Results of weed density, yield attributes, and yield on wheat crop were influenced by varying broad-spectrum herbicide treatments in eastern U.P., India

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. Resultsshowed 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 weed-free plot throughout the crop period. In termsof 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/m^2), number of spikes (303.00/m^2), 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 weedycheck treatment had thelowest 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/m^2), number of spikes (208.00/m^2), number of grains/spike (42.00), test weight (36.41 g), length of spike (10.31 cm) and grain yield (2.641 t/ha).

Introduction:

Wheat belongs to the Poaceae family and is believed to have originated from the MiddleEast 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%), aswell 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 (Nanher et al., 2015). In India, wheat is grown on approximately 31.45 million hectares, with a production of 107.59 million tonnes and a productivity of 3421 kilograms per hectare. Uttar Pradesh ranks first in both area and production,with 9.50 million hectares (30.19%) and 32.59 million tonnes (30.29%),respectively. Punjab has the highest productivity of 5008 kg/ha (3.52%) (Directorate of Economics & Statistics, DAC&FW, 2019-20).Weed infestation isa major problem in achieving high productivity in wheat, as it competes with the crop for moisture, nutrients, space, and light. Thisnot onlyincreases the cost of production, but also leads to a reduction in yield and can harbor insects and plant diseases, resulting in a decreasein 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. (2008), 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. Asaresult, 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.

Materials and Methods:

A field experiment entitled "Effect of Herbicides on Weed Control in Wheat" 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, withan 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 experimentconsisted 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 at1.0 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 blockdesign with four replications. The weekly mean maximum and minimum temperaturesranged from 18.97 to 39.060 C and 7.25 to 23.040 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 P_2O_5, and 40 kg K_2O/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)usinga 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.

Results and Discussion:

Density of Total Weed Population (No./m^2) 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/m^2), Clodinafop + Metsulfuron at 0.04 + 0.005 kg a.i./ha at 60 DAS (11.71/m^2), 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. (2018).

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/m^2) 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.Thiscould 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. (2018).

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/m^2) and Metsulfuron at 0.005 kg a.i./ha (279.00/m^2) showed similar results. The highest number of spikes per square meter was observed in the Clodinafop + Metsulfurontreatment, which also had the highest seed yield in comparison tothe weedy check. Other parameters such as the number of grains per spike, test weight (g), and length of spike (cm) didnot 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 providedby these treatments. Similar findings were also reported by Kumar et al. in 2018.

Yield of Wheat

As shown in Table 2, the grain yield of wheat was significantly higher in the weed-free treated plot comparedto 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 yielded5.422t/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, resultingin improved growth characteristicssuch as plant height, effective tillers, and enhanced photosynthetic activity.This, in turn, led to higher yield attributes suchasspikelets per spike, grain weight per plant, and test weight.The lower weed count and dry weight of weeds in these treatments alsocontributedto the improvedyieldsofboth grain and straw. (Nanher and Singh, 2015) Thelower 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 isconsistentwith the findingsofPaighan 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. (2016). Step-by-Step Advice: 1. Use proper sentence structure and punctuation: Thefirst sentence is a run-on sentence and should be broken up into two sentences. Also, make sure to use proper punctuation throughout the text. 2. Use clear and concise language: Avoid using complex or convoluted language. Instead, use simple and direct language to convey your message. 3. Use active voice: In scientific writing, it is important to use active voice to clearly state the subject and action of the sentence. For example, instead of saying "the higher yields under these treatments could be ascribed to better controlof weeds," say "better control of weeds resulted in higher yields under these treatments." 4. Use specific and accurate data: Instead of saying "resulted statistically similar higher grain yield," provide the exact yield numbers for each treatment to make the data more specific and accurate. 5.Use proper citation format: When citing sources, make sure to use the correct format (e.g. author's last name and year of publication) and include a full reference list at the end of the text. 6. Use parallel structure: When listing multiple items,make sure to use parallel structure. Forexample, instead of saying "no. of spikes/m^2, no. of grains/spike, test weight (g) and length of spike (cm)," say "number of spikes/m^2, number of grains/spike, test weight (g), and length of spike (cm)." 7. Use consistent verb tense: Make sure to use the same verb tense throughout the text. In this case, the past tense is appropriate since the study has already been conducted. 8. Use proper terminology: Make sure to use the correct terminology for the subject matter. For example, use "yieldattributes" insteadof "growth characters." 9. Use proper capitalization: Capitalize proper nouns

