SWEET LUPIN FOR SEED PRODUCTION

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SUMMARY

Two trials, one comparing 4 varieties of *Lupinus angustifolius* and the other comparing six sowing dates with two varieties were conducted during 1972/73.

Uniharvest produced higher seed yield than Uniwhite or Unicrop and all were higher than Frost. Uniharvest produced more, but lighter seeds than Unicrop or Uniwhite.

Uniharvest and Unicrop were compared over six sowing dates in spring. Yields generally decreased with later sowing except for the fifth sowing when 22m of rain at flowering resulted in increased yields similar to the second sowing. The yield of seed from higher order inflorescences decreased at later sowings.

Differences in date of flowering between varieties increased as sowing became later and days from sowing decreased with later sowing but at a slower rate with Uniharvest.

INTRODUCTION

Lupins have been cultivated in New Zealand for many years predominantly in Canterbury and mainly for forage and green manuring. Initially, the only varieties available were high in bitter alkaloids which limited their use for forage. Development of low alkaloid "sweet" varieties about 1930 increased interest in the crop. Evaluation and breeding of sweet lupin was carried out by the then Agronomy Division, D.S.I.R., Lincoln (Allen 1949) and later by the Crop Research Division, D.S.I.R. (van Steveninck 1956). Work there indicated that the two species best suited for New Zealand conditions were *Lupinus angustifolius* and *L. luteus* (Allen 1949). Interest in the crop declined during the 1950s due to improved fertility and better farming methods on the light land where lupins were largely grown (White 1961).

About the same time, interest in lupins by farmers in Western Australia increased. Gladstones developed a white flowered, soft seeded. sweet variety of *L. angustifolius* with markedly reduced seed shattering (Gladstones 1967) thus reducing an important limitation of lupins as a seed crop. He followed this by releasing a completely non-shattering variety, Uniharvest and recently a further non shattering variety. Unicrop, which has almost no vernalisation requirement making it earlier maturing under some conditions.

In recent years, the rapid growth of the pig and poulty industry and intensive feeding of other livestock has created a world-wide demand for good quality protein. Alkaloid-free lupin seed compare very favourably for this purpose with other forms of vegetable protein (Gladstones 1970). Furthermore, the reduced availability of milk proteins to the pig industry in New Zealand and the high price of animal proteins has helped the acceptance of lupin seed as a viable source of feed protein.

Little work has been reported of the production of lupin for seed in New Zealand so work commenced in 1971 at Massey University aimed at obtaining more information on seed production and two trials are reported here.

EXPERIMENTAL

Experiment I - Variety Trial.

Four cultivars of *L. angustifolius* (Uniharvest, Uniwhite, Unicrop and Frost) and one of *L. luteus* (Weiko III) were sown on 3 August 1972. Each plot consisted of 6 rows, 18cm apart and 3m long in a randomised block design with 4 replications. They were sown with a "Stanhay" seeder at 7cm spacing at a depth of 2.5cm. Superphosphate at the rate of 250 kg/ha was broadcast prior to sowing and 1.1 kg/ha a.i. of atrazine was applied immediately after sowing and gave excellent weed control.

1.8m of lengths of the 4 centre rows were harvested by hand on 10 January for yield and yield component measurements.

Experiment II - Sequential Sowing Trial.

Plots of Uniharvest and Unicrop were sown on six sowing dates (Table I) at approximately 2 weekly intervals commencing on 3 August. At each sowing, three rows 6.5 m long of each variety were sown by hand at 30.5 cm inter- and intra-row spacing. This spacing was chosen to provide some inter-plant competition but also to allow ready access to the centre row for individual plant measurement. There were three replications of each variety in randomised blocks. Fertiliser application and weed control were the same as in Experiment 1.

Ten plants from the centre row of each plot were identified and once flowering commenced, flower and pod development were recorded regularly, As each plot matured, the plants previously measured were harvested and components of yield assessed.

