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Lupinosis... restricting factor

By J. G. Allen, Veterinary Pathologist, Animal Health Laboratories

Other articles in this Journal have emphasised lupins' great value in crop rotations and as a source of high protein seed. As standing crops, or as stubble, they also can provide valuable summer feed for livestock. However, in some circumstances their grazing value can be limited severely by the disease lupinosis.

Although lupins were introduced into Western Australia more than 80 years ago, and have been accepted as a useful stock feed for the past 60 years, the first outbreak of lupinosis did not occur until 1948. Subsequently, the disease has occurred during every summer since 1950, but its severity year by year has varied greatly throughout the agricultural areas. Since 'sweet' lupins were introduced in the 1970s, lupinosis has been a widespread and severe problem in the summers of 1974/75 and 1981/82. Natural outbreaks of lupinosis have affected sheep mainly, but cattle, horses and donkeys also have been affected.

Lupinosis is caused by toxins produced by a fungus which colonises lupins. The fungus, Phomopsis leptostromiformis, infects the green lupin but persists on the dead plant. The 'bitter' blue lupins, Lupinus coventini and L. angustifolius and the currently available 'sweet' lupin cultivars of L. angustifolius, are all equally susceptible to infection by the fungus. The toxins mainly damage the liver.

Factors affecting lupinosis

- **Presence of the fungus.** Nearly all stands of lupins in Western Australia each season will be infected by Phomopsis, but the amount of it will vary. The more fungus present, the greater the risk of lupinosis. Techniques are available to assess rapidly the amount of fungus present.

- **Weather.** Temperature, rainfall, humidity and dews all influence the production of toxin by Phomopsis. The precise details of how these predisposing factors work in the field have yet to be determined, but in the laboratory the optimum temperature for toxin production is 25°C. Research workers believe that periods of rainfall, high humidity, or consistent dews during periods when the daily maximum temperatures are about 25°C, could create ideal conditions for toxin production.

- **Time of grazing.** Generally, the risk of toxicity increases as summer progresses. Thus it is usually best to graze lupins early in summer.

- **Alternative feed.** Most of the fungus and thus most of the toxin is located in the lupin stem. Generally, sheep will eat other available parts of the plant in preference to the stem. Thus the smaller the proportion of lupin stem in any stand of lupins, the lower the risk of lupinosis. For this reason unharvested, weedy lupin crops present a lower risk than efficiently harvested, weed-free crops. Stock should never be allowed to graze lupin stubble in which no lupin seed is readily available.

- **Stocking rates.** High stocking rates, particularly more than 30 sheep per hectare, increase the risk of lupinosis. This is partly because increased grazing pressure, which allows less grazing selectivity, results in more lupin stalk material being eaten.

- **Water points.** If only one water point is provided in a large paddock the risk of lupinosis increases. Because sheep will not range great
distances from their water source in summer, artificially high stocking rates are created around such single water points.

- **Age of sheep.** Weaner sheep are more susceptible to lupinosis than adults. This is partly because of a difference in the eating experience and habits of the two age groups. Younger sheep are less selective. They do not eat as much lupin seed as adults, but eat more lupin stems. Weaner sheep also are more likely to develop nutritional white muscle disease (myopathy) and lupinosis-associated myopathy, than adults.

- **Hungry sheep.** Hungry sheep are less selective grazers and should never be moved onto lupins.

- **Individual sheep grazers.** Sheep like lupins, particularly the ‘sweet’ varieties, and often will graze them in preference to pasture or cereal stubbles. If they have access to a small area of lupins in a large paddock of cereal stubble the risk of lupinosis may increase because the sheep may preferentially graze the lupins thus artificially creating a very high stocking rate on them. Even in a normal situation some sheep will eat more lupin stem than others. This can be used to advantage because such sheep will act as early indicators of an impending outbreak of lupinosis in the flock.

