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H G. Neil
C. M. Ralph
A. W. Hogstrom

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Grateful acknowledgment is made to Messrs. K and V. Williams for their valuable advice and assistance in conducting this trial which called for a considerable amount of management and attention to detail. Grateful acknowledgment is made to Mr. W. J. Toms for the assistance rendered by him in the designing of the trial and to Dr. M. R. Gardiner, Chief Veterinary Pathologist, at the Animal Health and Nutrition Laboratories for the detailed examination of the livers.
A Grazing Management Trial for the Control of Lupinosis in Sheep

By H. G. NEIL, B.Sc. (Agric.), C. M. RALPH, B.Sc. (Agric.), and A. W. HOGSTROM, B.Sc. (Agric.), Advisers, Wheat and Sheep Division

A "WASTING" disease of sheep grazing on lupin stands, usually accompanied by heavy mortality, has become a serious problem in coastal areas between Perth and Geraldton in the past ten years.

Dry stands of West Australian blue lupin (Lupinus digitatus Forsk)* are used extensively in the Dandaragan and Gingin districts for grazing sheep during the summer months. This lupin is also used as a pioneer species in the development of light land in the country west of the Midland Railway.

Since 1950 the area sown to lupins in the Dandaragan area has increased by some 50,000 acres while along the coastal belt large tracts of light land have been sown to lupins. The increased area of lupins and the consequent changes in pasture management have contributed to the incidence of the disease which has caused losses of up to nearly 80 per cent. in some individual flocks.

The disease "lupinosis" was described by Bennetts (1) who has reported that it occurs on pastures carrying the W.A. blue lupin and the N.Z. blue lupin (L. angustifolius Linn).

A survey of the Dandaragan district conducted by the Department of Agriculture in 1959 (Neil et al (2) ) showed that lupinosis occurs where sheep are compelled to eat mainly lupin roughage. Indications were that any practice which tended to reduce the intake of lupin roughage would reduce the incidence of the disease.

INVESTIGATION AT CREIGHTON PARK

In order to test the effect of diet on the control of lupinosis a trial was started at Dandaragan on V. and K. Williams property, "Creighton Park," in January, 1960. The site of the experiment was a paddock in which sheep had developed lupinosis in the previous month as well as in other seasons.

This paddock carried a six year old lupin stand on second class marri (red gum) country. It had been grazed continuously since the 1957/58 summer, with the result that there was very little feed other than a dense stand of lupins which, under normal grazing could be expected to fatten sheep at the stocking rate used. An area of 20 acres with a uniform cover of lupins was divided into four paddocks, each with its own water supply.

The sheep on the left did not have any hay supplement while the sheep on the right received a supplement of hay throughout the whole experiment.

* Previously referred to as Lupinus varius.
Experimental Sheep.

Four groups, each of 20 sheep, were randomly selected from 80 merino wethers which had been purchased from the eastern wheatbelt where no previous experience of lupin grazing was likely, and then held on a Dandaragan property from September on a pasture containing some old lupin seed. They ranged in age from 2-tooth to fresh, full mouth. After weighing and marking with numbered ear tags, one group was placed in each of the four paddocks.

Experimental Treatments.

Group 1.—Received a ration of hay for the entire experimental period of 97 days and remained in the same paddock.

Group 2.—Also received a ration of hay for the whole period but after 46 days was moved to the paddock occupied until then by Group 4.

Group 3.—Received no hay during the experiment and remained in the same paddock for the entire period.

Group 4.—Did not receive a ration of hay for the first 46 days of the experiment at which time they were moved to the paddock previously occupied by Group 2 and given a ration of hay for the remaining period.

Procedure.

The sheep were weighed fortnightly for the first 46 days and then weekly for the remaining period. Where possible a post mortem was conducted on any sheep dying and liver samples sent to the Animal Health and Nutrition laboratories for confirmation of the disease. At the end of the experiment all surviving sheep were forwarded to Robbs Jetty abattoirs for slaughter and appraisal. Liver samples from every sheep were examined in the laboratory.

