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Effect of Different Herbicides on the Growth and Yield of Wheat (*Triticum aestivum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Wheat, a critical crop for global food security, faces significant challenges from weed infestation, which can drastically reduce yields. This study, conducted over two years at Sri Durga Ji P.G. College in Chandeswar, Azamgarh, U.P., investigated the efficacy of various herbicide treatments on the growth and yield of wheat using a Randomized Block Design. Key treatments included a weed-free control (T_{12}), combinations of Sulfosulfuron with Metsulfuron (T_2), and Pendimethalin with hand weeding (T_{10}). The study found that comprehensive weed management strategies, particularly those combining multiple herbicides, significantly enhanced spike density, spike length, number of spikelets per spike, and overall grain yield. While the weed-free condition consistently

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showed the highest growth parameters and economic returns, it also incurred the highest cultivation costs. Conversely, the weedy check (T_{11}) demonstrated the detrimental effects of uncontrolled weeds, showing the lowest growth and yield. Overall, effective herbicide management not only improves wheat productivity but also contributes to economic returns, underscoring the need for meticulous weed control in wheat cultivation.

Keywords: Growth; herbicide; weeds; wheat; yield.

1. INTRODUCTION

Wheat is the second-most important cereals crop next to the rice and it is member of the Poaceae family and is hexaploid with 42 chromosomes. Wheat is a substantial source of calories and carbohydrates and has no fat. It is the leading source of vegetable protein in human cuisine worldwide with a protein content of around 13%, which is very high when compared to other major cereals. It also contains plenty of fibre, calcium, thiamine, niacin, iron, riboflavin, vitamin D and other vitamins and minerals like riboflavin. When eaten whole, wheat provides a variety of nutrients and dietary fibre [1]. India's food security is built on wheat. It is used to make things like bread, cakes, biscuits, noodles, petri dishes, and chapatti. Starch (60–68%), protein (8–15%), fat (1.5–2.0%), cellulose (2.0–2.5%), and minerals (1.5–2.0%) are all present in wheat grains [2]. By delivering more than 50% of the calories to the population who rely on it the most, the wheat crop significantly contributes to the nation's food security.

Since 1960, global grain production, including wheat, has tripled and is expected to continue increasing into the mid-21st century. Wheat, integral to 35% of the global population's diet, is the most widely consumed crop. Its unique gluten properties make it essential for processed foods, with demand rising due to global industrialization and Western dietary influences. By 2050, the demand for food grains like wheat is expected to double. In the 2018-2019 season, wheat was cultivated on about 215.45 million hectares worldwide, yielding approximately 730.90 million metric tons [3]. In India alone, the 2020-2021 forecast estimated a production of around 107.59 million metric tons on 31.45 million hectares, with Uttar Pradesh, Punjab, and Madhya Pradesh being key contributors [4].

Weeds pose significant challenges to wheat farming, particularly with the advent of high-yielding dwarf varieties that are more susceptible to weed infestation. Weeds like Phalaris minor and Avena ludoviciana can reduce wheat yields by 15-50% depending on the density and type. Effective weed management strategies include manual weeding, mechanical methods, and the use of herbicides. However, herbicide resistance, such as that developed against Isoproturon by Phalaris minor, complicates control efforts. Newer herbicides like Fenoxaprop, Clodinafop, and Sulfosulfuron have been effective in controlling resistant strains, but issues such as toxicity and the impact on subsequent crops remain concerns.

Herbicides play a crucial role in controlling wheat weeds, with chemicals like Sulfosulfuron and Metsulfuron-methyl being prominent. These herbicides are systemic and selective, targeting specific weed species without harming the wheat. However, the continuous use of a single herbicide can lead to resistance and environmental concerns. Herbicides are necessary for managing broadleaf and grassy weeds, with combinations and sequences of different herbicides often required to manage complex weed flora effectively. In summary, the global importance of wheat continues to grow alongside challenges such as weed management. Advances in agricultural techniques and herbicide development are vital to sustaining wheat production in the face of increasing demand and agricultural hurdles.

