

Determining Suitable Combination of Sorgaab and Pendimethalin for Weed Control in Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

A field trial to determine the suitable combination of Sorgaab (sorghum water extract) with reduced rates of Pendimethalin for weed control in cotton was carried out at Agronomic Research Farm, University of Agriculture, Faisalabad. Sorgaab @ 12 and 16 L ha⁻¹ was combined with Pendimethalin at reduced rates as 833, 625 and 416 g a.i. ha⁻¹, respectively and were compared with full dose of Pendimethalin @ 1.25 kg a.i. ha⁻¹. A weedy check was maintained as control. Results of the study showed that combined spray of Sorgaab @ 12 L ha⁻¹ + 2/3 Pendimethalin @ 833 g a.i. ha⁻¹ showed maximum reduction (85.17%) in total weed dry weight recorded at 45 DAS and was statistically at par with all other treatments except control. Combined spray of Sorgaab @ 16 L ha⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha⁻¹ showed maximum reduction (31.75%) in the total weed dry weight recorded at 65 DAS and was at par with full dose of Pendimethalin @ 1.25 kg a.i. ha⁻¹. The increase in seed cotton yield was maximum with Sorgaab @ 12 L ha⁻¹ + 1/2 Pendimethalin @ 625 g a.i. ha⁻¹ and higher by 31.5% than control, and also it was the most economical as compared with other treatments.

Key Words: Allelopathy; Cotton; Sorgaab (sorghum water extract); Pendimethalin; Weeds

INTRODUCTION

Use of allelopathic materials in combination with reduced rates of herbicides is major focus of present research in Pakistan. Sorgaab (Sorghum water extract) is being investigated for this purpose. Several studies conducted by Cheema and associates (Cheema *et al.*, 2002; Cheema *et al.*, 2000; Ahmad *et al.*, 2000; Khaliq *et al.*, 2002) have revealed that weed inhibition with Sorgaab ranged between 40-50% which is less than weed control achieved with herbicides (80-100%). Although herbicides are very effective in controlling weeds yet certain risks as environmental pollution and human health are involved in herbicide use. Use of herbicides require technical know how which is generally lacking in the country. Improper use of herbicides may lead to crop injury, health hazards, soil and water pollution and in certain cases, target weeds are not controlled because of low doses used by farmers. Herbicide resistance in weeds due to continuous use of the same herbicide for several years is also an emerging problem. These problems have opened new avenues of research i.e. identifying new herbicides, utilizing natural and biological control measures and combining and integrating one or more methods of weed control. One approach may be reduction in herbicide usage in combination with allelopathic materials as Sorgaab, which contains a number of allelochemicals, which are mainly phenolic compounds.

Cheema *et al.* (2002) has investigated the possibilities of reducing the herbicide dose in combination with Sorgaab and reported that Sorgaab @ 12 L ha⁻¹ combined with Pendimethalin @ 0.5 kg a.i. ha⁻¹ (reduced by 60%) applied at sowing was quite effective in suppressing the density and

growth of *Trianthema portulacastrum*. In another study, Cheema *et al.* (2003) found that doses of Pendimethalin and S-metolachlor can be reduced by 67% in combination with Sorgaab. Despite these initial trials, the need still exists to verify the previous results and maximize possible reduction in herbicide dose. This study was, therefore, aimed at determining the best dose combination of Sorgaab and Pendimethalin for weed control in cotton crop under agro-ecological conditions of Faisalabad (Pakistan).

MATERIALS AND METHODS

The present research was carried out at the Agronomic Research Area, University of Agriculture Faisalabad. The experiment was laid out in RCBD with four replications in plots measuring 7 x 3 m. Sorgaab @ 12 and 16 L ha⁻¹ was combined with Pendimethalin at reduced rates as 833, 625 and 416 g a.i. ha⁻¹, respectively and were compared with full dose of Pendimethalin @ 1.25 kg a.i. ha⁻¹. A weedy check was maintained as control.