The supplementary ration consisted of oaten hay fed twice weekly at the rate of 1 lb. per head per day. The hay was placed in racks, two to each paddock, away from the water trough.

Results of the Experiment.

The following table shows mortalities in different groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of deaths</th>
<th>Percentage of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

There were no deaths in either of the supplementary fed Groups 1 and 2 and no further deaths in Group 4 after feeding commenced. Where no hay was fed, eight deaths occurred in Group 3 whereas in Group 4 three died in the first 46 day period, when they received no hay.

From the 11 sheep that died during the experiment seven liver samples were forwarded for examination and in all cases severe lupinosis damage was reported.

Weight Losses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial average weight</th>
<th>Average weight after 46 days</th>
<th>Average weight losses for the 46 day period</th>
<th>Average weight after 97 days</th>
<th>Average weight losses over the 97 day period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>103.6 lb</td>
<td>97.7 lb</td>
<td>5.9 lb</td>
<td>92.2 lb</td>
<td>11.4 lb</td>
</tr>
<tr>
<td>2</td>
<td>103.5 lb</td>
<td>101.6 lb</td>
<td>12 lb</td>
<td>96.0 lb</td>
<td>7.5 lb</td>
</tr>
<tr>
<td>3</td>
<td>103.8 lb</td>
<td>92.6 lb</td>
<td>11.2 lb</td>
<td>78.0 lb</td>
<td>25.8 lb</td>
</tr>
<tr>
<td>4</td>
<td>97.31 lb</td>
<td>82.6 lb</td>
<td>14.7 lb</td>
<td>84.2 lb</td>
<td>15.1 lb</td>
</tr>
</tbody>
</table>

All groups lost weight over the 97 day experimental period however, Group 3, which received no hay, lost more than three times as much as the supplementary fed Group 2 and twice as much as the supplementary fed Group 1.

Group 4 lost weight rapidly in the first 46 days when on lupins only and, when given a hay supplement, made small body weight gains in the next 51 days.
Liver Symptoms.
Liver samples from every sheep slaughtered at Robb's Jetty were examined in the laboratory. All livers showed severe damage resulting from lupinosis. Those of Group 3 were the most affected, followed by Group 4. Group 1 and 2 were the least affected. The intensity of liver damage was correlated to weight loss and with the carcase gradings.

Cost of Hay Supplement.
It is important to note that the cost of the hay for the whole experimental period at 8s. 1d. per head, was obviously economically sound as the price difference between the supplemented and unsupplemented groups of the sheep was 18s. 8d. per head. The gross returns showed even greater differences at £62 5s. 5d. and £26 3s. 6d. respectively as this takes into account losses due to deaths. Labour costs of feeding are not taken into account.

The prices obtained at Robb's Jetty when the sheep were sold for slaughter, were equivalent to prices ruling at the metropolitan markets at the time.

Discussion.
The most important result of the experiment was the striking confirmation obtained for the hypothesis that the incidence of lupinosis could be reduced by means of supplementary feeding. All deaths in the experimental sheep occurred in groups receiving no supplementary feeding.

For the first 46 days of the experiment, before any of the sheep had been changed from one paddock to another, two of the sheep in Group 4 died of lupinosis. A third sheep died three days after moving and obviously was so badly affected with the disease that there was no chance of recovery.

At the change over period, when Groups 3 and 4 had fed solely on lupin roughage during the previous 46 days, the average live weight of these groups did not differ significantly, but both were significantly lower than Groups 1 and 2. However, at the end of the experimental period when Group 4 had received a supplementary ration of hay for 51 days, the average live weight of that group was significantly higher than Group 3 and similar to Groups

Carcase Weights.

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Carcase Weight</td>
<td>35.9</td>
<td>37.4</td>
<td>25.3</td>
<td>29.4</td>
</tr>
</tbody>
</table>

On examination after slaughter at Robb's Jetty, the sheep from the two supplementary fed Groups 1 and 2 had much higher carcase weights and carcase gradings than either the Group 3 (no supplementary feeding) or Group 4 (which received hay for only the second half of the experiment.)

