

DRYLAND LUCERNE ESTABLISHMENT BY OVERDRILLING IN CENTRAL OTAGO

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Abstract

Two field trials in semi-arid Central Otago compared lucerne establishment drilled in spring using five types of overdrilling equipment, with and without the use of glyphosate applied in early spring to control the resident vegetation. A cultivated treatment was included.

The first trial, on a deep soil, gave 45-61% of viable seed establishing from overdrilling after herbicide application, similar to the cultivation treatment. Without herbicide establishment was 10-24%. The second trial, on a shallow stony soil, gave very low (0-7%) establishment owing to inadequate control of sorrel by cultivation and herbicide and to the dry spring. Differences in drill performance were small.

Keywords: lucerne. *Medicago sativa* L., brown grey earth, pasture improvement, overdrilling, cultivation, soil moisture, herbicide dessication. drill coulter.

INTRODUCTION

Lucerne has long been recognised as the legume most suited to the drought-prone semi-arid and sub-humid zones of Central Otago (Ludecke, 1962) where white clover does not persist. In such environments lucerne-based pastures have a higher feed quality, are higher yielding and are less variable in production from year to year than pastures based on white clover (Janson, 1974).

There are still very few farms in Central Otago with a high proportion of land in lucerne for grazing (Talbot, 1982). Conventional lucerne introduction is costly and even undesirable on some soils. Erosion hazards limit cultivation on steep slopes while on shallow or stony soils wind erosion or the presence of large stones or rocks may limit the use of conventional cultivation. There is a need to develop reliable, alternative methods of lucerne introduction for the semi-arid and sub-humid zones of Central Otago (Musgrave et. al., 1975).

Ludecke (1962) obtained excellent establishment of lucerne by sod-seeding (overdrilling without herbicide) in Central Otago. However, variable results have been obtained in later trials in Canterbury and similarly in the North Island when using various overdrilling and minimum tillage approaches. Poor seedling vigour, competition from inadequately controlled existing vegetation, and improper seed placement have contributed to the problems (Janson and White, 1971; Atkinson, 1976). Some of these problems may have been overcome using recently developed drilling equipment, improved herbicides, seed coating and inoculation (Musgrave, 1982).

This paper reports two field trials which compared lucerne establishment from five types of overdrilling equipment with and without glyphosate herbicide to control the resident vegetation. A cultivated treatment was included for comparison. The trials were established at two sites, one moist (Ophir) and one dry (Alexandra), in the semi-arid Brown Grey Earth zone of Central Otago.

METHODS AND MATERIALS

Trial 1

The trial was conducted near Ophir (rainfall 420mm) on a Chapman sandy loam soil. These soils are deep with a pH of 6.0-6.2 throughout the profile. The dense, short vegetation was dominated by ryegrass (*Lolium perenne*) with *Poa pratensis*, hairgrass (*Vulpia megalura*) and haresfoot trefoil (*Trifolium arvense*) also contributing.

Six drilling treatments with and without compaction by a Cambridge roller were compared at two lucerne seeding rates. A fully randomised factorial design with two replicates was used. Plot size was 50 m x 3 m.

Details of the six drilling treatments are as follows:

1. Cultivation. Rotary hoe on 15/8/80 and spring-tyne cultivator just prior to drilling with Duncan Seedliner.
2. Slot cultivation. The N.Z.A.E.I. Rotodril is a modified rotary hoe which cultivates a 100 mm wide strip at 250 mm intervals to a depth of 75 mm into which seed and fertiliser are simultaneously introduced.
3. Triple disc coulters. Duncan 730 Multiseeder fitted with plain front disc.
4. Triple disc coulters and glyphosate. As in 3 with 2.2 kg/ha glyphosate applied on 27/8/80.
5. Hoe coulters. Duncan Seedliner fitted with narrow "lucerne" tips.
6. Hoe coulters and glyphosate. As in 5 with 2.2 kg/ha glyphosate applied on 27/8/80.

Owing to heavy rain on the planned sowing date of 4/9/80 and unavailability of machinery, sowing was delayed until 1/10/80. Drying winds and little rain were experienced in the three weeks prior to sowing, forming a rough seedbed in the cultivation treatment. The seeding rates were 3.4 and 9.1 kg/ha of bare seed equivalent using commercially coated and inoculated seed, cultivar 'WL 318'. Seed was drilled to a depth of 15-20mm with fertiliser 400 kg/ha of 1:1 mix of lime and molybdate superphosphate. All treatments except slot cultivation were chain harrowed and appropriate plots rolled. At sowing the --9 a.m. soil temperature at 10 cm depth was 9°C. Rhizobia counts indicated 680 per seed. Rainfall and soil moisture recordings were taken over the spring establishment period. Lucerne establishment was assessed in the autumn following sowing from plant counts made on 15 random samples of 0.3 m length taken down individual drill rows from each plot. A similar assessment was made for plant survival in the second autumn following sowing. Plants were dug from the sample area to allow more precise counts at high lucerne plant densities.

