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Effect of row spacing, mulching and weed control on weed growth and yield of soybean (*Glycine max*)

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ABSTRACT

A field study carried out during the rainy season of 1992 and 1993 revealed that reduction in row spacing from 45 cm to 25 cm increased the weed-control efficiency by 21.7% and grain yield by 15.6%. The oil content was also increased but protein content decreased. Though mulching at 5 tonnes/ha was effective in controlling weeds (23%) and increasing grain yield (9.3%), it was found uneconomical. Weed control through maintenance of weed-free conditions up to 75 days after sowing or application of fluchloralin at 1.5 kg/ha preplanting incorporation + interculturing at 40 days after sowing were equally effective. However, the latter was economically more viable. Combined application of all the above treatments were found beneficial than their singe use.

Soybean [*Glycine max* (L.) Merr.] is an important rainy season (*kharif*) crop of Madhya Pradesh. Simultaneous emergence and rapid growth of weeds leads to severe crop–weed competitions and reduction of crop yields. Rainfall pattern of the region does not permit timely intercultivations to control weeds and their manual control is also very difficult on large scale on account of high cost and labour shortage. Adoption of an integrated approach is therefore essential. Keeping above in view, the present investigation was carried out.

MATERIALS AND METHODS

An experiment was conducted at CIAE, Bhopal, in the rainy season of 1992 and 1993. The soil of the experimental plot was black clayey (deep Vertisols) with organic carbon content 0.54% and available N, P and K 174, 11 and 245 kg/ha respectively. Soil was neutral in reaction (pH 7.3). The area received an average rainfall of 900 mm in rainy season. the actual rainfall received during the growth period of the crop, i.e. from July to October was 226, 262, 92 and 47 mm in 1992 and 324, 187, 473 and 49 mm in 1993.

Soybean crop variety 'PK 472' was sown at the row spacings of 25, 35, and 45 cm on 2 July 1992 and 4 July 1993 respectively. Mulching at 0 and 5 tonnes/ha of dry grass was applied immediately after sowing in between the crop rows. Weed-control methods included weedy check, weed-free conditions up to 75 days, weeding twice at 20 and 40 days after sowing either by hand-weeding or interculturing with animal-drawn weeders, application of fluchloralin at 1.5 kg/ha as preplanting incorporation and a combination of fluchloralin at 1.5 kg/ha + 1 interculturing at 40 days after sowing. The experiment was laid out in split-plot design with 3 replications. All the recommended package of practices were followed for the crop. Weed-control efficiency and weed-

Table 1. Effect of row spacing, mulching and weed-control methods on weeds and crop growth at 75 days after sowing and yield attributes at harvest of soybean (average of 2 years)

Treatment	Weed/ m^2 (WCE)	Weed dry weight/m^2 (g) (WSE)	Leaf-area index	Dry matter (g/plant)	Branches/ plant	Nodules/ plant	Nudule dry weight (mg/plant)	Pods/ plant	Pod weight g/plant	1,000-seed weight (g)
Row spacing (cm)										
45	44.3 (–)	20.5 (–)	5.5	32.8	31.0	88.7	238.6	180	143.0	94.3
35	40.8 (7.9)	17.9 (12.5)	6.0	28.9	30.1	82.2	200.0	160	130.1	90.4
25	34.7 (21.7)	15.3 (25.0)	6.2	24.5	28.9	71.6	179.3	147	119.8	85.5
CD (P = 0.05)	6.1	3.39	0.5	2.4	0.9	3.4	12.0	5	6.3	0.4
Mulching (tonnes/ha)										
0	45.2 (–)	20.5 (–)	5.7	27.4	28.2	77.7	192.0	154	125.9	88.0
5	34.6 (23.4)	15.3 (25.2)	6.1	29.4	31.8	84.0	219.9	171	136.1	92.2
CD (P = 0.05)	2.1	1.1	0.2	0.6	0.6	1.2	5.2	3	2.8	0.4
Weed-control method										
Weedy check	72.1 (–)	32.1 (–)	4.5	21.4	25.9	72.9	206.3	149	106.0	87.0
Weed-free	21.4 (70.3)	9.5 (70.4)	6.6	32.7	32.3	85.1	217.1	173	145.3	92.2
Weeding twice (20 , 40 DAS)	32.4 (55.1)	14.4 (55.3)	6.2	29.0	30.8	83.6	197.4	164	136.0	90.7
Fluchloralin @ 1.5 kg/ha (ppi)	44.8 (37.9)	20.7 (35.6)	5.9	26.9	28.9	78.7	201.4	154	126.9	88.6
Fluchloralin @ 1.5kg/ha – interculturing at 40 days	28.8 (60.0)	12.8 (60.2)	6.3	31.1	32.1	84.2	204.4	171	140.6	92.0
CD (P = 0.05)	3.0	1.4	0.6	1.3	0.7	1.7	11.4	4	4.7	0.7

Figures in parentheses are weed-control efficiency (%) and weed-suppressing efficiency (%) respectively

suppressibility index were calculated respectively from the data on weed population and weed dry weight collected from 0.5 m x 0.5 m quadrant at 75 days stage of the crop. The observations on crop growth parameters were also recorded at this stage. Protein and oil contents were determined by adopting standard procedures, at the harvesting stage of the crop.

