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Harshit Srivastav
M.Sc. (Ag) Scholar, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Ravikesh Kumar Pal
Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Shudeer
Ph. D Scholar, Department of Entomology, University of Agricultural Sciences Bangalore, CoA, GKVK, Bengaluru, Karnataka, India

Awanindra Kumar Tiwari
Scientist- Plant Protection (Entomology), Krishi vigyan Kendra, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Durgesh Kumar Maurya
Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Gaurav Srivastav
M.Sc. (Ag) Scholar, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Corresponding Author:
Durgesh Kumar Maurya
Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Effect of weed control and fertilizer management on wheat (*Triticum aestivum* L.)

Harshit Srivastav, Ravikesh Kumar Pal, Shudeer, Awanindra Kumar Tiwari, Durgesh Kumar Maurya and Gaurav Srivastav

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Abstract
A field experiment was conducted during rabi season of 2023-24 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of weed control and fertilizer management on wheat (*Triticum aestivum* L.). The soil was normal in pH of 7.62, electrical conductivity (EC) of 0.25 dSm^{-1}, organic carbon content of 0.44%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 215.60, 19.58, and 148.50 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2023-24. The experiment consisted of 15 treatment combinations {3 nutrient level & 5 weed control}, was laid out in Factorial Randomized Block Design (FRBD) with three replications.

Keywords: Herbicides, mustard, nutrients

Introduction
The sector's staple grain, wheat (*Triticum aestivum* L.), is a member of the Poaceae family. It is a cereal crop, and caryopsis is the name of the seed. The North-Western parts of the Indian subcontinent, which include Afghanistan as a neighbor, are the wheat's origin region. This region is also the center of origin for bread wheat. In the winter, it is typically grown in areas with temperate and tropical climates. It is regarded as an essential component of food safety in many different countries. Wheat is the primary source of vegetarian protein for human meals worldwide and has a higher protein content than the majority of other cereals. It is a staple meal in India, served after rice. The three cultivated species of wheat are known as Marconi wheat, Emmer wheat, and common bread wheat, respectively: *Triticum aestivum*, Triticum durum, and *Triticum dicoccon*. For the production of chapattis, bread, cakes, biscuits, pastries, and other bakery goods, 80–85% of wheat is used. The ingredients for making rawa, suji, and seaway are wheat. Specifically, livestock are fed with wheat straw. Because of its enormous productivity and acreage, it is referred to as the "king of cereals". According to FAS/USDA 2019–20, wheat is the most productive crop in the world, requiring an area of 217.02 mha and a production of 764.50 mmt, or 3.52 mt ha^{-1}. During the 2018–19 rabi season in India, the total wheat crop production was 99.87 mmt on a 29.65 mha cultivated area, yielding a productivity of 3.37 mt ha^{-1} (Anonymous, 2019–20) [2]. In terms of India, the six northern states of Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, and Bihar account for nearly 91% of the country's wheat production. U.P. is ranked highest among them in terms of area (9.54 mha) and production (32.74 mt); however, in comparison to Punjab (5123 kg ha^{-1}) and Haryana (5195 kg ha^{-1}) states, its productivity (3432 kg ha^{-1}) is relatively low (Anonymous, 2018-19) [3].
The wheat crop is the second most important food grain crop in Indian agriculture, after rice. The foundation of Indian agriculture is wheat cultivation, which is healthier than other cereals from a nutritional standpoint. Wheat grains contain 60–67% starch, 8–15% protein, 1.5–2.0% fat, 2.0–2.5% cellulose, and 1.5–2.0% minerals (Rathore, 2001) [5]. Roughly 73% of the average diet's calories and proteins come from wheat (Heyne 1987) [4].
Fertilizer application alone has a negative impact on soil health and crop productivity; thus, integrating different sources of nitrogenous (organic and inorganic) fertilizer is more appropriate

because it lowers the need for chemical fertilizer application and cultivation costs. In addition to being an environmentally friendly approach, this method also shows that FYM in combination with chemical fertilizer has a positive effect on wheat (Ram and Mir, 2006; Gupta *et al*., 2006) [6, 7]. Since ancient times, farmers have applied farmyard manure (FYM) to the soil. This practice has improved soil fertility, enhanced crop yield, increased soil organic matter, increased microbiological activity, and improved soil structure for sustainable agriculture (Behara *et al*., 2006 and Khan *et al*., 2007) [8, 9].

