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Growth and yield parameters of wheat (*Triticum aestivum* L.) as affected by different herbicides on different weeds in the field

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Abstract
A field experiment was carried out in the 2022–2023 rabi season by the School of Agricultural Sciences at Dr. K. N. Modi University in Newai. The study's objective was to investigate the effects of several herbicides on wheat's growth and yield characteristics. The trial employed six treatment combinations: control, manual weeding, 2-4 D spray at 25 and 50 DAS, tribuzing spray at 25 and 50 DAS, methylfuran spray at 25 and 50 DAS, and a combination of isoproturon 1.0 and 2-4 D at 0.5 kg/ha. Three replications and an RBD layout characterised the experiment. The experimental study's various weed control strategies had no discernible impact on either the starting or end plant populations. The pesticides used after emergence. T_5 (Metsulfuron spray at 25 and 50 DAS), T_2 (manual weeding), and T_4 (Metribuzin spray at 25 and 50 DAS) were the other herbicidal treatments that showed the highest tiller count, which was found under T_3 (2-4 D spray at 25 and 50 DAS). Dry matter buildup was highest in the T_6 (Mixture of Isoproturon 1.0 + 2-4 D @ 0.5 kg/ha) plot. although T_3 (2-4 D spray at 25 and 50 DAS) was significantly less than T_5 (Metsulfuron spray at 25 and 50 DAS), T_2 (manual weeding), and T_4 (Metribuzin spray at 25 and 50 DAS). T_6 (weed-free) had the largest spike length, statistically comparable to T_3 (2-4 D spray at 25 and 50 DAS). T_5 (Metsulfuron spray at 25 and 75 DAS) came in second. The highest grain count, earhead-1, was observed in T_6 (1.0 + 2-4 D @ 0.5 kg/ha) is the isoproturon. In the T_6 (Isoproturon 1.0 + 2-4 D @ 0.5 kg/ha) plot, the maximum test weight was noted. T_3 showed the highest grain yield (Spray 2-4 D at 25 and 50 DAS). T_3 showed the maximum yield of grains (2-4 D spray at 25 and 50 DAS). T_1 (Control) recorded the largest amount of nutrients absorbed by the crop, followed by T_3 (2-4 D spray at 25 and 50 DAS) and T_5 (Metsulfuron spray at 25 and 50 DAS). T_3 (Spray 2-4 D at 25 and 50 DAS) generated the greatest net returns, and T_6 and T_5 (Metsulfuron spray at 25 and 50 DAS) came in second and third, respectively. T_3 (2-4 D spray at 25 and 50 DAS) plots had the highest benefit-cost ratio.

Keywords: Growth, yield parameters, *Triticum aestivum* L., herbicides, weeds

Introduction
Triticum aestivum L., or wheat, is one of India's most important crops. due to its vastness as well as its flexibility in a range of agroclimatic conditions and crop-growing environments. The world's second-largest producer of wheat is India. In India, wheat is a significant crop for rabi cereal. In the grass family, wheat belongs to the genus Triticum. or poaceae family. South Western Asia is where wheat originated. Although there are dozens of varieties of wheat, the three most significant Bread is made from common wheat (*Triticum aestivum*), and pasta is made from duram wheat (*T. durum*).
Macaroni and spaghetti (alimentary pastes); club wheat (*T. compactum*), which is used to make cakes, crackers, cookies, etc and other baked goods because it is softer. breads and flours.
Emmer wheat (*Triticum diccocum*) was used in ancient times; Einkorn wheat (*Triticum monococcum*) is domesticated from wild Einkorn. Furthermore, the industry uses a portion of wheat to make starch, paste, malt, dextrose, gluten, alcohol, and other products.
Biscuits, cakes, flakes, bread, and other baked goods are also made with wheat. It is produced in many different geographic locations and meteorological conditions. India ranks second globally in terms of output (110 million tonnes) with a productivity per acre average of 3.05 metric tonnes, lagging behind China, while having the largest area under cultivation for wheat (29.8 million hectares).

