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EFFECT OF PRE AND POST EMERGENCE HERBICIDES ON YIELD AND ECONOMICS OF SOYBEAN (*GLYCINE MAX* L.)

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ABSTRACT

A field study was conducted during the *kharif* season of 2024 at the Agronomy Farm, College of Agriculture, Latur, Maharashtra, India to evaluate the impact of various pre- and post-emergence herbicides on soybean yield and economic returns. Experiment was conducted in randomized block design with 3 replications and 7 treatments *viz*, Pendimethalin 38.7 % CS @ 677.25 g a.i./ha (PE) (T_1), Metribuzin 70% WP @ 0.525 kg a.i./ha (PE) (T_2), Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE) (T_3), Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (PoE) (T_4), Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i. /ha (PoE) (T_5), Weed free (T_6) and weed check (T_7). Each treatment was replicated three times. Results revealed that among all treatments, weed free (T_6) treatment resulted in significantly higher seed yield, straw yield per hectare, gross monetary returns, which was statistically at par with T_4 and T_5. However, T_4 recorded the highest NMR and benefit-cost ratio.
Keywords **:** Soybean, Weed management, Phytotoxicity, Herbicide, Economics.

Introduction

The Food and Agricultural Organization (FAO) classifies soybean as an oilseed rather than a legume. While it thrives in warm and hot climates, it was originally used as a nitrogen fixer in early crop rotation systems because it wasn't suitable for cooking due to the presence of trypsin inhibitors. Soybean plays a crucial role in enhancing soil fertility by fixing 45 to 60 kg of atmospheric nitrogen per hectare through its root nodules, and it contributes organic matter to the soil, adding about 0.5 to 1.5 tons per hectare through leaf drop. Despite advancements in soybean coverage and production, productivity remains a concern due to various challenges. Key issues include the prevalence of rained areas with heavy weed infestations, which diminish crop quality and yield. Ineffective cultivation practices, along with a lack of farmer knowledge regarding effective weed management. Weed control is crucial for improving agricultural productivity. The first 30 days after sowing of soybean is considered to be critical with respect to weed-crop competition. Heavy infestation of weeds leads to reduction in yield and quality also affected adversely. Panneerselvam and Lourduraj (2000) concluded that critical period of crop weed competition in soybean is reported to be first 45 DAS. The control of weeds in early stage in soybean is very critical Sandil *et al*. (2015) reported that weeds alone are responsible for reduction in seed yield of soybean to the extent of 25 to 70% depending upon the weed flora and intensity. Weeds not only compete for resources, leading to lower yields and higher production costs, but they also complicate harvesting and can spread pests and diseases. An effective weed management strategy should aim to reduce weed density, minimize crop damage and shift to less aggressive weed species. Historically, mechanical and chemical methods were used for weed control, but the rise of cost-effective herbicides has shifted the focus towards post-emergence solutions. Unfortunately, the overuse of single-action herbicides in conjunction with reduced tillage has led to widespread weed resistance. Early weed competition is particularly damaging to soybean yields, especially during the wet season. Yield losses can range from 25% to 70%, with the first 15 to 45 days of growth being critical for reducing weed interference and securing a successful harvest. Keeping in view the present experiment was conducted to study the effect of pre and post emergence herbicides on growth and yield of soybean (*Glycine max* L.).

Materials and Methods

A field experiment was conducted at Agronomy field, College of Agriculture, Latur (Maharashtra). Geographically, Latur is situated at 18° 5' to 18° 24' North latitude and 77° 36' East longitude. Its height above mean sea level is about 633.85 m and has subtropical climate. In the experimental field, the soil had clayey (vertisols) texture, was moderately alkaline (pH 7.68), low nitrogen (125.44 kg ha^{-1}), low phosphorus (9.21 kg ha^{-1}) and high potassium (1045.60 kg ha^{-1}). Experiment was conducted in randomized block design with 3 replications and 7 treatments *viz*, T_1-Pendimethalin 38.7 % CS @ 677.25 g a.i./ha (PE), T_2-Metribuzin 70% WP @ 0.525 kg a.i./ha (PE), T_3-Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE), T_4-Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME, T_5- Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i /ha, T_6-Weed free and T_7- weed check. All the herbicides were applied by knapsack sprayer fitted with flat fan nozzle. The soybean variety MAUS-158 was sown on 30 June 2024 through dibbling by one or two seeds per hill at a spacing of 45 cm x 5 cm. The recommended fertilizer dose of 30:60:30 NPK kg ha^{-1} was applied at the time of sowing. The Observations were taken from the net plot area and converted to per hectare values using standard conversion factors. The statistical technique of analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967) and the cost of cultivation was calculated using the current market prices of inputs and soybean during the season.