- **‘Sweet’ or ‘bitter’ lupins?** Lupinosis should be less likely to affect sheep grazing the blue ‘bitter’ lupins because they are not a cultivated crop and are not harvested. This results in a large proportion of alternative feed in the form of lupin seed, weeds, grasses and clover always being available to grazing livestock. Furthermore, the stems of the ‘bitter’ lupins are generally thicker and far less palatable than those of ‘sweet’ lupins, and hence are less readily eaten. The exception is when the hard bitter lupin stems are softened by dampness after rain.

- **Sheep or cattle?** Sheep are more susceptible to lupinosis than cattle, but one should never assume that cattle will not develop the disease. In fact there is evidence that cattle grazing lupins frequently suffer liver damage, but usually this is not severe enough to produce disease symptoms. The lupinosis toxins produce two distinct syndromes in cattle.

  The first . . . the fatty liver syndrome . . . accounts for most outbreaks of the disease and most deaths. It appears only in late-pregnant or recently-calved cows. It results when the lupinosis toxins cause mild loss of appetite in animals going through a period of nutritional stress. When this happens the animal uses its fat reserves for energy, but in doing so, big quantities of toxic compounds called ketones are produced. These kill the animal.

  The second . . . the cirrhotic liver syndrome . . . occurs less frequently and can appear in all classes of cattle. It is simply chronic lupinosis, similar to that affecting sheep, but is often not recognised until the break of the season, when affected animals may develop photosensitisation.

**Normal procedures for preventing lupinosis**

The first rule for preventing lupinosis is always to regard lupins as potentially toxic.

Next, one must develop the ability to recognise the early signs of lupinosis in grazing livestock. Affected sheep lose their appetite, become lethargic and develop varying degrees of jaundice. They can be detected easily by moving the flock over 100 to 200 metres, when they will lag behind. These stragglers should be caught and examined for jaundice, which will show as a yellowing or a muddying discolouration of the mucous membranes of the eyes and mouth. As soon as affected sheep are detected, the flock should be moved off the lupins.

When sheep are introduced onto lupins they should be checked daily for the first week, and thereafter three times a week. If rain falls when sheep are grazing ‘bitter’ lupins, they should be removed until the lupins dry out. If they are grazing ‘sweet’ lupins, it is not absolutely necessary to move them after rain, but they should be checked daily for the next seven days.

**Agronomic and management techniques for preventing lupinosis**

- **Lupin hay.** If lupins are cut just after they have flowered, then baled, rolled or stacked as hay, much of the *Phomopsis* present will become dehydrated and die. The resulting feed is far less likely to cause lupinosis. The success of this technique depends on quick drying of the cut lupins, so conditioning is recommended.

- **Lupin/oats polycultures.** The individual yields of lupins and oats can be increased by growing the two together as a mixed polyculture crop. Growing the two crops together also frequently results in lower levels of infection of the lupins by *Phomopsis*, and a greater proportion of non-lupin alternative feed being available to grazing sheep.

- **Rotational grazing.** One way to force livestock to graze non-lupin material is to graze lupins in rotation with non-lupin material, such as cereal stubble or good pasture. The liver is a remarkably organ. During the non-lupin rotation, much of the damage caused during the lupin rotation is repaired. Generally, if the sheep show no ill-effects during the lupin rotation period, then seven to ten days should be adequate for the non-lupin rotation period.

- **Fungicides.** Research has shown that applying fungicides to lupin crops at strategic times will significantly reduce the amount of fungus present, reduce the risk of lupinosis and increase the yield of lupin grain.

- **Burning.** The most nutritionally beneficial component of the dry lupin plant is the seed. It is possible to rake and burn to provide access to the seed but not the other components of the lupin plant. A thorough burn is necessary to ensure that the risk of lupinosis is removed. However, this practice reduces the potential grazing time and dramatically increases the risk of erosion on the land involved.

**Acknowledgment**

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90
Water use by lupins ... their potential effect on soil salinity

R. A. Nulsen, Division of Resource Management

There may seem little connection between growing lupins and controlling the spread of soil salinity. However, an examination of the causes of soil salinity and an appreciation of the relative water use by lupins, wheat, barley and sub. clover will show that there is a prospect of using lupins for soil salinity control.