India's wheat-growing states include Madhya Pradesh, Punjab, Rajasthan, Haryana, Gujarat, Maharashtra, Bihar, and Uttar Pradesh. Uttar Pradesh is the most productive state in terms of both area and output. however Punjab is ranked highest in terms of productivity. Various varieties of wheat, including hard wheat, pissi wheat, amber wheat, and soft wheat, are cultivated and utilised in the production of bread, pastries, chapaties, and bakery goods. To make Rawa, Suji, and Sewaiya, hard wheat is utilised. The primary purpose of wheat straw is to feed livestock. The crop yields 13.88 million metric tonnes annually on an area of 3.09 million hectares in Rajasthan, with an average productivity of 3971 kg ha-1. The area and production of wheat are extremely low in Rajasthan, a non-traditional wheat-growing province. to raise the output to a level comparable with other non- traditional wheat-growing regions in India in order to fulfil the significant demand for food.

More attention must be paid to matching agronomic methods, weed, disease, and pest problems in wheat, as well as the use of new high-yielding cultivars in order to reach the desired production and productivity. Weeds are one of the main factors limiting wheat production; they compete with crops for nutrients, moisture, sun radiation, and space.

Compared to other parts of India, Rajasthan's weed flora is completely unrelated to wheat. India experiences a 28–53% decrease in wheat grain output as a result of weed competition. Weed management with the conventional approach is labor-intensive, time- consuming, and slow. Not only is labour growing more expensive, but it is also getting harder to find. Only feasible on a limited scale, hand weeding requires a lot of work, time, and energy, but it works well for annual weeds. The quest for alternatives, such as the use of herbicides either alone or in conjunction with hand weeding, was prompted by the rising costs of labour and their scarcity.

Though less expensive, mechanical methods are limited to controlling weeds between rows rather than those within. The best, most sensible, most affordable, and most efficient way to lessen early weed competition and crop production losses in such circumstances is to use herbicides. However, continued usage of some herbicides has resulted in the development of resistant weeds, exacerbating weed issues. Phalaris minor, for example, has evolved isoproturon resistance in Punjab and Haryana's rice-wheat cropping systems.

Mechanical solutions are less expensive, but they can only eradicate weeds between rows, not within them. Herbicide application is the best, most practical, most economical, and most effective approach to reduce crop output losses due to early weed competition. Nonetheless, continuous pesticide use has resulted in the proliferation of resistant weeds, exacerbating the weed problem. For instance, in Punjab and Haryana's rice- wheat cropping systems, Phalaris minor has developed isoproturon resistance.

Herbicides account for only 8% of all pesticides used in India, where the average herbicide used is 35 grammes per year.

Thus, a comparative analysis of various weed control strategies for wheat is necessary, as is India's wheat-growing states include Madhya Pradesh, Punjab, Rajasthan, Haryana, Gujarat, Maharashtra, Bihar, and Uttar Pradesh. While Punjab is ranked highest in terms of productivity, Uttar Pradesh is ranked first in terms of area and production. Various varieties of wheat, including hard wheat, pissi wheat, amber wheat, and soft wheat, are cultivated and utilised in the production of bread, pastries, chapaties, and bakery goods. Rawa, Suji, and Sewaiya are made from hard wheat. The primary use of wheat straw is as animal feed.

