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Use of Sorgaab (Sorghum Water Extract) as a Natural Weed Inhibitor in Spring Mungbean

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ABSTRACT

A field trial was carried out to examine the feasibility of using sorgaab (sorghum water extract) as a natural weed inhibitor in spring mungbean during 1999 at Agronomic Research Area, University of Agriculture, Faisalabad. Sorgaab sprays (1-4) were tested and compared with one hand weeding and pre-emergence application of pendimethalin @ 1.0 kg a.i. ha^{-1}. Results of the study showed that three foliar sprays of sorgaab (20 + 30 + 40 DAS), one hand weeding (30 DAS) and pendimethalin spray (1.0 kg a.i. ha^{-1}) inhibited the total weed density by 31.58, 22.81 and 35.96%, respectively. An inhibition of 44.11, 28 and 43% in total weed dry weight was noticed by three sorgaab sprays, one hand weeding and pendimethalin treatment, respectively. Three sorgaab sprays enhanced grain yield of mungbean by 18%, while hand weeding and pendimethalin treatment increased grain yield by 10% and 13%, respectively.

Key Words: Sorgaab; Pendimethalin; Mungbean; Weed inhibition

INTRODUCTION

Weed infestation in mungbean crop is one of the main causes of low yield per hectare against the potential yield. Uncontrolled weeds can reduce mungbean yield by 28% (Ali, 1992). Control of weeds with herbicides and mechanical means is prevalent in Pakistan. However, higher cost of labor, technological and environmental problems associated with herbicide use, limit their use and emphasize the need to search for new alternatives. Sorghum allelopathy has successfully shown its ability to inhibit the weeds and enhanced the yields in crops as wheat, maize and soybean etc. (Ahmad, 1998; Cheema, 1998; Khaliq *et al.,* 1999). Sorghum allelochemicals are species specific and concentration dependent in their effects (Cheema & Ahmad, 1992). Similarly Cheema *et al*. (1999) revealed that two foliar sprays of sorgaab (10%) at 30 and 40 days after sowing increased wheat grain yield by 21%, while sorgaab (5%) at 30 and 40 DAS increased the yield in the range of 7 to 16%, the overall weed density and biomass were reduced by 22 and 46%, respectively. The objective of this study was to evaluate the effectiveness of sorgaab (sorghum water extract) as a natural weed inhibitor in spring mungbean.

MATERIALS AND METHODS

To examine the influence of sorgaab on growth and yield of spring mungbean and its weeds, a field experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad during the year 1999. The experiment was laid out in randomized complete block design (RCBD) with four replications. The net plot size was 5 x 1.8 m. Mungbean cv. NM-54 was planted in the last week of February 1999 with single row hand drill, using seed @ 20 kg per hectare by maintaining 30 cm and 10 cm distance between rows and plants, respectively. A basal dose of 20 kg N and 50 kg P_2O_5 per hectare was applied in the form of Urea and SSP. Mature sorghum herbage (stalk) was chaffed into 2-3 cm pieces then soaked in water in a ratio of 1:10 w/v (sorghum to water) for 24 hours. The filtrate (sorgaab) was either used fresh or stored in deep freezer for subsequent use. The volume of sorgaab spray (300 L ha^{-1}) and pendimethalin dose (1.0 kg a.i. ha^{-1}) was measured by calibration, prior to spraying. Sorgaab was sprayed on mungbean and its weeds with the help of knap sack hand sprayer fitted with flat fan nozzle, while pendimethalin was applied as pre-emergence weedicide. One hand weeding was given with the help of hand hoe (*Kasola*). The experimental treatments were one sorgaab spray 20 days after sowing (DAS), two sorgaab sprays 20 + 30 DAS, three sorgaab sprays 20 + 30 + 40 DAS, four sorgaab sprays 20 + 30 + 40 + 50 DAS, one hand weeding 30 DAS, pendimethalin treatment (pre-emergence) @ 1.0 kg a.i. ha^{-1} and control (weedy check). *Cyperus rotundus, Chenopodium album* and *Convolvulus arvensis* were the main weeds, while a few plants of *Portulaca oleracea* and *Rumex dentatus* were recorded at the experimental site. Data on weed dynamics (density, fresh and dry weights) were recorded twice at 35 and 55 DAS from two randomly selected quadrates (50 x 50 cm) from each experimental unit. Individual weed count was made. Weeds were cut from ground surface and weighed fresh and after drying in an oven at 80 ºC for 48 hours. Data on various mungbean plant growth parameters as plant height, leaf area, number of pods per plant and number of grains per pod were recorded from randomly selected samples. Stalk and grain yields were recorded from plots and converted into kg ha^{-1}. Data were analyzed statistically by using analysis of variance technique and least significant difference (LSD) at 5% probability was applied to compare the differences among the treatment means (Steel & Torrie, 1984). Economic analysis was performed to establish the economical treatments (Buyerlee, 1988).