The soil type was Ohakea Silt Loam which had been tile drained and had a pH of 5.6. Soil conditions were wet during August (Table I) and rainfall during November and December were well below normal.

TABLE I: Rainfall and temperature recordings, Massey University, Spring 1972

	Rainfall (mm)		Mean Temperature (°C)	
	1972	10 yr mean	Min	Max.
August	77.7	89	3.6	12.1
September	55.0	83	7.8	14.8
October	64.8	75	12.3	19.6
November	29.6	72	11.4	19.9
December	39.8	118	10.2	19.2

RESULTS

Experiment I

Establishment of the *L. angustifolius* varieties was rapid and even.Weiko III, however, established poorly apparently due to the wet conditions which followed sowing. The established population of this variety was significantly lower than that of the other varieties so its yields are not included in these results.

Yield of Uniharvest was significantly ($P<0.05$) higher than Uniwhite (Table 2) but Unicrop was not significantly different from Uniwhite or Uniharvest. Frost was significantly below the other three varieties in yield.

TABLE 2: Experiment I - Mean values of yield and yield components.

Variety	Yield*/plot (g)	Seeds/plant	Weight*/seed (g)
Uniharvest	612 aA	70 aA	0.219 bB
Unicrop	560 abA	52 cC	0.256 aA
Uniwhite	544 bA	58 bcBC	0.221 bB
Frost	466 cB	65 abAB	0.204 cC

* Oven dried seed

Despite the similarity in total yield between the Uni-series there were some interesting differences in yield components (Table 2). Uniharvest produced significantly ($P<0.05$) more seeds per plant than either Unicrop or Uniwhite. In Unicrop, this was compensated for by a higher seed weight than either of the other two varieties. It was the combined low seed weight and low seed number which resulted in the poorer yield of Uniwhite. Similar trends in yield components have been noted by Gladstones (Pers. Comm.). Differences in seed number were related to pod number as there were no significant differences in number of seeds per pod.

Frost had similar pod and seed numbers to Uniharvest but a much smaller seed resulted in its low yield.

Experiment II

The flowering dates of the two varieties reacted differently to sowing date, (Table 3), with Uniharvest being consistently and increasingly later than Unicrop. Days from sowing to flowering also reduced steadily with Unicrop reducing at a faster rate.

Seed yield per plant declined from sowings 1 to 4, increased for sowing 5, and dropped again at sowing 6 (Fig. 1). Sowings 4 and 6 were significantly lower than sowings 1 and 2 ($P<0.05$). There was no significant difference between varieties. The increased yield of sowing 5 over sowing 3 and 4 was mainly due to increased number of flowers and pods produced. (Table 4). Uniharvest consistently set more flowers than Unicrop, but the final number of pods set was only slightly greater.

As in Experiment 1, Uniharvest produced more seeds per plant but with lower seed weight than Unicrop, both varieties showing similar trends according to sowing dates (Fig. 1). Again seed number per plant was largely a function of pod number as seed number per pod showed little change with sowings.

From Fig. 2, it is apparent that the main reason for the decline in pod number, and therefore yield, with later sowings was that fewer tertiary and quarternary pods were being set on later sown plants. The contribution of quaternary pods to yield ceased at the third sowing. Only in Unicrop were tertiary pods contributing significantly after the fourth sowing due probably to its earlier flowering enabling it to develop more tertiary inflorescences. Primary pods appeared to play a relatively minor role in influencing yield. With early sowings when tertiary pods were contributing significantly to yield, primary and secondary pods were remaining relatively constant. However, at later sowings when tertiary pod yields were small both primary and secondary pods influenced the change in yield obtained at sowing five.

