Evaluation of Different Herbicides and Their Application Methods in Rainfed Soybean

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ABSTRACT

Two experiments were conducted during spring 1986 and 1987 at Barani Agricultural College, Rawalpindi and National Agricultural Research Centre, Islamabad, respectively, to evaluate the efficacy of three herbicides viz pendimethalin, fomesafen and fluazifop-butyl when applied by sprayer as well as sand mix broadcasting methods. In both the years of experimentation grasses and sedges were found to be the major component of the weed flora composition and broad leaved weeds were negligible in 1986 while in 1987 it contributed 19% to the total weed density of 234 plants/ m2. A combination of fluazifop-butyl + fomesafen proved excellent to control all the three classes of weeds. Fluazifop-butyl alone reduced density of grassy weeds to a significant level. Fomesafen was most effective against broad leaved weeds but in 1986, due to negligible numbers of broad leaved weeds, it did not contribute much to increase yield. Although sand mix broadcast application gave 39% to 47% weed control but sprayer application was much superior showing 65% to 78% weed control. Pendimethalin was the only herbicide when applied by both sprayer and sand mix broadcasting methods offered excellent weed control. Although highest yield (615.75 and 634.91 Kg/ ha in 1986 and 1987 respectively) was obtained by hand weeding but it was not significantly different from the treatments where fluazifop-butyl + fomesafen was applied by sprayer. Yield reduction in the treatments where fomesafen was applied by both methods of herbicide application, was due to low density of broad leaved weeds. Economic analysis showed that the application of fluazifop-butyl + fomesafen by sprayer and pendimethalin by sprayer as well as sand mix broadcast were the most economical and efficient than hand weeding.

INTRODUCTION

Being a summer crop of monsoon region, the major constraint in soybean production is heavy weed infestation. As compared to manual and mechanical weeding methods, herbicides have been found to be very effective against broad leave as well as grassy weeds (Muller-Warrant and Koch 1983, Marka and Donald 1984, Amiseppa 1986, Beale *et. al.* 1986, Ilnicki *et al* 1986). However, the effect of herbicides depends upon the degree of infestation and type of weed flora present in the field.

Jain and Dubey (1985) tried fluazifop-butyl, fomesafen and fluchloralin at various rates and in different combinations in soybean. They found that the highest grain yield was

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obtained under weed free condition but weed control efficiency of fluazifop-butyl + fomesafen each at 1.0 Kg ai/ha and fluchloralin was equally good. In another study Rezende *et al* (1985) observed that pendimethalin alone and with combination of fluorodifen effectively controlled the weeds in soybean and caused a significant increase in yield as compared to weedy check. Kitchen *et al* (1984) also determined the efficacy of fomesafen against broad leaf weeds. They reported that 0.28 Kg ai/ha of fomesafen gave 100% control of broad leaf weeds but grasses and sedges remained uncontrolled.

Any technology how efficient it may be, will not accepted by the farmers if it does not fit into the socioeconomic system of the community. The same is true about chemical weed control. The herbicide technology did not get popularity mainly because of involvement of the use of sprayer. Besides investment, use of sprayer requires a skill and the illiterate farmers are hesitant to handle it. Its calibrations and computations also add to the complications in its use. The situation demands an easier and economical method of application which may substitute the use of sprayer. Hence Shad (1987) conducted a number of experiments on simple and economical methods of herbicide application and observed that application of chlortoluron + MCPA, 2,4-D sodium salt and isoproturon in wheat, metolachlor + atrazine in maize, butachor, thiobencarb and oxadiazon in rice, and pendimethalin, fluazifop-butyl in soybean, by sand mix broadcast method gave as good weed control as with sprayer application. Consequently the present study was conducted to evaluate the effectiveness of some pre and post emergence herbicides and their methods of application in soybean.

MATERIALS AND METHODS

Experiments were conducted during spring 1986 and 1987 at Barani Agricultural College Rawalpindi and National Agricultural Research Centre, Islamabad, respectively, to evaluate the efficacy of different herbicides when applied by sprayer or as a sand mix broadcasting methods.

The soybean variety used in these experiments was Williams-82. Planting was done with simple hand drill in rows 45cm apart. Plot size was 1.80 x 5m.

Normal cultural practices were applied before seed bed preparation. Fertilizer at the rate of 25 Kg/ha nitrogen and 2.5 Kg/ha of P_2O_5 was uniformly applied to all the plots at the time of seedbed preparation. Normal crop protection measures were adopted. The detail of the treatments are given in table 1.

