Indian Journal of Agronomy **52** (1) : 74–76 (March 2007)

Evaluation of efficacy of post-emergence herbicides in soybean (*Glycine max*)

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Received: September 2006

ABSTRACT

A field experiment was conducted at the research farm of the university during rainy (*kharif*) season 2001 and 2002 to evaluate the efficacy of post-emergence herbicides against weeds in soybean [*Glycine max* (L.) Merr.]. Among the weeds, the grassy weeds were predominant (69%) in the experimental field compared with broad-leaf weeds (31%). Post-emergence application of haloxyfop ethoxy-ethyl at 50 g/ha or higher rates (75 and 100 g/ha) gave effective control of grassy weeds only. Imazethapyr at 75 g/ha controlled only broad-leaf weeds. Haloxyfop ethoxy-ethyl (50 g/ha) controlled grassy weeds better and gave yield-attributing traits and yield comparable to those of hand-weeding and proved more remunerative than imazethapyr 75 g/ha as well as hand-weeding treatment.

Key words : Soybean, Weed control, Post-emergence herbicides, Nodulation, Economics

Presently a number of herbicides like alachlor, fluchloralin, pendimethalin, metribuzin etc. are commercially available for weed control in soybean [*Glycine max* (L.) Merr.], but they are applied either before sowing the crop or after the emergence of soybean seedlings. The sowing time of most of the crops including soybean is short in rainy (*kharif*) season and the farmers give first priority to sowing of the crop rather than to herbicide application for the control of weeds. Consequently, various grassy and broad-leaf weeds emerge simultaneously with the crop plants and rob it of essential nutrients, space and moisture, causing substantial loss in yield (35-55%), depending on the type of weed flora and density of weeds (Kewat *et al.*, 2000; Kurchania *et al.*, 2000). Recently some herbicides, particularly haloxyfop ethoxyl-ethyl and imazethapyr are beign marketed with the assurance of selective control of post-emergement weeds in soybean. Since the information on efficacy of both the herbicides is meagre, a comprehensive study was undertaken to adjudge the activity of post-emergence herbicides against weeds in soybean.

MATERIALS AND METHODS

The study was conducted on clay soil during *kharif* 2001 and 2002, having pH 7.2, electrical conductivity 0.2 dS/m and organic carbon 0.66 per cent, and analysing low in available N (270 kg/ha) and medium in P (22.4 kg/ha) and K (256 kg/ha). The seven treatments comprised four rates of haloxyfopethoxyethyl (Gallent 10 EC) @ 25, 50, 75 and 100 g/ha as post-emergence at 14 days after sowing (DAS); imazethapyr 75 g/ha at 21 DAS and two hand-weedings (20 and 40 DAS) including weedy check. These were tested in randomized block design with four replications. Soybean 'JS 90-41' was sown @ 80 kg/ha on 28 and 30 June with a row spacing of 30 cm during both the years along with fertilizer dose of 20 kg N + 80 kg P_2O_5 +20 kg K_2O/ha. Herbicides were applied using flat-fan nozzle in the foot-sprayer with a spray volume equivalent to 500 l/ha. The species-wise weed population was recorded by the least-count quardrat (0.25 m × 0.25 m) method at 45 DAS, whereas the weed biomass was recorded at harvest and weed-control efficiency was calculated accordingly. The economic analysis of each treatment was done on the basis of prevailing market prices of the inputs used and outputs obtained under each treatment. The market price of heloxyfop ethoxyethyl (EE) and imazethapyr were Rs 1,800 and 1,850/ha respectively, whereas the cost of two weedings (20 and 40 DAS) amounted to Rs 3,500 for 50 mandays. The rates of seed and straw were taken Rs 10 and 0.5/kg respectively.

RESULTS AND DISCUSSION

Effect on weeds

The weed density averaged over two seasons revealed that grassy weeds (69%) were dominant in the experimental field compared with non-grassy weeds (31%).

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Echinochloa crus-galli was rampant (66.7%) amongst the grassy weeds, whereas *Commelina communis* (17.2%) was dominant among the broad-leaf weeds. Besides, *Phyllanthus niruri*, *Cyanotis axillaries*, *Digiteria adscendence* and *Dinebra arabica* were fewer.