Methodology

Seed yield (kg ha^{-1})

Soybean plants from each net plot were harvested, threshed to separate the seeds, and the seeds were cleaned by winnowing. The weight of sun-dried seeds per net plot (kg $plot^{-1}$) was recorded and converted to seed yield (kg ha^{-1}).

Straw yield (kg ha^{-1})

Before threshing, weight of sun-dried biological yield from each net plot was recorded. Then seed weights were subtracted from total biological yield and remaining weights was counted as straw yield in kg and converted to straw yield (kg ha^{-1}).

Economics

Gross monetary returns

Gross monetary returns (Rs. ha^{-1}) obtained due to different treatments in the present study were worked out by considering market prices of economic produce, by- product and crop residues during the experimental year.

Cost of cultivation

Cost of cultivation (Rs. ha^{-1}) of each treatment was worked out by considering the prevailing price of inputs, charges for cultivation, labour, land and other charges.

Net monetary returns

Net monetary returns (Rs. ha^{-1}) of each treatment were worked out by deducting the mean cost of cultivation (Rs. ha^{-1}) of each treatment from the gross monetary returns (Rs. ha^{-1}) gained from the respective treatment.

Benefit: Cost ratio (B: C)

Benefit: cost ratio of each treatment was calculated by dividing the gross monetary returns with its mean cost of cultivation.

Statistical analysis and interpretation of data

Data obtained on various variables were analyzed by analysis of variance method (Panse and Sukhatme, 1967). The total variance (S2) and degree of freedom (n-1) were partitioned into different possible sources. The variance due to various treatments were compared with error of variance to find out 'F' values and ultimately for testing the significance at P = 0.05. The standard errors for the treatment based on error variance were calculated. Whenever, the results were found to be significant, critical differences were also calculated for comparison of treatment means at 5 per cent level of significance (CD at P = 0.05).

Results and Discussion

Seed yield (q ha^{-1})

The data related to seed yield (Table 1) indicated that soybean seed yield was significantly affected by the different treatments applied. Among the various treatments, weed free (T_6) recorded highest seed yield of 2882 kg ha^{-1}, which was at par with Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4) and Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i./ha (T_5) and found significantly superior over rest of the treatments.

In contrast, the lowest seed yield of 982 kg ha^{-1} was recorded under Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE) (T_3) might be due to phytotoxic effect of herbicide. The higher yield in weed-free and herbicide treatments such as T_4 and T_5 may be attributed to enhanced light interception, nutrient uptake and pod formation, due to better weed suppression throughout the crop's critical growth stages. These results align with previous findings by Reddy *et al.* (2013) and Kulal *et al.* (2017).

Straw yield (q ha^{-1})

Data on straw yield as presented in Table 1 revealed that the straw yield was significantly affected by different weed management treatments. Mean straw yield across treatments was 3261 kg ha^{-1}. The maximum straw yield (4640 kg ha^{-1}) was recorded in the weed-free treatment (T_6), which was significantly superior to all other treatments. This was followed by Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4) and Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i/ha (T_5), both of which provided efficient weed control and promoted robust vegetative growth.

Among the remaining weed control treatments, Metribuzin 70% WP @ 0.525 kg a.i./ha (PE) (T_2) and Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE) (T_3) recorded the lowest straw yields. This reduction in biomass is likely due to the phytotoxic effect of metribuzin, which adversely affected early crop establishment and vegetative growth. Metribuzin-induced toxicity symptoms such as chlorosis and stunted growth likely contributed to the significantly lower straw accumulation in these treatments.

