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RESEARCH NOTE

Weed management effect on weeds, productivity and economics of soybean

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ABSTRACT

A field experiment was carried out during *Kharif* season of 2016 at Agricultural Research Farm of Tirhut College of Agriculture, Dholi, Dr. RPCAU, Pusa to evaluate the efficacy of weed management treatments in soybean and identify most effective and economic weed management method. The experiment consisted of nine weed management treatments which were replicated thrice in randomized block design. Weed free [hand weeding twice 20 and 40 days after sowing (DAS)] followed by pre-emergence application (PE) of pendimethalin 1.0 kg/ha along with post-emergence application (PoE) of quizalofop-ethyl 50 g/ha at 25 DAS have significantly reduced total weed density and biomass and attained the highest weed control efficiency and soybean yield. The net returns and B:C were significantly higher with pendimethalin 1.0 kg/ha PE along with quizalofop-ethyl 50 g/ha PoE at 25 DAS due to lesser cost of herbicides usage compared to hand weeding.

Keywords: Economics; Hand weeding; Pendimethalin; Quizalofop-ethyl; Soybean; Weed management

Soybean (*Glycine max* (L.) Merril) is one of the most significant oilseed crops, which has got enormous potential as food, oil, fuel, and a variety of industrial applications (Gandhi 2009). High-quality protein (40–42%) and other minerals like calcium and iron are abundant in soybean. Bihar holds immense potential for the cultivation of soybean. Weeds are believed to be the main production factor restricting soybean productivity since they cause 84% yield reduction when left unweeded (Singh 2007). Due to intermittent rainfall during rainy season, manual weeding by farmers is constrained by limited availability and high wages of farm workers resulting in difficulty to control the weeds manually during critical period of crop growth. Thus, herbicides are being used to control weeds particularly at initial growth stages, as herbicides will control the emerging weeds for a considerable period of time (Nainwal *et al*. 2010). Mulching is also a good option to conserve moisture and reduce weeds (Bhardwaj 2013). Integration of different weed management strategies would result in better management of weeds as compared to any single management method (Rao and Nagamani 2010). Hence, this study was undertaken to assess the efficacy and economics of different weed management treatments to manage weeds in soybean effectively and enhance soybean productivity economically.

The experiment was carried out during *Kharif* 2016 at Agricultural Research Farm of Tirhut College of Agriculture, Dholi, Dr. RPCAU, Pusa. The experiment was laid out in randomised block design with 3 replications. The treatment details of the experimental plot includes: straw mulch 5 t/ha, post-emergence (PoE) of quizalofop-ethyl 50 g/ha + chlorimuron-ethyl 9.0 g/ha at 25 days after seeding (DAS), quizalofop-ethyl 50 g/ha PoE at 25 DAS, pre-emergence (PE) of pendimethalin 1.0 kg/ha, pendimethalin 1.0 kg/ha PE + quizalofop-ethyl 50 g/ha PoE at 25 DAS, imazethapyr 100 g/ha PE, imazethapyr 100 g/ha PE + fenoxaprop 100 g/ha PoE at 25 DAS, weed free (hand weeding twice at 20 DAS and 40 DAS) and weedy check. The soil of the experimental plot was sandy loam in texture, alkaline in reaction (pH 8.46), low in organic carbon (0.48), available N (217.3 kg/ha), P (17.62 kg/ha) and K (120.05 kg/ha). The soybean variety "*JS – 335*" was sown at a spacing of 45 cm × 5 cm using the seed rate of 75 kg/ha by following recommended package of practices. The gross plot size was 4.5 × 5 m. The uniform dose of fertilizer used was 30:60:20:20 (N-P-K –S kg/ha). Stock solution of respective quantity of each herbicide was prepared separately, by dissolving in half litre of water and made up to required quantity of spray solution (spray volume) by adding water. The spray solution was dissolved in water as per requirement (600 litre/ha) and applied with knapsack sprayer by using the flat fan nozzle. All the necessary cultural practices were carried out uniformly to bring the crop at maturity. Weeds were counted using a quadrat of 0.25 square meter (0.5 × 0.5 m), and data obtained were expressed as density (no./m^2). The percent composition of weed flora was estimated from weedy check plot. To record weed biomass

