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EFFECT OF WEED COMPETITION AND INTER-ROW CULTIVATION ON YIELD OF GRAIN SORGHUM

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SUMMARY

Three experiments were conducted from 1973 to 1975 to determine the effect of weed competition and inter-row cultivation on the yield of grain sorghum on an alluvial soil at Biloela Research Station in central Queensland. Black pigweed *(Trianthema portulacastrum* L.) was the main weed species involved.

Over the three years, weed competition in unweeded treatments reduced grain yields by an average of 29% compared with weed-free treatments and by 24% compared with inter-row cultivation treatments. Under weed-free conditions, inter-row cultivation did not have a significant effect ($P < 0 \cdot 05$) on grain yield in any of the experiments, indicating that the main benefit of inter-row cultivation was in reducing weed competition. In most cases, grain yields of weed-free and inter-row cultivation treatments did not differ significantly ($P < 0 \cdot 05$), indicating that inter-row cultivation generally reduced weed competition to a level at which yields were not adversely affected.

I. INTRODUCTION

In the Dawson–Callide area of central Queensland, black pigweed (*Trianthema portulacastrum* L.) is a major weed of summer crops.

Inter-row cultivation of grain sorghum crops grown in rows 0·71 m to 1·07 m apart is a recommended method of controlling weeds in grain sorghum, although the use of herbicides for this purpose is increasing. In addition to its function of controlling weed growth, inter-row cultivation is also believed to stimulate soil nitrate production and improve moisture penetration (Bygott 1956).

Experiments were commenced in 1973 to gain further information on the effects of weed competition and inter-row cultivation on yields of grain sorghum under raingrown conditions in this area.

II. MATERIALS AND METHODS

Three experiments were carried out at Biloela Research Station (latitude 24° 22′S; longitude 150° 31′E) between 1973 and 1975. Soil type was a fine sandy clay loam overlying a dark, medium clay (Dd 1·13, Northcote 1971). Soil nitrate levels in the 0 to 20-cm layer at planting were moderately high (approximately 20 ppm).

Depth of moist soil at planting and monthly rainfall recorded at Biloela Research Station for each experiment, together with long term average monthly rainfall are given in table 1. Planting and harvesting dates for each experiment are also shown.

TABLE 1

MONTHLY RAINFALL (mm), DEPTH OF MOIST SOIL AT PLANTING (m), PLANTING AND HARVEST DATES

Year	1973	1974	1975	Average Long Term Rainfall 1924–1973
Rainfall				
Jan	59	185	130	106
Feb	151	49	148	115
Mar	94	51	42	68
Apr	0	17	44	38
May	5	44	0	36
Jun	87	2	39	39
Depth of moist soil at planting (m)	1·2	1·2	1·2	
Planting date	9 Feb	21 Jan	10 Feb	
Harvest date	26 Jun	4 Jun	21 Jul	

Treatments are shown in table 2. Experiment design was a randomized block of four replicates, with plot size being 12 m $\times$ 3 m for 0·36-m and 0·71-m row spacing (8 and 4 rows wide respectively) and 12 m $\times$ 4 m for the 1·02-m row spacing (4 rows wide). Data rows for dry matter and grain yield determinations were the middle four at 0·36-m spacing and the middle two at 0·71 and 1·02-m spacings.

The experiments were planted between mid-January and mid-February (table 1). All plots were planted at a higher rate than required with the cultivar E57* and subsequently hand thinned to give population densities of approximately 86 000 ha^{-1} in 1973 and 1974 and 50 000 ha^{-1} in 1975. The lower densities in 1975 resulted from the use of poor quality seed.

Weed free conditions were obtained by pre-emergence application of atrazine (2 chloro-4-ethylamino-6-isopropylamino-1, 3, 5-triazine) at a rate of 1·1 kg a.c. ha^{-1}, supplemented by hand weeding as required. In 1973 and 1975, one inter-row cultivation was carried out 3 and 5 weeks after planting, respectively, when sorghum plants were 20 to 30 cm and 30 to 45 cm in height, respectively. In 1974, inter-row cultivation was carried out twice, at 2 and 4 weeks after planting, when plants were approximately 10 cm and 30 to 40 cm in height respectively. Heights were measured to the top of the leaf whorl.

