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EFFECT OF WEED MANAGEMENT ON GROWTH, YIELD AND ECONOMICS OF SOYBEAN

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ABSTRACT

A field experiment was carried out during the *kharif* season of 2015-16 at Agronomy Farm, College of Agriculture, Nagpur to study the the effect of herbicides on the growth, yield and the economics of soybean. Weed control through herbicidal treatment in combination with mechanical weed control were found comparable to weed free (T_2) treatment. Weed free check treatment being at par with treatments Imazaethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9), Imazethapyr @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_7) and Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8) and recorded significantly higher plant height, number of branches and dry matter accumulation plant^{-1} in soybean, thereby improving yield contributing characters viz., number of pods plant^{-1}, seed yield plant^{-1} and consequently recorded highest seed (1503 kg ha^{-1}) and straw yield (2122 kg ha^{-1}). In terms of economic returns, treatment Imazaethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}) recorded significantly higher GMR (Rs. 50858 ha^{-1}), NMR (Rs.29816 ha^{-1}) and B:C ratio (2.41) over cultural and alone application of herbicides followed by Imazethapyr + Imazamox @75 g a.i. ha^{-1}at 20 DAS + 1 hoeing at 35 DAS (T_9), Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoing at 35 DAS (T_8) and Imazethapyr @ 75g a.i. ha^{-1}at 20 DAS + 1 hoeing at 35 DAS (T_7).

(Key words. Soybean, Imazethapyr , Imazamox, weed control)

INTRODUCTION

Soybean (*Glycine max*. L.) is unique crop in regards to nutritional value because it contains complete protein, carbohydrates, fats, vitamins and folic acid as well as minerals including calcium and iron required for good nutrition. It has been used in production of variety of food products like soy flour, soy grits, soymilk and industrial products such as beverages, nuggets, chunk and milk. Soybean revolutionized the rural economy and improved socio-economic status of farmers. Soybean cultivation has placed India on the world map in recent past. Soybean has not only gained the vital importance in Indian Agriculture, but also plays a decisive role in oil economy of India.

Soybean crop is susceptible for weed competition for first 30-40 DAS. It is essential to keep the crop weed free during initial stage of the plant growth to achieve optimum yield. One of the reasons for low productivity of soybean is the poor weed control during early period of crop weed competition. Hoeing and hand weeding are the most efficient methods of weed control. But these operations could not be performed in time due to erratic weather conditions and labour scarcity and high wages. The chemical method of weed control can be very effective in killing the weeds before their emergence as well as post emergence. The use of herbicides or chemicals has assumed a great significance, particularly in intensive agriculture due to their ability of providing quick, effective, selective and economical weed management in terms of time, money and labour. Pre and post emergence application of herbicides is becoming popular and regarded as one of the most labour saving innovation in modern agriculture. Spraying of pre-emergence herbicides helps to minimize the crop weed competition during critical growth stages. In soybean there are few pre-emergence herbicide like pendimethalin which is well adopted by farmers. Recently some new molecular selective post-emergence herbicide viz., Imazethapyr, Imazathapyr + Imazamox are being marketed with the assurance of selective control of early post emergent weeds in soybean.

Yield loss due to weeds ranges from 31% to 84% depending on crop cultivar, nature and density of weeds, spacing, fertilizer application method, duration and time of weed infestation and environmental condition (Kachroo *et al*., 2003). Hence, present investigation was conducted to

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study the effect of weeed management on the growth and yield of soybean and to work out the economics.

MATERIALS AND METHODS

A field experiment was condcted during *kharif* season of 2015-2016 at Agronomy Section, College of Agriculture, Nagpur. The experiment was laid out in randomized block design with ten treatments replicated thrice. The treatments comprised of Weedy check (T_1), Weed free (T_2), Imazethapyr @ 75 g a.i. ha^{-1}at 20 DAS (T_3), Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} (T_4), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1}at 20 DAS (T_5), Imazethapyr + Imazamox @ 100 g a.i. ha^{-1}at 20 DAS (T_6) and combination of chemical and mechanical weed management practices i.e. Imazethapyr @ 75 g a.i. ha^{-1}at 20 DAS + hoing at 35 DAS (T_7), Pre- emergence Pendimethalin @ 1 kg a.i ha^{-1} + 1 hoing at 35 DAS (T_8), Imazethapyr+ Imazamox @75 g a.i ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9) and Imazethapyr+ Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}).

