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Effect of integrated weed management onweed dynamics, yield and economics of soybean (*Glycine max* L.)

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ABSTRACT

The experiment entitled "Effect of Integrated weed management on weed dynamics, yield and economics of Soybean (*Glycine max* L.)", was conducted at the Crop Research center, School of Agriculture, ITM University, Gwalior (M.P.), India during the *kharif* season of the year 2022. The experiment consisted of twelve treatments and three replications laid out in Randomized block design with the application of different pre and post emergence herbicides, along with two hand weeding's at 20 and 40 DAS and weedy check treatments. The herbicides were used individually as well as in sequence with hand weeding practices. All the weed control treatments showed significant reduction of weed flora, weed density and weed biomass as compared to weedy check. Two hand weedings at 20 and 40 DAS recorded significantly less the weed density (66.25 no. m^{-2}), weed dry matter accumulation (46.33 g m^{-2}) and attained the higher weed control efficiency (81.53 %), no. of pods $plant^{-1}$ (32.27), no. of seeds pod^{-1} (3.07), grain yield (2094 Kg ha^{-1}) and straw yield (2826.90 Kg ha^{-1}) and found at *par* with the post-emergence application of Imazethapyr + Imazamox @ 70 g a.i. ha^{-1}*fb* HW (at 40 DAS) and Imazethapyr @ 125 g a.i. ha^{-1}*fb* HW (at 40 DAS). The maximum net returns and B-C ratio were recorded higher with Imazethapyr + Imazamox @ 70 g a.i. ha^{-1}*fb* HW (at 40 DAS).

Key words: *Grain yield, Imazethapyr + imazamox, Net returns, Soybean and Weed density*

Introduction

Soybean (*Glycine max* L.) commonly known as 'Soya' is a unique crop with high nutritional value, providing 40-42% protein and 20-22% edible oil besides soybean contains 26% carbohydrates, 4% minerals, and 2% phospholipids, rich in polyunsaturated fattyacids. In addition, it contains a good amount of vitamin C, 5-6% crude fiber. In India, soybean is grown in about area of 12.09 M ha under diverse agro-climatic and soil conditions with average production and productivity of 12.04 million tonnes and 1140 Kg ha^{-1}, respectively. The highest soybean growing area and production is in Madhya Pradesh so it iscalled 'Soya-state'and also known as 'Soybean Bowl'. While in Madhya Pradesh it is cultivated in an area of 5.01 million ha, production of5.4 tonnes with productivity of 1043Kg ha^{-1} and contributes about 60% production in around 55% of soybean grown area of the country (Anonymous, 2021). Weeds are a major threat in *kharif* season which adversely affect the yield. The extent of yield reduction depends upon the density of weed species, crop varieties, weather conditions and fertility of the soil.

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Losses due to weeds have been one of the major limiting factors in soybean production because weeds compete with soybean for light, moisture, and nutrients in the early season being the most critical. The majority of yield loss due to weed competition occurs during the 30 to 45 DAS, thus control should be prioritized at this time. The integrated method of weed control is found to be more suitable for the management of abroad spectrum of weeds (Meena *et al.,* 2018). Weeds cause tremendous economic coststo agriculture andnatural resources in terms of crop loss, loss of land utility, health-related problems and the costs of control (Parmar *et al.,* 2019)

