# THE EVALUATION OF SOME LUPIN SPECIES NEW TO NEW ZEALAND

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ABSTRACT

Twenty-eight lines from 9 species of lupins were grown at Lincoln to evaluate potential for seed or forage production. More commonly used cultivars were grown for comparison plants. Data are given on size and general growth habit of plants. None of the species appear to be suitable for forage production. From records of flower formation and abscission, there appears to be little real difference in the patterns of flower set among species, although there are very great differences in the duration of flowering and degree of pod shattering.

Data on seed characteristics includes 1000 seed weight, individual plant seed yields, embryo/testa ratios, oil content, acid detergent fibre, and total nitrogen content.

All but two lines were bitter. **Lupinus mutabilis** shows sufficient promise to be examined further as a potential seed crop. Four species may be of use for bare ground stabilisation.

## INTRODUCTION

Only two lupin species have been grown in New Zealand as commercial seed crops, **Lupinus angustifolius** and **L. luteus**. Only the former species is used for forage purposes. Most agronomic research has concentrated on **L. angustifolius** and **L. luteus** (Withers **et al.** 1974; Withers, 1975; Withers **et al.** 1975; Stoker, 1975). Recently **L. albus** has also been investigated. **Lupinus cosentinii** has also been examined as a commercial crop species (Hill and Horn, 1975), while **L. pilosus** (Hill, pers. comm.) and **L. mutabilis** (Palmer, pers. comm.) have been grown in small plots in New Zealand. In England, a small scale trial with **L. mutabilis** indicated that this species has potential for seed production (Masefield, 1975).

To expand the limited number of species available, 34 lines from ten species were introduced to examine their potential for forage or grain legume production, as well as characteristics that may be of use in breeding programmes or other projects. The current commercial cultivars of **L. angustifolius** (Unicrop, Uniharvest) and **L. luteus** (Weiko III) were grown with the newly introduced species as a reference point for judging their potential.

This trial was carried out to select lines to be examined in more detail in a properly replicated trial. It was not possible to have replicate plots for each line because of the small numbers of seeds obtained for most lines. Only the flower data in Table 2 were subjected to statistical analysis.

## METHODS

### Sowing

The seed was hand sown in mid September 1975 in single rows, with 10 cm between plants and 1 m between rows. No seed inoculant or fertiliser was used, and because of unknown tolerances, no chemical protection was given against weeds, diseases or pests. Six lines of **L. mutabilis** were similarly sown on arrival in late October.

A third sowing to determine frost tolerance of all lines was made in early April 1976. Treatment was as for the first two sowings except for the use of atrazine at 1.5 kg a.i./ha (pre-emergent) to control weeds.

### Harvesting and measurements

The data on germination included an assessment of rate as well as percentage germination. Early growth was assessed over the four weeks following germination. In the frost hardiness data, values of 4 and 5 indicate survival and active growth during frosts, respectively.

The data on flower formation and abscission are the means from 10 plants and flower abscission is presented as the percentage of flowers that formed but failed to set pods.

Seed was harvested by hand as it became ripe to enable more accurate seed yields to be determined despite the severe shattering problem in the wild lines. Single plant seed yields are means of three plants only.

Seed weights are on an air dry basis. Oil, nitrogen and fibre figures were obtained using ground whole seed and are expressed on a dry weight basis. Total nitrogen was measured using a micro-Kjeldahl digestion followed by Autoanalyser measurement of ammonia. Oil contents were obtained gravimetrically after overnight Soxhlet extraction of dry ground seed with petroleum ether. Fibre was determined by the acid detergent fibre method. (Bailey and Ulyatt, 1970).

## PLANT MATERIAL

Thirt-four lines from ten different species were introduced. Six of these failed to establish. Details of the successful lines and origins of the seed are shown in Table 1. Of these, line 862 was reclassified as **L. angustifolius.**

## RESULTS

Data on the vegetative growth characteristics are summarised in Table 1. The established cultivars were generally superior in these to all introduced lines except those of **L. albus** and **L. angustifolius.** In the second trial, all species showed only minor temporary yellowing of the leaf tips in response to the 1.5 a.i.

