



Results of Weed Density, Yield Attributes, and Yield on Wheat Crop were Influenced by Varying Broad-spectrum Herbicide Treatments in Eastern U.P., India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2024/v46i12298

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/111732>

Original Research Article

Received: 14/11/2023

Accepted: 18/01/2024

Published: 24/01/2024

ABSTRACT

In the year 2015-16, a field experimental trial was conducted during the rabi season to assess the impact of various broad spectrum herbicide treatments on weed density and yield in wheat crops. The experiment followed a randomized block design with four replications, and a total of eight treatments were tested. The wheat cultivar DBW-17 was used as the test crop. Results showed that weed density and dry matter accumulation of weeds increased up to 90 days of crop growth, but decreased at 120 days in the weedy check treatment. In contrast, no weeds were recorded in the

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weed-free plot throughout the crop period. In terms of the wheat crop, the weed-free plot had the highest total dry matter accumulation at all stages (30 DAS-32.62, 60 DAS-278.26, 90 DAS-934.49 and 120 DAS-1276.28 g/m²), number of spikes (303.00/m²), number of grains/spike (51.00), test weight (40.40 g), length of spike (11.12 cm) and grain yield (5.422 t/ha). On the other hand, the weedy check treatment had the lowest total dry matter accumulation at all stages (30 DAS-28.78, 60 DAS-207.24, 90 DAS-679.82 and 120 DAS-932.76 g/m²), number of spikes (208.00/m²), number of grains/spike (42.00), test weight (36.41 g), length of spike (10.31 cm) and grain yield (2.641 t/ha).

Keywords: Weed density; yield attributes; wheat crops; herbicide treatments on weed.

1. INTRODUCTION

Wheat belongs to the Poaceae family and is believed to have originated from the Middle East region of Asia. It provides approximately 20% of the total food calories for the human race. Wheat grain consists of starch (60-68%), protein (6-21%), fat (1.5-2.0%), cellulose (2.0-2.5%), and minerals (1.8%), as well as vitamins. One unique property of wheat, compared to other cereals, is its gluten protein which enables leavened dough to rise by forming small gas cells. This allows bakers to produce light breads [1]. In India, wheat is grown on approximately 31.13 million hectares, with a production of 109.59 million tonnes and a productivity of 3521 kilograms per hectare. Uttar Pradesh ranks first in both area and production, with 9.85 million hectares (32.40 %) and 35.51 million tonnes (32.40 %) respectively. Punjab has the highest productivity of 4868 kg/ha (Directorate of Economics & Statistics, DAC&FW, 2020-2021). Weed infestation is a major problem in achieving high productivity in wheat, as it competes with the crop for moisture, nutrients, space, and light. This not only increases the cost of production, but also leads to a reduction in yield and can harbor insects and plant diseases, resulting in a decrease in the quality of farm produce and land value. In India, weeds are causing significant losses in agricultural production. In a study by Kristensen et al. [2], it was found that weed biomass was generally lower and yield was higher in a uniform pattern, except in one case where a combination of factors gave one weed species an early size advantage over the crop. When weeds were controlled with herbicide, no effects of crop density or spatial uniformity on crop biomass or yield were observed. Currently, manual weeding is a costly and time-consuming process. As a result, chemical weed control is gaining popularity. The aim of this experiment was to investigate the response of various herbicides and their combinations on weed biomass and grain yield in a wheat crop.

2. MATERIALS AND METHODS

A field experiment was conducted at the crop research farm (Pilikothi) of the Agronomy Department, Tilak Dhari Post Graduate College, Jaunpur (Uttar Pradesh) during the rabi season of 2015-16. The experimental soil was sandy loam in texture, with an alkaline pH of 7.49, low organic carbon content (0.45%), medium available nitrogen (257.15 kg/ha), high available phosphorus (7.0 kg/ha), and available potassium (188.16 kg/ha). The experiment consisted of eight treatments: T1- Weedy, T2- Weed-free, T3- Pendimethalin at 1.0 kg a.i./ha, T4- Clodinafop + metsulfuron at 0.04 + 0.005 kg a.i./ha, T5- Isoproturon at 1.0 kg a.i./ha, T6- Metsulfuron at 0.005 kg a.i./ha, T7- Sulfosulfuron at 0.03 kg a.i./ha, and T8- Metribuzin at 0.3 kg a.i./ha. The experiment was laid out in a randomized block design with four replications. The weekly mean maximum and minimum temperatures ranged from 18.97 to 39.06 °C and 7.25 to 23.04 °C, respectively. The maximum and minimum relative humidity varied from 94.57 and 19.71 percent, respectively, and a total of 46.3 mm of rainfall was received during the crop period (Source : Banaras Hindu University, Banaras) . The wheat cultivar DBW-17 was grown in the experimental field. Urea, single superphosphate, and muriate of potash were used to supply 140 kg N, 60 kg P₂O₅, and 40 kg K₂O/ha, respectively. Half of the nitrogen and the full dose of phosphate and potassium were applied as basal dressing, while the remaining half of the nitrogen was top-dressed in two equal doses. To create ideal conditions for good germination, pre-sowing irrigation was given 10 days before sowing. Irrigation was applied at critical growth stages of the crop. The herbicide treatments were executed at 3 and 33 days after sowing (DAS) using a manually operated knapsack sprayer fitted with a flat fan nozzle. The weed density and dry weight of grass and broad-leaf weeds were analyzed using the transformation of square root ($\sqrt{x + 1}$) before carrying out analysis

