A PRELIMINARY EVALUATION OF LUPINUS COSENTINII IN CANTERBURY

G.D. Hill and P.E. Horn
Department of Plant Science
Lincoln College
Canterbury

ABSTRACT

A preliminary evaluation of four sweet non shattering breeding lines of **Lupinus cosentinii** (CB 14, 15, 18, 19) was conducted at Lincoln College during the spring and summer of 1974/75.

Yield of seed ranged from 76 g m^{-2} in CB 15 to 164 g m^{-2} in CB 18. These yields were lower than those reported by Western Australian workers for this species. On a per plant basis seed yield ranged from 7.8 g per plant in CB 15 to 22.0 g per plant in CB 19, the latter equalling yield on a per plant basis in Western Australia. In all lines the ratio of seed to vegetative material was high with harvest index ranging from 48 per cent in CB 15 to 55 per cent in CB 18.

In the Canterbury environment the plants had an exceptionally short growing season and when sown in mid October were ready for harvest by the second week in February.

INTRODUCTION

The species **Lupinus cosentinii** is a native of the Mediterranean basin. It was introduced into Western Australia during the last century and is now naturalised in a 600 km strip, on the Swan Coastal Plain (Gladstones, 1974). Its main agricultural use was to increase soil fertility and provide grazing for sheep (Gladstones, 1970).

Gladstones (1958a) commenced genetic studies on **L. cosentinii** in 1954, and these were followed by mutation breeding experiments (Gladstones, 1958b). A breeding programme followed to obtain plants that were sweet, non-shattering, soft-seeded and had a range of flowering dates.

Up to the present time genes have been isolated for all these characteristics except soft seed (Gladstones and Francis, 1965, Gladstones, 1967; Gladstones and Hill, 1969), and a number of breeding lines incorporating various combinations of genes have been developed (Gladstones, pers. comm.).

Seed protein levels in **L. cosentinii** are similar to those obtained from other lupins (Gladstones, 1970) and seed yields of up to gm^{-2} have been obtained from sweet breeding lines in Western Australian trials (Farrington and Gladstones, 1974).

One of us (G.H.D.) introduced **L. consentinii** into New Zealand in 1973 when preliminary bulking up of seed was commenced. Development of a method of scarification using concentrated sulphuric acid (Horn and Hill, 1974) removed the necessity for hand or mechanical scarification (Howells **et al.**, 1971). In the spring of 1974 a trial was sown at Lincoln College to provide a preliminary assessment of four sweet, non-shattering breeding lines. The lines selected were CB 14, 15, 18 and 19 and their known genetic characteristics are shown in Table 1.

TABLE 1: **L. cosentinii** genotypes evaluated

Breeding Line	Genotype*
CB 14	sw_1, Bo, co.
CB 15	sw_1, xe, co.
CB 18	ssw_1, Bo, ma.
CB 19	ssw_1, xe, ma.

* Genes: sw_1 = sweet; Bo = early flowering; co = coniunctus = reduced pod shattering; xe = early flowering; ssw_1 = semi sweet; ma = macer = reduced pod shattering.

MATERIALS AND METHODS

Seed was scarified using the method of Horn and Hill (1974), inoculated with a commercial lupin inoculant and sown at a depth of 4 cm with a Stanhay precision seeder. Rows were 25 cm apart and distance within the row was 10 cm (40 seeds m^{-2}).

A randomised block design with four replicates was used. The trial was sown on a Wakanui Silt Loam at the Lincoln College Research Farm on the 10th October 1974. Each plot was 2.5 m wide and 10 m long.

During the course of the experiment three one metre lengths of row were selected at random in each plot and the number of established plants counted.

At maturity three plants from each plot were taken at random from the centre six rows of the plot. These were analysed for number of nodes to flowering, number of primary pods formed, number of secondary pods formed, total seed per plant, total seed weight and harvest index.

Following this, 2 m by 8 m of each plot was harvested for total yield determination. Harvested pods were dried using a forced draught blower, and threshed. The experiment was harvested on the 10th February 1975.

RESULTS AND DISCUSSION

Survival of acid scarified seed in the field is shown in Table 2. It ranged from 40 per cent in CB 19 to 79 per cent in CB 14. Poor survival of CB 19 may have been due to acid damage of the New Zealand seed used, which was apparently softer than the Western Australian seed used in the development of the acid scarification method (Horn and Hill, 1974).

