Lupins in Western Australia. 2. Cultivation methods

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LUPINS IN WESTERN AUSTRALIA

2. CULTIVATION METHODS

By J. S. GLADSTONES, Department of Agronomy, Institute of Agriculture, University of Western Australia

While lupins are by and large plants of lighter and less fertile soils, important differences exist among them in their soil preferences. There may also be some differences in climatic requirements. Present knowledge of these differences is summarized in the Table below.

Variation in the kind of cultural treatment needed also arises from the differing purposes for which lupin crops are grown, for example, whether they are sweet or bitter, and whether they are intended for grazing or for harvesting. For these reasons the different species and varieties must be dealt with to some extent separately.

**Sandplain (W.A. blue) lupin**

(*Lupinus cosentini*)

The sandplain lupin is at present grown only for soil improvement and summer grazing. Both of the cultivars available are bitter and hard-seeded, and their pods shatter rapidly at maturity.

The main characteristics of sandplain lupins are their tolerance of sandy soils and low fertility, and a marked susceptibility to frost. For these reasons cultivation is mainly in west coastal districts, extending inland only on sandy soils of the northern wheatbelt, where growing season temperatures are mild.

Ability to thrive on infertile, deep sands enables sandplain lupins to be grown on many sites where medics, clovers, and even serradella fail. Their long-term role as grazing plants will probably be confined to these soils.

Because of the danger of lupinosis in stock, together with some difficulties in grazing management, it is important that they do not occupy too great a proportion of the farm area. But on poorer sands, sandplain lupins should continue to fill a valuable role in districts suited to them.

The cultivar Chapman grows well in districts with 16 to 18 inches or more annual rainfall. In drier northern districts, Box's Early should be used. Recent research has shown that this variety is early because it does not require exposure to cold (vernalization) to trigger flowering.

The first article in the series (Journal of Agriculture, August, 1969) described the lupin varieties grown in Western Australia. This and the next article discuss the more important agronomic differences among them, and give recommendations for their cultivation. It must be emphasized that these recommendations may need in time to be changed. Growing of lupins as crop plants is still in its infancy, and much remains to be learned.

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Germinating in late summer, it will flower immediately in autumn. The danger of excessively early flowering following an early season break means that it cannot be recommended for more southerly districts.

**General cultural recommendations for sandplain lupins**

Seed of the sandplain lupin should be drilled as soon as possible after the opening rains, or, better still, broadcast and harrowed in before the break of season. Seeding rate will depend on germination rate of the seed sample used (which will vary because of hard-seededness), and whether it is desired to achieve a full stand immediately.

Five to 10 lb. per acre will usually achieve a good stand in the second year, while 30 to 50 lb. or more may be needed to do this in the first year. Sowing mixed with oats or other cereal is often practised, either for harvesting after the lupins have shed, or to provide more balanced grazing in the first summer.

Seed inoculation does not appear to be necessary in the West Midlands and Geraldton districts, but may be advisable elsewhere. The seeds should be covered only lightly, about \( \frac{1}{2} \) to \( \frac{3}{4} \) in. being the ideal depth. Superphosphate should be used at not less than the rate recommended for pasture improvement in the area (Department of Agriculture Bulletin 3614).

Sandplain lupins are susceptible to molybdenum deficiency, and since most soils used for lupin growing are likely to be low in molybdenum, application is advised wherever it has not been used previously. On such soils cobalt is also likely to be low, for grazing animals if not for plants, and in view of a possible contributory role of cobalt deficiency in lupinosis, application of that element at the same time may be a worthwhile precaution.

Responses by sandplain lupins to copper are at the most very rare. Nor do they appear normally to need added zinc.