Materials and Methods

During the 2022–2023 rabi season, at the Dr. K.N. Modi University's agronomy farm in Newai, Rajasthan's School of Agricultural Sciences, the current study, titled "Effect of different herbicides on the growth and yield parameters of wheat (*Triticum aestivum* L.)," is being carried out. Within the trial plot, the available phosphorus was 29 kilogrammes per hour, the available potassium was 268 kilogrammes per hour, the available nitrogen was low (270.00 kg ha-1) and sandy loam made up the soil's texture. With a pH of 8.4, the soil reaction was slightly alkaline. The crop was able to grow normally in this soil. Over the course of 18 plots, six treatments and three replications were carried outT_1 was the control, T_2 was hand weeding, and T_3 was 2,4-D spraying at 25 The treatments were T_1: control, T_2: hand weeding, T_3: 2,4-D spray at 25 and 50 DAS, T_4: tributing spray at 25 and 50 DAS, T_5: metsulfuron spray at 25 and 50 DAS, and T_6: a mixture of isoproturon 1.0 similar 2,4-D at 0.5 kg/ha. 5.0 m x 2.8 m and 4 m x 2 m, respectively, were the gross and net plot sizes. Sowing was done on 10th December 2022 and spacing was 20 cm 10 centimetres. Applying urea, DAP, MOP, and gypsum in accordance with treatment protocols allowed for the recommended dosage of fertiliser to be administered.

Measures for protecting plants and implementing recommended practices were followed. April 22, 2023, was the harvest date of the crop.

Results and Discussion

Grow that tributes

Table 1 presents information on how different treatments affect growth attributes include the height of the plant, the quantity of green leaves, and the area of the leaves.

Plant height (cm)

Throughout the crop's many growth stages, data on the impact of different treatments on mean plant height (cm) was frequently recorded. It showed that, with the exception of 25 DAS, the weed control treatments significantly affected plant height at every stage of crop growth. The T_6 (combination of isoproturon 1.0 + 2-4 D @ 0.5 kg/ha) at 25 DAS had the tallest plants. T_3 (2-4

D) mist at 25 and 50DAS) among the different herbicides used, recorded the maximum plant height (21.14 and 95.12 cm at 25 and 75 DAS); this was comparable to T_5 (Metsulfuron spray at 25 and 50 DAS) and much greater than all other herbicidal treatments. T_1 (Control) had the smallest plant height measured.

Leaf area (cm^2)

Different treatments influenced the mean number of leaf areas at various growth stages of the crop.

Different treatments significantly affected the leaf area. It indicated that leaf area increases although the plant's height increased, the largest leaf area was noticed in the T_5 (Metsulfuron 5.79 and 7.98 cm2 at 25 and 50 DAS, respectively). After that, T_6 combination of 2-4 D and isoproturon 1.0 @ 0.5 kg/ha recorded 5.71 and 7.91 cm2 of leaf area, followed by T_4 and T_3. The lowest leaf area (cm2) was recorded in T_2 (handweeding)

Table 1: Growth attributes affected by different treatments.

S. No	Treatments	Plant height (25 DAS)	Plant height (75 DAS)	Leaf area (25 DAS)	Leaf area (75 DAS)
1.	T_1 (Control)	18.46	73.44	4.39	5.61
2.	T_2 (Hand weeding)	19.90	94.02	4.27	5.46
3.	T_3 (2-4 D spray at 25 and 50 DAS)	21.14	95.12	5.39	6.67
4.	T_4 (Metribuzin spray at 25 and 50 DAS)	19.50	92.90	5.54	7.20
5.	T_5 (Metsulfuron spray at 25 and 50 DAS)	20.05	94.45	5.79	7.98
6.	T_6 (Blend of 1.0 + 2-4 D at 0.5 kg/ha for isoproturon)	22.05	88.55	5.71	7.91
	SE m±	0.76	0.47	0.19	0.30
	CD (at 5%)	2.28	1.45	0.57	0.90

Table 2: Yield attributes affected by different herbicides.

