# THE ESTABLISHMENT OF LUCERNE *(Medicago sativa L)* WITH COVER CROPS

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## SUMMARY

In four field trials lucerne was established from seed sown at several rates and with and without several cover crops, barley, peas and linseed. Post-emergence weedicide treatments were included. In three trials establishment with a cover crop or dense infestations of fathen did not reduce the numbers of lucerne plants which established but reduced the yield of lucerne at first harvest.

## INTRODUCTION

Three main advantages have been claimed for sowing lucerne with annual crops instead of sowing it alone. The "cover" crop may establish more quickly than the lucerne, and so protect it and the field from soil erosion; it may reduce competition from weeds; and it may provide a profitable return before the lucerne becomes economically productive. As well as conferring these possible benefits, the cover crop also competes with the establishing lucerne, so the outcome of sowing with or without a cover crop will vary with the balance of competitive effects between weeds, cover crop and lucerne.

The cover crop may alter the numbers of lucerne plants which become established, and/or it may reduce their size. Reductions in plant numbers may have permanent effects on lucerne production if the number falls below the minimum needed for maximum production. Reductions in plant size may have temporary effects if suppressed plants later increase to the size of plants established without competition.

The advantages of the use of cover crops and ways of reducing their disadvantages have been reviewed by Charles (1958), Kilcher and Heinrichs (1960), Santhirasegaram and Black (1965).

Briggs and Harrison (1953) found barley and oats to be superior to sudan grass, buck wheat, millet and soya beans, and Klebesadel and Smith (1959) found that the undersown species established better under a spring sown than under an autumn sown cover crop. They ranked wheat as being more competitive than barley, which was more competitive than oats.

Most work has shown that the yield of the under-sown species is considerably reduced in the year of establishment.

Santhirasegaran and Black (1965) concluded that to increase the establishment of the under-sown species, crop species or varieties which make less demands on light, nutrients and water should be used and that the cover crop should be sown at a reduced seeding rate and drilled in wide rows at right angles to the under-sown species.

Schmid and Behrens (1972) compared lucerne established under an oat cover crop, with lucerne established with four herbicide treatments. Sprayed strands were denser in the first autumn but subsequent production was the same. They concluded that establishment with a cover crop was more profitable.

Tossell and Fulkerson (1960) found that weed numbers decreased as the cover crop seeding rate increased and the row width decreased.

Stivers (1956) showed that ladino clover caused nitrogen deficiency in maize when they were sown together and Charles (1960) showed that broad-red clover reduced oat yields less when nitrogen fertiliser was applied. Pendleton (1957) found that red clover reduced the yield of an oat cover crop and the reduction increased as the oat row width increased and when the season was dry. Both Charles and Pendleton found that under-sowing reduced the number of oat panicles while the other components of yield were unchanged.

Jarvis et al (1958), McGowan and Williams (1971) however found that barley yields were not reduced when sown with several different under-sown species.

TABLE 1 : LUCERNE SEEDING RATES, COVER CROPS AND THEIR SEEDING RATES AND WEEDICIDES USED IN FOUR TRIALS.

| Trial | Sowing Date | Lucerne Seeding Rate kg/ha | Cover Crop (Seeding Rate kg/ha) | Weedicide |
|---|---|---|---|---|
| 1 | 5.10.66 | 5.6 | barley | MCPB |
| | | 11.2 | (56) | |
| | | 16.8 | peas (200) | MCPB |
| | | | linseed (45) | MCPB |
| | | | nil | MCPB |
| | | | nil | nil |
| 2 | 26. 9.69 | 5.6 | barley | 24DB |
| | | 11.2 | (56) | |
| | | | peas (200) | MCPB |
| | | | nil | 24DB |
| | | | nil | Benefin |
| | | | nil | nil |
| 3 | 5.11.70 | 2.8 | barley | nil |
| | | 5.6 | (56) | |
| | | 11.2 | nil | Paraquat June 1971 |
| | | | nil | Paraquat October 1971 |
| | | | nil | nil |
| 4 | 24. 9.71 | nil | nil | |
| | | 2.9 | barley | |
| | | 3.9 | (56) | |
| | | 5.8 | barley (115) | |

## MATERIALS AND METHODS

In four field trials Wairau lucerne was sown at varying seeding rates with barley, peas and linseed, and treated with herbicides to control fathen (*Chenopodium album*) and storksbill (*Erodium cicutarium*) and *E. moschatum*, the main annual weeds. The soil was a Paparua sandy loam, limed to, or above, pH 5.8. The cover crops were drilled in 17.5 cm rows, and the lucerne drilled across the cover crop rows on the same day. Details of the experimental treatments are given in Table 1.

