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Soil–Herbicide Interactions and Productivity Response of Wheat (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted at Vivekananda Global University Research Farm, Jaipur, Rajasthan, during the rabi season to evaluate the efficacy of different herbicides and weed management practices in wheat. The experiment was laid out in a randomized block design with 11 treatments including pre- and post-emergence herbicides, hand weeding, weedy check, and weed-free conditions, replicated thrice. Growth parameters, weed dry matter, yield attributes, and productivity were recorded and statistically analyzed. Weed-free plots recorded the lowest weed dry matter (0 kg/ha) and produced the highest plant height (79.33 cm), ear length (12.74 cm), and grains per spike (43.2). Among chemical treatments, clodinafop-propargyl + metsulfuron methyl, sulfosulfuron + metsulfuron, and hand weeding at 30–35 DAS proved most effective, significantly reducing weed biomass (172–180 kg/ha) while enhancing growth traits. Grain yield was highest under weed-free conditions (48.69 q/ha), closely followed by clodinafop + metsulfuron (46.19 q/ha) and hand weeding (46.99 q/ha). The weedy check produced the lowest grain yield (34.46 q/ha), reflecting nearly 29% yield loss due to unchecked weed competition. Harvest index remained relatively stable across treatments (44.8–46.0), indicating that weed control influenced biomass accumulation more than partitioning efficiency. Effective weed management significantly improves wheat growth and productivity. While weed-free plots gave maximum yields, herbicidal combinations such as clodinafop-propargyl + metsulfuron methyl and sulfosulfuron + metsulfuron, along with timely hand weeding, were nearly as effective and economically feasible. Integrated approaches combining manual and chemical methods offer a sustainable strategy for wheat weed management in semi-arid environments.

Keywords: Pulses, Protein source, Nitrogen fixation, Kharif crop, Biofertilizers, and Rhizobium

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Introduction

Wheat [*Triticum aestivum* (L.)] is considered to be the most valuable of all cereal crops grown across the world, with 224.82 million ha, 785 million tonnes, and a productivity of 3.49 t/ha [1]. It owns approximately 17 percent of the world's acreage under crop and even offers nearly 40 percent of the global population because of its high nutritional content, particularly proteins (12.6 percent) and carbohydrates (78.1 percent) [2]. India enjoys 34.15 million ha of wheat, yielding 114 million tonnes against 3338 kg/ha. Uttar Pradesh is top in terms of area and production, whereas Punjab tops productivity. In Rajasthan, the area and production are 2.94 million ha/10, 25 million tonnes [3]. Submergence in wheat crop occurs on a large scale due to the presence of weeds, where the crop involved in the list is the first one on the list, followed *by Phalaris minor, Asphodelus tenuifolius, Fumaria parviflorum, and Convolvulus arvensis* [4]. Manual weeding is practical in soil aeration and formation of the root, but is both unduly costly in nature and is cumbersome, so, theoretically, chemical control is considered more practical and less costly [5]. Traditional herbicides 2, 4-D and isoproturon have the drawback that they fail to control grassy weeds and also develop resistance [6]. More recent herbicides, especially sulfonylureas (metsulfuron-methyl, sulfosulfuron) and carfentrazone, offer wide-spectrum weed management at low dosing with great efficacy [7].

Herbicides like sulfosulfuron and metsulfuron act by inhibiting acetolactate synthase (ALS), an essential enzyme in branched-chain amino acid synthesis, leading to growth arrest and plant death. When combined (e.g., sulfosulfuron + metsulfuron), they provide broader weed-spectrum control and reduce the risk of resistance development. However, chemical interactions with soil properties and companion herbicides can influence persistence, selectivity, and overall weed suppression efficacy. Climate change and heat waves are, however, changing weed flora, leaning towards C4 more as opposed to C3 crops such as wheat. It could minimize the effectiveness of the existing herbicides and needs consideration of the new, broad-spectrum molecules as a way of managing the weed in an environmentally friendly manner [8].

