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Effect of Weed Management and Fertility Levels on Productivity and Economics of Soybean [*Glycine max* (L.) Merrill] in Central Narmada Valley of Madhya Pradesh, India

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A B S T R A C T

An experiment was conducted at Krishi Vigyan Kendra, Hoshangabad (MP) during Kharif season year 2014 and 2015. The experiment comprising of seven weed management practices in main plot and 4 fertility levels in sub- plots with 3 replication at KVK field. As per pooled data Increase in seed yield by two hand weeding at 20 and 45 DAS, Imazamox + Imazethapyr @ 75 g(a.i.)/ha, Imazethapyr @ 100 ml(a.i.)/ha at 18 DAS, Pendimethalin @ 1.0 lt.(a.i.)/ha + 1 HW (35 DAS), Quizalofop-ethyl @ 50 ml. (a.i.)/ha and Clodinafop-propargyl 60 @ g (a.i)/ha was 2198, 2020, 1956, 1895, 1649 and 1525 kg/ha higher, respectively over weedy check. 2 hand weeding registered highest soybean straw yield (3235 kg/ha) followed by Imazamox + Imazethapyr @ 75 g (a.i)/ha (3052 kg/ha), which were significantly superior over weedy check. Among the fertility levels, application of 100 and 125 % N, P_2O_5, K_2O along with sulphur significantly influenced yields of soybean over 100 % N, P_2O_5, K_2O, both of these maximized the seed yield (1755 and 1790 kg/ha) and straw yield (2723 and 2760 kg/ha) over 100 and 125 % N, P_2O_5, K_2O without sulphur.

Introduction

In India, soybean [*Glycine max* (L.) Merrill] is a valuable resource for both oil and protein and is used for a wide variety of consumer uses today. Unfortunately, there is decline for soybean acreage where it reached 11.23 million ha in 2016 with an average yield of 11.50 million ton as a result of higher production costs and lower net returns as compared with the other crops. Soybean, ranks first amongst oilseed crops in the world and it contributes nearly 25 per cent of world's total oil and fat production. Madhya Pradesh is one of the major soybean growing states having an area of 50.10 lakh ha with production 45.35 lakh metric tons. The various factors of low productivity of soybean, competition by weeds is the major one. In order to achieve enhanced crop production and higher benefits from applied inputs, weeds must be managed using any of the safe and effective weed control measures. Presently recommended pre - emergence herbicides are either having narrow

spectrum of weed control or less effective against different flushes of broad leaved weeds. Next to weed management in soybean, nutrient management is another important aspect, which can significantly augment the productivity of soybean (Jadon *et al.,* 2016). It becomes immediate necessity to restore the soil productivity by improving the overall fertility and health of the arable land through nutrient management. Hence, to evaluate the productivity and economical viability of soybean, the present investigation was under taken.

Materials and Methods

A field experiment was conducted at field of Krishi Vigyan Kendra, Hoshangabad (Madhya Pradesh) during rainy season 2014 and 2015 to evaluate the productivity and economical viability of soybean as influenced by weed management and fertility levels. The soil of the experimental field was clay loam in texture, alkaline in reaction (pH 7.23), medium in organic carbon (0.49 and 0.53 %), medium in available nitrogen (340 and 344 kg/ha), medium available phosphorus (24.75 and 24.15 kg/ha) and higher in available potash (340 and 335 kg/ha) and low in available S (8.25 and 8.80 ppm) during the year 2014 and 2015, respectively. The experiment was laid out in split plot design comprising of seven weed management practices in main plot [T_1-weedy check, T_2 -2 hand weeding (HW) at 20 and 45 days after sowing (DAS), T_3- Pendimethalin @ 1.0 lt. (a.i.) per ha with one hand weeding at 35 DAS, T_4- Imazethapyr @ 100 ml (a.i.) ha at 18 DAS, T_5- Imazamox + Imazethapyr @ 75 g (a.i.)/ha at 18 DAS, T_6- Clodinafop-propargyl @ 60 g (a.i.)/ha at 18 DAS and T_7- Quizalofop-ethyl @ 50 g (a.i.) ha at 18 DAS and four fertility levels (T_8-100 % N, P_2O_5, K_2O, T_9- 100 % N, P_2O_5, K_2O with sulphur, T_{10}- 125 % N, P_2O_5, K_2O and T_{11}- 125 % N, P_2O_5, K_2O with sulphur) in sub- plots with 3 replications at KVK field. Sowing of soybean cv. JS 20-29 was done on July, 2014 and 2015 with line sowing by drilling 75 kg seeds per ha in rows 45 cm apart. Nitrogen, phosphorus, potash and sulphur were applied as per treatment at sowing as basal. Full quantity of nitrogen and phosphorus were applied through urea (after adjusting N available through DAP) and DAP, respectively, whereas potash was applied through muriate of potash, and sulphur through gypsum. The recommended dose of fertilizers for soybean in the zone is 20 kg nitrogen, 60 kg phosphorus, 20 kg potash and 25 kg sulphur per ha, respectively. Observation on yield attributing characters and yields were recorded at harvest. Treatment-wise monetary return was worked out taking into consideration the prevailing market price of crop produce and input used. Statistical methods based on analysis of variance technique as described by Gomez and Gomez (1984) were employed and the critical difference for the comparison of treatment mean was worked out , whereas the F-test was significant at 5% level of significance.

