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Comparative Efficiency of Physical, Chemical and Combination Methods of Weed Control in Grain Sorghum

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ABSTRACT

Field experiments to study the comparative efficiency of physical, chemical and combination methods of weed control in grain sorghum (Var. CSH. 1) showed that among the fourteen treatments tried two combination treatments the pre-emergence application of either atrazine or propazine at 0.5 kg per ha followed by one late season hand weeding at 45 days after sowing were significantly superior in efficiency and selectivity. These treatments were on par with three manual weedings given to this crop and recorded high net returns per unit area.

INTRODUCTION

Sorghum (*Sorghum vulgare* Pers.) crop is subjected to severe competition from weeds on account of wider spacing, heavy fertilization at sowing time, high temperature and the onset of monsoon soon after sowing. These factors contribute to more growth rate of weeds and thereby severely restrict the early growth and development of crop plants and finally restrict their seed yield.

Burnside *et al.* (1964) reported that unchecked weed growth in sorghum crop caused reduction in plant height, size and number of heads per plant and number of seeds per panicle at the time of harvest. The yield reductions due to unchecked weed growth in hybrid sorghum ranged from 160 kg to 1366 kg per ha (Phillips, 1960 and Wiese *et al.*, 1964). Wiese *et al.* (1964) observed that a reduction in the number of seeds per head in grain sorghum occurred if the weed competition was not checked early in the season. Burnside and Wicks (1967 and 1969) found that weeds that emerged four weeks after planting did not reduce sorghum yields.

MATERIALS AND METHODS

With a view to comparing the efficiency of physical, chemical and combination methods of weed control in grain sorghum (Var. CSH. 1) the field experiments were conducted during

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the *kharif* seasons of 1968-69 and 1969-70 at the Division of Agronomy, Indian Agricultural Research Institute, New Delhi.

The experiments were laid in Randomised Block Design with four replications in both the seasons. Based on the findings obtained in the first season, three of the treatments were modified and new treatments introduced in the second year The treatment details in 1968-69 were:

(1) Unweeded control: (C); (2) Early season weeding at 3 weeks: (EW); (3) Late season weeding at 5 weeks: (LW); (4) Repeated weeding at 3, 5 and 7 weeks after sowing: (RW); (5) Pre-emergence Atrazine at 0.5 kg/ha + Treat (3): (AL+LW); (6) Treat (2) + Post-emergence Atrazine at 0.5 kg/ha: (EW + AL); (7) Pre-emergence Propazine at 0.5 kg/ha + Treat (3): (PL+LW); (8) Treat (2) + Post-emergence Propazine at 0 5 kg/ha: (EW + PL); (9) Pre-emergence Atrazine at 1 kg/ha: (AH); (10) Pre-emergence Pro-pazine at 1 Kg/ha: (PH); (11) Pre-emergence Atrazine + Propazine at 0.5 kg/ha each (ALPL) (12) Early season MSMA 2 kg/ha, post-emergence: (MA); (13) Directed Paraquat 2 lit/ha: (PQ); (14) Treat (13) + Post-emergence Atrazine at 0.5 kg/ha: (PQ+AL). During the second season trial in 1969-70, three treatments which were not promising (T9, 10 and 14) were replaced with the following treatments: (1) Pre-emergence Atrazine at 0.5 kg/ha + Post-emergence MSMA at 2 kg/ha: (AL+MA); (2) Pre-emergence Propazine at 0.5 kg/ha + Post-emergence MSMA at 2 kg/ha: (PL+MA); (3) Pre-emergence Norea at 1 kg/ha: (NO). In both the seasons there were 14 treatments in each replication

The net plot sizes were 8.0 × 3 7 m in the first year and 6.0 × 3.7 m in the second year. There were 10 rows of plants in each plot with a spacing 46.0 × 16 0 cm in 1968-69 and 40.0× 15.0 cm in 1969-70. The fertilizers were applied at the following rates in each season. Nitrogen 120 kg, phosphorus 60 kg and potash 60 kg per ha. Half the dose of nitrogen in the form of urea, the entire quantity of phosphorus and potash in the form of superphosphate and muriate of potash respectively were applied as basal dressing. The remaining quantity of urea was applied in two split doses by top dressing. Sowing was done by dibbling the seeds in the furrows made by a shallow ploughing with *desi* plough. The sowing was followed by planking to cover the seeds. Thinning the sorghum crop was done twenty days after sowing so as to leave a uniform intra-row spacing. Periodical irrigations and pest control measures were adopted.