Material and Methods

It was tried at the Vivekananda Global University Research farm in Jaipur during the Kharif season in a different sowing. The area experiences semi-arid weather, with an average of 550 mm of annual precipitation, much of which falls between July and September. The used soil (sandy loam) has medium levels of phosphate, high levels of potassium, and low levels of phosphorus. This type of wheat is known as Raj. 3077. One standard agronomic procedure concerned the crop with a seed rate of 100 kg/ha and an interrow spacing of 22.5 cm. Eleven treatments, three replications, and randomized blocks are used in the design execution.

The details of treatment are below:

Table 1 Treatment details: Eleven weed management treatments were imposed as follows:

S.No.	Treatments	Symbols
i.	Weedy check	T1
ii.	Hand weeding at 30-35 DAS	T2
iii.	2,4-D ester @ 0.5 kg/ha at 30-35 DAS	T3
iv.	Sulfosulfuron @ 25 g a.i. at 30-35 DAS	T4
v.	Metsulfuron methyl 4 g/ha at 30- 35 DAS.	T5
vi.	Sulfosulfuron 75% + Metsulfuron methyl 5% WG 32g	T6
vii.	60g a.i./ha Piroxofop- propargyl 15 percent WP at 30-35 DAS	T7
viii.	Clodinafop-propargyl15% + Metsulfuron methyl 1% aiai/da total at 30- 35 DAS	T8
ix.	Carfentrazone ethyl 15 g/ha 30-35 DAS.	T9
x.	Pendimethalin pre-emergence	T10
xi.	Weed free	T11

Data collected

Crop measurements and weeds was monitored and noted during the course of the trial. In measuring the impacts of different methods of weed management, data on the buildup of weed dry matter. Respondent growth measures, which were monitored in agricultural studies, are plant height (cm) at 30 DAS, 60 DAS, 90 DAS, and harvest. To determine the overall performance of wheat in different weed control treatments, such parameters of yield as grain yield (kg ha -1), straw yield (kg ha -1), biological yield (kg ha -1), and harvest index was measured at the end.

Result and Discussion

Impact on Growth Traits (Table 1)

Crop-weed competition was the strongest, with weedy check (1631 kg/ha) having the greatest quantity of weed dry matter. To exemplify their greater efficacy in reducing the amount of weed, the weed-free treatment instead, completely removed the weed biomass (0 kg/ha), and was followed by the hand weeding (172.41 kg/ha), sulfosulfuron (172.55 kg/ha), and clodinafop + metsulfuron (180.25 kg/ha) treatments.

With inefficient weed control methods, crop developmental traits such as height of the plant, length of the ear, and the number of grains in the spike greatly improved [9]. Ear length (12.74 cm) and maximum plant height (79.33 cm at harvest), and grains/spike (43.2) were obtained in the weed-free condition. Clodinafop + metsulfuron (77.77 cm, 12.39 cm, 41.6 grains) in close sequence followed these, making it possible that both herbicide combinations and manual weeding might be effective to reduce competition with weeds and improve crop growth.

On the other hand, weedy check plots had the lowest score (62.73 cm height, 7.1 cm ear length, 31.2 grains/spike) due to uncontrolled interference of weeds that reduced the photosynthetic capacity of the crop [10].

Impact on Yield and Harvest Index (Table 2)

Yield attributes came very closely after that of growth traits. The entire yield of grain was highest in the weed-free treatment (48.69 q/ha), then hand weeding (46.99 q/ha), and, finally, clodinafop + metsulfuron (46.19 q/ha). The same treatments have also resulted in increased straw yield and biological yield, which suggests that they are effective in raising the source and sink capacity of the crop [10, 11].

Production per hectare of the grains was lowest (34.46 q/ha), approximately 29 percent lower than in the area without weeds. Piroxofop-propargyl was relatively weak (37.56 q/ha) in comparison with other post-emergence herbicides, which suggests the incomplete inhibition of weeds. Nevertheless, there was a similarity in the values of harvest index (HI) across treatments (44.8-46.0), hence showing that the weed control was more effective in influencing the overall output than it was in the partitioning efficiency [12].

