Paper 2
LUCERNE ESTABLISHMENT — CONVENTIONAL

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INTRODUCTION

The general requirements for successful establishment of lucerne in conventionally prepared seedbeds have been known for many years. Lime is best applied six months prior to sowing if the soil is too acid for good nodulation to be achieved by lime coating or lime applications with the seed. Perennial weeds such as couch (*Agropyron repens*), browntop (*Agrostis* spp.), yarrow (*Achillea millefolium*), docks (*Rumex* spp.) and sorrel (*R. acetosella*) need to be eliminated prior to the final cultivations. Annual weed populations can be reduced by repeated cultivation. The final seedbed should be firm, especially when soil moisture is limited, to give good depth control and better soil moisture supply close to the seed. Seed is best sown with a drill, slowly and not cross-drilled which in addition to being time consuming and expensive results in the first seeding being deeper than is desired.

The sowing depth depends on the soil moisture supply; the seed should be sown as shallow as possible, preferably 5-15 mm, but into moist soil except if irrigation can be applied immediately after sowing, and provided that it is not deeper than 25 mm. If the seed has to be sown at 25 mm, to be in contact with soil moisture, cover harrowing should be avoided. Seed should be treated with viable inoculant not more than a day prior to sowing. Superphosphate, or lime-reverted superphosphate if the seed is mixed with the fertiliser, applied at sowing improves early growth and the competitiveness of the lucerne seedling on most soils.

Since the last major review of lucerne growing in New Zealand (Langer, 1967) new information has been collected in a number of aspects of establishment and these will be covered in this paper.

PRIOR CROP

A national survey* of lucerne growing in the mid 1970's showed that brassicas were the most common prior crop (38%), followed by cereals (22%), pasture (19%) and greenfeed (15%). White (1968) was of the opinion that turnips or rape were suitable prior crops on lighter soils and peas, potatoes or rape on better land but that lucerne not be established after a long period of cropping because of lowered fertility and increased weeds. According to the survey lucerne is seldom followed directly by lucerne (5%). The advisability of sowing lucerne immediately after lucerne may depend on the disease status in the previous stand. T.P. Palmer (pers. comm.) found normal establishment six months after cultivating a runout stand but stand life was possibly reduced. Further research is required to determine if a problem does exist in establishing lucerne after lucerne.

Wynn-Williams (1976b) found that lucerne sown in March showed better emergence and survival after a fallow than following spring barley which was in turn better than following winter wheat. Soil moisture was similar under the three treatments. Seedbed conditions, other than soil moisture, may have favoured the sowing following a fallow. For example the percentage of surviving plants which nodulated was inversely related to survival, perhaps reflecting differences in the soil nitrogen status at sowing. Foth *et al.* (1960) obtained better establishment after fallow than after oats and attributed this difference to soil moisture.

*The DSIR and MAF conducted a lucerne pest and disease survey between October 1975 and March 1976. Parts of the results have already been published (Ashby *et al.*, 1979; Sanderson, 1976; Somerfield and Burnett, 1976). The survey covered a non-random sample of 248 paddocks throughout New Zealand and some of the previously unpublished agronomic data is presented throughout this paper and that of Dunbier *et al.* (Paper 1).

SOWING TIMES

In considering alternative sowing times, soil moisture, soil temperature, weeds and pests should be taken into account. In New Zealand lucerne is generally sown in the spring or early summer (Fig. 1) and limited trial work would support this practice. Seed should be drilled into moist soil rather than into dry soil in anticipation of rain. This necessitates sowing earlier on shallow and light textured soils. Sowing into dry soil may result in reduced rhizobial survival and greater risk of soil crusting, and the consequent poor seedling emergence, if heavy rain occurs. Reynolds (1969) recommended that lucerne seed be soaked for 24 hours in skim milk to aid establishment on high country soils in which moisture supply only lasts a few days even after soaking rains.

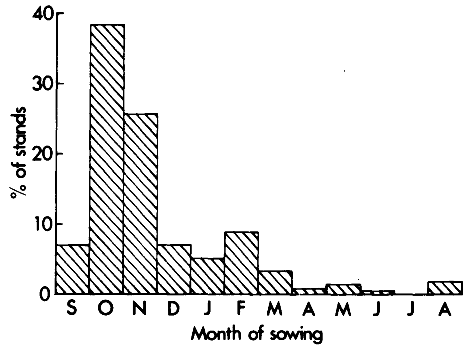

Figure 1: Month of lucerne sowing in N.Z. (1975/76 National Lucerne Survey, n = 215).

