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Effect of weed control practices on weed dynamics, yield and economics of soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

The experiment was laid out in randomized block design with three replications and eight weed control treatments *viz.*, weedy check, polythene mulching as pre emergence (PE), pendimethalin30EC (PE), chlorimuron ethyl 9g ha^{-1}as post emergence (POE), quizalofop ethyl 50g ha^{-1} (POE), imazethapyr 100g ha^{-1} as early post emergence (EPOE), one hand weeding at 40 days after sowing (DAS) and two hand weeding at 20 and 40 DAS. The results showed that polythene mulching had the lowest weed dry matter due to effectively suppression of weed emergence. It was followed by twice hand weeding at 20 and 40 days after sowing. Weed index was found to be the highest with weedy check (42.10%) followed by the pre-emergence application of pendimethalin (19.09%). The effect of herbicide applied as pre-emergence was subdued at this belated stage, which may possibly be on account of longer period after application and restricted effective residual period. Plant height, number of pods per plant and grain yield of soybean was found to be highest in the treatments twice hand weeding at 20 and 40 DAS as well as polythene mulching. However, the net return and B:C ratio was lower in comparison to imazethapyr and quizalofop ethyl due to higher cost of labour and polythene material respectively. On an average, the application of imazethapyr as early post emergence (3.17) and quizalofop ethyl (3.02) gave significantly highest B:C ratio than the other treatments for soybean.

Key words: Hand weeding, Herbicides, Pre-emergence, Post-emergence, Soybean, Weed control.

INTRODUCTION

Soybean (*Glycine max*) is an important oilseed crop for human consumption. Its yield is lost up to 80% due to weed competition in many parts of the world. Unchecked weeds have been reported to decrease soybean yield by 50.4% (Kewat and Pandey, 2001). Soybean are not strong competitors in the early part of the season, therefore weeds out grow them. Heavy infestation of weeds in soybean greatly interferes with timeliness and efficiency of harvest. The extent of damage on the soybean crop varies with the weed species involved. Soybean usually develops a full canopy cover at eight weeks after emergence and can then compete with weeds up to maturity. Little or no reduction in yield occurs if soybean are kept weed free for the first fourweeks.This is the critical period for weed competition in soybeans. Therefore weed control at appropriate time using a suitable method is a must for ensuring effective weed control and obtaining high grain yields of soybean. Herbicides alone or in combination with hand weeding have been found quite effective in controlling weeds and increasing the yield of soybean (Kumar *et al*., 2003). Therefore, studies were carried out to find out suitable weed control methods in soybean using pre-emergence and post-emergence herbicides.

MATERIALS AND METHODS

The field experiment was conducted during rainy season of 2009 and 2010 at the Research Farm, College of Agriculture, Central Agricultural University, Imphal, India (24°45'N, 93°56'E; altitude 774.5m above mean sea level). The experimental soil was clay loam in texture with pH of 5.5, low in organic carbon (0.48%), available nitrogen (210 kg ha^{-1}), available P_2O_5 (17.5 kg ha^{-1}) and available K_2O (186 kg ha^{-1}), respectively. The experiment consisted of eight treatments *viz.* T_1-Weedy check (control), T_2- Polythene mulching, T_3- Pendimethalin 30EC 1kg ha^{-1} (PE), T_4- Chlorimuron ethyl 9 g ha^{-1} (POE), T_5- Quizalofop ethyl 50g ha^{-1} (POE), T_6- Imazethapyr 100g ha^{-1}as early post emergence (EPOE), T_7- One hand weeding (HW) at 40 DAS and T_8-

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Two HW at 20 and 40 DAS. The experiment was laid out in a randomize block design with three replications. All the pre-emergence herbicides were applied 3days after sowing of crop seed. The early post- emergence was applied at 15 DAS whereas the post-emergence herbicides were applied at 20 DAS by using a knapsack sprayer fitted with flat-fan nozzle with volume of 750lit ha^{-1} water. Recommended dose of fertilizer 20kg N + 60kg P_2O_5 + 40 kg K_2O $ha^{-1}$was applied as basal at the time of sowing. Soybean, cv. JS-335 was sown in the first week of June of two consecutive years and harvested in the first week of October. The seeds were inoculated with *Bradyrhizobiun japonicum* culture and sown at a spacing of 45cm x 10cm.The data on weed population and weed biomass were taken at 30 and 60 DAS with the help of random quadrate (1.0 m) method. These were subjected to "(x + 0.05) to normalize their distribution.

