THE EFFECT OF CULTURAL TREATMENTS ON ESTABLISHMENT OF *MACROPTILIUM ATROPURPUREUM* CV. SIRATRO OVERSOWN IN A *SETARIA ANCEPS* SWARD

SAYAN TUDSRI*† AND P. C. WHITEMAN*

ABSTRACT

Siratro established poorly and growth was severely restricted when oversown into setaria swards without cultivation. Establishment was satisfactory after two passes with a rotary hoe at 7.5 cm depth. Cutting at 5 cm, spraying with paraquat or burning did not allow successful establishment and growth in uncultivated plots. These treatments applied before cultivation did not reduce setaria tiller density after cultivation. Burning significantly increased setaria tiller density, while after cultivation setaria tiller density in burnt and paraquat sprayed plots was significantly higher than the control. It was concluded that treatments applied before cultivation and oversowing were disadvantageous.

INTRODUCTION

Re-establishment of legumes into depleted swards of introduced sown tropical grasses has generally been less successful than oversowing of legumes into natural grasslands. In the latter, particularly with *Stylosanthes humilis,* rainfall and soil moisture conditions appear to be more important than the pretreatment (Miller 1967). In some cases reduction of grass cover gave poorer establishment due to less favourable surface moisture conditions (Miller and Perry 1968).

In the case of sown pastures under more favourable conditions of soil moisture and fertility, competition from the already established grass is a major factor affecting successful establishment. In attempting to re-establish the legume component, farmers are seeking low cost methods which will reduce grass competition, without the necessity of full seedbed preparation and the added cost of resowing the grass. Some success has been achieved with minimal preparation techniques with some pasture combinations.

- — Chemical spraying. Murtagh (1963) obtained successful establishment of *Glycine wightii* when spraying of *Paspalum* dominant pasture with 2, 2-DPA (dalapon) was combined with sod-seeding. Better establishment of *Desmodium uncinatum* in *Hyparrhenia* pastures was obtained following herbicide spraying than by slashing or burning (Keya *et al* 1972).
- — Burning. Douglas (1965) established Siratro and *Stylosanthes guianensis* by oversowing after burning blady grass (*Imperata cylindrica*), but *Lotononis bainesii, D. uncinatum* and *G. wightii* established less well in these conditions. Both Smith (1963) in Rhodesia and Keya *et al.* (1972) in Kenya found that legume establishment was better with burning of *Hyparrhenia pastures* followed by light cultivation than with other pretreatments.
- — Heavy grazing. Norman (1961) reported that *S. humilis* establishment was higher in heavily grazed than in ungrazed pastures.

Although establishment of tropical legumes has been obtained without cultivation, in most cases establishment was improved where these techniques were combined. However with a vigorous densely tillering species such *S. anceps* cv. Kazungula (Hacker and Jones 1969), cultivation alone may not ensure successful establishment. Minimal cultivation methods by either tyne or disc renovation were insufficient to

* Department of Agriculture, University of Queensland, St. Lucia, Queensland 4067.
† Present address: Department of Agronomy, College of Agriculture, Kasetsart University, Bangkhen, Bangkok-9, Thailand.

allow Siratro or *D. intortum* to establish in Kazungula setaria swards (Middleton 1973).

This paper reports on the effects of paraquat spraying, burning and slashing pre-treatments alone, and in combination with cultivation, on the establishment of Siratro in a Kazungula setaria sward.

MATERIALS AND METHODS

Site

The experiment was conducted at the University of Queensland Mt. Cotton Research Station on a low fertility red-yellow podzolic soil (pH 5.3). The experimental area was established in 1969 as a Kazungula setaria, Siratro, Greenleaf desmodium pasture and had been intermittently grazed by sheep and cattle. The pasture had reverted to a grass dominant sward and nitrogen fertilizer had been applied, the last at 42 kg N ha^{-1} on 27th February, 1974.