Visual crop toxicity rating using 0-10 scale, where 0 = No injury, 5 = 50% injury and 10 = 100% injury was recorded as soon as sign of herbicidal injury showed up.

Weed density was determined by taking two quadrate of 50 x 50 cm each randomly at 45 days after seeding (DAS) and classified as grasses,

Table 1. Details of the treatments applied during both the years of experimentation in soybean.

Treatments	Percentage purity	Rate (Kg ai/ha)	Methods of application	Time of application
Pendimethalin	33	1.48	Sand mix broadcast	Pre-Emergence
Pendimethalin	33	1.48	Sprayer application	Pre-Emergence
Fluazifop-butyl	13	0.50	Sand mix broadcast	Post-Emergence
Fluazifop-butyl	13	0.50	Sprayer application	Post-Emergence
Fomesafen	25	0.25	Sand mix broadcast	Post-Emergence
Fomesafen	25	0.25	Sprayer application	Post-Emergence
Fluazifop-butyl + fomesafen	13/25	0.50/0.25	Sand mix broadcast	Post-Emergence
Fluazifop-butyl + fomesafen	13/25	0.50/0.25	Sprayer application	Post-Emergence
Hand weeding	-	-	-	-
Weedy check	-	-	-	-

sedges and broad leaf weeds. Grain yield determination was based on the weight of threshed grain and was adjusted at 13% moisture level by the following formula.

$$\text{Yield (Kg/ha) at 13\% MC} = \text{Plot yield (Kg)} \times \frac{10,000}{\text{harvested area}} \times \frac{\text{\%age of moisture}}{87}$$

All the data were statistically analysed by using analysis of variance and Duncans New Multiple Range Test was applied to determine level of differences among different treatment means.

RESULTS AND DISCUSSION

In both the years of experimentation grasses and sedges were found to be the major component of the weed flora and in 1986 the broad leaved weeds were presented at a density of only 6 plants/ m^2 (Table 2 & 3).

During both the years of experimentation, irrespective of the methods of herbicide application pendimethalin, fluazifop-butyl and a combination of fluazifop-butyl and fomesafen reduced the density of grasses to a significantly low level. Fomesafen alone as expected could not control this class of weeds. Pendimethalin and fluazifop-butyl did not give a good control of sedges but density of sedges recorded in these plots was much lower as compared to weedy check. However, interestingly fomesafen alone as well as in combination with fluazifop-butyl showed the best

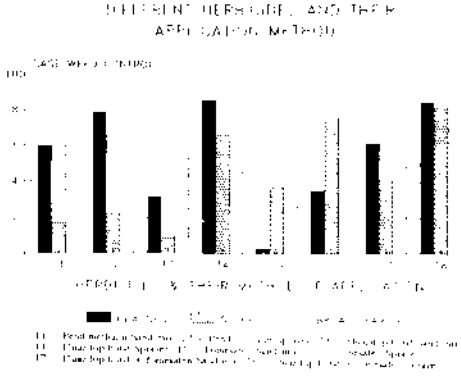

Table 2. Weed flora composition as affected by different herbicides and their methods of application in soybean(1986).

Treatments	*E.colona*	*Bracharia sp*	*C.rotundus*	*D.arvensis*	*C.arvensis*
Pendimethalin (Sand mix)	15	19	16	0	0
Pendimethalin (spray)	12	13	14	2	0
Fluazifop-butyl (Sand mix)	22	10	15	3	0
Fluazifop-butyl (spray)	5	6	9	3	2
Fomesafen (Sand mix)	34	22	4	2	0
Fomesafen (spray)	31	16	4	1	0
Fluazifop-butyl + fomesafen (Sand mix)	23	6	7	3	0
Fluazifop-butyl + fomesafen (spray)	3	6	4	0	0
Hand weeding	-	-	-	-	-
Weedy check	37	28	7	3	3

control of sedges. Broad leaved although present in a very low density were very well controlled by all the herbicides except fluazifop-butyl alone (Fig 1).

Some interesting facts were revealed in this study. Firstly the plots where the grasses were controlled by pendimethalin and fluazifop-butyl, the density of sedges showed a significant increase. It indicates that grasses are good competitor of sedges and the sedges such as *Cyperus rotundus* get better established in the absence of grasses. Secondly the application of fomesafen alone and in combination with fluazifop-butyl successfully controlled all kinds of weeds including sedges and as such were found to be compatible with each other. This control of sedges by fomesafen needs further thorough investigation.