Soybean variety NRC-37 (Ahilya-4) was grown at 45 cm x 05 cm spacing with 30:75:00 NPK kg ha^{-1}.on clayey soil with slightly alkaline in reaction (pH 7.7), The soil was moderate in organic carbon, low in nitrogen, medium in available phosphorus and high in potassium. The recommended production practices were followed for soybean cultivation.

Five representative plants in each net plot were selected randomly and height of selected plants was measured from the surface of the soil up to the tip of main shoot. The height was measured at an interval of 30 days till the harvest of crop. The number of branches from the randomly selected five plants was counted and average was worked out. For dry matter study one plant from each net plot was randomly sampled periodically. Root portion was separated and shoot portion of plant was kept in brown paper bag. After partial drying, samples were kept in hot air oven at 65^0 C for drying till the constant weight was obtained. The number of pods from five randomly selected plants from net plot was counted and average was worked out. From the pods of five observation plants, the seeds were separated after shelling and weight of seed $plant^{-1}$ was worked out. From the seed produced of each plot and 100 seeds were randomly selected and weighed. The produce was threshed and seed produced from each net plot was weighed to record seed yield net $plot^{-1}$ and yield in kg ha^{-1} was calculated. The straw derived from each net $plot^{-1}$ was weighted and recorded as straw yield net $plot^{-1}$. The total expenditure involved in raising the crop was calculated at prevailing market rates. The cost of different weed management treatments was worked out considering the prevailing rates of wages and price of herbicide. Gross monetary returns were worked out considering the market prices of the soybean seed and straw. From these figures net monetary returns were calculated for each treatment for comparison.

RESULTS AND DISCUSSION

Growth parameters of soybean

Significantly maximum plant height and number of branches $plant^{-1}$ were observed in treatment T_2-Weed free check at harvest over rest of the treatments except treatments Imazethapyr + Imazamox @ 100 g a.i.ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9),Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS (T_7) and Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8). However, all these treatments were found at par with each other.

The lowest plant height and number of branches $plant^{-1}$ were noticed in weedy check (T_1) treatment at all growth stages.The height of the soybean plant was an important growth parameter for obtaining higher yield. As height of plant increase it produces more auxiliary bud on it's stem, which enhance the induction of more flower and pod on the plant.

The increase in plant height and more number of branches $plant^{-1}$ might be due to less crop-weed competition for moisture, nutrients and space that increased the height of plant thus producing more number of nodes that induces more branches. These finding were in accordance with the results reported by Meena *et al.* (2012). They reported that treatment of two hand weedings produced the best growth parameters and yield attributing characters followed by Imazamox+Imazethapyr and quizalofop-ethyl.

Treatment weed free check (T_2) recorded maximum dry matter accumulation $plant^{-1}$ and was significantly superior amongst all other treatments except the herbicidal treatments i.e Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9), Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + hoeing at 35 DAS (T_7), Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8) which were found at par with weed free check (T_2) . The increase in dry matter accumulation $plant^{-1}$ in weed mamagement treatments might be due to less crop-weed competition, there by facilitating luxurious crop growth resulting in to more dry matter production $plant^{-1}$ as compared to control treatment (T_1). Results are in conformity with the findings of Meena *et al.* (2012), who reported that two hand weedings showed the maximum control of weeds, producing higher dry matter followed by Imazamox+Imazethapyr and quizalofop-ethyl application.