TABLE 1: Vegetative growth characteristics of lupin species.

| Species | Line or C.V. | Origin | Germin- ation* | Early Growth* | Frost* Hardiness | Height cm | Habit |
|---|---|---|---|---|---|---|---|
| Introduced | | | | | | | |
| **L. albococcineus** | 770 | USSR | 4 | 1 | 3 | 40– 50 | Woody main stem with close strong |
| | 775 | USSR | 3 | 2 | 2 | 40– 60 | upper and lower branching. |
| **L. albus** | 771 | USSR | 4 | 4 | 5 | 50– 60 | Erect, strong open upper branching, |
| | Astra | Chile | 4 | 5 | 5 | 40– 60 | no lower branching. |
| | Multolupa | Chile | 4 | 4 | 5 | 30– 80 | |
| **L. angustifolius** | 862 | Argentina | 5 | 5 | 5 | 50– 60 | Erect, prolific upper and lower branching, |
| | Bitter Blue | N.Z. | 4 | 5 | 5 | 50– 70 | leaves dense. |
| **L. elegans** | 734 | Australia | 4 | 2 | 1 | 40– 60 | Thick woody main axis. |
| | 776 | USSR | 2 | 2 | 3 | 30– 60 | Very strong close upper |
| | 782 | USSR | 3 | 2 | 2 | 40– 50 | branching. |
| **L. hirsutissimus** | 738 | Germany | 1 | 3 | 1 | 20– 40 | Rosette with weak lower branching |
| **L. hirsutus** | 779 | USSR | 1 | 1 | 0 | 20– 30 | after flower spike emerges. |
| **L. mutabilis** | 736 | Germany | 5 | 3 | 1 | 60–100 | Erect strong fleshy axis. |
| | 777 | USSR | 5 | 3 | 2 | 60–100 | Strong open upper branching, |
| | 780 | USSR | 3 | 2 | 2 | 60– 90 | no lower branching. |
| | 785 | Belgium | 5 | 3 | 1 | 60–110 | Leaves sparse. |
| | 792 | Poland | 5 | 3 | 0 | 40– 90 | |
| | 880 | Bolivia | 2 | 3 | 1 | 50– 90 | |
| | 881 | England | 2 | 3 | 2 | 30– 50 | |
| | 882 | Argentina | 3 | 2 | 1 | 50– 80 | |
| | 883 | Argentina | 5 | 4 | 1 | 60–100 | |
| | 884 | Peru | 5 | 4 | 2 | 90–110 | |
| | 885 | Sth Africa | 5 | 4 | 2 | 60– 90 | |
| **L. nanus** | 768 | USSR | 1 | 4 | 3 | 30– 40 | Rosette with strong lower and |
| | 774 | USSR | 2 | 4 | 4 | 20– 30 | upper branching after flower |
| | 851 | Czechoslovakia | 3 | 4 | 4 | 20– 30 | spikes emerge. |
| **L. pubescens** | 737 | Germany | 3 | 2 | 0 | 40– 60 | Thick woody main axis. |
| | 778 | USSR | 3 | 2 | 2 | 50– 60 | Very strong close upper branching, |
| | 781 | USSR | 3 | 2 | 2 | 50– 60 | leaves dense. |
| | 784 | Belgium | 3 | 2 | 2 | 30– 70 | |
| Established | | | | | | | |
| **L. angustifolius** | Unicrop | N.Z. | 4 | 4 | 5 | 40– 60 | |
| | Uniharvest | N.Z. | 4 | 4 | 5 | 40– 60 | |
| **L. luteus** | Weiko III | N.Z. | 3 | 3 | 4 | 30– 60 | Erect open upper and lower branching. |

* Subjective scale 0-5, low to high.

kg/ha atrazine. No fungal or viral diseases were observed in any of the lines, despite a summer that was more humid than is usual in Canterbury.