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weeds were cut at ground level, washed with tap water, sun-dried in hot air oven at 70 °C for 48 hrs and then weighed (weed biomass). For the statistical analysis weed density and biomass were converted to 1 m^2 and imposed square root transformation by using formula ($\sqrt{x + 0.5}$) before analysis. The grain yield was taken from 1 m^2 area in the centre of each plot and expressed in t/ha at 14% moisture content. Economic analysis was done as per the prevailing cost of inputs and selling price of output as per the concerning years. Statistical analysis was done by adopting appropriate method of Analysis of Variance (Gomez and Gomez 1984).

Weed flora

The weed flora observed in the experimental plots were identified and classified based on their morphology **(Table 1).** There were 14 dominant weed species observed in the experimental field out of which 6 were broad-leaved weeds, 5 grasses and 3 sedges.

Table 1. Weed flora associated with the soybean

Broad-leaved	*Eclipta alba, Phyllanthus niruri, Physalis minima, Leucas aspera, Digera arvensis* and *Croton sparsiflorus*
Grasses	*Digitaria sanguinalis, Cynodon dactylon, Sorghum halepense, Dicanthium annualatum* and *Eleusine indica*
Sedges	*Cyperus rotundus, Cyperus diformis,* and *Fimbristylis milliaceae*

Effect on weeds

All the herbicidal treatments reduced the weed density and biomass as compared to weedy check (**Table 2**). Weed free recorded lowest weed density and biomass among all the treatments. Among the herbicidal treatments, pendimethalin 1.0 kg/ha PE + quizalofop-p-ethyl 50 g/ha PoE at 25 DAS showed lowest weed density and biomass. This might be due to the application of pendimethalin as pre-emergence herbicide that prevented cell division and elongation in weeds, which effectively hindered the germination of weed seeds. Subsequently applied quizalofop-ethyl PoE at 25 DAS effectively controlled latter emerged weeds, due to inhibition of fatty acid synthesis conforming findings of Andhale and Kathmale (2019), Nagre *et al.* (2017) and Jadhav (2013).

Weed control efficiency indicated the extent of effectiveness of weed biomass reduction by weed control treatments over weedy check. During the cropping period hand weeding twice recorded higher WCE (62.57%) while among the herbicidal treatments higher WCE (57.18%) was obtained with pendimethalin 1.0 kg/ha PE + quizalofop-ethyl 50 g/ha PoE at 25 DAS (**Table 2**). More reduction of weed biomass by reducing the weed density in these treatments has resulted in higher WCE.

Effect on soybean

Among the treatments, weedy check recorded significantly lower number of pods and number of seeds per pod (**Table 3**) due to weed competition. Durigan *et al.* (1983) reported that number of pods per plant was the most affected character among yield parameters due to heavy infestation of weeds. All the herbicide treatments and hand weeding produced heavier 100-grains (9.25 to 9.49 g) than weedy check (8.89 g) on account of favorable conditions under the reduced weed stress in these treatments than weedy check. Weed free situation proved significantly superior in respect of all crop growth parameters and yield attributes among the treatments but was found at par with pendimethalin 1.0 kg/ha PE + quizalofop-p-ethyl 50 g/ha PoE at 25 DAS. This enhanced yield attributes could be due to reduced weed-crop and interplant competition, which resulted in higher availability of moisture and nutrients to the crop and increased light interception. These results were in line with earlier finding of Sharma *et al.* (2016) in soybean.

The grain and stover yield obtained with hand weeding twice at 20 DAS and at 40 DAS (1.87 t/ha) was significantly superior over all other treatments and was statistically at par with pendimethalin 1.0 kg

Table 2. Effect of weed management on weed density, weed biomass and weed control efficiency in soybean