S. No	Treatments	Spike length (cm)	Grain ear head (g)	Test weight (g)	Grain yield (kg)	Straw yield (kg)
1.	T_1 (Control)	11.10	36.68	42.31	3026.96	4576.96
2.	T_2(Hand weeding)	11.86	42.07	46.76	3626.76	5276.79
3.	T_3 (2-4 D spray at 25 and 50 DAS)	12.46	43.69	49.22	3924.92	9451.66
4.	T_4 (Metribuzin spray at 25 and 50 DAS)	11.24	39.08	46.81	3107.53	7767.52
5.	T_5 (Metsulfuron spray at 25 and 50 DAS)	12.33	44.90	48.41	3717.76	9016.52
6.	T_6 (Isoproturon 1.0 + 2-4 D combination at 0.5 kg/ha)	12.56	45.80	44.27	4011.52	9590.42
	SE m±	0.25	0.30	0.28	43.70	104.20
	CD (at 5%)	0.76	0.92	0.86	134.63	321.02

Growth Analysis
The LAI (leaf area index) and other growth functions were determined using the information on growth characteristics, including leaf area, plant height, etc.

Attributes of yield
Data on the yield and features contributing to the yield were recorded after the observations. such as spike length (cm), grain Test weight (g), grain yield (kg/ha), straw yield (kg/ha), ear head (g), and so on.

Spike length
Every weed control technique was discovered to have a substantial effect on spike length. The T_6 treatment (blended at 0.5 kg/ha of isoproturon 1.0 + 2-4 D) recorded the longest spike length (12.56), which was statistically comparable to the T_3 therapy (12.46) and significantly superior to all other treatments (2-4 D spray at 50 DAS).

Grains earhead-1
According to the findings, the T_6 treatment (Mixture of Isoproturon 1.0 + 2- 4 D @ 0.5 kg/ha) generated the greatest amount of grains per head-1 (45.80) followed by T_5 (Metsulfuron spray at 25 and 50 DAS).

Test weight
The highest test weight was observed in T_3 (2,4D spray at 25 and 50 DAS) (49.22 g) and lowest in T_1 (Control) (42.31 g). Among the different herbicidal treatments, T_5 (Metsulfuron spray at 25 and 50 DAS) (48.41 g) was discovered to be noticeably better than the rest of the therapies.

Grain yield
The T_6 treatment (0.5 kg/ha of isoproturon 1.0 + 2-4 D combined) produced the highest grain yield because the weeds that significantly reduced the yield in the T_1 control were frequently eliminated.

The herbicidal treatment T_6 (isoproturon 1.0 + 2-4 D combined at a rate of 0.5 kg/ha) likewise yielded the most of all the treatments; it was comparable to T_1 (control) and far greater than any other. Due to a severe weed infestation, which decreased wheat output, T_1 (Control) had the lowest grain yield recorded.

Straw yield
T_6 The mixture of isoproturon 1.0 + 2-4 D @ 0.5 kg/ha yielded the most amount of straw (5578.89 kg/ha). shown to be considerably greater than the yields of the other treatments. T_1 (Control) yielded the least amount of straw.

Harvest index
The T_6 (mixture of 2-4 D at 0.5 kg/ha and isoproturon 1.0) as well T_1 (control) (39.80) had the highest and lowest harvest indices, respectively. The herbicidal treatment T_3 (2-4 D spray at 25 and 50 DAS) was shown to be much better than the other herbicidal treatments, as seen by the maximum harvest index it recorded.

Conclusion
The application of herbicides such metsulfuron and 2,4-D is effective in removing the weeds that have taken over the crop field, according toward the findings of the current experiment. Following T_5 (Metsulfuron spray at 25 and 50 DAS), T_6 (2,4D 0.5 kg/ha + isoproturon 1.0 kg/ha) application) produced yield attributes that were found to be equivalent with T_3 (2,4-D at 25 and 50 DAS), with considerably better growth. The outcomes are comparable to a crop free of weeds and serve as a suitable substitute for the time-consuming and costly hand weeding method.

Furthermore, because metsulfuron breaks down more quickly in soil than other herbicides, it is safe to use in agricultural fields, according to bioassay studies conducted on indicator plants to test the persistence of herbicides.

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