Weed infestation and management is one of the key factors among many others that contribute to low yield. Crop plants are in competition with weeds, which reduces yield by 20–50%. P. minor, *Chenopodium album*, *Melilotus alba*, *Fumeria parviflora*, *Medicago denticulata*, *Vicia hirsuita*, *Vicia sativa*, *Avena ludoviciana*, *Coronopus didymus*, and *Reumex acetocel* are the notable weeds that can be identified in wheat fields. Reduction in wheat crop yield of 15–50%, depending on weed density and weed flora type (Jat *et al*., 2003) [11]. One of the most dangerous problems with wheat in the rice-wheat cropping system is Phalaris minor, which accounts for 65% of crop losses. (2008) Chhokar *et al*. Mechanical, chemical, and cultural methods are frequently employed to eradicate weeds. Timely control of weeds is impeded by unfavorable weather conditions and labor shortages during peak season. As a result, mechanical weed control techniques and hand or manual weeding by themselves are ineffective. Thus, chemical weed control is an essential alternative. Because weed killers are so successful and efficient, they have proven to be a useful and very effective way to control weeds in wheat (Azad *et al*., 1997) [13]. But weeds become resistant when a single herbicide is applied repeatedly. In the 1990s, reports of resistant strains of Phalaris minor from Western U.P. and Haryana were made against isoproturon. Later, new herbicide molecules such as Fenoxaprop-ethyl, Clodinofop, and Sulfosulfuron were registered and suggested as a means of managing Phalaris minor in wheat (Walia, U.S. and Brar, L.S., 2006) [15].

Materials and Methods

A field experiment was conducted during rabi season of 2023-24 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of weed control and fertilizer management on wheat (*Triticum aestivum* L.).The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm^{-1}, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2023-24. The experiment consisted of 15 treatment combinations {3 nutrient level & 5 weed control}, was laid out in Factorial Randomized Block Design (FRBD) with three replications. F1: 100% RDF, F2: 75% RDF + 10 t ha^{-1}FYM, F3: 50% RDF + 15 t ha^{-1} FYM Weed control:, W1: Metribuzin @ 150 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1}, W2: Sulfosulfuron @ 30 g a.i. ha^{-1}+ Metsulfuron @ 2 g a.i. ha^{-1}, W3: Clodinofop @ 60 g a.i. ha^{-1}, W4: Two hand weeding (after first and second irrigation), W5: Weedy Check data were gathered on five plants chosen from each plot.

Results and Discussion

Yield and yield attributes

Effective tillers m^{-2}

The number of tillers (m-2) was also significantly influenced by all weed control methods. Of these, twice hand weeding produced the highest number of effective tillers (273.27 m-2), which was comparable to sulfosulfuron + metsulfuron @ 30+2 g a.i. ha^{-1} (268.80 m-2) and significantly higher than the remaining weed control methods. Additionally, Barthwal *et al*. (2013) [16] and Jat *et al*. (2013) [17] have reported results that are similar. It could be the result of effective weed control, as Tomar & Tomar (2014) [19] have also reported similar results with low densities and dry weights of weeds.

Length of spike (cm)

Every weed control method had a major impact on the spike's length (in centimeters). W4 recorded the maximum length of spike (10.30 cm) after two manual weeding sessions; this was significantly higher than the weedy check, but it was on par with sulfosulfuron + metsulfuron @ 30+2 g a.i.ha^{-1}, metribuzin + metsulfuron @ 150+4 g a.i.ha^{-1}, and W3 clodinafop @ 60 g a.i.ha^{-1}. Similar results have also been reported by Sharma *et al*. (2005) [21]. It could be because there were more nutrients, moisture, spaces, and lights available, which led to the plants' improved growth and development. Singh (2011) [23] also presented comparable findings.

Number of grains $spike^{-1}$

The maximum number of grains $spike^{-1}$ recorded with twice hand weeding (44.43) was comparable to sulfosulfuron + metsulfuron @ 30+2 g a.i.ha^{-1} and metribuzin + metsulfuron @ 150+4 g a.i.ha^{-1}. All weed control techniques had a significant impact on the number of grains $spike^{-1}$. This may be the result of successfully controlling weeds in crop fields during the crop's main growing season, which improves the availability of nutrients, moisture, space, and light and promotes better plant growth and development. Singh (2015) [23] also presented comparable findings.

Grain weight $spike^{-1}$

Every weed control method had a major impact on the grain weight $spike^{-1}$. The treatment of twice-hand weeding produced the highest grain weight $spike^{-1}$, which was significantly higher than the other weed control methods and on par with sulfosulfuron + metsulfuron @ 30+2 g a.i.ha^{-1} (1.87). This could be the result of increased leaf area, which increased photosynthesis and the production of photosynthates. Chopra *et al*. (2008) [10] also presented similar findings.

Test weight (g)

All the weed control practices influenced the 1000 grain weight significantly. The highest 1000 grain weight recorded with the treatment twice hand weeding which was being at par with sulfosulfuron + metsulfuron @ 30+2 g a.i.ha^{-1} and W1 metribuzin + metsulfuron @ 150+4 g a.i.ha^{-1}, which was significantly higher than rest of the weed control practices. This might be due to less competition for different resources resulted more translocation of food from source to sink relationship and it is the cumulative function of various growth parameters and yield attribute. Similar results have been also been reported by Barthwal *et al*. (2013) [16].

Grain yield (q ha^{-1})

The weed control practices also had significant effect on grain yield. The data further revealed that the twice hand weeding recorded significantly highest grain yield (51.20 q ha^{-1}) and being at par with sulfosulfuron + metsulfuron @ 30+2 g a.i.ha^{-1} (50.18 q ha^{-1}) and significantly higher than rest of the weed control practices. It might be due to more translocation of food

from source to sink responsibly more yield. The similar findings have been also been reported by Malik *et al*. (2011) [24] and Tomar and Tomar (2014) [19].

