STUDIES WITH PASTURE GRASSES ON THE BLACK CRACKING CLAYS OF THE CENTRAL HIGHLANDS OF QUEENSLAND 2. SOWING METHODS

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ABSTRACT

Three trials, with treatments designed to improve the establishment of grasses on the black self-mulching cracking clay soils of the Central Highlands, are discussed.

The treatments included pelleting with superphosphate, surface and depth sowings into wet and dry soil, mulching with wheat and barley straw at 3,000 *kg per hectare, applying pressure above the planted seed, cultivating after sowing and soaking seed before sowing.*

Sowing dry seed on the dry soil surface and mulching with wheat straw was the most successful treatment tested and Bothriochloa insculpta *cv. Hatch and* Cenchrus ciliaris *cv. Nunbank the best cultivars used.*

INTRODUCTION

The deleterious effect of a rapidly drying cultivated soil surface has been discussed by Leslie (1965). Watt (1972) states that the top 6 mm of a black soil can dry below wilting point within a day or so after rain. Since means of reducing the soil surface drying rate should improve grass establishment (Leslie 1966) it was believed that the value of an organic mulch should be tested. Seedling emergence can also be improved by the reduced surface sealing below a mulch (Rickert 1971, Army *et al.* 1961). The problem of establishing sown pastures on the black cracking clays of the Central Highlands is due to the rapid rate of drying of the surface soil under the hot dry weather which often follows rainfall (Younger and Gilmore 1978). Means of slowing down the drying rate of the surface soil and of increasing the rate of germination are investigated. Seed pelleting with superphosphate has been recommended as an aid to establishment. Scott (1975) found that physical rather than fertilizer properties of a seed coating could be an aid to establishment and survival. Scott establishment. On these often phosphorus deficient soils it was hoped that the fertilizer properties of a seed coating could be an aid to establishment and survival. Scott (1975) found reverted superphosphate to be among the best coating materials on fine textured soils but that incorporating fertilizers in the seed coat may de detrimental during germination, although advantageous at later stages. Another reason for coating the seed was to facilitate broadcasting in windy conditions and as a means of sowing seed with planters. It was also envisaged that a heavy pelleted seed would improve the efficiency and accuracy of aerial sowing and increase penetration through vegetation.

METHODS AND RESULTS

General

The three experiments were carried out during the period 1971–1974 on a portion of the site used for the experiments reported by Younger and Gilmore (1978). A description of the soils and climate of the region and the site has already been given (Younger and Gilmore 1978).

All seed was treated with thiram (fungicide) and benzene hexachloride (insecticide) before sowing.

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Experiment 1

On 22 December, 1971 an eight treatment by four replication split plot trial was planted in a well prepared seed-bed which contained stored moisture to 10 cm below the soil surface. Sub-plots were 1.9 × 7.4 m. The grass used was *Cenchrus ciliaris* cv. Nunbank.

Main plot sowing treatments were:

(a) on the surface and lightly covered,
(b) on the surface and mulched with 3,000 kg ha^{-1} wheat straw,
(c) on the surface and cultivated with a combine drill once,
(d) on the surface and cultivated with a combine drill three times.

Subplots were seed pelleting with superphosphate *vs.* unpelleted.

All treatments were sown at a seeding rate equivalent to 9 kg ha^{-1} of unpelleted seed (fascicles). The pelleting method used was to coat the fascicles with finely ground superphosphate using gum arabic as a sticker. The ratio of coating to fascicle was 11:1 by weight. Unpelleted fascicles were mixed with damp sawdust to facilitate hand broadcasting. Rain (42 mm) fell during the period 24 December to 31 December, 1971. Only the accumulated rainfall is available for this period, but some rain fell every day for the seven day period and the weather was cloudy for most of the time. Seedling populations were estimated 30 days after sowing by counting four 0.92 m × 0.92 m quadrats per sub plot. Dry matter yields were measured from quadrat samples (1.07 m × 7.35 m) cut on 2 March, 1972. A modified forage harvester (Younger, 1973) was used to cut, catch and weigh the green samples which were then subsampled for dry matter determination.