Cotton variety F.H. 1000 was sown on a well-prepared seedbed in 75 cm spaced rows with hand drill on May 27, 2003. Nitrogen and phosphorous was applied @ 110 and 60 kg, ha⁻¹, respectively in the form of urea and diammonim phosphate (DAP) as a basal dose. Thinning was done manually when the plants attained 20-25 cm height to maintain 30 cm plant-to-plant distance. Insect pests were controlled by using recommended insecticides. Sorgaab was prepared by following the method devised by Cheema and Khaliq (2000). Volume of the spray was 350 L ha⁻¹ and was sprayed in respective plots by using knapsack hand sprayer fitted with T jet nozzle. The data regarding weed density

were recorded from two quadrates of 50 x 50 cm at 15, 40 and 60 DAS. Weeds were harvested at ground level at 40 and 60 DAS and their fresh weights were recorded. Dry weight of the same was recorded after drying in an oven at 80°C for 48 h. Seed cotton yield (kg plot⁻¹) was recorded using standard sampling procedure and then converted on hectare basis.

The data so collected for different parameters were analyzed statistically using Fisher's analysis of variance technique and differences among the treatment means were compared by using the least significant difference (LSD) test at 0.05 probability level (Steel & Torrie, 1984). The treatments were compared by employing economic and marginal analyses (Buyerlee, 1988). Marginal rate of return MRR (%) was calculated as dividing the change in the net benefits by change in cost that vary and expressed as percentage.

RESULTS AND DISCUSSION

Horse purslane and Purple nut sedge were present in the field, the first being the major weed. Weed density (Table I) was significantly suppressed in all the treatments as compared to control plots. Maximum suppression (73.05%) of weeds was noted with Sorgaab @ of 16 L ha⁻¹ + 1/2 Pendimethalin @ 625g a.i. ha⁻¹ followed by Sorgaab @ 16 L ha⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha⁻¹ with 71.05% reduction in total weed density at 15 DAS; whereas, at 40 DAS, maximum reduction (69.07%) was recorded with Pendimethalin full dose @ 1.25 kg a.i ha⁻¹. However, at 60 DAS, maximum control (38.88%) was noted with Sorgaab @ 16 L ha⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha⁻¹ and minimum control (16%) with Sorgaab @ 12 L ha⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha⁻¹.

Combined spray of Sorgaab @ 12 L ha⁻¹ + 2/3 Pendimethalin @ 833 g a.i ha⁻¹ showed maximum reduction of 85.17% in total weed dry weight recorded at 45 DAS and was statistically at par with all the treatments except control (Table II). However, in case of 65 DAS combined spray of Sorgaab @ 16 L ha⁻¹ + 1/3 Pendimethalin @ 416 g a.i ha⁻¹ showed maximum reduction (31.75%) in the total weed dry weight recorded and was followed by Pendimethalin full dose @ 1.25 kg a.i ha⁻¹, which reduced the total weed dry weight by 26% over control. These findings suggest that herbicide dose can considerably be reduced when used in combination with Sorgaab. The results confirm the work of Cheema *et al.* (2003) who reported that Pendimethalin dose could be reduced by 67% in combination with Sorgaab.

Seed cotton yield (Table III) indicated that treatment combination i.e. Sorgaab @ 12 L ha⁻¹ + 1/2 Pendimethalin @ 625 g a.i ha⁻¹ produced maximum yield with 31.52% increase over control and it was statistically at par with the other treatments viz. Pendimethalin full dose @ 1.25 kg a.i ha⁻¹, Sorgaab 12 L ha⁻¹ combined with 1/3 dose of Pendimethalin @ 416 g a.i ha⁻¹ as well as Sorgaab @ 16 L ha⁻¹ combined with 2/3, 1/2, 1/3 doses of Pendimethalin with 18.47, 16.29, 24.99, 18.47 and 24.99% increase in seed

Table I. Effect of Sorgaab in combination with pendimethalin and pendimethalin alone on total weed density (0.5 m²)

Treatments	15 DAS	40 DAS	60DAS
T ₁ = Sorgaab @ 12 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i ha ⁻¹	6.62 b (65.15)	20 e (68.68)	12.25 cde (31.94)
T ₂ = Sorgaab @ 12 L ha ⁻¹ +1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	6.87 b (68.84)	20.87 de (67.32)	14.87 bc (17.38)
T ₃ = Sorgaab @ 12 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	5.75 bc (69.72)	33 b (48.33)	15.12 b (16)
T ₄ = Sorgaab @ 16 L ha ⁻¹ +2/3 Pendimethalin @ 833 g a.i.ha ⁻¹	5.62 bc (70.42)	24.37 cd (57.14)	14.5 bcd (19.44)
T ₅ = Sorgaab @ 16 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i.ha ⁻¹	5.12 c (73.05)	31.25 b (51.85)	11.87 de (34.05)
T ₆ = Sorgaab @ 16 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i.ha ⁻¹	5.50 bc (71.05)	25 c (60.85)	11 e (3.888)
T ₇ =Pendimethalin full dose @ 1.25 kg a.i ha ⁻¹	5.62 bc (70.42)	19.75e (69.07)	14.25 bcd (20.83)
T ₈ = Control (Weedy check)	19 a (---)	63.7 a (---)	18 a (---)
LSD	1.49	4.159	2.792