2. MATERIALS AND METHODS

The experiment was conducted at Sri Durga Ji P.G. College in Chandeswar, Azamgarh, U.P., which spans 4234 square km and is primarily agricultural, focusing on pulses, oil seeds, sugar cane, and fruits like mango and guava. Azamgarh is geographically situated between 25°38' and 26°27' North latitude, and 82°40' and 83°52' East longitude. It is bordered by Mau, Gorakhpur, Ghazipur, Jaunpur, Sultanpur, and Ambedkar Nagar. The region experiences a hot climate year-round, with temperatures ranging from 48°F to 103°F and approximately 73.21 millimeters of precipitation annually. Azamgarh has limited industrial development, with notable industries including sugar milling, Banarasi sari production, and black pottery.The experimental crop in Azamgarh was uniformly fertilized with

120 kg of nitrogen (N), 80 kg of phosphorus (P), and 80 kg of potassium (K) per hectare, using urea, diammonium phosphate, and muriate of potash respectively. At sowing, the entire dose of P and K along with one-third of N was applied, with the remaining N top-dressed after the first irrigation. Fertilizers were spread right before seeding to promote effective uptake. Sowing involved the HD-2967 wheat variety, planted at 100 kg per hectare with a row spacing of 20 cm, manually completed on November 21 for the 2020–21 season and November 03 for the 2021–22 season. Treatments varied between plots, addressing pre-emergence and post-emergence needs. Irrigation was scheduled at critical growth stages, from 20 to 25 days after sowing (DAS), ensuring no water stress occurred.

Weed management was adapted per plot based on specific treatment plans. Harvesting involved manual cutting with serrate edge sickles once 85% of the panicles had matured spikelets. Post-harvest, grains were sun-dried for 4-5 days, then threshed using both tractor-drawn equipment and manual labor. The biological yield was determined by weighing the produce post-threshing, and the grain yield was recorded after adjusting for a 14% moisture content.

3. RESULTS AND DISCUSSION

The two-year wheat cultivation experiments highlighted the importance of effective weed management for optimizing wheat growth and productivity:

3.1 Weed Control and Crop Performance

Treatments like weed-free conditions (T_{12}) and Pendimethalin pre-emergence followed by hand weeding (T_{10}) showed superior performance in spike density, spike length, number of spikelets per spike, and grain count, demonstrating the positive impact of rigorous weed management. The weedy check (T_{11}) displayed consistently lower performance, underscoring the detrimental effects of weeds. Similar results were also noted by Singh et al. [5], Pala et al. [6], and Nanher et al. [7].

3.2 Herbicide Efficacy

Combinations of herbicides (e.g., Sulfosulfuron with Metsulfuron, Clodinafop with Metsulfuron) were more effective than single applications, suggesting synergistic benefits similar result observed by Zahan et al. [8], Mekonnen et al. [9].

3.3 Grain Quality

There were no significant differences in grain quality, as measured by test weight, among different treatments. The increase in crop yield, attributed to improved crop growth, is consistent with the enhancement in wheat yield attributes reported by Kumar et al. [10] due to irrigation.

3.4 Plant Height and Tillering

The highest plant heights and tiller counts were recorded in the weed-free treatment, with similar performance from T_{10}, T_2, and T_8. These results remained consistent across different growth stages, except at the very early stage (30 DAS) where differences were not significant.

The lowest performance in both parameters was noted in the weedy check, throughout all growth stages. These results support the findings of Gharde et al. [5], Chandra et al. [11].

3.5 Yield attributes and yield

The analysis of yield attribute data clearly demonstrates that different nutrient management practices had a significant impact on yield character attributes such as number of spike (m^{-2}), length of spike (cm), number of spikelet's spike^{-1} and number of grains spike^{-1}, but that the weight of 1000 grains (g) was not significantly impacted.

