EFFECT OF VARIOUS PELLETING MATERIALS ON ESTABLISHMENT AND GROWTH OF *LOTUS PEDUNCULATUS*

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Abstract

The effects of inoculation and pelleting, with two storage periods, were investigated on the establishment of 'Grasslands Maku' Lotus *pedunculatus* at three sites.

When seeds were sown one day after treatment, none of the treatments gave consistently better establishment than inoculation-only, although the addition of gum arabic adhesive alone significantly increased establishment on one site. However, after 15-day storage of the seed, establishment was higher from gum arabic adhesive alone than from inoculated-only seed although the effect attained significance on only two sites. In contrast, establishment of pelleted seed, apart from rock-phosphate/dolomite on one site, was similar to or less than that from inoculated-only seed. There was a consistent trend for all pelleting treatments to give a lower degree of establishment than did gum arabic adhesive alone.

Lotus dry matter production in the second growing season was measured on one site and the importance of maximizing establishment was demonstrated by the marked treatment effects on lotus yield.

INTRODUCTION

THE IMPORTANCE of seed pelleting for oversown clover in New Zealand is well recognized. Pelleting can increase establishment of oversown clover through improved survival of rhizobia on the seed after inoculation (Lowther, 1975a) and on acid soils can increase nodulation by raising the pH in the vicinity of the seedling root (Lowther, 1975b). However, little information is available on pelleting of Lotus *pedunculatus*. Rhizobia that form effective nodules on *L. pedunculatus* differ from clover rhizobia in that they are slow-growing alkali producers and are adapted to acid soils (Norris, 1965).

In New Zealand, the addition of lime to the soil has been shown to increase nodulation of *L. pedunculatus* on acid soils (Greenwood, 1961; Lowther, unpub. results). However, in contrast to white clover (Lowther, 1975b), lime pelleting had no apparent effect on the nodulation of lotus in the absence of broadcast lime (Lowther, unpub. results). It is possible that the lack

of effect of lime pelleting on nodulation was due to a detrimental effect of lime pelleting on the survival of rhizobia on the lotus seed, as suggested by Norris (1971). It therefore appeared important to investigate a range of pelleting materials on the establishment of oversown lotus, especially in acid soils.

EXPERIMENTAL

The experiment consisted of the following treatments applied to the seed of 'Grasslands Maku' *L. pedunculatus:*

SEED TREATMENTS

(1) Not inoculated.
(2) Inoculated.
(3) Inoculated + gum arabic adhesive.
(4) (3) + lime coat.
(5) (3) + dolomite coat.
(6) (3) + rock-phosphate coat.
(7) (3) + rock-phosphate/dolomite (50/50) coat.

Seed was inoculated with commercial peat inoculant (Rhizocote; Fruitgrowers Chemical Co., Nelson) which supplied in excess of 2.3 X 10" rhizobia (strain CC814S) per seed. The inoculant was mixed with 45% (w/v) gum arabic (May and Baker) and applied to the seed in treatments 3 to 7 at the rate of 4 ml of gum arabic solution per 100 g of seed. Treatments 4 to 7 were then coated with the respective materials (supplied by Lime and Marble Ltd, Christchurch) at the rate of 70 g of coating per 100 g of seed.

STORAGE TREATMENTS

Seed treatments 2 to 7 were prepared 16 days and 1 day before sowing and stored in an unheated room at 5 to 10°C.

SITES

The treatments, arranged in four randomized blocks, were oversown at three sites in the Otago tussock grasslands (see Table 1). Plot size was 3 X 2 m.

A basal dressing of molybdic superphosphate at 300 kg/ha was applied 2 to 3 weeks before sowing. Seed was broadcast at the rate of 5 kg/ha bare seed on September 5, 1973.

TABLE 1: DESCRIPTION OF SITES

Site	*Soil*	*pH* (0-3 cm)*	*Altitude (m)*	*Vegetation*
Berwick	Waipori	4.6	420	Snow tussock (*Chionochloa* sp.), sweet vernal *(Anthoxanthum odoratum)*, browntop *(Agrostis tenuis)* and native herbs; dense cover.
Lammermoors	Tcviot	4.9	880	Snow tussock, browntop, sweet vernal, native herbs; bare ground.
Tara Hills	Kaikoura	5.5	1070	Snow tussock, fescue tussock *(Festuca novae-zelandiae)*, and bare ground.