Light grazing can be carried out in later winter and spring, as sheep generally avoid bitter lupin plants once they have passed the seedling stage, concentrating instead on associated grasses, etc. During late spring the stocking rate can be increased where much grass is present, to keep the grass from getting too rank. Much heavier grazing can be started as soon as the lupins are ripe. The fact that sheep may have to be spelled from lupin paddocks after summer rains to avoid lupinosis makes it advisable to graze as heavily as possible in summer when conditions are safe.

Sheep should be removed from lupin paddocks as soon as the season breaks in autumn, and, depending on seedling density, kept out until the plants are reasonably well grown in mid winter. Controlled grazing in autumn or early winter may, however, be carried out if the lupin seedlings are dense and need thinning, and in fact set stocking becomes feasible in the second and later years of a good lupin stand, except insofar as management is needed in summer to avoid lupinosis.

Lupin stands that have been allowed to become too dense may become impenetrable to sheep when mature. In that case, the only remedy is to mow swathes through the stand, some time before maturity.

Where it is desired to eliminate sandplain lupins, the paddock should be very heavily stocked after the opening rains. The young seedlings are susceptible to grazing, and unlike at other stages in the growing season, are fairly rapidly eaten by sheep. Permanent elimination of sandplain lupins may require this treatment for several years, to deal with the backlog of hard seeds present in the soil. Hormone sprays, to which lupins are very susceptible, are also useful for killing isolated patches and volunteer stands along roadsides.

Established sandplain lupin stands are topdressed with superphosphate at the normal district rate for established pastures. After a phosphate bank has been built up in the soil, the rate can be reduced somewhat, or applications limited to every second year.

1 Lupinosis will be discussed briefly in a later article.
Sandplain lupin stands may deteriorate after a few years, but cereal cropping for a year or two will usually rejuvenate them. Burning of the dry lupin stalks the summer before cropping will improve the nitrogen supply to the cereals, and reduce the incidence of weeds, which tend to build up due to the system of lupin grazing management. Lupins in the cereal crop can be readily controlled with suitable weedicide sprays.

Re-seeding of the lupins may be necessary after more than one cereal crop in northern agricultural districts, where breakdown of the hard seeds during summer is rapid and most seeds germinate in the autumn following their formation; but in cooler, more southern lupin districts sufficient hard seeds normally persist in the soil to give natural regeneration for several years.

Deterioration of old lupin stands seems to be reduced also by other treatments involving spring, summer, or autumn cultivation. This may take such forms as late summer harrowing, or dry seeding of oats or other cereals into the stand. The benefits of cultivation can often be seen in firebreaks, where lupins tend to be more vigorous than elsewhere.

The basis for their greater vigour is uncertain, but one factor may be the turning under and release of nutrients accumulated in surface organic matter. Another may be that on all but the sandiest soils, the surface tends in time to harden. Lupin seeds lying on the surface are then not trodden in by stock. When they germinate on the surface, the thick, fleshy root often fails to penetrate the soil surface, so that the seedling perishes on the first dry day; or if penetration does occur, root development may be abnormal and the plant consequently weakened. This could, in fact, be a prime reason why long-term persistence of undisturbed lupins is confined to soils with a loose, sandy surface. A third possible factor is that cultivation may remove or bury dry lupin residues, thus minimising the carry-over of disease organisms from the previous season. Burning of excess lupin residues in late summer achieves the same result.

Bitter narrow-leafed and yellow lupins

It is unlikely that bitter varieties of narrow-leafed lupins (*L. angustifolius*), or of yellow lupins (*L. luteus*) will continue to find a place in Western Australian agriculture. In neither case is there a sufficient advantage over sweet varieties, except perhaps in the restricted context of the orchard or vineyard as a green manure crop.

For broad acre cultivation, there are compelling reasons why bitter lupins of these species should in fact not be used; and if already present, why they should be eliminated. The reasons for this are discussed in a later article.

