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REDUCING ISOPROTURON DOSE IN COMBINATION WITH *SORGAAB* FOR WEED CONTROL IN WHEAT

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ABSTRACT

Allelopathic products inhibit weeds but less than herbicides while herbicides are costly and inflict environmental pollution. A field study was conducted to determine a suitable combination of sorgaab and isoproturon rate. Sorgaab @ 12 L ha^{-1} was combined with reduced rates of isoproturon viz. 300, 400, 500, 600, 700, 800 and 900 g a.i. ha^{-1} respectively. Two foliar sprays of sorgaab at 30 and 40 days after sowing (DAS) and isoproturon @ 1 kg a.i. ha^{-1} (recommend dose) at 30 DAS were applied as standard treatments during 2001 and 2002. Results of the study revealed that isoproturon @ 400 g a.i. ha^{-1} combined with sorgaab @ 12 L ha^{-1} decreased total weed density and dry weight by 72 and 77%, respectively in 2001 while treatment combination of isoproturon @ 500 g a.i. ha^{-1} (half dose) with sorgaab @ 12 L ha^{-1} reduced the total density and dry weight by 92 and 94% in 2002 which were statistically at par with full dose of isoproturon @ 1000 g a.i. ha^{-1} during both the years. The increase in wheat yield ranged 20 to 40% and 10 to 34% during 2001 and 2002, respectively. Economic analysis showed that treatment combination as sorgaab @ 12 L ha^{-1} + isoproturon @ 500 g a.i. ha^{-1} was economical treatment during both the years of study.

Key words: Sorgaab, Isoproturon, Weed control, Wheat, Allelopathy.

INTRODUCTION

Allelopathic effects of *sorgaab* (sorghum water extract) have been demonstrated in recent studies (Cheema *et al.*, 2000 & 2001). Suppression of weeds with 1, 2 or 3 foliar sprays of *sorgaab* was 20-48% in wheat (Cheema *et al.*, 1998), 34-57% in maize (Ahmad *et al.*, 2000) and 16-68% in mungbean (Cheema *et al.*, 2000). Although weed inhibition with *sorgaab* is economical and environmentally benign yet the percentage of weed control is less than herbicides which control weeds up to 80% or more.

Use of herbicides though provides effective weed control yet the herbicides require specific know how and also risks of environmental pollution and health hazards are involved. It has been suggested in recent studies that dose of cotton herbicides could be reduced by 50-67% in combination with *sorgaab* @ 12 L ha^{-1} (Cheema *et al.*, 2002 & 2003). In another study Cheema *et al.*, (2003) indicated that *sorgaab* combined with lower dose of MCPA @ 150 g a.i. ha^{-1} and fenoxaprop-p-ethyl @ 375 g a.i. ha^{-1}gave effective weed control in wheat crop. The present studies were initiated to investigate the possibility of reducing dose of isoproturon in combination with *sorgaab* for weed control in irrigated wheat.

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Materials And Methods

A two-year field study was conducted to investigate the feasibility of reducing isoproturon dose in combination with *sorgaab* (sorghum water extract) for weed control in wheat at Agronomic Research Farm, University of Agriculture, Faisalabad Pakistan. The soil belongs to Lyallpur soil series (Aridisol-fine-silty, mixed, hyperthermic ustalfic, Haplargid in USDA classification and Haplic yermosols in FAO classification scheme). The pH of saturated soil paste (pH_s) and electrical conductivity (EC) of the saturated extract (EC_e) were 7.9 and 0.41 dSm^{-1}, respectively. The wheat cultivars Punjab-96 and Uqaab-2000 were planted manually on moist seedbed in 25 cm apart rows with single row hand drill on November 25, 2000 and November 15, 2001, respectively. In addition to soaking irrigation, four subsequent irrigations at tillering, booting, anthesis and grain development stages were applied. *Sorgaab* @ 12 L ha^{-1} was prepared by following the procedure devised by Cheema *et al.* (2002). The experiments were laid out in randomized complete block design with four replications. The plot sizes were 7×2 m^2 and 5×2 m^2 during 2000 & 2001, respectively. The experiments comprised of the treatments as follows: *Sorgaab* @ 12 L ha^{-1} was sprayed alone at 30 and 40 DAS. *Sorgaab* @ 12 L ha^{-1} was combined with reduced rates of isoproturon i.e. 300, 400, 500, 600, 700, 800 and 900 g a.i. ha^{-1} and applied as foliar sprays at 30 DAS. Full dose of isoproturon @ 1000 g a.i. ha^{-1} was also sprayed at 30 DAS as standard treatment. A weedy check was maintained as control plot during both the years. Volume of spray (300 L ha-1) was determined by calibration. Spraying was done with Knapsack hand sprayer fitted with flat fan nozzle number 8003 at a pressure of 207 kPa. Data on weed density, fresh and dry weights recorded at 60 DAS from two randomly selected quadrates (50×50 cm) from each experimental plot during both the years. Weeds were cut from ground surface and were weighed as fresh and after drying in an oven at 70 ^{0}C for 48 hours. Data on wheat plant height, number of spikelets per spike and number of grains per spike were recorded from randomly selected 20 tillers. Wheat was threshed manually to determine grain yield per plot that was converted into Mg ha^{-1}. Data collected were subjected to Fishers' analysis of variance technique. Least significant difference (LSD) test was applied at 0.05 probability level to compare treatment means (Steel and Torrie, 1984). Economic and marginal analyses were performed by following procedures devised by Byerlee (1988).