Treatment	Weed density (no./m^2)	Weed biomass (g/m^2)	Weed control efficiency (%)
Straw mulch 5 t/ha	9.26	8.85	38.88
Quizalofop-ethyl 50 g/ha + chlorimuron-ethyl 9.0 g/ha PoE (25 DAS)	8.84	7.65	47.17
Quizalofop- ethyl 50 g/ha PoE (25 DAS)	9.21	8.61	40.54
Pendimethalin 1.0 kg/ha PE	9.35	8.93	38.33
Pendimethalin 1.0 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE (25 DAS)	6.42	6.20	57.18
Imazethapyr 100 g/ha PE	8.62	8.41	41.92
Imazethapyr 100 g/ha PE + fenoxaprop 100 g/ha PoE (25 DAS)	7.58	6.38	55.94
Weed free	5.62	5.42	62.57
Weedy check	12.68	14.48	-
LSD (p=0.05)	1.37	0.74	-

PE: pre-emergence, PoE: post-emergence, DAS = days after sowing

Table 3. Plant height, yield attributes, yield and economics of soybean as influenced by weed management treatments

Treatment	Plant height (cm)	Pods/ plant	Seeds/ pod	100-seed weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Gross returns (x10^3 `/ha)	Net returns (x10^3 `/ha)	B:C
Straw mulch 5 t/ha	50.88	33.75	2.73	9.32	1.26	2.87	56.06	17.77	1.46
Quizalofop-ethyl 50 g/ha + chlorimuron-ethyl 9.0 g/ha PoE (25 DAS)	55.30	34.15	2.68	9.36	1.33	2.76	58.53	28.35	1.94
Quizalofop-ethyl 50 g/ha PoE (25 DAS)	52.68	32.38	1.98	9.25	1.23	2.78	54.55	25.37	1.87
Pendimethalin 1.0 kg/ha PE	53.25	32.62	2.25	9.31	1.25	2.84	55.59	26.30	1.90
Pendimethalin 1.0 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE (25 DAS)	56.87	36.25	2.20	9.48	1.64	3.15	71.97	40.79	2.31
Imazethapyr 100 g/ha PE	54.32	33.15	2.59	9.35	1.33	2.95	58.90	30.01	2.04
Imazethapyr 100 g/ha PE + fenoxaprop 100 g/ha PoE (25 DAS)	55.81	35.41	2.25	9.42	1.56	3.07	68.70	38.31	2.26
Weed free	58.75	38.50	2.85	9.49	1.87	3.43	81.47	40.59	1.99
Weedy check	42.85	28.63	1.55	8.89	0.66	1.89	29.97	2.68	1.10
LSD (p=0.05)	2.63	4.05	0.22	0.30	0.23	0.34	5.86	5.86	0.19

PE: pre-emergence, PoE: post-emergence, DAS = days after sowing

/ha PE + quizalofop-p-ethyl 50 g/ha PoE at 25 DAS (1.64 t/ha) and closely followed by imazethapyr 100 g/ha PE + fenoxaprop 100 g/ha PoE at 25 DAS (1.56 t/ha). The increased yield may be due to lesser competition and non phyto-toxicity resulted in better vegetative growth and favorable yield attributes as reported by Thirumalaikumar *et al.* (2017).

Economics

The highest gross returns (₹ 81466/ha) among the treatments was realized under weed free situation and was closely followed by pendimethalin 1.0 kg/ha PE + quizalofop-ethyl 50 g/ha PoE at 25 DAS (₹ 71970/ha) and imazethapyr 100 g/ha PE + fenoxaprop 100 g/ha PoE at 25 DAS (₹ 68704/ha). Pendimethalin 1.0 kg/ha PE + quizalofop-ethyl 50 g/ ha PoE at 25 DAS produced significantly highest net return (₹ 40790/ha) and B:C (2.31) over all other weed management treatments, whereas the weedy check gave least net return (₹ 2676/ha) and B:C (1.10) (**Table 3**). This could be due to higher growth parameters and yield attributes as a result of reduced competition between weeds and crop for water and nutrients. Though weed free treatment recorded highest yield but it failed to obtain highest net return and B:C due to higher labour wages. Similar findings were obtained by Jadhav and Kashid 2019, Parmer *et al.* (2016) and Patel *et al.* (2016).

Conclusion

Pendimethalin 1.0 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE at 25 DAS was found effective and most remunerative weed management practice in soybean under rainfed condition of Bihar and would be promising to control weeds of soybean in areas where labour is too expensive and time is a constraint.

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