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Impact of Weed Control Measures on Soybean (*Glycine max* L.) under Kymore Plateau and Satpura Hills

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field study was carried out at college farm of JNKVV, Jabalpur, M.P. to investigate the effect of different weed control treatments on weed flora and soybean. The experiment was laid out in randomized block design with three replications. Nine treatments were comprised of chlorimuron-ethyl 12, 24, 36, 48 and 72 g ha^{-1}, hand weeding, mechanical weeding, combined application of weeding and chlorimuron 24 g ha^{-1} and lastly weedy check. Application of herbicide and weeding effectively controlled weeds flora and their density rather than weedy check. Among all the treatments hand weeding recorded higher yield attributes, yield (1.69 t ha^{-1} grain) and net monetary returns (`20011.7 $ha^{-1}$), but it was at par with chlorimuron-ethyl 24 g/ha along with mechanical weeding, that recorded 1.69 t $ha^{-1}$ grain yield and `20023.8 ha^{-1} NMR.

Keywords: Chlorimuron-ethyl; NMR; soybean; weeding; yield.

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1. INTRODUCTION

Among oilseeds, soybean is one of the important crops of India. Soybean produced 23% of total vegetable oil of India [1]. It has also been termed as miracle bean and golden bean because, it contains about 40 per cent protein, 20 per cent oil which is rich in poly- unsaturated fatty acids and anti-oxidants. India recorded 11.33 million ha area, 13.79 million tones production and around 12.17 q ha^{-1} productivity of soybean [2].

Being a *kharif* season crop, it suffers from severe infestation of weeds, which rob it of essential nutrients, space and moisture, causing substantial loss in yield as it reduces the quality of seeds, it depends on weed flora and density [3,4]. The excessive occurrence of weeds, limit the full expression of yield potential of crop, thus an early control of weeds in soybean is very essential and if it is not done, the yield losses may reach up to 25-80 per cent (depending upon type of weed flora and density). Hand weeding is one of the most efficient mean to control weeds in soybean, but it is time consuming and difficult due to unavailability of labours during peak period of demand. Weeding during critical growth stages is sometimes not possible due to continuous heavy downpours [5]. Use of mechanical weeding by hand hoe is popular in the Malwa tract of the state.

Thus, weeds can be controlled manually by pulling, mechanically, and chemically by application of herbicides or by a combination of these methods [6]. But, application of suitable herbicide appears to be an effective alternative option to minimize the weed problems timely [7]. Chorimuron–ethyl has been found very effective post emergence herbicide, for controlling both sedge and broad leaves weed but less in grassy weeds in soybean. Therefore, present investigation was carried out to assess the impact of weed control measures on soybean.

2. MATERIALS AND METHODS

A field experiment was executed in *kharif* season of 2012 at product testing unit, Adhartal farm, J.N.K.V.V., Jabalpur, (M.P.) which is situated at 23^0 9' North latitude and 79^0 58' East longitudes with an altitude of 411.78 meters above the mean sea level. It is classified as “Kymore Plateau and Satpura Hills” agro climatic zone as per norms of National Agriculture Research Project (NARP), New Delhi. The total rainfall received during the crop season was 1542 mm, which was equally distributed in 54 rainy days from June to third week of November. The soil of the experimental field was clayey in texture, neutral in reaction (pH 7.2), medium in organic carbon (0.60 per cent), available N (372 kg ha^{-1}), available P (16.40 kg P_2O_5 ha^{-1}) and high in available K (293 kg K_2O ha^{-1}).

