Lupins in Western Australia. 5. The grazing value of green and mature lupins

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WHETHER or not lupins are grown primarily as a grain crop, grazing of standing crops and harvested stubbles will continue to be an important use. This article examines the uses of sweet lupins for forage, and the main problem of lupin grazing, lupinosis.

**Sweet lupins for green forage**

The poor recovery of sweet lupins after grazing in the early growth stages generally precludes grazing in the autumn, winter, or early spring, except of self-sown stands which it is desired to eradicate. Where the stand is to be harvested, the value of the yield lost normally far outweighs that of the grazing gained.

There may be some place for grazing of sweet lupins towards the end of the growing season, after flowering has finished and the lupins have finished their main growth. Again, this would be confined to crops not intended for harvest, as the green pods are attractive to stock. The main situations where such a use might be justified are where other feed has matured and it is necessary to keep weaner sheep growing rapidly, or where there are likely to be more lupins than could be fully used in the restricted dry grazing period after maturity.

Sweet lupins have been successfully used to make both hay and silage, with best results being obtained by cutting toward the end of flowering. For hay-making, drying may be difficult, especially with yellow lupins because of their thick, fleshy stems. On the other hand, yellow lupins have the advantage of dropping their leaves less readily than other lupins as they dry.

There is no reason why green sweet lupins should not be artificially dried and ground to meal, as is done with lucerne, for use in poultry and other stock feeds. Up to full flowering their crude protein content is 20 per cent, or higher in the whole tops (moisture-free basis), and fibre contents are moderate. Quality falls off rapidly from late flowering onwards. Sweet varieties of narrow-leafed lupin are probably more suitable than yellow lupins as they generally have a lower water content and are much less hairy, so that the meal does not become fluffy.

**Grazing value of mature lupin crops and stubbles**

Traditionally, bitter lupins have been used in Western Australia for summer grazing, with stock eating the fallen leaves, pods, smaller twigs, and to some extent (though apparently very inconsistently) the fallen seeds. In recent years sweet lupins have been used in the same way, with considerable success.

Field experience has suggested that the sweet varieties are superior for fattening weaner sheep and probably other stock, and that, at least with narrow-leafed lupins, stock will consume all parts of the mature plant. The non-shattering pods of new varieties being developed will have the further advantage of allowing greater access to the seeds, especially by cattle. The use of special purpose lupin crops for summer grazing, and their place in the overall farming system, are at present being studied intensively by CSIRO workers at the Yalanbee Experiment Station, Baker's Hill.

The grazing value of the stubble after harvest will be important in the economics of sweet lupin growing for grain. Field experience is so far limited, but apart from a possible lupinosis risk (see below) there
can be little doubt that the stubble of sweet lupins is greatly superior in grazing value to that of cereals.

The table below sets out the average gross compositions of various mature lupin components, as found in a general survey in Western Australia by Gardiner and Gorman. The figures refer mainly to sandplain lupins, but other lupins should not differ greatly.

Protein contents in all non-seed components of mature lupins are high compared with those of cereal stubbles and mature grasses, and comparable with those of mature sub. clover tops. The crude fibre contents of the stems are high, but those of the pods and leaves (including petioles) are relatively low, with quite high levels of extractable carbohydrates. Overall, the composition of lupin crop residues compares favourably with that of a mature sub. clover based pasture.

Residues from lupin crops normally amount to 1½ to 3 tons per acre.

Heavy lupin crops, such as might be attained with very early seeding on suitable land, leave as much as 4 tons or more of residues per acre after harvest. The average grazing value of the material is lower than with lighter crops, as much of the extra weight is in the form of coarse stems. Nevertheless a high proportion of the stems should be still be usable, at least by cattle, while finer fractions readily grazed by sheep will still be present in quantities similar to those from less rank crops.

Direct measurements of the summer stock-carrying capacities of sweet lupin stubbles are not yet available, but from the above figures it can be predicted that they will be considerably higher than for cereal stubbles, and probably at least comparable with those of good legume-based pastures.