Representative carcases from each of the groups in the experiment. The two on the left had hay supplements for the whole period, the third carcase did not have any hay and the fourth carcase had hay only for the second half of the experimental period.

Carcase Gradings.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of carcases in each grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
</tr>
<tr>
<td>White</td>
<td>10</td>
</tr>
<tr>
<td>Boner</td>
<td>10</td>
</tr>
<tr>
<td>Sausage</td>
<td>...</td>
</tr>
</tbody>
</table>

While the carcase weights of Group 4 were not much higher than Group 3 they received better carcase gradings.
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1 and 2 (see Table II). After the remaining sheep of Group 4 were shifted and fed a ration in the paddock where Group 2 had been grazing, deaths ceased and weight losses stopped.

The sheep Group 2 which had received a hay ration were moved into the paddock where lupinosis mortality had already occurred and the hay ration continued. None of these sheep died and the weight losses were not significantly different to Group 1 which also received hay throughout the experiment.

The purpose of interchanging Groups 2 and 4 after 46 days was to confirm that the absence of deaths from lupinosis in Group 2 was not specific to the paddock but was in fact due to the feeding of the hay supplement. As no deaths occurred in Group 2 before or after they were shifted and the hay supplement continued, it is reasonable to assume that the deaths in Group 4 were due to a lack of supplement and not to some differences between the two paddocks.

There are, however, two very obvious facts—firstly, the sheep receiving the oaten ration for the whole period did not gain in weight as would be expected and secondly, that all sheep suffered some liver damage and that the degree of this damage was correlated with loss of live weight.

These differences in weight losses and deaths between the various groups suggest that oaten hay has a protective action; that there is some dietetic factor involved; or, that the sheep did not eat enough of the lupin roughage to cause the rapid loss in condition and death.

The supplementary fed groups did not have as severe liver damage as either the unsupplemented group or the group receiving hay for the last 51 days of the trial only.

Mention should be made that the hay was fed twice weekly and the sheep were often without hay for 2 to 3 days as the whole ration was eaten by the second day.

It may be that sheep need a continuous diet of hay to eat with the lupins, or that the hay ration of 1 lb. per head per day may not have been enough to supply the protective action or dietetic factor involved to overcome the effect of the disease.

Experimental work is in progress at the Animal Health and Nutrition Laboratories under the direction of Dr. M. R. Gardiner, to determine the specific cause of the disease; also field trials will be continued on Messrs. K. and V. Williams property, over the 1960/61 summer, to study the effect of different grazing and sheep husbandry practices.

A lupinosis affected sheep from the non-supplemented group

**RECOMMENDATIONS**

The experiment has demonstrated the importance of a supplementary ration in controlling the more severe manifestations of lupinosis. It should be possible in practice to provide this supplement by alterations in grazing management thus avoiding the necessity for hand feeding. Deferred grazing in early winter will allow grasses to establish in a lupin stand, or, a high stocking rate early in the season will reduce the lupin density. The sowing of cereals in a lupin stand or in an adjacent area, allowing access, will provide a continuous ration of other roughage.

Recovery of slightly affected sheep can be brought about by moving them off lupins or chaining and burning the lupins to remove the parts of the plant causing the disease. (Neil et al (2).)

Affected sheep should not be moved onto green pastures as photosensitisation is likely to occur, delaying the recovery.
SUMMARY

(1) The feeding of a supplementary ration of oaten hay to sheep grazing in a lupin stand prevented any deaths in a 97 day experimental period.

(2) Feeding hay prevented any further losses in a group which had suffered three deaths in a 46 day period when it received no hay supplement.

(3) The control group receiving no hay suffered eight deaths (40 per cent.) in the 97 day period.

(4) Live weight losses were reduced by over 60 per cent. by feeding a hay supplement and in a group affected by lupinosis the feeding of hay prevented further weight losses.

(5) Carcase weights and carcase gradings of the supplemented groups were much superior to the non-supplemented groups.

(6) The non fed groups had the greatest liver damage from lupinosis.

(7) Some of the aspects of grazing management likely to control the disease have been discussed.

ACKNOWLEDGMENTS

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REFERENCES


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