The experiment involved nine treatments such as chlorimuron-ethyl 12, 24, 36, 48, 72 g ha^{-1}, hand weeding, mechanical weeding, combined application of chlorimuron 24 g ha^{-1} + hand hoeing and last one is weedy check, which were arranged in a randomized block design with three replications. The herbicide spray solution was prepared by mixing the required quantity of herbicide in water at 500 litre ha^{-1} for each plot. Before sowing, the seeds were treated with carbendazim at 2.0 g kg^{-1} of seeds followed by inoculation with *Rhizobium japonicum* culture at 5 g kg^{-1} of seeds. Seed rate was 70 kg ha^{-1} of JS 97-52 variety of soybean. Fertilizer application (20 kg N + 60 kg P_2O_5 + 20 kg K_2O ha^{-1}) was applied as basal application through urea, single super phosphate and murate of potash.

Crop management was done by using the recommended package of practices. The observations on population of major weeds and other associated weeds were recorded at 45 DAS and harvest by quadrate count method. The percentage composition of weed flora was estimated from weedy check plot. Formula of relative density proposed by [8].

$$\text{Relative Density (\%)} = \frac{\text{Number of individuals of the same species}}{\text{Number of individuals of all species}} \text{ x } 100$$

Weed index measures the reduction in crop yield due to weed competition as against weed free treatment is expressed in percentage and it was determined with the help of following formula (suggested by [9]). Here X is seed yield from weed free plot (hand weeding), Y is seed yield from the treated plot.

$$\text{WI (\%)} = \frac{X - Y}{X} \text{ x } 100$$

Data of plant parameters as plant height, dry weight, nodulation, number of pods per plant, seeds per pod, seed index is directly measured from the representative samples from each plot. The seed yield per net plot was recorded after winnowing the seed with the help of double pan balance. Finally, seed yield of each plot was converted in to seed yield per hectare. Haulm

yield was determined by subtracting seed yield (economical yield) of each plot from biological yield (bundle weight) of the same plot. The net monetary returns (NMR) per hectare under each treatment was determined by subtracting the cost of cultivation of a particular treatment from the GMR of the same treatment. The collected data was analysed statistically using RBD as delineated by [10] with the help of ANOVA.

3. RESULTS AND DISCUSSION

3.1 Weed Flora and Relative Density of Weeds

After the application of the herbicide weeds are controlled. But, in weedy check plots highest intensity of monocot were recorded at 45 DAS and harvest of soybean. Among monocot *Echinochloa colona (26.27* and 21.18 per cent) was the most dominant weed followed by *Cyperus iria* (11.59 and 14.70 per cent) at 45 DAS and harvest respectively, whereas dicot weeds like *Eclipta alba* (9.34 and 12.58 per cent), *Commelina benghalensis* (4.82 and 8.91 per cent), *Alternanthera philoxiroides* (16.37 and 14.89 per cent) and other weeds (31.61 and 23.65 per cent) were present in lesser number in soybean ecosystem (Table 1). Almost similar weed flora associated with soybean was reported by [11,12,13,14].

3.2 Weed Index

Results revealed that maximum reduction in yield (36 per cent) occurred in weedy check plots where weeds were not controlled throughout the crop season. Combined application of Chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding curbed the weed menace substantially bringing down WI to the tune of 5.3 per cent (Table 2). But in the hand weeding plots zero per cent yield reduction was observed as compared to other treatments of the investigation. This findings correlates with the findings of [15].

3.3 Yield Attributes and Yield

Yield attributes, namely number of pods per plant and number of seeds per pod were significantly superior in the weed free treatment (154.06 and 2.67. respectively) than other treatments. Treatment chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding produced higher number of pods per plant and seeds per pod as (151.64 and 2.61, respectively) as compared to other treatments on account of maximum reduction in weed growth (Table 2). Excellent growth and development of soybean plants under weed free environment during critical period of crop growth might have resulted in higher number of pods per plant and seeds per pod under weed free treatment as compared to weedy check, which had severe weed competition right from early growth stages and ultimately resulted in most inferior yield attributes. Almost similar results were obtained by [16,17].

Minimum seed index (9.02 g) was recorded in weedy check plot. Among the herbicidal treatments combined application of Chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding (9.83 g) produced higher seed index as compared to other treatments (Table 2). It may be because of maximum reduction in weed growth, coupled with no inhibitory effects on soybean plants and maximum transformation of nutrients as assimilates towards seeds resulted in higher seed index in these treatments. Results are in close conformity with the findings of [16,18, 14].