All the weed-contol treatments greatly reduced the individual weed population and their total dry weight over weedy check, which had the maximum density of weeds (313/m^2) and weed biomass (4,364 kg/ha) (Table 1). Post-emergence application of haloxyfop ethoxy-ethyl at lowest rate (25 g/ha) did not curb the population of grassy weeds satisfactorily, but was markedly effective when applied at 50 g/ha or higher rates (75-100 g/ha), and these treatments even surpassed hand-weeding in controlling the grassy weeds. But its efficacy against broad-leaf weeds was almost zero at all the rates. However, imazethapyr (75 g/ha) gave excellent control of broad-leafy weeds only when applied at post-emergence to soybean, and it proved superior to the rest of the treatments except hand-weeding twice. The selective action is the reason for better control of grassy and broad-leaf weeds with the post-emergence application of haloxyfop EE (50 to 100 g/ha) and imazethapyr (75 g/ha) respectively. Jain *et al.* (2000) as well as Kushwah and Vyas (2005) also reported similar results from their studies. The weed-control efficiency indicated that haloxyfop ethoxy-ethyl at lowest rate (25 g/ha) paralysed the weed biomass production up to 70 per cent, but where it increased to 77 and 79 per cent applied at higher rates (50 and 75 g/ha), and also proved significantly syperior to imazethapyr (75 g/ha), which curbed the weed biomass production only by 52 per cent because of zero efficacy against dominant grassy weeds. However, haloxyfop ethoxy-ethyl at 50 and 75 g/ha could not surpass the hand-weeding treatment, which checked the weed growth to the maximum extent (98) due to elimination of most of the weeds at 20 and 40 DAS.

Yield reduction was maximum (64%) when the weeds were not controlled throughout the crop season in weedy plots; but it was almost 0 per cent when the plots were hand-weeded twice due to elimination of all sorts of weeds during the critical period of crop-weed competition. Post-emergence application of haloxyfop ethoxy ethyl also checked the yield reduction appreciably (91%) when applied at 50-75 g/ha and proved superior to its lowest (25 g/ha) and highest doses (100 g/ha), including imazethapyr 75 g/ha. Excellent control of grassy weeds by the application of haloxyfop ethoxy-ethyl at 50 to 75 g/ha could be the reason for minimum yield reduction in soybean. Poor activity of imazethapyr at 75 g/ha against predominant grassy weeds as well as haloxyfop ethoxyethyl at lowest rate (25 g/ha) and phytotoxicity on the soybean plants at the highest rate (100 g/ha) are the reasons for

Table 1. Influence of post-emergence herbicides on weed population (45 DAS), weed biomass, weed-control efficiency and weed index at harvest in soybean (mean data of 2 seasons)

Treatment	Dose (g/ha)	Time of application (DAS)	Weed population (No./m^2)						Weed biomass (kg/ha)	WCE (%)	Weed index (%)
			Echinochloa crus-galli	*Digiteria adscendence*	*Dinebra arabica*	*Commelina communis*	*Phyllanthus niruri*	*Cynotis axillaries*			
Haloxyfop-EE	25	14	5	0	2	57	22	16	1,309	70	15
Haloxyfop-EE	50	14	0	0	0	52	23	17	971	77	9
Haloxyfop-EE	75	14	0	0	0	51	24	18	887	79	9
Haloxyfop-EE	100	14	0	0	0	50	24	17	889	77	15
Imazethapyr	75	21	200	4	5	1	10	9	2,058	52	42
Hand-weeding	2	20,40	5	2	3	3	2	3	80	98	
Weedy check			209	4	4	54	24	18	4,364		64
CD (P=0.05)									98		

Table 2. Influence of post-emergence herbicides on nodulation, yield-attributing traits, yield and economics of soybean (mean data of 2 seasons)

