A SPACING AND DEFOLIATION STUDY WITH UNICROP LUPINS

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ABSTRACT

Trials were sown at Palmerston North during April and October 1974. The main treatments were different intra-row spacing 5, 10, 20 and 30 cm (with constant 20 cm between rows) using **Lupinus angustifolius** c.v. Unicrop. Sub treatments were nil, early and late "topping" which involved removal of the growing point at the 7-8 leaf stage and when the primary flower bud was first visible.

Mean seed yields from the autumn sowing increased from 183g/m^2 at 30 cm spacing to 366 g/m^2 at 5 cm spacing. With the spring sowing, intact plants had yields increasing from 323 g/m^2 to 402 g/m^2 over the same spacing but early defoliated plants had reduced yield as plant density increased. Overall, defoliation reduced seed yield by between 100 and 120 g/m^2.

On a per plant basis, vegetative yield, seed yield and yield components except seed weight reduced with increasing population.

The primary response was the number of lateral branches and thus lateral inflorescences produced. These were reduced with defoliation and as population density increased. As the number of pods per inflorescence and seeds per pod remained relatively constant, the variation in lateral inflorescence numbers had a direct effect on seed yield through pod numbers. Higher order laterals were the most responsive to treatments.

The seed yields of autumn and spring sowings were similar for equivalent treatments but the yields of the autumn sowings were limited by fungal disease which caused the loss of early-formed pods.

INTRODUCTION

Limited information to date indicates that the response of lupin seed yield to population changes is low (Withers **et. al.** 1974, P.J. Rhodes, personal communication). The overall yields in the former trial were low and the site had poor moisture retention so it was decided to sow a further population trial on a heavier soil type with a wider range of populations.

Previous work, (Withers 1973, Withers **et al.** 1974) showed that a high proportion of seed yield is usually obtained from lateral branches. It was observed that plants which had the primary apex removed produced increased numbers of laterals so it was possible that early decapitation, by stimulating more lateral inflorescences, could increase seed yield. As any such response could be modified by population density the defoliation study was carried out in conjunction with the population trial.

EXPERIMENTAL

Two separate experiments with the same basic design were sown at Massey University on 25-26 April and 1-2 October using **Lupinus angustifolius** c.v. Unicrop. Each trial was a split-plot randomised block design with 5 replications. Main plots were population treatments which had 20 cm inter-row spacing with 5, 10, 20 and 30 cm intra-row spacings. Sub-plots were nil, early, and late defoliation. The early defoliation treatment was to remove the top of the plant with scissors when the plant had reached 7-8 expanded leaves, leaving five expanded leaves. The late treatment was carried out when the primary flower bud was just visible and 16 leaves remained after topping.

Prior to sowing, a basal dressing of 48 kg P/ha and 112 kg K/ha as potassic superphosphate was applied. Three seeds per position were sown by hand and after emergence, thinned to one plant per position. A pre-emergent spray of 1.1 kg/ha a.i. of atrazine gave effective weed control.

An early harvest of 2 plants per sub-plot was made on 18 October for the autumn-sown trial and 7 January for the spring-sown trial when each crop had its 3rd sequence of pods forming. Measurements of plant size and weight, numbers of branches and pods were made. A final harvest was made at maturity when 15 plants per sub-plot were sampled and seed yield and components were measured. Seed and plant material was dried at 80^o C for 12 hours.

RESULTS

Yield of oven dried seed is presented in Table 1. For the autumn sowing, mean yields increased significantly as spacing density increased up to the 20 cm spacing. This did not occur for the spring sowing because of opposing trends within the defoliation treatments. At this time, the undefoliated and the late defoliated plots increased yields with increasing plant density but for the early defoliated plot the reverse occurred. The overall effect was no difference in mean yields for spacing at the spring sowing.