RESULTS AND DISCUSSION

Weed Flora: The pre-dominant grassy weeds were *Echinochloa colona and Cynodon dactylon* and *Cyperus rotundus, Cyperus iria,* and *Fimbristylis miliacea* were the sedges. Among broad-leaved weeds, *Commelina benghalensis, Spilanthus paniculata, Galinsoga parviflora, Chenopodium album* and *Amaranthus spp.* were most common.

Weed density: Density of monocot (grasses and sedge) weeds were much higher than that of broad- leaved weeds throughout the crop growing season. Weed density at 60 DAS was higher as compared to those recorded at 30 DAS irrespective of the species. Kundu *et al*. (2011) also reported that weed density at 45 DAS was higher as compared to those recorded at early stages irrespective of species.The weed intensity of all species significantly reduced by the application of herbicide either applied as pre-or post-emergence at both stages of crop (30 and 60 DAS) growth. The result showed that polythene mulching performed significantly better with respect to control of different weed species. Post emergence application of imazethapyr reduced the density of both monocot as well as dicot weeds significantly as compared to pre-emergence herbicides under study. The lowest weed density was recorded with twice hand weeding and polythene mulching followed by imazethapyr. Similar finding was also reported by Kundu *et al*. (2011).

Weed biomass: Biomass (gm^{-2}) of different weed species recorded at 30 and 60 DAS differed significantly under different treatments (Table 1). Significantly highest biomass of weeds was observed in weedy check All the weed control treatments significantly reduced dry matter accumulation of weeds over control. Polythene mulching has the lowest weed dry matter due to effectively suppression of weed emergence.It was followed by twice hand weeding at 20 and 40 days after sowing. Similar findings were also reported by Yadav *et al*. (2011). Among the chemical herbicides pre-emergence application of pendimethalin was found effective in controlling both monocot and dicot weeds at 30 DAS. Moreover, the post-emergence herbicides were applied only

Table 1: Effect of different weed control treatments on density, dry matter, weed control efficiency of weed at 30 and 60 DAS and weed index on soybean (pooled data for two years)

Treatment	Weed density (no./m^2)				Weed dry matter (g/m^2)		Weed control efficiency (%)		Weed Index (%)
	30 DAS		60 DAS						
	Monocot	Dicot	Monocot	Dicot	30 DAS	60 DAS	30 DAS	60 DAS	
Weedy check	13.60^{f} (185)	16.52^{e} (112)	8.97^{d} (273)	13.71^{d} (188)	88.91^{e}	340.08^{d}	0.00	0.00	52.61^{e}
Polythene mulching (PE)	2.24^{a} (5)	3.46^{a} (9)	2.12^{a} (12)	3.23^{a} (11)	2.65^{a}	32.57^{a}	97.00^{e}	90.42^{d}	0.96^{a}
Pendimenthalin 30 EC @1kg ha^{-1} (PE)	4.69^{b} (22)	4.58^{ab} (27)	9.65^{d} (128)	3.45^{a} (68)	12.75^{b}	76.23^{c}	85.60^{d}	77.52^{a}	19.01^{cd}
Chlorimuron ethyl 9g ha^{-1} (POE)	6.25^{d} (39)	5.66^{b} (16)	2.86^{a} (76)	4.21^{a} (45)	21.34^{c}	47.84^{ab}	75.94^{b}	85.90^{b}	25.31^{d}
Quizalofop ethyl 50g ha^{-1} (POE)	5.63^{c} (32)	11.31^{d} (18)	4.22^{b} (34)	8.24^{c} (13)	20.68^{c}	42.12^{ab}	76.69^{b}	87.60^{bc}	9.02^{bc}
Imazethapyr 100g ha^{-1} (EPOE)	6.93^{d} (48)	8.71^{c} (12)	3.22^{c} (62)	6.71^{b} (16)	18.56^{c}	38.68^{a}	79.08^{c}	88.62^{c}	5.99^{ab}
One HW at 40 DAS	12.77^{e} (163)	7.81^{c} (129)	3.34^{bc} (32)	3.58^{a} (12)	48.52^{d}	46.42^{ab}	45.29^{a}	86.32^{bc}	16.70^{c}
Two hand weeding at 20 and 40 DAS	4.28^{b} (32)	5.82^{b} (9)	3.11^{ab} (21)	3.97^{a} (18)	12.47^{b}	32.92^{a}	85.94^{d}	90.31^{d}	0.00^{a}
SEm (±)	0.26	0.68	0.51	0.49	1.47	6.18	1.30	1.25	3.16
LSD (P=0.05)	0.56	1.48	1.08	1.06	3.15	13.23	2.79	2.67	6.78