TABLE 2: Field survival of acid scarified **L. cosentinii** seed

Breeding Line	Mature Plants m^{-2}	Per cent Survival
CB 14	31.5a	79
CB 15	28.5 a	71
CB 18	28.5 a	71
CB 19	16.0 b	40

The presence of numerous pink nodules on plants that were pulled to check on inoculation would indicate that the acid scarification did not affect establishment of the **Rhizobium** symbiosis. This confirms similar laboratory findings by Greenwood (pers. comm.).

TABLE 3: Pods and seeds per plant in spring sown **L. consentinii**

Breeding Line	Nodes to Flowering	Primary Pods/plant	Secondary Pods Plant	Seed/plant	Seed/pod
CB 14	10.2a	7.8a	10.9b	51.5b	2.7bc
CB 15	10.8a	5.1b	7.8b	34.9b	2.6c
CB 18	11.1a	7.7a	4.8b	37.5b	9ab
CB 19	10.2a	7.3a	18.8a	87.9a	3.2a

The number of nodes to flowering, pods set and seeds produced are shown in Table 3.

Flowering in all lines occurred at about the tenth node and this is far lower than that reported for plants carrying the **xe** gene in Western Australian conditions (Gladstones and Hill, 1969). This would tend to confirm their assertion that factors other than vernalisation requirements are important in determining flowering in this species.

The number of flowers formed on the primary inflorescence was not recorded, but the number of pods on the main axis — primary pods — (5.1 to 7.7) was generally more than the 3.2 to 6.8 reported by Farrington and Gladstones (1974).

With Western Australian autumn sown **L. cosentinii** a considerable proportion of the yield of early flowering genotypes was obtained from second and higher order apical axes. In this experiment only first order (secondary pods) apical axes were formed. The total number of pods per plant was at all times lower than those recorded by Farrington and Gladstones (1974) (26.1 from CB 19 compared with 31.2 to 49.0). Because of the lower number of pods formed and the generally lower number of seeds per pod (2.6 to 3.2 compared with 2.8 to 3.4) the total number of seeds per plant was less than the 100 or more obtained by the Western Australian workers.

One characteristic that does not appear to be under genetic control is mean seed weight. In our experiment there was no significant difference between mean seed weight (190-200 mg) among the breeding lines (Table 4). In the Western Australian trial, with material of very similar genetic composition, mean seed weights varied from 144 to 188 mg. Presumably because of the higher seed weights, the per plant dry seed yield of 17.1 g for CB 19 was approaching the 17.2 to 21.1 obtained in Western Australia.

The harvest index of **L. cosentinii** has not been reported before and the values of 48.3 to 55.3 indicate that a high proportion of the total assimilates are utilised in the production of seed.

Yield ranged from 76 g m^{-2} in CB 15 to 164 g m^{-2} in CB 18. Here a cautionary note should again be sounded about the extrapolation of yield from a few plants up to larger areas. By multiplying yield per plant by estimated population the yields from this experiment were between 191 and 291 g m^{-2}. The results of Farrington and Gladtones (1974) were based on the yield of a single row of 8 plants in a 1.6 by 2 m plot. It is probable that values below the estimated 500 g m^{-2} reported in their experiment would have been obtained if a larger area had been harvested.

The protein content of the seed from this trial has not at this stage been determined. However, the protein content of **L. cosentinii** sown nearby in an inoculation trial ranged from 38.1 to 40.6 per cent and is therefore comparable with normal values reported from Western Australian work (Gladstones, 1970).

The late sowing of this trial probably contributed to the low yields, as most lupin workers recommend sowing as early as possible for maximum seed yield (Gladstones, 1970). Withers **et al.** (1974) have shown that with other lupin species grown at Palmerston North, yield declined as sowing date approached early October. The late sowing in this experiment was enforced by the wet spring experienced in Canterbury in 1974. It would therefore be worth repeating sowing in early spring.

