

Integrated weed control and its economics in soybean (*Glycine max*) grown in Mollisols of Uttar Pradesh

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ABSTRACT

A field experiment was conducted during the rainy seasons of 1988 and 1989. Ten treatments were with and without 1 hand-weeding (fluchloralin @ 1.0 kg/ha pre-plant soil incorporated, metolachlor @ 1.0 kg/ha, alachlor @ 2.0 kg/ha, pendimethalin @ 0.5 kg/ha all as pre-emergence), 2 hand-weedings at 30 and 45 days and weedy (check). Dominant weeds were *Cyperus rotundus* L. (45%), *Echinochloa* spp. (35%), *Trianthema portulacastrum* L. (10%) and *Sorghum halepense* (L.) Pers. (5%) in soybean [*Glycine max* (L.) Merr.]. Alachlor @ 2.0 kg/ha + 1 hand-weeding resulted in maximum decrease in dry matter (94.5%) of weed. Integration of 1 hand-weeding was significantly superior to pure herbicide treatments. Alachlor @ 2.0 kg/ha gave the highest seed yield, which was 36.4% more than weedy check and resulted in highest net return.

Intense weed competition is one of the main constraints of soybean [*Glycine max* (L.) Merr.] productivity and reduction in the yield due to weeds varies from 35 to 50%, depending upon type of weeds, their intensity and time of crop-weed competition (Chandel and Saxena, 1988). Integration of manual and chemical weed control at the maximum weed growth, when crop plants are more subjected to competition from weeds, becomes essential. In the present study an attempt was made to evaluate effect of integrated methods on weeds, and to find out the effect of these methods on yield and quality of soybean.

MATERIALS AND METHODS

A field experiment was conducted during rainy seasons of 1988 and 1989 at Crop Research Centre, Pantnagar, on a

loamy Mollisol of pH 7.6. The soil had organic carbon (%) 1.82, available P_2O_5 93.5 kg/ha and available K_2O 369 kg/ha. Ten treatments of weed control were evaluated (Table 1) in randomized block design, replicated thrice.

Soybean ('PK 262' a determinate type), was sown on 25 and 27 June in 1988 and 1989 respectively using 75 kg seed/ha. Seed was inoculated with *Bradyrhizobium japonicum* culture @ 500 g/75 kg seed. Crop was fertilized with 100 kg diammonium phosphate/ha as basal. Weed-control operations were done as per treatments. Observations on weeds were made at 30 and 60 days after sowing. Data on growth of soybean were recorded at 30 and 60 days after sowing and at harvest. Weeds of experimental field were identified and their intensity was recorded.

RESULTS AND DISCUSSION

Weed flora

Major 8 species of weeds belonging to different groups were identified. Their occurrence and intensity varied in different treatments during both the years. Intensity (%) of weeds varied due to alone chemical and chemical + 1 hand-weeding at 30 days after sowing. Maximum weed infestation (100%) was observed in weedy (check) and the dominant weeds were *Echinochloa colonum* L. (35%), *Cyperus rotundus* L. (40%), *Sorghum halepense* (L.) Pers. (5%), *Celosia argentea* L. (5%), *Trianthema portulacastrum* L. (10%), *Solanum nigrum* L. (5%), contributing to 100% infestation due to no control and their differential response to herbicides applied to control different weed species. The minimum intensity of weeds (10–27%) was observed in metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days, followed by metolachlor @ 1.0 kg/ha (30–32%), 2 hand-weedings at 30 and 45 days (38–43%) and alachlor @ 2.0 kg/ha (40–45%). *Cyperus rotundus* could not be effectively controlled by any of these herbicides. Metolachlor and alachlor were able to control weed growth in the initial stage of the plant growth up to 30 days and then the effectiveness of the herbicides decreased, resulting in higher dry matter of weed (Table 1).