In this review establishment is taken as the number of seedlings which emerge as a percentage of viable seed sown; seedling survival as the number of seedlings, as a percentage of viable seed sown, which survive through to the spring following sowing; germination rate as a measure of the rate of seedling emergence and can be calculated independently of establishment as is done with the coefficient of rate of germination (Table 2).

TABLE 1: Sowing date and lucerne establishment on a Himatangi sand. After Smith and Stiefel (1978) with correction (R.G. Smith pers. comm.).

Sowing date	Establishment seedlings/m[2]	Establishment % of viable seed[1]
September 2	169 a[2]	42
October 29	87 b	22
April 4	91 b	23
May 14	134 a	34

[1] Assuming 9 kg viable seed/ha and 440,000 seeds/kg.
[2] Duncan's multiple range test.

Wynn-Williams (1976a) showed that the rate of germination increased with soil temperature and was greatest in December but the optimum temperature for germination rate was greater than that for seedling establishment. Experience has suggested that lucerne germination rate must be rapid for good establishment (Elliott, 1975; Whitelaw, 1975) but this trial showed, when moisture was adequate, establishment and seedling survival were greatest in October and November sowings and were lower in a December sowing presumably because of super-optimal soil temperature. According to Smith and Stiefel (1978) establishment on Himatangi sand is especially dependent on soil moisture, wind erosion and soil temperatures and they showed large differences in establishment at different sowing times (Table 1).

Spring sowings (Sept., Oct., Nov.) on a Templeton silt loam resulted in the earliest forage production and the greatest daily growth rate of the young crop (Wynn-Williams, 1976a). Sowing in December instead of October reduced yield in the first, second and third years by 4240, 5500 and 2150 kg/ha respectively. The Sept-Dec sowings were repeated to investigate why a December sowing resulted in an extended loss of forage production, in spite of adequate plant density. Similar trends in germination rate and establishment were apparent but the yield from a December sowing was as good as an October sowing in the season following sowing (Table 2). The reason for the

TABLE 2: Sowing dates in 1975 and 1976 and coefficient of rate of germination, establishment and yield.

Sowing date	Coefficient of[1] rate of germination 1975	1976	Establishment (% of viable seed) 1975	1976	Yield (1st year t/ha) 1975	1976
Sept. 18 & 29	8.6 D[2]	9.0 C	49.2 B	58.2 A	16.9 A	17.5 a
Oct. 18 & 29	11.0 C	10.2 BC	56.5 A	57.7 A	17.7 A	19.1 a
Nov. 19 & 24	13.3 B	11.3 B	59.0 A	47.2 B	16.7 A	16.6 a
Dec. 19 & 20	16.0 A	14.0 A	45.7 B	46.0 B	12.2 B	16.5 a
CV%	10.7	8.1	15.1	14.3	13.5	16.6

[1] $CRG = \frac{\Sigma N \times 100}{\Sigma DN}$ N = number germinating on day D, D = number of days after sowing.
[2] Waller & Duncan test.

difference between December 1975 and 1976 sowings might be attributable to soil temperature and moisture conditions. Soil conditions following the December 1976 sowing were cooler than usual and comparable to November 1975 and 1976 and more "favourable" than December 1975 (Table 3).

Janson (1972) also found that on a shallow stony soil (Lismore silt loam) delaying sowing from the end of September until the middle of November resulted in reduced forage production in the season following sowing, in addition to the expected reduction in the establishment season. Janson and Knight (1973) showed that a late September sowing was superior to late November either irrigated or non-irrigated, and the effect of delayed sowing on yield continued on even after the effects of cover crops had disappeared.

Janson (1972) showed that although sowing at the end of September resulted in more weeds in the first cut of the establishment season, than sowing in mid-November, there were fewer weeds in subsequent cuts. Similarly Wynn-Williams and Palmer (1976) concluded that at Lincoln, at least, the choice of sowing date should be based on considerations other than the need to avoid weed problems. Delaying sowing until December reduced weed growth at the first cut to less than 260 kg/ha, compared with 1940 kg/ha from an October sowing, but an earlier sowing was superior from all other points of view.

TABLE 3: Mean soil temperature (20 mm) and soil moisture (0-60 mm) for the first 28 days following sowing.