All the herbicidal treated plots produced significantly higher seed and stover yield than weedy check (10.86 q ha^{-1} and 27.01 q ha^{-1}, respectively). Yield was increased with the increased application rates of chlorimuron-ethyl 12, 24, 36, 48, 72 g ha^{-1} and when combined application of Chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding was applied yield was increases at higher magnitude (16.08 q ha-1 seed yield and 34.0 q ha^{-1} stover yield). However, hand weeded plots (20 and 40 DAS) registered the highest seed and stover yield (16.98 q ha^{-1} and 34.96 q ha^{-1}, respectively) and proved significantly superior to all the treatments (Table 2), except chlorimuron-ethyl 24 g + mechanical weeding (40 DAS). [19] also supported the findings. The crop under weed free plots attained lush growth due to elimination of weeds from inter and intra row spaces besides better aeration due to manipulation of surface soil and thus, more space, water, light and nutrients were available for the better growth and development, which resulted into superior yield attributes and development, and consequently the highest yield. [12,20] also reported the similar results. Although hand weeding as an effective method of weed control for achieving the maximum yield of soybean. But the high cost of manpower and the difficulty of finding workers when necessary and in the desired quantity, make this method only complementary to others, and should be done when the weeds are still young and the soil is not too humid. In the case combined application of herbicide along with weeding found economically more feasible, supported by [4].

Table 1. Weed flora of soybean during *kharif season* in weedy check plots at 45 DAS and at harvest

S. No.	Weed flora	Density m^{-2}		Relative density (%)	
		45 DAS	Harvest	45 DAS	Harvest
	Monocot				
1	*Echinocloa colona*	58.67	65.56	26.27	21.18
2	*Cyperus iria*	25.89	45.50	11.59	14.70
	Dicot				
3	*Alternanthera philoxaroides*	36.57	46.07	16.37	14.89
4	*Eclipta alba*	20.88	38.93	9.34	12.58
5	*Commmelina benghalensis*	10.78	27.58	4.82	8.91
6	**Others**	70.62	85.86	31.61	27.65
	Total	223.40	309.5	100.00	100.00

Table 2. Influence of weed control treatments on yield attributes, yield, weed index and economics of soybean

Treatments	Pods $plant^{-1}$	Seeds pod^{-1}	Seed Index (g)	Weed index (%)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})
T_1 - Chlorimuron-ethyl 12g/ha	130.88	2.20	9.17	30.2	11.85	29.17	28990.7	11135.7
T_2 - Chlorimuron-ethyl 24g/ha	146.65	2.33	9.35	12.4	14.88	31.95	35752.8	17872.8
T_3 - Chlorimuron-ethyl 36g/ha	150.41	2.37	9.42	11	15.12	32.35	36435.1	18530.1
T_4 - Chlorimuron-ethyl 48g/ha	151.67	2.38	9.48	10.4	15.22	32.41	36715.9	18785.9
T_5 - Chlorimuron-ethyl 72g/ha	153.07	2.40	9.52	9.7	15.34	32.65	37046.1	19065.1
T_6 - Hand weeding (20 & 40 DAS)	154.06	2.67	9.95	0	16.98	34.96	41141.7	20011.7
T_7 - Mechanical weeding (20 DAS)	147.05	2.45	9.49	12.2	14.91	32.52	35848.6	15918.6
T_8- Chlorimuron-ethyl24g/ha +MW (40 DAS)	151.64	2.61	9.83	5.3	16.08	34.00	38863.8	20023.8
T_9 - Weedy check	130.90	2.00	9.02	36	10.86	27.01	26601.6	9071.6
SEm±	0.19	0.15	0.06	_	0.49	0.27		
CD at 5%	0.58	0.46	NS	_	1.47	0.82		