The crop sown under weed free conditions recorded the significantly highest number of spike (m^{-2}), length of spike (cm), number of spikelet's spike^{-1} and number of grains spike^{-1}, which might due to the weed free conditions provide readily plant nutrients to the crop plants instead of wastage consumption by the weeds. Similar responses were also recorded by Mekonnen et al. [9]. Except the test weight, all other yield attributes were at par with treatment T_{10} (Pendimethalin 1.0 kg a.i. ha^{-1} pre-emergence followed by hand weeding at 30 DAS), T_2 (Sulfosulfuron 25 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}) and T_8 (Fenoxaprop 9 EC 240 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}), which might due to the combinations of the application of various pre and post-emergence herbicides as well as hand weeding contribute to establishing favourable growing conditions with reduced competition for light, soil moisture and nutrients between crop plants and weeds, which produces yield attributes with comparable values. Similar results were also reported by Chandra et al. [11], Singh et al. [12],[13].

Table 1. Effect of different herbicides application on yield attributes of wheat

Symbol	Treatments	Number of spike (m^{-2})		Spike length (cm)		Number of spikelet's $spike^{-1}$		Number of grains $spike^{-1}$		Test weight (g)	
		2020-21	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**
T_1	Sulfosulfuron 25 g a.i. ha^{-1}	319.62	312.41	6.89	6.83	12.00	11.85	36.39	35.89	39.79	39.72
T_2	Sulfosulfuron 25 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	359.77	348.91	8.52	8.47	13.82	13.65	39.76	39.19	41.62	41.59
T_3	Sulfosulfuron 25 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	329.53	325.33	7.39	7.30	12.11	12.01	37.57	37.08	40.42	40.37
T_4	Clodinafop 60 g a.i. ha^{-1}	326.56	321.70	7.22	7.18	12.05	11.99	37.08	36.67	40.27	40.21
T_5	Clodinafop 60 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	340.04	330.42	7.86	7.79	12.93	12.76	38.62	38.13	41.18	41.11
T_6	Clodinafop 60 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	336.75	328.96	7.73	7.68	12.63	12.36	38.15	37.62	40.78	40.57
T_7	Fenoxaprop 9 EC 240 g a.i. ha^{-1}	320.90	313.66	7.01	6.90	12.04	11.94	36.74	36.11	40.05	40.00
T_8	Fenoxaprop 9 EC 240 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	347.01	339.46	8.30	8.24	13.71	13.45	39.23	38.79	41.49	41.48
T_9	Fenoxaprop 9 EC 240 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	333.58	321.53	7.52	7.46	12.16	12.09	37.89	37.23	40.50	40.42
T_{10}	Pendimethalin 1.0 kg a.i. ha^{-1} pre- emergence followed by hand weeding at 30 DAS	367.23	359.22	8.71	8.60	14.30	14.00	40.35	39.85	41.77	41.71
T_{11}	Weedy check	261.47	248.96	5.35	5.23	10.21	9.97	33.21	32.67	38.61	38.57
T_{12}	Weed free	374.69	365.71	8.99	8.92	14.83	14.41	42.68	42.10	41.98	41.95
	SEm±	**10.82**	**10.67**	**0.24**	**0.23**	**0.42**	**0.38**	**1.32**	**1.31**	**1.46**	**1.45**
	C.D.	**31.93**	**31.49**	**0.74**	**0.71**	**1.24**	**1.13**	**4.00**	**3.94**	**NS**	**NS**