Weed dry matter

There was a significant difference in weed dry matter due to different weed-control treatments at 30 and 60 days over the control (weedy check). Application of herbicides significantly decreased weed dry matter from the control at 30 days in 1988. Maximum and significant decrease (58.4%) in weed dry matter was recorded in alachlor

@ 2.0 kg/ha + 1 hand-weeding at 30 days, followed by alachlor @ 2.0 kg/ha (49.7%) and metolachlor @ 1.0 kg/ha at 32 days (32.8%). However, during 1989 reduction in weed dry matter (94.3%) was recorded in metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days, which was at par with alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days and with 2 hand-weedings at 30 and 45 days and significantly less than rest of the treatments. During 1989 metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days resulted in lowest weed dry matter and was at par with alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days and 2 hand-weedings at 30 and 45 days. As the growth advanced there was an increase in weed dry matter but the persistency of alachlor in the field to smother the weed growth was more as compared to rest of the herbicides, because at 60 days the lowest weed dry matter was observed in alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days, which was significantly less than rest of the herbicides with and without weeding. Integration of 1 hand-weeding after herbicides significantly reduced the weed dry matter at this stage. This finding is in close agreement with that of Dwivedi *et al.* (1991). Weed dry matter in fluchloralin @ 1.0 kg/ha + 1 hand-weeding at 30 days and that in metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days were at par during 1988, but only metolachlor was able to keep the weed growth under control in 1989 when it was compared with fluchloralin (Table 1).

Weed population

At 30 and 60 days the effect of herbicides with and without 1 hand-weeding on weed population was significantly different and lowest weed population was recorded in alachlor @ 2.0 kg/ha and alachlor @ 2.0 kg/

Table 1. Effect of integrated weed control on weed dry matter and weed population at different growth stages of soybean

Treatment	Weed population/m ²				Weed dry matter (g/m ²)			
	30 DAS		60 DAS		30 DAS		60 DAS	
	1988	1989	1988	1989	1988	1989	1988	1989
Fluchloralin @ 1.0 kg/ha (PPI)	68.0	54.0	74.0	65.0	81.5	110.8	165.6	240.0
Fluchloralin @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	82.0	73.0	42.0	49.0	98.1	75.0	96.2	142.5
Metolachlor @ 1.0 kg/ha (PE)	72.0	65.0	76.0	68.0	96.3	180.7	174.8	255.7
Metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	84.0	91.0	41.0	72.0	100.0	25.16	94.9	60.4
Alachlor @ 2.0 kg/ha (PE)	46.0	51.0	48.0	59.0	64.7	128.0	110.4	140.1
Alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 DAS	54.0	57.0	25.0	31.0	55.0	29.5	57.5	25.6
Pendimethalin @ 0.5 kg/ha (PE)	78.0	80.0	80.0	94.0	94.2	108.1	179.4	280.0
Pendimethalin @ 0.5 kg/ha + 1 hand-weeding at 30 DAS	89.0	78.0	49.0	44.0	106.8	127.5	112.7	200.3
2 hand-weedings at 30 and 45 DAS	104.0	81.0	99.0	56.0	122.8	46.2	227.7	100.3
Weedy (check)	115.0	145.0	128.0	181.0	128.5	450.0	294.0	1,247.0
CD (P = 0.05)	15.57	18.41	11.15	34.37	2.85	32.51	2.58	22.36

PPI, Pre-plant soil incorporated; PE, pre-emergence spray; DAS, days after sowing

ha + 1 hand-weeding at 30 days during 1988 and 1989 respectively. At 30 days it was at par with alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days and significantly less than rest of the treatments, whereas at 60 days alachlor along with 1 hand-weeding was at par with fluchloralin @ 1.0 kg/ha, fluchloralin @ 1.0 kg/ha + 1 hand-weeding, alachlor @ 2.0 kg/ha, pendimethalin @ 0.5 kg/ha + 1 hand-weeding and weeding at 30 and 45 days and less than rest of the treatments (Table 1). The maximum weed population was observed in weedy check. Alachlor with 1 hand-weeding at 30 days reduced the population of weeds as well as their dry matter more effectively than the other herbicides except metolachlor. However, herbicide alone and with 1 hand-weeding reduced the weed population. One interculture controlled the weeds emerged late. Less reduction in weed population due to herbicides applied alone was probably related to their efficacy and selectivity for later emerged weeds. Similar findings were also observed by Tiwari *et al.* (1992).