Table 2 presents data on the flowering characteristics of the different species. Only **L. albus** shows any useful reduction in the time to flowering over the established cultivars. The duration of flowering varied greatly among species. The lines of **L. hirsutus, L. hirsutissimus** and **L. nanus** stopped flowering in early summer and the seed ripened quickly. Second generation plants of some lines of **L. nanus** and **L. pubescens** had set seed before growth was stopped by frosts. Lines of **L. mutabilis** continued flowering strongly until the first frost. **Lupinus pubescens** continued flowering and setting seed until frosts of 1-4$^{o}$ C occurred. Flower production was highest in the compact forms with strong upper order branching. Although percentage flower abscission varied both within and among species, the pattern of flower abscission was the same. Pods were set only on the lower flowers with subsequent abscission in the upper parts of the flower heads. Lines of **L. albus** and **L. mutabilis** were noteworthy for their complete lack of pod shatter.

Data for seed characteristics are shown in Table 3. The lines of **L. mutabilis** had a uniformly high proportion of the seed weight in the embryo and were also comparatively low in fibre content in the seed. Some of these lines were also very high in seed oil content. Also noteworthy is the high total nitrogen content of some **L. mutabilis** lines, in some cases approaching nearly fifty percent crude protein (N%x 6.25).

All lines except **L. albus** c.v. Astra and Multolupa were bitter.

## DISCUSSION

None of the introduced lines appeared to have sufficient potential to be examined further for forage purposes.

The lines of **L. albococcineus, L. elegans, L. nanus** and **L. pubescens** were bitter, had compact growth habit, small seeds, severe pod shatter and

