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Effect of some new post-emergence herbicides on weed parameters and seed yield of soybean *(Glycine max)*

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ABSTRACT

A field experiment was conducted during the rainy season of 1996 and 1997 at Crop Research Centre, Pantnagar, on silt-loam soil to study the effect of post-emergence herbicides and their rates on the weed parameters and seed yield of soybean [*Glycine max* (L.) Merr.]. Plant height, number of trifoliates, dry matter/plant, yield attributes and seed yield of soybean, weed dry matter and weed density were significantly affected by herbicides. Highest seed yield and seed-production efficiency were obtained under 2 hand-weedings at 30 and 45 days after sowing and with anilophos @ 1.75 kg ai/ha, propaquizafop @ 75 g ai/ha and imazethapyr @ 100 g ai/ha, respectively, during 1996 and 1997.

Key words : Herbicides, Post-emergence, Soybean, Growth, Yield attributes, Weed control, Seed-production efficiency, Seed yield

Agro-climatic conditions of northern plains particularly of foot-hill and *bhabhar* regions of Uttar Pradesh are favourable for soybean production and its maximum potential could be achieved if weeds are managed timely. Poor yields in rainy-season crops including soybean may probably be due to weed infestation. Soybean growth and seed yield are seriously affected if weeds are not controlled at initial stages. Bhan (1994) reported 40–60% loss in seed yield in soybean due to weeds. During rainy season, frequent rains do not permit to weed removal mechanically or manually, timely. Also, weeds removal by manual method under such circumstances is costly and cumbersome, and sometimes not possible by the use of pre-emergence herbicides due to frequent rains. Therefore, in the present study, an attempt was made to evaluate the effect of different post-emergence herbicides at variable doses on weeds and seed yield of soybean.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season of 1996 and 1997 at Crop Research Centre on silt-loam soil (pH 7.4)

containing 0.72% organic carbon, 29.5 kg P/ha and 235 kg K/ha. Twelve treatments comprising chemical weed-control methods and hand-weedings (Table 1) were tested in randomized block design with 3 replications. The pre-planting and pre-emergence herbicides as checks were sprayed 1 day before and immediately after sowing of 'PK 1042' soybean. Soybean seeds were inoculated with *Bradyrhizobium japonicum* culture @ 500 g/75 kg seed. Soybean seeds were treated with Thiram 75% wp @ 4 g/kg seed before inoculation. Basal application of 100 kg diammonium phosphate (18:46:0)/ha was done. Two manual weedings at 30 and 45 days after sowing were done. Experiment was planted on 4 and 5 July and was harvested on 16 November and 28 October in 1996 and 1997 respectively. The seed production efficiency was calculated taking total economic yield of soybean, dividing by total duration of the crop. Weed-control efficiency was also calculated.

RESULTS AND DISCUSSION

The experimental field was infested with various weed species, consisting of both dicot and monocot weeds and sedges. Most common species in weedy plots were *Cyperus rotundus, Celosia argentea, Echinochloa colonum, Sorghum halepense, Cucumber* spp., *Cynodon dactylon, Trianthema monogyna, Physalis minima, Commelina benghalensis, Amaranthus viridis* and *Eclipta alba* etc.

Growth parameters

All the growth parameters except plant height at harvest were significantly affected due to various weed-control treatments (Table 1). During the first year, maximum plant height was obtained with post-emergence application (PoE) of propaquizafop @ 75 g ai/ha which was significantly superior to propaquizafop @ 50 g ai/ha and imazethapyr @ 100 g ai/ha (PoE) and was at par with rest of the treatments. In the second year, maximum plant height was recorded in weedy plots which was significantly more than imazethapyr @ g ai/ha and was on a par with rest of the treatments. All these annual variations in plant height of soybean were due to decreased efficacy of herbicides because of continual rains in 1996, the weeds could not be controlled. Thus, heavy infestation of weeds resulted in itiolated soybean plants competing for light, except in case of propaquizafop @ 50 g ai/ha and imazethapyr @100 g ai/ha, which was applied post-emergence, gave effective weed control. Minimum trifoliates/plant at 60 days during both the years were in weedy (check), which were significantly less than imazethapyr @ 75 g ai/ha and 2 hand-weedings at 30 and 45 days after sowing. It might be due to heavy weeds infestation, which reduced aeration, light, nutrients, water and space available to the soybean plants resulting in poor development of trifoliates (Table 1).

