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Inoculation and Lime-Pelleting of Leguminous Seeds

By W. P. CASS SMITH, B.Sc. (Agric.), Chief Biological Services Division, and OLGA M. GOSS, B.Sc. (Hons.), Plant Pathologist

IN Western Australia extensive areas of new land are brought under cultivation each year. Much of this virgin soil is only sparsely populated with the beneficial rhizobial bacteria which nodulate the roots of common pasture and forage legumes, such as subterranean clover, barrel medic, lucerne and field pea.

This deficiency can be corrected by inoculation of the seed, a practice which is now well known and widely applied by farmers in this State.

However, there are three essential requirements for effective inoculation:

• The inoculants (cultures) must be of high quality when manufactured, that is, they must contain effective rhizobial strains and adequate numbers of living bacteria to inoculate the recommended quantity of seed.
• The inoculants must be stored in a cool place until they are used, to prevent deterioration.
• Suitable sowing methods must be adopted to enable the bacteria inoculated on the seed to survive until germination.

Great care is now taken to ensure that the inoculants manufactured in Australia are of high quality. Standards have been set and accepted by the manufacturers, and each batch of culture produced is supervised and must be approved by UDALS* before it may be packaged for sale.

The proper storage of inoculants offered for sale in Western Australia has also been safeguarded as much as possible. As a result of representations made, it is understood that the inoculants after manufacture in the Eastern States are despatched here by air freight, or refrigerated surface transport, and, immediately on arrival, are cool stored by our leading distributors.

Farmers too have some responsibility in this matter. For example, inoculants should not be purchased several weeks before seeding if they are to be held in a hot shed. Rather they should be ordered early for later delivery unless they can be stored in the domestic refrigerator or a cool cellar.

Inoculants displayed in hot shop windows should be avoided.

*UDALS = (Sydney) University and (N.S.W.) Department of Agriculture Laboratory Service. Note that the choice of strains is not made by the manufacturer. They are selected as a result of co-operative tests in various States.
Fig. 2.—Serradella inoculation trial, Badgingarra Research Station, 1962 season

The plot on the right was established from inoculated lime pelleted seed, the centre plot from inoculated unpelleted seed and the plot on the left from uninoculated unpelleted seed.

Relative percentage yields were: inoculated lime pelleted, 100; inoculated unpelleted, 49; uninoculated unpelleted, 30.

Seeds for all plots were sown through the seed box of the combine drill and made only slight contact with superphosphate as they dropped into the soil.

In addition to the need for high quality inoculants which have been preserved by cool storage, the seeds must also be planted under conditions which favour the survival of the applied bacteria if the farmer is to obtain full value from inoculation.

Several practical problems have made this difficult. For instance dry-sowing is often unavoidable, due either to late opening rains, or to the large acreages being planted on some farms. This results in gradual desiccation and death of the bacteria. Sowing inoculated seed in contact with acid superphosphate fertiliser is also injurious to the bacteria.

In 1948 a method of lime-pelleting the inoculated seed was developed which overcame many of the problems and increased the chances of successful inoculation under these adverse conditions. (Cass Smith and Goss, 1958.)

However, it is only in recent years that it has been widely tested and adopted by farmers. It is estimated that some 500 tons of subterranean clover and other legume seeds were inoculated and lime-pelleted for sowing in 1963, and in 1964 a considerable increase is anticipated.

This method of seed inoculation and lime-pelleting can readily be carried out on the farm, and for various reasons, it is strongly recommended that farmers themselves process their requirements.

Details of Method

1. Prepare two pints of a five per cent. water solution of either
   Cellofas A† 2 oz. in 2 pints of hot water.
   Methocel†

   and leave to thicken by standing overnight in the refrigerator or a cool room.

2. Thoroughly mix and wet with half a pint of fresh or powdered skim milk the amount of inoculant recommended by the maker for treating—
   (a) 15 lb. of small seed (such as white or suckling clover),
   (b) 30 lb. of medium seed (such as subterranean clover, barrel medic or lucerne), or
   (c) 60 lb. of large seed (such as vetch, peas or lupins).

† Registered trade name.

Cellofas A is composed of methyl ethyl cellulose, 60 to 80 cps.
Methocel is composed of methyl cellulose, 400 cps.
Fig. 3.—Weiko yellow lupin inoculation trial, Badgingarra Research Station, 1962

Right, establishment from uninoculated unpelleted seed; centre, from inoculated lime pelleted seed; left, from inoculated unpelleted seed.

Relative percentage yields were: inoculated lime pelleted, 100; inoculated unpelleted, 44; uninoculated unpelleted, 13.

The method of sowing was the same as for the serradella trial illustrated in Fig. 2.

3. Thoroughly mix 1 and 2 and use to inoculate—
   (a) 15 lb. of small seed,
   (b) 30 lb. of medium seed,
   (c) 60 lb. of large seed,
stirring until all seeds are thoroughly wetted.

4. Add immediately, about 15 lb. of finely ground calcium carbonate (lime­stone) and stir rapidly until the pelleted seeds are evenly coated and well separated.

Scope
It is now recommended that this pelleting method should be applied as a standard practice whenever the seeds of pasture or forage legumes, such as clovers, barrel medic, lucerne, vetch or field pea are to be inoculated before planting. This recommendation is based on the results of trials both by the Department of Agriculture and some farmers.

