LUCERNE IN THE PUMICE COUNTRY

R. J. CLARE

Field Research Section, Department of Agriculture, Alexandra

Summary

Eleven years of experimentation have resulted in certain establishment procedures being recommended and it has been shown that direct drilling of lucerne into chemically killed turf has given yields comparable with normal cultivation methods. Maintenance top-dressing trials have shown responses to increased quantities of potash, intermittent responses to sulphur, consistent responses to lime, and fleeting responses to boron. A grazing experiment with four lucerne varieties is described where increased yields have been obtained from a comparison of haying and grazing over production from a pure hay stand.

INTRODUCTION

TAUPO is a comparatively undeveloped county with soils and climate somewhat different from the more developed counties in New Zealand where lucerne is normally grown.

An area of land at Wairakei was leased from the Lands and Survey Department in 1958 for use as a Soil Conservation Reserve. This area contains a portion of coarse-textured pumice flats which are typical of extensive areas in the Taupo County and also, to a substantial extent, of areas in Rotorua and adjacent counties.

Lucerne trials have been carried out here for over eleven years and results from these have been shown by farmer practice to be applicable not only on these coarse pumice soils but also on the finer ash soils where luceme grows much more vigorously.

Pumice country in its virgin state is unsuitable for lucerne as it lacks practically all the soil nutrients necessary for normal growth (Toxopeus, 1971).

Lucerne is usually grown in low rainfall areas owing to its ability to recover after drought and to seek out moisture at depth in the soil. In the higher rainfall zones, reliance is placed on pasture. In the Taupo region, where the rainfall is 45 to 50 in. a year, the coarse-textured free-draining pumice soils lack the ability to retain this moisture and the better pasture species often die out leaving a browntop-dominant sward.

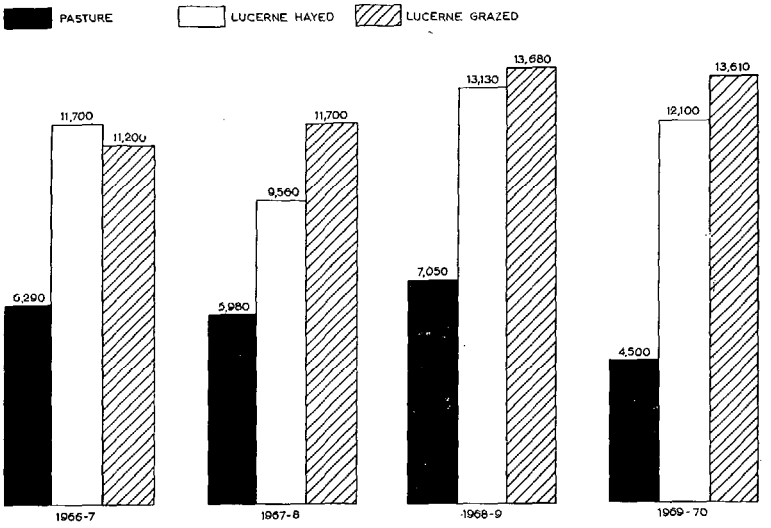

FIG. 1: *Seasonal yields of pasture and lucerne at Wairakei, 1966-7 to* 1969-70 in *lb DM/acre.*

The summers are frequently hot, and even short periods without rain can cause extreme dryness. The deep rooting system of lucerne provides an insurance against these dry periods, and it can give substantially increased yields over pasture. This is particularly so on the coaser-textured free-draining flat lands where on similar soil types under the same fertilizer regime but under different management lucerne produces 100 to 300% more dry matter per acre than pasture (Fig. 1).

As the result of eleven years of trials, techniques have been developed which ensure the establishment of high producing lucerne stands from pasture.

There is no doubt that lucerne is a great aid to increasing production on pumice soils. Farmers are aware of the need to increase production and are turning more and more to the use of lucerne to achieve this end. In the Taupo County in 1959, only 410 acres were in lucerne, whereas in 1969 the total acreage was 2,417.