At 60 days after sowing application of imazethapyr @ 75 g ai/ha and alachlor @ 2.0 kg ai/ha, as pre-emergence spray (PE), helped in producing maximum plant dry matter, which was significantly greater than trifluchloralin @ 1.0 kg ai/ha as pre-plant soil incorporated (PPI), Fenoxyprop-p-ethyl @ 70 g ai/ha (PoE), Anilophos @ 1.75 kg ai/ha (PE), weedy (check) and Trifluchlo-

Table 1. Effect of pre- and post-emergence herbicides on growth of soybean

Treatment	Plant height (cm)				Trifoliates/ plant		Dry matter (g/plant)			
	60 DAS		At harvest		60 DAS		60 DAS		At harvest	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Alachlor @ 2.0 kg ai/ha (PE)	82.5	72.6	76.8	65.6	17.0	36.0	16.4	22.4	29.5	26.9
Trifluchloralin @ 1.0 kg ai/ha (PPI)	96.1	75.0	85.2	72.7	19.0	25.0	12.4	14.3	29.6	24.7
Pendimethalin @ 1.0 kg ai/ha (PE)	84.0	75.9	74.3	72.7	20.0	29.0	17.8	19.3	40.0	21.7
Fenoxyprop-p-ethyl @ 50 g ai/ha (PoE)	87.5	74.8	85.6	70.0	19.0	30.0	20.7	20.7	31.4	19.9
Fenoxyprop-p-ethyl @ 70 g ai/ha (PoE)	95.9	74.6	78.1	64.6	15.0	31.0	15.0	18.0	40.8	19.4
Propaquizafop @ 50 g ai/ha (PoE)	76.7	68.5	80.6	64.7	20.0	33.0	18.8	20.0	28.6	22.0
Propaquizafop @ 75 g ai/ha (PoE)	101.8	78.1	74.4	74.3	17.0	30.0	17.5	15.5	40.6	22.6
Anilophos @ 1.75 kg ai/ha (PE)	84.0	69.1	78.6	63.4	16.0	35.0	16.1	15.5	38.6	18.9
Imazethapyr @ 75 g ai/ha (PoE)	87.6	75.0	83.1	70.3	25.0	28.0	25.0	21.4	27.3	22.9
Imazethapyr @ 100 g ai/ha (PoE)	84.3	63.2	82.0	60.0	22.0	37.0	22.8	19.9	35.3	23.8
Two hand-weedings at 30, 45 DAS	91.7	75.0	85.6	66.7	23.0	38.0	19.8	20.8	36.2	26.4
Weedy (ckeck)	92.2	78.3	85.0	65.3	16.0	31.0	13.1	14.0	26.7	15.6
CD (P=0.05)	16.07	11.81	NS	NS	8.68	8.79	8.79	6.15	NS	8.88

PE, Pre-emergence spray; PPI, pre-plant soil incorporation; PoE, Post-emergence application at 20–25 days; DAS, days after sowing

ralin @ 70 g ai/ha, weedy (check) in 1996 and 1997, respectively. Among pre-emergence herbicides, Alachlor @ 2.0 kg ai/ha was able to supress weed growth in the initial stage of plant, as a result of that during both the years there was a significant gain in the plant dry matter over weedy (ckeck). However, among the post-emergence herbicides, spray of Imazethapyr @ 75 g ai/ha gave the maximum plant dry matter during both years and was on par with its 100 g ai/ha dose and 2 hand-weedings. Performance of Imazethapyr was better than other post-emergence herbicides tested in controlling narrow and broad-leaved weeds. During 1997, at harvest, maximum plant dry matter (Table 1) was recorded with the application of Alachlor @ 2.0 kg ai/ha which was significantly greater than weedy (check) and on a par with rest of the treatments. This type of trend might be possible, because at maturity weeds around the plants started drying and further growth also stopped. Weed-control efficiency also reflects the same and maximum weed-control efficiency was recorded in 2 hand-weedings (Table 2). Two hand-weedings resulted in lowest weed dry-matter production at 60 days, which was on par with Alachlor @ 2.0 kg ai/ha, Pendimethalin @ 1.0 kg ai/ha, Fenoxaprop-p-ethyl @ 70 g ai/ha, Propaquizafop @ 75 g ai/ha, Anilophos @ 1.75 g ai/ha and Imazethapyr @ 100 g ai/ha and significantly greater than rest of the treatments (Table 2).