**LUPINOSIS**

The disease lupinosis, which sporadically afflicts stock grazing lupins or lupin stubble, is one of the main practical drawbacks of commercial lupin growing. It largely baffled research workers for 100 years, from the time of the first recorded outbreaks in Germany in the 1860’s. However recent research by Dr. M. R. Gardiner and his colleagues in the Western Australian Department of Agriculture has added much to our understanding of the disease, and a reasonable degree of field control now seems possible. Much nevertheless remains to be learned before complete success can be claimed.

Lupinosis is quite distinct from lupin alkaloid poisoning. Alkaloid poisoning is confined strictly to bitter lupin varieties. In milder cases it causes a transient intoxication with, as far as is known, no permanent after-effects. In severe cases alkaloid poisoning can be fatal, and some past losses in Western Australia of sheep on bitter lupins may be attributable to it. However, in recent years at least, most sheep losses on lupins appear to have been caused by lupinosis.

### Composition of mature lupins in general survey, 1954-1964

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Stems</th>
<th>Pods</th>
<th>Leaves</th>
<th>Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>Crude protein</td>
<td>6.1</td>
<td>3.4-11.3</td>
<td>5.2</td>
<td>3.5-17.3</td>
</tr>
<tr>
<td>Oil (ether extract)</td>
<td>0.8</td>
<td>0.2-1.5</td>
<td>0.6</td>
<td>0.1-0.9</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>48.8</td>
<td>26.1-54.6</td>
<td>37.3</td>
<td>33.6-42.2</td>
</tr>
<tr>
<td>N-free extract</td>
<td>40.0</td>
<td>35.2-47.8</td>
<td>54.5</td>
<td>50.2-58.4</td>
</tr>
<tr>
<td>Ash</td>
<td>4.8</td>
<td>2.2-8.5</td>
<td>3.5</td>
<td>2.1-4.0</td>
</tr>
</tbody>
</table>

† Apparent ash contents of the leaves were high, partly because of soil contamination.
Incidence

Lupinosis was not reported in Western Australia until 1948, despite the extensive use of lupins for some 40 years before. The first widespread outbreak was in 1951, and since then its incidence has fluctuated greatly between seasons. As in Germany in the last century, the incidence from paddock to paddock appears also to be erratic.

The disease has occurred on both the sandplain (W.A. blue) and narrow-leafed species. Sheep have mainly been affected, although lupinosis can also affect cattle, horses and other grazing animals.

Sheep losses have been serious only in some years, most notably 1951, 1959, and 1963, but a much greater hidden loss has been experienced due to an almost general failure in recent years of sheep to thrive and fatten on bitter lupins, as they are reported to have done in the past.

Contrary to reported overseas experience, cases of lupinosis have been recorded in Western Australia on sweet as well as bitter lupin varieties. The limited field evidence available nevertheless suggests that outbreaks are less frequent and generally less severe on the sweet varieties.

Symptoms

Lupinosis is characterised by liver damage and frequently by jaundice.* It may be acute, occurring within a few days of grazing toxic lupins, or it may develop in chronic form over a longer period. In the chronic form it is invariably accompanied by progressive loss of body condition.

Lupinosis-affected sheep are dull and stupid, and wander aimlessly. The sheep may die after varying intervals, or in milder cases they may recover after removal from lupins or with the appearance of green feed at the beginning of the next growing season. In some cases sheep may partially recover while still on lupins, due to diminishing toxicity of the lupins (see below).

One of the most striking aspects of lupinosis in its chronic form is that the animals almost cease to eat. Digestion of roughage in the rumen appears to be impaired, and the rumen may become packed with undigested fibrous material. Increasingly the direct effects of the initial toxin become confused with those of starvation, and perhaps with specific forms of malnutrition. Initially swollen, fatty and yellow, in the early stages of lupinosis the liver shrinks and becomes cirrhotic. An increased worm burden tends to add to the vicious circle of falling appetite and condition.

Disorder of liver function and/or loss in liver weight can result in abnormally high concentrations of stored liver copper, which under conditions of stress may be released suddenly into the blood stream to give rise to typical symptoms of copper poisoning. In fact it seems likely that some lupinosis deaths are more immediately due to this than to starvation or to the direct effects of the lupin toxin.