Month of sowing	Soil temperature (°C)		Soil moisture (%)	
	1975	1976	1975	1976
September	14.1	13.6	21.2	24.1
October	17.9	18.3	20.4	23.9
November	25.3	21.0	15.0	20.3
December	29.7	23.2	14.3	20.8

As the sowing time of lucerne is progressively delayed in the spring the potential yield for the establishment season can be decreased at a greater rate than the reduced growing time would suggest (Janson, 1972; Wynn-Williams, 1976a). When lucerne is used for only 3-4 years, production in the establishment year can be a significant part of the total stand yield. Under these conditions early spring sowing, high seeding rates and sowing without cover crops can all be considered.

In summary, spring sowings are more successful than summer or autumn sowings and on shallow, light textured soils September sowings should be aimed for (Janson, 1972; Janson and Knight, 1973; Whitelaw, 1975; Smith and Stiefel, 1978). On more moisture retentive soils sowing can be delayed to October or November (Wynn-Williams, 1976a).

ESTABLISHMENT

Lucerne survival, as a percentage of viable seed sown is low, even under very favourable conditions, with usually only 40-50% surviving the first year (Tesar and Jacobs, 1972). Part of this low survival is due to competition between plants causing self-thinning, but even at 2.5 kg/ha Wynn-Williams (unpubl. data) found that the best survival from fourteen sowings over two years was only 50%. Blair (1971a) found establishments of only 48% and 54% "in what appeared to be a well-prepared seedbed of favourable tilth and moisture content". In a study of 33 stands sown under variable conditions during October-November 1975 in the Rotorua-Taupo region McCully and Wynn-Williams (unpubl. data) estimated that only 47% of viable seeds produced seedlings. The major deficiencies observed in the latter stands were inadequate consolidation and control of perennial weeds. Some researchers have cited pathogens as a cause of poor establishment, but in only 11 of the 33 stands were "damping off" symptoms observable at a frequency greater than 10%. Blair (1971a) considered that the damping off fungi *Fusarium avenaceum, F. oxysporum* and *F. oxysporum* var. *redolens* were all pathogenic and readily isolated from roots of lucerne seedlings. Smith and Stiefel (1978) observed "damping off" during damp conditions following a mid-May sowing into a Himatangi sand (Table 1). The use of fungicide treated seed (0.35 g fenaminosulf plus 0.5 g thiram per 100 g seed) had no beneficial effect on initial establishment but severely depressed production by inhibiting nodulation. More recently fungicide treatment has given significant improvements in establishment (Close *et al.,* Paper 8).

SEEDING RATE

The average rate of seeding used by farmers has decreased over the years from more than 20 to 11.5 kg/ha* (range 4-20). Research indicates that rates could be further reduced, when yield in the establishment year is not important, provided care is taken with seedbed preparation and drilling.

Trials established at different seeding rates and plant spacings (Palmer and Wynn-Williams, 1976) showed that yields from established stands reach a maximum with plant densities as low as 30 plants/m^2. Any increase in density above this gave no increase in yield. During the seeding year and into the first production year, higher densities gave higher yields (Table 4). Only when rates less than 2 kg/ha were used did effects persist past the first production year. Higher seeding rates result in greater densities but not in proportion to the increased rates (Sims, 1975; Palmer and Wynn-Williams, 1976).

From the trials at DSIR Lincoln which were in the absence of major pests and diseases it was concluded that provided the seeding rate is high enough to give at least 30 plants/m^2 in the season following sowing then stand life is independent of the initial seeding rate (Fig. 2). Where

TABLE 4: Seeding rate and yield (kg/ha) in the season following sowing (mean of monthly sowings Sept-Dec 1976).

	Yield/cut				
Seeding rate	1	2	3	4	5
2.5	5020 B	4302 B	2824 b	2386 b	2152 a
10.0	5580 A	4776 A	2980 a	2529 a	2219 a
CV%	17.0	13.7	12.7	14.5	20.1

different populations were established, stands self-thinned over time to an equilibrium population above the minimum required for maximum production. However, in the presence of major pests and diseases the death rate will initially be density-dependent but subsequently may become quite unrelated to density. The stand age at which density-dependent disease death exceeds self-thinning death is not known. If this occurs after five years, from Figure 2, increasing the seeding rate would have no effect on prolonging stand life, but if it occurs after three years then each additional 5 kg/ha might extend stand life another year.