Fig. 1: Seed yield/plant, number of seeds/plant and seed weight for Experiment II

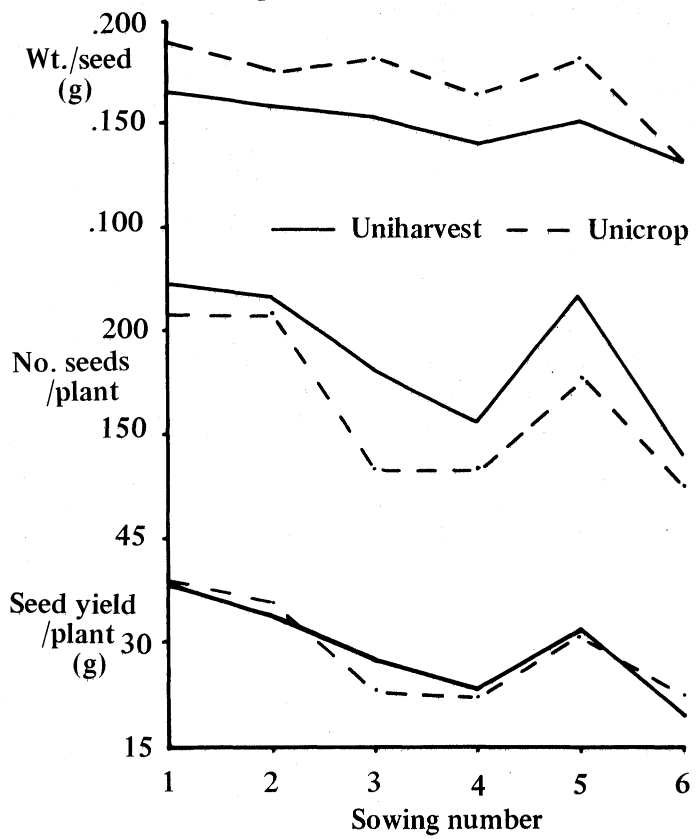
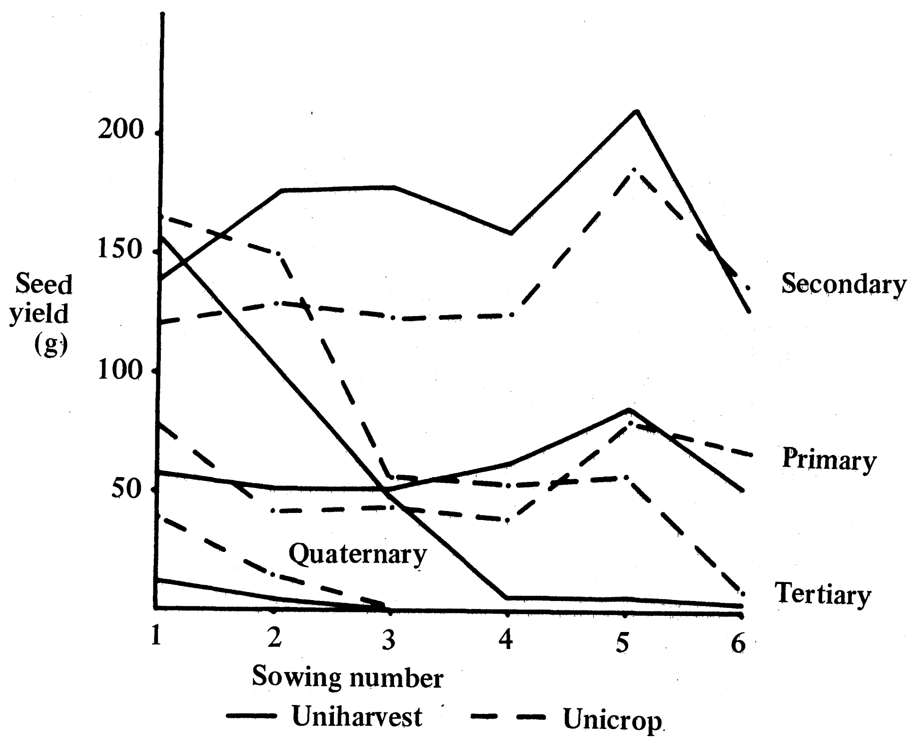


Fig. 2: Yield of seed from primary and higher order inflorescences.