Teratment (Dose g/ha)	Nodulation at 40 DAS		Pods/ plant	Seeds/ pod	Seed index (g)	Yield (q/ha)		NMR (Rs/ha)	B:C ratio
	Nodules/ plant	Fresh weight (g)				Seed	Straw		
Haloxyfop-EE (25)	113	1.065	10.3	2.4	8.3	8.70	29.50	2,575	1.33
Haloxyfop-EE (50)	125	1.078	10.9	2.5	8.4	9.35	31.15	2,857	1.35
Haloxyfop-EE (75)	117	1.068	11.3	2.5	8.4	9.36	31.20	2,420	1.28
Haloxyfop-EE (100)	113	1.067	11.4	2.5	8.4	8.70	29.45	122	1.13
Imazethapyr (75)	98	0.784	7.8	2.2	6.8	5.95	19.80	-1,598	0.81
Hand-weeding	122	1.072	11.5	2.7	9.0	10.25	34.20	1,460	1.13
Weedy check	86	0.596	4.2	1.9	5.7	3.70	12.50	-2,675	0.61
CD (P=0.05)	11	0.007	1.4	0.4	0.9	0.92	1.36		

NS = Non-significant, HI = harvest index; NMR = net monetary returns; B:C ratio = benefit:cost ratio

relatively higher reduction in yield of soybean.

Effect on crop

Nodulation yield-attributing traits and seed yield in soybean was affected significantly due to different weed-control treatments (Table 2). The number of nodules/plant and their fresh weight were higher with post-emergence application of haloxyfopethoxy ethyl at 50 g/ha, which proved significantly superior to the its other rates as well as to imazethapyr and weedy check, but was comparable to hand-weeding twice. The soybean plants under haloxyfop ethoxyethyl (50 g/ha) and in the hand-weeded plots had congenial soil environment due to better control of weeds during the critical period of crop-weed competition, which in turn recorded more number of nodules as well as their fresh weight. However, poor nodulation might have been caused due to inefficient control of weeds under haloxyfop ethoxy-ethyl at lowest rate (25 g/ha) and imazethapyr, heavy weed infestation under weedy check and the presence of haloxyfop ethoxyethyl molecules in the soil in lethal concentration at higher rates of application (75 and 100 g/ha).

The yield-attributing traits, viz. pods/plant, seeds/pod and seed index, were better under haloxyfop ethoxy ethyl when applied at 50 to 100 g/ha, which was significantly superior to imazethapyr (75 g/ha) and weedy check but was comparable to hand-weeding (Table 2). The seed and straw yields of soybean were less when the weeds were allowed to compete with the crop throughout season in the weedy check plots. But these yields increased identically when the weeds were controlled either by post-emergence herbicides or hand-weeding. The seed and straw yields were lower when haloxyfop ethyoxy-ethyl was applied at the lowest rate (25 g/ha) but were higher when it was applied at 50 and 75 g/ha and proved significantly superior to imazethapyr (75 g/ha) and weedy check, being on a par with hand-weeding twice. Superior yield-attributing traits contributed to higher yields under haloxyfop ethoxy-ethyl (50 and 75 g/ha) and hand-weeding twice. However, haloxyfop ethoxy-ethyl at the highest rate (100 g/ha) caused phytotoxicity to the crop plants, which led to reduction in seed yield of soybean.

Economics

There was loss in net monetary returns, when the weeds were not controlled throughout the crop season and when imazethapyr (75 g/ha) was applied to control the weeds in soybean respectively. Lower seed and straw yields due to severe crop-weed competition throughout the crop season in weedy plots and zero activity of imazethapyr (75 g/ha) against predominant grassy weeds could be the reasons for loss in both the treatments. However, post-emergence application of haloxyfop ethoxy ethyl at 50 g/ha was found more remunerative, as it fetched the maximum net monetary returns and benefit:cost ratio compared with other rates of haloxyfop ethoxy-ethyl and even surpassed hand-weeding treatment. Excellent control of dominant grassy weeds without any adverse effect on crop growth and nodulation with good seed and straw yields may be attributed to superior economic indices in this treatment. The higher cost of weed control (Rs 3,500/ha) is the reason for lower values of net monetary returns and benefit:cost ratio under hand-weeding treatment in spite of maximum seed and straw yields.

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