Trial II

The trial was conducted near Alexandra (rainfall 330 mm) on a Lowburn stony sand. These soils are shallow and stony with pH levels of 5.8-5.9 in the surface 0-7.5 cm and 5.6-5.7 at 7.5-30 cm depth. The sparse vegetative cover was dominated by sorrel (*Rumex acetosella*) and haresfoot trefoil.

The trial compared four overdrilling treatments, half of each plot given glyphosate herbicide and the other half without, with a cultivated no glyphosate treatment, in a randomized block design with three replications. Plot size was 50 m x 3 m. Details of the cultivated treatment and four overdrilling treatments are as follows:

Cultivation. Spring-tyne cultivator on 14/5/81 and again just prior to drilling

with Duncan Tillseeder.

Overdrilling Treatments:

1. Slot cultivation. N.Z.A.E.I. Rotodril
2. Triple disc couler. Duncan 730 Multiseeder fitted with fluted front disc
3. Hoe couler. Duncan Tillseeder
4. Chisel couler. Aitcheson 1000

As one drill, the Aitcheson 1000, could only apply low rates of fertiliser the 1: 1 lime and molybdate superphosphate mix was broadcast instead at 800 kg/ha two months prior to drilling. Glyphosate at 2.2 kg/ha was applied on 31/8/81 and the trial chain harrowed and the cultivated treatment only rolled on 2/9/81.

Dry soil conditions existed at sowing. The 9 a.m. soil temperature at 10 cm depth was 3°C. Rhizobia counts indicated 2200 per seed.

The seeding rate was 4.6 kg/ha of bare seed equivalent using commercially coated and inoculated seed, cultivar 'WL 318'.

Rainfall and soil moisture levels were taken over the spring establishment period. Lucerne establishment counts were made in the autumn following sowing using the same method as at Ophir with 25 samples per plot.

RESULTS

Soil Moisture

Less than 2.5 mm of rain fell in the two weeks prior to sowing at both sites. In the eight weeks after sowing 89 mm fell at Ophir (13% above average) and only 33 mm at Alexandra (31% below average). Two soil moisture samplings at Ophir and weekly samplings at Alexandra are reported in Table 1. Analysis of Alexandra data indicated a statistically significant effect of drilling treatment on soil moisture levels and that the herbicide treatment maintained higher soil moisture levels than the unsprayed uncultivated treatment.

Table 1: MEAN SOIL MOISTURE LEVELS (W/W%) FOLLOWING SOWING AT OPHIR AND ALEXANDRA

	Ophir (1980)*		Alexandra (1981)**	
Weeks after Sowing	1	3	1	2-10
No. of Samplings	1	1	2	9
Treatment				
1. Cultivated	14.4	17.1	10.1	5.8
2. Triple Disc	12.9	15.4	12.1	4.7
3. Triple Disc & Glyphosate	25.0	27.9	13.2	6.5

* O-50 mm depth using Troxler Nuclear Densometer; Wilting Point 9.8 (W/W% 15 bar)

** O-100 mm depth, gravimetric sampling; Wilting Point 4.0 (W/W% 15 bar from Rickard and Cossens (1973)).

Vegetation Control

At the Ophir site glyphosate gave complete control of the existing vegetation while at Alexandra control of the sorrel component was poor. Cultivation also failed to control sorrel at this site.

Establishment

Lucerne seedlings emerged earliest on the two herbicide treatments at Ophir.

Table 2: EFFECT OF SEED INTRODUCTION METHOD AND GLYPHOSATE HERBICIDE ON LUCERNE ESTABLISHMENT AT OPHIR (1980-82).

Treatment	% Establishment*	% Survival**
1. Cultivation	51 a	56 a
2. Slot cultivation	13 c	11 b
3. Triple disc coulter	24 b	18 b
4. Triple disc & glyphosate	61 a	56 a
5. Hoe coulter	10 c	12b
6. Hoe and glyphosate	45a	49 a

* Expressed as % plants established in autumn 1981 of viable seed sown in spring 1980.

** Expressed as % plants surviving in autumn 1982 of viable seed sown in spring 1980.

Within column values followed by different letters are significantly different at the 5% level, LSD test after log transformation of data.