GMR : Gross Monetary Returns, NMR : Net Monetary Returns

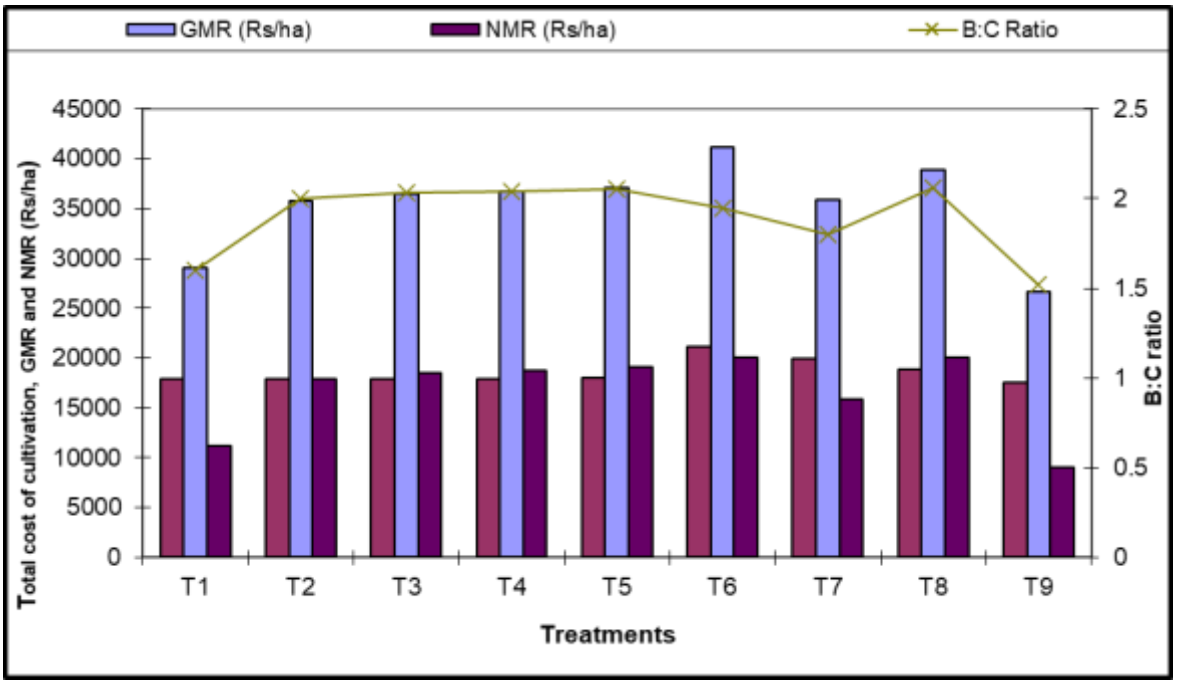

Fig. 1. Economics of different weed control treatment in soybean

3.4 Economics

It is obvious from the data that there was very less net monetary returns Rs 9071.6 ha^{-1} when crop was not weeded (Weedy check) throughout the crop season while highest NMR was gained from combined application of chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding (Rs 20023.8 ha^{-1}), closely followed by T_6 (Hand weeding) Rs 20011.7 ha^{-1} (Table 2 and Fig. 1). These findings were in confirmation with [15,21].

4. CONCLUSION

Among herbicidal treatments, combined application of Chlorimuron-ethyl 24 g ha^{-1} + mechanical weeding, was most effective to reduced most of weed flora. Application of chlorimuron-ethyl herbicide at 24 g ha^{-1} as early post-emergence along with mechanical weeding was significant superior for yield attributes and seed yield (16.08 q ha^{-1}) of soybean than rest of the treatments without any phytotoxicity on soybean plants. It was also found more remunerative in terms of NMR (Rs 20023.8 ha^{-1}) than application of chlorimuron-ethyl at 12 to 72 g ha^{-1} as early post-emergence.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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