RESULTS AND DISCUSSION

Effect of row spacing

Row spacing had a significant influence on weeds. Maximum weed density and dry weight were recorded in 45 cm row spacing compared with 35 and 25 cm row spacings. There was an increase of 21.7% in weed-control efficiency and 25% in weed suppressibility index of the soybean crop at 25 cm row spacing over 45 cm due to increased plant density which disturbed the normal growth of weeds (Table 1).

The crop growth was maximum at 75 days after sowing, as the canopy covered the inter-rows. The canopy coverage in terms of leaf-area index (LAI) was significantly higher at 25 cm row spacing over 45 cm but at par with 35 cm. Thus higher LAI at 25 cm and planophilic nature of soybean conopy which precluded penetration of solar radiation up to weeds were particularly responsible for major depressing effects on weeds. However, plant dry weight/plant and branching were the maximum at 45 cm row spacing due to more space available between the individual plants and less competition for space, nutrients, moisture and light. Nodulation of the individual plants was also highest with 45 cm row spacing. These characters had favourably reflected their influence on the yield attributes (pods/plant, pod yield/plant and 1,000-grain weight), which were significantly highest at 45 cm row spacing. Prasad *et al.* (1993) also reported similar results. But the improvement in the performance of the individual plants at 45 cm row spacing does not seem to transform into higher grain yields. At 25 cm row spacing, significantly superior grain yield was recorded during both the years (Table 2). This was basically due to the significantly higher depressing effects of weeds on crop with higher row spacing of 45 cm. The decrease in yield due to weeds at 25 cm row spacing was less and it increased to 19.7 and 11.6% at 45 cm and 6.8 and 5.3% at 35 cm row spacings during 1992 and 1993 respectively. Singh and Sharma (1989) also reported reduction in yield of 15–20% by increasing row spacing from 30 to 60 cm. The net returns and benefit: cost ratio were also increased with the reduction in the row width from 45 to 25 cm. The net returns increased by Rs 2,488 and 1,160/ha and benefit: cost ratio by 0.51 and 0.22 respectively, in 1992 and 1993. The oil content of the grain also significantly increased with the reduction in the row width from 45 to 35 cm in 1992 and to 25 cm in 1993. However, the protein content reduced significantly with decrease in row spacing for 45 to 25 cm during both the years.

Effect of mulching

Mulch @ 5 tonnes/ha effectively suppressed the weed growth, Beneficial effects of mulch were also observed on the leaf-area index, dry matter and branching of the individual plants as well as on the nodulation of the crop. There was a significant improvement in the number of pods and pod yield/plant and 1,000-seed weight (Table 1). The favourable effects of mulching on these characteristics ultimately influenced the seed yield significantly during both the years. The increase being 8.7 and 10.0% in

Table 2. Effect of row spacing, mulching and weed-control methods on grain yield, net returns and oil and protein contents of soybean

Treatment	Seed yield (q/ha)			Net returns (Rs/ha)		Benefit : cost ratio		Oil content (%)		Protein content (%)	
	1992	1993	Pooled	1992	1993	1992	1993	1992	1993	1992	1993
Row spacing (cm)											
45	13.51	12.59	13.00	6,618	5,882	1.58	1.40	18.3	19.1	44.5	45.5
35	15.68	13.48	14.58	8,274	6,514	1.94	1.52	18.8	19.2	44.3	45.4
25	16.82	14.24	15.53	9,106	7,042	2.09	1.62	19.1	19.4	44.2	45.1
CD (P = 0.05)	0.44	0.39	0.69					0.4	0.1	0.3	0.1
Mulching (tonnes/ha)											
0	14.60	12.74	13.67	7,490	6,002	1.79	1.43	18.6	19.0	44.2	45.4
5	16.00	14.15	15.07	8,102	6,630	1.73	1.41	18.9	19.4	44.5	45.7
CD (P = 0.05)	0.33	0.21	0.13					0.2	0.1	0.1	0.1
Weed-control method											
Weedy check	10.68	9.42	10.05	4,804	3,796	1.28	1.01	18.2	18.5	43.1	43.7
Weed-free	18.09	15.81	16.95	8,032	6,208	1.25	0.96	18.9	19.5	45.0	46.1
Weeding twice (20 , 40 DAS)	15.80	14.14	14.97	7,400	6,072	1.41	1.16	18.8	19.1	44.5	45.4
Fluchloralin @ 1.5 kg/ha (ppi)	15.12	13.06	14.09	7,906	6,258	1.88	1.49	18.7	19.3	44.3	45.3
Fluchloralin @ 1.5kg/ha + interculturing at 40 days	17.07	14.61	15.84	9,166	7,198	2.04	1.60	19.0	19.7	44.9	46.3
CD (P = 0.05)	0.41	0.32	0.32					0.4	0.1	0.3	0.2

