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Evaluation of Sorghum (*Sorghum bicolor*) Water Extract for Weed Control in Soybean

ABDUL KHALIQ, ZAHID ATA CHEEMA, MUHAMMAD ABID MUKHTAR AND SHAHZAD MAQSOOD AHMAD BASRA†
Departments of Agronomy and †Crop Physiology, University of Agriculture, Faisalabad- 38040, Pakistan

ABSTRACT

Sorgaab, water extract of mature *Sorghum bicolor* plants, was evaluated for its weed control activity in soybean crop and compared with commonly employed weed control practices i.e. hand weeding, Pendimethalin etc. Spraying of sorgaab at 25 and 45 days after sowing reduced the dry weight of all weeds by 19.71 to 41.88% except that of *Trianthema portulacastrum*. The yield of soybean was increased with two sprays of sorgaab by 9%. Pendemethalin @1.5 kg ha^{-1} a.i. as pre emergence spray controlled weeds effectively and increased soybean yield by 34% over control but was uneconomical due to higher cost of herbicide as compared with two sprays of sorgaab.

Key Words: Sorghum; Water Extract; Weed Control; Soybean

INTRODUCTION

Weed infestation in soybean crop is of serious concern. Uncontrolled weeds can reduce its yield by 60-80% (Fundora *et al.*, 1991). Although herbicides are effective in controlling weeds yet risks are involved in their handling and use. They may also pollute the soil and water environments. Due to increased awareness about such risks much emphasis is given to new methods of weed control which are safe and harmless. Mature sorghum herbage possesses a number of water-soluble allelochemicals (Putnam & Duke, 1974; Cheema, 1988). The use of sorghum water extract (sorgaab) as a foliar weed inhibitor in wheat has recently been reported (Cheema *et al.*, 1997). Similarly, Iqbal (1997) reported that sorgaab reduced weed biomass by 25-35% and increased wheat yield by 18.6%. The effects of sorghum allelochemicals are selective, species specific and concentration dependent (Cheema, 1988). This paper describes the weed inhibition activity of sorgaab in soybean crop and some kharif weeds.

MATERIALS AND METHODS

Sorghum herbage was harvested at maturity, dried, chaffed with fodder cutter (2-cm pieces) and stored under shade. Chaffed sorghum material was soaked in distilled water in the ratio of 1:20 (w/v) for 24 hours at ambient room temperature. This mixture (herbage + water) was passed through a Whattman filter paper # 40 to obtain sorgaab. The experiment comprised of the following treatments; two sprays of sorgaab [25 and 45 days after sowing (DAS)], one hand weeding (25 DAS) + one spray of sorgaab (45 DAS), one hand weeding (25 DAS) + two sprays of sorgaab (45 and 65 DAS), Hand weeding alone (25 DAS), Pendimethalin (Treflan 330 E, Cyanamid, USA), pre emergence @ 1.5 kg ha^{-1} active ingredient (a.i.) and control (weedy check). Experiment was laid out in randomized complete block design with four replications in plots measuring 7.0 x 1.8 m. Soybean variety 95-1 was planted in early August in 30 cm spaced rows with a single row hand drill. Crop management practices for all the treatments were uniform. A basal fertilizer doze @ 50 kg N, 75 kg P_2O_5 ha^{-1} in the form of urea and single super phosphate was applied at sowing. Normal irrigation was given to the crop. Prior to spraying of sorgaab and Pendemethalin volume of spray was calibrated by using ordinary water. Pendimethalin and sorgaab were sprayed in respective plots with the help of Knap Sack hand sprayer fitted with flat fan nozzle. The volume of spray for Pendimethalin and sorgaab was 300 l ha^{-1}. Hand weeding was done with the help of kasola (hand hoe).

Data on weed dynamics (density, fresh and dry weight) were recorded thrice at 25, 45 and 65 days after sowing (DAS) from randomly selected two quadrates (50X50 cm) from each experimental plot. Individual weed count was made. Weeds were cut from ground surface and weighed fresh and after drying in an oven at 80°C for 48 hours. Data on various soybean plant growth parameters were recorded from randomly selected samples. Stalk and

grain yield from plots was recorded in kg and was converted into kg ha^{-1}. Data collected were subjected to Fisher's analysis of variance technique and treatment means were separated using least significance difference (LSD) test at 0.05 probability level (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Major weed in the experimental area was *Trianthema portulacastrum*. Other weeds recorded were *Convulvolus arvensis, Cyperus rotundus, Dactyloctenium aegyptium* and *Cynodon dactylon.*

Weed density. Population of *Trianthema portulacastrum* recorded at 45 and 65 DAS was significantly suppressed by all treatments. Maximum mortality of *T. portulacastrum* on 45 and 65 days after sowing (92.55 & 72.42%, respectively) was recorded in plots where Pendimethalin was sprayed (Table I). Density of other weeds viz. *Convolvulus arvensis, Cyperus rotundus, dactyloctenium aegyptium* and *Cynodon dactylon* recorded was significantly suppressed by all the treatments except sorgaab two sprays at 25 and 45 DAS. Maximum weed suppression (44.4-67.0%) at 45 and 65 DAS was recorded in the plots where Pendimethalin was sprayed as pre-emergence. Similar weed suppression at 65 DAS was observed due to Pendimethalin spray and one hand weeding (25 DAS and one hand weeding (25 DAS) + one sorgaab spray (45 DAS).