Table II. Effect of concentrated Sorgaab in combination with pendimethalin and pendimethalin alone on total weed dry weight (g/0.5 m²)

Treatments	40 DAS	60DAS
T ₁ = Sorgaab @ 12 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i ha ⁻¹	5.12 b (85.17)	46.74bc (23.01)
T ₂ = Sorgaab @ 12 L ha ⁻¹ +1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	9.49 b (72.51)	52.48 ab (13.55)
T ₃ = Sorgaab @ 12 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	6.31 b (81.72)	49.89 bc (17.82)
T ₄ = Sorgaab @ 16 L ha ⁻¹ +2/3 Pendimethalin @ 833 g a.i.ha ⁻¹	7.64 b (77.87)	50.19 bc (17.32)
T ₅ = Sorgaab @ 16 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i.ha ⁻¹	11.95 b (65.39)	46.91 bc (22.73)
T ₆ = Sorgaab @ 16 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i.ha ⁻¹	8.18 b (73.31)	41.43 c (31.75)
T ₇ =Pendimethalin full dose @ 1.25 kg a.i ha ⁻¹	6.65 b (80.74)	44.86 bc (26.10)
T ₈ = Control (Weedy check)	34.53 a (---)	60.71 a (---)
LSD	9.20	10.14

cotton yield, respectively. Similar findings were obtained by Cheema *et al.* (2002), who reported that conc. Sorgaab @ 10 L ha⁻¹ with 1/3 dose of Pendimethalin @ 333 g a.i ha⁻¹ was the best treatment with highest seed cotton yield (1149 kg ha⁻¹).

Sorgaab combined with reduced rates of Pendimethalin suppressed weed population which increased the number of bolls per plant and seed cotton weight per boll, hence increased the seed cotton yield. These findings support the idea that herbicidal dose can be reduced by combining with natural allelopathic substances.

Economic analysis (Table IV) revealed that maximum net benefits were obtained with Sorgaab @ 12 L ha⁻¹+ 1/2 Pendimethalin @ 625 g a.i ha⁻¹ as pre-emergence. This was followed by Sorgaab @ 16 L ha⁻¹+ 1/3 Pendimethalin @ 416 g a.i ha⁻¹ and it gave maximum marginal rate of return. Sorgaab @ 12 L ha⁻¹+ 1/3 Pendimethalin @ 416 g a.i ha⁻¹ as pre-emergence also gave 518% MRR (Table V). Other treatments as Sorgaab @ 16 L ha⁻¹+ 2/3 Pendimethalin @ 833 g a.i ha⁻¹, Sorgaab @ 16 L ha⁻¹+ 1/2 Pendimethalin @ 625 g a.i ha⁻¹, Sorgaab @ 12 L ha⁻¹+ 2/3 Pendimethalin @ 833 g a.i ha⁻¹ and Pendimethalin full dose @ 1.25 kg a.i ha⁻¹

Table III. Effect of Sorgaab in combination with Pendimethalin and Pendimethalin alone on growth and yield of cotton

Treatment	plant height (cm)	No of bolls per plant	boll weight (g)	seed cotton yield kg ha ⁻¹
T ₁ = Sorgaab @ 12 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i. ha ⁻¹	137.52 ns	14.40cd	3.95d	1649.99bc
T ₂ = Sorgaab @ 12 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	136.85	17.25a	4.09a	2016.66a
T ₃ = Sorgaab @ 12 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	144.6	14.90bcd	3.96d	1783.33abc
T ₄ = Sorgaab @ 16 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i. ha ⁻¹	135.72	16.70ab	4.05ab	1916.66ab
T ₅ = Sorgaab @ 16 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	137.57	16.10abc	3.99cd	1816.66abc
T ₆ = Sorgaab @ 16 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	141.27	16.60ab	4.01bc	1916.66ab
T ₇ = Pendimethalin full dose @ 1.25 kg a.i. ha ⁻¹	137.6	15.65abcd	3.98cd	1816.66abc
T ₈ = Control (Weedy check)	137.1	14.05d	3.81e	1533.33c
LSD	Ns	1.912	0.046	283.98

