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Yield, nutrient uptake and economics of soybean under different weed management practices

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ABSTRACT

A field experiment was conducted during kharif season of 2014 at GBPUAT, Pantnagar (Uttarakhand) to find out the effect of integrated weed management options on soybean. The experiment was laidout in a randomized block design with four replications to evaluate ten treatments *viz.* Pre-emergence application of herbicide, sulfentrazone 48% SC @ 300 g a.i/ha, sulfentrazone 48% SC @ 360 g a.i/ha, sulfentrazone 48% SC @ 360 g a.i/ha + hand weeding (HW) at 40 (DAS) days after sowing, sulfentrazone 48% SC @ 300 g a.i/ha + HW at 40 DAS, pendimethalin 30 EC @ 750 g a.i/ha, pendimethalin 30 EC @ 1000 g a.i/ha, pendimethalin 30 EC @ 750 g a.i/ha + HW at 40 DAS and pendimethalin 30 EC @ 1000 g a.i/ha +HW at 40 DAS, weed-free and weedy check. Weed-free plot recorded higher grain yield (2.99 t/ha) followed by pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS. The highest nutrient (NPK) uptake (255.2, 37.2, 110.6 kg/ha) by crop was recorded under weed-free plot treatment. The highest net returns (Rs 49,037/ha) and benefit: cost ratio (1.76) were recorded under pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS. Thus, it could be concluded that pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS can be used for effective weed control in soybean.

Key words: Economics, nutrient uptake, soybean and yield.

Soybean [*Glycine max* (L.) Merrill] is the vital oil seed crop of India and the world and provide many nutritional and health benefits also and variety of end -uses (food, feed and edible). Apart from being a nutritional food for humans and animals, it improves soil fertility by fixing atmospheric nitrogen and by adding 1-1.5 t/ha leaf litter (Dass and Bhattacharyya, 2016). However, overall productivity (1.0 t/ha) is very low. Severe weed infestation in soybean crop is one of the most important reasons of its low yield. Soybean is very sensitive to early weed competition which starts with germination of crop and continues up to maturity. The crop is infested with a wide range of weed flora. The common grassy weeds of soybean include *Echinochloa colona, E. crusgalli, Eleusine indica, Dactyloctenium aegyptium, Cynodon dactylon and Sorghum halepense.* The common broad leaf weeds in soybean fields include *Trianthema monogyna, Celosia argentea, Amaranthus viridis, Phyllanthus niruri, Commelina benghalensis,* etc. and important sedges are *Cyperus rotundus* and *Cyperus iria.* In

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soybean cultivation, weed infestation is considered a persistent and complex constraint as it influences soybean growth, development and yield through competition for nutrients, water and light (Vollmann *et al.*, 2010). The weeds, if not controlled at critical period reduced the yield of soybean from 58 to 85% have been reported by (Singh and Singh, 1987; Chandel and Saxena, 2001).

Integrated weed management refers to the integration of several weed control measures e.g. soil solarisation, hand weeding , mulching, stale seed bed technique, crop rotations and so on. Among them, when labour is available, hand weeding gives effective control of weeds, maximum yield and net return (Rajput and Kushwaha, 2004). However, many time hoeing and hand weeding cannot be done due to unworkable soil condition, the prohibitive cost and shortage of labour during peak period and occurrence of intermittent rains during crop season. These factors make manual weeding less effective, problematic and uneconomical. Whereas use of herbicide not only improve crop yield by suppressing weeds, but also increase the availability of labour for other productive uses. However, continuous use of same herbicides may result resurgence of other weeds species besides occurrence of herbicide resistance in some weeds. Herbicides application may also cause pollution problems. Hence the integration of different weed control measures is important. Most of the farmers use pendimethalin to control weeds in soybean. But, pre-emergence application of Pendimethalin control only grasses and certain broadleaf weeds and sedges remained unaffected. The high intensity of sedges affects growth and yield of soybean adversely. Therefore, there is need to seek an alternative solution for appropriate control of sedges. A new chemical molecule sulfentrazone has been introduced to check all type of weeds, particularly sedges in *kharif* season crops. Pre-emergence applications of sulfentrazone resulted into reduction of sedges shoot number 95 % (Yelverton and Travis, 2012). The dose of this new molecule for soybean has to be validated under different soil and climatic conditions. Lack of suitable post-emergence herbicides for soybean, compel the farmer for HW to control weeds. Hence the current field investigation to find out a feasible and economic solution to weed problem in soybean.