RESULTS AND DISCUSSION

The main experimental findings are furnished in Table 1 and Table 2 and discussed below:

1) Weed flora

Survey of weeds in the experimental plots revealed the presence of the following groups of weed population. (i) Grass weeds: Crabgrass (*Digitaria sanguinalis*, L), Barnyard

TABLE 1. Effect of different weed control treatments and their comparative economics on sorghum crop and weeds: 1968—69

Treatments	Plant height (cm) at harvest	Leaf number per plant at harvest	Leaf area index at harvest	Earhead length at harvest (cm)	Seed number per panicle	1000-grain weight (gm)	Seed yield (Q ha)
C	160.2	12.97	2.063	27.3	1221	30.63	50.88
EW	147.9	14.25	2,458	25.9	1284	30.83	53.92
LW	160.4	13.49	2.377	26.8	1210	30.98	51.08
RW	144.8	14.59	2.781	27.1	1349	30.75	56.42
AL+LW	129.9	14.69	3.005	27.0	1362	30.53	56.62
EW+AL	151.6	14.31	2.563	28.4	1333	30.00	54.39
PL+LW	153.9	14.75	3.016	28.8	1407	30.05	57.14
EW+PL	142.4	13.72	2.381	26.1	1253	30.48	51.89
AH	129.9	13.41	2,033	25.5	886	32.50	39.19
PH	153.5	13.82	2.384	28.1	1232	31.25	52.37
ALPL	136.9	13.45	2.347	24.0	1252	29.95	51.02
MA	161.3	14.60	2.870	29.4	1247	30.88	56.62
PQ	150.2	13.55	2.378	25.9	1207	31.38	51.55
PQ+AL	150.2	13.94	2.445	25.9	1245	31.00	52.57
General Mean	147.9	13.97	2.507	27.0	1256	30.80	52.57
'F' test	**	**	**	**	**	**	**
SEm	5.26	0.27	0.041	0.8	6.58	0.36	1.93
CD 5%	.115	0.78	0.118	2.4	19.0	1.03	5.20
1%	20.2	1.04	0.158	3.2	25.0	1.38	6.96

Table 1 (Continued)

Treatments	Straw yield (kg/ha)	Mean No. of annual grass weeds/sq. m. at 60 days		Mean No. of nut-sedge/sq. m. at 60 days		Mean dry weight of weeds per 0.5 sq.m. at 95 days (g.)	Net profit (+) or loss (−) over control (Rs./ha)
		Original	Sq. root trans	Original	Log trans		
C	83.45	30.0	5.42	102.8	10.11	116.1	—
EW	89.73	10.5	3.24	62.5	7.88	32.1	230.60
LW	84.67	3.0	1.72	22.5	4.39	5.6	−18.20
RW	95.14	2.8	1.64	10.0	3.07	1.2	414.00
AL+LW	94.60	1.5	1.21	12.0	3.38	2.8	433.80
EW+AL	88.85	8.0	2.82	41.8	6.18	32.4	220.20
PL+LW	95.14	2.5	1.32	17.8	3.98	4.9	510.60
EW+PL	87.84	10.0	3.16	41.5	6.39	34.0	35.10
AH	74.66	3.8	1.93	36.3	6.01	47.5	−957.20
PH	87.50	10.8	3.23	58.5	7.51	52.7	93.80
ALPL	83.79	4.5	2.01	46.5	6.80	46.1	37.80
MA	94.94	11.3	3.35	16.0	3.99	81.8	418.70
PQ	82.10	22.5	4.70	65.5	7.93	67.0	−27.60
PQ+AL	86.15	11.5	3.33	40.3	6.21	64.2	22.80
General Mean	87.77	—	2.81	—	5.98	42.0	—
'F' test	**	—	**	—	**	**	—
SEm	3.60	—	0.25	—	0.20	7.3	—
C D 5%	10.27	—	0.73	—	0.58	20.8	—
1%	13.78	—	0.98	—	0.78	27.9	—

grass (*Echinochloa crusgalli*, L.), Watergrass (*E. Colonum* L.), Goose grass (*Eleusine indica* L.) and *Anjan* grass (*Cenchrus ciliaris*, L.). (ii) Broad leaf weeds: Niruri (*Phyllanthus niruri*, L.), Indian purslane (*Portulaca oleraceae* L.), Murga phool (*Digera arvensis* L.), Shathi (*Trianthema monogyna* L.) and Jungli jute (*Corchorus acutangulus* L.). (iii) Rhizomatous weeds: Nutsedge (*Cyperus rotundus* L.), Bermuda grass (*Cynodon dactylon* L.) and Johnson grass (*Sorghum halepense* L.)

Among the three groups of weed population, nutsedge under rhizomatous weeds, water grass and goosegrass under grass weeds constituted the major bulk of weeds and therefore were predominant. The dicot weeds were not a real problem since they were very few.