of variance. Comparisons were made on the transformed values.

3. RESULTS AND DISCUSSION

3.1 Density of Total Weed (No./m²)

Density of Total Weed (No./m²) The data in Table 1 clearly shows that the total density of weeds was effectively controlled in the weed-free treatment at all growth stages. However, in the chemically treated plots, such as those treated with Pendimethalin at 1.0 kg a.i./ha at 30 DAS (11.16/m²), Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha at 60 DAS (11.71/m²), Isoproturon at 1.0 kg a.i./ha at 90 DAS (11.05/m²), and Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha at 120 DAS (10.14/m²), there was a significant reduction in weed density. The highest weed population and dry matter were observed in the weedy check, confirming similar results found by Kaur et al. [3].

3.2 Total Weed Dry Matter Accumulation (g/m²)

The total dry matter accumulation of weeds was lowest in the weed-free treated plot during the cropping period. However, Pendimethalin at 1.0 kg a.i./ha at 30 DAS (2.30 g/m²) and Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha during 60, 90, and 120 DAS (4.50, 4.71, and 4.37 g/m²) efficiently reduced the weed dry matter accumulation during the cropping period, as shown in Table 1. The least reduction in dry matter of weeds was observed in Metsulfuron at 0.005 kg a.i./ha at 30 DAS interval (3.33 g/m²) and the weedy check plot during the rest of the stages (6.73, 8.81, and 8.48 g/m²). Significantly, the minimum dry weight of weeds was noted in the weed-free plot due to the lowest population of narrow and broadleaf weeds, while the highest dry weight of weeds was recorded in the weedy check plot. This could be attributed to the higher density and uncontrolled growth of weeds in the untreated check plot. Similar results were also reported by Sharma et al. [4].

3.3 Yield Attributes of Wheat

The number of spikes per square meter was significantly influenced by weed management practices in wheat. The adoption of a weed-free treatment resulted in a significant increase in the number of spikes per square meter. Additionally, the use of Clodinafop + Metsulfuron at 0.04 +

0.005 kg a.i./ha (283.00/m²) and Metsulfuron at 0.005 kg a.i./ha (279.00/m²) showed similar results. The highest number of spikes per square meter was observed in the Clodinafop + Metsulfuron treatment, which also had the highest seed yield in comparison to the weedy check. Other parameters such as the number of grains per spike, test weight (g), and length of spike (cm) did not show significant differences and are indicated in Table 2. However, the highest readings were seen in the weed-free condition crop. The application of Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha (49.00/spike, 39.55 g, and 10.85 cm) and Metsulfuron at 0.005 kg a.i./ha (49.00/spike, 39.47 g, and 10.82 cm) also resulted in the highest readings for these parameters, indicating better seed yield compared to the weedy check. This can be attributed to the effective weed control provided by these treatments. Similar findings were also reported by Kumar et al. in [5].

3.4 Yield of Wheat

As shown in Table 2, the grain yield of wheat was significantly higher in the weed-free treated plot compared to the weedy check. The application of Clodinafop + Metsulfuron at a rate of 0.04 + 0.005 kg a.i./ha resulted in a statistically similar higher grain yield of 4.916 t/ha, compared to the weed-free plot which yielded 5.422 t/ha. This increase in yield can be attributed to the better control of weeds, which may have allowed for higher uptake of nutrients and water, resulting in improved growth characteristics such as plant height, effective tillers, and enhanced photosynthetic activity. This, in turn, led to higher yield attributes such as spikelets per spike, grain weight per plant, and test weight. The lower weed count and dry weight of weeds in these treatments also contributed to the improved yields of both grain and straw [1]. The lower yield in the check plot may be due to poor root growth and a higher weed population, which would have competed with the wheat crop for space, water, and nutrients, ultimately leading to lower grain and straw yields. This is consistent with the findings of Paighan et al. (2013). The use of herbicides effectively reduced weed competition, allowing for more moisture, plant nutrients, and space for the crop to grow. It is evident that weeds significantly affected the yield attributing characters, resulting in lower biological and grain yield. This is in line with the results reported by Choudhary et al. [6].