Yield and yield contributing characters

Treatment (T_2) weed free check recorded maximum number of pods $plant^{-1}$ (29.35) as compared to other treatments and was found significantly superior over treatments weedy check (T_1), Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} 20 DAS (T_6), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} 20 DAS (T_5), Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS (T_3) and Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} (T_4). However, it was found on par with other herbicidal treatments

along with hoeing viz., Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9), Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS (T_7), Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8).

The increase in number of pods $plant^{-1}$ might be due to reduction in dry matter production by weeds under herbicidal and cultural treatments that subsequently increased nutrient and moisture availability to the soybean crop as compared to rest of the treatments. Halvankar (2005) found that 2 hand weeding at 30 and 45 DAS recorded the highest pods $plant^{-1}$ (36.2) and grain yield (27.07q ha^{-1}) of soybean

As regard the yield of seeds $plant^{-1}$, treatment (T_2) weed free check recorded significantly highest seed yield $plant^{-1}$, than all the other treatments. Treatments Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox@ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9),Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS (T_7),Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8) were found comparable with treatment (T_2) weed free check.

This might be due to more availability of nutrients and moisture as there was less competition between weeds and crop. Meena *et al.* (2012) observed maximum grain yield (17.94 q ha^{-1}) under weed free treatment (two hand weeding) which was found at par with treatment of Imazamox + Imazethapyr. Shrinivasrao *et al.* (2014) reported that weed control treatment of one hand weeding at 30 DAS+1 hoeing at 45 DAS recorded significantly more number of pods $plant^{-1}$, more number of seeds $plant^{-1}$, and higher seed yield $plant^{-1}$ as against all other treatments and was on par with Imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing at 30 DAS.

It is indicated that different weed control treatments did not have any significant influence on the 100 seed weight of soybean. However, numerically highest 100 seed weight was observed under the treatment (T_2) weed free check, followed by treatment Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}). Unweeded control treatment (T_1) recorded lowest 100 seed weight of soybean.

The seed yield ha^{-1} of soybean was significantly influenced by various weed control treatments. The treatment of weed free check (T_2) produced significantly maximum soybean seed yield (1503 kg ha^{-1}) and straw yield (2122 kg ha^{-1}) as compared to other treatments. However, the integrated weed control treatments viz., Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}),Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9),Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS (T_7), Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8),recorded statistically similar seed yield ha^{-1} with the treatment of weed free check (T_2). The control treatment (T_1) i.e. weedy check recorded lowest soybean seed yield (839 kg ha^{-1}) and straw yield (1425 kg ha^{-1})

Different weed management practices significantly improved the seed yield over weedy check; this might be due to the better weed control associated with decrease in weed population and improvement in yield contributing characters in these treatments. This result is in accordance to the findings of Raghuwanshi *et al.*(2005) as they observed that higher seed yield and seed production efficiency were obtained under weed-free treatment up to 60 DAS after sowing and with Imazethapyr + Imazamox-Fp at 25 g ha^{-1} post emergence (20 DAS). The same was concluded by Meena *et al. (*2012) that maximum grain yield (17.94 q ha^{-1}) was recorded under weed free treatment (two hand weeding) which was at par with treatment of Imazamox + Imazethapyr.

Economics

The various weed management treatments influenced significantly the economic return in soybean viz., GMR and NMR. Treatment weed free check (T_2) recorded significantly higher gross monetary returns of Rs. 51721ha^{-1},over all the other treatments. However, treatments Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}), Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9),Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS (T_7) and Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8) were found at par with treatment weed freecheck (T_2).

In respect of NMR, treatment of Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}) recorded significantly higher net monetary returns (Rs. 29816 ha^{-1}) over rest of the treatments including treatment weed free check (T_2)

The treatment Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_{10}) recorded highest benefit:cost ratio of 2.41 followed by treatments Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS (T_9),Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS (T_8).Lowest benefit:cost ratio of 1.60 was recorded in treatment weedy check (T_1) as a result of higher crop weed competition which reduced the soybean yield. The differences in B:C ratio is due to the cost of herbicides and productivity of the crop. Similar results were obtained by Singh *et al.* (2016), who revealed that among the weed control treatments, Imazethapyr 35 g ha^{-1} + Imazemox 35 g ha^{-1} fetches the highest net returns (Rs 28220/-) followed by Chlorimuron 9 g ha^{-1} + Quizalof – ethyl 60 g ha^{-1} (Rs 27619/-). The B: C ratio was maximum under Imazethapyr 35 g ha^{-1} + Imazemox 35 g ha^{-1} (2.47) followed by Chlorimuron 9 g ha^{-1} + Quizalof ethyl 60 g ha^{-1} (2.45).