Similar findings were also reported by Dubey (1998). This could be seen more clearly from weed-control efficiency. Whereas at harvest, weed-control efficiency in Trifluchloralin @ 1.0 kg ai/ha and Pendimethalin @ 1.0 kg ai/ha during 1996 was negative, which showed that herbicides failed in controlling weeds effectively due to continual rains. At 60 days after sowing, the lowest weed density was observed with 2 hand-weedings and application of Alachlor @ 2.0 kg ai/ha during 1996 and 1997, respectively, which was significantly less than Pendimethalin @ 1.0 kg ai/ha, Fenoxyprop-p-ethyl @ 50 g ai/ha, Propaquizafop @ 50 g ai/ha and Trifluchloralin @ 1.0 kg ai/ha, Pendimethalin @ 1.0 kg ai/ha, Fenoxyprop-p-ethyl @ 50 and 70 g ai/ha, Propaquizafop @ 50 and 75 g ai/ha, Anilophos @ 1.75 kg ai/ha, 2 hand weedings and weedy (check) in 1996 and 1997, respectively, and was on par with rest of the treatments. Though in 1997, with 2 hand-weedings, weed density was high but weedy dry matter was significantly less than other treatments. Dubey (1998) also reported similar observations that hand-weedings reduced weed population over unweeded plots. This was possibly due to effective weed control up to 60 days after sowing by the Alachlor @ 2.0 kg ai/ha and Imazethapyr @ 75 g ai/ha. This was also evident from weed-control efficiency (Table 2).

Yield attributes and seed yield

Except seeds/pod, all other yield attributes and seed yield varied significantly with various herbicidal treatments (Table 3). Lowest number of pods/plant was recorded in weedy (check). Propaquizafop @ 75 g ai/ha during 1996 and Alachlor @ 2.0 kg ai/ha during 1997 produced maximum pods/plant which were

Table 2. Effect of pre-and post-emergence herbicides on weed dry matter, weed density and weed-control efficiency of soybean

Treatment	Weed dry matter (g/m^2)				Weed density/ m^2		Weed-control efficiency (%)			
	60 DAS		At harvest		60 DAS		60 DAS		At harvest	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Alachlor @ 2.0 kg ai/ha (PE)	4.8	191.0	27.2	141.6	15.3	6.7	85.0	13.81	16.05	52.83
Trifluchloralin @ 1.0 kg ai/ha (PPI)	32.0	228.0	40.0	290.9	12.0	20.0	00.0	–3.64	–23.46	3.10
Pendimethalin @ 1.0 kg ai/ha (PE)	16.4	158.9	39.2	166.7	28.7	28.0	48.75	27.77	–21.60	44.77
Fenoxyprop-p-ethyl @ 50 g ai/ha (PoE)	41.2	209.6	24.0	118.7	28.7	24.0	–28.75	4.73	25.93	60.46
Fenoxyprop-p-ethyl @ 70 g ai/ha (PoE)	20.4	125.6	24.8	121.3	12.7	26.7	36.25	42.91	23.46	59.59
Propaquizafop @ 50 g ai/ha (PoE)	16.4	205.6	7.2	169.3	32.0	28.0	48.75	6.55	77.78	43.60
Propaquizafop @ 75 g ai/ha (PoE)	19.2	166.9	5.2	138.7	19.3	20.0	40.00	24.14	83.95	53.80
Anilophos @ 1.75 kg ai/ha (PE)	10.4	92.3	28.0	214.7	13.5	22.7	67.50	58.05	13.58	28.48
Imazethapyr @ 75 g ai/ha (PoE)	27.2	188.3	10.0	153.3	26.0	16.0	15.00	14.41	69.14	48.93
Imazethapyr @ 100 g ai/ha (PoE)	19.2	132.0	4.8	101.6	14.0	17.3	40.0	40.00	85.19	66.16
Two hand-weedings at 30, 45 DAS	4.4	40.0	1.3	70.7	5.7	21.2	86.25	81.82	95.99	76.45
Weedy (check)	32.0	220.0	32.4	300.2	20.0	25.3				
CD (P=0.05)	26.50	130.53	22.87	110.53	22.57	12.07				