Irrigation was a further treatment in Trial 4: "Not irrigated" receiving only rainfall. "Irrigated" was watered to field capacity when the moisture in the top 15 cm fell to 50% of available moisture. This required nine irrigations between sowing and crop harvest, and five between crop harvest and the last cut.

## RESULTS

### General:

In the case of trials 1,2 and 3, yields of grain from crops were measured, but not total dry matter yields. In Trial 1, the MCDB treatment eliminated fathen, but allowed a dense growth of storksbill. In trial 2, Benefin was ineffective in controlling fathen, and on 22 December fathen dry matter yields of 4,400 and 3,600 kg/ha were recorded on the Benefin and control plots respectively. In Trial 3, there was no significant growth of weeds before the barley harvest, but a considerable growth of storksbill occurred after harvest.

### Weed Yields:

Weed growth was reduced by irrigation and by the presence of barley. The presence of barley, and the effect of increasing seeding, was greater under non-irrigation than under irrigation. The presence of lucerne at increasing rates tended to reduce weed growth but this failed to reach significance. (Table 2).

Weed growth in later cuts was insignificant in all treatments.

TABLE 2 : TRIAL 4. HERBAGE YIELD OF WEEDS
DRY MATTER (KG/HA)

| | Lucerne Seeding Rate | Barley Seeding Rates (kg/ha) 0 | 56 | 112 | x |
|---|---|---|---|---|---|
| | 0 | - | 1521 | 403 | - |
| | 2.9 | 2100 | 1600 | 180 | 1300 |
| Non-Irrigated | 3.9 | 4000 | 640 | 210 | 1600 |
| | 5.8 | 1800 | 660 | 450 | 980 |
| | x | 2600 | 970 | 280 | 1290 |
| | 0 | - | 1424 | 669 | - |
| | 2.9 | 1500 | 1000 | 500 | 1000 |
| Irrigated | 3.9 | 1300 | 600 | 430 | 780 |
| | 5.8 | 1300 | 620 | 400 | 770 |
| | x | 1400 | 740 | 440 | 850 |

TABLE 3 : TRIALS 1,2,3. COVER CROP GRAIN YIELDS (KG/HA)

| Trial | Cover Crop | Yield |
|---|---|---|
| 1 | Barley | 4,300 |
| | Peas | 2,300 |
| | Linseed | 1,800 |
| 2 | Barley | 2,520 |
| | Peas | 1,140 |
| 3 | Barley | 2,800 |

TABLE 4 : TRIAL 4. BARLEY GRAIN YIELDS AND TOTAL YIELDS (KG/HA)

| | Seed Rate kg/ha Barley | Grain Yield 56 | Grain Yield 112 | Total Yield 56 | Total Yield 112 |
|---|---|---|---|---|---|
| | Lucerne | | | | |
| Irrigated | 0 | 3200 | 4100 | 7000 | 8400 |
| | 2.9 | 2500 | 4300 | 5600 | 9200 |
| | 3.9 | 2500 | 4000 | 6000 | 8700 |
| | 5.8 | 2600 | 3500 | 5900 | 7500 |
| Non-Irrigated | 0 | 2800 | 3400 | 6300 | 7000 |
| | 2.9 | 2200 | 3600 | 5000 | 7500 |
| | 3.9 | 2400 | 3800 | 5400 | 8100 |
| | 5.8 | 2400 | 3400 | 5900 | 7300 |

TABLE 5 : TRIAL 1. NUMBERS OF LUCERNE PLANTS PER METRE ROW WHICH ESTABLISHED AND PERSISTED AT DIFFERENT SEEDING RATES AND WITH & WITHOUT COVER CROPS.

| Lucerne Seeding Rate kg/ha | 5.6 | | 11.2 | | 16.8 | | C.V. All Treatments |
|---|---|---|---|---|---|---|---|
| Sampling Date | Cover Crop | No Crop | Cover Crop | No Crop | Cover Crop | No Crop | |
| December 1966 | 15.7 | 20.3 | 24.5 | 40.0 | 36.4 | 59.9 | 26% |
| June 1970 | 6.6 | 10.1 | 12.8 | 15.2 | 14.7 | 18.5 | 33% |
| April 1971 | 7.0 | 8.5 | 9.4 | 10.2 | 11.4 | 11.5 | 37% |
| April 1973 | 5.5 | 6.5 | 8.7 | 9.4 | 10.0 | 11.4 | 20% |

LOWER CROP YIELDS:

Competition between lucerne and barley resulted in a reduction in both barley grain and total yield. (Table 4). The decreased yield was a result of a reduced number of fertile tillers as found by both Pendleton (1957) and Charles (1960) in their work with oats.

The reduction is unlikely to be caused by competition for light, as irrigation, which increased the yield of the under-sown lucerne by 600%, did not alter the competitive effect.