DISCUSSION

In both experiments there was little difference in total yield between Uniharvest and Unicrop.

TABLE 3: Experiment II - Sowing dates, flowering dates and number of days to flowering.

Sowing	Sowing	50% Flowering Date			Days, Sowing to Flowering	
Number	Date	Unicrop	Uniharvest	Difference	Unicrop	Uniharvest
1	3 Aug	1 Nov	3 Nov	2	90	92
2	19 Aug	6 Nov	12 Nov	6	78	84
3	7 Sept	17 Nov	24 Nov	7	71	78
4	22 Sept	24 Nov	11 Dec	17	63	80
5	5 Oct	5 Dec	21 Dec	16	61	77
6	20 Oct	18 Dec	11 Jan	24	59	83

Unicrop has a low vernalisation requirement compared with Uniharvest but they are generally similar in other respects (Gladstones, pers. com.) The results in Table 3 clearly show the effect of vernalisation, photoperiod and temperature, all of which affect flowering (Rahman and Gladstones 1972). The increasing difference in flowering date between the varieties with later sowings could well be due to the relative vernalisaion requirement of Uniharvest and Unicrop. The shorter period from sowing to flowering with Unicrop may be due to increasing temperature and daylength. The vernalisation requirement may be causing the differen response of Uniharvest to temperature and daylength. As shown in this study, late-sown crops of Unicrop can mature earlier than Uniharvest sown at the same time but early sown crops would have little difference in maturity date.

TABLE 4: Experiment II - Flower and pod numbers per plant.

Sowing	Unicrop		Uniharvest	
Time	Flowers	Pods	Flowers	Pods
1	130 aA	59 aA	154 aA	62 aA
2	87 bB	55 aA	132 bB	59 abA
3	50 cB	40 bcB	99 cC	47 cdAB
4	47 cC	34 bcB	91 dC	40 cdB
5	64 bB	44 bAB	113 cBC	52 abcAB
6	53 cB	30 cB		39 dB

Lupins appeared to adjust to change in the environment by altering the number of flowers produced (Table 4). This is achieved by reducing the number of higher order inflorescences as the season advances probably due to increased moisture stress (Fig. 2). Again, with early sown crops there is little difference between varieties in this characteristic and in this trial, no difference was apparent until sowing 3. Subsequently, Unicrop had a greater tendency to produce tertiary pods due to its ability to flower earlier and produce more inflorescences while conditions are still favourable.

The increased yield at the fifth sowing is attributed to the 22m of rain which fell during the flowering period of both varieties. Flower number increased resulting in more pods (Table 4). This response to a small amount of rain indicates the sensitivity of this crop to moisture stress at flowering. It is probable that one of the main factors determining sowing date will be the expected moisture conditions at flowering.

It is considered that the flowering response of Uniwhite to sowing date would be similar to Uniharvest as their genetic constitutions are similar (Gladstones 1970).

Uniharvest is marginally superior to Uniwhite in yield apparently due to a greater number of pods per plant. Uniharvest would also be preferred for its non-shattering characteristics (Gladstones 1972) and its observed tendency to ripen more evenly.

The disadvantage of Frost is its small seed which severly limits yield despite similar numbers of pods and seeds to Uniharvest. It also tended to shatter and ripen unevenly. Furthermore. Frost has blue flowers which makes it difficult to distingush from the bitter blue variety.

It was unfortunate that the yields of Weiko III could not be included in the results as its reported higher seed protein level and better adaptation to wet conditions makes it an attractive possibility. However, other work (Gladstones 1972, Withers, unpublished) would indicate that it is not likely to yield as well as the Uni-series.

In general these trials have shown that lupins can produce satisfactory seed yields from both early and late spring sowing even under relatively dry Manawatu conditions but that under these conditions early sowing is preferable to maximise yields.

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