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Nodulation of legumes on new light land. 2. Protection of rhizobia from the toxic action of superphosphate and trace elements

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VAST areas of new light land being developed in Western Australia are deficient in trace elements such as copper, zinc and molybdenum as well as in phosphorus. These fertilisers are known to be damaging to the rhizobial bacteria inoculated on the seed unless they are protected by lime pelleting.

This was demonstrated in a field experiment at Badgingarra Research Station in 1964. The experiment also showed that providing the inoculum was protected by a lime pellet, inoculated seed of subterranean clover could be safely mixed with the fertiliser before sowing if desired.

The Experiment

Soil type and land preparation in this experiment were as described in Part 1 of this series. Standard peat culture inoculum was again used, at recommended rates.

Fertilisers

A pre-plant dressing of superphosphate was given at the rate of 100 lb. per acre and at planting, zinc, copper and molybdenum superphosphate was applied at the rate of 180 lb. per acre.

Seed Treatments

Seed treatments were applied as follows:

(1) Seed inoculated and lime-pelleted by the method of Cass Smith and Goss (1964) using Methocel as the adhesive (internal inoculation).

(2) Seed lime-pelleted by the same method but the culture was dusted onto the outside of the dried lime pellet (external inoculation).

(3) Seed lime-pelleted but no inoculation used.

The seed treatments were carried out two or three days before planting.

Sowing

The seed was sown at a depth of 1 in. to 1½ in. through a combine drill at the rate of 10 lb. of actual seed per acre. The soil was dry at sowing and rain did not fall until three weeks later. Two sowing methods were used, namely:

(a) Seed sown through the grain box using reducing cogs to ensure the correct seeding rate, and the fertiliser through the fertiliser box. Thus there was minimum contact between seed and fertiliser as it entered the soil (designated separate).

(b) Seed and fertiliser thoroughly mixed and sown through the fertiliser box (designated mixed).

Experimental Design

The six treatments were randomised within each of two replications. Each plot measured 10.5 links wide x 300 links long, and there was a buffer of 2 links between plots.
Sampling

Nodulation assessments and yield cuts were made as described in Part 1 of this series. The maximum nodulation value was 200.

Results

The nodulation assessments and dry weight yields are shown in Table 1, which indicates the following points:

- When the peat inoculum was placed inside the lime pellet, plant nodulation and yields were not significantly different (0.01 probability level) irrespective of the method of sowing. (Fig. 1).

- Nodulation and yield of plants from externally-inoculated pellets sown with the fertilisers was reduced when compared with that of internally-inoculated seed. (Fig. 2).

- When the inoculum was placed on the outside of the pellet, plant
Table 1.—Nodulation and yield

The effect of the placement of rhizobia and of fertiliser in relation to the seed, on nodulation and dry weight yields of Geraldton subterranean clover.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>NOODULATION</th>
<th>MEAN YIELDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry wt/quadrat (gms.)</td>
<td>Transformed values (100 log10)</td>
</tr>
<tr>
<td>Placement of inoculum</td>
<td>Placement of fertilizer</td>
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<tr>
<td>Internal</td>
<td>Separate</td>
<td>155-0</td>
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<td>Internal</td>
<td>Mixed</td>
<td>145-5</td>
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<tr>
<td>External</td>
<td>Separate</td>
<td>116-5</td>
</tr>
<tr>
<td>External</td>
<td>Mixed</td>
<td>74-0</td>
</tr>
<tr>
<td>No inoc.</td>
<td>Separate</td>
<td>33-5</td>
</tr>
<tr>
<td>No inoc.</td>
<td>Mixed</td>
<td>29-5</td>
</tr>
</tbody>
</table>

Difference for Significance
- P < 0.05 40.73
- ≤ 0.01 63.88
- ≤ 0.001 108.67

Figures linked by unbroken lines are not significantly different from one another at the 0.01 probability level.

nodulation and yield was maintained, provided that the seed was sown through the grain box. (Fig. 3).

Nodulation and yield were very poor when the seed was not inoculated.

Similar general trends were obtained with Cyprus barrel medic, but nodulation and yields were poor due to the use of superphosphate instead of basic superphosphate, which is essential for Cyprus barrel medic on this soil type.

The results show that lime-pelleting of seed inoculated in the normal manner, adequately protects the rhizobia from the toxic effects of the fertiliser, even when the seed is mixed with the fertiliser.

Discussion

It is necessary to inoculate clover and medic seed shown in new country in Western Australia and it is even advantageous when regenerating old pastures. To obtain the best results, every care must be taken to ensure that the rhizobia placed on the seed remain viable. If the rhizobia are in contact with the fertiliser, that is, unprotected by a lime pellet, establishment may be little better than no inoculation if the seed is mixed with the fertiliser.

Many other research workers including Cass Smith and Pittman (1938), Jenkins et al. (1954), Reid (1930), Strang and Wilson (1956) and Vincent (1954) have demonstrated the toxic effect of superphosphate, copper, zinc and even very alkaline superphosphate, and it has been generally accepted that lime-pelleting protects inoculum on the seed from any of these toxic materials. To be effective, the pellet must be applied around the inoculated seed and a good quality lime used. Some lime has been found to be very alkaline and this leads to very poor nodulation (Goss and Shipton, unpublished data).

Recommendation

All inoculated pasture seeds should be lime-pelleted before planting, with a finely ground lime stone which has been registered as suitable by the Department of Agriculture. Lime pelleting is of even greater importance if inoculated seed is to be mixed with fertiliser before sowing, but care must be taken to ensure that the pelleting results in good seed cover.

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REFERENCES

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