neal, G.W. 1983. Maku lotus seed production in practice. Proc. of N.Z. Grassl. Assoc. 44:36-41.
17. Rossiter, R.C. 1961. The influence of defoliation on the components of seed yield in swards of subterranean clover (*Trifolium subterraneum* L.). Australian J. of Agric. Res. 12: 821-833.
18. Sheath, G.W. 1980. Production and regrowth characteristics of *Lotus pedunculatus* Cav. cv. 'Grasslands Maku'. N.Z. J. of Agric. Res. 23:201-109.

Scarification of Lotus Seed[1]

M.D. Hare and M.P. Rolston[2]

ABSTRACT

Seed of 'Grasslands Maku' tetraploid lotus (*Lotus pedunculatus* Cav. syn. *L. uliginosus* Schkuhr) was scarified by hot water, sulphuric acid and mechanical treatments.

Hot water treatments were effective at 80 C and 90 C for 1 minute immersion. Seed death increased as time of immersion and the temperature of the hot water were increased. All sulphuric acid treatments above 10 minutes immersion in acid significantly increased seed germination, the optimum immersion time occurring at between 60 and 75 minutes.

A commercial Eddy-Giant Huller and Scarifier fitted with rubber concaves scarified seed effectively by impaction when seed was passed quickly through the machine, the optimum speed being 800-900 rpm (73% germination). Increasing the speed and number of passes increased abnormal germinating seed significantly. Higher normal germinations (78%) were achieved using a Westrup polisher which significantly reduced hardseededness in Maku lotus.

The problems of scarifying Maku lotus seed on a commercial scale are discussed and recommendations for commercial scarification presented.

Additional index words: **normal germinating seed; abnormal germinating seed; hard seed; seed processing; seedlot quality.**

INTRODUCTION

Hardseededness is a characteristic of many herbage legumes (Rolston, 1978; Tran and Cavanagh, 1984) which enables seed to persist through unfavorable conditions, and is important in regeneration and persistence of many annual species (Quinlivan, 1971; Suckling and Charlton, 1978). 'Grasslands Maku' tetraploid lotus (*Lotus pedunculatus* Cav.), syn. (*L. uliginosus* Schkuhr) machine harvested seed lines

[1]A contribution of Grasslands Division, Department of Scientific and Industrial Research, Palmerston North, New Zealand. Received for publication 26 August 1985.
[2]Scientists, Grasslands Division, DSIR, Private Bag, Palmerston North, New Zealand.