The increased straw yield in the weed-free, Propaquizafop + Imazethapyr @ 62.5 + 91.7 g a.i./ha (T_4) and Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i/ha (T_5) might be attributed to superior weed suppression, which allowed better canopy development, light interception and dry matter accumulation throughout the vegetative phase. These results are supported by Reddy *et al.* (2013) and Venkatesha *et al.* (2008).

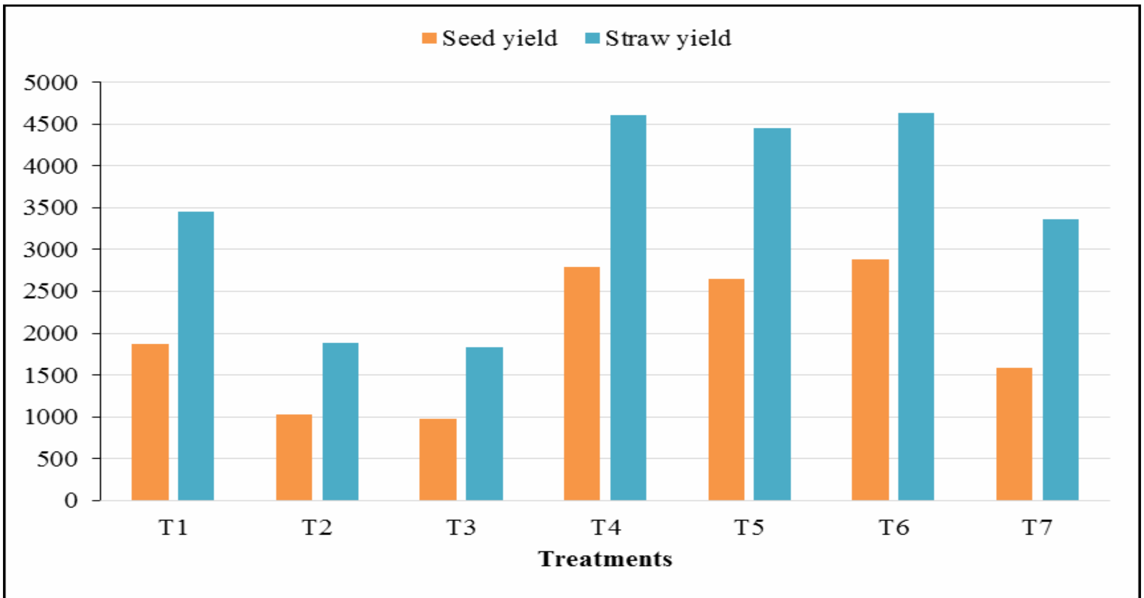

Fig. 1: Seed yield (kg ha^{-1}) and Straw yield (kg ha^{-1}) of soybean as influenced by various treatments

Economics

In terms of economics different weed management practices showed clear effect on both gross monetary return (GMR), net monetary return (NMR) and Benefit:Cost Ratio as presented in Table 2. Weed-free treatment (T_6) recorded highest GMR (Rs. 1,40,999 ha^{-1}), which was statistically superior to all other treatments except Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4) (Rs. 1,36,623 ha^{-1}) and Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL (T_5) (Rs. 1,29,672 ha^{-1}). These superior returns can be attributed to effective weed control that maximized seed yield while maintaining reasonable production costs. Similar results were reported by Kulal *et al.*, 2017 and Samudre *et al.*, (2019).

Highest net monetary returns (Rs. 92,737 ha^{-1}) were recorded with the application of Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4) which was at par with the weed free (T_6) (Rs. 92,363 ha^{-1}) treatment and Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL

(T_5) (Rs. 86,419 ha^{-1}) treatment. Similar results were also reported by Sanjay *et al.,* (2016).

Highest B:C ratio (3.11) was obtained in Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4), closely followed by Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i/ha (T_5) with a B:C ratio of 3.00, and the weed-free treatment (T_6), which recorded 2.90. These treatments resulted in better economic efficiency due to higher seed yield relative to cost of cultivation.