Table 2 Impact of weed management on growth traits of wheat

S.no	Treatments	Weed dry matter production (kg/ha)	Plant height			At harvest	Length of ear (cm)	No of grains per spike
			At 30 DAS	At 60 DAS	At 90 DAS			
1	Weedy check	1631	16.69	34.73	62.73	76.05	7.1	31.2
2	Hand weeding at 30 – 35 DAS	172.41	17.39	37.39	77.48	88.14	12.56	42
3	2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	206.81	16.77	36.77	75.11	85.11	9.3	37
4	Sulfosulfuron @ 25 g a. i. at 30-35 DAS	172.55	17.16	37.16	75.49	85.48	8.9	36.8
5	Metsulfuron methyl 4 g/ha at 30- 35 DAS.	201.15	17.33	37.33	67.66	77.66	9.7	38
6	Sulfosulfuron 75% + Metsulfuron methyl 5% WG 32g	180.11	17.7	37.7	77.7	88.12	12.35	41
7	60g a. i. /ha Piroxofop-propargyl 15 percent WP at 30 – 35 DAS	213.73	16.52	36.52	70.11	82.44	7.9	33.6
8	Clodinafop-propargyl15% + Metsulfuron methyl 1% aiai/da total at 30- 35 DAS	180.25	17.44	37.44	77.77	87.77	12.39	41.6
9	Carfentrazone ethyl 15 g/ha 30-35 DAS.	181.45	17.06	37.06	76.09	83.43	10.3	39.2
10	Pendimethalin pre emergence	208.45	17.23	37.23	75.49	82.62	8.5	35.8
11	Weed free	0	17.96	37.96	79.33	90.33	12.74	43.2