The mean yields from defoliated plots were significantly lower than those from undefoliated plots at both sowing times. This effect was apparent at only the 5 and 10 cm spacings resulting in a significant interaction ($P < 0.01$) between spacing and defoliation.

Yield per plant reduced as density increased and when plants were defoliated (Table 2). Generally, all

TABLE 1. Yield of oven dried seed (g/m^2)

AUTUMN SOWN

Defoliation	Spacing				
	5 cm	10 cm	20 cm	30 cm	Mean
Nil	542 aA*	334 a	210 a	226 a	328 aA
Early	272 bB	235 b	152 a	159 a	204 bB
Late	283 bB	204 b	173 a	166 a	207 bB
Mean	366 aA	258 bB	178 cB	183 cB	

SPRING SOWN

Defoliation	Spacing				
	5 cm	10 cm	20 cm	30 cm	Mean
Nil	402 aA*	330 aA	288 a	272 a	323 aA
Early	180 cC	230 bB	238 a	250 a	225 bB
Late	265 bB	228 bB	247 a	235 a	245 bB
Mean	283 a	263 a	258 a	253 a	

*Duncans lettering in body of table applies to within column only.

components of yield remained stable or followed the same trend. An exception was the number of fertile inflorescences (inflorescence producing seed of commercial quality) for the spring sown defoliation treatments which increased significantly with defoliation. However this increase was offset by a significant reduction in numbers of pods per inflorescence which did not occur elsewhere.

TABLE 2. Yield per plant and components of yield (Final Harvest)

SPACING EFFECTS

Autumn Sown	Spacing			
	5 cm	10 cm	20 cm	30 cm
Yield/plant (g)	3.9 dC	5.2 cd BC	7.1 bB	11.0 aA
Fertile inflorescences/ plant	3.4 cC	5.5 bB	6.7 bB	8.7 aA
No pods/inflorescence	3.0 abA	2.5 bA	3.1 aA	3.3 aA
No pods/plant	10.2 dC	13.7 cC	20.7 bB	28.7 aA
No seeds/pod	3.7 a	3.9 a	3.8 a	4.0 a
Hundred seed weight (g)	11.4 a	11.2 a	10.9 a	11.1 a
Spring Sown				
Yield/plant (g)	2.8 dD	5.2 cC	10.3 bB	15.2 aA
Fertile inflorescences/ plant	2.5 dC	4.1 cC	7.7 bB	10.6 aA
No. pods/inflorescence	2.1 bB	2.3 bB	2.6 aA	2.9 aA
No. pods/plant	5.2 dD	9.33 cC	19.3 bB	27.7 aA
No. seeds/pod	3.3 a	3.3 a	3.2 a	3.4 a
Hundred seed weight (g)	4.5 a	14.5 a	13.8 a	13.6 a

DEFOLIATION EFFECTS

Autumn Sown	Nil	Early	Late
Yield/plant (g)	8.5 aA	5.8 bA	6.1 bA
Fertile inflorescences/plant	7.3 aA	5.5 bB	5.4 bB
No. pods/inflorescence	2.9 aA	3.0 aA	3.1 aA
No. pods/plant	21.1 aA	16.5 bB	16.9 bB
No. seeds/pod	3.5 a	3.1 a	3.3 a
Hundred seed weight (g)	11.6 aA	10.9 bA	10.9 bA
Spring Sown			
Yield/plant (g)	9.6 aA	7.7 bB	7.8 bB
Fertile inflorescences/plant	5.2 bB	6.7 aA	6.8 aA
No. pods/inflorescence	3.4 aA	2.1 bB	2.0 bB
No. pods/plant	17.7 aA	14.9 bB	13.6 bB
No. seeds/pod	4.0 a	3.9 a	3.9 a
Hundred seed weight	14.2 aA	13.4 cB	14.7 bA

The number of pods per plant was the main component contributing to yield effects (r = 0.969) but pod numbers were mainly determined by the number of fertile inflorescences per plant (r = 0.884). Other components were relatively constant.

