Reducing the cost of lucerne establishment in Western Australia

R.A.Latta[1] and L-J.Blacklow[2]

[1]Agriculture Western Australia, Katanning, WA.
Formally [2] University of Western Australia, Katanning, WA.

ABSTRACT

The effect of covercrop, sowing rate and row spacing on lucerne (*Medicago sativa)* was studied in the Western Australian wheat-belt at 2 sites during 1996 and 1997, and at a further 8 sites in 1999/00. Lucerne density in the year of sowing was proportional to sowing rate. Lucerne biomass in the year of sowing was decreased with increased covercrop sowing rate in the first year but was unaffected in the second year. Failures in establishing the lucerne at a satisfactory density occurred at 33% of the 12 sites over the 3 years. Failures were largely due to either environmental and/or management issues. The study showed that the risk factor associated with establishing lucerne was not increased by either reduced sowing rates or alternate row covercropping strategies. Covercropping was shown to be an effective strategy for addressing the cost of establishment in the Western Australian environment.

KEY WOrDS

Lucerne, establishment, barley, covercrops, sowing rates.

INTRODUCTION

Establishing pastures under field crops (covercropping) is a compromise method of pasture establishment used primarily for economic reasons but also to protect seedlings from wind and sand damage. Extensive studies in the 1960's (2) found that undersowing annual legume pastures in the medium to low rainfall areas (300-400 mm annual rainfall) of Western Australia was frequently unsuccessful due to the inability to compete for water, light and nutrients. In some situations there was also some evidence of crop grain yield loss due to excessive competition from the pasture. Seedlings of perennial pasture species can be expected to be more susceptible to competition from cover crops than annuals as they must develop a deep enough root system by the end of spring to survive the summer drought typical of this Mediterranean environment.

The early recommendations for establishing lucerne (*Medicago sativa*) in the low to medium rainfall region of South Australia was to sow lucerne at 1 to 2 kg/ha on 35 cm spacings behind the covering tynes of the seeder between every 2nd row of crop sown at the normal 17.5 cm spacing (3). More recent work (5) has identified the opportunities to successfully establish perennial pastures by sowing the pasture and crop in each alternate row (17.5 to 20 cm spacings) and adjusting sowing depth and fertilisers commensurate with the crop requirements.

Research to determine the required lucerne plant density required to optimise biomass production, water utilisation and weed competition in the Western Australian environment has not been definitive. Results from recent studies (1, 2) found that 25-30 lucerne plants/m^2 were productive over a range of seasons and soil types. In supporting this contention plant densities which established at >50/m^2 declined rapidly to about 40 plants/m^2. Fifteen lucerne plants/m^2 were found to be less effective at fully exploring and accessing stored soil water than higher densities although they were able to maintain comparative biomass production. It is considered that in the 325-400 mm agricultural region of WA the target for successful lucerne establishment should be 20-30 lucerne plants/m^2 present at the break of the season following establishment.

It is currently recommended that dryland lucerne to be sown as a monoculture at 4-5 kg/ha throughout WA. The objective of this study was to determine the viability of a reduced seeding rate (2 kg vs. 4 kg/ha) and covercropping options to establish a successful lucerne stand. The following experiment evaluated the effect of cover crop sowing rate and row spacing on lucerne establishment, and cover crop grain yield at a range of sites in the wheat-belt of Western Australia.

MATERIALS AND METHODS

In both 1996 and 1997 two experimental sites were established in the Great Southern region of Western Australia, approximately latitude 34^0S, longitude 118^0E. In 1999 eight experiments were conducted at sites throughout the wider agricultural region bounded by latitudes 29?S to 34?S and longitudes 116?E to 134?E. All sites in all 3 years were located within the 325 to 400 mm annual rainfall isohyets. All were sown onto sand over clay duplex soils with sand layers which varied from <0.01 m to >1 m. Surface soil pH was in the range 4.5 to 6.0 ($CaCl_2$).

Experiments were sown in May 1996 and 1997 with a conventional tined seeder. In 1999 sowing commenced on 3 June with the final experiment established on 8 July 1999. The 1999 sites were all sown with a six row cultiseeder with trailing press wheels at 0.2m row spacing. Fertiliser was applied at all sites by seeder at 10 kg/ha of P with rates of K from 0 to 50 kg/ha as recommended by commercial “CSBP Soil Analysis Service”.

The lucerne cv. Sceptre was sown in the 1996 and 1997 experiments as both a monoculture at 0.2 m row spacing and in an alternate row configuration with barley cv. Stirling sown at 30 kg/ha. The seeding rates were 2 and 4 kg/ha in 1996 and 4 kg/ha in 1997. In 1999, the same variety of lucerne and covercrop were used but with a wider range of row spacing and seeding rate treatments (Table 1). Experimental design was a randomised complete block and treatments were replicated four times in 1996 and 1997 experiments and three times in the 1999 experiments.