In summary the seeding rate used should be related to sowing date and seedbed conditions. Spring sowing under good conditions 2.5 kg viable/ha has been adequate but autumn sowing under marginal conditions even 10 kg/ha may not result in a stand of adequate density.

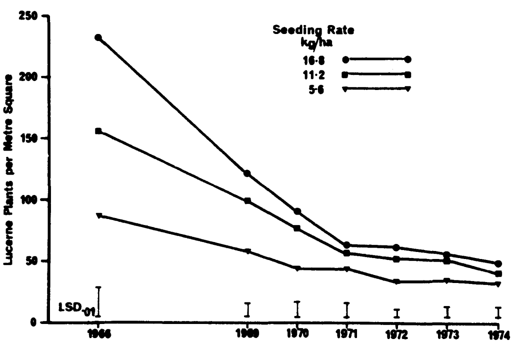

Figure 2: Seeding rate and lucerne density over time (Palmer and Wynn-Williams, 1976).

SOIL ACIDITY

The minimum pH for the growth of lucerne differs from that at which *Rhizobium meliloti* function effectively with *R. meliloti* requiring a higher pH. In North America pH near 7.0 is "required" in much of the area where lucerne is grown (Rhykerd and Overdahl, 1972) but stands in New Zealand are grown on considerably more acid soils. Blair (1971a) found that the average soil pH of 119 new sowings in Canterbury and Otago was only 6.0. From 147 returns in the lucerne disease survey, the average soil pH of stands was 5.9 (±0.4) with only 3% in the range 6.6-7.0 (Fig. 3). These results suggest that either the recommendation that "the soil pH should measure at least 6.0 and preferably 6.5-7.0" (Langer, 1973) is too high or the majority of lucerne stands are too acid and production and/or longevity are suffering as a consequence.

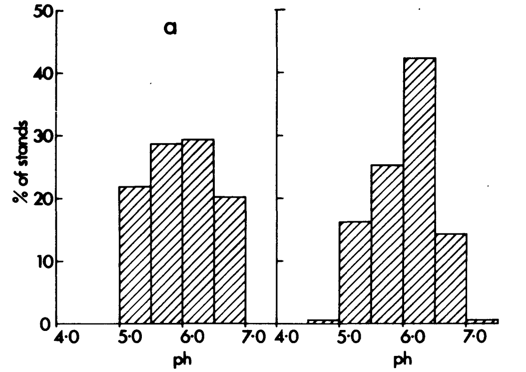

Figure 3: Soil pH of lucerne stands sampled in two surveys: a Blair (1971) n = 119; b 1975/76 survey n = 147.

The pH requirement for lucerne root growth is largely unknown. White (1967) reports that lucerne taproots fork when soil of pH 5.0 is encountered. Percival (1978) reported that lucerne roots on a Kiripaka bouldery silt loam were down 1.65 m in spite of the pH at 1.0 m being 5.0. On a Okaihau gravelly friable clay roots did not reach 0.5 m where the pH was 4.8 at that depth.

Yield increases from raised pH generally do not differentiate between nodulation and general growth responses. White (1970) showed that dry matter production was similar at pH 5.6 or 5.9 but considerably increased at pH 6.5. He found that cultivars differed in relative response to lime. Similarly Simpson *et al.* (1979) raised the pH at a depth of 0.1 to 0.85 m from 5.9 to 6.4. This doubled top yield in a droughted treatment and more than trebled top yield under a surface watered treatment and gave greater than a seven-fold increase in root length at 0.6-0.85 m. Obviously the application of lime at depth is impractical and uneconomic but these authors showed that genotypes exist which tolerate acidic subsoils.

Nodulation

Successful lucerne nodulation requires application of a good quality inoculant to the seed and good survival allowing successful invasion of the root hairs. Investigations suggest that nodulation may not be very successful in New Zealand.

Certified lucerne inoculants have been available in New Zealand since 1955. The Seed Testing Station, MAF, Palmerston North does the testing and approved lucerne inoculant must:

(1) contain a minimum of 1.0×10^{10} viable rhizobia per kilogram of seed to be inoculated at any time up to the expiry date (usually 6 months after manufacture);

(2) be a pure culture of *Rhizobium meliloti;*

(3) be serologically identifiable with the initial culture supplied;

(4) be effective for nodulation and nitrogen fixation;

(5) state clearly the expiry date.