2. **Effect on weed control:**

All the weed control treatments reduced the weed population significantly over unweeded control.

Annual grass weeds

Among the treatments, pre-emergence application of either atrazine or propazine at 0.5 kg per ha followed by one late season weeding (AL + LW and PL + LW) were equal to three repeated manual weedings (RW) given to this crop in bringing down the annual grass weeds population. MSMA (MA) and Paraquat (PQ) were not efficient in controlling the annual grass weeds.

In both the seasons, the efficiency in annual grass weeds population was about 88 and 95 under RW as compared to C. With regard to combination treatments the per cent was comparatively larger in the first season as compared to the second season in PL + LW and AL + LW as compared to C. These combinations, therefore, appeared to have acted better in the first season as compared to the second season.

Nutsedge

The nutsedge population in AL + LW in 1968-69 was the minimum and equal to RW. This was followed by PL + LW and MA. In the second season MA, PQ, AL + MA, PL + MA and NO were better than the other treatments and equal to RW.

In both the seasons, the population of nutsedge under MA recorded at 60 days was at par with RW ten days after the last weeding operation. It, therefore, appeared that one single application of MA was able to contain the nutsedge population as efficiently as 3 repeated manual weedings. Dube *et al.* (1968) observed applications of MSMA were required to each lethal concentrations to get effective control of nutsedge. In the present investigation, only one directed post-emergence spray of MSMA at 2 kg a.i. per ha three weeks after sowing kept the nutsedge population in level with repeated weedings.

Dry weight of weeds:

As regards the dry weight of weeds in both the seasons the treatments AL + LW and PL + LW were superior to all the other weed control treatments except RW which was on

TABLE 2. Effect of different weed control treatments and their comparative economics on sorghum crop and weeds : 1969–70

Treatments	Plant height at harvest (cm.)	Leaf number per plant at harvest	Leaf area index at harvest	Earhead length at harvest (cm)	Seed number per panicle	1000-grain weight (g)	Seed yield (Q/ha)
C	116.1	11.13	1,451	27.90	511	30.12	22.29
EW	114.2	12.31	1,600	30.35	643	30.93	28.83
LW	115.4	12.25	1,555	28.48	565	30.79	25.23
RW	112.8	13.25	2,241	29.98	789	31.14	35.59
AL+LW	112.1	13.19	2,032	29.46	770	30.51	34.13
EW+AL	120.9	13.06	1,829	30.71	695	30.46	30.86
PL+LW	114.9	13.25	2,098	29.25	777	31.39	35.48
EW+PL	117.1	13.13	1,834	30.30	685	31.24	31.08
AL+MA	108.9	12.00	1,555	30.20	506	31.19	23.03
PL+MA	112.8	12.50	1,609	30.02	622	31.82	28.82
ALPL	115.5	12.50	1,711	28.50	649	31.39	29.62
MA	109.1	12.30	1 593	30.48	580	30.99	26.13
PQ	105.7	12.19	1,082	28.42	578	30.25	25.50
NO	115.3	13.13	2,019	29.25	701	30.64	31.20
General Mean	113.9	12.58	1,765	29.54	648	30.84	29.13
'F' test	*	**	**	N. S.	**	N.S.	**
SEm	2.7	0.33	0.035	0.76	4.47	0.74	1.05
C D 5%	7.9	0.95	0 099	–	13	–	3.01
1%	–	1.28	0.130	–	17	–	4.04

Table 2 [Continued]

Treatments	Straw yield (Q/ha)	Mean No. of annual grass weeds/ sq. m. at 65 days		Mean No. of nutsedge/sq. m. at 65 days		Mean dry weight f weeds/0.5 sq. m. at 95 days (g.)	Net profit (+) or loss (−) over control (Rs./ha.)
		i ginal	Sq. root Trans.	Original	og Trans		
C	48.27	132.3	11.35	145.0	2.16	117.5	—
EW	60.29	34.0	5.83	96.8	1.98	32.4	533.00
LW	55.07	7.3	2.65	73.3	1.85	57.7	228.80
RW	78.13	6.8	2.54	27.8	1.43	8.7	1094.60
AL+LW	72.14	21.5	4.59	70.5	1.84	11.7	988.00
EW+AL	70.27	21.3	4.51	80.3	1.99	28.1	740.40
PL+LW	76.98	27.5	5.17	57.8	1.72	9.4	1130.90
EW+PL	68.72	20.5	4.41	66.8	1.96	28.2	740.30
AL+MA	59.12	43.0	6.41	34.5	1.52	30.2	27.80
PL+MA	68.99	41.5	6.21	35.5	1.55	29.2	532.50
ALPL	63.09	57.3	7.42	55.8	1.72	29.1	610.00
MA	48.27	35.5	5.77	34.0	1.51	37.6	338.50
PO	65.04	32.8	5.68	33.0	1.51	56.0	233.50
NO	57.95	29.0	5.36	39.8	1.58	22.7	808.10
General Mean	71.91	—	5.56	—	1.73	05.7	—
'F' test	**	—	**	—	**	**	—
SEm	6.23	—	0.66	—	0.06	1.50	—
CD 5%	6.23	—	1.88	—	0.17	4.3	—
1%	8.34	—	2.52	—	0.23	5.7	—