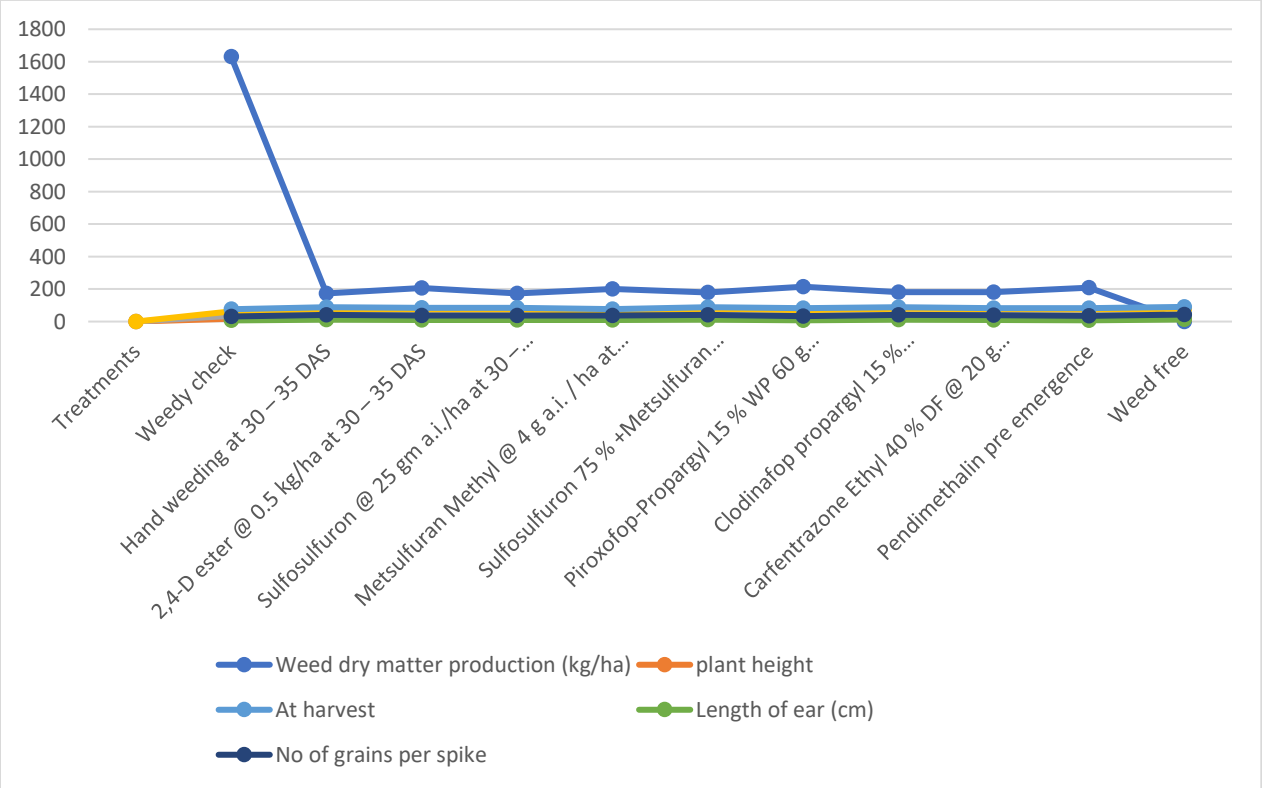


Figure 1 Treatment results.

Growth Attributes (Table 2)

Wheat growth characteristics were significantly influenced by practices in weed control. Weedy check showed the greatest quantity of weedy check dry matter (1631 kg/ha), but the weed-free harbor showed no weedy check biomass. The management of the herbicides with the lowest weedy dry matter was clodinafop + metsulfuron (180.25 kg/ha), sulfosulfuron (172.55 kg/ha), and hand weeding (172.41 kg/ha).

The weed-free treatment had the tallest plants at harvest (79.33 cm), followed by hand weeding (77.48 cm) and clodinafop + metsulfuron (77.77 cm). Under the weedy check, the lowest plant height was measured at 62.73 cm.

There was also a significant variation in the ear length according to treatment. Weed-free treatment (12.74 cm) yielded the longest ear, which was succeeded by sulfosulfuron + metsulfuron (12.35 cm) and hand weeding (12.56 cm). Ear length (weedy check 7.1 cm) was also the shortest. The treatment that received the largest number of grains per spike was the weed-free (43.2), after which was hand weeding (42.0) and clodinafop + metsulfuron (41.6). The lowest amount of grains per spike (31.2) was at the weedy check.

Yield and Harvest Index (Table 3)

Weed control measures had a major impact on wheat grain yield. The weed-free treatment produced the maximum grain yield (48.69 q/ha), followed by clodinafop + metsulfuron (46.19 q/ha) and hand weeding (46.99 q/ha). The weedy check produced the lowest yield (34.46 q/ha).

Similar trends were seen in straw yield, which was lowest in the weedy check (41.35 q/ha) and highest in weed-free plots (58.40 q/ha). As a result, the biological yield was lowest in the weedy check (75.81 q/ha) and highest under weed-free conditions (107.09 q/ha).

Table 3 Effect of weed control treatments on yield and harvest index of wheat

S.No	Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index
1.	Weedy check	34.46	41.35	75.81	45.46
2.	Hand weeding at 30 – 35 DAS	46.99	56.33	103.32	45.48
3.	2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	41.56	49.04	90.6	45.87
4.	Sulfosulfuron @ 25 g a.i. at 30-35 DAS	40.37	48.42	88.79	45.47
5.	Metsulfuron methyl 4 g/ha at 30- 35 DAS.	43.58	51.16	94.74	46
6.	Sulfosulfuron 75 % +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	45.71	55.43	101.14	45.19
7.	60g a.i./ha Piroxofop- propargyl 15 percent WP at 30 – 35 DAS	37.56	46.09	83.65	44.9
8.	Clodinafop-propargyl15% + Metsulfuron methyl 1% aiai/da total at 30- 35 DAS	46.19	55.94	102.13	45.23
9.	Carfentrazone ethyl 15 g/ha 30-35 DAS.	44.15	51.74	95.89	46.04
10.	Pendimethalin pre-emergence	39.11	48.22	87.33	44.78
11.	Weed free	48.69	58.4	107.09	45.47

Harvest index values varied little between treatments, ranging from 44.78 to 46.04. Pendimethalin produced the lowest HI (44.78), while carfentrazone ethyl produced the highest (46.04).

Straw and biological yields followed the same trend—lowest in weedy check, highest in weed-free plots—underscoring the importance of reducing weed biomass to bolster total productivity. Harvest Index (HI) remained relatively stable across all treatments (44.8–46.0), reflecting that weed control principally improves absolute yield rather than altering dry-matter partitioning [13].