Materials and Methods

The experiment was laid out at the Crop Research Center, School of Agriculture, Department of Agronomy, ITM University, Gwalior (M.P.) during the *kharif* season of 2022. The climate of these region is sub-tropical with humid monsoon having hot summer and cool winters. the total rainfall received during the entire cropping season was 230.2 mm. The texture of the experimental soil was sandy clay loam in nature, having soil pH 7.64, organic carbon 0.44%, available N 160.50 Kg ha^{-1}, available $P_2O_5$15.2 Kg ha^{-1} and available K_2O 230.60 Kg ha^{-1}. The experiment was carried out in randomized block design (RBD) with 12 treatments and consisting of 3 replications. The treatments comprised of T_1: Pendimethalin (30%EC) at 1000 gha^{-1}(PE) *fb* HW at 40 DAS, T_2: Pendimethalin (30%EC) at 900 gha^{-1}(PE), T_3: Pendimethalin (30%EC) at 750 g ha^{-1}(PE) *fb* HW at 40 DAS, T_4: Metribuzin(70%WP) at 500 gha^{-1}(PE), T_5: Metribuzin(70%WP) at 400 g ha^{-1}(PE)*fb* HW at 40 DAS, T_6: Imazethapyr(10% SL) at 125 gha^{-1}(POE)*fb* HW at 40 DAS, T_7: Imazethapyr(10%SL) at 100 g ha^{-1}(POE), T_8: Imazethapyr(10%SL) at 75 g ha^{-1}(POE)*fb* HW at 40 DAS, T_9: Imazethapyr (35%EC)+ Imazamox (35%EC) at 70 gha^{-1}(POE)*fb* HW at 40 DAS, T_{10}: Imazethapyr (35%EC)+ Imazamox (35%EC) at 80 gha^{-1}(POE), T_{11}: Hand weeding at 20 DAS & 40 DAS and T_{12}: Weedy check. Soybean variety "JS- 9560" was sown using seed rate of 75 Kg ha^{-1} with spacing of 45 X 10 cm and seeds were treated with carbendazim @ 2 gkg^{-1} seeds. The nutrients were applied as a basal dose of 20 Kg N, 60 Kg P_2O_5, and 40 Kg K_2O ha^{-1}. Weed density (no. m^{-2}), weed dry matter (g m^{-2}) and weed control efficiency (WCE %) observations was recorded on weeds at 80 days after crop growth stage. Yield attributes, yield and economics of crop was recorded.By subtracting the specific treatment's cultivation costs from the gross return, the net return was calculated. Cost of cultivationha^{-1} was calculated considering the prevailing charges of cultural operations and input cost also included. Dividing the net return by the cost of cultivation, the benefit-cost ratio was computed. Analysis of variance (ANOVA) methods for randomized block designs wereused to analyze statistical data on crops and weeds (Gomez and Gomez, 1984). The data on weed density and weed dry matter thus obtained were subjected to square root transformed data X= "5e + 0.5.

Results and Discussion

Weed flora

The experimental field was infested with Narrow leaf weeds, broadleaf weeds andsedges. The important weed species at 80 days stage were *Echinochloa crusgalli* (19.17%), *Dactyloctenium aegyptium* (11.41%), *Commelina benghalensis* (10.01%), *Digera arvensis* (11.07%), *Cyperus rotundus* (36.97%) and other weeds (11.55%). include *Cynodon dactylon*, *Euphorbia hirta*, *Trianthema postulacastrum*, and *Amaranthus viridis.*

Effect on weeds

The data on weed density, weed dry weight and weed control efficiency were recorded at 80 days crop growth stage, were presented in Table 1. Weed density, weed dry matter and weed control efficiency were significantly influenced bydifferent weed control treatments. Weedy check treatment recorded the highest weed density and weed dry matter as compared to rest of the treatments. T_{10}: Two hand weeding's at 20 & 40 DAS significantly lower weed density (66.25 no. m^{-2}) and dry weight of weeds (46.33 g m^{-2}) at 80 DAS were recorded *at par* with the T_9: Imazethapyr (35%EC) + Imazamox (35%EC) at 70 gha^{-1}(POE) *fb* HW (at 40 DAS) and T_6: Imazethapyr (10%SL) at 125 gha^{-1} (POE) *fb* HW (at 40 DAS). This might due it acts as ALS (Aceto lactate synthesis) inhibitor, thus stops cell division and reduce the carbohydrate translocation in the susceptible plant and it can control the broad spectrum of weeds. Similar findings were obtained by Singh *et al.,* (2016) and Sharma *et al.,* (2016)

Weed control efficiency (WCE) measured by how effectively weed control treatments reducing

Table 1. Effect of IWM on the weed density (no. m^{-2}), weed dry matter (g m^{-2}), and weed control efficiency (%).