RESULTS AND DISCUSSION

All the treatments significantly suppressed total weed population Table I. Weeds counted on 55 DAS revealed that four sorgaab sprays (20 + 30 + 40 + 50 DAS) reduced total weed population by 39% and was followed by pendimethalin with 36% reduction, while three sorgaab sprays decreased total weed density by 32%. The reduction in weed number with sorgaab foliar sprays indicated the allelopathic effect of sorghum water extract. In case of individual weeds, maximum inhibition in the density of purple nutsedge (51%) was obtained with four sorgaab sprays and was followed by three sorgaab sprays (38%). This supports the findings of Rauf (1998) and Ahmad (1999) who suggested suppressive effects of sorgaab on purple nutsedge. Results (Table I) revealed that plots with pendimethalin @ 1.0 kg a.i. ha^{-1} showed maximum inhibition (85.71%) in density of field bindweed and was followed by 71.43 and 64.29% with four and three sorgaab sprays. 42.86% inhibition was noted by two sorgaab sprays and one hand weeding (30 DAS) each. In case of lambsquater density, maximum suppression (90%) was observed by pendimethalin and was followed by 80 and 60% reduction with four and three sorgaab sprays. 40% reduction was obtained with two sorgaab sprays which was statistically on par with one hand weeding. The results confirm the findings of Cheema and Ahmad (1992) and Iqbal (1997) who demonstrated the suppression of weeds population with sorghum water extract.

Maximum reduction (47.59%) in total weed dry weight was obtained with four sorgaab sprays and was followed by 44.11% and 43.93% with three sorgaab sprays and pendimethalin, respectively (Table II). The suppression of weed dry weight with incorporation of sorghum root, stem and leaves was also reported by Cheema and Ahmad (1992).

Dry weight of purple nutsedge was significantly suppressed in all the treatments (Table II). Plots with four sorgaab sprays gave maximum suppression (57%) and was followed by three sorgaab sprays (46%). One hand weeding reduced the dry weight of purple nutsedge by 26%, which was statistically on par with two sorgaab sprays and pendimethalin treatment. Similar findings were reported by Al-Juboory and Ahmad (1994) and Sana (1999) who indicated suppression of purple nutsedge with sorghum allelochemicals. Pendimethalin treatment appeared more suppressive in reducing dry weight of field bindweed by 85.78% and was followed by 67.56 and 52.44% with four and three sorgaab sprays, respectively. Similar findings were reported by Cheema and Ahmad (1992) and Ahmad (1999) who stated reduction in dry weight of field bindweed was an indicative of suppressive effects of sorghum bicolor. Dry weight of lambsquater was significantly suppressed by all weed control treatments as compared to control. Maximum inhibition (87.57%) was obtained with pendimethalin and was statistically on par with four sorgaab sprays that were followed by 44% reduction with three sorgaab sprays. The results are in confirmation with Kalair (1989) and Iqbal (1997) who reported that sorghum allelopathy had inhibitory effects on growth and dry weight of lambsquater due to its water soluble, phoytotoxic allelochemicals.

Plant height of mungbean was significantly influenced by all the treatments (Table III). Maximum plant height

Table I. Effect of various weed control practices on the density of weeds (50 x 50 cm^2)

Treatments	Purple nutsedge	Field bindweed	Lambsquater	Total weed density
Control	19.50 a	3.50 a	2.50 a	28.50 a
One sorgaab spray (20 DAS)	17.25 b (11.54)	2.50 b (28.57)	2.00 ab (20.00)	25.25 b (11.40)
Two sorgaab sprays (20+30 DAS)	15.00 d (23.08)	2.00 b (42.86)	1.50 bc (40.00)	23.50 c (17.54)
Three sorgaab sprays (20+30+40 DAS)	12.00 e (38.40)	1.25 c (64.29)	1.00 cd (60.00)	19.50 e (31.58)
Four sorgaab sprays (20+30 +40+50 DAS)	9.50 f (51.28)	1.00 cd (71.43)	0.50 de (80.00)	17.50 f (38.60)
One hand weeding (30 DAS)	16.00 cd (17.95)	2.00 b (42.86)	1.50 bc (40.00)	22.00 d (22.81)
Pendimethalin (1.0 kg a.i. ha^{-1})	17.00 bc (12.82)	0.50 d (85.71)	0.25 e (90.00)	18.25 f (35.96)
LSD (0.05)	1.12	0.55	0.73	1.11