Weed dry weight. Dry weight of *T. portulacastrum* recorded 45 DAS was reduced significantly (69.32 – 96.89%) by all treatments except two sorgaab sprays (25 and 45 DAS) which showed similar dry weight of *Trianthema* as in control plots (Table II). Dry weight of other weeds was suppressed significantly (38.20 – 73.42%) in all the treatments over control. The reduction in dry weight of other weeds recorded at 65

Table I. Effect of various weed control practices on weed density (g/50 x 50 cm)

Treatments	45 DAS		65 DAS	
	Trianthema Portulacastrum	Other Weeds	*Trianthema Portulacastrum*	Other Weeds
Control	47.00 a*	7.87 a	6.87 a	14.75 a
Sorgaab two sprays (25 and 45 DAS)	33.25 b	7.00 ab	3.3 d	9.25 b
One H.W. (25 DAS) + sorgaab one spray (45 DAS)	17.50 cd	6.62 b	5.87 b	5.00 d
One H. W. (25 DAS) + sorgaab two sprays (45 and 65 DAS)	14.50 d	3.25 d	4.87 c	6.25 c
One H. W. (25 DAS)	19.50 c	3.75 cd	3.25 d	5.87 cd
Pendemethalin pre em @ 1.5 kg ha^{-1} a.i.	3.50 e	4.37 c	1.62 e	4.75 d
LSD	4.59	0.98	0.84	1.15

Table II. Effect of various weed control practices on dry weight (g) of weeds

Treatments	45 DAS		65 DAS	
	Trianthema Portulacastrum	Other Weeds	*Trianthema Portulacastrum*	Other Weeds
Control	28.83 a*	1.91 a	3.76 c	4.34 a
Sorgaab two sprays (25 and 45 DAS)	24.81 a (-13.94)**	1.10 b (-41.88)	3.95 c (+5.05)	3.49 b (-19.71)
One H.W. (25 DAS) + sorgaab one spray (45 DAS)	6.93 b (-75.96)	1.07 b (-43.97)	5.82 a (+54.78)	2.90 c (-33.17)
One H. W. (25 DAS) + sorgaab two sprays (45 and 65 DAS)	8.84 b (-69.32)	0.62 d (-67.53)	4.85 b (+28.98)	2.5 d (-42.48)
One H. W. (25 DAS)	7.44 b (-74.19)	0.51 d (-73.42)	5.34 ab (+42.20)	1.54 e (-64.50)
Pendemethalin pre em @ 1.5 kg ha^{-1} a.i.	0.89 c (-96.89)	1.18 b (-38.20)	1.60 d (-57.44)	1.43 e (-66.98)
LSD	5.72	0.16	0.69	0.36

* = Any two means in a column not sharing a letter differ significantly at p = 0.05; ** = Figures given in parenthesis show percent increase/decrease over control; Other weeds = *Convolvulus arvensis, Cyperus rotundus, Dactyloctenium aegyptium and Cynodon dactylon*; Sorgaab =Sorghum water extract; DAS = Days after sowing; H. W.=Hand weeding; Pre.em.= pre-emergence; a.i. = Active ingredient.

DAS ranged between 19.71 – 66.98%. Dry weight of *T. portulacastrum* at 65 DAS was either equal or higher than control in most treatments except Pendimethalin pre-emergence where the dry weight of *Trianthema* remained less than control. Varied response of different treatments at 45 and 65 days was possibly due to species specific effect of sorgaab and the initial variation in the density of *T. portulacastrum,* Similar findings have also been reported by Purvis *et al.* (1985).

Growth and yield of soybean. Weed control practices exhibited suppressive effects on plant height (Table III). Maximum reduction (7.99%) in plant height over control occurred where Pendimethalin was sprayed as pre emergence herbicide. It was followed by two sprays of sorgaab (25 and 45 DAS), one hand weeding (25 DAS) and one hand weeding (25 DAS) + two sprays of sorgaab (45 and 65 DAS) and being statistically similar. Reduction in plant height under Pendimethalin and/or sorghum extracts may be due to their phytotoxic/inhibitory effects on plant growth as reported previously (Pope *et al.,* 1985; Boza & Villalobos, 1987). All the treatments significantly increased number of pods per plant as compared to control (Table III). Maximum pods per plant (33.69) were recorded in plots where Pendimethalin was sprayed. Number of pods per plants recorded in plots where one hand weeding (25 DAS) + one spray of sorgaab (45 DAS) and one hand weeding (25 DAS) + two sprays of sorgaab (45 and 65 DAS) done were statistically similar to those recorded in Pendimethalin sprayed plots. Reduced weed crop competition in treated plots might have increased the growth of soybean that resulted in increased number of pods per plant. All weed control practices significantly increased leaf area per plant over control. Maximum leaf area (796.5 cm^2) was recorded in plots where Pendimethalin was sprayed. Two sprays of sorgaab (25 and 45 DAS) and one hand weeding (25 DAS) produced similar leaf area per plant. Increase in leaf area was probably due to less weed-crop competition in these treatments as compared to control.