Table 2. Effect of different herbicides application on yields of wheat

Symbol	Treatments	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Biological yield (q ha^{-1})		Harvest index (%)	
		2020-21	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**
T_1	Sulfosulfuron 25 g a.i. ha^{-1}	38.78	38.11	53.22	52.60	92.00	90.71	42.15	42.01
T_2	Sulfosulfuron 25 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	45.85	45.40	59.21	58.70	105.06	104.10	43.64	43.61
T_3	Sulfosulfuron 25 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	41.04	40.57	55.96	55.35	97.00	95.92	42.31	42.30
T_4	Clodinafop 60 g a.i. ha^{-1}	40.16	39.66	54.83	54.26	94.99	93.92	42.28	42.23
T_5	Clodinafop 60 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	43.07	42.63	58.07	57.49	101.14	100.12	42.59	42.58
T_6	Clodinafop 60 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	42.40	41.95	57.53	56.92	99.93	98.87	42.43	42.43
T_7	Fenoxaprop 9 EC 240 g a.i. ha^{-1}	39.53	39.13	54.14	53.49	93.67	92.62	42.20	42.25
T_8	Fenoxaprop 9 EC 240 g a.i. ha^{-1} + Metsulfuron 20 g a.i. ha^{-1}	44.91	44.37	58.48	57.84	103.39	102.21	43.45	43.41
T_9	Fenoxaprop 9 EC 240 g a.i. ha^{-1} + Carfentrazone 50 g a.i. ha^{-1}	41.78	41.25	56.78	56.08	98.56	97.33	42.39	42.38
T_{10}	Pendimethalin 1.0 kg a.i. ha^{-1} pre- emergence followed by hand weeding at 30 DAS	46.67	46.12	62.63	62.06	109.30	108.18	42.70	42.63
T_{11}	Weedy check	23.74	22.07	32.73	32.18	56.47	54.25	42.04	40.68
T_{12}	Weed free	48.23	47.73	64.01	63.42	112.24	111.15	42.95	42.92
	SEm±	**1.50**	**1.48**	**1.98**	**1.91**	**3.48**	**3.39**	**1.53**	**1.52**
	C.D.	**4.44**	**4.38**	**5.86**	**5.64**	**10.28**	**10.01**	**NS**	**NS**