Table 3: EFFECT OF SEED INTRODUCTION METHOD AND GLYPHOSATE HERBICIDE ON LUCERNE ESTABLISHMENT AT ALEXANDRA (1981-82).

Treatment	% Establishment *	
Overdrilled	No Glyphosate	Glyphosate
1. Slot cultivation	2.3	3.9
2. Triple disc coulter	0.5	5.1
3. Hoe coulter	0.2	6.4
4. Chisel coulter	0	7.1
-Cultivation	6.5	

SED = 1.1 for overdrilled treatments

SED = 1.9 for comparison of cultivation with overdrilled, glyphosate treatments

* Expressed as % plants established in autumn,, 1982 of viable seed sown in spring 1981.

Turf tended to fall back over the groove formed by the hoe coulter in some places preventing seedling emergence. After 10 weeks lucerne plants had reached 50-100 mm at Ophir on the cultivated and two sprayed treatments and 20-30 mm on the unsprayed slot cultivation, **triple disc** and hoe coulter treatments. Further growth occurred in summer and autumn.

In contrast, the lucerne seedlings grew very slowly at Alexandra. By April 1982 plants were still only 10-50 mm tall with no growth from October. Some insect (leaf roller caterpillar) and rabbit damage occurred.

The results of lucerne plant counts at Ophir are outlined in Table 2. Establishment densities of 54 to 76 plants/m² were achieved at 3.4 kg/ha seeding rate on the cultivated and two sprayed treatments. Lucerne establishment and survival were not significantly different at the two seeding rates used nor were they influenced by the compaction treatment. Establishment at the end of the first season's growth on the Alexandra trial is given in Table 3. Establishment rates were low.

DISCUSSION

The marked response to herbicide or cultivation at both sites (Tables 2 and 3) indicates the importance of controlling competition from the resident vegetation. The lucerne seedling is very vulnerable to competition in periods of drought stress if it has not had time for full tap root development (Musgrave, 1982). The levels of lucerne establishment at Ophir (Table 2) were similar to those reported for cultivated seedbeds in Canterbury by Wynn Williams (1982). The lower establishment on the drier shallower soil at Alexandra also indicates the importance of high soil moisture and possible soil fertility and pH.

An early spring herbicide application followed by drilling is the simplest overdrilling approach in this environment and is adaptable to a one-pass operation. While this timing is optimum for lucerne introduction (Musgrave, 1977) it is probably not optimum for herbicide application as was illustrated by poor sorrel control in the Alexandra trial. As no attempt was made to define the most appropriate herbicide material, rate, and timing for vegetation control in these trials, research is continuing, including the use of autumn applications and autumn and spring split applications.

Maintaining adequate soil moisture levels is critical for successful establishment. Musgrave (1977) showed that the optimum time for sowing coincided with 10 cm soil temperatures of **3-7°C** and records from these trials indicate early to mid-September would be the best time for sowing. He also suggested that lack of effective rainfall in areas receiving less than 500 mm may still limit establishment despite sowing at this optimum time. Local farmer practice is to sow when effective rainfall of over 25 mm falls in 2-3 days in the months of September and October or January to March. In these trials no such periods of effective rainfall were recorded at Alexandra in spring 1981. In addition the **Lowburn** soil at Alexandra has a low water holding ability, compared with the Chapman soil at Ophir.

Higher soil moisture levels were maintained below glyphosate-treated vegetation at Ophir and Alexandra (Table 1) similar to results reported by Brash et al (1982) in a trial at Omarama and by Smith and Stiefel (1978). However these higher soil moisture levels did not lead to higher plant survival on the triple disc coulter and glyphosate treatment compared to the cultivated treatment at either site. Control of the competition from the existing vegetation must

be more important than higher soil moisture levels although this moisture conserving effect cannot be overlooked in a semi-arid climate.

These results indicate the over-riding influence of soil, climatic and sward conditions and imply that given adequate control of the vegetation any of the drills tested would be suitable if they meter out seed uniformly to the correct depth and then cover it.

Establishment from slot cultivation shows that the additional use of herbicide to control the vegetation between the cultivated slots is necessary although Dunbar et al (1980) indicated 'satisfactory lucerne establishment was obtained from slot cultivation without herbicide in a very wet season in the MacKenzie Basin.

Wynn-Williams (1982) suggested a plant population of over 30/m² is desirable although Musgrave (1977) found 10-15/m² were sufficient to maximise yields in a semi-arid environment. The good plant establishment obtained at Ophir shows that conventional seeding rates of 10 kg/ha could be halved where adequate moisture and competition control are maintained over the establishment period.

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