Results And Discussion

Total weed density in the experimental field was generally low probably due to the preceding crops as berseem (*Trifolium alexandarinum*) and sorghum (*Sorghum bicolor*) in the rotation. Among the weeds, canary grass (*Phalaris minor*) was the main weed species and was followed by yellow sweet clover (*Melilotus parviflora*), swine cress (*Coronopus didymus*) while a few plants of other weeds as dock (*Rumex dentatus*), wild oat (*Avena fatua*), blue pimpernel (*Anagallis arvensis*), lambsquarters (*Chenopodium album*) and purple nutsedge (*Cyperus rotundus*), wild medic (*Medicago denticulata*) and field bind weed (*Convolvulus arvensis*) were also present.

Weed density was significantly low in all the treatments as compared to control (weedy check) during both the years (Table-1). Weed mortality during 2001 was same in treatment combinations of *sorgaab* @ 12 L ha^{-1} + isoproturon @ 400, 600, 700 and 800 g a.i. ha^{-1} g a.i. ha^{-1} and full dose of isoproturon @ 1 kg a.i. ha^{-1} except *sorgaab* @ 12 L ha^{-1} + isoproturon @ 500 and 900 g a.i. ha^{-1}. The range of weed control was 72 to 79% while in the year 2002 the weed mortality ranged from 64 to 97% but treatment combinations as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 400 or 700 g a.i. ha^{-1} were statistically less effective than other treatments. The weed control with treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 300 g a.i. ha^{-1} was only 52 and 42% respectively during both the years and the weed control with two foliar sprays of *sorgaab* @ 12 L ha^{-1} at 30 and 40 DAS remained in the range of 32 and 29%, during 2001 and 2002, respectively.

Maximum reduction in weed dry weight was obtained in treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 900 g a.i. ha^{-1} during 2001 and *sorgaab* @ 12 L ha^{-1} + isoproturon @ 600 g a.i. ha^{-1} during 2002. However, these were statistically same with full dose of isoproturon @ 1000 g a.i. ha^{-1}. Treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 400 g a.i. ha^{-1} was also equal to full dose of isoproturon @ 1 kg a.i. ha^{-1} during 2001 but during 2002, it was less effective with only 57% reduction. *Sorgaab* two sprays reduced the dry weight by 14-15% during both the years.

The results of these experiments clearly show that isoproturon at lower rates than its full dose combined with *sorgaab* @ 12 L ha^{-1} can effectively control the density and growth of weeds in wheat (Table-1). It appeared that isoproturon @ 400-600 g a.i. ha^{-1} was sufficient to give weed control equal to full dose of isoproturon @ 1 kg a.i. ha^{-1}. These findings support the previous work (Cheema *et al.* 2002) that herbicides dose can be reduced in combination with allelopathic *sorgaab*.

Wheat grain yield was significantly high in all the treatments during 2001 with maximum increase (40.4%) in treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 800 g a.i. ha^{-1} and was followed by treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 900 g a.i. ha^{-1} with 35.5% increase in grain yield while *sorgaab* two foliar sprays at 30 and 40 DAS, full dose of isoproturon @ 1 kg a.i. ha^{-1} and *sorgaab* @ 12 L ha^{-1} + isoproturon @ 400 g a.i. ha^{-1} were statistically on par with each other with 27, 28, 28.5% increase in grain yield over control (weedy check) respectively. During the year 2002, the increase in wheat grain yield was similar (25.3%) in treatment combination as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 600 g a.i. ha^{-1} and full dose of isoproturon @ 1 kg a.i. ha^{-1} and interestingly these were statistically at par with other treatment combinations. The increase in grain yield with two foliar sprays of *sorgaab* was only 9% during 2002.Yield determining components as fertile tillers, spikelets, number of grains and 1000-grain weight and plant height were usually influenced significantly expect fertile tillers during 2001 and plant height during 2002 (Table -2).