Design and Treatments

The experiment was a randomized split plot with four replications. The main plots were: untreated sward (control); cut at 5 cm and removed; cut and burnt *in situ*; paraquat spraying. The split plot treatments were: cultivation and no cultivation. Sub-plot size was 3 m × 5 m.

In order to reduce the effect of the previous N application, the whole area was cut and removed on October 10, 1974. The sprayed plots were sprayed twice with "Grammoxone" (at 1.1 kg a.i. ha^{-1} each time) on the 5th and 8th December to ensure an effective kill. The cut plots were cut at 5 cm and removed with a forage harvester on December 5th, while the burnt plots were cut at 5 cm, the material left and burnt 4 days later on December 9. The sub-plot cultivation treatments were then imposed with a rotary hoe. Two passes at 7.5 cm depth were made in each cultivation sub-plot.

Basal fertilizer was applied on the same day (December 9) at 122 kg ha^{-1} potassium sulphate and 248 kg ha^{-1} single super. Siratro seed, treated with "aldrin" (Jones 1965) and inoculated with CB 756 was surface sown at 8 kg ha^{-1}.

Measurements

Before imposing the treatments setaria tiller density was determined by counting five 0.2 × 0.2 m quadrats in each sub-plot. Dry matter yield was also estimated using the electronic capacitance meter (Jones and Haydock 1970) after calibration in the adjacent setaria area.

After the treatments were imposed seedling counts were made on five occasions on December 16th and 23rd, 1974, January 6th, February 3rd, and March 3rd, 1975, approximately 1, 2, 4, 8 and 12 weeks after oversowing. Fifteen quadrats, 0.2 × 0.2 m were counted in each plot. Setaria tiller density was determined as previously described on March 4th, 1975. Dry matter yields and botanical composition were measured on March 10th, 1975, after cutting three quadrats 0.4 × 0.4 m at 5 cm in each plot.

RESULTS

Conditions were dry at sowing, with 0, 4, 8, 49 and 68 mm of rain recorded during weeks, 1, 2, 3, 4 and 5 after sowing. Irrigation was applied at 25 mm per application in weeks 1 and 2. Total rainfall over the 12 weeks was 280 mm.

Setaria Tiller Density

In the uncultivated treatments, tiller density was not significantly changed in the control or cutting treatment, but significantly reduced by spraying, and significantly increased by burning (Table 1). Cultivation reduced tiller density by 49% in the control and 42% in the cut treatments, but only by 30% in the sprayed and 24% in the burnt treatments.

TABLE 1

Effects of pretreatments and cultivation on Setaria tiller density before and after treatment.

(Tillers m^{-2})

Pretreatment	Before Treatment (2-xii-74)		After Treatment (4-iii-1975)	
	Cult.[1]	Uncult.[1]	Cult.[2]	Uncult.[2]
Control	522	510	268[a]	449[b]
Burning	581	535	445[b]	731[c]
Cutting	482	434	283[a]	511[b]
Spraying	522	424	366[a,b]	201[a]
Mean[3]	527[b]	476[b]	340[a]	473[b]

[1] No significant difference between plots designated to particular treatments.
[2] Values in the same column with different letters differ at P = 0·05.
[3] Mean values in the same horizontal line with different letters differ at P = 0·01.

Legume emergence and establishment

Germination was most rapid in the cultivated plots. In the uncultivated treatments some germination was noted in the first week in the sprayed and control plots, but was delayed until the 3rd week in the cut and burnt plots (Fig. 1). Mean seedling density in the uncultivated plots was significantly lower at each sample occasion (Fig. 2).

There was no significant difference due to pretreatments in the cultivated plots (Fig. 1). However in the uncultivated plots the cut plots maintained significantly higher seedling densities than the sprayed or control treatments. At week 4 there was no significant difference between cut and burnt plots, but seedling density then declined in the burnt treatment (Fig. 1). After week 4 there was no significant difference in legume density between the cut uncultivated plots and the cultivated plots, but seedlings in the uncultivated plots were thin and etiolated as is reflected in legume yields (Table 2).