Original values are in parentheses Means followed by same superscripts within the same column are not significantly different at the 5% level of probability based on Duncan's Multiple Range Test.

20 days after sowing and the time gap between application and expression of effect at the time of observation was limited. This may be the reason for less control of weeds by post-emergence herbicides at 30 DAS. However, at 60 DAS the scenario was different than observed at 30 DAS. Among herbicides the application of imazethapyr as post emergence significantly reduced the dicot as well as monocot weeds (Table1). The effect of herbicide applied as pre-emergence was subdued at this belated stage, which may possibly be on account of longer period after application and restricted effective residual period. In general, the performance of pre-emergence herbicides to control monocot weeds was relatively lower than all the post-emergence applied herbicides. These results are in conformity with the findings of Meena (2004).

Weed control efficiency (WCE) and weed index (WI): Weed control efficiency was significantly higher in polythene mulching followed by twice hand weeding at 20 and 40 DAS at both 30 and 60 days after sowing. Among the chemical herbicides pre-emergence application of pendimethalin recorded the maximum weed control efficiency (85.60%) over control at 30 DAS. At 60 DAS the maximum weed control efficiency was obtained from post-emergence applied imazethapyr among the chemical herbicides. The herbicide imazethapyr is known to be very effective in controlling broad range of weeds including annual and perennial grasses for soybean and other legume crops (Patel *et al.*, 2009). Application of chlorimuron ethyl (75.94%) and quizalofop ethyl (76.69%) were found to be at par.More reduction in weed dry weight by reducing the weed density in these treatments might have resulted in higher weed control efficiency. The effective weed management, particularly within the first 40 to 45 days is most critical and later the crop canopy by and large keeps the weed count low in soybean, can work out to be a tool to curtail the substantial losses in yield due to weed infestation. The variation in efficiency in weed management related to mode and time of application of herbicides and the selectivity of herbicides to control specific group or species of weeds provides adequate opportunity to contain weed infestation in soybean fields.

Weed index refers to reduction in yield due to the presence of weeds in comparison to the yield of twice hand weeding at 20 and 40 days after sowing. Maximum weed index was observed in control plot (52.61%) followed by chlorimuron ethyl (25.31%), pendimethalin (19.01%) and one hand weeding at 20 DAS (16.70%). The lowest weed index (0.96%) was observed from pre-emergence application of polythene mulching followed by imazethapyr (5.99%) and quizalofop ethyl (9.02%). These observations are in conformity with the findings reported by Kushwah and Vyas (2005).

