# PELLETING OF SEED

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## INTRODUCTION

The need for clover in pastures is becoming increasingly well recognised and has been adequately dealt with, particularly regarding hill country pastures in the two papers already presented this morning.

Two aspects are of great practical importance. First it is necessary to recognise that on much of the hill country the sowing of clover without phosphate it liable to result in a waste of time, money, and effort. Exactly the same applies to the application of phosplate to clover-deficient pastures.

Second, it is necessary to appreciate that the mere broadcasting of seed and phosphate will not invariably result in improved pastures. There are many factors operating between the time of sowing and permanent establishment that may result in either success or failure. Such factors are height of herbage, incidence of pests. weather conditions, soil condition, and the composition of the sward itself.

It has been thought that some of the factors limiting successful establishment may be eliminated by surrounding, or pelleting, the seed with either inert or fertilising materials. In the United States of America this process has been praetised in connection with vegetable seeds around which have been placed materials such as insecticides and fungicides.* Work with fertilisers has not been encouraging as the "quantity that can be incorporated in the coating and not be toxic to the seed is very small."

A further objective has been to make coated seeds of a uniform size and shape in order to facilitate precise planting.

The problem of clover establishment on hill country requires a different approach. Two aspects have been considered :

1. The surrounding of the seed with an 'inert material which may possibly act as a "seed-bed" when sown on hill-country swards. Incidental to this is the possible reduction in loss from depredation by birds.

* "Southern Seedsman," February, 1949, p. 13.

2. The surrounding of the seed with a fertiliser in order that these may be close enough to each other to' give the maximum utilisation of the fertiliser. In broadcasting mixed seed and fertiliser there is a considerable chance of these landing on the ground too far apart. If pelleting is successful, it may be possible to reduce the 'normal rate of seeding of clover and application of fertiliser because of the more efficient use that can be made of both. Pelleting may therefore assist considerably in the establishment of clovers. It will not, however, eliminate the broadcast distribution of fertilisers that will be subsequently reauired, although it may reduce the amount reauired in the first place.

The foregoing describes the objectives that have been -behind the work that has been carried out.

## METHODS OF PELLETING

Various methods of pelleting seed were considered before work was started.

1. **Tumbler Method:** In this method a rotating bowl is used. The seed is placed in the bowl, moistened,. 'and the powdered material added. As the seed tumbles round the bowl it picks up the powder and with alternate spraying with moisture and addition of powder a pellet builds up around the seed which acts as a nucleus.

2. **Extrusion Method:** A pug consisting of seed and moistened powder is forced through a relatively small jet in a manner similar to that used in tooth paste tubes, etc. Variations in coatings can be provided by arranging a series of concentric extrusion jets. The pelleted seed is cut off automatically at the face of the jet.

3. **Compression Method:** A method in use in the U.S.A. is the mixing of the seed and pelleting material into a paste and passing the whole through a series of cogs which compress the mixture, forming it into a series of pellets.

4. **Contiriuous Belt Method:** This is an elaboration 'of the extrusion method. The extruded material is. dropped between moving belts which in oscillating and moving at different speeds in opposite directions cause the pellet to be rounded.

5. **Sun-dried' Mud Brick Method:** In South Africa

some work has been carried out on the mixing of seed, soil, adhesives,- etc., into a paste, spreading the paste out on a flat surface to dry, and then breaking it up roughly with an implement.

Of the various ones considered it was decided to use the tumbler method, as it has been in use in New Zealand for many years by confectioners and chemists. Suitable equipment was readily available. It was also considered to be the most suitable, particularly for experimental purposes, as the process- was the most likely to produce single-seeded pellets. -Other methods produce pellets containing a varying number of seeds. Such would be a disadvantage;. particularly for experimental work. While the tumbler, method is relatively slow. and is not a continuous process, it allows successive coatings of different materials to be applied with ease.