Paradoxically, copper toxicity in lupinosis can occur on feed which by normal standards is marginal or even copper-deficient.

Possible causes

The nature of the toxin which triggers lupinosis is not known. Early German workers suspected that it was produced by fungi growing on the maturing or dead lupins, and recent observations by Gardiner and others in Western Australia seem to confirm this. Severe outbreaks in Western Australia typically follow summer rains, especially when these are followed by a few days of humid, cloudy weather.

The most serious risk of lupinosis can be avoided if stock are immediately taken off lupins when these conditions occur, and kept off until two weeks or more after a return to fine, dry weather. The toxin seems to break down under hot, dry conditions.

Other factors are undoubtedly involved besides specific toxins. Mould growth may play another part by making lupin and perhaps other feed less palatable, thereby contributing to reduced feed intake. Deficient or marginal cobalt levels in lupins and other feed may also contribute to the downward spiral of feed intake and general nutritional status seen in...
chronic lupinosis. Most lupin soils in Western Australia are low in cobalt, and there is some evidence that lupins, especially the narrow-leafed lupin, take up cobalt weakly from the soil.

Other trace elements such as molybdenum are known to influence liver copper storage in sheep, but their role, if any, in lupinosis is unknown.

Level of nutrition

General palatability and nutritional value of the feed available almost certainly have a strong influence on the course of chronic lupinosis. Although the evidence is sketchy, it suggests that as long as feed acceptability is high enough, the fall-off in consumption and consequent malnutrition in chronic lupinosis may be to some extent avoided.

Additional direct effects of nutritional level on the toxin are suggested by analogy with certain other plant and fungal toxins, although they have yet to be demonstrated for lupin toxins. In ruminants many such toxins are broken down by bacteria in the rumen to harmless substances. This requires that bacteria be present and active in sufficient numbers, which in turn depends on adequate digestible supplies of energy, nitrogen, and other nutrients.

Many studies have shown that the capacity of the liver itself to withstand toxins depends on adequate dietary levels of protein, or of specific "liver protective" factors which tend to be associated with protein. Animals receiving ample protein have been found to withstand much higher doses of toxins without liver damage than those on protein-deficient diets. Other experiments have suggested that the livers of sheep and other animals accumulate greater amounts of copper when protein in the diet is low than when it is high.

Any of these effects could contribute to the course of lupinosis. They emphasise the basic importance of feed quality and palatability in lupinosis—not only of the lupins themselves but also of other feed available at the same time. They might also explain the apparently lower incidence of lupinosis on sweet than on bitter lupin varieties.

RECOMMENDATIONS FOR AVOIDING LUPINOSIS

Present evidence suggests that the danger of lupinosis can be lessened by the following measures.

- Remove stock from lupin paddocks when summer rains come, and return them only after two to three weeks of hot, dry weather. Efficient use of lupin paddocks will therefore depend on heavy stocking during the safe periods.
- In paddocks where other feed besides lupins is present, maintain the best possible feed quality with emphasis on legumes such as clovers and serradellas.
- Ensure that the animals have an ample supply of cobalt. Regular use of cobalt superphosphate is advised with narrow-leafed lupins (L. angustifolius). On most lupin soils this is probably advisable with other lupin types as well.
- Do not top-dress unnecessarily with copper. Where copper must be applied for other crops in the rotation, ensure that it is drilled or otherwise incorporated into the soil, rather than left on the surface where it may be picked up directly by sheep.
- Grow sweet in preference to bitter lupin varieties wherever possible, but continue to observe all other precautions.
- Keep lupin stands as free as possible from fungal infection by rotating (where feasible) lupins with other crops, by use of healthy seed for sowing, and by use of adequate fertiliser to help the plants to throw off fungal attack.

Acknowledgment

Much of the discussion on lupinosis is based on published papers of Dr. M. R. Gardiner, of the Western Australian Department of Agriculture, to whom grateful acknowledgment is made.