Results and Discussion

The findings revealed that two hand weeding at 20 and 45 DAS and ready mix of Imazamox + Imazethapyr @ 75 g (a.i.) ha at 18 DAS recorded highest values of growth characters as well as yield attributes and were statistically superior over rest of the herbicides and weedy check except Imazethapyr @ 100 g (a.i.)/ ha which was at par with ready mix treatment (Table 1 and 2). Among the herbicidal treatments, application of hand weeding (HW) at 20 and 45 DAS recorded maximum number of plants (20.95 per sqm), dry matter accumulation of plants at harvest (18.32 g/plant), number of branches (2.57 per plant), pods (53.27 per plant) and seed index (9.16 g/100 seeds), which was significantly higher over weedy check. Among the fertility levels, application of 100 and 125 per cent N,

P_2O_5, K_2O along with sulphur were significantly superior over 100 per cent N, P_2O_5, K_2O with respect to yield attributes namely, average number of plants (20.70 and 20.65 per sqm) dry matter production at harvest (17.18 and 17.49 g/plant), number of branches (2.37 and 2.41/plant), number of pods (42.69 and 43.72 /plant) and seed index (9.02 and 9.04 g/100 seeds), respectively. The overall increase in these yield attributes may be the result of reduction in weed flora due to herbicide application and balanced nutrition to the crop plants. Malik *et al.,* (2006) and Habimana *et al.,* (2013) also observed significant effect of weed control and fertility levels in increasing yield attributes of soybean and by Bairwa, *et al.,* (2012) in case of mung bean. All the weed management practices significantly enhanced seed and straw yields of soybean over weedy check during the study period (Table 2).

On pooled basis, increase in seed yield by two hand weeding at 20 and 45 DAS, ready mix of Imazamox + Imazethapyr @ 75 g (a.i.)/ha at 18 DAS, Imazethapyr @ 100 ml (a.i)/ha at 18 DAS, Pendimethalin @ 1.0 lt. (a.i.)/ha with 1 HW (35 DAS), Quizalofop-ethyl @ 50 ml (a.i.)/ ha and Clodinafop-propargyl 60 @ g (a.i.)/ha was 2198, 2020, 1956, 1895, 1649 and 1525 kg/ha higher, respectively over control. Likewise all the weed management practices also produced significantly higher straw yield of soybean as compared to control. Two hand weeding registered highest soybean straw yield (3235 kg/ha) followed by ready mix of Imazamox + Imazethapyr @ 75 g (a.i.)/ ha (3052 kg/ha), which were significantly superior over weedy check. Weed control treatments might have facilitated higher photosynthates production and translocation from source to sink, resulting in overall improvement yields as compared to control. The results so obtained corroborate with the findings of Goud *et al.,* (2013) in case of chickpea crop. Among the fertility levels, application of 100 and 125 % N, P_2O_5, K_2O along with sulphur significantly influenced yields of soybean over 100 % N, P_2O_5, K_2O both of these maximized the seed (2198 and 2020 kg/ha) and straw yield (3235 and 3052 kg/ha) over 100 % N, P_2O_5, K_2O.

Neither weed management practices nor fertility levels could significantly influence harvest index of soybean crop. The results corroborate the findings of Singh (2005). As far as the weed management practices are concerned, maximum net returns (Rs. 45816/ha) and B: C ratio (2.87) were recorded by two hand weeding at 20 and 45 DAS followed by ready mix of Imazamox +Imazethapyr @ 75 g (a.i)/ha at 18 DAS in terms of net returns (Rs. 40120/ha) and higher B: C ratio was recorded (2.87 and 2.64) with same treatments. Hese results are in agreement with the findings of Gurmu *et al.,* (2009) and Ngalamu *et al.,* (2013). Izaguirre - Mayoral and Sinclair (2005) also expressed that the soybean varieties differed substantially among themselves for nutrient accumulation and nutrient use efficiencies. Among the fertility levels, maximum net returns (Rs. 31640/ha) and B:C ratio (2.29) were obtained with application of 100 % N, P_2O_5, K_2O with sulphur and it was almost equal to 125 % N, P_2O_5, K_2O with sulphur (Rs. 32760/ha) in terms of B:C ratio (2.34).