The herbicides and their combinations showed moderately to satisfactorily control of weeds; 65 to 78% with sprayer and 39 to 47% by sand mix broadcasting method. In both the years post emergence application of a combination of fluazifop-butyl + fomesafen with sprayer performed the best in terms of weed density (10 to 38 plants/ m^2) and weed biomass (15.6 to 25.6 grams/ m^2). This combination gave an excellent control of grasses and good control of sedges and broad leaved weeds. When the same mixture was applied by sand mix broadcasting method, it showed only 45-60% weed control. Pendimethalin was the only herbicide when applied by sprayer as well as sand mix broadcasting methods gave good control of weed flora, but late emergence of *Cyperus rotundus* caused a considerable increase in weed density. Similar trend was also shown in terms of weed biomass (Table 4).

Table 3. Weed flora composition as affected by different herbicides and their methods of application in soybean (1987).

Treatments	*E.colona*	*S.halepense*	*D.aegyptium*	*C.dactylon*	*Eragrostis*	*C.rotundus*	*C.arvensis*	*D.arvensis*	*M.sativa*	*Ipomoea*	*E.heterocarpa*	*E.alternata*
Pendimethalin (Sand mix)	3	0	3	8	8	60	3	5	0	0	3	5
Pendimethalin (spray)	2	0	0	2	0	58	2	0	0	0	0	5
Fluazifop-butyl (Sand mix)	0	0	44	9	11	68	2	9	0	0	2	8
Fluazifop-butyl (spray)	0	1	3	5	0	21	2	9	0	2	0	9
Fomesafen (Sand mix)	4	1	67 .	9	1	53	1	0	1	0	0	7
Fomesafen (spray)	4	0	28	0	12	17	0	0	0	0	0	0
Fluazifop-butyl + fomesafen (Sand mix)	4	0	14	2	4	47	1	4	5	0	0	12
Fluazifop-butyl + fomesafen (spray)	2	0	4	0	8	2	0	0	0	0	0	2
Hand weeding		-	-	-	-	-	-	-	-	-	-	-
Weedy check	16	0	52	3	6	82	2	28	4	1	0	10

Table 4. Total weed density and weed biomass as affected by different herbicides and their methods of application in soybean.

Treatment	Rate (Kg ai/ha)	Weed density (No/m2) 1986	1987	Weed biomass (gms/m2) 1986	1987
Pendimethalin (Sand mix)	1.48	50 BC	98 C	64.8 C	117.6 C
Pendimethalin (spray)	1.48	42 C	69 DE	40.8 D	42.8 D
Fluazifop-butyl (Sand mix)	0.50	50 BC	153 B	56.4 C	183.6 B
Fluazifop-butyl (spray)	0.50	25 DE	52 EF	32.4 D	40.0 D
Fomesafen (Sand mix)	0.25	62 AB	144 B	82.8 AB	172.8 B
Fomesafen (spray)	0.25	52 BC	61 EF	79.2 B	61.2 D
Fluazifop-butyl + fomesafen (Sand mix)	0.5 + 0.25	39 CD	93 CD	38.4 D	111.6 C
Fluazifop-butyl + fomesafen (spray)	0.5 + 0.25	13 E	28 F	15.6 E	25.6 D
Hand weeding	-	- F	- G	- F	- E
Weedy check	-	78 A	204 A	99.6	310.8 A

Means followed by common letters in a column are not significantly different.

Fluazifop-butyl satisfactorily controlled grasses but showed very little phytotoxicity to sedges. However, application by sand mix broadcasting method could not perform as good as the spray application (Table 4).

Fomesafen was most effective against broad leaved weeds but at the same time gave slight injury to soybean crop. Although fomesafen did not show any phytotoxicity to grasses and sedges but heavy infestation of grassy weeds suppressed the germination and growth of *Cyperus rotundus*. It indicates that *Cyperus rotundus* was relatively more sensitive to light and space occupation.

Weed competition decreased about 47% grain yield in both the years of experimentation. The highest yield of 615.75 and 634.9 kg/ ha in 1986 and 1987, respectively, was obtained from hand weeded plots but it was at par with the post emergence application of fluazifop-butyl + fomesafen. Post emergence application of fluazifop-butyl gave 78% increase in yield in 1986 and 76% in 1987 and it was much higher than fomesafen application. The least increase in yield by fomesafen was due to heavy infestation of grassy weeds after controlling broad leaved weeds by this herbicide (Table 5).