Sweet lupins

The most important difference in the cultivation of sweet and bitter lupin varieties is that sweet varieties are much more palatable, and consequently are susceptible to grazing in the green state by stock and vermin. Some light grazing may be tolerated after the seedling stage, but the loss in seed yield is likely to be far greater than the value of the grazing. For the same reason the mature plants—especially the seeds—are more palatable and of greater value for stock than those of bitter varieties.

Certain insect pests (red-legged earth mites, lucerne fleas, and aphids) will attack sweet, but not bitter, lupins. On the other hand climbing cutworms, which are perhaps the most serious pest of lupins in Western Australia, attack both types equally.

The incidence of diseases appears to be similar for bitter and sweet varieties, at least in *L. luteus* and *L. angustifolius*. With *L. albus* there has been some evidence that sweet forms are more susceptible to fungal leaf spots, although this may not be an essential difference between the two types.

In vigour of growth the sweet varieties appear to equal their corresponding bitter forms, at least under reasonably favourable conditions. The possibility that the bitter forms are more hardy under adverse conditions cannot be discounted.

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There has also been some suggestion, on the basis of field experience in 1968, that the sweet varieties at present available in Australia are more liable to flower shedding and poor pod setting under conditions of unusual cold and/or heat at flowering. This possibility is being investigated.

**Agronomic characteristics of sweet lupin varieties**

The principal sweet lupin varieties grown in Western Australia are Weiko III (yellow lupin) and Uniwhite (narrow-leafed lupin). Borre (narrow-leafed lupin) is now being superseded by Uniwhite, and will not be discussed further. Uniwhite will itself soon be superseded by varieties of the same species with fully non-shattering pods, but apart from that their agronomic characteristics should not be greatly different. No discussion is included of sweet forms of *L. albus*, as none is yet commercially available. However some preliminary information is included in the Table.

**WEIKO III**

Weiko III grows best in higher rainfall districts, with an annual rainfall of 25 in. or more; or 18 to 20 in. or more on the Esperance Downs. It will grow on most sandy, gravelly, or sandy loam soils, and tolerates soil acidity. However it is very sensitive to alkalinity, and will not stand more than a very slight trace of free limestone in the soil. As a general guide, soils which carry medics of any kind are unsuitable.

Unlike most lupins, Weiko III will tolerate a degree of temporary waterlogging. Some frost damage has been observed in cold districts, but for most districts its frost resistance appears adequate.

Seed yields of Weiko III are in general not as high as those of other lupins grown in Western Australia, good yields depending on a sufficiency of moisture and moderate temperatures during flowering and pod filling. A very high seed protein content (over 40 per cent., on a moisture-free basis) to some extent compensates for this.

**UNIWHITE**

Uniwhite and other varieties of *L. angustifolius* are probably the most frost-tolerant of the lupin varieties commercially available, withstanding temperatures down to about 20° F. without injury. The possibility remains that lighter frosts at flowering may upset pod setting, but apart from this they should not normally be affected by low temperatures experienced in Western Australia.

Rainfall limits of the existing narrow-leafed lupin varieties have not been clearly defined. On present indications, they are reasonably reliable where annual rainfall exceeds 20-22 inches in northern areas, or about 17 in. along the south coast. New early-maturing varieties in the course of development may extend cultivation into wheatbelt district with an annual rainfall exceeding about 14 in.¹

Of all lupin varieties currently available, Weiko III is the easiest to harvest because of its non-shattering pods.

A weakness of Weiko III is its relative susceptibility to insect pests, most notably red-legged earth mites in the seedling stage, aphids in the bud stage, and climbing cutworms in the green pod stage. Competition from weeds tends to be more serious than with sandplain and narrow-leafed lupins, because of Weiko III's lower seedling growth habit. It also seems more prone to nodulation failure than other lupin types.

For these reasons the future of Weiko III (and perhaps of other yellow lupin varieties) may be confined, in Western Australia, to particular areas and soils in higher-rainfall districts which specially suit its requirements. The seed will probably maintain a price premium for stock feed purposes because of its very high protein content.