Table 1. Seeding rates and row spacings of lucerne cv. Sceptre and barley cv. Stirling in 1999 experiments (Note: a row spacing of 0.4 m represents an alternate row configuration).

	Lucerne		Barley	
Treatment	Seeding rate (kg/ha)	Row spacing (m)	Seeding rate (kg/ha)	Row spacing (m)
1	4	0.2	0	-
2	2	0.4	0	-
3	2	0.2	60	0.2
4	2	0.4	60	0.4
5	2	0.2	30	0.2
6	2	0.4	30	0.4
7	2	0.4	15	0.4

8	2	0.2	30	0.2-0.6-0.2-0.6 cont.

Lucerne plant densities and biomass production in the 1996 experiments were measured in November 1996 and 1997. The 1997 experiments lucerne densities assessed in August, October and December 1997. In the 1999 experiments lucerne densities were counted following emergence in August 1999, and again in December and in April 2000. Biomass production and barley grain yields were measured in December 1999. Measurements were collected across all 6 rows in each plot. Plots were continuously sown to remove any border effect. Plot size was 10 m x 1.2 m.

RESULTS

May to November rainfall was below average in 1996, deciles 3 and 4 and above average in 1997, deciles 6 and 7. Between April 1999 and November 1999 rainfall was near to or below average at all sites, deciles 3 to 5. From December 1999 to March 2000 it was well above average, decile 9.

Table 2. Mean lucerne density (plants/m^2) and biomass production (kg DM/ha) from the two experiments sown in 1996.

Treatments	November 1996		November 1997	
Seeding rates (kg/ha)	Lucerne density	Lucerne biomass	Lucerne density	Lucerne biomass
Lucerne 2	12	600	8	1000
Lucerne 4	24	1200	15	1500
Lucerne 2 + barley 30	12	120	9	1000
Lucerne 4 + barley 30	24	250	14	1500

Increasing the sowing rate from 2 to 4 kg/ha doubled the plant numbers which established in 1996 (Table 2). This relative difference was maintained through to November 1997. Lucerne biomass was substantially lower in November 1996 under the barley covercrop compared to the no covercrop treatment, however by November 1997 biomass was correlated with plant density not the establishment method.

Table 3. Mean lucerne density (plants/m^2) from the two experiments sown in 1997.

Treatments	August 1997	October 1997	December 1997
Seeding rate (kg/ha)	Lucerne density	Lucerne density	Lucerne density
Lucerne 4	35	28	20
Lucerne 4 + barley 30	27	24	23

The barley covercrop had no effect on the number of lucerne plants that survived the seven months following seeding (Table 3). Lucerne density declined from about 30 to 20/m^2 over that period.

Table 4. Mean lucerne density (plants/m^2), biomass production (kg/ha dry matter) and barley grain yields (t/ha) from eight sites sown in 1999. Figures in parenthesis are the maximum and minimum figures from all sites.

Crop seeding rate (kg/ha)	Lucerne plant density			Biomass	Grain yield
@ row spacing (m)	Aug. 1999	Dec. 1999	Mar. 2000	Dec. 1999	Dec. 1999
Luc 4@0.2 barley 0	56 (86-23)	35 (50-15)	35 (57-16)	359 (720-86)	0
Luc 2@0.4 barley 0	48 (74-26)	36 (48-16)	29 (39-15)	399 (948-85)	0
Luc 2@0.2 + barl 60@0.2	30 (45-15)	17 (24-10)	17 (29-9)	100 (287-8)	2 (3.6-0.7)
Luc 2@0.4 + barl 60@0.4	39 (63-25)	23 (36-19)	24 (37-19)	120 (303-17)	1.9 (2.9-0.5)
Luc 2@0.2 + barl 30@0.4	28 (54-14)	19 (36-13)	20 (29-13)	119 (280-18)	1.6 (2.5-0.6)
Luc 2@0.4 + barl 30@0.4	36 (55-20)	27 (40-16)	25 (42-16)	184 (434-28)	1.4 (2.2-0.2)
Luc 2@0.4 + barl 15@0.4	39 (54-25)	26 (34-17)	24 (29-16)	185 (463-41)	1.6 (2.6-0.3)
Luc 2@0.2 + barl 30@0.2-0.6-0.2-0.6 cont.	39 (64-20)	27 (36-18)	25 (37-19)	235 (602-53)	1.5 (2.1-0.6)
L.s.d.(P=0.05) treatment		2.6		69	0.3
L.s.d.(P=0.05) treat x time		4.6			

At the 1999 sites lucerne plant densities declined between August and December under all treatments, however there was no further decline from December until March (Table 4). The 4 kg/ha sowing rate treatment retained higher lucerne plant densities at the completion of the study. In comparison to all other treatments sowing lucerne with 0.2 m spaced rows under barley reduced lucerne plant density throughout study.