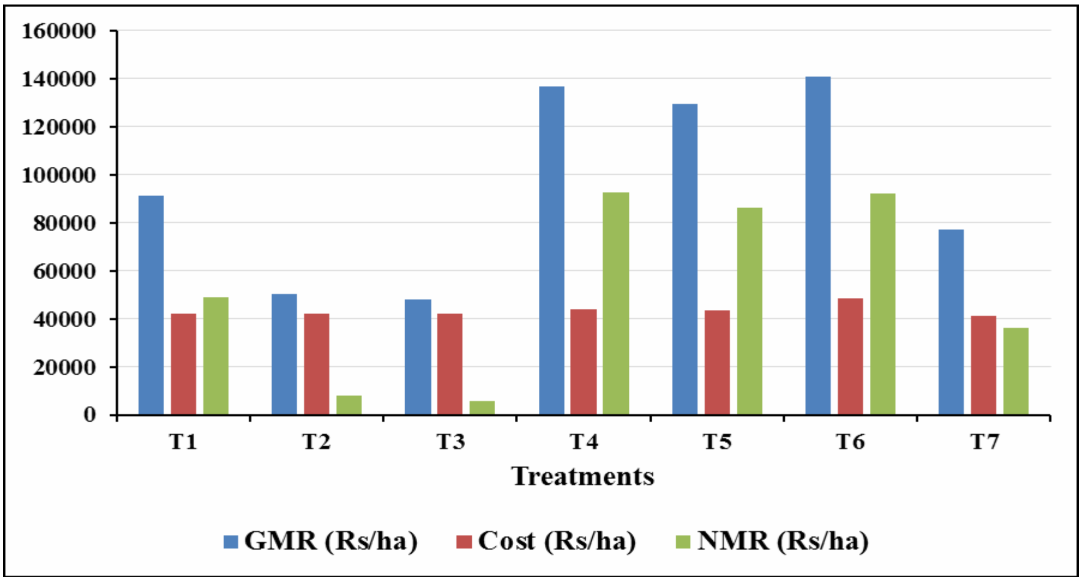

Fig. 2: Economics (Rs. ha^{-1}) of soybean as influenced by various treatment

Table 1: Seed yield (kg/ha) and Straw yield (kg/ha) as influenced by different treatments

Treatments	Seed yield (kg/ha)	Straw yield (kg ha^{-1})
T_1 – Pendimethalin 38.7 % CS @ 677.25 g a.i./ha (PE)	1867	3451
T_2 – Metribuzin 70% WP @ 0.525 kg a.i./ha (PE)	1029	1885
T_3 – Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE)	982	1830
T_4 – Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	2792	4613
T_5 – Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i./ha	2651	4446
T_6 – Weed free	2882	4640
T_7 – Weed check	1581	3360
SE ±	**82**	**128**
CD @5%	**245**	**382**
Grand Mean	**1968**	**3261**

Table 2: Economics (Rs. ha^{-1}) of soybean crop cultivation as influenced by different treatments

Treatments	Economics			
	GMR	CoC	NMR	B:C ratio
T_1 – Pendimethalin 38.7 % CS @ 677.25 g a.i./ha (PE)	91317	42301	49015	2.16
T_2 – Metribuzin 70% WP @ 0.525 kg a.i./ha (PE)	50134	42335	7798	1.18
T_3 – Metribuzin 70% WP @ 0.525 kg a.i./ha (PoE)	48055	42335	5720	1.14
T_4 – Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	136623	43885	92737	3.11
T_5 – Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i./ha	129672	43253	86419	3.00
T_6 – Weed free	140999	48635	92363	2.90
T_7 – Weed check	77318	41135	36182	1.88
SE ±	**4012**	**-**	**4012**	**-**
CD @5%	**12026**	**-**	**12026**	**-**
Grand Mean	**96302**	**43411**	**52891**	**2.20**

Plate 1 : Drone view of experimental plot

Plate 2: Phytotoxicity caused by Metribuzin treatment

Conclusion

Among different weed management treatments, The weed-free treatment (T_6) achieved the highest seed yield (2882 kg ha^{-1}) along with maximum gross monetary return (Rs. 1,40,999 ha^{-1}). However, Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME (T_4) recorded the highest net monetary return (Rs. 92,737 ha^{-1}) and benefit-cost ratio (3.11), which was closely followed by Fomesafen 11.1% + Fluazifop-butyl 11% w/w SL @ 250 g a.i./ha (T_5) with a B:C ratio of 3.00

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