### General Soil and Temperature Requirements of Commercially Cultivated Lupin Species

<table>
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<tr>
<th>Species</th>
<th>Preferred Soil Types</th>
<th>Preferred Soil pH</th>
<th>Temperature Requirements</th>
<th>Annual Rainfall Range, Commercial Varieties (South-Western Australia)</th>
</tr>
</thead>
</table>
| *L. cosentini* (Sandplain, or W.A. blue, lupin) | Yellow or brown sands and loamy sands; sand over limestone, loam or gravel. Soil must be well drained. | Moderately acid to mildly alkaline | Mild growing season temperatures, very susceptible to frost. Grows best in coastal and northern agricultural districts. | cv. Chapman 16-35 in.  
|                          |                                                                                             |                                    |                                                                  | cv. Box's Early 12-18 in.                                                  |
| *L. luteus* (Yellow lupin) | Loamy sands and sandy loams; sand over gravel, loam or clay; gravelly soils. Has some tolerance of temporary waterlogging. | Strongly to mildly acid            | Has reasonable frost tolerance, but may suffer damage in frost-prone locations in colder districts. | cv. Weiko III 22-45 in.                                                   |
| *L. angustifolius* (Narrow-leafed, or N.Z. blue, lupin) | Loamy sands and sandy loams; sand over gravel, loam or clay; gravelly soils. Soil must be well drained. | Moderately acid to neutral         | Frost (to 20°F) and cold tolerant; grows well in both coastal and inland areas of Western Australia. | cv. Commercial Bitter  
|                          |                                                                                             |                                    |                                                                  | cv. Borre J  
|                          |                                                                                             |                                    |                                                                  | cv. Uniwhite J                                                      |
| *L. albus* (White lupin) | More fertile loamy sands; sandy loams; loams. Good drainage probably required.             | Mildly acid to mildly alkaline     | Similar to *L. angustifolius*?                                   | No commercial varieties at present.                                       |

that is, the better class brown sands and loamy sands, sands overlying a heavier subsoil, gravelly soils, and sandy loams. Deep white sands, and any soils subject to waterlogging, are definitely to be avoided.

Narrow-leafed lupins are more sensitive to extreme soil acidity than yellow lupins, but less sensitive to the presence of some free limestone. Most Western Australian soils in districts with suitable rainfall fall within a suitable range of soil acidity.

Nodulation troubles seem to be less frequent than with Weiko III, but are more frequent than with sandplain lupins and may constitute a problem on some soils. Inoculation is advised on any soils which have not previously carried lupins or serratella.

Uniwhite competes with weeds better than Weiko III because of its taller early growth, and can smother most weeds provided the stand is dense enough. It is also less susceptible to some insect pests. Some attack by red-legged earth mites, lucerne fleas, and aphids may occur, but

in experience so far this has not often been serious enough to warrant spraying. It is also slightly less readily attacked by climbing cutworms in the pod stage than either sandplain or yellow lupin.

The seeds of Uniwhite shed more slowly than those of the commercial bitter or Borre varieties of narrow-leafed lupin. Under normal circumstances, steady shedding starts from one to three weeks after ripening, and careful harvesting as soon as the crop is ripe will recover most of the seed. Serious losses may occur, however, if there is a sudden hot spell at or immediately after ripening.

Seed yields (not allowing for losses by shedding) are generally higher than those of Weiko III, in some areas substantially so. On the other hand the protein content of the seeds is lower, averaging about 33 to 35 per cent. on a moisture-free basis. This means that a slightly lower price can be expected, where the seed is to be used for feed purposes.

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1 For a detailed discussion of pod shattering in lupins, see J. S. Gladstones (1967)—Australian Journal of Experimental Agriculture and Animal Husbandry, vol.7, pp. 360-366. Uniwhite carries the gene *tardus* for reduced shattering. See also Department of Agriculture Bulletin 3502, "Uniwhite lupin".
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