PLANT NUMBERS:

In Trial 1, fewer plants established in sowings with barley and peas than in the control treatments. With linseed numbers were intermediate between the other two groups, and not significantly different from either group. In Table 5, the results from the three crop treatments have been combined, and the lucerne with and without weed control treatments have also been combined.

More plants established without competition from a cover crop, and these differences in plant numbers persisted, though the differences in 1971 and 1972 were not significant. More plants established at the higher seeding rates. When sown without cover crops, the increase in plant numbers established was directly proportional to increases in seeding rate, but under cover crops, proportionally fewer plants established at higher seeding rates.

TABLE 6 : NUMBERS OF LUCERNE PLANTS PER METRE OF ROW ESTABLISHING AND PERSISTING AT DIFFERENT SOWING RATES. TRIAL 2.

| Seeding Rate (kg/ha) | March 1970 | April 1971 | April 1972 |
|---|---|---|---|
| 5.6 | 32.4 | 25.6 | 15.4 |
| 11.2 | 48.4 | 35.0 | 19.0 |
| C of V (all treatments) | 30% | 45% | 17% |

TABLE 7 : TRIAL 3. NUMBERS OF LUCERNE PLANTS PER METRE ROW WHICH ESTABLISHED AND PERSISTED FROM DIFFERENT SEEDING RATES

| Seeding Rate kg/ha | March 1971 | June 1972 |
|---|---|---|
| 2.8 | 22.6 | 17.8 |
| 5.6 | 38.5 | 27.9 |
| 11.2 | 53.2 | 32.5 |
| C.V. | 20% | 37% |

There were no significant differences between the numbers of lucerne plants established under different cover crops and weed control treatments in Trials 2 and 3. The higher seeding rates of lucerne gave higher numbers of lucerne plants, but a lower proportion of the seed sown produced plants. (Tables 6,7).

In Trial 4, plants were counted three times in the establishment year. Sowing with barley had no effect on lucerne plant numbers. Results from sowing rate and irrigation treatments at the three sampling dates are given in Table 8.

Irrigation and higher seeding rates increased plant numbers. In October, plant numbers were directly proportional to seeding rates. Over all treatments, plant numbers were not significantly different at different sampling dates, but the interaction between sampling dates and seeding rates was significant, with numbers rising at the lower seeding rates and falling at the higher rates, resulting in a lower proportional establishment from the higher seeding rates. Zaleski (1957) found similar increases and decreases in plant survival in the seeding year, and attributed them to establishment from hard seeds in sparser populations, and competitive killing of plants in denser populations.

In Trial 1 sown in 1966, seedling lucerne competing with barley, peas or linseed had lower plant population than lucerne competing with fathen or storksbill. In Trial 2, 3 and 4 sown in 1969, 1970 and 1971 respectively, competition from other species had no effect on lucerne plant numbers.

TABLE 8 : NUMBERS OF LUCERNE PLANTS PER METRE ROW FROM THREE SOWING RATES AND IRRIGATED AND NON-IRRIGATED TREATMENTS AT THREE SAMPLING DATES.

| | Sowing Rate kg/ha | Plants per metre row Oct. | Dec. | Feb. | x |
|---|---|---|---|---|---|
| | 2.9 | 14.7 | 16.0 | 16.6 | 15.8 |
| Non-Irrigated | 3.9 | 17.8 | 20.5 | 18.8 | 19.1 |
| | 5.8 | 28.8 | 27.4 | 26.7 | 27.5 |
| | $\bar{x}$ | 20.3 | 21.4 | 20.8 | 20.8 |
| | 2.9 | 15.3 | 17.6 | 18.1 | 17.0 |
| Irrigated | 3.9 | 25.3 | 22.2 | 22.7 | 21.8 |
| | 5.8 | 31.2 | 30.0 | 28.2 | 29.8 |
| | $\bar{X}$ | 22.3 | 23.3 | 23.0 | 22.9 |
| | CV% | 13 | 15 | 9 | 13 |

Mean Bo: 22.0, B1 = 21.9
B2 = 21.6.

Lucerne Yields:

Trial 1 yields were not measured during the year of establishment. Subsequently there have been no significant differences in yield from any treatments.

TABLE 9 : TRIAL 2. FORAGE DRY MATTER YIELDS KG/HA

| Treatment | 28.1.70 | 2.7.70 Lucerne | 2.7.70 Lucerne Weeds | 27.9.70 Lucerne | 6.11.70-5. 2.71 Lucerne |
|---|---|---|---|---|---|
| Control | - | 650 b | 650 | 3560 c | 23,000 |
| Benefin | - | 770 a | 770 | 4090 b | 25,000 |
| 24DB | 2220 | 810 a | 110 | 4510 a | 25,000 |
| Peas + Benefin + MCPB | 1890 | 770 a | 770 | 4080 b | 24,000 |
| Barley + 24DB | - | 680 b | 1560 | 3820 bc | 25,000 |

The lucerne which was sown with barley or competed with a heavy infestation of fathen, gave no useful yield in the autumn after sowing. Lucerne yields from treatments established in competition with weeds, barley or peas were lower than lucerne sown alone and treated with 24DB until the year after sowing.