Spacing influenced the number of lateral branches (Table 3)) with wider spaced plants producing more than narrow-spaced plants. The most responsive were the higher order laterals. Table 4 shows that this effect was carried over into the number of fertile inflorescences present at final harvest. The final effect on pod numbers is shown in Figure 1. There is increased production from the higher order lateral inflorescences for autumn sowing and from the wider spacings.

These results contrast with the lack of response to population changes obtained last year (Withers **et al.** 1974). The marked reduction in plant numbers contributing to yield at the higher populations reported in that trial did not occur in this study, and it seems that it is this factor which has been the cause of the different responses to population as the yield of seed per plant is similar.

Lupins responded to varying population pressures by altering the number of lateral branches, especially of the higher order (Table 3). This determines the inflorescence number and pod number as pod numbers per inflorescence are relatively constant (Table 2). Pod numbers in turn have a direct influence on seed yield due to stable numbers of seeds per pod and seed weight. As population declined, the trend of increased seed yield per plant was not enough to compensate for lowered plant numbers so that seed yield per unit area also declined.

TABLE 3. Effect of spacing on branch number and vegetative yield (Early Harvest)

	Stem Sequence number	Spacing 5 cm	10 cm	20 cm	30 cm
AUTUMN SOWN					
Branch number/plant	2	2.9 bB	2.8 bB	3.3 bB	4.3 aA
	3	4.7 bBC	6.3 bBC	8.4 aAB	10.0 aA
	4	5.8 cC	8.1 cBC	12.8 bB	18.8 aA
	5	1.1 bC	3.7 bBC	9.8 aAB	12.5 aA
Mean plant dry weight (g)		4.6 bB	6.8 bB	11.0 aAB	15.4 aA
Dry weight/m ^{2} (g)		463 aA	338 abAB	274 bB	257 bB
SPRING SOWN					
Branch number/plant	2	3.5 bB	4.2 bB	7.3 aA	8.4 aA
	3	5.6 cC	7.2 cC	12.4 bB	19.4 aA
	4	4.9 dD	9.3 cC	17.6 bB	22.5 aA
Mean plant dry weight (g)		9.3 dD	14.9 cC	27.6 bB	39.4 aA
Dry weight/m ^{2} (g)		933 aA	742 bB	689b	656 bB

TABLE 4 Spacing effects on numbers of inflorescences per plant for intact plants (Final Harvest)

	Inflorescence sequence number	Spacing 5 cm	10 cm	20 cm	30 cm
AUTUMN SOWN					
Fertile Inflorescences Per Plant	3	1.1 a	2.1 a	2.2 a	2.5 a
	4	1.6 cB	2.4 bAB	3.1 aA	3.3 aA
	5	1.3 cC	2.1 cBC	3.0 bAB	4.0 aA
	6	0.5 a	0 a	0.3 a	1.2 a
SPRING SOWN					
Fertile Inflorescences per plant	2	1.3 cC	1.9 cBC	2.9 bAB	3.7 aA
	3	0.3 cB	0.5 cB	3.1 bA	4.3 aA

DISCUSSION

This trial indicates that Unicrop lupins may yield significantly more seed at higher populations than are normally sown. The closest spacing used was equivalent to 180 kg/ha sowing rate assuming 0.15 g/seed and 80% survival. Normal sowing rates are between 100 and 120 kg/ha. The increases in yield between the 10 cm and 5 cm spacings indicate that the optimum population for these conditions had not been reached and further yield increases would have been possible with higher densities.

Comparison with previous work (Withers 1973, Farrington 1974, Withers **et al.** 1974, Perry and Pool 1975) shows that lupin response to planting date and probably to other environmental influences such as moisture stress (Biddiscombe 1975) is similar to that shown here to population. These factors seem to interact to determine the number of lateral branches which can be formed. Hence the aim when atempting to maximise yield should be to combine managerial and environmental factors in such a way so as to maximise the number of lateral branches and inforescences per unit area.