## REQUIREMENTS FOR PELLETS

In the making of pellets two features have to be sought. First the pelleting material must be. of assistance in the establishment of the seedling clover. This assistance may be in the nature of a protective coating only or it may include fertilisers, insecticides, fungicides, nodule-forming bacteria, growth-regulating substances, or pest deterrents. Second, the pelleting material must be able to stand up to handling and transport. Soft or brittle pellets, while satisfactory in other respects, are of no value if they break on handling.

## EXPERIMENTS IN PELLETING

The first experimental pelleting of seed by the Department of Agriculture was carried out in December, 1947, when a quantity of subterranean clover seed was pelleted with an inert clay-Kaolin. This was carried out by a firm of manufacturing chemists in Wellington. The object of this experiment was to ascertain if the pelleting of seed was practicable and if so whether it had any effect on the seed.

The pelleting was found to be quite practicable and to have no appreciable effect on germination. The germination test was as follows:

| | Germination (12 days) | Hard Seeds | Abnormal Growths |
|---|---|---|---|
| Untreated . | 88% | 9% | 3% |
| Pelleted . | 84% | 7% | 3% |

During 'Easter., 1948, further trials were carried out on a home-made tumbler attached to a lathe. A nuniber of pellets of various composition were made. Sizes varied from a diameter of 3.4 mm. to 10.4 mm. The pellets were examined and then reactions to handling and added moisture were noted. A small-scale trial was sown out with- these pellets on a closely grazed hill pasture on March 30, 1948.

The overall conclusions from this preliminary trial were as follows:—

1. Plaster of paris made a hard pellet which split in two when the seed swelled after sufficient moisture had been added.
2. Kaolin made a soft pellet which disintegrated more and more rapidly as the amount of moisture was increased. When dropped into water the pellet disintegrated within 1 minute. When placed on a wet flannel there was slumping but no disintegration at the end of 12 hours.
3. Basic slag made an extremely brittle pellet which could be strengthened somewhat by the addition of plaster, of paris.
4. Nitrogen in the. form of nitrate of soda assisted in making a satisfactory pellet, but adversely affected germination.
5. Very small amounts of added phosphate had no marked beneficial effects on the strike or vigour of the seedlings, although the soil was low in phosphate.
6. Seeds pelleted up t.o a diameter of 7.4 mm. with plaster of paris were not markedly inferior to untreated seed with regard to. strike in the field (control 38 per cent. strike, pelleted 32 per cent. strike).

Early in January, 1949, when work was transferred 'to the Soil Fertility Research Station at Hamilton; a tumbler type of pelleting machine was secured and a wide range of solid materials were tried. A number of solutions were also tried in an endeavour to. locate a suitable adhesive material. The chief materials used were :-

1. Solids: Bentopite, reverted superphosphate, serpentine superphosphate, North African phosphate, basic slag, cement, and various clays.
2. Solutions: Methyl cellulose, sulphate of ammonia, casein glue; milk, water, urea,' and nitrate of soda.

The general experience with the combinations showed that while certain fertilisers such as serpentine superphosphate and basic slag produced pellets that did not reduce germination, they were not hard enough to stand handling. On the other hand pellets made with sulphate of ammonia, nitrate of soda, and superphosphate; while being satisfactorily hard, had a harmful effect on germination. The following table shows some of the results:—

| No. | Pelleting Material | Quality of Pellet | Germ- ination % | Abnormal Growths % |
|---|---|---|---|---|
| 1 | Control not pelleted . | — | 86 | 2 |
| 44 | Bentonite, serp. super. plus sulphate of ammonia . | Hard | 33 | 19 |
| 19 | Superphosphate . . | Hard | 8 | ? |
| 47 | Bentonite . . . | Soft | 82 | 1 |

The foregoing shows the variation that was secured in the nature of pellets and in the germination.