Plant dry matter

There was a significant difference in plant dry matter of soybean at both the stages of study during 1988 and 1989. At 60 days maximum dry matter of plant was recorded in alachlor @ 2.0 kg/ha, which was at par with alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days and metolachlor @ 1.0 kg/ha, and significantly greater than rest of the treatments during 1988. The lowest dry matter was recorded in weedy (check) in both years. The maximum was recorded in fluchloralin @ 1.0 kg/ha + 1 hand-weeding at 30 days in 1989, which was at par with fluchloralin @ 1.0 kg/ha and metolachlor @ 1.0 kg/ha. During 1989, favourable weather conditions resulted in better plant growth

and dry matter/plant. Integration of 1 hand-weeding with herbicide significantly increased dry matter/plant at both the stages and increase in dry matter/plant at harvest was more compared than that at 60 days (Table 2). Such an increase was due to better plant growth during 1989 and low weed-dry matter in the plots where 1 hand-weeding was done. It was able to provide less competition of weeds with plant for nutrients, water, space and light. Weeding after 30 days along with the herbicide spray increased its efficiency to control the weeds (Singh *et al.*, 1992).

At harvest maximum dry matter (90.5 – 106.2 g/plant) was recorded in alachlor @ 2.0 kg/ha and alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days, which were at par with metolachlor @ 1.0 kg/ha, alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days and metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days, alachlor @ 1.0 kg/ha and 2 hand-weedings at 30 and 45 days in 1988 and 1989 respectively and significantly greater than rest of the treatments (Table 2).

Minimum plant dry matter was recorded in weedy (check). Thus herbicides with and without 1 hand-weeding increased the plant dry matter at both the stages of study. Bhan and Paliwal (1983) also reported such an increase.

Yield attributes and yield

Different weed-control treatments significantly affected the number of pods/plant and grain yield. During 1988, maximum number of pods was recorded in alachlor @ 2.0 kg/ha, which was at par with metolachlor @ 1.0 kg/ha, metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days and alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 days. The former treatments were significantly greater than rest of the

Table 2. Effect of integrated weed control on plant dry matter, yield attributes and seed yield of soybean

Treatment	Dry matter (g/plant)				Number of pods/ plant		Seed yield (q/ha)	
	60 DAS		At harvest		1988	1989	1988	1989
	1988	1989	1988	1989				
Fluchloralin @ 1.0 kg/ha (PPI)	20.6	27.5	78.5	85.2	110.8	54.0	18.83	19.91
Fluchloralin @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	19.2	31.2	73.2	93.2	110.6	83.7	17.03	25.94
Metolachlor @ 1.0 kg/ha + (PE)	21.8	27.3	82.4	80.6	111.6	65.0	19.43	17.75
Metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	20.5	28.1	78.5	97.7	111.7	69.7	19.16	28.94
Alachlor @ 2.0 kg/ha (PE)	23.6	28.4	90.5	110.4	116.6	74.0	20.82	19.53
Alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 DAS	22.1	30.7	85.0	106.2	116.0	99.3	19.99	26.41
Pendimethalin @ 0.5 kg/ha (PE)	19.4	24.6	74.4	70.6	108.9	53.3	14.76	15.25
Pendimethalin @ 0.5 kg/ha + 1 hand-weeding at 30 DAS	19.7	26.1	75.7	86.9	110.0	55.7	14.16	26.11
2 hand-weedings at 30 and 45 DAS	18.8	27.5	71.8	94.4	109.0	136.7	16.66	24.39
Weedy (check)	12.4	18.0	38.8	30.0	90.4	37.3	7.49	2.08
CD (P = 0.05)	2.02	5.22	8.04	11.75	5.55	20.44	4.36	3.74