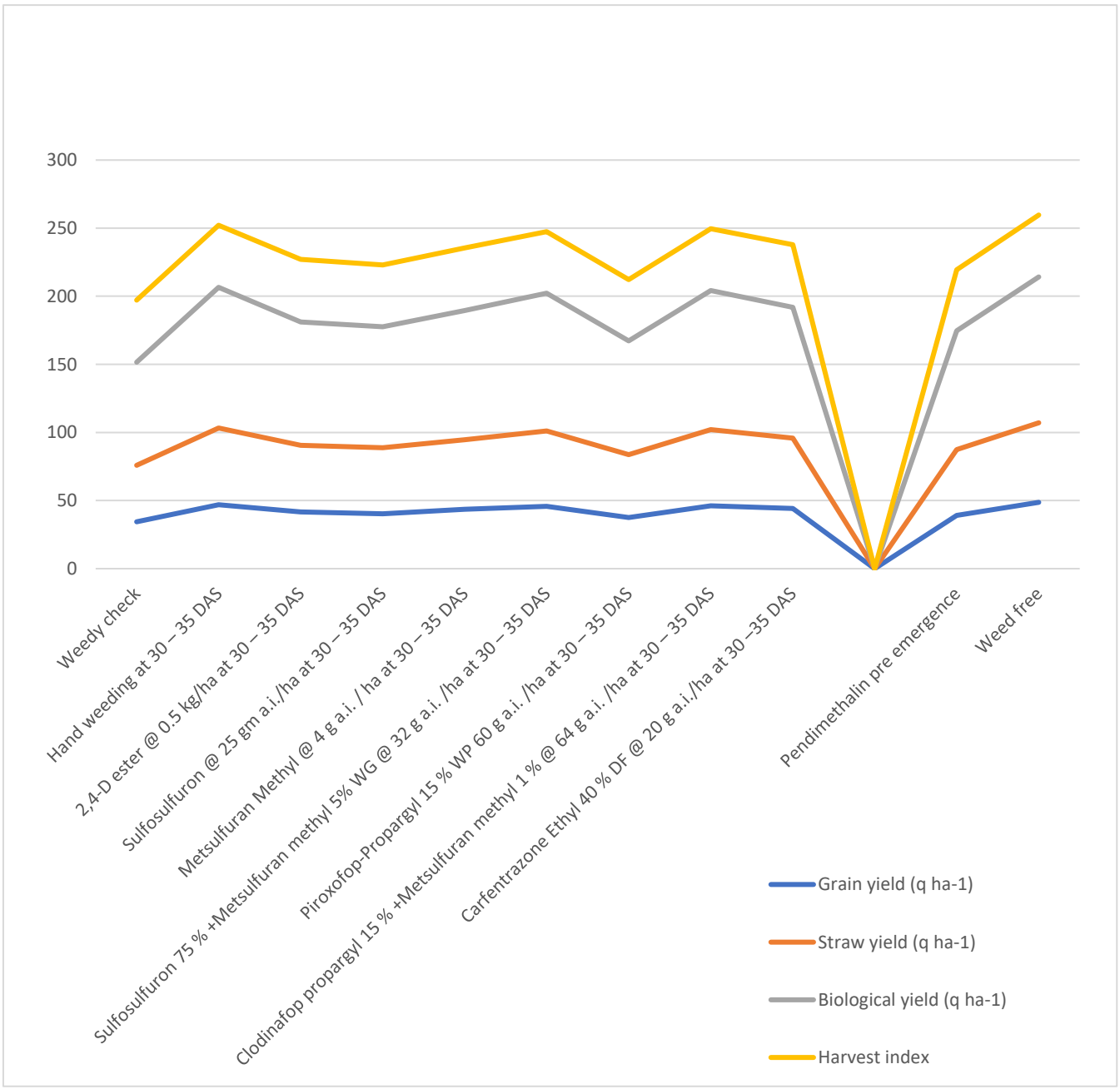
In semi-arid sandy loam soils, herbicide persistence is often moderated by high temperatures and low organic matter, leading to faster photodegradation and microbial breakdown. However, sulfonylurea and triazine herbicides may persist longer under alkaline pH, posing a risk of residual activity on succeeding crops. Limited rainfall reduces leaching potential, though occasional intense showers can enhance downward movement in coarse-textured soils.