Results

Pelleting reduced ($P < 0.01$) emergence from 20.3 m^{-2} to 13.5 m^{-2} but increased yield ($P < 0.05$). Cultivating once after surface sowing was not superior to lightly covering with harrows; cultivating three times markedly reduced emergence when seed was pelleted. The mulch treatment increased both establishment ($P < 0.05$) and dry matter yield ($P < 0.05$).

Experiment 2

The aim of this experiment was to test various methods of improving establishment by increasing the contact time between seed and wet soil and by soaking the seed before sowing.

Six of the eight treatments (Table 2) consisted of dry or presoaked seed (12 hours in water at 21°C) of *C. ciliaris* cv. Nunbank (47% germination)

(a) Sown on the soil surface and harrowed,
(b) Sown to a depth of 5 cm into dry soil,
(c) Sown to a depth of 5 cm into wet soil.

A seventh treatment was pressure, estimated at around 6 k Pa, applied by means of running a wheelbarrow along the rows of sown seed and the eighth treatment was a mulch of 3,000 kg ha^{-1} wheat straw held in place with wire netting.

Dry fascicles were treated with a sticker (gum arabic) and pelleted with finely ground superphosphate. Presoaked fascicles were pelleted without a sticker which was satisfactory if the seed was sown before the pellet became too dry.

Plots were 6 m long and contained two rows 1 m apart. One hundred fascicles were sown in each row. The dry sowing was done on 12 December, 1972 and the wet on 3 January, 1973 after 60 mm rain on 30 and 31 December, 1972. A locally made 2-row planter was used for the depth plantings.

The design was a four replicate randomized block.

A second fall of rain (30 mm) on 8 and 9 January, 1973 ensured germination. Establishment counts were made 30 days later on 8 February. All plants were counted

TABLE 1

The effects of seed treatment, seed covering and cultivation on Cenchrus ciliaris *cv. Nunbank seedling population 30 days after sowing, and dry matter production (kg ha^{-1}) 2 months after sowing in Experiment* 1

	Population (m^{-2})			Dry matter yield (kg ha^{-1})		
	Not Pelleted	Pelleted	Mean	Not Pelleted	Pelleted	Mean
Seed sown on surface and lightly covered	17.6	12.6	15.1	4 240	4 990	4 620
Seed sown on surface and mulched with 3 000 kg ha^{-1} wheat straw	23.9	20.6	22.3	5 430	6 120	5 780
Seed sown on surface and cultivated once	19.1	12.3	15.7	4 260	4 940	4 600
Seed sown on surface and cultivated three times	20.6	8.7	14.7	3 540	4 390	3 970
MEAN	20.3	13.5		4 370	5 110	
L.S.D. (P=0.05) Seed covering and cultivation			6.1			1 030
L.S.D. (P=0.05) Seed pelleting (means)		5.9			730	
L.S.D. (P=0.05) Seed pelleting *vs.* treatments		8.6			1 460	

TABLE 2

Effect of sowing methods and seed treatments on seedling establishment and dry matter yield of Cenchrus ciliaris *cv. Nunbank* 30 *days after emergence in Experiment* 2

Treatment	Establishment (%)	Mean dry matter yield (g)	
		per plant	per plot
1. Dry seed sown on dry soil surface, harrowed and mulched	7.1 (0.269)*	35.4	498.4
2. Dry seed sown on dry soil surface and harrowed	2.1 (0.146)	2.7	11.5
3. Presoaked seed sown to 5 cm in wet soil, pressure applied and mulched	4.2 (0.207)	16.8	142.2
4. Presoaked seed sown to 5 cm in wet soil	1.8 (0.133)	6.5	22.9
5. Dry seed sown to 5 cm in wet soil	2.0 (0.143)	3.1	12.9
6. Presoaked seed sown to 5 cm in wet soil and pressure applied	1.8 (0.134)	7.4	26.7
7. Dry seed sown to 5 cm in wet soil and pressure applied	2.1 (0.146)	8.5	36.2
8. Dry seed sown to 5 cm in dry soil	0.6 .(0078)	10.8	16.0
L.S.D. (P=0.05)	(0.084)	11.0	

*Inverse sine $\sqrt{P}$ transformation applied

and removed to the laboratory where any roots were removed and tops were oven dried.