At present there are three approved lucerne inoculants available in New Zealand: Rhizocote (Lime and Marble, Nelson), Nodulaid (Agricultural Chemicals Pty Ltd, Australia) and Nitrogerm (Root Nodule Pty Ltd, Australia). All use either of two strains PDDCC 2751 (U45 in Australia) or PDDCC 2752 (SU47 in Australia) which have been recommended for use in New Zealand and have been shown to be satisfactory with a large number of lucerne cultivars (C.N. Hale, Plant Diseases Division, DSIR, pers. comm.).

However, as Blair (1971b) has pointed out, the problem is not so much one of numbers of suitable, viable rhizobia in the packet but of survival on the seed. Parle *et al.* (1973) showed that eighteen batches, from a number of suppliers, were all capable of supplying in excess of 10,000 viable rhizobia per seed. Levels on the seed after drying for one hour were less than 1000/seed from 8 of the 18 and less than 100/seed from 4 of the 18.

Blair (1971a) concluded from his survey that nodulation of lucerne occurs at a low level of efficiency under field conditions. He found that 6-8 weeks after sowing 65% of the crops had 30% or less plants nodulated. He attributed much of this failure to low pH at the time of sowing. "Good" nodulation occurred only at pH 6.0-7.0. Close *et al.* (1971) obtained 37% and 56% nodulated plants 7-8 months after sowing conventionally inoculated seed in two trials. They also showed that irrigation three months after sowing significantly increased percentage nodulation. Blair (1971b) also examined mature stands and 60% of the crops had 40% or more of the plants nodulated. The percentage of plants which are nodulated may increase with time, although Close *et al.* (1971) found no consistent trend.

Wynn-Williams (1976a) examined the effect of time of sowing on nodulation and found a maximum of 92% of plants nodulated in a September sowing, with a decline to 51% in June, presumably due to low soil temperatures. Sowing in late December also markedly reduced nodulation, which may have been a consequence of high soil temperatures, or higher nitrate levels.

In the 1968/69 season unsatisfactory nodulation of new stands was widespread in NZ especially in Canterbury and Taupo areas. Failures occurred in both slurry inoculated and inoculated-pelleted seed suggesting that the problem was with the inoculum cultures, although not all sowings which used the particular brand of inoculant involved, failed to nodulate. It was concluded therefore, that the quality of the inoculum at that time was low and this combined with the dry conditions which prevailed resulted in nodulation failure. In response to these nodulation failures manufacture of a granule of calcite with a coat of peat based inoculum was commenced. Post emergence treatments of unnodulated stands using these granules at 16.8 kg/ha drilled or 22.4 kg/ha broadcast were effective especially in moist soil (Close *et al.,* 1971).

Further work is required to establish the nodulation status of stands in New Zealand. The implications of poor nodulation on the nitrogen cycle are largely unknown, particularly under a grazing regime. Poor nodulation may lead to early stand decline, as it has been suggested by Aube and Gagnon (1970) that nodulated plants are more resistant to attack by pathogens.

More work is required to establish the yield response of different cultivars to lime on various soils and to differentiate between nodulation and general growth responses.

PESTS AT ESTABLISHMENT

Although mature lucerne plants are tolerant of attack by grass grub (*Costelytra zealandica*) larvae, seedlings up to six months old are highly susceptible to damage (Pottinger and Macfarlane, 1967). Problems have been encountered with sowing lucerne into soil which was infested with grass grub larvae. Cultivation should be continued long enough to ensure that grass grub larvae have been killed prior to sowing.

Following glasshouse trials which showed that blue-green lucerne aphid (*Acyrthosiphon kondoi*) severely reduced the growth of lucerne seedlings and killed some of them (Wynn-Williams and Burnett, 1977) it was recommended that stands be sown with insecticide granules for protection. The recommendation was that disulfoton or thiometon granules be applied at 1 kg a.i./ha either with the fertiliser or with the fertiliser-seed mix. However, although this treatment reduced aphid numbers for at least six weeks it had no beneficial effect on plant establishment in trials (Palmer, 1977; Wynn-Williams, unpubl. data). It is now recommended that stands should be sown early, and sprayed post emergence if aphids are present in significant numbers (Kain and Trought, Paper 7).

Sitona weevil (*Sitona discoideus*) adults have caused damage to autumn sown crops giving further support to the recommendation for spring sowing.