Materials and Methods

An experiment was conducted during the *kharif* season of 2014 at GBPUAT, Pantnagar, (Uttarakhand). The experimental site falls in sub-humid and subtropical climatic zone and situated in *tarai* belt of Shivalik range of foot hills of Himalayas. Geographically, it is located at 29°N latitude and 79.29°E longitude and an altitude of 243.84 meter above mean sea level. During the crop season, the weekly mean maximum and minimum temperatures ranged between 34.3º and 28.5ºC and the relative humidity ranged from 88 to 92% in the morning (7:00 AM) and 38 to 79.3% in afternoon (2.00 PM). A total of 396.6 mm rainfall was received during the crop season. Soil of experimental field was clay loam in texture. It is of alluvial origin and is classified as *Auic Hapludoll*. The chemical analysis of upper 20 cm soil showed that it was medium in organic carbon (0.68%), available nitrogen (286.8 kg / ha) and high in available phosphorus (26.6 kg / ha) and available potassium (268 kg / ha). Soybean variety "PS-1347" was shown on 4th June, 2014 @ 75kg / ha seed rate at 45 cm row to row spacing and 5 cm plant to plant spacing, and harvested on 10th November, 2014. Normal crop husbandry practices were followed for successful raising of the crop. The data obtained were subjected to statistical analysis and were tested at five per cent level of significance to interpret the treatment differences as suggested by Gomez and Gomez (2010).

Results and Discussion

Grain and straw yield : The yield of soybean was influenced significantly due to various weed control treatments. The highest grain yield of soybean (2.99 t / ha) was recorded in weed-free treatment, which was significantly higher than all other treatments except pre-emergence application of sulfentrazone 48% SC @ 360 g a.i / ha + HW. Among the herbicidal treatments, the highest grain yield was recorded under pre-emergence application of sulfentrazone 48% SC @ 360 g a.i / ha + HW which was at par with

sulfentrazone 48% SC @ 300 g a.i/ha + HW, pendimethalin 30 EC @ 750 g a.i/ha + HW and pendimethalin 30EC@1000g a.i/ha + HW and significantly higher than sulfentrazone 48% SC @ 300 g a.i/ha, sulfentrazone 48% SC @ 360 g a.i/ha, pendimethalin 30 EC @ 750 g a.i/ha and pendimethalin 30 EC @ 1000 g a.i/ha pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS yielded 69.9 % higher than weedy check. The highest straw yield (5.8 t/ha) was recorded in weedy check plot. Among the herbicidal treatments, pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW being at par with pre-emergence application of sulfentrazone 48% SC @ 300 g a.i/ha + HW and pendimethalin 30 EC @ 1000 g a.i/ha + HW, exhibited significantly higher straw yield (5.3 t/ha) than all other remaining herbicidal treatments. Pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW out yielded over weedy check to the tune of 57.68 %. The lowest straw yield was recorded in weedy check. Higher grain and straw yield under these treatments might be attributed to the improved growth and yield attributing characters it is because the weed-free environment at initial stage of crop growth till the critical period of the crop-weed competition facilitated, good growth of crop by offering least competition for water, nutrients, light and space, ultimately resulting higher grain yield. Due to lower competition, growth parameters like branches/plant, trifoliate leaves and plant dry matter and yield attributes like pods/plant, seeds/pod and 1000-grain weight increased in weed-free treatment Younesabdi *et al.* (2013).

Nutrients uptake : Weed management practices influenced nitrogen, phosphorus and potassium uptake by crop significantly (Table1). All weed management practices recorded significantly highest uptake of nitrogen by crop as compared to weedy check. The higher nitrogen uptake was recorded in weed-free plot which was at par with pre-emergence application of sulfentrazone 48% SC @ 360 g a.i /ha + HW and exhibited significantly higher nitrogen uptake than all other treatments. Among the herbicidal treatments the higher nitrogen uptake was observed in pre-emergence application of sulfentrazone 48% SC @ 360 g a.i /ha + HW which being at par with pre-emergence application of sulfentrazone 48% SC @ 300 g a.i /ha + HW, pendimethalin 30 EC @750 g a.i/ha + HW, recorded significantly higher nitrogen uptake than all other remaining herbicidal treatments. All weed management practices influenced significantly higher uptake of phosphorus as compared to weedy check. The highest phosphorus uptake was recorded in weed-free plot which was significantly higher than all other treatments. Among the herbicidal treatments the highest phosphorus uptake was observed in pre-emergence application of sulfentrazone 48% SC @ 360 g a.i /ha + HW which was at par with pre-emergence application of sulfentrazone 48% SC @ 300 g a.i/ha + HW, pre-application of pendimethalin 30 EC @ 750 g a.i/ha + HW and pre-application of pendimethalin 30 EC @ 1000 g a.i/ha + HW and recorded significantly higher phosphorus uptake than all other remaining herbicidal treatments. The highest potassium uptake was recorded in weed-free plot which was significantly higher than all other treatments. Among weed management practices higher potassium uptake was observed in pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW which was at par with pre-emergence application of sulfentrazone 48% SC @ 300 g a.i/ha + HW and exhibited significantly higher potassium uptake than all other remaining herbicidal treatments. Since nutrient uptake is a numerical product of nutrient content and dry matter accumulation which was higher under above maintained treatments. The higher uptake of nutrients under these treatments might also be due to less or no contribution of weeds in removal of nutrients (Table 1) and grain and straw yield of soybean. The suppression of weeds under these treatments might have attributed to more proliferation of root system and higher dry matter accumulation by individual plant due to better availability of resources to the crop for growth. This in turn resulted in higher yield in comparison to other treatments Sankaranarayan *et al.* (2002).