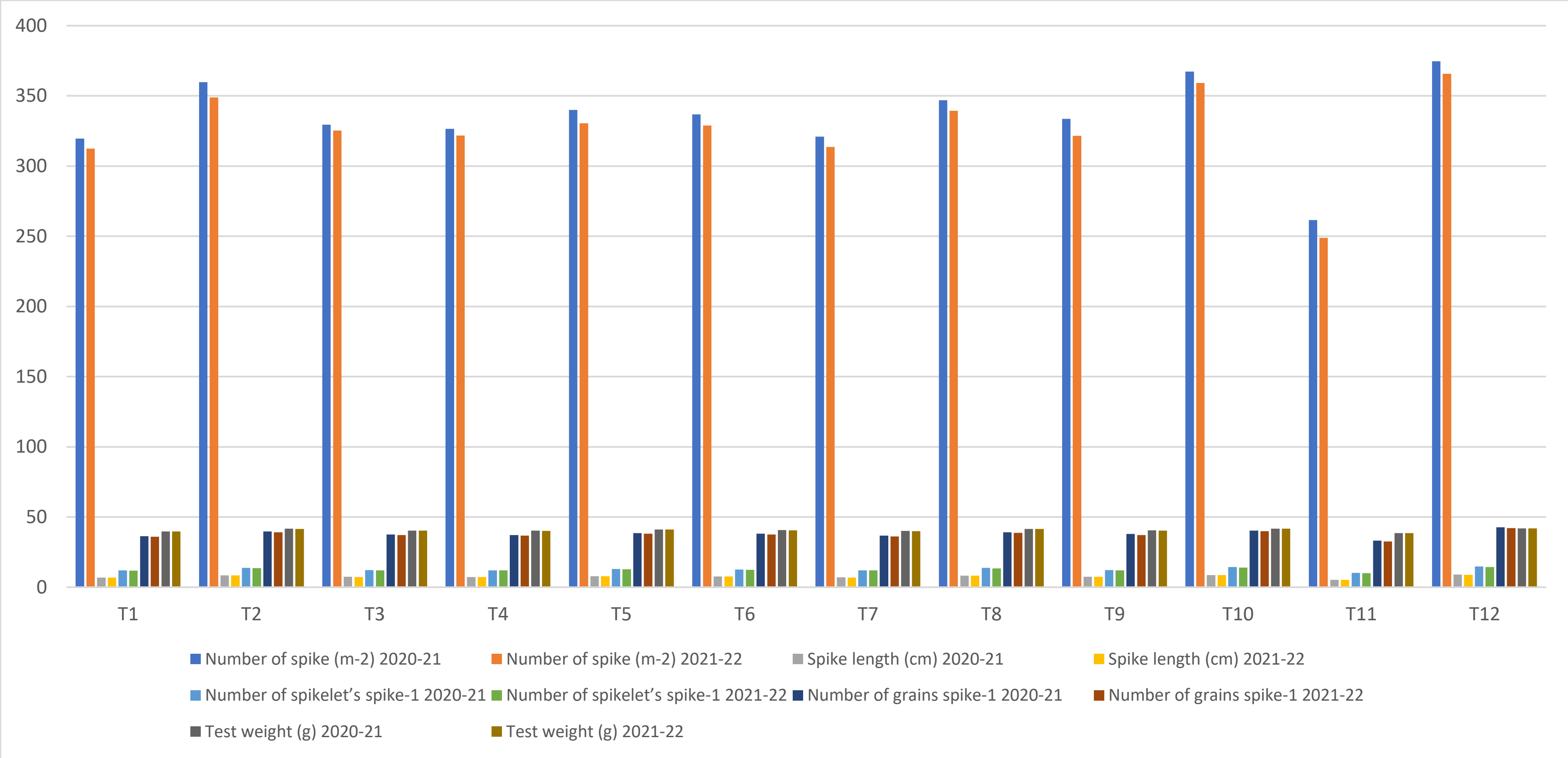

Fig. 1. Effect of different herbicides application on yield attributes of wheat

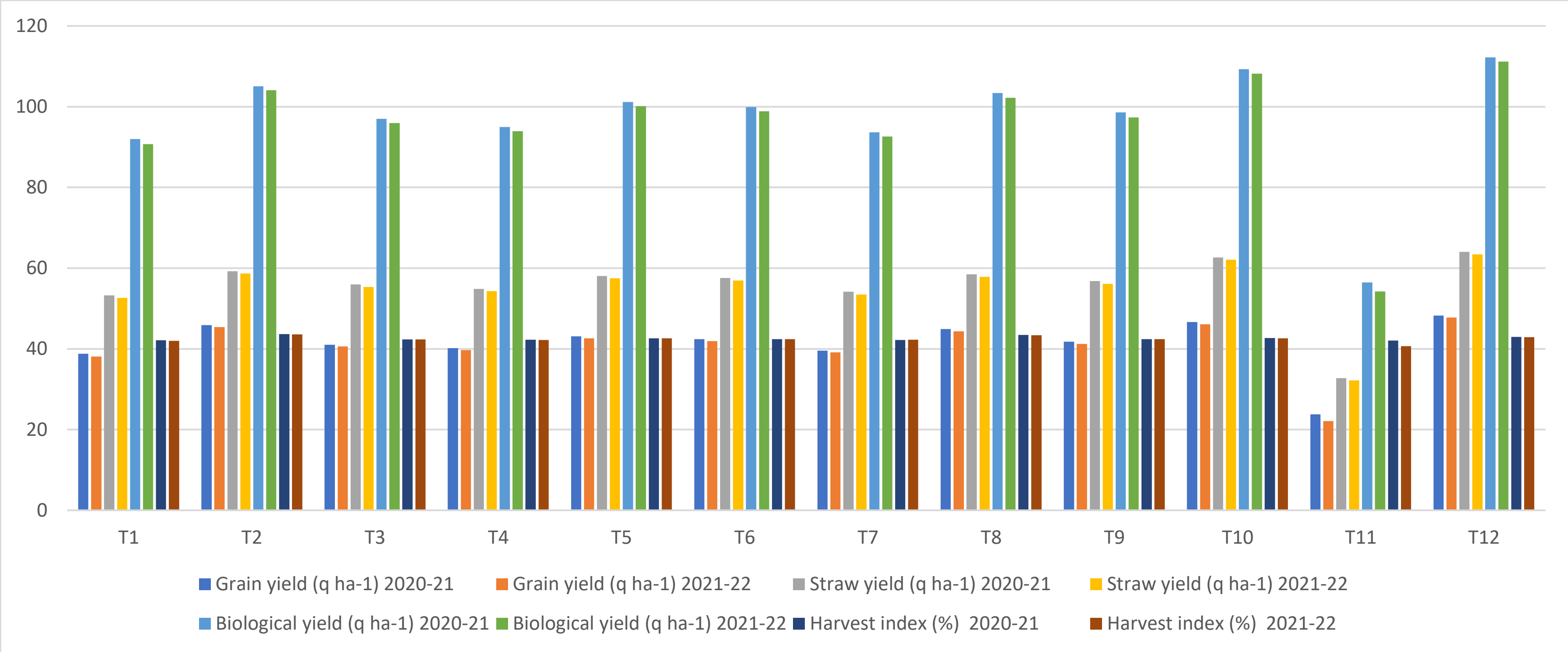

Fig. 2. Effect of different herbicides application on yields of wheat

4. CONCLUSION

Herbicide treatments significantly influenced the growth, yield, and weed management of wheat over two experimental years. The weed-free treatment (T_{12}) consistently showed the highest growth parameters, yield attributes, and economic returns, closely matched by treatments T_{10} (Pendimethalin pre-emergence followed by hand weeding), T_2 (Sulfosulfuron with Metsulfuron), and T_8 (Fenoxaprop with Metsulfuron). These treatments also recorded minimal weed density and maximum weed control efficiency.Conversely, the weedy check (T_{11}) displayed the lowest growth and yield metrics, along with the highest weed density and nutrient uptake by weeds, underlining the negative impact of unmanaged weeds.Economically, the weed-free treatment (T_{12}) and similar high-performing treatments incurred the highest cultivation costs but also yielded the highest gross returns. Notably, treatment T_2 achieved the highest net returns and benefit-cost ratio, suggesting it as the most cost-effective option among the high-performing herbicide treatments. Overall, effective herbicide management not only enhances crop growth and yield but also optimizes economic returns by balancing costs with benefits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shewry PR, Hey SJ. Review: The contribution of wheat to human diet and health. Fd. & Ene. Security. 2015;4(3):178-202.
2. Rathore AL. Studies on nitrogen and irrigation requirement of late sown wheat. Indian Journal of Agronomy. 2001;46(4): 659-664.
3. Anonymous. Agricultural statistics at a glance, directorate of economics & statistics, DAC & FW; 2019.