RATES OF SEEDING

Initial trial work showed that lucerne drilled at 20 lb/ac gave denser establishment but suffered more from drought, as shown by the severe wilting of the plants, than did lucerne drilled at

12 lb/ac which remained green. One year after sowing all plots gave equal production. Two later trials were sown in 1964 and 1965 and yields from these are shown in Table 1.

TABLE 1: RATES OF SEEDING
(Yield in lb DM/ac)

Kate (lb/ac)	*1964 Trial* 2 *cuts 1965-6*	*1965 Trial* 3 cuts 1966-7
Drilled:		
2½	6,750 bA	8,050 cB
5	7,330 abA	8,710 abcAB
10	7,590 abA	8,250 bcB
Broadcast:		
6	6,910 abA	9,010 abAB
12	7,010 abA	9,160 aAB
18	7,910 aA	9,440 aA

Even though broadcasting was shown to be as good as drilling lucerne ½ to ¾ in. deep with an ordinary coulter drill at 7 in. spacings between rows, this was attributed to sowing in seasons when more rainfall than usual was recorded, just prior to and after sowing.

Drilling lucerne is usually preferred, in order to place the inoculated seed into a damper zone of the soil in drier seasons.

In optimum sowing conditions, the lower rates ensure a dense stand being established but with slow nodulation and often far from ideal sowing conditions some additional seed provides insurance against poor plant survival.

Past experience of lucerne growing on these soil types has shown that after two to three years the number of plants thins out to a static level. Plant counts made four months after sowing have shown 16 plants/sq. ft but these were reduced tc 3 plants/sq. ft after three years. These numbers have then remaintained constant when adequate nutrients were applied and good management maintained.

ESTABLISHMENT OF LUCERNE

Establishment procedures have developed largely as a result of observational trials and field experience at Wairakei, and these have been adopted by farmers who have also found the methods used give satisfactory results.

If the area to be sown in luceme contained high proportions of browntop and other twitch grasses, cultivation immediately before sowing tended to increase the weed competition. In this

higher rainfall region early ploughing, fallowing and frequent harrowing **have** increaesd rather than reduced the weed competition. In these cases it was shown to be best to kill the sward with suitable chemicals prior to cultivation.

In early October, lime was broadcast **at** ½ ton/ac followed by ploughing and rolling the furrows. This restored firm contact with the subsoil and facilitated the movement of soil moisture back into the topsoil. Adequate consolidation appeared to be essential for ultimate success.

A further ½ ton lime per acre was broadcast and lightly disced in. Nodulation was better when these two separate applications of lime were applied. The disced-in lime appeared to encourage and speed the formation of nodules down in the layer of lime applied before ploughing. Four to six cwt per acre of 30% potassic serpentine-superphosphate plus 20 lb borax and 8 lb of copper sulphate per acre was broadcast and harrowed in and **the** ground rolled until completely consolidated.

Times of sowing were examined over **three** years and for optimum results it was found that the end of October to early November was the best time for sowing seed.

The seed was carefully inoculated and drilled in at S to 10 lb/ac with 3 cwt lime per acre. Sowing with lime helped to ensure good nodulation and was found to be extremely important. N.Z. Certified (Wairau) variety gave consistently high yields with a good leaf: stem ratio.

In January the stands were topped with the mower or grazed and an additional 3 to 4 cwt/ac 50% potassic superphosphate was broadcast.

DIRECT DRILLING OF LUCERNE

Cultivation costs are high, so direct drilling into chemically treated turf could become an important method of establishment. This could be particularly so on areas where cultivation is difficult and could cause erosion.

Preliminary investigation carried out in 1968 showed that direct drilling into turf killed with 5 lb 2,2-DPA + 2 oz dicamba per acre, followed three weeks later by 4 oz paraquat per acre compared favourably with conventional cultivation methods and no differences in yield were obtained in any cuts (Clare and Matthews, 1969). Seed was drilled in ¾ to 1 in. deep with a 9-coulter disc-type 'drill followed by a rolling to close the cuts made in the turf.