Straw yield (q ha^{-1})

The results of the weed control practices showed that twice hand weeding produced the highest straw yield (75.43 q ha^{-1}) and was significantly higher than other weed control practices. It was also on par with sulfosulfuron + metsulfuron @ 30+2 g a.i. ha^{-1} (73.79 q ha^{-1}). This could be as a result of the weeds being effectively controlled, which improved the growth parameters and yield attributes. Higher yield attributes, when combined with better vegetative growth, led to higher yields of grain and straw. Sasode *et al*. (2017) [26] have also reported findings that are similar.

Biological yield (q ha^{-1})

The biological yield over weedy check increased significantly as a result of all weed control techniques. The two hand weeding methods produced the highest biological yield (126.63 q ha^{-1}), which was considerably higher than the other weed control methods and on par with sulfosulfuron + metsulfuron @ 30+2 g a.i. ha^{-1} (123.98 q ha^{-1}). This could be because more growth and development led to a higher biological yield through effective weed control achieved by such treatment enhancement. The similar findings have been also been reported by Malik *et al*. (2011) [24] and Tomar and Tomar (2014) [19].

Harvest index (%)

The maximum index of 44.8 percent was observed under weed control practices with 75% RDF + 10 t ha^{-1} FYM and 39.95 percent under sulfosulfuron + metsulfuron @ 30+2 g a.i. ha^{-1}. This could be because using effective weed control techniques led to a proportionate increase in the distribution of grain, a photosynthetic sink, increasing the harvest index. Kumari *et al*. (2013) [25] have also reported comparable findings.

Table 1: Effect of nutrient and weed control practices on yield attributes of wheat crop

Treatments	Yield attributes				
	Effective tillers (m-2)	Length of spike (cm)	No. of grains spike^{-1}	Grain weight spike^{-1}	Test Weight (g)
Nutrient management					
F_1-100% RDF	253.36	9.81	42.94	1.76	40.88
F_2-75% RDF + 10 t ha^{-1}FYM	281.54	10.00	43.34	1.79	41.28
F_3-50% RDF + 15 t ha^{-1}FYM	233.68	9.62	42.78	1.74	40.68
SEm±	3.392	0.184	0.787	0.035	0.609
CD at 5%	9.828	NS	NS	NS	NS
Weed control					
W_1-Metribuzin @1 50 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1}	257.13	9.70	42.47	1.72	40.47
W_2-Sulfosulfuron @ 30 g a.i. ha^{-1}+ Metsulfuron @ 2 g a.i. ha^{-1}	268.80	10.20	44.27	1.87	42.17
W_3 -Clodinofop @ 60 g a.i. ha^{-1}	247.23	9.65	41.30	1.71	39.80
W_4-Two hand weeding	273.27	10.30	44.43	1.87	42.17
W_5 -Weedy Check	234.53	9.20	41.00	1.64	39.57
SEm±	4.379	0.238	1.017	0.045	0.786
CD at 5%	12.689	0.690	2.946	0.130	2.277

Table 2: Effect of nutrient and weed control practices on grain yield, straw yield, biological yield (q ha^{-1}) and harvest index plant of wheat

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biologic al yield (q ha^{-1})	Harvest index (%)
Nutrient management				
F_1-100% RDF	45.48	68.68	114.16	39.78
F_2-75% RDF + 10 t ha^{-1}FYM	49.59	74.38	123.97	39.95
F_3-50% RDF + 15 t ha^{-1}FYM	40.80	61.59	102.39	39.79
SEm±	0.619	1.303	2.257	0.822
CD at 5%	1.794	3.776	6.541	NS
Weed control				
W_1-Metribuzin+ Metsulfuron (@ 150 +4 g a.i. ha^{-1})	43.98	66.07	109.02	40.33
W_2-Sulfosulfuron+ Metsulfuron (@ 30+2 g a.i. ha^{-1})	50.18	73.79	123.98	40.48
W_3 -Clodinofop @ 60 g a.i. ha^{-1}	42.50	65.04	108.57	39.14
W_4-Two hand weeding (after first and second irrigation)	51.20	75.43	126.63	40.43
W_5 -Weedy Check	38.58	60.74	99.32	38.84
SEm±	0.799	1.683	2.914	1.061
CD at 5%	2.316	4.875	8.444	NS

Conclusion

At 60 and 90 DAS, the minimum dry weight of weeds was recorded when 100% RDF treatment was applied and Sulfosulfuron + Metsulfuron @ 30+2 g a.i. ha^{-1} was sprayed. The highest grain yield (49.59 q ha^{-1} & 50.18 q ha^{-1}), straw yield (74.38 q ha^{-1} & 73.79 q ha^{-1}), and total biological yield (123.97 q ha^{-1} & 123.98 q ha^{-1}) were obtained by applying a 75% RDF+ 10 t ha^{-1} FYM treatment along with the spraying of Sulfosulfuron + Metsulfuron @ 30+2 g a.i. ha^{-1}. These results were significantly higher than the other treatments while remaining comparable to two hand weeding.

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