Because of the damage by the acid, some indication of the effect of population on yield was obtained. Mean weight of dry seed per plant on CB 19 was 17.1 g while on CB 18 it was 7.4 g per plant. An increasing amount of evidence is being obtained that lupins respond to high sowing densities (Porter and Hill, unpublished; Lucas,

TABLE 4: Mean seed weight, seed weight per plant, harvest indes and yield in spring sown **L. cosentinii**

Breeding Line	Mean Seed Wt. (mg)	Seed wt./Plant (g) Air Dry	Oven Dry	Harvest Index	Seed Yield
CB 14	200a	11.6b	9.3b	48.4b	123.1b
CB 15	190a	7.8b	6.7b	48.3b	76.2c
CB 18	200a	8.2b	7.4b	55.3a	163a
CB 19	190a	22.0a	17.1a	51.3b	85.0b

TABLE 5: Comparison of yield and protein production from lupins and grain legume species in Canterbury*

Species	Yield g m^{-2}	% C.P.	Protein g m^{-2}
Glycine max	134	42	56
L. albus	270	38	103
L. angustifolius	400	34	136
L. cosentinii	164	39	64
L. luteus	180	42	76
Pisum arvense	400	26	104
Vicia faba	300	22	66

* Based on reported farm yields and experimental results Dougherty (1969); Gladstones (1970); Hill (unpublished); Porter (unpublished).

pers. comm.) and any repeat of this experiment should probably also include higher sowing rates than the 40 plants m^{-2} used here.

CONCLUSIONS

L. consentinii is a wild plant that is being domesticated as a grain legume. The preliminary results reported in this experiment in Canterbury would indicate that it has some potential in the New Zealand environment and that further experimental work would be justified (Table 5).

In view of its susceptibility to frost, its adaptation to deep sands (Gladstones, 1970) and its almost entirely coastal lowland natural distribution (Gladstones, 1974) it would appear that it may have more potential in the North Island than in the South Island.

Irrespective of the most suitable location for growing this plant as a crop the first experimental priorities would appear to be determination of optimum sowing date and rate.

ACKNOWLEDGEMENTS

Mr G. Meijer and his team for assistance in the field and Mr R. Moir for assistance in the laboratory.

REFERENCES

Dougherty, C.T. 1969. The influence of irrigation, row spacing, plant population, and inoculation on the yield of soybeans in Canterbury. New Zealand Journal of Agricultural Research **12**: 367-80.

Farrington, P. and Gladstones, J.S. 1974. Effect of genotype on yield of narrow field lupin [**Lupinus angustifolius**] and sandplain lupin [**Lupinus cosentinii**]. Australian Journal of Experimental Agriculture and Animal Husbandry. **14**: 742-8.

Gladstones, J.S. 1958a. A study of the genetics and agronomy of the genus Lupinus with particular reference to varieties of potential in Western Australia. Ph.D. Thesis, University of Western Australia pp. 1-355.

Gladstones, J.S. 1958b. Induction of mutation in the West Australian blue lupin [**Lupinus digitatus** Forsk.] by X-irradiation. Australian Journal of Agricultural Research **9**: 473-82.

Gladstones, J.S. 1967. Selection for economic characters in **Lupinus angustifolius** and **L. digitatus** 1. Non-shattering pods. Australian Journal of Experimental Agriculture and Animal Husbandry **7**: 360-6.

Glastones, J.S. 1970. Lupins as crop plants Field Crop Abstracts **23**: 123-48.

Gladstones, J.S. 1974. Lupins of the Mediterranean region and Africa. Technical Bulletin No. 26, Department of Agriculture, Western Australia pp. 21-24.

Gladstones, J.S. and Francis, C.M. 1965. Low alkaloid mutants of **Lupinus digitatus** Forsk. Nature **207**: 553.4.

Gladstones, J.S. and Hill, G.D. 1969. Selection for economic characters in **Lupinus angustifolius** and **L. Digitatus.** 2. Time of flowering. Australian Journal of Experimental Agriculture and Animal Husbandry **9**: 213.20.

Horn, Philippa E. and Hill, G.D. 1974. Chemical scarification of seeds of **Lupinus consentinii.** Journal of the Australian Institute of Agricultural Science **40**: 85-7.

Howells, K.J., Beresford, J.D. Farrington, P. and Couper, R.G. 1971. Saw seed scarifier for large grained legumes. Journal of the Australian Institute of Agriculture Science **37**: 158 -60.

Withers, N.J., Baker, C.J. and Lynch, T.J. 1975. Some effect of date, rate and method of sowing on lupin seed yield. Proceedings Agronomy Society of New Zealand **4**: 4-8.