Table 1. Response of total weed density and total dry matter accumulation of weeds to various weed management practices

Treatments	Density of total weed (No./m ²)				Total dry matter accumulation of weeds (g/m ²)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
Weedy	16.62 (276.50)	19.26 (372.00)	19.80 (392.50)	13.90 (193.50)	3.24 (9.63)	6.73 (44.89)	8.81 (76.89)	8.48 (71.39)
Weed free	1.00 (00)	1.00 (00)	1.00 (00)	1.00 (00)	1.00 (00)	1.00 (00)	1.00 (00)	1.00 (00)
Pendimethalin at 1.0 kg a.i./ha	11.16 (124.00)	13.06 (170.25)	13.69 (187.75)	11.44 (130.00)	2.30 (4.33)	4.86 (22.86)	5.94 (34.47)	5.57 (30.16)
Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha	16.49 (272.25)	11.71 (137.50)	12.16 (149.25)	10.14 (102.00)	3.21 (9.56)	4.50 (19.33)	4.71 (21.37)	4.37 (18.23)
Isoproturon at 1.0 kg a.i./ha	16.48 (274.75)	14.14 (200.00)	11.05 (121.75)	12.26 (150.25)	3.24 (9.58)	5.35 (27.77)	6.42 (40.39)	6.10 (36.41)
Metsulfuron at 0.005 kg a.i./ha	16.62 (277.25)	12.04 (144.75)	12.53 (157.00)	10.49 (109.50)	3.33 (10.17)	4.56 (19.97)	5.12 (25.35)	4.85 (22.69)
Sulfosulfuron at 0.03 kg a.i./ha	16.44 (270.50)	14.53 (211.00)	15.21 (231.25)	12.47 (156.00)	3.22 (9.46)	5.56 (30.02)	6.60 (42.89)	6.26 (38.32)
Metribuzin at 0.3 kg a.i./ha	16.39 (269.25)	13.67 (186.50)	14.11 (201.00)	11.81 (139.00)	3.22 (9.43)	5.18 (25.97)	6.18 (37.33)	5.85 (32.38)
SEm+	0.712	0.544	0.549	0.462	0.151	0.229	0.225	0.215
C.D. at 5%	2.107	1.612	1.625	1.367	0.447	0.679	0.667	0.636

Table 2. Response of yield attributes and yield of wheat to various weed management practices

Treatment	Total dry matter accumulation of crops (g/m ²)				Yield attributes and yield				
	30 DAS	60 DAS	90 DAS	120 DAS	No. of spikes/m ²	No. of grains/spike	Test weight (g)	Length of spike (cm)	Grain yield (t/ha)
Weedy	28.78	207.24	679.82	932.76	208.00	42.00	36.41	10.31	2.641
Weed free	32.62	278.26	934.49	1276.28	303.00	51.00	40.40	11.12	5.422
Pendimethalin at 1.0 kg a.i./ha	31.36	232.83	808.13	1109.21	251.00	47.00	37.12	10.67	3.709
Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha	30.26	266.42	886.32	1222.58	283.00	49.00	39.55	10.85	4.916
Isoproturon at 1.0 kg a.i./ha	29.92	222.04	732.02	1053.74	234.00	46.00	36.98	10.53	3.257
Metsulfuron at 0.005 kg a.i./ha	30.89	263.41	873.83	1213.42	279.00	49.00	39.47	10.82	4.639
Sulfosulfuron at 0.03 kg a.i./ha	29.15	216.25	719.62	992.26	224.00	46.00	36.48	10.49	3.207
Metribuzin at 0.3 kg a.i./ha	28.82	226.16	753.23	1067.52	240.00	47.00	37.05	10.59	3.595
SEm+	1.300	7.613	26.437	40.811	8.431	1.779	1.447	0.361	0.177
C.D. at 5%	NS	22.542	78.275	120.835	24.96	NS	NS	NS	0.525



Plate 1. General view of crop



Plate 2. Irrigation in experimental crop



Plate 3. Recording of data



Plate 4. Tagging of experimental plot

4. CONCLUSION

It can be concluded that the herbicidal application of Clodinafop + Metsulfuron at a rate of 0.04 + 0.005 kg a.i./ha effectively controlled weed density. This reduction in weed competition allowed for better accumulation of applied inputs in the wheat crop, resulting in improved growth in yield attributes and overall yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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