TABLE 2: COMPARISON OF CULTIVATION AND DIRECT DRILLING OF LUCERNE
(Yield lb DM/ac)

	Cut 17/3/70			Cut
	Lucerne	*Weeds*	*Total*	*5/11/70*
Control (plough)	1,060 abA	540 aA	1,600 a	2,950
Chem. treat. (plough)	1,220 aA	570 aA	1,790 a	2,870
Chem. treat. (plough) + 3 lb benfluralin	1,270 aA	80 bB	1,350 a	2,820
Direct drill	830 bA	770 aA	1,600 a	2,920
Mean sig. diff.			470	350
c v %	31.9	65.6	28.2	11.6

A further detailed trial, the results of which are given in Table 2, was commenced in November 1969 and compared four methods of establishment:

(1) No chemical treatment prior to cultivation.

(2) Chemical treatment of turf prior to cultivation.

(3) Chemical treatment of turf prior to cultivation plus soil incorporated benfluralin ("Benefin") at 3 lb/ac.

(4) Chemical treatment of turf with the luceme seed drilled directly into this chemically killed turf.

The chemical treatment of the turf was 5 lb 2,2-DPA + 2 oz dicamba per acre, followed three weeks later by 4 oz paraquat per acre. Adequate basal fertilizer was applied to all plots, being harrowed in on the cultivated plots but left on top of those which were direct drilled.

By the end of the first growing season (1969-70) total dry matter yields were comparable. The percentage of weeds was lowest on the benfluralin plots and the lucerne component was lowest on the direct-drilled plots.

Sorrel *(Rumex acetosella)* was the weed most dominant on the direct drilled plot and least so on the benfluralin plots. At the commencement of the 1970-71 season, no differences between treatments were recorded. Subsequently, all plots were very even with a minor infestation of docks *(Rumex* spp.) and Californian thistles (*Cirsium arvense*) scattered throughout all plots.

FERTILIZER REQUIREMENTS ON ESTABLISHED LUCERNE

Two trials commenced in 1964 were superimposed on a two-year-old stand of lucerne which had been established in the

method previously described. The second season this area received 8 cwt 30% potassic serpentine-superphosphate plus 20 lb borax and 10 lb copper sulphate per acre.

PHOSPHATE, POTASH AND SULPHUR

This trial, commenced in October 1964, compared the following treatments:

Phosphorus — 10, 20 and 40 lb P/ac applied as calcium monophosphate

Potassium — 0, 1 and 3 cwt/ac muriate of potash

Sulphur — 0, 1 and 2 cwt/ac gypsum

The basal fertilizer applied annually was 20 lb borax, 2 cwt dolomite and 10 lb copper sulphate per acre; 5 oz sodium molybdate per acre was applied twice over the period of the trial.

Results are shown in Table 3.

TABLE 3: MAIN EFFECTS OF PHOSPHATE, POTASH AND SULPHUR
(lb DM/ac)

Rates per acre	*4 cuts 1965-6*	*4 cuts 1966-7*	*3 cuts 1967-8*
Ibex:			
10 lb P	11,110 a	10,940 a	9,000 a
20 lb P	11,350 a	11,110 a	9,120 a
401b P	11,340 a	11,030 a	8,990 a
KCl:			
0	10,530 cc	10,420 cC	8,520 cC
1 cwt	11,260 bB	11,160 bB	9,080 bB
3 cwt	12,010 aA	11,510 aA	9,510 aA
Gypsum:			
0	11,020 bB	10,880 bA	8,820 bB
1 cwt	11,410 aA	11,150 aA	8,950 bB
2cwt	11,370 aAB	11,060 aAB	9,340 aA
cv %	3.4	3.3	2.8

Responses occurred to increased rates of potash. Responses to sulphur were recorded with no real difference between 1 cwt and 2 cwt except for the 1967-8 season when 2 cwt gave increased yields over 1 cwt. No responses were recorded to increased rates of P/acre over 10 lb applied as ibex.