In the autumn of 1949 some 20 trials- were laid down in clover-deficient hill pastures in various parts of New Zealand. Details of the materials used were as follows:-

| Plot | Pelleted with | Germn. | lb of serpent. Superphosphate per 1 lb Seed | Approx. Number Pellets per lb |
|---|---|---|---|---|
| | **White Clover** | | | |
| 1 | Bentonite . . . | 82 | — | — |
| 2 | Bentonite and serp. super. | 97 | 3.35 | 18.700 |
| 3 | Control (seed only) | 82 | — | 708,750 (seeds) |
| 4 | Bentonite and serp. super. (extra quantity) | 76 | 20.3 | 13,580 |
| 5 | Bentonite, serp. super and S/A . , . | 61 | 6.6 (0.9S/A) | -30,100 |
| 6 | Bentonite and basic slag | 86 | 6.0 | 43,700 |
| | **Subterranean Clover** | | | |
| 7 | Bentonite and serp. super. | 85 | 2.67 | 9,030 |
| 8 | Bentanita and basic slag | 79 | 3.9 | 6,970 |
| 9 | Control (seed only) | 86 | — | 74,480 (seeds) |
| 10 | Rentonite . . . | 87 | — | |
| 11 | Bentonite and serp. super. (extra quantity) . | 85 | 12.9 | 2,330 |
| 12 | Bentonite and serp. super. S/A . . . . | 79 | 2.2 (0.3S/A) | 5,610 |

To date these trials have produced no clear-cut evidence to show that pelleting is any better or worse than no pelleting. Some trials failed completely or nearly completely. The section in which white clover was pelleted with various materials has been a great deal poorer than the subterranean clover pelleted with similar materials

The presence of volunteer white clover has in several trials made impossible the recognition of the seedlings that have developed from the pellets.

**White Clover Section:** In eleven trials where it was possible to make counts, the average strike was 3.0 per cent., ranging from 0 per cent. to 49.29 per cent. No treatments were outstandingly superior overall, but in five out of eight trials, pellet No. 5, which contained bentonite, serpentine superphosphate, and sulphate of ammonia, was the best. In one trial where the strike of white clover was particularly good this plot had a strike. of 49.29 per cent.. with the untreated seed at 28 per cent!

**Subterranean Clover Section:** In- fifteen trials the average strike was 22.1 per cent. with a range from 1.3 per cent. to 59.3 per cent. Owing to the very variable results it has not been possible to isolate any treatment as being outstanding. Eoth serpentine superphosphate and basic slag are apparently not harmful and in several instances appear to be better than controls.

**Comments:**

1. The pellets used in these trials do not indicate that pelleting is advantageous. This does not, however, mean that pelleting as a whole is unsatisfactory, as it is quite possible that more useful pellets can be made.

2. It has been noticed that in the larger pellets particularly, the radicle frequently fails to reach the ground before being dried up by the wind. It should be pointed out that the radicle does not necessarily go straight down to the soil. It frequently goes up and over the side of the pellet.

3. Pelleting may have an advantage in protecting-seeds from birds. 'It has been noticed that birds (pigeons) will take seeds but will not disturb pellets.

4. It has been noticed that in broadcast plots where some pellets have been sown on their own and others have been topdressed with superphosphate at 2 cwt. per acre the latter are considerably better.

Subsequent to the preparation of the pellets for the foregoing trials an investigation- into the chemical aspects of pelleting was commenced.

The factors to be considered required:'

1. Resistance to breakage from shock and abrasion during handling -and 'aggregation. on storage.
2. The dimensions to be such that adequate fertiliser would be supplied to maintain herbage demands.
3. Ability to disintegrate. under. weathering for germination to be effective.

4. Local concentration of soluble fertilises salts -around the seed to be low enough to avoid germination injury and pH suitable.
5. The materials required to be commercially available.
6. The pellet produced to be mainly phosphatic with a minimum of inert material.