TABLE 2

Effect of pretreatments and cultivation on dry matter yields of legume and total yield at 12 weeks after oversowing.

Dry Matter Yield (kg ha^{-1})

Pretreatment	Legume		Total (legume + grass)	
	Cult.	Uncult.	Cult.	Uncult.
Control	372[a] [1]	0[a]	2220[a]	8933[a]
Burning	214[a]	12[a]	2058[a]	5273[b]
Cutting	232[a]	20[a]	2070[a]	4580[b]
Spraying	371[a]	2[a]	1939[a]	4321[b]
Mean[2]	297[a]	9[b]	2072[c]	5774[d]

[1] Values in the same column with different letters differ at P = 0·05.
[2] Mean values in the same horizontal line with different letters differ at P = 0·05.

Dry Matter Yields

Although pretreatment effects were not significant in the uncultivated plots, it is obvious that legume growth was prevented in the control and sprayed plots, and very poor in the cut and burnt plots (Table 2). Cultivation markedly increased legume growth, and although pretreatment effects were not significant, growth rate appears to have been reduced in the cut and the burnt plots.

As expected, cultivation significantly reduced setaria yield, and again there was no effect of pretreatment (Table 2). In the uncultivated treatment yield was significantly higher in the control, but not different in the other treatments although it

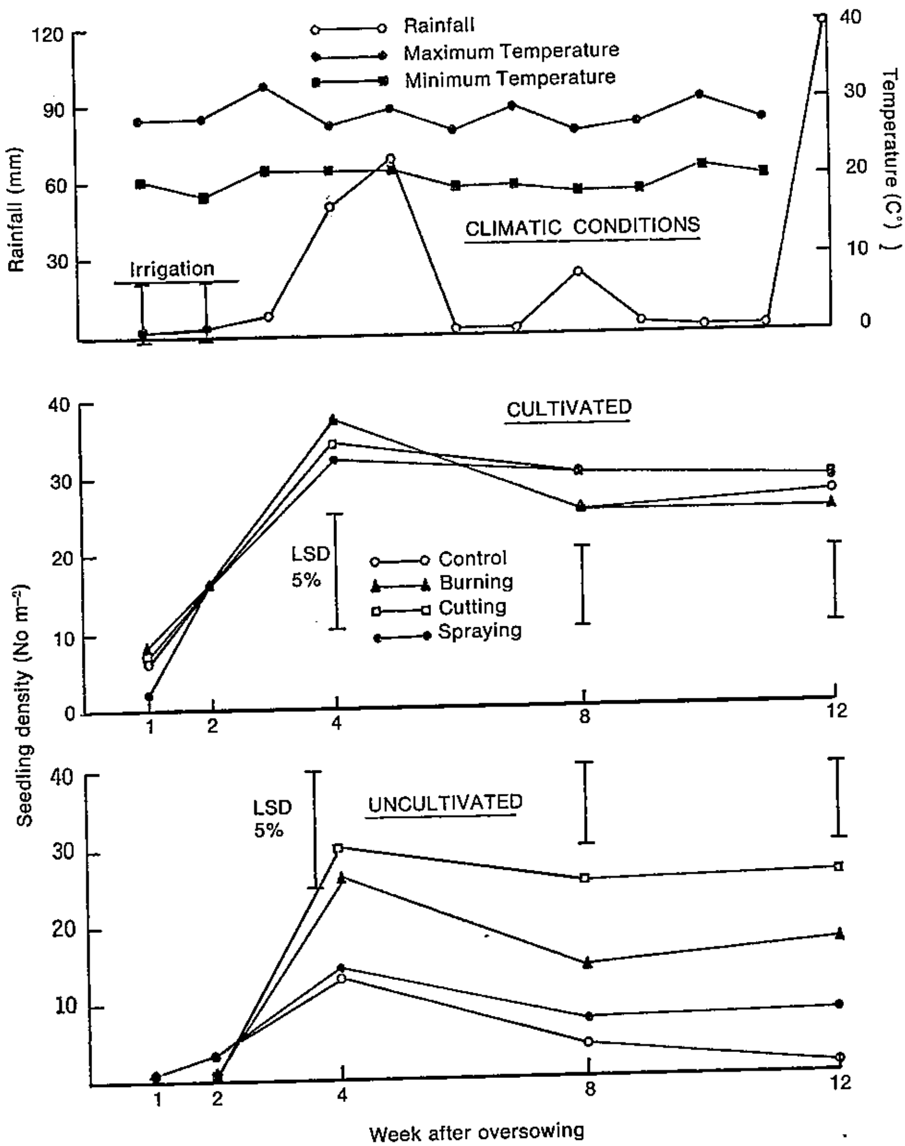

FIGURE 1

Changes in seedling density with time in cultivated and uncultivated plots given a range of pretreatments. Climatic means are shown for the establishment period.

tended to be higher, in keeping with the higher tiller densities, in the burnt plots (Table 2).

DISCUSSION