The variation in grain yield among treatment combinations during both the years may be due to differential response of the wheat cultivars. Cheema *et al.*, (2002) revealed that various wheat varieties respond differently to *sorgaab*. Wheat plant height and number of spikelets per spike in case of wheat *cv.* Punjab 96 were relatively better which resulted in significant increase in grain yield during 2001 than the standard treatment as full dose of isoproturon @ 1 kg a.i. ha^{-1} (Table-2). Relatively low weed density during 2002 (Table-1) might be the other reason for difference in response.

Interestingly during both the years of study combination of *sorgaab* @ 12 L ha^{-1} + isoproturon @ 500 g a.i. ha^{-1} produced almost equal wheat grain yield to the full dose of isoproturon @ 1 kg a.i. ha^{-1} which clearly revealed that isoproturon dose can safely be reduced by 50% in combination with *sorgaab* @ 12 L ha^{-1}.

Economic analyses of the data for both the years (Table-3) revealed that treatment combination of *sorgaab* @ 12 L ha^{-1} with isoproturon @ 500 g a.i. ha^{-1}, *sorgaab* 12 L ha^{-1} two sprays and the treatment combination @ 12 L ha^{-1} + isoproturon @ 800 g a.i. ha^{-1} were economical treatments and all other treatments were uneconomical during 2001 In the year 2002, treatment combinations as *sorgaab* @ 12 L ha^{-1} + isoproturon @ 300, 400, 500 and 600 g a.i. ha^{-1} were economical but other treatments were uneconomical due to less benefits.

On the basis of these findings it can be suggested that the dose of isoproturon can be reduced considerably (50%) by combining with *sorgaab* @ 12 L ha^{-1}. However, there is need to continue similar studies with different herbicides at different locations.

Table-1. Combined effect of conc. *sorgaab* with reduced rates of isoproturon on total weed density per 0.5 m^2 and dry weight (g per 0.5 m^2) at 60 DAS

Treatments	2001		2002	
	Weed density	Weed dry weight	Weed density	Weed dry weight
Control (weedy check).	50 75 a	25.57 a	38 000 a	2 037 a
Sorgaab @ 12 Lha^{-1} Two sprays at 30 & 40 DAS	31 75 b (37 43)	22.05 a (13.77)	27 12 b (28.61)	1.72 b (15.17)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 300 g a.i ha^{-1}	24.00 c (52 70)	13.87 b (45.76)	21.87 c (42.43)	1.36 c (32.98)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 400 g a.i. ha^{-1}	14.00 d (72.41)	5.78 de (77.37)	13.75 d (63.81)	0.86 d (57.53)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 500 g a.i. ha^{-1}	22.25 c (56 16)	8.99 cd (64.82)	2.87 f (92.43)	0.11 f (94.25)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 600 g a i ha^{-1}	11.00 d (78 33)	6.34 de (75.20)	1.75 f (95.39)	0.07 f (96.46)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 700 g a i ha^{-1}	11.25 d (77 83)	7.87 cd (69.22)	8.12 e (78.61)	0.46 e (77.41)
Sorgaab @ 12Lha^{-1} + isoproturon @ 800 g a.i ha^{-1}	13.50 d (73.40)	10.51 bc (58.89)	2.37 f (93.75)	0.60 e (70.29)
Sorgaab @ 12 Lha^{-1} + isoproturon @ 900 g a i ha^{-1}	23 00 c (54 68)	3.57 e (86.03)	2.37 f (93.75)	0 38 e (81.34)
Isoproturon @ 1 kg a.i. ha^{-1}	10.75 d (78 81)	5 49 de (78 52)	0.87 f (97.69)	0.12 f (94.10)
$LSD_{0\,05}$	5.88	3.80	2.60	0.24

Means with different letters in the respective category differ significantly at α 0.05. Figures given in parenthesis show percent decrease over control.

