International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664
Received: 05-05-2026, Accepted: 05-06-2026, Published: 20-06-2026
Volume 8, Issue 2, 2026, Page No. 299-303

Improving wheat (*Triticum Aestivum* L.) Productivity through effective weed management practices in the Prayagraj region

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DOI: https://doi.org/10.66856/ijaps.2026.8.2.8127

Abstract
A field experiment was conducted during *Rabi* 2025-26 at Crop Research Farm, Department of Agronomy, PRSU, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. Among the treatments, T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) recorded the maximum plant height (101.67 cm), number of tillers per square meter (329.80), Leaf area index (3.97), and dry matter accumulation (781.76 g/m^{-2}) at all stages, indicating better vegetative growth. However, the highest grain yield (46.83 q/ha), straw yield (109.7 q/ha), and biological yield (156.53 q/ha) were recorded under T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence), which was significantly superior in terms of yield and yield-attributing characters Number of earhead m^{-2} (384.85), Number of grain per earhead (51.52), Weight of earhead (2.9 g), Length of earhead (9.24 cm), Test weight (42.6 g), Seed yield (46.83 q/ha), Straw yield (109.7 /ha), Biological yield (156.53 q/ha). The study concludes that weed management, especially the application of herbicide combination with Carfentrazone-ETHYL 40% DF 250 g/ha (T_6), significantly enhances the growth, yield, and profitability of wheat under the agro -climatic conditions of Southern Uttar Pradesh.

Keywords: Weed management practices, growth, yield and economy

Introduction
"Wheat (*Triticum aestivum* L.) Makes up 36.08% of the nation's total food grain basket and is the second most important cereal crop after rice". While Wheat is the foundation of India's food security, it is grown under a variety of agroclimatic conditions. Bread, cakes, biscuits, noodles, petri dishes, chapatti, and more are all made using it. 60-68% starch, 8-15% protein, 1.5-2.0% fat, 2.0-2.5% cellulose, and 1.5-2.0% minerals make up wheat grains. In India, Wheat is primarily grown in the northern and central parts of the country, with Uttar Pradesh being the leading Wheat-producing state. India ranks second globally in Wheat production after China, with an output of 113.3 million tonnes and an average productivity of 3559 kg ha^{-1} Department of Agriculture & Farmers Welfare. (2024-25). Key wheat producing states include Uttar Pradesh (35.65 million tonnes), Madhya Pradesh (23.03 million tonnes), and Punjab (17.99 million tonnes), with corresponding cultivated areas of 9.75, 7.75 and 3.52 million hectares respectively. One of the obstacles to wheat production is weeds. Multiple weed infestations in wheat reduce growth, yield qualities, and grain yields because they compete with the available resources. *Phalaris minor* of the grassy group, *Chenopodium album*, *Anagallis arvensis*, *Melilotus alba*, *Convonvulus arvensis*, and *Cyperus rotundus* of the sedges group were among the common weeds discovered on Wheat farms. *Cynodon dactylon*, *Vicia hirsuta*, *Lathyrus apaca*, *and Avena fatua* were the other less significant weeds. Rahaman and Mukherjee (2009) revealed similar weed flora of Wheat crops under normal planted conditions. However, intensive cropping techniques, which heavily rely on chemical fertilisers like potassium (K), phosphorus (P), and nitrogen (N), present several difficulties for wheat farming. By increasing crop growth, dry matter buildup, and canopy cover, intensive NPK fertiliser application lowers soil evaporation and enhances yield (Saffariha *et al.*, 2021). Long-term reliance on chemical fertilisers, however, has resulted in nutrient imbalances in the soil, deterioration of soil fertility, and stagnation or even a decrease in production levels (Dawe & Dobermann, 1999; Pathak *et al.*, 2003). Manual weeding is only feasible on a limited scale and works well for annual weeds, but it is time-consuming, energy-intensive, and tedious (Patro and Ray, 2016).
The acetohydroxy acid synthase (AHAS) or acetolactate synthase (ALS) enzyme, which catalyses the synthesis of three branched amino acids, such as leucine, isoleucine, and valine, is directly inhibited by metsulfuron herbicide, which mostly controls broad-leaved weeds (Das, 2008). 2,4-D at 500 g ha^{-1} by itself or in conjunction with one-hand weeding is an efficient method for reducing BLW weeds. 2,4-D is a synthetic auxin or "auxin mimic." Hence Present investigation was carried out to “Improving Wheat (*Triticum Aestivum* L.) Productivity through Effective Weed Management Practices in the Prayagraj Region”

Materials and Methods
1. Experimental Site
The study, “Improving Wheat (*Triticum Aestivum* L.) Productivity through Effective Weed Management Practices in the Prayagraj Region “was conducted in *Rabi* 2025-2026 at the Crop Research Farm, Department of Agronomy, PRSU, Prayagraj, UP. The farm is situated at 25.28º N

latitude, 81.54º E longitude, and 98m above mean sea level. This place is located around 12 km from Prayagraj city on the Allahabad Mirzapur Road. The department provided all the facilities needed for agricultural growing.