TABLE 2: Flower and seed setting data of lupins species

| Species | Line or C.V. | Time to flowering (weeks) | Primary flowers formed | | Flower abscission (%) | | Primary pods set | | End of flowering (season) | Pod Shattering* |
|---|---|---|---|---|---|---|---|---|---|---|
| Introduced | | | | | | | | | | |
| **L. alboccoccineus** | 770 | 12 | 69.7 | (0.3)+ | 36.7 | (*3.7)+ | 47.3 | (5.6)+ | Autumn | 2 |
| | 775 | 11 | 70.3 | (3.0) | 50.4 | (3.4) | 34.6 | (2.3) | Autumn | 2 |
| **L. albus** | 771 | 9 | 20.3 | (1.1) | 73.3 | (2.3) | 5.5 | (1.8) | Early Autumn (dry) | 0 |
| | Astra | 8 | 30.0 | (2.5) | 74.6 | (2.0) | 7.9 | (1.2) | Early Autumn (dry) | 0 |
| | Multolupa | 9 | 19.8 | (0.9) | 59.9 | (3.8) | 7.7 | (0.5) | Early Autumn (dry) | 0 |
| **L. angustifolius** | 862 | 12 | 36.8 | (0.7) | 60.9 | (1.1) | 14.4 | (0.5) | Summer drought | 3 |
| | Bitter Blue | 10 | 37.8 | (1.5) | 60.0 | (1.3) | 15.1 | (0.7) | Summer drought (late) | 2 |
| **L. elegans** | 734 | 12 | 75.1 | (3.2) | 65.8 | (3.4) | 25.3 | (2.4) | First frost | 2 |
| | 776 | 13 | 49.7 | (2.8) | 42.1 | (2.7) | 28.4 | (1.3) | Autumn | 2 |
| | 782 | 14 | 50.2 | (2.3) | 37.4 | (2.8) | 31.3 | (1.8) | Autumn | 2 |
| **L. hirsutissimus** | 738 | 10 | 27.5 | (2.1) | 35.3 | (5.0) | 17.2 | (1.4) | Early summer | 3 |
| **L. hirsutus** | 779 | 11 | 16.3 | (2.2) | 25.8 | (7.5) | 12.0 | (1.4) | Early summer | 3 |
| **L. mutabilis** | 736 | 12 | 54.3 | (1.8) | 50.1 | (2.7) | 27.1 | (1.8) | First frost | 0 |
| | 777 | 11 | 59.6 | (3.8) | 44.5 | (3.7) | 33.8 | (3.8) | First frost | 1 |
| | 780 | 13 | 41.5 | (1.9) | 53.9 | (2.5) | 19.0 | (0.8) | First frost | 0 |
| | 785 | 12 | 54.2 | (2.1) | 50.9 | (2.7) | 26.5 | (1.5) | First frost | 1 |
| | 792 | 12 | 39.9 | (3.0) | 57.7 | (3.5) | 16.8 | (1.6) | First frost | 1 |
| | 880 | 12 | 30.0 | (1.6) | 45.5 | (1.8) | 15.0 | (1.4) | First frost | 0 |
| | 881 | 13 | 32.3 | (3.3) | 55.7 | (4.0) | 14.4 | (2.0) | First frost | 0 |
| | 882 | 11 | 32.8 | (2.4) | 62.1 | (3.1) | 12.1 | (0.9) | First frost | 0 |
| | 883 | 11 | 34.3 | (2.9) | 64.3 | (3.2) | 12.5 | (1.8) | First frost | 0 |
| | 884 | 11 | 32.3 | (1.5) | 48.4 | (3.2) | 16.7 | (1.3) | First frost | 0 |
| | 885 | 12 | 37.2 | (2.9) | 74.9 | (1.1) | 9.3 | (0.8) | First frost | 0 |
| **L. nanus** | 768 | 10 | – | | – | | – | | Early summer | 3 |
| | 774 | 11 | 63.3 | (3.6) | 49.8 | (3.9) | 31.1 | (2.0) | Early summer | 3 |
| | 851 | 12 | 63.7 | (6.4) | 42.2 | (4.3) | 37.3 | (6.8) | Early summer | 3 |
| **L. pubescens** | 737 | 11 | 81.8 | (3.2) | 53.4 | (2.1) | 38.0 | (2.1) | First frost | 2 |
| | 778 | 12 | 80.2 | (3.1) | 45.9 | (3.3) | 42.9 | (2.3) | First frost | 2 |
| | 781 | 11 | 61.0 | (3.1) | 47.6 | (4.4) | 31.8 | (2.8) | Heavy frost | 2 |
| | 784 | 11 | 69.4 | (1.4) | 52.9 | (2.0) | 32.8 | (1.8) | Heavy frost | 2 |
| Established | | | | | | | | | | |
| **L. angustifolius** | Unicrop | 11 | 39.9 | 0.7 | 60.3 | 2.3 | 15.7 | 0.7 | Summer drought | 0 |
| | Uniharvest | 11 | 36.5 | 1.3 | 65.1 | 2.7 | 12.6 | 0.9 | Summer drought (late) | 1 |
| **L. luteus** | Weiko II | 11 | 35.5 | 1.3 | 66.1 | 2.1 | 11.9 | 0.9 | Summer drought | 0 |

* subjective scale 0-3, absent to severe.
\+ standard deviation of mean.

unsatisfactory flowering habits for seed production. Further examination would appear to be unjustifiable in terms of seed production. However, these characteristics appear suited for use in ground stabilisation work.

The large seeded lines of **L. albus, L. angustifolius** and **L. mutabilis** appeared worthy of further examination. The seed characteristics of **L. mutabilis** lines were a considerable improvement over the established lines and had only two drawbacks. Limited frost resistance would restrict sowing dates. Masefield (1975) however, reported some lines of **L. mutabilis** were significantly frost resistant. The bitterness of all **L. mutabilis** lines was the other drawback. Brucher (1968) has already demonstratted that it is possible to obtain a sweet mutant and preliminary work is under way at Lincoln with this aim in mind.

We believe that there is real potential in **L. mutabilis** for improving the nutritional quality of seed produced by established lupin varieties and further trials to obtain reliable yield figures are planned.