Table IV. Economic analysis

	T1	T2	T3	T4	T5	T6	T7	T8	Remarks
Seed cotton Yield	1649.99	2016.66	1783.22	1917.66	1816.66	1916.66	1816.66	1533.33	Kg ha ⁻¹
Adjusted Yield	1485.00	1815.00	1604.90	1725.90	1635.00	1725.00	1635.00	1380	To bring at farmer's level (10 % less)
Gross Income	31556.25	38568.75	34104.12	36675.37	34743.75	38656	34743.75	29325	Rs850 / 40 Kg
Cost of Herbicide	1135.91	852.27	572.72	1135.91	852.27	572.72	1704.54	-----	Pendimethalin @ 450/L
Cost of Sorgaab	50	50	50	60066	66.66	66.66	-----	-----	Expenditure on preparation of 12 L Sorgaab Rs 50/ -
Spray application cost	100	100	100	100	100	100	100	-----	Rs 100 / man (one man per day ha ⁻¹)
Sprayer Rent	50	50	50	50	50	50	50	-----	Rs 50 / spray
Cost that vary	1335.91	1052.27	772.72	1352.57	1068.93	789.38	185454	-----	Rs ha ⁻¹
Net benefits	30220	37516.48	33329.41	35322.8	33674.82	35866.62	32889.21	29325S	Rs ha ⁻¹

T₁ = Sorgaab @ 12 L ha⁻¹ + Pendimethalin @ 833 g a.i. ha⁻¹; T₂ = Sorgaab @ 12 L ha⁻¹ + Pendimethalin @ 625 g a.i. ha⁻¹; T₃ = Sorgaab @ 12 L ha⁻¹ + Pendimethalin @ 416 g a.i. ha⁻¹; T₄ = Sorgaab @ 16 L ha⁻¹ + Pendimethalin @ 833 g a.i. ha⁻¹; T₅ = Sorgaab @ 16 L ha⁻¹ + Pendimethalin @ 625 g a.i. ha⁻¹; T₆ = Sorgaab @ 16 L ha⁻¹ + Pendimethalin @ 416 g a.i. ha⁻¹; T₇ = Pendimethalin full dose @ 1.25kg a.i. ha⁻¹; T₈ = Control (Weedy Check)

Table V. Marginal and dominance analysis

Treatments	Cost vary (Rs ha ⁻¹)	that Net benefit (Rs ha ⁻¹)	Marginal rate of return (%)
T8= Control (Weedy check)	029325	0	
T3= Sorgaab @ 12 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	772.72	33329.41	518.22
T6= Sorgaab @ 16 L ha ⁻¹ + 1/3 Pendimethalin @ 416 g a.i. ha ⁻¹	789.38	35866.62	15229.35
T2= Srgaab @ 12 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	1052.87	37516.48	626.15
T5= Sorgaab @ 16 L ha ⁻¹ + 1/2 Pendimethalin @ 625 g a.i. ha ⁻¹	1068.93	33674.82	D
T1= Sorgaab @ 12 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i. ha ⁻¹	1335.91	30220	D
T4= Srgaab @ 16 L ha ⁻¹ + 2/3 Pendimethalin @ 833 g a.i. ha ⁻¹	1352.57	35322.8	D
T7= Pendimethalin full dose @ 1.25 kg a.i. ha ⁻¹	1854.54	32889.21	D

D = Dominated due to less benefits than preceding treatments; MRR = MRR was calculated as dividing the change in the benefits by change in cost and expressed as percentage; Variable Cost = The cost of purchased inputs, labour and machinery ha⁻¹ that vary between the experimental treatments; Net Benefit = Gross income – variable cost.

were dominated due to higher costs that vary and hence uneconomical.

Based on these findings, it could be suggested that dose of Pendimethalin (stomp 330 E) can be reduced by 50% in combination with Sorgaab (sorghum water extract) @ 12 L ha⁻¹ as pre-emergence spray for controlling cotton weeds particularly horse purslane.

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