Among the methods of herbicide application, sprayer application performed better in terms of weed density (33 to 52 plants/ m^2), weed biomass (42.1 to 42.4 grams/ m^2) and yield (506.97 to 520.19 Kg/ ha) followed by sand mix broadcast method (50 to 122 plants/ m^2, 60.6 to 146.4 grams/ m^2 and

Table 5. Grain yield and percent increase over weedy check as affected by different herbicides and their methods of application.

Treatment	Rate (Kg ai/ha)	Grain Yield (Kg/ha) 1986	1987	%age Increase 1986	1987
Pendimethalin (Sand mix)	1.48	501.50 C	527.59 D	55.7	57.8
Pendimethalin (spray)	1.48	517.27 C	567.53 C	60.6	69.7
Fluazifop-butyl (Sand mix)	0.50	356.00 E	347.01 F	10.6	3.8
Fluazifop-butyl (spray)	0.50	574.10 B	589.70 BC	78.3	76.4
Fomesafen (Sand mix)	0.25	321.50 F	319.27 G	0	0
Fomesafen (spray)	0.25	340.75 EF	320.56 G	5.8	0.1
Fluazifop-butyl + fomesafen (Sand mix)	0.5 + 0.25	446.75 D	415.35 E	38.7	24.0
Fluazifop-butyl + fomesafen (spray)	0.5 + 0.25	595.75 AB	602.97 B	85.0	80.3
Hand weeding	-	615.75 A	634.91 A	91.2	89.8
Weedy check	-	322.00 F	334.35 FG		-

Means followed by common letters in a column are not significantly different.

406.44 to 402.31 Kg/ha respectively) (Table 6). These observations indicate that although the sprayer applications were superior but sand mix broadcast method of application also performed satisfactory. It is due to the fact that soil applied herbicides may cause a significant reduction in weed density with sprayer as well as sand mix broadcast method of herbicide application while foliar applied herbicides only with sprayer application would perform better.

Economic analysis revealed that although the highest yield was obtained by hand weeding in both the years of experimentation but cost benefit ratios in respect of hand weeding (1.47 in 1986 and 1.50 in 1987) were much lower than (2.40 in 1986 and 2.87 in 1987) obtained with pendimethalin applied by sprayer which was at par with (2.27 and 2.45 in 1986 and 1987 respectively) sand mix

Table 6. Weed density, weed biomass, grain yield and cost benefit ratio as affected by different methods of herbicide applicatios

Parameters	Methods of Herbicid Application			
	Sand Mix B.C		Spray	
	1986	1987	1986	1987
Weed Density (No/m2)	50	122	33	52
Weed Biomass (Gms/m2)	60.6	146.4	42.1	42.4
Grain Yield (Kg/ha)	406.44	402.31	506.97	520.19
Cost Benefit Ratio	1.06	2.16	0.86	2.29

Table 7. Cost Benefit Ratio as effected by different herbicides and their methods of application.

Treatment	Rate (Kg ai/ha)	Cost Benefit Rato	
		1986	1987
Pendimethalin (Sand mix)	1.48	2.27	2.45
Pendimethalin (spray)	1.48	2.40	2.87
Fluazifop-butyl (Sand mix)	0.50	0.40	0.16
Fluazifop-butyl (spray)	0.50	3.11	3.15
Fomesafen (Sand mix)	0.25	0.01	-0.19
Fomesafen (spray)	0.25	-0.23	-0.17
Fluazifop-butyl + fomesafen (Sand mix)	0.5 + 0.25	1.04	0.68
Fluazifop-butyl + fomesafen (spray)	0.5 + 0.25	2.25	2.20
Hand weeding	-	1.47	1.50
Weedy check	-	-	-

broadcasting method of ampliation. The cost benefit ratios of a mixture of fluazifop-butyl and fomesafen with spray application were 2.25 and 2.20 in 1986 and in 1987 respectively, which were lower than the pendimethalin and higher than hand weeding. The least cost benefit ratios were obtained from the treatments where fomesafen was applied by sprayer as well as sand mix broadcasting method (Table 7).

It can be concluded that pendimethalin is the best herbicide to give an economical weed control whether applied by sprayer or sand mix broadcast method. A tank mixture of fluazifop-butyl and fomesafen which showed the least weed control could also prove economical if the doses are lowered with no loss in efficiency.

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