The nitrogen and phosphorus fertilization package increased grain yield by 90 per cent, grain nitrogen and phosphorus uptakes by 183 and 252 per cent, and stover nitrogen and phosphorus uptakes by152 and 121 per cent. Similar findings were reported by Mandal *et al.,* (2013) and Fahong *et al.,* (2004). Application of nitrogen has an advantage over control with reference to soybean growth, development, yield attributes, yield, nitrogen uptake, nitrogen use efficiencies and economical parameters (Table 1). The split application of recommended dose also

produced higher yield than one time use.

Table.1 Impact of weed management and fertility levels on yield attributing parameters of Soybean

Treatments	Plant population (sqm)	Dry matter production (g/plant)	Branches (No/Plant)	Pod (No/Plant)	Seed index (g/100 seeds)
Main treatments (Weed management)					
T_1	19.15	15.01	2.05	27.39	8.84
T_2	20.95	18.32	2.57	53.27	9.16
T_3	20.32	16.98	2.37	43.43	9.04
T_4	20.10	17.23	2.39	45.80	9.04
T_5	20.35	17.94	2.49	47.23	9.08
T_6	20.35	16.61	2.21	34.77	8.95
T_7	20.30	16.91	2.26	36.89	8.97
SEm (+)	**0.39**	**0.31**	**0.04**	**1.04**	**0.04**
CD (P=0.05)	**1.16**	**0.91**	**0.12**	**3.04**	**0.11**
Sub treatments (Nutrient management)					
T_8	20.50	16.39	2.20	37.43	8.99
T_9	20.70	17.18	2.37	42.69	9.02
T_{10}	20.21	16.95	2.32	41.18	9.00
T_{11}	20.65	17.49	2.41	43.72	9.04
SEm (+)	**0.38**	**0.19**	**0.03**	**0.64**	**0.01**
CD (P=0.05)	**1.12**	**0.54**	**0.09**	**1.83**	**0.04**

Table.2 Impact of weed management and fertility levels on yields parameters and economics of Soybean

Treatments	Economic yield (kg/ha)	Straw yield (Kg/ha)	Harvest Index (%)	CoC (Rs/ha)	GMR (Rs/ha)	NMRs (Rs/ha)	B-C ratio
Main treatments (Weed management)							
T_1	910	1480	38.08	24520	29120	4600	1.19
T_2	2198	3235	40.46	24520	70336	45816	2.87
T_3	1895	2901	39.51	24520	60640	36120	2.47
T_4	1956	2950	39.87	24520	62592	38072	2.55
T_5	2020	3052	39.83	24520	64640	40120	2.64
T_6	1525	2345	39.41	24520	48800	24280	1.99
T_7	1649	2522	39.53	24520	52768	28248	2.15
SEm (+)	**35.25**	**54.24**	**0.17**	**-**	**1580**	**1376**	**0.08**
CD (P=0.05)	**105.04**	**161.63**	**0.49**	**-**	**4597.8**	**4059**	**0.25**
Sub treatments (Nutrient management)							
T_8	1610	2448	39.67	24520	51520	27000	2.10
T_9	1755	2760	39.90	24520	56160	31640	2.29
T_{10}	1598	2644	36.67	24520	51136	26616	2.09
T_{11}	1790	2723	39.66	24520	57280	32760	2.34
SEm (+)	**22.20**	**32.68**	**0.09**	**-**	**1648**	**789**	**0.05**
CD (P=0.05)	**66.15**	**97.05**	**0.266**	**-**	**4927**	**2359**	**0.14**

Note: Soybean sold by Rs 32 per kg, CoC- Cost of Cultivation, GMRs – Gross Monetary Returns, NMRs – Net Monetary Returns

The soybean yield increased as the levels of nitrogen increased. Further yield enhancement was also recorded when nitrogen was applied in two splits (basal and at R 5 stage). The maximum yield was 36 was noted with 20 kg N per ha as basal + 40 kg N per ha at R5 stage, which was higher by 34.49 per cent over control, 26.46 per cent over recommended dose, 18.54 per cent over 40 kg N per ha as basal, 17.69 per cent over 10 +10 kg N per ha and 10.66 per cent over 20 + 20 kg N per ha. A similar trend was also recorded in case of straw yield. Nitrogen uptake was also increased as the levels of nitrogen increases and further enhancement was recorded with split application of nitrogen. Maximum N2 fixation occurs between the R3 and R5 stages of soybean development (Wesley *et al.*, 2013).

From the study, it could be concluded that among the produced highest yield (2198 kg/ha) of soybean in two hand weeding at 20 and 45 DAS with B:C ratio 2.87 and next best herbicidal treatments, application of ready mix of Imazamox + Imazethapyr @ 75 g (a.i.)/ha at 18 DAS produced higher seed yield (2020 kg/ha) with B:C ratio of 2.64, while among the fertility levels application sulphur produced higher seed yield (1790 kg/ha) with 2.34, Benefit -Costs ratio.

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