LUCERNE ESTABLISHMENT : PRECISION VERSUS CONVENTIONAL SOWING METHODS

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Abstract

Lucerne was sown at several sowing rates with both a roller drill and a precision seeder. Plant population counts and dry matter yields were recorded at regular intervals. The high seeding rate treatments showed higher plant mortalities than those sown at lower rates, resulting in a tendency for the population to reach an optimum, regardless of sowing method or rate. There were no significant differences obtained in the dry matter yields obtained from any treatment. Thus it would appear that precision seeding techniques enable lower seeding rates of lucerne to be sown successfully, owing to the better distribution of the seeds by the drill.

INTRODUCTION

THE recent dry summer periods experienced in many parts of New Zealand have stimulated a great deal of interest in lucerne production throughout the country.

The majority of lucerne stands have been sown with a conventional grain drill or a roller drill using mainly external force-feed seeders as a means of distributing the seed. Sowing rates have been estimated by Palmer (1971) to vary between 5 and 15 kg/ha, whereas Blair (1971) considers 9 to 22 kg/ha to be more realistic. However, the moist common sowing rate appears to be approximately 11 to 12 kg/ha.

Donald (1956), Takasaki *et al.* (1970) and Jarvis (1962) each found that populations down to approximately 400 000 plants/ha gave comparable if not better yields than swards of higher population density. Theoretically this population could be obtained from a seeding rate of 1.3 kg/ha assuming 75% field emergence. It would therefore appear that the higher sowing rates commonly used by the farmer are far in excess of theoretical needs and presumably effect the high plant mortality that occurs in an establishing stand. This question, therefore, is particularly important when the potential savings in costs at present seed prices are realized.

At lower seed rates, however, it is difficult to achieve an even distribution of seed along the row with conventional seed drills. Seed metering mechanisms have been criticized for many years for their irregularity of distribution, and modern seed drills have shown little improvement. Recent measurements by Blair (1971) have demonstrated how variable the resulting seedling distribution can be. Although part of this observation must be attributed to the germination capacity of the seed, the fact remains that the somewhat random distribution of seed generally obtained can result in severe competition between seedlings. Also gaps are often left along the row which permit weeds to establish with ease.

Precision seed drills have been designed to overcome these limitations. They were initially developed for the British sugar beet industry but are now used around the world for numerous vegetable crops as well as many other row crops. They are designed to separate individual seeds from the bulk and sow them at regular, predetermined intervals. The efficiency of achieving this single seed sowing is dependent on the drill design and the seed size and shape but generally fairly high accuracy can be obtained.

For small or irregular seeds, a process of seed pelleting is commonly adopted to produce a relatively uniform seed shape which is more suitable for precision sowing techniques.

The sowing of pelleted lucerne seed by a precision drill should therefore enable a more even distribution of seed to be obtained than with conventional drills, especially at lower seeding rates.

This trial was designed to investigate the minimum seeding rate that might be practical for lucerne establishment when sown with a precision drill. At the same time any loss in dry matter yield when compared with conventional sowing methods must be avoided.

METHOD

A trial consisting of a randomized complete block design with six replicates and an irrigation/non-irrigation treatment superimposed, was sown on October 24, 1974, on an inorganic silt soil at the Massey University No. 2 Dairy Unit. Ploughing and cultivations were carried out to produce a level, firm, clod-free seedbed suitable for precision sowing. Lime was added at the rate of 3.0 tonne/ha and 250 kg/ha of superphosphate potash was broadcast before final cultivations took place.

The treatments were as follows:

<i>Drill</i>	<i>Row Width (cm)</i>	<i>Seed Spacing (cm)</i>	<i>Desired Seed Rate (kg/ha)</i>
1. Roller	7.5	random	12.0
2. „	7.5	„	„
3. Precision	7.5	4.6	60.73
4. „	7.5	6.9	4.9
5. „	15.0	6.1	2.7
6. „	15.0	12.2	1.4
7. „	15.0	15.2	1.1

Treatment 1 was considered to be the conventional sowing method and Treatment 2 was intended to examine the possibility of using the roller drill at a lower seed rate than normal.

Treatments 3 to 7 were sown using an 11-unit Stanhay belt seeder to meter the pelleted lucerne seed as accurately as possible.

Although several trials have been recorded where various planting patterns were used (e.g., Jarvis, 1962; Rumbaugh, 1963), the method of selecting the patterns often seemed somewhat arbitrary. Consequently little guidance was obtained in the selection of planting patterns from previous work. The choice of row widths for the precision drill was governed by the two-row-coulter width being fixed at 7.5 cm whilst the choice of 15.0 cm rows was dependent on the narrowest practical row space that could be obtained using single-row coulters with alternate units in tandem. The seed spacings were chosen to give a suitable range of seed rates bearing in mind the results obtained from earlier trials.