Weed dry matter in non-weed-free treatments was determined 4 to 6 weeks after planting by cutting two 1-m^2 samples from each plot, drying these at 75°C and then weighing.

Sorghum whole plant dry matter yields were determined at anthesis from samples 1 m in length cut from each of the data rows in each plot, giving sample sizes of 1·42 m^2 at 0·36-m and 0·71-m row spacings and 2·04 m^2 at 1·02-m spacing. These samples were then dried at 75°C and weighed.

*DeKalb Shand Seed Company Pty. Ltd. registered cultivar.

The upper two leaves of 20 randomly selected plants per plot were removed at anthesis, dried at 75°C and subsequently analysed for nitrogen content.

A small plot autoheader was used to harvest the data rows for grain yield at maturity. Taking into account the lengths of row cut out for dry matter yield at anthesis, harvested plot size was 11 m $\times$ 1·42 m in the 0·36-m and 0·71-m row spacings and 11 m $\times$ 2·04 m in the 1·02-m row spacing. Yields were adjusted to a standard grain moisture content of 12%.

III. RESULTS AND DISCUSSION

Weed and sorghum dry matter yield, grain yield and leaf nitrogen content are given in table 2.

Rainfall received within 4 weeks of planting (table 1) resulted in weed emergence and growth at an early stage of crop development in all experiments, except in the weed-free treatments. Black pigweed was the main weed species present, with a small proportion of Urochloa grass (*Urochloa panicoides* Beauv.) also occurring.

Weed dry matter yields were significantly ($P < 0 \cdot 05$) lower in the inter-row cultivation than in nil weed control treatments in all years (table 2). In 1974, weed growth in nil weed control treatments was significantly ($P < 0 \cdot 05$) greater at the 1·02-m row spacing than at narrower spacings and a similar, though non-significant trend occurred in 1975. These results indicate that weed growth can be suppressed to some extent at narrower row spacings in grain sorghum, as reported by other workers (Burnside and Wicks 1969; Rahunatha and Sheelavanthar 1976).

Sorghum dry matter yield at anthesis and grain yield results (table 2) show that uncontrolled competition from black pigweed can cause marked yield reductions in grain sorghum. This is in contrast with previous findings at Biloela Research Station (J. E. Rawson, personal communication 1972) in which the elimination of black pigweed competition, either by use of atrazine or hand weeding did not result in higher grain yields at 0·36-m and 0·71-m row spacings.

Percentage reduction in grain yield in nil weed control treatments ranged from 16% to 42% (mean 29%) compared with weed-free, and 12% to 35% (mean 24%) compared with inter-row cultivation treatments.

Sorghum dry matter yield at anthesis, grain yield and leaf nitrogen content at anthesis (table 2) did not suffer significantly ($P < 0 \cdot 05$) between weed-free and inter-row cultivation + weed-free treatments at 0·71-m and 1·02-m row spacings in any of the experiments. This indicates that the main benefit of inter-row cultivation was through its effect in reducing weed competition, rather than through possible effects on soil moisture or nitrate status (Bygott 1956). However, in previous work at Biloela Research Station (J. E. Rawson, personal communication 1972), grain yield of sorghum grown in 0·71-m rows was significantly ($P < 0 \cdot 05$) increased by inter-row cultivation under weed-free conditions. The effect of inter-row cultivation on soil moisture and nitrate status could however, be influenced by factors such as timing and intensity of rainfall in relation to cultivation, nitrate content of the soil and soil moisture conditions at the time of cultivation.