This experiment demonstrated that there is little prospect of establishing an oversown legume such as Siratro in a setaria sward without a rigorous cultivation. Even two cultivations with a rotary hoe only reduced setaria tiller density by 49% or less. Middleton (1973) after cultivation with tyne or disc harrows obtained no significant

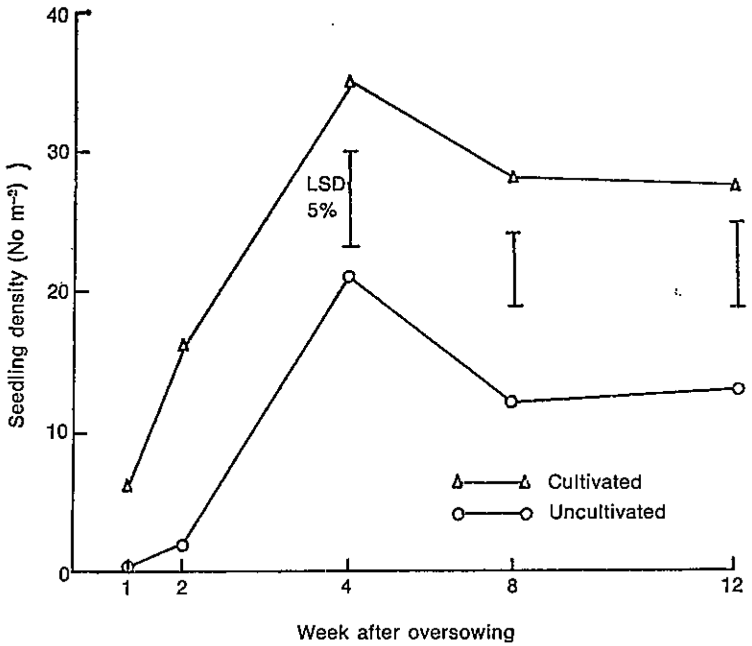

FIGURE 2

Main effect of cultivation and no-cultivation over all pretreatments on seedling density.

reduction in setaria population and only a 7% emergence of Siratro and desmodium which contributed less than 6% of total pasture dry matter after 11 months.

This study also demonstrates that since cultivation is necessary, there is little purpose in applying treatments before cultivation. In fact both burning and herbicide spraying gave higher tiller densities after cultivation than cutting or control treatments. Before cultivation for oversowing, heavy grazing to utilize the yield and reduce litter would appear to be the simplest management.

The advantages of cultivation were mainly related to the greatly reduced grass competition, but better soil-seed contact and surface moisture conditions would be important (Grimmet 1964). In contrast to the findings of other workers (McWilliam and Dowling 1970; Keya *et al.* 1972) who obtained improved legume establishment after sward desiccation by herbicide, establishment in the present experiment was reduced in the sprayed uncultivated treatments even though setaria tiller density was reduced by 53%. The thick cover of surface litter may have prevented seed penetration to the soil surface, and where seed did penetrate seedling emergence may have been smothered by the litter layer.