Table-2. Combined effect of conc. *sorgaab* with reduced rates of isoproturon on yield and yield components of wheat

Treatments	Plant height (cm)		Fertile tillers (m^{-2})		Spikelets $spike^{-1}$		Grains $spike^{-1}$		1000 grain Wt. (g)		Grain yield (Mg ha^{-1})	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Control (weedy check).	83.85d	106.25	355.27^{NS}	210.90 e	16.38 f	18.65 e	41.45 e	42.75 g	44.04 g	37.77 f	2.94 e	3.51 c
Sorgaab @ 12 Lha^{-1}; two sprays at 30 & 40 DAS.	86.90 cd	106.86	368.90	236.10 d	16.95 def	20.40 d	42.65 de	46 35 f	44.37 f	41.71 e	3.74 c (27.19)	3.85 bc (9.67)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 300 g a.i. ha^{-1}	88.47 bc	106.77	359.60	250.00 bc	16.65 ef	20.88 cd	43.17 d	49.60 e	45.25 e	42.45 de	3.52 d (19.58)	4.25 ab (20.96)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 400 g a.i. ha^{-1}	91.07 ab	106.35	370.50	253.30 ab	17.83 abc	21.45 bc	44.20 cd	51.91 cd	45.56 bcd	43.66 bc	3.78 c (28.55)	4.36 ab (24.18)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 500 g a.i. ha^{-1}	89.78 abc	107.30	362.18	256.00 ab	18.50 a	21.83 b	46.63 a	53.67 b	45.66 bc	44.37 b	3.87 bc (31.60)	4.65 a (32.25)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 600 g a.i. ha^{-1}	89.10 abc	105.67	360.75	261.40 a	16.63 bcd	23.02 a	43.88 cd	55.02 ab	45.60 bcd	45.49 a	3.88 bc (31.87)	4.70 a (33.87)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 700 g a.i. ha^{-1}	90.90 ab	105.90	370.25	248.30 bc	16.95 def	21.60 bc	44.13 cd	53.55 bc	45.43 d	44.21 b	3.86 bc (31.13)	4.59 a (30.66)
Sorgaab @ 12Lha^{-1}+isoproturon @ 800 g a.i. ha^{-1}	92.30 a	107.62	365.80	247.50 bc	18.33 ab	21.23 bc	44.78 bc	51.30 d	45.89 a	43.87 bc	4.13 a (40.39)	4.31 ab (22.58)
Sorgaab @ 12 Lha^{-1}+isoproturon @ 900 g a.i. ha^{-1}	91.78 ab	106.40	364.82	242.80 cd	18.08 abc	20.92 cd	46.25 ab	49.28 e	45.74 ab	42.90 cd	3.99 ab (35.53)	4.33 ab (23.24)
Isoproturon @ 1 kg a.i. ha^{-1}	89.05 abc	107.17	368.50	262.10 a	17.45 cde	23.30 a	45.05 bc	55.95 a	45.50 cd	46.01 a	3.77 c (28.17)	4.70 a (33.87)
$LSD_{0.05}$	3.285			9.058	0.7691	0.7254	1.430	1.693	0.1777	1.010	0.165	0.881

Means with different letters in the respective category differ significantly at α 0.05; Figures in parenthesis show percent increase over control.

Table-3. Marginal analysis of different weed control methods in wheat

Treatments	Variable cost (Rs.)*		Net Benefit (Rs.ha^{-1})		Marginal Rate of Return** (%)	
	2001	2002	2001	2002	2001	2002
Control (weedy check)	0	0	19882.50	23733.00	-	-
Sorgaab @ 12 Lha^{-1}+isoproturon @ 300 g a.i. ha^{-1}	552.50	260.00	23222.50	28447.75	604.52	1813.36
Sorgaab @ 12 Lha^{-1}+isoproturon @ 400 g a.i. ha^{-1}	660.00	280.00	24900.00	29190.50	4667.44	3713.75
Sorgaab @ 12 Lha^{-1}+isoproturon @ 500 g a.i. ha^{-1}	767.50	300.00	25400.00	31087.50	465.11	9485.00
Sorgaab @ 12 Lha^{-1}; two sprays at 30 & 40 DAS	330.00	300.00	24960.00	27753.00	D***	D
Sorgaab @ 12 Lha^{-1}+isoproturon @ 600 g a.i. ha^{-1}	875.00	320.00	25345.00	31452.25	D	1823.75
Sorgaab @ 12 Lha^{-1}+isoproturon @ 700 g a.i. ha^{-1}	982.50	340.00	25087.50	30699.50	D	D
Isoproturon @ 1 kg a.i. ha^{-1}	1205.00	350.00	24218.50	31422.25	D	D
Sorgaab @ 12Lha^{-1}+isoproturon @ 800 g a.i. ha^{-1}	1090.00	360.00	26825.00	28732.50	441.86	D
Sorgaab @ 12 Lha^{-1}+isoproturon @ 900 g a.i. ha^{-1}	1197.50	380.00	25750.00	28867.75	D	D

* Variable cost that vary is the cost that is incurred on variable inputs in the production of a particular commodity;

** Marginal rate of return (MRR%)= change in net benefit/change in variable cost × 100 ;

*** D= dominated, any treatment that had net benefits that were less than or equal to those of a treatment with lower variable cost was taken to be dominated.

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