TABLE 10 : TRIAL 3. FORAGE DRY MATTER YIELDS KG/HA

| Treatment | 29.9.71 Lucerne | 29.9.71 Weeds | 25.11.71 | 10.1.72 |
|---|---|---|---|---|
| Control | 1640 b | 4100 a | 3420 b | 1600 a |
| Barley | 970 c | 3540 b | 3070 c | 1630 a |
| Paraquat 17.6.71 | 2210 a | 2210 c | 4275 a | 1830 a |
| Paraquat 19.10.71 | 1640 b | 4100 a | 2780 c | 1890 a |

In Trial 3, sowing with barley in spring, reduced lucerne production until the following summer. The dense infestation of storksbill which established in autumn 1971 also reduced lucerne production until summer 1971. The increased production of lucerne on the plots treated with paraquat in winter 1971 did not compensate for the loss of production from storksbill.

Treatment with paraquat in October killed the storksbill before it seeded, but reduced the production of lucerne in the subsequent harvest, so that total production from the two paraquat treatments was the same but lower than from the control plots. (Table 10).

In Trial 4 three lucerne harvests were taken in the year of sowing. (Table 11).

All main effects except lucerne rates were significant at 1%.

Barley x irrigation, barley x dates and irrigation x dates were significant at 1%. The irrigation response of lucerne increased as the barley rate increased, in spite of the barley yield increasing with irrigation. This indicates that competition for moisture was more important than competition for light in this trial.

TABLE 11 : TRIAL 4 EFFECT OF COVER CROP AND IRRIGATION ON LUCERNE PRODUCTION IN THE ESTABLISHMENT YEAR.

LUCERNE DRY MATTER YIELD (KG/HA)

| Barley Seeding Rate kg/ha | "Harvest" Cut 25.1.72 | | 1st Production Cut 14.3.72 | | 2nd Production Cut 9.5.72 | |
|---|---|---|---|---|---|---|
| | Io | I1 | Io | I1 | Io | I1 |
| 0 | 2160 AB | 5840 A | 2900 B | 5190 A | 1900 A | 2900 A |
| 56 | 460 C | 2880 AB | 1660 C | 4740 A | 1420 B | 2780 A |
| 112 | 240 C | 1690 B | 1350 C | 4000 AB | 1190 B | 2560 A |
| CV% | 8.8 | | 3.9 | | 3.5 | |

Io = No irrigation

I1 = Irrigated.

## DISCUSSION AND CONCLUSIONS

In one trial of four, sowing with a cover crop reduced the numbers of lucerne plants which established. In the other three trials, establishment with a cover crop, or dense infestations of fathen, did not reduce the numbers of lucerne plants. In the trial where cover crops reduced numbers of lucerne plants, the general establishment of lucerne plants was about half that from similar sowing rates in the other trials. It may be that cover crops reduce lucerne establishment when conditions for lucerne establishment are unfavourable.

Trial 4, included an irrigation treatment in a year in which 187 mm or rainfall fell in the period from September to January compared with the average rainfall of 257 mm for that period. Results from this trial suggest that shortage of moisture is not a critical factor in lucerne establishment on well prepared seed beds in this area.

Denser stands of cover crops or weeds, or lodged cover crops, may have reduced plant numbers. However, conditions which increased the production from the cover crop may equally have increased the growth of the lucerne, as happened with the irrigated treatment in Trial 4.

Sowing increased amounts of lucerne seed resulted in a lower proportional establishment. In Trial 4 this resulted from a higher death rate of seedlings at the higher seeding rates, and a greater establishment from late germinating seeds at the lower seeding rates. Zaleski (1957) obtained similar results. Competition between lucerne plants at the higher seeding rates is apparently more likely to cause death of lucerne plants than competition between lucerne and other species.

Competition with a cover crop, or with weeds, reduced considerably the size of the lucerne plants at the time of crop harvest. This resulted in lower yield of the lucerne for some time after the removal of the competing species. Apart from this temporary effect, there was no evidence that sowing with a cover crop would result in permanent reductions in yield.

In the one trial where the effect of lucerne on the yield of the cover crop was measured, sowing with lucerne reduced the yield of the cover crop, the number of fertile tillers being reduced.

In all trials, sowing with a cover crop was more profitable than sowing lucerne alone.

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