Germination of seed on the exposed soil surface in the burnt and cut treatments was delayed, apparently due to a less favourable surface moisture regime, similar to the findings of Miller and Perry (1968). Once germinated, establishment and growth was higher in these treatments due to less shading by the grass in the early stages. However competition and shading was rapidly established and seedling growth markedly inhibited compared with the cultivated treatments.

Of particular interest was the effect of burning on setaria tiller density. Burning significantly increased tiller density in the uncultivated treatments, and gave significantly higher tiller densities than the other treatments after cultivation. The release of available nutrients from the ash may have been important. Phosphorus, potassium, calcium and sulphur were applied before imposing the treatments, so that tillering may have been stimulated by the release of available nitrogen, or possibly other elements. Burning after a cleaning cut is practised by some tropical grass seed producers. Burning has been shown to increase seed yield in some temperate grasses (Cowan 1970). The observed stimulation of tillering in the present experiment may provide a rationale for this practice.

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REFERENCES

COWAN, J. R. (1970)—Factors influencing the production of high quality forage crop seed. *Proceedings of the XI International Grassland Congress*, Surfers Paradise, 1970: 305-8.

DOUGLAS, N. J. (1965)—Tropical legumes on a blady grass burn. *Queensland Agricultural Journal*, **91**: 36-9.

GRIMMET, S. G. (1964)—Prepared seed-beds best for pasture establishment. *Agricultural Gazette N.S.W.* **75**: 930-4.

HACKER, J. B., and JONES, R. J. (1969)—The *Setaria sphacelata* complex—a Review. *Tropical Grasslands* **3**: 13-34.

JONES, R. J. (1965)—The use of cyclodiene insecticides as liquid seed dressings to control bean fly (*Melanagromyza phaseoli*) in species of *Phaseolus* and *Vigna marina* in south-eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **5**: 458-65.

JONES, R. J., and HAYDOCK, K. P. (1970)—Yield estimation of tropical and temperate species using an electronic capacitance meter. *Journal of Agricultural Science*, Cambridge, **75**: 27-36.

KEYA, N. C. O., OLSEN, F. J., and HOLLIDAY, R. (1972)—Comparison of seed-beds for oversowing a *Chloris gayana* (Kunth) *Desmodium uncinatum* (Jacq) mixture in *Hyparrhenia* Grassland. *East African Agriculture and Forestry Journal* **37**: 286-93.

MCWILLIAM, J. R., and DOWLING, P. M. (1970)—Factors influencing the germination and establishment of pasture seed on the soil surface. *Proceedings of the XI International Grassland Congress*, Surfers Paradise, 1970: 578-83.

MIDDLETON, C. H. (1973)—Oversowing legumes into grass swards. *Queensland Agricultural Journal* **99**: 217-20.

MILLER, H. P. (1967)—The effect of pre-treatment of native pasture and sowing rate on establishment of Townsville lucerne on Tippera clay-loam at Katherine, N.T. *Australian Journal of Experimental Agriculture and Animal Husbandry* **7**: 515-7.

MILLER, H. P., and PERRY, R. A. (1968)—Preliminary studies on the establishment of Townsville lucerne (*Stylosanthes humilis*) in uncleared native pasture at Katherine, N.T. *Australian Journal of Experimental Agriculture and Animal Husbandry* **8**: 26-32.

MURTAGH, G. J. (1963)—Herbicides as an aid to the establishment of sod-sown *Glycine javanica*. *Australian Journal of Experimental Agriculture and Animal Husbandry* **3**: 173-6.

NORMAN, M. J. T. (1961)—Establishment of pasture with minimum cultivation at Katherine, N.T. C.S.I.R.O. Australia. Division of Land Research and Regional Survey. Technical Paper No. 14.

SMITH, C. A. (1963)—Oversowing pasture legumes into *Hyparrhenia* grassland of northern Rhodesia. *Nature*, London, **200**: 811-2.

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