Conclusion

The present research has conclusively shown that weed management practices had tremendous effects on wheat growth, yield traits, and productivity. The tallest height of the plants, length of ear, grains per spike, and, finally, the greatest yield of grains (48.69 q/ha), straw manufacturing, and biological yield were all achieved in the weed-free environment.

Nonetheless, due to the higher labor and monetary expenditure, farmers are barely able to maintain plots weed-free during the farming period. The most successful weed management treatments, in the of growth properties and yield performance, were a herbicidal combination of clodinafop propargyl + metsulfuron methyl and hand weeding at 30 to 35 DAS. They also compared well statistically with that of the weed-free. Results of additional interventions, including sulfosulfuron + metsulfuron methyl, were motivating, but pendimethalin and piroxofop-propargyl were notably less effective. The fact that the harvest index values during treatment were relatively equal is an indication that the suppression of weeds on the overall biomass yield was more influential compared to the suppression of weeds on the dry matter partitioning. Its findings underscore the reality that timely and effective weed management not only reduces the development of the weeds, but also ensures enhanced nutrient availability, enhances crop stand, and higher yield. Therefore, application of an integrated weed control program where manual weeding is used in liaison with specific herbicides is the most feasible and long-term approach to enhancing production and profitability of wheat cultivation under a field-based environment.

Figure 2 Yield attributes.



Reference

[1] Anonymous. Agricultural Statistics at a Glance 2023. Ministry of Agriculture and Farmers Welfare, Government of India; 2023.

[2] Kumar R, Singh R, Sharma I, Sharma RK. Wheat production in India: Technologies to face future challenges. Journal of Wheat Research. 2011;3(2):1–12.
[3] Directorate of Economics and Statistics. Agricultural Statistics, Rajasthan 2023. Government of Rajasthan; 2023.
[4] Malik RK, Singh S. Evolving strategies and challenges for managing Phalaris minor in India. Indian Journal of Weed Science. 1995;27(1):1–18.
[5] Yaduraju NT. Weed management in field crops: An overview. Indian Journal of Agronomy. 2006;51(3):186–203.
[6] Balyan RS, Malik RK, Panwar RS, Singh S. Competitive ability of winter wheat cultivars with wild oat (Avena ludoviciana). Weed Science. 1991;39(2):154–8.
[7] Singh R, Singh S, Malik RK. Sulfosulfuron and metsulfuron: Two new herbicides for weed control in wheat. Indian Farming. 2005;55(2):17–20.
[8] Chauhan BS, Mahajan G, Sardana V, Timsina J, Jat ML. Productivity and sustainability of the rice–wheat cropping system in the Indo-Gangetic Plains of the Indian subcontinent: Problems, opportunities, and strategies. Advances in Agronomy. 2012;117:315–69.
[9] Rishav R, Sushant, Birendra K, Mahendra S. Efficacy of different weed management practices on growth and yield of wheat (Triticum aestivum L.). The Pharma Innovation Journal. 2020;9(5):122-132
[10] Singh, M. Yadav S. Clodinafop + Metsulfuron post-emergence herbicide effectively reduced weed biomass and boosted growth. The Pharma Innovation Journal. 2023.
[11] Thakur SK, Singh RP. Effect of herbicide combinations on growth, yield, and nutrient uptake in irrigated wheat. Indian Journal of Weed Science. 2020;52(1):45-52
[12] Dhari, T. Sulfosulfuron (0.03 kg/ha) improved plant height, dry weight, grains/spike vs weedy check. International Journal of Current Microbiology and Applied Sciences. 2025;12(2):12–20.
[13] Malik RS, Yadav A, Kumari R. Ready-mix clodinafop-propargyl + metsulfuron-methyl in wheat. Indian Journal of Weed Science. 2013;45(3):179–82.

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