PPI, Pre-plant soil incorporated; PE, pre-emergence spray; DAS, days after sowing

treatments. However, during 1989 maximum number of pods/plant was recorded in 2 hand-weedings, which was significantly greater than rest of the treatments and followed by alachlor @ 2.0 kg/ha + 1 hand weeding at 30 days. The lowest number of pods/plant was recorded during both the years in weedy condition. In general, the pods/plant increased with integration of 1 hand-weeding in all the herbicides during 1989. Herbicide treatments increased the number of branches/plant, resulting possibly in more number of pods/plant. Goyal *et al.* (1991) also indicated that herbicides with 1 hand-weeding increased the yield attributes. Grain yield was significantly influenced by

different weed-control treatments. During the first year the highest grain yield was recorded with alachlor @ 2.0 kg/ha which was at par with and without 1 hand-weeding with fluchloralin, metolachlor and 2 hand-weedings at 30 and 45 days and significantly greater than pendimethalin @ 0.5 kg/ha alone, with 1 hand-weeding and weedy condition, whereas during the second year integration of 1 hand-weeding with herbicide increased the seed yield. Goyal *et al.* (1991) also reported increase in yield with integration of 1 hand-weeding with herbicides and Chandel and Saxena (1987) reported an increase in grain yield of soybean with pendimethalin @ 1.0 kg and metolachlor @ 1.0 kg/ha. Chandel and

Table 3. Effect of integrated weed control on economics of soybean

Treatment	Net return (Rs/ha)	
	1988	1989
Fluchloralin @ 1.0 kg/ha (PPI)	3,402	4,864
Fluchloralin @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	2,862	9,441
Metolachlor @ 1.0 kg/ha (PE)	3,582	6,110
Metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	3,501	10,906
Alachlor @ 2.0 kg/ha (PE)	4,009	6,943
Alachlor @ 2.0 kg/ha + 1 hand-weeding at 30 DAS	3,750	9,587
Pendimethalin @ 0.5 kg/ha (PE)	2,001	4,758
Pendimethalin @ 1.0 kg/ha + 1 hand-weeding at 30 DAS	2,001	9,388
Two hand-weedings at 30 and 45 DAS	2,751	8,286
Weedy (check)	1,050	-1,271

PPI, Pre-plant soil incorporated; PE, pre-emergence spray; DAS, days after sowing

Cultivation cost of soybean (Rs/ha), 1,993 and 2,310; sale price of soybean (Rs/q), 300 and 500; price of alachlor (Rs/litre), 90 and 100.00; price of fluchloralin (Rs/litre), 175 and 175; price of pendimethalin (Rs/litre), 136 and 140 in 1988 and 1989 respectively; price of metolachlor (Rs/litre) 190 in 1989; labour charges (Rs/day/labour), 13.20 and 19.80; spraying charges for 3 labourers/day/ha (Rs). 39.60 and 59.60

Hand-weeding, 200 m²/labour/day

Saxena (1988) reported reduction in grain yield (34 to 66%) due to weed competition in soybean in Uttar Pradesh.

Economics

Maximum net returns were obtained with alachlor @ 2.0 kg/ha and metolachlor @ 1.0 kg/ha + 1 hand-weeding at 30 days during 1988 and 1989 respectively. Weedy check showed net loss of Rs 1,271/ha in 1989 because of lowest grain yield and highest weed dry matter (128.5 – 450 g/m² to 294.0 – 1,247 g/m²) and weed populations (115–145/m² to 128–181/m²) which competed with the crop plants for growth resources. The highest grain yield of soybean with alachlor and metolachlor resulted in the maximum net returns (Rs 4,009 – 10,906/ha). Dwivedi *et al.* (1991) indicated that fluchloralin and metolachlor were as efficient as cultural methods of weed control but they may prove better in situation where manual weeding is not possible (Table 3).

It was concluded that on an average 1 hand-weeding at 30 days after pre-emer-

gence spray of herbicide was better than manual weeding or pre-emergence herbicide application alone for increasing seed yield of soybean.

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