SOME INFLUENCES OF STRAW MULCH, NITROGEN FERTILIZER AND OAT COMPANION CROPS ON ESTABLISHMENT OF SABI PANIC

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ABSTRACT

Sabi panic (Panicum maximum) *was sown with a companion crop of oats at three stages of development and with various rates of straw mulch and nitrogen fertilizer in sub-coastal south-eastern Queensland.*

Straw mulch reduced soil drying rate and soil temperature at 1 cm and improved seedling emergence. Maximum emergence occurred with a mulch of 8000 to 10000 kg/ha (8 to 10 tons/ac).

Companion crops adversely affected establishment.

Applications of nitrogen up to 160 kg/ha (143 lbs/ac) did not affect emergence but improved dry matter production of sown grass.

INTRODUCTION

Establishment of fine-seeded grasses is often disappointing on heavy soils. Successful emergence of pasture seedlings often depends on rate of emergence in relation to rate of soil drying (Leslie, 1965). Both functions could be influenced by modification of the surface soil microenvironment. This paper reports on the effects of a straw mulch, oat companion crop, and applied nitrogen on seedling emergence and early seedling growth.

METHODS

Five field experiments were conducted on basalt derived self mulching sandy clay (44% clay, 15% silt, 41% sand) at 'Brian Pastures' Gayndah (25° 39'S, 151° 45'E); average annual rainfall is 711 mm of which 60% is received from October to March inclusive. Sabi panic (*Panicum maximum* cv. Sabi) was sown at 4.5 kg/ha viable seed.

Experiments 1, 2, and 3 were of a latin square design and consisted of five treatments, (i) open sown (without mulch or crop), (ii) under a straw mulch of 5000 kg/ha, (iii) together with an oat crop, (iv) into an oat crop two weeks of age, and (v) into an oat crop four weeks of age. No fertilizer was applied and grass was surface sown. Plot size was 3.7 m x 2.3 m with crops arranged in 15 cm rows by 5 cm intra row spacing.

Soil temperatures were recorded daily at 9.00 a.m. and 1.00 p.m. and gravimetric soil moisture of the 0-1.2 cm and 1.2-2.5 cm horizons were determined every other day. Seedlings were counted in eight fixed quadrats of 6 dm^2 per plot, at 14, 28, and 42 days after irrigation. Herbage dry matter yield was measured on day 42. Light interception 2 cm above the soil surface was recorded periodically.

Experiments 4 and 5 investigated the effects of rate of mulch and nitrogen fertilizer application on establishment. Experiment 4 was a split plot latin square with mulch as main plots (2 m x 4 m) at 0, 2500, 5000, 10000, and 20000 kg/ha and sub plots of 0 and 100 kg/ha of nitrogen as urea. All plots received a basal dressing of superphosphate at 250 kg/ha. Seed and fertilizer were raked into the surface soil and irrigation commenced on 1.iv.69. Seedlings were counted 30 days after irrigation and again in spring using 6 quadrats of 6 dm^2 per sub-plot. Herbage yields were also obtained at the last count. Experiment 5 consisted of 3 replications of a 4 x 4 factorial with a plot size of 2.2 x 1.25 m. Straw mulch was laid down at 0,

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TABLE 1 *Rainfall, temperature and evaporation for trial periods*

Climatic factor	Growth period (days)	Experiment 1	2	3	4	5
Commencement date	–	25.iii.69	22.v.69	23.vii.69	1.iv.69	17.x.69
Rainfall additional to irrigation (mm)	1–14	15	16	0	0	32
	15–28	1	2	0	1	14
	29–42	1	10	28	2	104
	Total	17	28	28	3	150
Mean atmospheric temperature (°C)	1–14	23.4	17.9	15.1	22.6	21.7
	15–28	21.9	15.0	17.3	20.6	23.9
	29–42	20.4	15.6	18.5	19.6	23.7
	Mean	21.9	16.2	17.0	20.9	23.1
Mean daily free water evaporation (mm)	1–14	6	3	4	6	4
	15–28	5	3	4	5	6
	29–42	4	2	4	4	6
	Mean	5	3	4	5	6

TABLE 2 *Grass emergence and production in relation to sowing methods and micro environment*