Growth and yield of soybean: Maximum plant height was recorded from two hand weeding at 20 and 40 DAS (69.58 cm) followed by polythene mulching (68.56cm) and imazethapyr (65.72cm). Number of pods per plant was significantly higher in two hand weeding at 20 and 40 DAS (88.57) followed by polythene mulching (78.38) and imazethapyr (57.54). The increase in number of pods per plant might be due to better control of weeds from earlier stage itself. Similarly, Singh and Mehra (2000) reported that due to better weed control results into higher number of pods, number of seeds per pod and bold seeds were obtained. The lowest pods per plant was observed in control plot (19.21) followed by chlorimuron ethyl (37.52). It might be due to competition of soybean with weeds for their growth and development factors like nutrient, moisture and sunlight. Hundred seeds weight was also significantly higher intwo hand weeding at 20 and 40 DAS (12.89) followed bypolythene mulching (12.86) and imazethapyr (12.56g). The lowest was observed in control plot (12.22g) followed by pendimethalin (12.26g).

Table 2: Effect of different weed control treatments on growth, yield and economics in soybean (pooled data for two years)

Treatment	Plant height (cm)	Pods/ plant	100 seed weight (g)	Grain yield (kg. ha^{-1})	Stover yield (kg.ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Weedy check	47.57^{a}	19.21^{a}	12.22^{a}	1047^{a}	1360^{a}	26100^{a}	1.24^{a}
Polythene mulching (PE)	68.56^{e}	78.38^{f}	12.86^{d}	2189^{d}	2878^{d}	56505^{b}	1.35^{a}
Pendimenthalin 30 EC @1kg/ha (PE)	58.78^{c}	48.59^{c}	12.26^{a}	1790^{b}	2420^{b}	58065^{bc}	2.58^{b}
Chlorimuron ethyl 9g ha^{-1} (POE)	62.52^{cd}	37.52^{b}	12.48^{c}	1649^{b}	2385^{b}	51805^{b}	2.31^{b}
Quizalofop ethyl 50g ha^{-1} (POE)	64.89^{de}	52.74^{d}	12.48b^{c}	2009^{c}	2678^{cd}	67905^{d}	3.02^{c}
Imazethapyr 100g ha^{-1} (EPOE)	65.72^{d}	57.54^{e}	12.56b^{c}	2078^{cd}	2778^{cd}	71110^{d}	3.17
One HW at 40 DAS	53.68^{b}	47.43^{c}	12.45b^{c}	1839^{b}	2610^{bc}	60255^{c}	2.68^{b}
Two hand weeding at 20 and 40 DAS	69.58^{e}	88.57^{g}	12.89^{d}	2210^{d}	3089^{d}	71450^{d}	2.55^{b}
SEm (±)	2.21	1.92	0.04	72	114	3220	0.14
LSD (P=0.05)	4.73	4.10	0.09	153	243	6891	0.30

* Means followed by same superscripts within the same column are not significantly different at the 5% level of probability based on Duncan's Multiple Range Test.

The highest grain yield (2210kg ha^{-1}) was recorded in two hand weeding which remained at par with pre-emergence application of polythene mulching (2189 kg ha^{-1}). It might be due to the fact that the crop was kept free of competition with weeds at the early critical stages of growth which resulted in favourable environment to have higher nutrient uptake and better source sink relationship. All the weed management treatments were significantly superior to the control treatment (1047kg ha^{-1}). In general, use of post-emergence herbicides led to comparatively higher seed yield than pre-emergence herbicides. Similar finding was also reported by Pandey *et al*. (2007). Chandel and Saxena (2001) also reported that post emergence application of imazethapyr at 100 g ha^{-1} was found to be effective in controlling weeds at various stages and also enhanced the grain yield to the tune of 51% over control in soybean.

Economics: Application of imazethapyr as post emergence recoded significantly higher B:C ratio (3.17) than other treatments (Table 2) followed by quizalofop ethyl (3.02). These results are in close conformity with the findings of Jain *et al*. (2000).

CONCLUSION

It may be concluded that higher economic yields may be achieved in soybean by applying early post-emergence imazethapyr at the rate of 100g ha^{-1} at 15 DAS.

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