COVER CROPS

Use

The majority of lucerne in New Zealand is sown without a cover or companion crop. Overall 24%* of stands were sown with cover crops in the early to mid-nineteen seventies with the practice being very much more popular in Canterbury (38%) and Marlborough (41%). Whitelaw (1975) stated that virtually all the stands contracted for dehydration in mid-Canterbury, at that time, were established with cover crops.

The reasons given for sowing lucerne with cover crops include: protection of the undersown species; suppression of weed growth; and the provision of a profitable return in the establishment year. Only under few circumstances is the protection of the undersown species by the cover crop of greater magnitude than the suppression of the undersown species by the cover crop. Smith and Stiefel (1978) reported that the establishment of lucerne on unconsolidated dunes (Waitarere sand) was unsuccessful without protection by cover crops from wind erosion and high sand temperature. Palmer (1977) showed that a cover crop of barley, but not peas, reduced blue-green lucerne aphid infestations but in spite of this 'protection' cover crops reduced lucerne establishment in this trial more than weeds. Cover crops increase lucerne's susceptibility to grass grub, as the smaller the seedling at the time of the third stage larvae in February to December (Kelsey, 1951), the greater the risk of seedling death from larval attack. It can be concluded that in most situations cover crops do not protect, but suppress, the undersown species.

Similarly, the argument for the suppression of weeds seldom holds. For example, Wynn-Williams (1974) showed that the greater the combined lucerne and cover crop growth the lesser the weed growth but the cover crop was more competitive than the weeds it 'replaced'.

The use of cover crops to provide a cash return in the establishment year is dependent on the relative value of forage and grain. Wynn-Williams (1976c) found that over three trials the mean grain yield from a barley cover crop approximately equalled the reduction in forage yield of the undersown lucerne. In most years the value of grain will be 3-5 times that of the lucerne. Janson (1978) pointed out that the economic advantages of cover crops were greater on better soils but the gross margins of barley undersown with lucerne were 4-5 times greater than those of lucerne sown alone on both heavy and light soils.

Type

Spring sown crops linseed, barley, wheat, maize and peas have all been shown to be satisfactory in trials (Palmer and Wynn-Williams, 1972; Janson and Knight, 1973; Wynn-Williams, 1976b; Palmer, 1977) and in practice (Whitelaw, 1975). Of a total of nine trials, all included barley of which two showed reductions in lucerne establishment, five included peas with two showing reductions and three included wheat and linseed and two included forage maize with none showing reductions. Smith and Stiefel (1978) found lupins or mustard to be satisfactory in sand country.

Research and farmer practice have shown both spring and autumn sown forage cover crops to be successful. Janson (1975a) found turnips and greenfeed barley reduced lucerne establishment by 30% but by the second year yields were the same from lucerne sown alone and with a cover crop. Elliott (1973) also reported turnips to be successful and McMillan (1973) recommended swedes in the pumice country. Janson (1975a) suggests that autumn cover crops such as 'Grasslands Tama' tetraploid Westerwolds ryegrass which continue vigorous growth in the spring should not be used. Under Tama, lucerne establishment was reduced 82% and yields were never restored.

New Zealand results are in general agreement with those from overseas and show that crops which mature early, cast least shade, and use the least soil moisture are more successful as cover crops than late maturing, tall, leafy, and moisture demanding crops and cultivars.

Management

When establishing lucerne with a cover crop the seedbed should be prepared as for lucerne, the cover crop drilled, the paddock harrowed and rolled and the lucerne drilled.

Recommendations on the use of cover crops invariably advocate sowing the cover crop at reduced rates. This is a reasonable safeguard against excessive competition but has not always been substantiated by trial work in New Zealand. In five trials, in which spring cover crop seeding rates were examined in terms of lucerne establishment; two of three showed barley rates should be reduced; one of three showed spring wheat rates should be reduced; one of two showed linseed rates should be reduced; and neither of two showed pea rates should be reduced. Janson (1975a) showed that York Globe turnips sown at 0.98 kg/ha did not increase turnip yields over sowing at 0.28 kg/ha, but reduced lucerne establishment.

Reducing the cover crop seeding rate can lower the yield of cash crops and increase weed growth but has the advantages of increased lucerne growth and reduced risk of stand failure because of high soil moisture stress and lodging.

Following the harvest of cash cover crops, residues should be removed quickly and completely to avoid seedling death beneath the trash.