Advantages
Seed inoculated and lime-pelleted by this technique may be sown in contact with toxic fertiliser such as superphosphate without injury to the bacteria, and unless the seed is sown in contact with the fertiliser the recommended depth of sowing cannot be obtained with any precision. (A sowing depth of 1 to 1½ inches is recommended for the sowing of clover and medic seeds in sandy surfaced soils.—Toms, 1958.)

The rhizobia on the inoculated pelleted seed survive for a longer period. Enough seed may be inoculated and pelleted at one time to last for several days’ seeding and also the bacteria are afforded some protection from desiccation when sowing in dry soil is unavoidable.

In soils where the acidity is marginal for nodulation, pelleting by this technique can make the difference between success and failure.

Materials
For satisfactory results it is necessary to use a fresh inoculant of the right strain of bacteria and suitable grades of ground calcium carbonate, and Cellofas A or Methocel.

When ordering commercial inoculants, specify the type and amount of seed to be inoculated. On receipt, check the label to ensure that the correct strain has been forwarded, and that the inoculant is still
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The establishment was a failure where the seed was only inoculated and sown through the fertiliser box of the drill, mixed with superphosphate.

Good establishment was obtained where the inoculated seed was also lime pelleted and sown through the fertiliser box.

Fresh as indicated by the expiry date. Do not call barrel medic barrel clover. Note that a "lucerne group" inoculant is required for Cyprus, "173" and commercial strains of barrel medic, as well as lucerne and harbinger medic. Commercial inoculants are available from leading stock firms and some seedsmen.

Finely ground limestone (calcium carbonate) is the only type of lime suitable for pelleting. Builders' lime, hydrated lime and air slacked lime are injurious. An excellent ground limestone for pelleting purposes is imported by Harrisons and Crosfield Ltd., 331 Murray Street, Perth, and is retailed through leading stock firms. It is understood that the price is about 4d. per pound. The recommended grade of this ground limestone is MAF and these letters should be branded on the bags. This grade contains 99 per cent. pure calcium carbonate and has a fineness of grinding of between 300 and 400 mesh.

The adhesive agents—Cellofas A and Methocel—are available respectively from Imperial Chemical Industries Ltd., 171 St. George's Terrace, and Swift & Co., 198 Wellington Street, or their retail agents. It is understood that in each case the price will vary from approximately 15s 6d. per lb. (1 to 4 lb. lots) to 13s. 7d. for 5 to 13 lb. lots.

Hints on Processing the Pellets

(1) Small amounts of seed can readily be pelleted by hand in ordinary kitchen utensils.

Large amounts can be pelleted very satisfactorily in a clean cement mixer. Note that the first batch which is pelleted may be somewhat inferior to the remainder as residues of the lime and Cellofas or Methocel adhere to the walls of the mixer. Other satisfactory methods reported by farmers include shovel mixing on a smooth, clean floor and tumbler mixing in a rotating 44 gallon drum.
(2) After inoculating the seed with the bacteria mixed with milk and Cellofas or Methocel, add immediately the total quantity of lime required to pellet that amount of seed. Inferior pellets result when lime is added bit by bit.

(3) After preparation allow the pellets to firm and set for about 24 hours before planting, by spreading out thinly on a clean floor or sheet in the shed.

Adjustment of Sowing Rate for Pelleted Seed

Note that:

FOR SMALL SEED—3 lb. of plain seed per acre is equivalent to about 6 lb. of pelleted seed.

FOR MEDIUM SEED—6 lb. of plain seed per acre is equivalent to about 9 lb. of pelleted seed.

FOR LARGE SEED—40 lb. of plain seed per acre is equivalent to about 50 lb. of pelleted seed.

Sowing Methods for Pelleted Seed

1. It is recommended that pelleted medium or large seed be sown through the ordinary seed box of the "combine" drill so that it drops into the soil with the fertiliser at a precise depth. Special reducing cogs may be obtained for most drills to reduce the sowing rate.

2. Pelleted seed may also be sown through the fertiliser box, but this method is only recommended for small areas. If this method is used, add the requisite amount of seed to the fertiliser in the box and mix thoroughly.

3. It is difficult to achieve a uniform rate of seeding when pelleted seed is sown through a small seeds box attachment, for as the box empties, the sowing rate is reduced. If this method is used, keep the small seeds box as full as possible.

Soil Moisture

For best results inoculated pelleted seed should be planted in moist soil where germination will soon occur. However, where dry-sowing is unavoidable, this pelleting method increases the chances of successful nodulation; in some cases it has promoted good stands even when the seed has been planted in dry soil for up to six weeks before subsequent rain.

Unfortunately dry-sowing is fraught with some risk for if the opening rain is light, the seed may germinate and die before emergence. If dry-sowing is intended the inoculated pelleted seed should be drilled into the soil rather than sown on the surface.

Seed Treatment with Insecticides

Tests carried out last season by Professor J. M. Vincent of Sydney University have shown that the systemic insecticide Rogor† is toxic to rhizobia inoculated on the seed. When clover and lucerne seeds are treated with Rogor either 24 hours before, or at the same time as, inoculation, the applied rhizobia are killed. (Private communication.)

At present therefore, it is recommended that systemic insecticides should not be applied to seed which is also to be inoculated. However, further work is planned to study the persistence of Rogor toxicity on treated seeds.

REFERENCES


†Registered trade name. Rogor is composed of dimethyl phosphorothiolothionate.
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