Weed control practices significantly increased grain yield of soybean over control (Table III). Highest grain yield (996.1 kg ha^{-1}) was obtained where Pendimethalin was sprayed and it was 33.97% higher than control. One hand weeding alone (25 DAS) or one hand weeding (25 DAS) + one sorgaab spray (45 DAS) increased soybean yield by 18.50 and 18.33%, respectively over control. Two sprays of sorgaab at 25 and 45 DAS increased soybean yield 8.28%. Chemical weed control and spray of sorgaab suppressed weed population, which resulted in increase in assimilatory system (leaf area), sink capacity (number of pods per plant) and hence increased grain yield.

Economic and dominance analyses of various weed control practices (Tables IV & V) reveal that two sprays of sorgaab (25 and 45 DAS) was the most economical weed control practice in soybean. It resulted in maximum net benefits and 46.78% marginal rate of return over control. All other treatments were dominated by this treatment due to higher cost that vary in all such treatments.

Table III. Effect of various weed control practices on yield and yield components of soybean

Treatments	Plant height (cm)	No. of pods per plant	Leaf area (cm^2)	Grain yield (kg ha^{-1})	% increase over control
Control	59.03 a*	24.88 c	639.3 e	743.50 d	-
Sorgaab two sprays (25 and 45 DAS)	56.67 c	27.78 b	663.3 d	805.10 c	8.28
One H.W. (25 DAS) + sorgaab one spray (45 DAS)	58.46 b	32.55 a	751.7 b	879.80 b	18.33
One H. W. (25 DAS) + sorgaab two sprays (45 and 65 DAS)	57.14 c	31.80 a	704.7 c	837.90 c	12.69
One H. W. (25 DAS)	58.07 b	27.98 b	655.3 d	881.20 b	18.52
Pendemethalin pre em @ 1.5 kg ha^{-1} a.i.	54.31 d	33.69 a	796.5 a	996.10 a	33.97
LSD	0.54	2.73	8.728	33.34	---

*= Any two means in a column not sharing a letter differ significantly at p = 0.05; ** = Figures given in parenthesis show percent increase/decrease over control; Sorgaab = Sorghum water extract; DAS = Days after sowing; H.W.= Hand weeding; Pre.em.= pre-emergence; a.i. = Active ingredient.

Table IV. Economic analysis of various weed control practices in soybean

	T_1	T_2	T_3	T_4	T_5	T_6	Remarks
Total yield	743.50	805.10	879.80	837.90	881.20	996.20	kg ha^{-1}
Adjusted yield	669.20	724.60	791.82	754.11	793.08	896.40	10% less than actual yield
Value in Rs.	4600.75	4981.62	5438.125	5184.50	5452.43	6160.00	Rs. 275/40 kg
Cost of hand weeding	-	-	800.00	800.00	800.00	-	Rs.80/man/day (10 men ha^{-1})
Cost of herbicide	-	-	-	-	-	2025.00	Rs. 450/ l (Stomp)
Cost of Sorgaab	-	24.00	12.00	24.00	-	-	Rupees
Spray application cost	-	160.00	80.00	160.00	-	80.00	Rs. 80 / spray
Sprayer rent	-	100.00	50.00	100.00	-	50.00	Rs. 50 / spray
Cost that vary	-	284.00	942.00	1084.00	800.00	2155.00	Rupees
Net benefit	4600.75	4733.62	4496.12	4100.50	4652.42	4005.00	Rupees

T1 = Control ; T2 = Sorgaab two sprays (25 and 45 DAS); T3 = One hand weeding (25 DAS) + sorgaab one spray (45 DAS); T4 = One hand weeding (25 DAS) + sorgaab two sprays (25 and 65 DAS); T5 = One hand weeding (25 DAS); T6 = Pendemethalin pre-emergence @ 1.5 kg ha^{-1} active ingredient

Table V. Marginal analysis of various weed control practices in soybean

Treatments	Cost that vary (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	Marginal rate of return (%)
Control	0	4600.75	-
Sorgaab two sprays (25 and 45 DAS)	284	4733.62	46.78
One H.W. (25 DAS)	800	4652.42 D	-
One H.W. (25 DAS) + Sorgaab one spray (45 DAS)	942	4496.12 D	-
One H.W. (25 DAS) + Sorgaab two sprays (45 and 65 DAS)	1084	4100.50 D	-
Pendimethalin pre emergence @ 1.5 kg ha^{-1} a.i.	2155	4005.00 D	-

D=Dominated; H.W.=Hand Weeding; a.i.=active ingradient

CONCLUSIONS

Results of this study indicate that sorgaab was not much effective against *T. portulacastrum.* However it reduced the growth of all other weeds observed in soybean fields. Moreover, it had no adverse effects on soybean when used prior to flowering. Hence it could be used as a natural herbicide for soybean crop.

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