In comparison to a mean December biomass figure of 212 kg/ha; sowing lucerne at 2 and 4 kg/ha without a barley covercrop increased biomass; sowing lucerne at 0.2 m spaced rows with 60 and 30 kg/ha of barley, and with 60 kg/ha of barley at 0.4 m spaced rows reduced biomass. Sowing barley at 60 kg/ha at both 0.2 and 0.4 spaced rows increased barley grain yield compared to 30 and 15 kg/ha sowing rates.

There was a significant difference in lucerne densities between sites. Lucerne numbers declined from approximately 50 to 30 on the wetter, shallower sand sites and from 20 to 10 on the drier deeper sand sites during the study. Biomass varied from almost 1000 to <20 kg DM/ha and barley grain yields from 3.6 to <0.5 t/ha.

DISCUSSION

The outcomes from this study provide a guide as to the likely establishment success rate of lucerne sown with a cover or companion crop. The 1996 and 1997 experiments produced less than satisfactory establishment, possibly due to a number of reasons which may include; unsuitable seeding machinery resulting in variable sowing depth with poor emergence, insect competition, weed infestation and a water deficit. There were no indications that the barley covercrop reduced lucerne plant numbers at establishment. However, the above average rainfall over the 1996/97 summer and autumn period could be expected to have favoured lucerne establishment and survival.

The 1999 studies covered a wide range of environmental variables in soil type, rainfall, pest and weed infestations. It provided a good representation of success probabilities in one year that may not be encountered for a number of years if working at 1 or 2 sites in one region. Based on the estimated requirement of a lucerne density of >20 plants available at the break of the season following establishment (1, 2) the mean of 2 of the 8 sites did not achieve that goal. The 2 sites produced unsatisfactory low densities even when sown without a covercrop. The environmental variables controlled establishment success irrespective of the cultivated crops row sowing configuration or density.

The higher 60 kg/ha barley seeding rate, sown at 0.2 m spaced rows, produced <20 lucerne plants/m^2 at 6 of the 8 sites compared to 3 out of 8 sites when row spacings of both the barley (60 kg/ha) and lucerne were increased to 0.4m. At 5 of the 8 sites lucerne sown at 0.2 row spacing under 30 kg/ha of barley <20 lucerne plants established, this reduced to 3 of the 8 when lucerne row spacing increased to 0.4 m (alternate rows). Both the triple spaced configuration, barley at 0.6-0.2-0.6, and the barley sown at 15 kg/ha produced a marginal increase in successfully established sites, in comparison with the alternate row lucerne and barley sown both at 30 and 60 kg/ha, at 6 of the 8 sites compared the 5 out 8 sites respectively.

Increased barley seeding rates showed a trend towards lower lucerne biomass. The good survival of lucerne plants over the summer irrespective of their plant biomass measured in December may be as a result of well above average rain during that period over most sites. However the 1996 study gave similar results with no loss of plants over the summer period. As expected the reduction in barley seeding rates resulted in up to a 25% loss in grain yield.

CONCLUSIONS

This study provides the justification for the recommendation of a new lucerne establishment package for WA. It shows that lucerne can be successfully established by reducing the barley seeding rate by blocking every second or more of the seeding tynes. It has not been considered feasible to establish lucerne as a monoculture over several million hectares. This technology with a reduced lucerne seeding rate provides the catalyst for the widespread sowing of lucerne in the WA wheatbelt.

If grain yields measured in this study can be repeated commercially it gives a major impetus to removing the perceived economic loss associated with the lucerne establishment year. It reduces the cost of establishing lucerne, although there may be increased herbicide costs associated with protecting the lucerne and the loss in crop yield as a result of the reduced seeding rate.

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REFERENCES

1. Latta, R.A., Blacklow, L.J. and Cocks, P.S. In press. *Aust. J. Agric. Res*.

2. Lattta, R.A., Cocks, P.S. and Matthews, C. In press. *Agroforestry Systems.*

3. Potter, J.S. 1965. *Journal Department of Agriculture South Australia* . 68 July : 414 - 416

4. Poole, M.L., Gartrell, J.W. and Nicholas, D.A.N. 1970. *J. Dept. of Agric. W. A*. Vol.11, 4th Series, 1970.

5. Taylor, J.M.. Jackman, M.A. and Bluett, C.A. 1992. *Proceedings of the 6th Australian Agronomy Conference.* Armidale. 593.