4. Anonymous. Foreign agricultural service, United States department of agriculture; 2021.
5. Gharde Y, Singh PK, Dubey RP, Gupta PK. Assessment of yield and economic losses in agriculture due to weeds in India. Crop Protection. 2018;107:12-18.
   Available:https://doi.org/10.1016/j.cropro.2018.01.007
6. Pala F, Mennan H. Common weeds in wheat field. In book: Bacterial practices in agriculture. Publisher: Iksad Publishing House. 2021;311-332.
7. Nanher AH, Singh R, Yadav S, Tyagi S. Effects of weed control treatments on wheat crop and associated weeds. Trends in Biosciences. 2015;8(2):421-428.
8. Zahan T, Rahman MM, Begum M. Weed control efficacy of herbicides in wheat under strip tillage system. Fundamental and Applied Agriculture. 2016;1(2):92-96.
9. Mekonnen G. Wheat (*Triticum aestivum* L.) yield and yield components as influenced by herbicide application in Kaffa Zone, Southwestern Ethiopia. International Journal of Agronomy. 2022;1-14.
   Available:https://doi.org/10.1155/2022/3202931
10. Kumar B, Hasanain M, Raza MDB, Yadav RB, Singh RK, Mishra R, Ahmad G, Singh D. Effect of weed management practices on nutrient uptake and wheat productivity (*Triticum aestivum*). Indian Journal of Agricultural Sciences. 2022;92(3):405-407.
11. Chandra RS, Yohn CW, Coburn CW. Effect of herbicide banding on yield and biodiversity levels of field corn. Proceedings of Northeast Weed Science Society. 2018;65:93.
12. Singh PR, Singh AK, Nayak R, Singh RPK. Fenoxaprop-p-ethyl effect against weeds in late sown wheat. Indian Journal of Weed Science. 2016;48(3):328–329.
    DOI: 10.5958/0974-8164.2016.00082
13. Singh V, Jat ML, Ganie ZA, Chauhan BS, Gupta RK. Herbicide options for effective weed management in dry direct-seeded rice under scented rice-wheat rotation of western Indo-Gangetic Plains. Crop Protection. 2018;81:168-176.

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