Typically, soil salinity in Western Australia results when salts stored in the soil are dissolved in the increased amount of water which percolates to the deeper layers of the soil after deep-rooted, perennial, native vegetation is replaced by shallow-rooted annual agricultural species. The increased percolation therefore causes both a rise in the level of the groundwater and an increase in groundwater salinity. When the saline groundwater rises to within one or two metres of the soil surface, capillary transport can effectively deposit enough salt close to the soil surface to inhibit the growth of common agricultural crops and pastures.

If deep percolation, that is, recharge of the groundwater, can be reduced, there would ultimately be a beneficial effect through the reduction of soil salinity.

Table I. Potential recharge under four species at Kondut and Cunderdin

<table>
<thead>
<tr>
<th>Site</th>
<th>Rainfall (mm)</th>
<th>Wheat</th>
<th>Potential recharge (mm) under:</th>
<th>Barley</th>
<th>Lupins</th>
<th>Clover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kondut</td>
<td>162</td>
<td>47</td>
<td>9</td>
<td>80</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Cunderdin</td>
<td>238</td>
<td>139</td>
<td>8</td>
<td>61</td>
<td>162</td>
<td></td>
</tr>
</tbody>
</table>

Comparative water use by crops and pastures

Measurements of water use by lupins, barley, wheat and sub. clover have been made at Kondut in 1980 and Cunderdin in 1981 using a ventilated chamber system. With the ventilated chamber, a section of crop is covered with a plastic 'tent'. The tent is open at one end and has a fan at the other to provide a continuous air flow. The amount of water vapour in the air entering and leaving the tent is measured. The difference in water vapour concentration is the amount of water given off by the enclosed plants and soil.

At both sites lupins used much more water than sub. clover, but the productivity of lupins relative to the cereals was very dependent on the season. Also, barley used significantly more water than wheat at both sites.

Daily water use data for mid-season at Cunderdin show that lupins not only have a higher peak rate of water use than the other species but they also use water for more hours of the day.

Potential recharge reduction

The sites at Kondut and Cunderdin were loamy sand soils. There was no surface runoff. Therefore it is reasonable to assume that the difference between the rainfall and the total water use by the plants represents water percolating beyond the root zone, to become recharge. The potential recharge under the different species is given in Table I.

The potential average annual recharge under a number of possible cropping rotations can be calculated using the data from Table I.

Table II. Potential average annual recharge under different cropping rotations at Kondut and Cunderdin

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Average annual recharge (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCC</td>
<td>99 (100)*</td>
</tr>
<tr>
<td>WC</td>
<td>86 (87)</td>
</tr>
<tr>
<td>WW</td>
<td>47 (47)</td>
</tr>
<tr>
<td>WL</td>
<td>64 (65)</td>
</tr>
<tr>
<td>BL</td>
<td>44 (44)</td>
</tr>
</tbody>
</table>

Kondut | 154 (100) | 150 (97) |
Cunderdin | 139 (90) | 100 (65) | 72 (47) |

The figures in brackets represents the recharge as a percentage of the WCC recharge, where W = wheat, C = clover, L = lupins and B = barley.

While none of the rotations eliminates recharge, rotations containing lupins instead of clover contribute much less water to the groundwater recharge. As would be expected on a freely draining soil, seasonal rainfall has a direct influence on the recharge.

The above calculations are based on only two years' data, collected at two sites during two very different seasons. The results shown may not apply generally, however the relative positions of the various species is significant. The important point is that lupins use considerably more of the rainfall than clover.

While this article has only described the effects of lupins as an alternative for recharge manipulation, other crops, other tillage techniques and alternative landscape management systems also can affect recharge.

Conclusion

In a cereal-legume rotation incorporating lupins instead of sub. clover, the amount of rainfall escaping beyond the root zone to the groundwater is reduced considerably.

An experiment has been started to test the success, or otherwise, of using a cropping rotation incorporating lupins to control soil salinity.