Observation	Experiment	Open Sown	Mulch 5000 kg/ha	Together with oats	Into oats at 2 weeks	Into oats at 4 weeks	Least significant difference 5%
Mean 9.00 am soil temperature at 1.2 cm for 10 days after irrigation °C	1	28.0	25.9	28.0	27.7	26.3	0.9
	2	20.1	18.1	19.9	19.4	19.3	0.7
	3	17.3	14.2	17.1	16.6	15.1	0.8
Mean soil moisture % at 0–1.2 cm from 5 occasions within 10 days of irrigation	1	24.8	33.2	25.3	23.9	25.2	2.5
	2	27.6	34.3	27.4	30.5	30.7	2.1
	3	20.8	30.5	21.1	20.9	22.2	1.8
Percentage light interception at 2 cm	1 day 9	—	—	0.9	10.7	42.6	NA
	2 ,, 14	—	—	4.0	21.6	61.8	NA
	3 ,, 15	—	—	0.5	12.4	46.8	NA
Seedling density 14 days after irrigation (plants/m²)	1	60.7	213.2	32.2	21.0	21.0	26.9
	2	2.9	71.0	1.3	10.0	2.3	23.9
	3	1.6	2.9	0	1.6	0.3	N.S.
Seedling density 42 days after irrigation (plants/m²)	1	42.3	131.3	22.2	8.4	1.9	20.3
	2	4.2	117.0	1.0	9.4	0	32.6
	3	7.7	33.6	3.2	3.9	1.9	10.2
Seedling yield 42 days after irrigation (g/m²)	1	10.1	34.4	3.6	0.4	T	N.A.
	2	0.4	1.1	T	T	T	N.A.
	3	0.4	0.4	T	T	T	N.A.
Other species yield 42 days after irrigation	1	91.6	101.9	50.6	32.4	1.7	N.A.
	2	26.2	10.6	3.0	7.7	12.9	N.A.
	3	8.1	5.3	3.3	0.9	0.9	N.A.
Companion crop yield 42 days after irrigation (g/m²)	1	—	—	30.0	87.2	142.2	N.A.
	2	—	—	82.5	165.5	292.2	N.A.
	3	—	—	44.7	97.7	158.2	N.A.

N.S. — Not significant
N.A. — Not available
T — Trace

Note: 10 seedlings per square metre is equivalent to 1% emergence of viable seed.

2000, 4000 and 8000 kg/ha and nitrogen as ammonium sulphate was applied at 0, 40, 80 and 160 kg/ha. All plots received 200 kg/ha superphosphate and 40 kg/ha muriate of potash. Seed and fertilizer were raked into surface soil prior to mulch application. Rain fell soon after completion of sowing on 17.x.69. Seedling counts were made at 21 and 36 days after sowing from 8 fixed quadrats of 10 dm^2 per plot.

Mulch was applied after sowing and consisted of mature native pasture, cut, chaffed and oven dried. Experiments 1, 2, 3 and 4 were spray irrigated applying 30 mm over a 30 hour period after sowing.

RESULTS

Temperature and evaporation data for the trial periods are presented in Table 1. Total rainfall for the duration of experiment 4 (1.iv.69 to 7.xi.69) was 194 mm of which 106 mm fell during the final 38 days.

In experiments 1, 2 and 3 seedling emergence at 14 days after sowing, and survival 42 days after sowing were significantly greater under a straw mulch and this was associated with lower soil temperatures and reduced rates of soil drying. To a lesser degree soil drying rates and soil temperatures were reduced beneath the most advanced oat crop. However seedling emergence with crops was either inferior to or did not differ significantly from open sown treatments. High seedling mortality and reduced weed growth also occurred with companion crops.

TABLE 3

Sabi panic establishment and rates of mulch and nitrogen fertilizer

Experiment 4	Mulch kg/ha					Nitrogen kg/ha	
	0	2500	5000	10000	20000	0	100
Density at 30.iv.69 Day 30 (plants/m^2)	2.1	6.2 (18.8)	27.3	77.5	29.9	29.6	27.6 N.S.
Density at 7.xi.69 (plants/m^2)	12.5	32.0	42.7 (21.2)	78.6	25.5	39.0	37.5 N.S.
Grass Yield at 7.xi.69 (g/m^2)	15.0	27.9	42.1 (24.3)	64.2	53.7	30.4	50.8 (14.4)
Other species yield 7.xi.69 (g/m^2)	98.8	79.3	76.6 (44.3)	31.4	33.1	53.4	74.3 (13.6)
Total DM yield 7.xi.69 (g/m^2)	113.8	107.2	118.7 N.S.	95.6	86.8	83.8	125.1 (15.3)
Experiment 5	0	2000	4000	8000		0	160
Density at day 21 (plants/m^2)	0.9	11.8	27.5 (7.8)	37.0		19.6	17.6 N.S.
Density at day 36 (plants/m^2)	0.9	13.4	31.5 (6.8)	35.5		21.4	19.3 N.S.