A commercial mini-pelleted seed was used for the trial, this being recommended to the farmer by the processors.

Plant population counts were taken one month after sowing and again at each of the three succeeding harvests over 3 months. Plant populations were measured from three random sites per plot.

Dry matter yields were determined at three harvest dates, the first as seedlings and the second and third when the crop reached the 10% flowering stage. All plots were harvested at the same time by random sampling and the samples subsequently oven-dried for dry weight determination.

Weeds were no real problem even in the low density treatments as all plots were sprayed with 2,4-DB (2.5 l/ha) at the 3- to 4-leaf stage of the crop. This operation was considered to be particularly important for the lower population treatments.

TABLE 1: PLANT POPULATION PER HECTARE $\times 10^{-6}$

<i>Treatment</i>	<i>25/11/74</i>			<i>23/12/74</i>			<i>17/1/75</i>			<i>26/2/75</i>		
	<i>Irrig.</i>	<i>Non Irrig.</i>	<i>Mean</i>	<i>Irrig.</i>	<i>Non Irrig.</i>	<i>Mean</i>	<i>Irrig.</i>	<i>Non Irrig.</i>	<i>Mean</i>	<i>Irrig.</i>	<i>Non Irrig.</i>	<i>Mean</i>
1	2.93	3.07	3.00	2.84	2.94	2.89	1.49	1.25	1.37	1.42	1.32	1.37
2	1.66	1.86	1.76	2.20	1.69	1.95	1.14	1.21	1.18	0.91	0.92	0.92
3	2.94	2.89	2.91	2.62	1.92	2.21	1.47	1.39	1.43	1.72	1.56	1.64
4	2.22	2.54	2.38	2.10	1.74	1.92	1.59	1.39	1.49	1.32	1.75	1.54
5	1.35	1.20	1.28	1.13	1.09	1.11	0.91	0.91	0.91	0.85	0.70	0.77
6	0.85	0.69	0.77	0.64	0.72	0.68	0.61	0.53	0.57	0.62	0.49	0.56
7	0.83	0.81	0.82	0.74	0.79	0.77	0.51	0.50	0.51	0.43	0.41	0.42

Irrigation was applied two weeks after sowing as it was considered important that all seedlings be given good growing conditions. A total of 65 mm of water was applied over a period of 4 weeks to the irrigated area.

FIG. 1: Number of seeds sown/ha and established plants/ha per treatment over the experimental period.

RESULTS

PLANT POPULATIONS

The number of plants per hectare at four dates are given in Table 1.

The irrigation treatment had no significant effect on plant establishment. Consequently the mean populations for each sowing treatment are presented in Fig. 1. All treatments and particularly those of the high seeding rates show a general decline in plant numbers over the first three months from sowing (up to January 17) followed by little change to the final measurement on February 26.

HERBAGE YIELD

As there was no significant effect due to irrigation, only the main effects of sowing treatments on dry matter yields are presented in Table 2.

TABLE 2: DRY MATTER YIELD (kg/ha)

<i>Treatment</i>	<i>1st Harvest 23/12/74</i>	<i>2nd Harvest 17/1/75</i>	<i>3rd Harvest 26/2/75</i>
1	3400	6310	2853
2	3440	7260	2168
3	2673	6274	2320
4	2828	7052	2336
5	2480	7080	2502
6	2147	6247	2438
7	2400	5680	2068
Statistical significance	N.S.	N.S.	N.S.

DISCUSSION

The lack of any irrigation effect on production reflects the adequacy of soil moisture for lucerne establishment and growth over the experimental period.

The number of seeds sown per hectare by the roller drill was estimated from the seeding rate obtained from calibration of the drill. The number of seeds sown per hectare by the precision drill should in theory be able to be calculated since the row widths and seed spacings are known. This assumes that only single seeds were sown. However, a check of the sowing accuracy

of the precision drill unit on a test rig gave 71% single seeds, 24% doubles, 4% trebles and 1% misses for the mini-pelleted seed used in the trial. An 'appropriate correction factor applied to the theoretical seed numbers should therefore result in a reliable estimate of the number of seeds actually sown for each treatment and is presented in Table 3.

It is anticipated that a more accurate metering of single seeds would have been obtained if fully pelleted seeds were used. The more economic mini-pellet was chosen for the trial, however, as it would be more practical for the farmer.

A comparison of the estimated seed numbers sown with the plant population at final harvest gives an approximate assessment of the plant mortality rates including any seed's which failed to germinate. The total mortality rate for each treatment expressed as a percentage of seeds sown, and the number of plants present at final harvest (expressed as a percentage of the number of plants established one month after sowing are given in Table 3.