Results

As in Experiment 1, the best establishment was achieved by sowing on a dry seedbed and mulching with 3,000 kg ha^{-1} wheat straw (Table 2). Mulching also increased oven dry matter yield. The component effect for the eight treatments used can be compared for average plant weight and establishment (Table 3). Only one pairwise comparison is significant; when mulch is compared with no mulch (Treatment 1 *vs.* 2) the mulch is superior for both establishment and average plant weight. When the mulch was applied to presoaked seed planted 5 cm deep in wet soil and pressure applied (Treatment 3 *vs.* 6) there was a small non-significant increase in establishment and average plant weight.

TABLE 3

Component effects from eight treatments on dry matter yield and establishment in Experiment 2

Comparison	Treatment No. Pair	Difference between pairs of treatments	
		Establishment (%)	Mean Plant Wt.
Mulch *vs* no mulch	1 *vs* 2	4.92 (0.123)*	32.68
	3 *vs* 6	2.45 (0.073)	9.42
Presoak *vs* dry seed	4 *vs* 5	—0.29 (—0.010)	3.43
	6 *vs* 7	—0.32 (—0.012)	—1.11
Wet *vs* dry seed-bed	5 *vs* 8	1.43 (0.065)	—7.73
Pressure *vs* no pressure	7 *vs* 5	0.07 (0.003)	5.39
	6 *vs* 4	0.04 (0.001)	0.85
5 cm depth *vs* surface sown and harrowed	8 *vs* 2	—1.52 (—0.068)	8.11
L.S.D. (P=0.05)		(0.084)	11.0

*Transformed by inverse sine $\sqrt{P}$

Experiment 3

It was concluded, from experiments 1 and 2, that an organic surface mulch improved emergence of *C. ciliaris*, so it was decided to utilize a small area of barley stubble to test the practicability of this method for a range of grass species. Wheat or barley is harvested in the Central Highlands from September to November, and, provided the stubble is reasonably free from weeds, it can be held over to provide mulch material for grasses sown in December and January.

In this experiment it was necessary to use three equal area strips of (i) bare fallow which had been under cultivation for six months and (ii) and (iii) strips of barley stubble which remained from an October, 1973 harvest. The stubble area was halved and, following planting of the sub plots, one half was slashed and the other lightly cultivated with a Massey Ferguson tiller. The bare fallow area was spike-tooth harrowed.

Within each area of differing seedbed four replications, each of five grasses (Table 4), were planted in 5 m × 2 m subplots at 10 kg ha^{-1} of seed. Seed was mixed with damp sawdust for even hand broadcasting on 18 December, 1973.

The soil was dry and cracked on the stubble area but a fine tilth was obtained by harrowing the fallow area. The stubble was slashed or cultivated and the fallow area was harrowed immediately after sowing.

Twenty-two wet days in January, 1974 and a total of 420 mm rain ensured establishment. Establishment counts were made on 18 January by counting all the seedlings in the sub plots.

TABLE 4

Establishment (plants m^{-2}) of five grass cultivars under three sowing methods in Experiment 3

	Sown into barley stubble and cultivated	Sown into barley stubble and slashed	Sown on bare soil and harrowed	Mean
Panicum maximum Q14734	0.9 (1.18)*	0.8 (1.12)	0.2 (0.86)	0.6
Cenchrus ciliaris cv. Nunbank	13.1 (3.69)	30.6 (5.58)	10.9 (3.37)	18.2
Urochloa mosambicensis cv. Nixon	0.3 (0.88)	0.4 (0.93)	0.2 (0.83)	0.3
Bothriochloa insculpta cv. Hatch	17.1 (4.20)	41.6 (6.49)	10.6 (3.33)	23.1
Cenchrus ciliaris cv. Molopo	0.4 (0.95)	1.7 (1.48)	0.2 (0.84)	0.8
Mean	6.4	15.0	4.4	8.6
L.S.D. between cultivars (P=0.05)		(0.57)		
(P=0.01)		(0.77)		