N.S. — Not significant
( ) — Least significant difference ($P = 0.05$)

Seedling emergence increased with increasing rate of mulch up to a maximum at 10000 kg/ha. This effect persisted through a dry winter and was still evident from density counts and grass yield the following spring. Nitrogen at 100 kg/ha did not influence seedling population but improved spring yields of sown grass and other species. Nitrogen at 160 kg/ha had no effect on seedling emergence in experiment 5. Seedling emergence again increased with increasing rates of mulch but the superiority at 21 days of 8000 kg/ha did not persist to 36 days.

DISCUSSION

Oats as a companion crop at three stages of development and on three separate occasions offered no advantage over open sowing in seedling emergence and early seedling growth, thereby supporting the conclusion that companion crops are not "nurse" crops to undersown pasture. (Santhirasageram and Black, 1965). Crops at 4 weeks of age with high light interception reduced soil temperature but any reduction in surface soil drying rate was short lived and did not improve seedling emergence. High seedling mortality recorded in companion crop treatments probably resulted from competition for light, moisture and/or nutrients between the crop and pasture seedlings (Donald, 1963). However, as only light frosts were experienced during the trial period, the likelyhood remains that companion species may protect seedlings from severe frosts (Teakle, 1957).

Seedling emergence improved with increasing rates of straw mulch up to 10000 kg/ha. This response is probably due to an alteration to soil drying rate and/or rate of seedling emergence. Stubble from either well grown winter cereal, grain sorghum, or eaten out forage sorghum could provide a mulch of 2500-5000 kg/ha. A technique of banding cut stubble would further increase the effective rate of mulch.

A high surface albedo* and low thermal conductivity of a mulch causes lower day soil temperature and less diurnal variation in soil temperature compared to bare soil (Hanks et al, 1961; Slatyer and McLlroy, 1961). However, under cloudy conditions and with moist soil, seed zone soil temperatures differ little between mulched and bare soil (McCalla and Duley, 1946). This was confirmed in that, at 1 p.m. on 25.iii.69 (a cloudy day), soon after irrigation of experiment 1, soil temperature of the mulch treatment was 29.5°C and of bare soil 29.6°C. As initiation of germination would be expected during such a period, the temperature regime beneath a mulch would have little direct influence on this growth function. However with the onset of fine weather and the development of different temperature regimes the rate of continued germination and of seedling emergence could be influenced (Leslie, 1968).

Time of sowing also influences temperature regimes in the seed zone. Smaller seedling populations with the May and July sowing (experiment 2 and 3 respectively) compared to the February sowing (experiment 1) were possibly due to lower soil temperatures reducing rate of emergence. Mid winter appears to be an unsuitable time for sowing Sabi panic.

Evaporation rate from moist soil beneath mulch is less than from bare soil, due to lower soil temperatures and hence heat energy available for water vaporisation. Also resistance to water vapour diffusion is increased due to the greater thickness of static air layer in the mulch. (Russel, 1939; Hide, 1954). However, as the surface soil dries the upward movement of water within the soil has a greater influence than mulch on evaporation (Army et al, 1961).

Surface soil moisture content under a mulch is high because of reduced rate of evaporation. It is likely that improved seedling emergence recorded in this treatment resulted from the reduced evaporation rate.

The reduced seedling emergence and yield in the 20000 kg/ha treatment of experiment 4 is probably due to seedling inability to penetrate the mulch. A second possibility is that effective irrigation or rainfall was less in this treatment due to the amount of water required to saturate the layer of mulch.

Greater dry matter production of sown grasses in mulch treatments resulted from increased plant population. Smith (1966) reported that straw mulches of 2500 and 5000 kg/ha, and also increased sowing rates, improved dry matter production of three tropical grass species during the establishment year. Production of weed species was inversely related to sown grass production so that total yield of all

* Albedo is a term denoting the reflection coefficient for short wave radiation.

treatments of experiment 4 was similar. This probably reflects moisture limiting growth as dry conditions prevailed.

Nitrogen fertilizer as urea or ammonium sulphate did not influence seedling population in experiments 4 and 5 which is contrary to reports by Ward and Blaser (1961), Carter (1967) and Rud (1967). Using a range of temperate species these workers reported wide differences in species tolerance to nitrogen fertilizer during the germination and emergence phase of growth. It is possible that Sabi panic possesses a high tolerance to nitrogen fertilizer. Rainfall data suggests mild leaching of fertilizer from the seed zone during wetting. However the application of nitrogen fertilizer increased dry matter production of both sown grass and other species.

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