*pH determined on a 1: 2.5 soil: water suspension.

Three months after sowing, 20 (Berwick) or 40 (Lammermoors, Tara Hills) seedlings in each plot were pegged with wire markers. At this stage there were no treatment effects apparent on the seedlings which were usually less than 2 cm high. The number of these seedlings that were healthy (= nodulated) was recorded, and expressed as a percentage of pegged seedlings, on the following dates: Berwick, January 25; Lammermoors, February 14; Tara Hills, April 18, 1974. On April 9, 1975, dry matter production was determined on the Berwick site by cutting the plots with a sickle bar mower.

RESULTS

PERCENTAGE OF SEEDLINGS ESTABLISHED (Table 2)

In the absence of inoculation, lotus almost completely failed to establish on all sites.

With seed stored for 1 day, establishment from gum arabic adhesive alone was higher than From inoculation-only on the Lammermoors site, but was not significantly different on the other two sites. Results from lime, dolomite, and rock-phosphate/dolomite coatings were not significantly different from inoculation-only. In contrast, rock-phosphate coating markedly reduced establishment on the Berwick and Lammermoors sites.

TABLE 2: TREATMENT EFFECTS ON THE PERCENTAGE OF LOTUS SEEDLINGS ESTABLISHING

Treatment	Site			Mean
	Berwick	Lammermoors	Tarn Hills	
Not inoculated*	1	0	1	1
1-day storage:				
Inoculated	28 a†	28 bc	14 ab	23 ab
Gum arabic adhesive	33 a	41 a	15 ab	30 a
Lime coat	34 a	38 ab	14 ab	29 a
Dolomite coat	26 a	23 cd	10 b	20 bc
Rock-phosphate coat	14 bc	14 de	8 b	12 de
Rock-phosphate/dolomite coat	30 a	36 ab	13 ab	26 a
15-day storage:				
Inoculated	11 c	17 d	16 ab	14 cd
Gum arabic adhesive	34 a	28 bc	22 a	28 a
Lime coat	13 c	19 cd	6 b	13 de
Dolomite coat	8 c	5 e	8 b	7 ef
Rock-phosphate coat	5 c	5 e	6 b	5 f
Rock-phosphate/dolomite coat	24 ab	19 cd	6 b	16 cd
L.S.D. $P<0.05$ =		11		6
$P<0.01$ =		14		8

Site X treatment interaction significant ($P<0.05$). CV = 41%.
Days X treatment interaction significant ($P<0.05$).

*Data from not inoculated treatments not included in analysis.
†Within each site, values without common fetter arc significantly different ($P<0.05$) by Duncan's Range Test.

With seed stored for 15 days, establishment from gum arabic adhesive was higher than that from inoculation-only on the Berwick and Lammermoors sites, while the apparent increase at Tara Hills failed to reach significance. Apart from rock-phosphate/dolomite at Berwick, none of the coating materials increased establishment compared with inoculated-only seed. Except in a few cases on individual sites, pelleting the seed gave significantly lower establishment than treatment with gum arabic adhesive alone.

LOTUS DRY MATTER PRODUCTION AT BERWICK (Table 3)

Little lotus grew in the absence of inoculation and these plots were not cut.

TABLE 3: EFFECTS ON LOTUS DRY MATTER PRODUCTION (kg/ha) AND NITROGEN CONTENT (%) AT BERWICK AFTER 19 MONTHS

Treatment	*Dry Matter (kg/ha)*	*Nitrogen (%)*
1-day storage:		
Inoculated	2730 abc	2.44 a
Gum arabic adhesive	3130 a	2.71 a
Lime coat	3110 ab	2.27 a
Dolomite coat	2830 ab	2.18 a
Rock-phosphate coat	2670 abc	2.26 a
Rock-phosphate/dolomite coat	3030 ab	2.31 a
15-day storage:		
Inoculated	2290 bcd	2.06 a
Gum arabic adhesive	3350 a	2.41 a
Lime coat	1910 cde	2.16 a
Dolomite coat	1250 ef	2.42 a
Rock-phosphate coat	830 f	2.70 a
Rock-phosphate/dolomite coat	1660 def	2.41 a
L.S.D. $P<0.05$ =	840	
$P<0.01$ =	1129	
CV	24%	13%

Days X treatment interaction significant ($P<0.05$) on dry matter.