TABLE 3: FINAL PLANT POPULATIONS EXPRESSED AS A PERCENTAGE OF NUMBER OF SEEDS SOWN AND AS A PERCENTAGE OF PLANTS ESTABLISHED AT ONE MONTH AFTER SOWING

<i>Treatment</i>	<i>Estimated Seed Nos. Sown ($\times 10^{-3}$)</i>	<i>Final Plant Populn as % of Seeds Sown (%)</i>	<i>Final Plant Populn as % of Plant Populn one month after Sowing (%)</i>
1	5760	23.8	45.7
2	2880	31.9	52.3
4	3861,	43.1	56.6
5	2523 1418	61.0 54.3	60.2 54.7
6	711	78.9	72.7
7	568	73.9	51.2

The precision sown treatments, particularly at the lower seed-ing rates, gave better seed germination and lower plant mortalities. Thus each seed sown through the precision drill stood more chance of becoming established and waste of seed was reduced. The unexpectedly low final plant population of Treatment 7 cannot be explained.

The roller drilled treatments (1 and 2) experienced higher plant mortality than the precision drilled treatments as shown by the gradient of the graphs in Fig. 1. There appeared to be a

tendency for the higher populations to have higher death rates as also noted by Takasaki *et al.* (1970) and Zaleski (1959).

This phenomenon resulted in a tendency for the high sowing rate treatments 1 to 4 to reach an optimum population irrespective of the sowing method or sowing rate. After this population had been reached, the mortality rate tended to decline. The optimum population would appear to have been reached at the time of the January harvest.

Treatments 5, 6 and 7 with lower populations showed a lower death rate -- i.e., a greater proportion of seeds sown produced plants which survived for the period of the trial.

The average dry matter yield for each treatment at all three harvests can be compared from Table 2. Although not statistically significant, there was a tendency for the higher seeding rate treatments with higher plant populations to show higher early dry matter production. However, by the final harvest on February 28, the differences between these treatments were relatively small. The differences were also relatively small by the second harvest on January 17 (except for the lowest seeding rate, Treatment 7) which suggests that considerably lower seeding rates of lucerne could be adopted by farmers if precision drills were used.

CONCLUSIONS

It would appear from the trial that precision sowing methods enable lucerne to be sown at low seeding rates, in the order of 2 kg/ha, without any significant reduction in dry matter yield. This is probably due to the tendency of the sward to reach a desirable population, irrespective of the number of seeds sown.

The cost of operating a precision drill is fairly high and this would serve to partly offset any savings in seed costs. The cost of pelleting must also be considered. At present seed prices, it may be more economical to use a lower seed rate through a conventional drill if the metering mechanism will handle lower seed rates satisfactorily and if good conditions occur at the time of establishment. The roller drill used in the trial gave comparable yields at the lower seed rate which was in fact the minimum rate that this particular drill design could handle without modifications. It is considered that other existing seed metering systems designed to handle sowing rates down to the order of 2 kg/ha through a conventional drill often produce inadequate seed distribution, resulting in lower yields. Further work is required to verify this hypothesis.

As seed prices rise, the use of precision sowing methods may become more attractive. New designs of drills allowing more efficient operation will also be produced in the future and this would also serve to encourage precision seeding methods.

Trials on two farms where 4.2 ha and 3.0 ha of lucerne were sown in the spring of 1974 by a precision drill at a seed rate of 3.0 kg/ha 'are growing to the satisfaction of the farmers. Both farmers consider the (saving in seed costs to have been worth while even though drilling costs were greater. However, further work must be carried out under different environmental conditions before the precision sowing of lucerne can be considered to be both agronomically satisfactory as well as economic.

REFERENCES

- Blair, I. D., 1971: Aspects of the seedling development of lucerne (*Medicago sativa* L.). *Proc. 1st Conj., Agron. Soc. N.Z.*: 87.
- Donald, C. M., 1956: Competition among pasture plants. *Proc. 7th int. Grassld Congr.*: 80.
- Jarvis, R. H., 1962: Studies on lucerne and lucerne grass leys. V. Plant population studies with lucerne. *J. agric. Sci., Camb.*, 59: 281.
- Palmer, T. P., 1971: Plant density and herbage production in lucerne (*Medicago sativa* L.). *Proc. 1st Conj., Agron. Soc. N.Z.*: 77.
- Rumbaugh, M. D., 1963: Effects of population density on some components of yield of alfalfa. *Crop Sci.*, 3: 423.
- Takasaki, Y.; Takahashi, N.; Yokoyama, K., 1970: Studies on the performance of alfalfa swards. I. Yield and change in plant numbers in alfalfa swards at different densities. *Crop Sci. Soc. Jap.*, 39: 144.
- Zaleski, A., 1959: Lucerne investigations. IV. Effect of germination and seed rates on establishment, mortality and yield of dry matter and protein per acre. *J. agric. Sci., Camb.*, 53: 260.