Interaction at the 5% level of significance between gypsum and potassium chloride showed increased response to high rates when combined.

LIME, MOLYBDENUM AND BORON

This trial, laid down in 1964, compared the following treatments:

Lime — 0, 10 cwt, 20 cwt and 40 cwt/ac
Molybdenum — 0 and 5 oz/ac as sodium molybdate
Boron — 0 and 20 lb/ac as borax

The lime treatments were applied annually for the first three years during which period the pH increased from 5.6 to 6.4 on the 40 cwt lime plots. Sodium molybdate was applied once only at laying down; the borax treatment was applied annually. The basal fertilizer of 8 cwt 50% potassic serpentine-superphosphate was applied annually.

Results are shown in Table 4.

TABLE 4: MAIN EFFECTS OF LIME, MOLYBDENUM AND BORON (lb DM/ac)

Rates per *Acre*	4 cuts *1965-6*	3 *cuts* *1966-7*	3 *cuts* *1967-S*	3 cuts *1968-9*
Lime:				
0	9,470 cB	6,960 bB	8,670 a	8,310 bB
10 cwt	9,990 bA	7,110 bB	8,650 a	8,840 aA
20 cwt	10,000 bA	7,120 bB	8,370 a	8,960 aA
40 cwt	10,400 aA	7,460 aA	8,790 a	9,000 aA
Molybdenum:				
0	9,970 a	7,160 a	8,660 a	8,800 a
5 oz	9,970 a	7,170 a	8,760 a	8,760 a
Borax:				
0	9,880 a	7,060 bB	8,690 a	8,660 bA
20 lb	10,060 aA	7,280 aA	8,720 a	8,890 aA
CV %	4.3	3.8	5.2	3.6

Responses to lime have been small but fairly consistent with only fleeting responses to boron. No responses were recorded to molybdenum.

MANAGEMENT OF LUCERNE VARIETIES

Four varieties of lucerne were compared under two management systems in a large-scale experiment at Wairakei. The varieties were Rhizoma and College Glutinosa (grazing lucernes), Wairau and Hunter River (general-purpose lucernes). Six ¼-acre areas of each of these varieties were established in the 1965-6 season.

Their production and persistency were to have been compared on paddocks cut exclusively for hay, with those where one hay cut was taken and then the lucerne grazed for the rest of the season; but those paddocks that were to have been cut exclusively for hay were grazed over the late autumn and winter period to remove any growth made after the final hay cut. This was practised for the first three years and no differences in production occurred under the two management systems.

In the fourth winter (1969) grazing was exluded from the hayed paddocks and the grazed treatments yielded significantly more in the 1969-70 season than those not grazed.

Wairau was the most consistent high yielding variety. Differences in favour of grazing over haying were more marked in the two grazing varieties, Rhizoma and Glutinosa, than in the two general-purpose varieties, Hunter River and Wairau (Table 5).

TABLE 5: LUCERNE VARIETY YIELDS UNDER HAYING AND GRAZING

(Ilb DM/ac for 1969-70 seasonj

	Hayed	*Grazed*
Rhizoma	10,190 eC	12,180 bcAB
Glutinosa	10,740 deBC	13,190 abA
Hunter River	11,770 cdABC	12,440 abcAB
Wairau	12,100 bcAB	13,610 aA

Lucerne was grazed at the 100% bud pre-flowering stage ***(i.e.,*** full height stage) with large numbers of sheep per acre — at least 400 ewes/ac to ensure a four-day maximum grazing period with approximately 36 days of spelling.