Irrigation decreases the magnitude and duration of the suppression of lucerne by a cover crop (Table 5). On a Lismore silt loam the response to irrigation was considerably greater, as was the effect of the barley cover crop, than on a Templeton silt loam. With increasing water supply, either from irrigation or on the more moisture retentive soil, the relative effect of the cover crop decreased. From this and farmer experience it is apparent that competition between the cover crop and the undersown lucerne increases with decreasing moisture supply.

TABLE 5: Irrigation effect on establishment year lucerne yields (kg/ha) sown alone or with barley.

Sowing method	Yield Non-Irr	Irr.	% inc	Non-irr	Irr.	% inc
Alone	1260	4800	381	6950	13930	100
With barley	200	1530	695	3540	10400	294
as %	17	32		51	75	
Soil type	Lismore silt loam			Templeton silt loam		
Source	Janson (1973)			Wynn-Williams (1976c)		

IRRIGATION

There is an old adage that lucerne should not be irrigated in the seeding year or surface rooting will be encouraged and the strongly taprooted nature of lucerne will be discouraged. However assessments, made on a Lismore soil (Lobb, 1967) and a Templeton silt loam (Wynn-Williams, 1974), show little difference in rooting depth and only a slight increase in the ratio of roots near the surface, in irrigated stands compared with non-irrigated stands (Table 6). Janson (1975b) obtained similar results in reconstructed profiles. He found a better distribution of roots down the profile overall and a small decrease in percentage of roots in the surface layer with irrigation six months after sowing but this was reversed after 2½ years.

It can be concluded from these results that irrigation in the establishment year increases first year forage yield and root growth and has a slight, if any, effect on root distribution and can be recommended.

TABLE 6: Lucerne root distribution with and without irrigation.

	Percentage of total root weight in top of profile			
	Lobb	Wynn-Williams	Janson	
Irrigated	87	87	70	55
Non-irrigated	78	81	75	52
Years from sowing to sampling	6	1	½	2½

EARLY MANAGEMENT

Farmers commonly graze new stands, when they first reach a height of approximately 150 mm, to reduce competition from weeds. Musgrave (1972) showed, in simulated swards, that an early cutting at the 4-5 leaf stage did not alter crown development and had no effect on subsequent yield. He concluded therefore, that a quick early grazing would be beneficial in the presence of weed competition. In addition Clare (1968) recommends tine harrowing immediately after topping or a quick grazing on the pumice soils.

Apart from an early weed control grazing, management in the establishment phase should be lenient. Janson (1972) showed substantially reduced second year yields following frequent (pre-bud) establishment year cutting in comparison to less frequent (early flower) cutting. Early cutting in the establishment year also increased weed growth in the following year.

CONCLUSIONS

In recent years many aspects of lucerne establishment in New Zealand have been investigated and knowledge of the culture of the crop increased. However, in reviewing this work it becomes apparent that work is still required in a number of areas.

Farmers often want to establish lucerne after run out lucerne, and although indications suggest that as long as a cultivar with appropriate resistance is sown this practice is feasible, further trial work is required to confirm this. Of perhaps low priority but needing further work is the problem of generally low establishment even under apparently favourable conditions.

The major deficiency in our knowledge of lucerne establishment in New Zealand is in the area of soil pH and its effect on lucerne establishment, nodulation and growth. In fact although not specific to establishment further work is required on the nodulation and the nitrogen cycle generally in lucerne stands especially under grazing.

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DISCUSSION

Wall: Reverted super is sometimes pH 5.6 so we recommend that seed be drilled with lime only.

Q: What fungicides have been used as seed treatments?

Wynn-Williams: Fungicide treatment is probably only practical for pelleted seed and then treatment has not always had any effect on establishment. A wide range of fungicides have been tested.

Cox: What are the merits of coated seed versus bare seed?

Wynn-Williams: My personal conclusion is that under conventional cultivation I wouldn't waste my money on it. However, there may be circumstances, for example high soil temperatures or low pH, where coated seed may give better rhizobial survival and be justified.

Percival: What evidence is there for the high pH requirements of nodulation?

Wynn-Williams: The requirements are different for nodulation and lucerne growth but what the optimums are I don't know. The significance of pH varies with region and soil group.

White: On a Hororata stony loam near Oxford, surface pH was 6.0 but at 10-15 cm pH was 4.5-4.8 and the roots were forking and growing laterally. This was associated with high Al levels as well as low pH.