Hence, in situation where timely weeding is not feasible due to paucity and high cost of labour as well as unfavorable weather and soil condition, integrated weed management through post emergence application of Imazaethapyr + Imazamox @ 75 or 100 g a.i.$ha^{\dagger 1}$at 20 DAS + 1 hoeing at 35 DAS orImazethapyr @ 75g a.i. $ha^{\dagger 1}$ 20 DAS + 1 hoeing at 35 DAS or Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoing at 35 DAS may be preferred to farmers practice for better weed management in soybean.

Table 1. Influence of Imazethapyr + Imazamox on plant height, no. of branches, dry matter of plant, number of pods, seed yield, test weight, as influenced by different treatments

Treatments	Plant height (cm) at harvest	Number of branches plant^{-1} at harvest	Dry Matter plant^{-1} (g) at harvest	No. of pod plant^{-1}	Seed yield plant^{-1} (g)	100 seed weight (g)
T_1 :Control (Weedy check)	49.46	4.65	17.32	21.20	5.07	9.86
T_2 :Weed free check	58.55	7.05	24.15	29.35	7.92	10.28
T_3 :Imazethapyr@ 75 g a.i. ha^{-1} 20 DAS	53.68	5.26	19.32	25.05	6.40	10.06
T_4 : Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1}	53.68	5.12	18.90	24.83	6.25	10.00
T_5 : Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} 20 DAS	53.65	5.33	20.69	25.38	6.48	10.12
T_6 :Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} 20 DAS	54.13	5.49	21.39	25.89	6.58	10.15
T_7 :Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS	56.51	6.48	22.82	27.95	7.45	10.18
T_8 : Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS	56.33	6.30	22.61	27.66	7.30	10.16
T_9 :Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS	56.72	6.61	23.12	28.05	7.55	10.22
T_{10} :Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS	57.00	6.70	23.55	28.40	7.79	10.24
SE (m)±	0.75	0.26	0.54	0.60	0.22	0.43
CD at 5%	2.25	0.77	1.60	1.78	0.65	-
GM	54.98	5.89	21.39	26.37	6.88	10.12

Table 2. Influence of Imazethapyr + Imazamox on seed yield, straw yield and economics of soybean as influenced by different treatments

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B.C. ration
T_1 :Control (Weedy check)	839	1425	29112	10890	1.60
T_2 :Weed free check	1503	2122	51721	22699	1.78
T_3 :Imazethapyr@ 75 g a.i. ha^{-1} 20 DAS	1219	1803	42030	22108	2.11
T_4 : Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1}	1129	1724	38981	18884	1.94
T_5 : Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} 20 DAS	1237	1812	42633	22798	2.15
T_6 :Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} 20 DAS	1251	1825	43108	22836	2.13
T_7 :Imazethapyr @ 75 g a.i. ha^{-1} 20 DAS + 1 hoeing at 35 DAS	1393	1988	47957	27235	2.31
T_8 : Pre- emergence Pendimethalin @ 1 kg a.i. ha^{-1} + 1 hoeing at 35 DAS	1378	1977	48440	27543	2.32
T_9 :Imazethapyr + Imazamox @ 75 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS	1410	2015	49553	28918	2.40
T_{10} :Imazethapyr + Imazamox @ 100 g a.i. ha^{-1} at 20 DAS + 1 hoeing at 35 DAS	1448	2069	50558	29816	2.41
SE (m)±	42	49.00	1019.00	1019	-
CD at 5%	125	147	3027	3027	-
GM	1281	1887	44442	23373	2.12

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