DAS, Days after sowing

Table 3. Effect pre- and post-emergence herbicides on yield attributes, seed yield and seed-production efficiency of soybean

Treatment	Pods/ plant		Seeds/ pod		1,000-seed weight (g)		Seed yield (q/ha)		Seed-production efficiency (kg/ha/day)	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Alachlor @ 2.0 kg ai/ha (PE)	48.0	84.1	2.1	2.4	127.3	86.3	6.66	11.94	5.12	10.38
Trifluchloralin @ 1.0 kg ai/ha (PPI)	40.5	68.4	2.0	2.4	134.0	82.3	2.01	3.90	1.54	1.33
Pendimethalin @ 1.0 kg ai/ha (PE)	63.1	67.1	2.1	2.6	112.3	92.5	6.25	7.83	8.40	6.80
Fenoxyprop-p-ethyl @ 50 g ai/ha (PoE)	47.4	55.7	2.0	2.3	132.3	91.5	2.15	4.06	1.65	3.53
Fenoxyprop-p-ethyl @ 70 g ai/ha (PoE)	67.7	63.9	2.0	2.4	115.6	86.7	4.23	4.92	3.25	3.73
Propaquizafop @ 50 g ai/ha (PoE)	43.7	57.8	2.1	2.4	122.3	83.3	7.57	10.38	5.82	9.02
Propaquizafop @ 75 g ai/ha (PoE)	76.2	51.3	2.2	2.5	117.3	84.3	7.64	6.73	5.87	5.85
Anilophos @ 1.75 kg ai/ha (PE)	65.5	72.6	2.0	2.5	119.0	97.3	6.87	13.30	5.28	11.56
Imazethapyr @ 75 g ai/ha (PoE)	45.6	57.6	2.1	2.5	130.6	86.3	7.22	8.18	5.55	7.11
Imazethapyr @100 g ai/ha (PoE)	48.7	69.3	2.1	2.5	117.3	93.0	7.08	16.42	5.44	14.27
Two hand weedings at 30 & 45 DAS	57.3	68.7	2.0	2.3	115.6	84.8	8.33	12.82	6.44	11.14
Weedy (check)	36.7	48.9	1.9	2.3	120.6	80.1	2.92	3.77	2.90	3.27
CD (P=0.05)	30.61	28.50	NS	NS	10.72	7.39	2.04	3.19	2.46	3.34

significantly more than Trifluchloralin @ 1.0 kg ai/ha, Propaquizafop @ 50 g ai/ha, weedy (check) and Propaquizafop @ 75 g ai/ha and weedy, respectively, during 1996 and 1997 and were at par with rest of the treatments. The 1,000-seed weight was also significantly affected due to various weed-control treatments and lowest was recorded under weedy (ckeck). Two hand-weedings and Imazethapyr @ 100 g ai/ha resulted in significantly higher yields than Trifluch-loralin @ 1.0 kg ai/ha, Pendimethalin @ 1.0 kg ai/ha, Fenoxyprop-p-ethyl @ 50 and 70 g ai/ha, weedy (ckeck) and Alachlor @ 2.0 kg ai/ha, Trifluchloralin @ 1.0 kg ai/ha, Pendimethalin @ 1.0 kg ai/ha, Fenoxyprop-p-ethyl @ 50 and 70 g ai/ha, Propaquizafop @ 50 and 75 g ai/ha, Imazethapyr @ 75 g ai/ha, 2 hand-weedings and weedy (ckeck) during 1996 and 1997 which was at par with rest of the treatments (Table 3). Similar findings were reported by Singh and Bajpai (1994). On the basis of yield data, among pre-emergence (PE) and pre-plant soil incorporated (PPI) Alachlor @ 2.0 kg ai/ha and among post-emergence herbicides (PoE) Imazethapyr @ 100 g ai/ha and 2 hand-weedings were found to be effective in controlling weeds at various stages, which was also confirmed through seed production efficiency and weed-control efficiency, respectively.

It was concluded that among various post-emergence herbicides tested Imaze-thapyr @ 100 g ai/ha was found effective in soybean in controlling weed and increasing seed yield and weed-control efficiency.

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