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Effect of pre and post emergence herbicides on growth and yield of soybean (*Glycine max* L.)

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Abstract
A field experiment was conducted during *kharif*, 2024 at Agronomy field, College of Agriculture, Latur (Maharashtra) to study the effect of pre and post emergence herbicides on growth and yield of soybean (*Glycine max* L.). 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 (T_4), Fomesafen 11.1% + Fluazifop-butyl 11% W/W SL @ 250 g a.i /ha (T_5), Weed free (T_6) and weed check (T_7). Results revealed that growth attributing character *viz*, plant height, number of branches, number of leaves, dry matter accumulation, leaf area index as well as yield attributing parameters *viz*, number of pod plant^{-1}, number of seeds pod^{-1}, test weight, seed yield, harvest index were found significantly maximum under weed free (T_6) treatment followed by Propaquizafop 2.5% + Imazethapyr 3.75% ME (T_4) and Fomesafen 11.1% + Fluazifop-butyl 11% W/W SL @ 250 g a.i /ha (T_5). Lowest weed density and weed dry matter production was obtained in Weed free (T_6) which was followed by Propaquizafop 2.5% + Imazethapyr 3.75% ME ha^{-1} (T_4) and Fomesafen 11.1% + Fluazifop-butyl 11% W/W SL @ 250 g a.i /ha (T_5). 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) showed phytotoxicity to soybean.

Keywords: Soybean, metribuzine, herbicide, weed management, phytotoxicity

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 rainfed 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) [1] 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) [2] 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 at Agronomy field, College of Agriculture, Latur (Maharashtra). 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 (T_7). All the herbicides were applied by knapsack sprayer fitted with flat fan nozzle. The sowing was done 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 statistical technique of analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967) [3].

Results and Discussion

Growth attributes

Growth parameters *viz*., plant height, number of leaves, number of branches and dry matter production were significantly influenced by various weed management treatments (Table 1). The highest plant height (56.77cm), number of leaves (26.73), number of branches (7.50) and dry matter production (20.20 g) were recorded in weed free treatment (T_6) which was significantly superior over rest of the treatments, except, application of 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) treatment. These might be due to better weed suppression, which reduced competition for growth resources such as nutrients, water, and light, thereby allowing optimal vegetative growth. These findings are similar with those reported by Parmar *et al*., (2015) [4] and Rashid *et al*., (2022) [5]. In contrary, the lowest plant height (32.80 cm), number of leaves (9.60), number of branches (3.57) and dry matter production (9.73 g) were observed due to Metribuzin 70% WP @ 0.525 kg a.i/ha (PoE) (T_3) due to the phytotoxic effect of herbicide.

Yield attributes

Number of pods $plant^{-1}$, seed yield $plant^{-1}$ and number of seeds $plant^{-1}$ of soybean were significantly influenced by various weed management treatments. The highest number of number of pods $plant^{-1}$, seed yield $plant^{-1}$ and number of seeds $plant^{-1}$ were observed in weed free (T_6) treatment, 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 significantly superior over rest of the treatments. This might be due to efficient weed control, with better crop growth resulting in higher yield attributes. Similar kind of results were reported by Bhimwal *et al.*, (2018) [6]. In contrary, the lowest yield attributes were observed in Metribuzin 70% WP @ 0.525 kg a.i/ha (PoE) (T_3) treatment due to the phytotoxicity of herbicide.

Seed yield and straw yield

The highest seed yield (2882 kg ha^{-1}) and straw yield (4640 kg ha^{-1}) were significantly improved with weed free treatment (T_6) which was at par with treatment 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. While the lowest seed yield (982 kg ha^{-1}) and straw yield (1830 kg ha^{-1}) were observed in Metribuzin 70% WP @ 0.525 kg a.i/ha (PoE) (T_3). The increase in seed yield and straw yield of soybean can be attributed to enhanced crop growth characteristics, such as greater plant height, a higher number of branches, and an increased number of pods per plant in the weed-free treatment. The effective control of weeds during critical growth stages contributed to reduced competition for resources. This optimal growing environment allowed the soybean plants to maximize their potential for growth and yield, resulting in improved straw and biological yield. Overall, the combination of reduced weed competition and favourable growth conditions significantly benefited the crop's productivity. These results align with previous findings by Reddy *et al.*, (2013) [7] and Kulal *et al.*, (2017) [8].

Table 1: Growth attributes of soybean as influenced by various treatments.

Treatments	Days After Sowing			
	Plant height (cm)	Number of leaves	Number of branches	Total dry matter production (g $plant^{-1}$)
T_1 - Pendimethalin 38.7% CS @ 677.25 g a.i/ha (PE)	49.40	18.63	6.33	17.67
T_2 - Metribuzin 70% WP @ 0.525 kg a.i/ha (PE)	33.87	11.00	4.07	10.07
T_3 - Metribuzin 70% WP @ 0.525 kg a.i/ha (PoE)	32.80	9.60	3.57	9.73
T_4-Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	55.13	25.07	7.14	19.67
T_5 - Fomesafen 11.1% + Fluazifop-butyl 11% W/W SL @ 250 g a.i /ha	54.07	24.50	7.03	18.17
T_6 - Weed free	56.77	26.73	7.50	20.20
T_7 - Weed check	41.20	16.20	5.73	16.83
SE ±	2.08	0.823	0.269	0.75
CD @5%	6.25	2.468	0.807	2.26
Grand Mean	46.17	18.82	5.91	16.05

Table 2: Yield attributes and yield of soybean as influenced by various treatments.

Treatments	Number of pods plant^{-1}	Seed yield plant^{-1} (g)	Number of seeds plant^{-1}	Straw yield (kg ha^{-1})	Seed yield (kg ha^{-1})
T_1 - Pendimethalin 38.7% CS @ 677.25 g a.i/ha (PE)	25.33	5.20	48.17	3451	1867
T_2 - Metribuzin 70% WP @ 0.525 kg a.i/ha (PE)	13.07	4.83	41.22	1885	1029
T_3 - Metribuzin 70% WP @ 0.525 kg a.i/ha (PoE)	12.67	4.70	40.25	1830	982
T_4 - Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME	39.03	5.60	53.02	4613	2792
T_5 - Fomesafen 11.1% + Fluazifop-butyl 11% W/W SL @ 250 g a.i /ha	37.33	5.53	51.10	4446	2651
T_6 - Weed free	41.07	6.03	61.28	4640	2882
T_7 - Weed check	22.67	5.13	46.10	3360	1581
SE ±	1.347	0.235	2.590	128	82
CD @5%	4.039	0.706	7.765	382	246
Grand Mean	27.31	5.29	48.74	3261	1969

Conclusion

Among different weed management treatments, weed free (T_6) was found most effective for getting higher growth and yield contributing characters and consequently highest seed yield (2882 kg ha^{-1}) and straw yield (4640 kg ha^{-1}) however, it was closely followed by the application of 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).

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