Treatments	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	WCE (%)
T_1: Pendimethalin (30%EC) at 1000 g a.i. ha^{-1}(PE) *fb* HWat 40 DAS	9.01(80.77)	7.80(60.35)	75.94
T_2: Pendimethalin (30%EC) at 900 g a.i. ha^{-1}(PE)	12.50(155.64)	10.86(117.48)	53.17
T_3: Pendimethalin (30%EC) at 750 g a.i. ha^{-1}(PE) *fb* HW at 40 DAS	9.09(82.19)	7.88(61.53)	75.47
T_4: Metribuzin (70% WP) at 500 g a.i. ha^{-1}(PE)	13.01(168.63)	11.16(124.00)	50.57
T_5: Metribuzin (70%WP) at 400 g a.i. ha^{-1}(PE)*fb* HW at 40 DAS	9.29(85.73)	8.38(69.67)	71.76
T_6: Imazethapyr (10%SL) at 125 g a.i. ha^{-1}(POE)*fb* HW at 40 DAS	8.56(72.72)	7.15(50.67)	79.80
T_7: Imazethapyr (10%SL) at 100 g a.i. ha^{-1} (POE)	11.22(125.49)	9.82(96.00)	63.92
T_8: Imazethapyr(10%SL) at 75 g a.i. ha^{-1}(POE)*fb* HW at 40 DAS	8.84(77.61)	7.76(59.78)	76.17
T_9: Imazethapyr (35%EC)+ Imazamox (35%EC) at 70 g a.i. ha^{-1}(POE) *fb* HW at 40 DAS	8.45(70.86)	7.01(48.67)	80.60
T_{10}: Imazethapyr (35%EC) +Imazamox (35%EC) at 80 g a.i. ha^{-1} (POE)	10.98(120.00)	8.97(79.88)	68.16
T_{11}: Hand weeding at 20 DAS & 40 DAS	8.17(66.25)	6.84(46.33)	81.53
T_{12}: Weedy check	15.35(235.08)	15.85(250.87)	0.00
SEm (±)	0.20	0.22	-
CD *at* 5%	0.59	0.64	-

Note: Fig. in parenthesis are the original value, $x=\sqrt{x+0.5}$ transformation.

the weeds as compared to weedy check. Which was significantly affected by different weed control treatments, the higher WCE was recorded with T_{11}: two hand weedings (at 20 & 40 DAS) found *at par* with the T_9: Imazethapyr (35%EC) + Imazamox (35%EC) at 70 g ha^{-1}(POE) *fb* HW (at 40 DAS) and T_6: Imazethapyr (10%SL) at 125 g ha^{-1} (POE) *fb* HW (at 40 DAS). Lower WCE recorded in the weedy check treatment. The similar result was found by (Vyas and Jain. 2003) this might be due to the effective con-

Table 2. Effect of INM on yield attributes, yield and economics of soybean.