par. The dry weight of weeds under unweeded check (C) was the highest and this was significantly superior than all the other treatments.

The percentage efficiency was calculated by adopting the formula $\frac{DWC - DWT}{DWC} \times 100$ where DWC = Dry weight of weeds in unweeded check and DWT = Dry weight of weeds in weed control treatment.

The efficiency under RW compared to C varied as 98.4 and 94.5 per cent in 1968 and 1969 respectively after 60 days of sowing. It therefore, appeared that repeated weedings brought down dry matter accumulation in weed growth in both the seasons to the same degree.

The efficiency under PL+LW and AL+LW as compared to C worked out to 95.7 and 89 8, for the former and 96.1 and 89.0 for the latter. The combination treatment of a pre-emergence application of atrazine or propazine followed by a manual weeding checked the dry matter accumulation in weed growth more or less to the same extent in both the years.

3. Effect on plant growth and yield

Plant height: The variation in plant height ranged from 161 3 to 129.9 cm in the first year and 120.9 to 105.7 cm in the second year. AH recorded the least plant height in the first year showing the stunting effect of atrazine at 1.0 kg/ha due to toxicity. MA and EW+AL recorded the maximum height in the first and second season respectively.

Leaf number: The highest leaf number per plant was recorded under PL+LW in both the seasons and it was on par with RW. The unweeded control (C) exhibited the lowest number per plant.

Leaf area index: The LA1 values in the first crop ranged from 3.016 (PL+LW) to 2.033 (AH) and 2.241 (RW) to 1.082 (PQ) in the second crop PL+LW and AL + LW were outstandingly superior to the other treatment in the first crop while RW, PL+LW and AL+LW were superior to other treatments in the second crop.

Earhead length: The earhead length was maximum under MA (29. 42 cm) and least under ALPL (23.97 cm) in the first crop In the second season crop the variation in earhead length ranged from 27.90 to 30.71 cm, however, none of the treatments was superior to the others.

Seed number per panicle: PL+LW, AL+LW and RW were the superior treatments in increasing the seed number per panicle than the rest of the treatments. In the first crop, AH recorded the least seed number per panicle and it was significantly inferior to even unweeded control (C).

1000-grain weight: The test grain weight was the highest in AH and significantly superior to the rest of the treatments. In the second season the treatment differences were not statistically significant.

Yield of grain and straw: The mean yield data reveal that the treatments PL+LW and AL+LW were con-

sistently superior in both the seasons and equal to repeated manual weedings (RW). AH recorded the least grain and straw yield in the first crop. Unweeded crop (C) recorded the lowest grain and straw yield in the second season.

The grain yield and grain number per panicle suffered a significant reduction under AH. Eventhough all the weed attributes were significantly reduced under AH, seed yield of the crop suffered under this treatment, which indicated that high dose of atrazine, was inhibitory to seed production. Rabago and Preston (1968) observed that atrazine at 1 to 3 kg/ha applied in sorghum crop in the clay soils of Cuba, completely eliminated grass weeds. Sorghum was injured and thinned by high doses of atrazine; however, grain yields were not affected. The present investigations also support the herbicidal efficiency of atrazine but high dose (1 kg/ha) did lead to reduction in grain yield as compared to control. It is quite likely that in the sandy loam type of soil of the present experiment, even 1 kg of atrazine proved inhibitory to grain production.

The behaviour of PL + LW in respect of plant and weed attributes was more or less similar to AL + LW when compared with RW in both the seasons.

The yield attributes responsible for increased yield in the combination treatments (PL + LW and AL + LW) were mainly the leaf number, leaf area index, seed number per panicle rather than earhead length and test grain weight.

Economics

Highest net return over control was obtained under PL + LW, Rs. 510.60 and Rs. 1130.90 in the first and second crop respectively. The treatments AH, ALPL, PO and LW were uneconomical in the first season.

Of the two seasons, PL + LW, AL + LW and RW gave higher returns in 1968-69, while PL + LW, RW, AL + LW and NO gave higher returns in 1969-70. The net return under PL + LW was relatively consistent in the two seasons.

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