When treated seed was stored for 1 day, there were no significant treatment effects on lotus dry matter production, which ranged from 2670 to 3130 kg/ha.

With seed stored for 15 days, there were marked treatment effects on lotus dry matter. The highest yield of lotus (3350 kg/ha) was obtained from the gum arabic adhesive treatment. There were no significant differences among inoculation-only, lime, or rock-phosphate/dolomite coating. However, dolomite and rock-phosphate coating reduced lotus dry matter production (1250 and 830 kg/ha, respectively) compared with inoculation-only (2290 kg/ha).

NITROGEN CONTENT OF FOLIAGE AT BERWICK (Table 3)

There were no significant treatment effects on percentage nitrogen in the lotus foliage.

DISCUSSION

The present results indicate the need for caution in recommending the use of pelleting on *L. pedunculatus*. Overall, gum arabic adhesive alone appeared to be the most consistently effec-

tive treatment for increasing the establishment of lotus, although its effect was more marked after 15 days' storage. Adhesive alone has also been shown to be effective in increasing the establishment of *Desmodium intortum* (Norris, 1967). In a similar experiment with white clover inoculated with *R. trifolii,* Lowther (1975a) found that, although the adhesive-alone treatment increased the survival of rhizobia on the seed, it did not increase the establishment of oversown clover. The use of 45% (w/v) gum arabic solution, as used in the present experiment, poses problems with the seed cementing together and cannot be recommended on a large scale. However, the use of lower strengths of gum arabic (e.g., 10%) have not proved as effective when tested with coating (Date et *al.,* 1965).

As a general rule, Norris (1967) recommended the use of reek-phosphate as a suitable pelleting material for alkali-producing rhizobia. However, in the present experiment, rock-phosphate coating reduced lotus establishment even with 1 day's storage and it was only when mixed with dolomite (50:50) that it appeared as a more suitable coating material. But, even after 15 days' storage, rock-phosphate/dolomite coating increased establishment over inoculated seed in only one case and there was a consistent trend for establishment from rock-phosphate/dolomite coated seed to be lower than that from gum arabic adhesive alone.

It is of interest that even on the acid, Berwick site where establishment of lotus has been increased by broadcast lime (Lowther, 1976) coating the seed with lime or Gafsa-phosphate/dolomite had no effect on the establishment of lotus sown 1 day after inoculation. It therefore appears that further work is required into inoculation and pelleting of lotus on acid soils as, apart from an effect on establishment, broadcast lime does not increase lotus growth on this soil (Lowther, 1976).

Lotus dry matter production was measured on only one site as it was assumed that the relationship between treatment effects on establishment and dry matter production would be similar on all sites. The marked effects of establishment on the lotus dry matter production in the second growing season confirm the importance of obtaining the best possible establishment of lotus (Lowther, 1976). Once established, lotus plants appeared to fix nitrogen satisfactorily in all treatments, as there were no treatment effects on the percentage nitrogen in the foliage.

A feature of the results was the relatively low establishment of lotus seedlings at Tara Hills. During the experiment it was

noticeable that lotus seed was slow to germinate and at Tara Hills, lotus seedlings were not ready to mark until four weeks after white clover sown at the same time in an adjacent experiment. Lotus seedlings were much smaller than white clover during the summer and it is possible that the low establishment (recorded in autumn) was a result of death of seedlings during the summer moisture stress. A visual observation of the trial in the following spring indicated that the majority of the plants in the open areas between the vegetative cover had been killed by frost,

The present results indicate that it is important to obtain a good establishment of oversown lotus to maximize potential lotus dry matter production. Inoculation of the seed just prior to sowing should be satisfactory but for experimental purposes the incorporation of a 45% gum arabic solution with the inoculant is recommended.

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