TABLE 2

TREATMENTS, WEED DRY MATTER YIELDS, SORGHUM DRY MATTER YIELDS AT ANTHESIS, GRAIN YIELDS, LEAF NITROGEN CONTENT AT ANTHESIS

Treatment		Weed Dry Matter Yield g m^{-2}			Sorghum Dry Matter Yield at Anthesis kg ha^{-1}			Grain Yield kg ha^{-1}			Leaf Nitrogen Content at Anthesis (%)		
Row Spacing	Weed Control	1973	1974	1975	1973	1974	1975	1973	1974	1975	1973	1974	1975
1. 0·36 m	Weed-free	0	0	0	6 419	6 158	3 547	4 316	3 159	2 903	3·08	2·50	2·69
2. 0·36 m	Nil weed control . .	130·3	64·6	164·6	5 375	6 741	3 313	3 446	2 045	2 199	3·06	2·28	2·43
3. 0·71 m	Inter-row cultivation	12·8	28·3	34·1	5 640	6 848	3 682	4 054	3 073	2 226	2·95	2·45	2·68
4. 0·71 m	Weed-free	0	0	0	6 018	6 427	3 558	3 969	3 590	2 621	3·04	2·54	2·80
5. 0·71 m	Inter-row cult + Weed-free	0	0	0	5 638	6 400	2 874	4 054	3 141	2 648	3·05	2·43	2·80
6. 0·71 m	Nil weed control . .	122·8	86·1	180·0	5 130	5 030	3 607	3 400	2 043	2 093	3·00	2·22	2·50
7. 1·02 m	Inter-row cultivation	16·5	19·6	22·3	5 171	5 712	3 318	3 822	2 933	2 498	3·00	2·48	2·72
8. 1·02 m	Weed-free	0	0	0	5 440	5 440	2 562	4 060	3 593	2 800	3·09	2·54	2·72
9. 1·02 m	Inter-row cult + Weed-free	0	0	0	5 062	5 400	3 771	3 831	3 489	2 293	3·17	2·58	2·85
10. 1·02 m	Nil weed control . .	138·5	130·3	203·6	4 405	3 946	2 546	3 506	1 921	1 481	3·00	2·28	2·37
Mean	. .	84·2	65·8	120·9	5 430	5 811	3 233	3 846	2 899	2 392	3·04	2·43	2·65
Necessary differences for significance 5%	. .	25·9	35·5	61·1	648	1 044	N.S.	559	603	536	·10	·18	·23
Necessary differences for significance 1%	. .	36·4	49·7	85·7	875	1 410	N.S.	755	814	729	·14	·25	·32

N.S. = F value not significant ($P < 0{\cdot}05$).

Sorghum dry matter yield at anthesis (table 2) in inter-row cultivation and weed-free treatments at 0·71-m and 1·02-m row spacings did not differ significantly ($P < 0 \cdot 05$) in any of the experiments, whilst grain yield (table 2) did ($P < 0 \cdot 05$) on only one occasion, at 1·02-m row spacing in 1974. Hence, under the seasonal conditions which prevailed (table 1), inter-row cultivation within approximately 4 weeks of planting generally reduced early weed competition to a level at which sorghum yields in these treatments did not differ significantly ($P < 0 \cdot 05$) from those in the weed-free treatments. Weeds which emerged after this time would not be expected to affect sorghum yields adversely (Burnside and Wicks 1967).

One inter-row cultivation was applied in the 1973 and 1975 trials and two in 1974, but no comparison of the effects of one or two cultivations was obtained. Phillips and Norman (1962) showed positive effects of one inter-row cultivation on yield of grain sorghum, but two cultivations showed no advantage over one. However, previous work (CSIRO 1959) had shown further increases in yield from a second inter-row cultivation and they considered these conflicting results were due to seasonal differences in rainfall or to differences in cultural technique.

Hence, under the conditions of these experiments, competition by black pigweed caused marked yield reductions in grain sorghum. Results indicated that one or two inter-row cultivations within approximately 4 weeks of planting generally reduced weed competition to a level at which yields were not adversely affected. The benefit of inter-row cultivation was considered to be due mainly to its effect in reducing weed competition, rather than on soil moisture or soil nitrate status.

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