*Figures in parentheses=$\sqrt{x + 0.5}$ transformation

Results

While the only possible arrangement of the seedbeds did not provide a valid estimate of error for testing the significance of differences obtained, it is clear that a better overall establishment was obtained when the stubble was slashed on top of the seed (Table 4). There is also a suggestion that lightly working the stubble gave a superior seedling establishment compared with the bare fallow treatment but the difference is small. Both *Cenchrus ciliaris* cv. Nunbank and *Bothriochloa insculpta* gave a high and effective seedling population in all treatments (Table 4) with *B. insculpta* significantly better in the two stubble treatments.

DISCUSSION

In all three experiments mulching was effective in improving establishment and increasing dry matter production. The increase in dry matter production in the mulched treatments is probably due to a combination of factors; better moisture conditions, better phosphorus utilization due to a greater concentration of roots near the soil surface (Othieno 1973), and better root development due to moisture and phosphorus.

In Experiment 2, the 5 cm planting depth was designed to provide better moisture conditions for the germinating seed. A small plot field trial (H. Bartels, personal communication) and our pot trials (unpublished data) showed that under intermittent rainfall with hot dry periods, buffel grass seed, planted at a depth of up to 7.6 cm emerged, whereas surface sown seed did not. It is now thought that under field conditions, when combined with a rolling treatment, 2.5 cm would have been a better depth.

The application of pressure above the seed, while effective in increasing the emergence of grain crops (Stickler and Fairbanks 1965, Doyle and Garland 1975) and pasture legumes (Tothill 1970), did not have a significant effect with pelleted buffel seed, either with dry or presoaked seed when planted at 5 cm depth. At that planting depth pressure was probably ineffective or the soil sufficiently wet to preclude a response.

Norman (1961) found that pelleting with superphosphate depressed emergence while Scott (1975) found that reverted superphosphate was one of the best coating materials on fine textured soils. With a protected seed like buffel, any adverse effects of the superphosphate coating would be lessened if the period between coating and germination is minimal. In an alkaline soil, phosphate should be readily available for promoting seedling vigour and the superphosphate treatment was therefore preferred to ground rock phosphate. It was very fortunate that a rain period, sufficient for germination, began two days after sowing and continued for eight days. Nonetheless emergence was reduced by pelleting, and this could have been due to several factors; the heavier coated fascicles falling down cracks or being worked down deeper by cultivation, the pH effect on germination (Scott 1975, Scott and Hay 1974) and osmotic effects. Any expected response to seed coating due to an improved moisture relationship (Scott 1975, Scott and Hay 1974) could have been reduced for any or all of these reasons. The weight-benefit expected from the pelleted seed would have been minimized by rain falling so soon after sowing, thus reducing wind loss of the unpelleted fascicles.

The increase in dry matter production from the pelleted seed is seen as a phosphate response, as about 8 kg P ha^{-1} were applied with the pelleted seed. Any moisture effect due to reduced population would have been small as the rainfall was adequate for the period of the trial.

The best treatment for establishment was sowing the seed on the dry soil surface under barley stubble and slashing. The amount of material was about 3,000 kg ha^{-1} which is what can be expected from a good average winter grain crop in this area.

Lesser amounts of mulch, it is believed, would still be effective, but to a lesser degree. Increasing the amount of mulch could be expected to further increase establishment (Greb 1966, Rickert 1973). In this harsh environment, for establishment of sown grasses, the ability of an organic mulch to reduce the rate of soil moisture loss should be exploited fully. Using whatever material is readily available and adjusting the seeding rate accordingly, would seem to be a reasonable practice. Planting winter grain crops to supply mulch material *in situ* is recommended whenever possible.

In the successful mulch treatments *Bothriochloa insculpta* cv. Hatch and *Cenchrus ciliaris* cv. Nunbank were the only grasses to give effective establishment. *C. ciliaris* cv. Molopo was given every chance but failed to prove itself on this type of soil in this area. *B. insculpta* cv. Hatch was also the most successful in the trials reported previously (Younger and Gilmore 1978).

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