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TABLE 3: Seed data from lupin species

| Species | Line or C.V. | Testa colour (*speckle) | Seed Yield per plant (gm) | 1000 seed wt. (gm) | % Embryo in total seed | Acid detergent fibre (%) | Oil content (%) | Total N content (%) |
|---|---|---|---|---|---|---|---|---|
| Introduced | | | | | | | | |
| **L. albococcineus** | 770 | Brown* | 3.7 | 21.7 | 82.8 | 21.4 | 15.0 | 6.16 |
| | 775 | Brown* | 12.5 | 28.1 | 83.4 | – | 14.8 | 7.20 |
| **L. albus** | 771 | White | – | 278.3 | – | – | – | |
| | Astra | White | 18.2 | 408.0 | 82.1 | 16.5 | 10.6 | 5.58 |
| | Multolupa | White | 23.2 | 242.2 | 79.8 | 14.9 | 10.5 | 6.02 |
| **L. angustifolius** | 862 | Dark brown* | 46.6 | 211.7 | 79.2 | – | 5.5 | 5.68 |
| | Bitter Blue | Dark brown* | 21.4 | 219.0 | 76.8 | 15.7 | 4.5 | 5.89 |
| **L. elegans** | 734 | Multicolour* | 18.6 | 27.3 | – | 20.9 | 15.3 | 6.83 |
| | 776 | Grey* | 9.1 | 17.6 | 81.5 | 12.4 | 9.9 | 7.39 |
| | 782 | Grey* | 6.2 | 16.2 | 80.3 | 10.8 | 9.8 | 7.01 |
| **L. hirsutissimus** | 738 | Brown* | 3.5 | 12.5 | 76.3 | 17.4 | 10.7 | 6.37 |
| **L. hirsutus** | 779 | Dark brown* | 1.1 | 24.9 | 78.5 | – | – | – |
| **L. mutabilis** | 736 | White | 15.3 | 154.9 | 86.9 | – | – | 7.63 |
| | 777 | Black/brown* | 34.3 | 37.8 | 85.9 | – | 13.3 | 7.79 |
| | 780 | White | 11.7 | 143.2 | 86.3 | – | – | 6.94 |
| | 785 | White | 22.9 | 83.5 | 87.3 | 15.9 | 14.5 | 7.45 |
| | 792 | White | 11.4 | 158.5 | 87.3 | 16.1 | 16.3 | 6.69 |
| | 880 | White | 11.4 | 196.1 | 87.1 | – | 15.9 | 7.04 |
| | 881 | White | 5.2 | 120.0 | 88.7 | – | – | – |
| | 882 | White | 10.8 | 200.4 | 88.5 | – | 18.6 | 6.92 |
| | 883 | White | 9.3 | 171.1 | 88.4 | – | 16.4 | 7.81 |
| | 884 | White | 13.2 | 194.6 | 86.9 | – | 16.8 | 7.50 |
| | 885 | White | 7.1 | 181.6 | 88.7 | 10.6 | 12.1 | 7.99 |
| **L. nanus** | 768 | Grey | – | 6.1 | – | – | – | 6.35 |
| | 774 | Grey | 1.2 | 6.6 | – | 24.4 | 8.2 | 6.58 |
| | 851 | Grey | – | 5.5 | – | – | – | – |
| **L. pubescens** | 737 | Multicolour* | 21.5 | 30.1 | 81.8 | 19.7 | 14.4 | 7.45 |
| | 778 | Multicolour* | 11.3 | 30.5 | 83.2 | 18.8 | 12.1 | 7.14 |
| | 781 | Multicolour* | 12.2 | 28.5 | 80.5 | – | – | 5.48 |
| | 784 | Beige | 7.9 | 27.4 | 82.1 | – | 14.8 | – |
| Established | | | | | | | | |
| **L. angustifolius** | Unicrop | Beige* | 19.2 | 191.6 | 76.7 | 17.2 | 4.6 | 5.52 |
| | Uniharvest | Beige* | 21.6 | 187.2 | 77.4 | 17.4 | 4.6 | 5.45 |
| **L. luteus** | Weiko III | White | 10.00 | 152.8 | 78.4 | 17.3 | 5.5 | 7.24 |


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