Treatments	No. of pods $Plant^{-1}$	No. of seeds Pod^{-1}	Grain Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})	Net Retunes (Rs, ha^{-1})	B-C Ratio (Rs. re^{-1} Invested)
T_1: Pendimethalin (30%EC) at 1000 g a.i. ha^{-1} (PE) *fb* HW at 40 DAS	28.55	2.62	1641.33	2330.69	61423	1.71
T_2: Pendimethalin (30%EC) at 900 g a.i. ha^{-1} (PE)	20.74	2.02	1151.65	1796.57	39089	1.32
T_3: Pendimethalin (30%EC) at 750 g a.i. ha^{-1} (PE) *fb* HW at 40 DAS	28.19	2.52	1522.67	2177.41	54972	1.56
T_4: Metribuzin (70% WP) at 500 g a.i. ha^{-1}(PE)	19.67	2.01	1103.48	1701.07	36968	1.28
T_5: Metribuzin(70%WP) at 400 g a.i. ha^{-1}(PE) *fb* HW at 40 DAS	24.85	2.37	1419.67	2129.50	49927	1.45
T_6: Imazethapyr (10%SL) at 125 g a.i. ha^{-1}(POE) *fb* HW at 40 DAS	29.53	2.93	1977.79	2641.08	81421	2.31
T_7: Imazethapyr (10% SL) at 100 g a.i. ha^{-1} (POE)	23.41	2.26	1344.00	2042.88	51097	1.76
T_8: Imazethapyr (10% SL) at 75 g a.i. ha^{-1} (POE) *fb* HW at 40 DAS	28.60	2.72	1677.33	2348.27	64677	1.87
T_9: Imazethapyr (35%EC)+ Imazamox (35%EC) at 70 g a.i. ha^{-1}(POE) *fb* HW at 40 DAS	30.96	2.99	2048.00	2697.30	84673	2.35
T_{10}:Imazethapyr(35%EC) +Imazamox (35%EC) at 80 g a.i. ha^{-1} (POE)	24.24	2.32	1394.67	2105.95	52625	1.73
T_{11}: Hand weeding at 20 DAS & 40 DAS	32.27	3.07	2094.00	2826.90	84019	2.12
T_{12}: Weedy check	17.03	1.63	882.18	1443.50	25219	0.91
SEm (±)	1.24	0.12	71.61	103.67	-	-
CD *at* 5%	3.63	0.34	210.03	304.04	-	-

trol of broad-spectrum by the application of post-emergence herbicides. (Kalpana *et al.*, 2004). The similar findings were obtained by Bagotiya *et al.*, (2018).

Effect on soybean

Different weed control treatments statistically influence the yield attributes and yield of the soybean (Table 2). A significantly higher no. of pods plant^{-1} (32.27), no. of seeds pod^{-1}(3.07), seed yield (2094 kg ha^{-1}), Straw yield (2826.90 Kg ha^{-1}), were recorded in T_{11}: Two hand weedings (at 20 & 40 DAS) followed by T_9: Imazethapyr (35%EC) + Imazamox (35%EC) at 70 g ha^{-1} (POE) *fb* HW (at 40 DAS) and T_6: Imazethapyr (10%SL) at 125 gha^{-1} (POE) *fb* HW (at 40 DAS). These might be due to these treatments control all types of weeds and provide favorable environment for the crop growth and results in higher grain yield. T_{12}: Weedy check treatment recorded the significantly lower yield as compared to all the treatments. The results are similar to Prachand *et al.*, 2015 and Deshkari *et al.*, 2019.

Economics

The maximum net returns were recorded in the post-emergence application of T_9: Imazethapyr (35%EC) + Imazamox (35%EC) at 70 gha^{-1} (POE) *fb* HW (at 40 DAS) (Rs. 84673 ha^{-1}) next in order T_6: Imazethapyr (10%SL) at 125 gha^{-1} (POE) *fb* HW (at 40 DAS) (Rs. 81421 ha^{-1}). The treatment T_{12}: Weedy check (Rs. 25219 ha^{-1}) recorded significantly minimum net returns as compared to all the treatments. The maximum Benefit-Cost ratio were recorded in the T_9: Imazethapyr (35%EC) + Imazamox (35%EC) at 70 g ha^{-1} (POE) *fb* HW (at 40 DAS)(2.35) next in order T_6: Imazethapyr (10%SL) at 125 gha^{-1} (POE) *fb* HW (at 40 DAS) (2.31). T_{12}: Weedy check (0.91) treatment recorded the minimum Benefit-Cost ratio as compared to all the treatments.

Conclusion

Based on the experimental results, it can be concluded that post-emergence application of Imazethapyr (35%EC) + Imazamox (35%EC) at 70 gha^{-1}(POE) *fb* HW (at 40 DAS) resulted in higher grain yield and economic returns with more weed control efficiency as compared to rest of the treatments. It is regarded as a suitable alternative for soybean's higher B-C ratio and broad spectrum of weed control.

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