Economics : Minimum and maximum cost of cultivation were observed in weedy check and weed-free treatment. In weed-free plot, five hand

Table 1. Yield, nutrient uptake and economics of soybean as influenced by various treatments.

Treatment	Yield (t/ha)		Nutrient uptake (kg/ha)			Economics		
	Grain	Straw	N	P	K	Cost of cultivation (Rs./ ha)	Net returns (Rs./ ha)	B:C ratio
Sulfentrazone 48% SC @ 300 g a.i /ha (PE)	2.04	3.95	160.22	23.05	60.75	23,128	33,972	1.47
Sulfentrazone 48% SC @ 360 g a.i /ha (PE)	2.19	4.01	172.17	24.35	68.11	23,316	37,507	1.61
Sulfentrazone 48% SC @300 g a.i /ha(PE) + HW 40 DAS	2.68	5.17	219.05	31.82	88.76	27,728	47,085	1.70
Sulfentrazone 48% SC @ 360 g a.i/ha(PE) + HW 40 DAS	2.76	5.28	229.53	32.72	93.36	27,916	49,037	1.76
Pendimethalin 30 EC @ 750 g a.i/ha (PE)	1.91	3.79	158.81	23.33	64.78	23,441	30,180	1.29
Pendimethaline 30 EC @1kg a.i /ha (PE)	1.97	3.87	175.03	24.22	66.80	23,841	31,397	1.32
Pendimethalin 30 EC @750 g a.i/ha (PE) + HW 40 DAS	2.57	4.81	203.54	29.48	76.69	28,041	43,557	1.55
Pendimethalin 30 EC @1 kg a.i/ha (PE) + HW 40 DAS	2.61	5.22	178.00	33.15	86.93	28,441	44,767	1.57
Weed free	2.98	5.85	255.21	37.20	110.56	45,191	38,287	0.85
Weedy check	0.832	2.19	73.33	11.23	31.80	22,191	1,895	0.09
S.Em.±	0.09	0.13	9.63	1.46	2.14	-	2,412	0.086
CD (P=0.05)	0.27	0.39	27.95	4.23	6.23	-	6,999	0.25

weeding was practiced. It resulted in the highest cost of cultivation. Among herbicidal treatments, sulfentrazone 48% SC @ 300 g a.i/ha and pendimethalin 30EC @750 g a.i/ha + HW showed lowest and highest cost of cultivation, respectively. The significantly highest net return (Rs 49,037/ha) was obtained in pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW which was at par with sulfentrazone 48% SC @ 300 g a.i/ha + HW, pendimethalin 30 EC @ 750g a.i/ha + HW and pendimethalin 30 EC @ 1000g a.i/ha + HW but recorded significantly higher net return than rest of the treatments. The lowest net return was observed in weedy check plot. It was noteworthy that weed-free crop remained significantly lower than those treatments where herbicides and hand weeding was practiced. The highest B:C ratio was observed in pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW which was significantly superior to pre-emergence application of sulfentrazone 48% SC@300 g a.i/ha, pendimethalin 30 @EC 750 g a.i/ha, pendimethalin 30 @EC 1000 g a.i/ha. Weed-free and weedy check but remained at par with rest of the treatments. Among all the treatments the highest net return was observed in case of pre-emergence application of sulfentrazone 48 % SC @ 360 g a.i/ha + HW at 40 DAS because of higher grain yield in this treatment. Pre-emergence application of sulfentrazone 48 % SC @ 360 g a.i/ha + HW at 40 DAS also gave higher benefit cost: ratio owing to more net return with low cost of cultivation. Though, weed-free plot recorded maximum grain yield and thus fetched highest gross return but higher cost incurred on several hand weeding to keep plot weed-free resulted in lower benefit cost ratio. The lowest net return and benefit:cost ratio was observed in weedy check because of higher crop weed competition

resulting in lower yield and eventually lower monetary returns.

Conclusion

The results of present study could be concluded here weed-free plot recorded higher grain yield (2.9 t/ha) followed by pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS. The highest nutrient (NPK) uptakes by crop were recorded under weed-free plot treatment. The highest net returns and benefit: cost ratio was recorded under pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha + HW at 40 DAS. Thus it can be suggested that pre-emergence application of sulfentrazone 48% SC @ 360 g a.i/ha +HW at 40 DAS may be used for effective weed control in soybean in the tarai region of Uttarakhand.

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