A consideration of these factors led to the conclusions that to prevent breakage the pellets would have to be firm but not brittle ; aggregation could be prevented by avoiding the use of materials which would result in products having hygroscopic or deliquiscent properties.

The size of the pellet would be dependent on the size of the seed and the rate of topdressing required; Subterranean clover seed, for example, needs to be coated until the pellet is about the same size as a sweet pea seed.

An impervious coating around the seed would prevent germination unless subject to disintegration under the influence of weathering or interaction with the enveloping fertiliser when wetted.

The combination of fertilisers used would have to result in a product of relatively low water solubility, and the predominate material would be superphosphate, basic slag, lime, serpentine, etc.

A summary of the foregoing considerations shows that the essential feature of the problem is to combine seed and commercially available fertiliser into abrasion- and shock-resistant pellets which will allow germination without injury in contact with the fertiliser.

The problem has been attacked by considering the likely products of interaction between superphosphate and various fertiliser salts in conjunction with neutralising agents such as serpentine and lime.

It was anticipated that the instantaneous reaction between a solution of di-ammonium and di-potassium with superphosphate would produce' dicalcium phosphate or a double salt with a similar low solubility. This worked very well, but it was not found possible to raise the pH of the-resultant product high enough to avoid injury to the seed. A solution of ammonia tried similarly was again successful from the point of view of a pellet, but germination was impaired. Sulphate of potassium and ammonium have been used also, but the limitation is again germination injury, probably due to a low pH in the final product. Various combinations of these fertilisers have been tried in conjunction. . with finely ground serpentine and hydrated lime in accordance with reactions expected to take place. Satisfactory pelleting was successful with many of these, but seed damage again was a persistent factor suggesting that more fundamental knowledge on the causes of seed damage is worth while. The successful pelleting of clover with hydrated lime, basic slag, and superphosphate points to the probability that alkaline conditions around the seed. itself may solve the problem. and enable greater flexibility in the outer shell.

It must be emphasised at this stage, however, that the method used for producing a pellet dictates the possible combination of fertilisers which may be used.

In most of the experimental work so far the tumbler system, where each seed is coated with fertiliser, has been employed. This system requires instantaneous reaction between the spray and fertiliser powder and quick setting. Moreover, the dry materials used must be finely ground, and with superphosphate as the main ingredient this requires pre-drying to enable satisfactory grinding to be effected.

If, on the other hand, suitable pellets and granules are produced from a mixture of fertiliser pug and seed, the choice of selection of raw materials is more flexible and outweighs the disadvantages of a random distribution of seed. For example, superphosphate dried at 150 degrees C. and ground to a powder will not pellet very satisfactorily with the tumbler system, but sets well if moulded from a pug, and in a laboratory experiment subterranean clover seed germination, contrary to expectations, was not impaired on moist quartz sand. Superphosphate, serpentine, and sulphate of potash can be used successfully from a pug, but have not been thoroughly tested by the tumbling method.

Arising out of the research, a mixture with possibilities for fertilising grain, particularly winter-sown wheat, is the combination of superphosphate with urea followed by a solution of formaldehyde. The pH of the urea-superphosphate mix favours the formation of urea-formaldehyde within about two minutes, but the proportion of urea to formaldehyde must be closely controlled to give a product which favours slow decomposition of the complex to yield a supply of nitrogen as the season becomes warmer. This mix has not been found practicable with the tumbler system and the effect on seed germination is not known.

It must be re-emphasised that the ultimate mixtures adopted must depend upon the method used in pelleting.

**Conclusion:** Although; up to the present time, pelleting of clover seed has not given any spectacular or distinct leads as to its value, the work carried. out has served as a useful preliminary to detailed chemical studies of the problem. The chemical investigations, as outlined, have given a useful lead to the production of a pellet that appears satisfactory in the two essential respects, namely, lack of germination injury and hardness.

It is intended to sow down trials this autumn with similar pellets incorporating varying quantities of fertiliser.