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

Treatments	Purple nutsedge	Field bindweed	Lambsquater	Total weed dry weight
Control	9.49 a	2.25 a	3.54 a	16.39 a
One sorgaab spray (20 DAS)	8.07 b (14.96)	1.91 b (15.11)	3.01 ab (14.97)	14.12 b (13.85)
Two sorgaab sprays (20+30 DAS)	7.00 d (26.24)	1.67 c (25.78)	2.87 ab (18.93)	12.50 c (23.73)
Three sorgaab sprays (20+30+40 DAS)	5.13 e (45.94)	1.07 d (52.44)	1.98 c (44.07)	9.16 e (44.11)
Four sorgaab sprays (20+30 +40+50 DAS)	4.09 f (56.90)	0.73 e (67.56)	1.02 d (71.19)	8.59 f (47.59)
One hand weeding (30 DAS)	6.99 d (26.34)	1.67 c (25.78)	2.64 bc (25.42)	11.80 d (28.00)
Pendimethalin (1.0 kg a.i. ha^{-1})	7.14 c (24.76)	0.32 f (85.78)	0.44 d (87.57)	9.19 e (43.93)
LSD (0.05)	0.09	0.21	0.86	0.44

Any two means not sharing a letter in common differ significantly at 5% level of probability; Figures given in parenthesis show percent reduction over control; DAS = Days after sowing

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

Treatments	Plant height (cm)	Leaf area (cm^2)	No. of pods Per plant	No. of grains per pod	1000-grain weight (g)	Grain yield (kg ha^{-1})
Control	29.65 e	418.5 g	7.83 e	6.30 e	60.20 g	1155 e
One sorgaab spray (20 DAS)	31.17 d	421.3 f	8.33 d	6.60 de	61.50 f	1195 e (3.46)
Two sorgaab sprays (20+30 DAS)	32.29 bc	435.3 d	9.25 c	6.81 cd	63.20 d	1250 c (8.23)
Three sorgaab sprays (20+30+40 DAS)	33.35 a	467.4 a	10.50 a	7.88 a	71.90 a	1360 a (17.75)
Four sorgaab sprays (20+30 +40+50 DAS)	32.13 c	426.8 e	9.17 c	6.75 cd	62.30 e	1220 b (5.63)
One hand weeding (30 DAS)	32.80 b	442.5 c	9.37 c	6.94 c	64.41 c	1270 c (9.96)
Pendimethalin (1.0 kg a.i. ha^{-1})	33.40 a	448.8 b	9.80 b	7.44 ab	69.21 b	1300 ab (12.55)
LSD (0.05)	0.51	1.81	0.36	0.33	0.47	23.09

Any two means not sharing a letter in common differ significantly at 5% level of probability; Figures given in parenthesis show percent increase over control; DAS = Days after sowing

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

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Remarks
Total grain yield	1155	1195	1250	1360	1220	1270	1300	kg ha^{-1}
Adjusted yield	1039.5	1075.5	1125.0	1224.0	1098.0	1143.0	1170.0	kg ha^{-1} (10% discount)
Gross income	15592.5	16132.5	16875.0	18360.0	16470.0	17145.0	17550.0	@ Rs. 1500/100kg
Cost of hand weeding	--	--	--	--	--	800	--	10 men/day/ha @ Rs. 80/man
Cost of herbicide	--	--	--	--	--	--	1760	Pendimethalin @ Rs. 440/liter
Cost of Sorgaab	--	30	60	90	120	--	--	Rs. 10/40kg Sorghum+sorgaab preparation @ Rs. 80/man (One man/day/ha)
Spray application cost	--	80	160	240	320	--	80	
Sprayer rent	--	50	100	150	200	--	50	Rs. 50/spray
Cost that vary	--	160	320	480	640	800	1890	Rs. ha^{-1}
Net benefit	15592.5	15972.5	16555.0	17880.0	15830.0	16345.0	15660.0	Rs. ha^{-1}