Table 3. Effect of interaction between row spacing, mulching and weed control methods on yield (q/ha) of soybean

Treatment	No mulching row spacing				Mulching			
	45	35	25	Mean	45	35	25	Mean
Weed-control methods								
Weed-check	8.7	10.2	10.7	9.9	9.2	10.6	10.9	10.2
Weed-free	14.8	16.1	17.3	16.3	16.0	18.1	19.4	17.4
Weeding twice (20, 40 days)	13.0	14.3	15.4	14.2	14.6	15.6	17.0	15.7
Fluchloralin @ 1.5 kg/ha (ppi)	12.0	13.5	14.5	13.3	13.4	15.1	15.6	14.7
Fluchloralin + Interculturing at 40 days	13.2	15.1	16.3	14.9	15.1	17.3	18.1	16.8
Mean	12.3	13.8	14.8	13.7	13.6	15.1	16.2	15.1
CD (P = 0.05)								
Row spacing x weed control	0.6							
Row spacing x mulching	0.1							
Weed control x mulching	0.3							
Row spacing x mulching x weed-control	0.6							

1992 and 1993, respectively, over no-mulch plots (Table 2). The net returns were increased by Rs. 612 and 628/ha but the benefit : cost ratio was reduced from 1.79 to 1.73 in 1992 and from 1.43 to 1.41 in 1993. Though mulching reduced the weed growth and increased the yield but not economically effective. Singh *et al.* (1992) also reported similar results.

The seed quality in respect of oil and protein contents significantly improved due to mulch application, probably through improved availability of moisture and nutrients as a result of weed suppression.

Effect of weed control

Various weed-control methods showed significant effect in reducing the weed infestation. The highest weed-control efficiency (70.3%) and weed suppressibility index (70.4%) were recorded in weed-free plots, followed by pre-planting incorporation of fluchloralin @ 1.5 kg/ha + 1 interculturing at days after sources (60%) and 2 weedings at 20 and 40 days (55%). Similar trend in LAI, dry matter, branches/ plant and nodulation and yield attributes were observed (Table 1). This has also reflected its influence on the seed yield which was significantly increased during both the years. Unweeded check caused 40.5% reduction in seed yield compared with weed-free conditions. Weed-free plots recorded significantly highest seed yields over all the other treatments.

The next best treatment of fluchloralin + 1 interculturing at 40 days recorded an advantage of 57.6% in seed yield over weedy check. Fluchloralin alone @ 1.5 kg/ha proved less effective than 2 weedings at 20 and 40 days but fluchloralin in combination with interculturing at 40 days was superior to all the other treatments in terms of net returns. It gave the maximum net returns of Rs. 9,166/ha and Rs. 7,198/ha in 1992 and 1993, which was higher by Rs 1,134/ha and

Rs. 990/ha than weed-free plots. Similarly, benefit : cost ratio was also higher in the above treatment over weed-free plots due to higher cost of labour involved for maintaining the plots weed free (Tiwari *et al.*, 1988).

Oil and protein contents of seed were also significantly improved owing to weed-control treatments. Maximum concentrations were observed under plots treated with fluchloralin + 1 interculturing and weed-free plots.

The interaction effects between row spacing x mulching, row spacing x weed-control methods, mulching x weed-control methods and their combined effects were significant in a pooled analysis (Table 3). It was inferred that the individual weed-control systems like reduction of row spacing from 45 to 25 cm, mulching and weed control through the application of fluchloralin + interculturing at 40 days were not only effective individually but their combined effects were significantly more effective in the comprehensive control of weeds. It gave 16.5, 20.1 and 14.3% higher seed yield, respectively, over individual treatments of 25 cm row spacing, mulching and application of fluchloralin + interculturing.

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