DISCUSSION

When it is realized that practically no lucerne was grown in the Taupo region 13 or 14 years ago and that until the last 3 or 4 years the only experimental work being carried out on lucerne in the Taupo county was on the Wairakei area, it can be seen that a great deal has been learned about the establishment, management and maintenance fertilizer requirements of lucerne over this relatively short period. Nevertheless, a great deal more has yet to be learned.

Procedures outlined ensure good establishment of lucerne but more recent experiments at Wairakei suggest that when serpentine-superphosphate was drilled with the seed in addition to the 3 cwt lime, and molybdenum was applied, even better estabilshment resulted on the coarser soil types. lt appears probable that, if the seed could be placed more precisely in the soil, lower seeding rates could be used.

Now that more is known of the nutrient needs of lucerne on these soil types, the deep placement of lime may not be so necessary, as, when direct drilling was practised, the lime was placed on the surface, and subsequent establishment of the plants was good.

Yields of IO,OOO-14,000 lb dry matter per acre per annum have been maintained when 8 cwt 50% potassic serpentine-superphosphate plus 20 lb of borax was applied annually in three split dressings — 3 cwt/ac in August, again after the first hay cut, and 2 cwt/ac after the second hay cut. The borax was applied at the second dressing when copper sulphate was also applied if herbage showed low copper levels. Half a ton of lime was applied every second year. These maintenance dressings resulted in soil quick test P figures rising dramatically and it is now apparent that lower rates of phosphate can be used. These rates of potash and borax appear to be minimal as deficiency symptoms of both these elements can occasionally be seen. Even though herbage analyses have shown low copper levels, the application of copper sulphate has not appeared to improve stock health or the vigour of the plants and this may not be required. The application rate of lime appeared satisfactory.

It' appears probable that a straight potassic fertilizer plus a sulphur-fortified low rate of serpentine-super-phosphate plus borax and lime would supply the needs of the plants. Fertilizer application rates on areas of lucerne predominantly grazed may not require to be as high.

ACKNOWLEDGEMENTS

I wish to acknowledge the advice and encouragement given me in conducting these and other trials by C. R. Taylor, formerly Farm Advisory Officer, Rotorua, and the assistance of the Wairakei Research Station staff. Also R. B. Gordon, Farm Advisory Officer, Taupo, for his encouragement in presenting this paper and the Biometrics Section for statistical results.

REFERENCES

Clare, R. J.; Matthews, L. J., 1969: *Proc. 22nd N.Z. Weed & Pest Control Conf.*: 114-5.

Toxopeus, M. R. J., 1971: *Proc. N.Z. Grassld Ass., 33:* 60-7.

DISCUSSION

During (Ruakura) asked whether allowance was made for the differential uptake of KCl under haying and grazing and if anything was known of the lime maintenance requirement after initial establishment. Clare agreed that potash would be depleted under haying. Both areas were treated similarly and so higher yields could be expected under grazing. He felt that lower rates of fertilizer could be used where nutrients were returned by the animal. They had not followed through the maintenance requirements as far as lime was concerned. Mitchell (Palmerston North) asked if there was any potential for lucerne on rolling steeper country. Clare thought it could be readily introduced into areas similar to Ward's by disc-drilling and that it would raise the production potential of these areas from 8,000 to 14,000 lb DM/acre. Toxopeus (Ruakura) suggested that there was some place for lucerne/grass mixtures but Clare disagreed, although he conceded that there might be some advantage from overdriiling cold-tolerant grasses to boost winter production. Joblin (Ruakura) commented on the very high costs of establishing lucerne and asked whether these could be reduced. ***Clare*** thought that perhaps direct drilling with placement of fertilizer could reduce the cost of that item and he agreed that further research was essential to try to find cheaper means of establishment. Of course, the greater reliability of lucerne compared with pasture did help to outweigh the disadvantage of high costs of establishment. Langer (Lincoln College) asked if lucerne production was sufficiently even over the growing season to enable the setting up of a lucerne drying industry. Clare maintained that it was, although it was lower in the summer, and he felt there was great potential for such an industry in the Taupo area.