Defoliation does not seem to be a practical method to increase seed yields because these results indicate that at populations which produce good yields, competition prevents the required stimulation of higher order lateral numbers to occur.

other crops are likely to produce greater yields. Lupins would however have the advantage of being tolerant to most of the herbicides used in maize growing and would fix an unknown amount of nitrogen.

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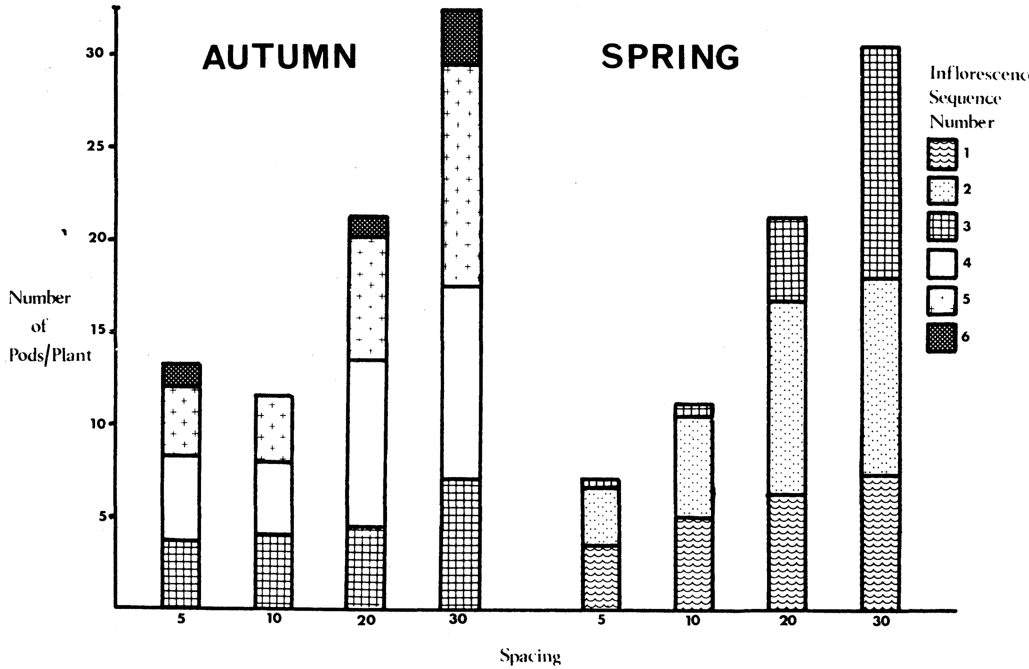

Figure 1: Effect of spacing on pods per plant.

Generally there was little difference in seed yield between equivalent treatments in the autumn and sping sowings. However, the spring trial was sown later than desirable and an earlier sowing may have resulted in higher yields (Withers **et al.** 1974). Except for seed weight, components of yield were generally lower for spring-sown plants. The autumn-sown plants did not reach their potential yield because of the loss of the primary and secondary pods (see Fig. 1) due probably to attacks of fungal disease, mainly **Stemphylium botryosum**, which Tate (1968) has shown to cause severe loss of pods and foliage, and **Pleiochaeta setosa**. Disease became serious in the early spring causing early leaf fall. Later in October and November, the pods also became infected to the extent that no seed was produced from early-formed pods.

Disease was also evident in spring sown plants but it did not become significant. It is a similar disease problem which limits **L. angustifolius** varieties in the warm humid areas of New Zealand (J. Palmer and I. McQueen personal communications) and may also be a problem of autumn sowings in other parts of the North Island.

Vegetative yield per plant follows the expected trend of reduced plant weight as population density increases (Table 3). The plant weight per square metre is of interest despite the small sample size because of the possibility of using lupins as a winter silage crop grown between two maize crops. The yield obtained here is not high and

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