T_1 = Control (weedy check); T_5 = Four sorgaab sprays 20 + 30 + 40 + 50 DAS; T_2 = One sorgaab spray 20 DAS; T_6 = One hand weeding 30 DAS; T_3 = Two sorgaab sprays 20 + 30 DAS; T_7 = Pendimethalin pre-emergence @ 1.0 kg a.i. ha^{-1}; T_4 = Three sorgaab sprays 20 + 30 +40 DAS

(33.40cm) was observed with herbicidal treatment and was followed by and statistically on par with three sorgaab sprays. The plots with one hand weeding (30 DAS) resulted in 32.80 cm plant height, which was statistically similar to with two and four sorgaab sprays. The results are in line with the work of Ahmad (1998) and Sana (1999) who reported that enhanced plant height was possibly due to better weed control.

A significant positive influence on leaf area was observed by all the treatments (Table III). Three sorgaab sprays produced maximum leaf area (467.4 cm^2), which significantly differed with all other treatments and was followed by pendimethalin treatment (448.8 cm^2). The results are in line with the work of Angiras *et al*. (1987) who stated that no suppressive effect was seen on leaf establishment of soybean by *Sorghum halepense*. All the treatments had positive significant effects on number of pods per plant as compared to control. Three foliar sprays of sorgaab resulted in maximum number of pods (10.50) per plant and were followed by 9.80 and 9.37 pods per plant with pendimethalin and hand weeding, respectively. Similar results were recorded by Stoimenova and Mikova (1992) and Rakha (1999) who reported more number of pods per plant, were mainly due to better weed control, low weed density and hence low weed crop competition.

Three sorgaab sprays produced maximum number of grains (7.88) per pod and was followed by 7.44 grains with herbicidal treatment (Table III). Hand weeding produced 6.94 grains per pod, which was statistically same with two and four sorgaab sprays. Results are in accordance with Rakha (1999) who reported that weed suppression through sorghum allelopathy provided better crop growth for more grains formation. All the treatments had significant promoting effects on grains weight as compared to control. Maximum increase (19.44% over control) resulted in the plots with three sorgaab sprays and was followed by 15% increase with pendimethalin. The results are in accordance with Weston (1996) who stated increased yield was possibly due to heavier grains and reduced weed infestation.

The yield of mungbean was significantly higher in most of the treatments as compared to control except one sorgaab spray (20 DAS). Three foliar sprays of sorgaab produced maximum grain yield (1360 kg ha^{-1}) and it enhanced the yield by 18% as compared to control. The next better treatment was pendimethalin with an increase of 13% (over control). One hand weeding increased yield by 10% as compared to control. This increase in grain yield may be due to better weed management, better leaf area, more number of pods, more and heavier grains etc. Results are in accordance with Allah Rakha (1999) who reported that three sprays of sorgaab (15 + 30 + 45 DAS) increased grain yield of mungbean by 18.8%.

Economic analysis (Table IV) revealed that three foliar sprays of sorgaab at 20 + 30 + 40 DAS gave the highest net benefits and was followed by two sorgaab sprays (20 + 30 DAS) and one hand weeding (30 DAS). Marginal

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

Treatments	Cost that vary Rs.ha^{-1}	Net benefit Rs.ha^{-1}	Marginal rate of return (%)
T_1 = Control (weedy check)	0	15592.5	0
T_2 = One Sorgaab Spray 20 DAS	160	15972.5	237.50
T_3 = Two Sorgaab sprays 20 + 30 DAS	320	16555.0	364.06
T_4 = Three Sorgaab sprays 20 + 30 + 40 DAS	480	17880.0	828.13
T_5 = Four Sorgaab sprays 20 + 30 + 40 + 50 DAS	640	15830.0	D
T_6 = One hand weeding 30 DAS	800	16345.0	D
T_7 =Pendimethalin pre-emergence @ 1.0 kg a.i. ha^{-1}	1890	15660.0	D

D = Dominated; DAS = Days after sowing; Marginal rate of return (MRR)= Change in net benefits/ Change in cost x 100; Cost that vary = the cost that is incurred on the variable inputs in the production of a particular commodity

analysis (Table V) further showed that three foliar sprays of sorgaab were better in terms of maximum (828.13%) marginal rate of return and was followed by two-sorgaab sprays. So on the basis of above discussion it could be concluded that three foliar sprays pf sorgaab (20 + 30 + 40 DAS) may be used as a natural weed inhibitor in spring mungbean.

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