and the first word of each sentence. 10. Proofread for grammar and spelling errors: Before submitting your writing, make sure to proofread for any grammar or spelling errors. This will help improve the overall quality of the writing.

Conclusion:

It canbe 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 allowedfor better accumulation of applied inputs in the wheat crop, resulting in improved growth in yield attributes and overall yield.

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Table 1. Responseof total weed density andtotal dry matteraccumulationof weedsto variousweed management practices

Treatments	Density oftotal weed population (No./m²)				Total dry matteraccumulationof weeds (g/m²)			
	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 (192.50)	3.24 (9.62)	6.73 (44.89)	8.81 (76.89)	8.48 (71.29)
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 (4.22)	4.86 (22.86)	5.94 (34.47)	5.57 (30.16)
Clodinafop +Metsulfuronat 0.04 +0.005 kg a.i./ha	16.49 (272.25)	11.71 (137.50)	12.16 (149.25)	10.14 (103.00)	3.21 (9.56)	4.50 (19.22)	4.71 (21.27)	4.37 (18.22)
Isoproturonat1.0 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 (40.29)	6.10 (36.41)
Metsulfuronat 0.005 kga.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 (25.25)	4.85 (22.69)
Sulfosulfuronat 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 (9.42)	5.18 (25.97)	6.18 (37.22)	5.85 (33.28)
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. Responseof yieldattributesandyieldof wheat to various weed management practices

Treatment	Total dry matteraccumulation(g/m²)				Yieldattributes andyield				
	30 DAS	60 DAS	90 DAS	120 DAS	No. of spikes/m²	No. of grains/	Test weight	Length of spike	Grain yield
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 +Metsulfuronat 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
Isoproturonat1.0 kg a.i./ha	29.92	222.04	732.02	1053.74	234.00	46.00	36.98	10.53	3.257
Metsulfuronat 0.005 kga.i./ha	30.89	263.41	873.83	1213.42	279.00	49.00	39.47	10.82	4.639

Sulfosulfuronat 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

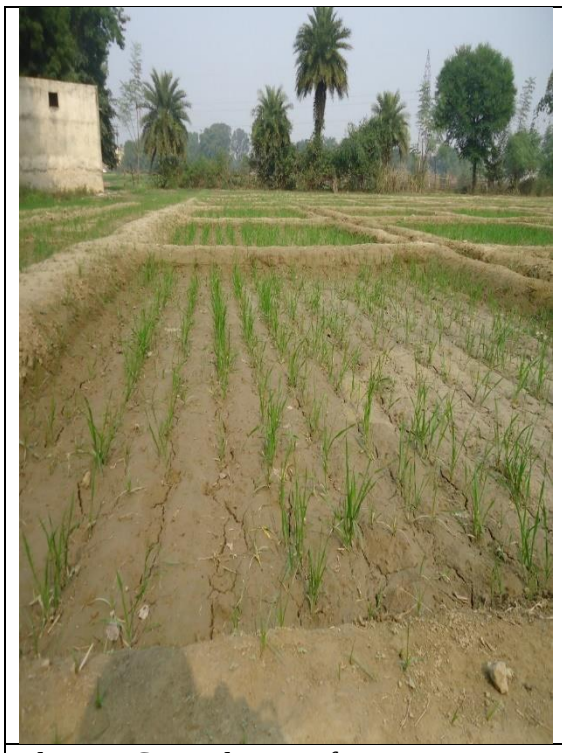

Plate : 1 General view of crop

Plate :2 Tagging of crop plant

Plate: 3 Recording of data

Plate: 4:Irrigationinexperimental crop