2. Climate and weather condition

Prayagraj has a climate that is both subtropical and semi-arid, having both extremes of temperature-winter and summer. As a cool-season (*Rabi*) crop, wheat (*Triticum aestivum* L.) thrives in climates with moderate temperatures and relative dryness. In general, Prayagraj's agroclimatic conditions-which are found in Uttar Pradesh's Middle Gangetic Plains-are ideal for growing wheat. Typically, the crop is planted in November and harvested in March or April.

3. Experimental Details

An experiment was laid out in Randomized Block Design (RBD) with nine treatments and three replications. The treatments comprised of weed management practices under study in Wheat crop. All herbicides were used as pre and post emergence. Treatments are as follows: T_1 - Weed-free check (manual weeding throughout the crop period), T_2 - Integrated weed management (Pendimethalin 1 kg/ha + one hand weeding at 30 DAS), T_3 - Pendimethalin @ 1.0 kg/ha (pre-emergence), T_4 - Metsulfuron methyl @ 4g/ha (post-emergence), T_5 - Metribuzin @ 250 g/ha (early post-emergence), T_6 - Carfentrazone-ETHYL 40% DF 20 g/ha, T_7 - Clodinafop @ 1 kg/ha , T_8 - Sulfosulfuron @ 25 g/ha (post-emergence), T_9 - Isoproturon @ 1.50 kg/ha (post and pre-emergence). The size of each Plot 9 m^2 3 meter length and 3 meter width. In experiment total number of plots was 27.

4. Agronomy Practices

Pre-sowing irrigation was provided 8 - 10 days before to Wheat crop sowing since field preparation and effective germination/emergence depend on an ideal moisture level. In order to provide well-pulverized soil appropriate for the seeding and germination of Wheat crops, the field was harrowed thrice before being cultivated and planked.

5. Seed and Sowing

Wheat variety Shree Ram (303) KVK Kaushambi was selected for this study during my Research work. The seed rate used was 110 kg ha^{-1} while healthy and clean seeds were sown at 25 cm rows distance with the help of seed drill and broadcasting Method. The sowing of all plots was done on November 21, during 2025. And wheat crop was harvested when attained the physical maturity.

6. Fertilizer Application

The wheat crop was uniformly fertilized according to the Recommended Dose of Fertilizers (RDF). The first basal dose was applied at the time of sowing 120 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1} using urea, di-ammonium phosphate, and potash murate, respectively. The remaining nitrogen was treated as a top dressing in two equal splits, 25% after the first irrigation and 25% after the Third.

7. Weed Management

Weeds were removed manually in one-hand weeding at 30 days interval after sowing as per treatments and all the herbicides were applied as pre- and post-emergence at 35 DAS of wheat, as per treatments, with the help of a knap-sack sprayer fitted with flat-fan nozzle with a spray volume of 450 L ha^{-1} water.

8. Observation Recorded

The number of tillers per m^2, plant height (cm), dry matter accumulation per m^2, and LAI were the growth variables that were observed. The following standard procedures were used to record the yield and yield attribute characteristics: Test weight (g), grain yield (q/ha), straw yield (q/ha), Biological yield (q/ha), Harvest index (%), Number of earhead per m^2, Number of grains per earhead, weight of earhead (g) and Length of earhead (cm). As recommended by Gomez and Gomez (1984), the harvest index had to be established while the data acquired on various observations were statistically examined using the analysis of variance (ANOVA) approach. Additionally, my experimental design utilizes a two-way ANOVA. The following formula was used to get the standard error of mean for several major effects;

$$SEm\pm=\sqrt{2VE/r}$$

The treatments mean was compared using the Critical difference at 5 % probability level by Randomized block design (RBD) model as obtained by Co.stat 6.311, 1998-2005 as statistical programme.

Results and Discussion

1. Growth Characters

1.1 Plant Height

The study result presented in Table 1 indicates that, growth characteristics such as plant height increased significantly by the different weed management practices at 25, 50, 75, 100 day and harvest stage of crop growth. At 50 DAS maximum plant height recorded under T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) being at par with T_6 Carfentrazone-ETHYL 40% DF 20 g/ha and significantly higher than herbicidal treatments and lowest plant height recorded under T_1 Weed-free check (manual weeding throughout the crop period).

1.2 Number of tillers (m^2)

The number of tillers m^{-2} increased up to 100th day stage of crop growth and thereafter, it decreased slightly as seen in the data presented in Table 2. The number of tillers m^{-2} increased significantly under various weed management practices as compared to Weed-free check (manual weeding throughout the crop period) at all the growth stages. T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) recorded significantly higher number of tiller m^{-2}than other weed management practices, being at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence), And lowest is T_1 Weed-free check (manual weeding throughout the crop period). It may be attributed to the fact that there was better availability of nutrients under well managed plots which resulted in better number of tillers m^{-2} than other treatments as equally reported by Tomar and Vivek [11], Bibi *et al.* [12], Kumar *et al.* [10].

1.3 Dry matter accumulation (g m^{-2})

Dry matter accumulation and the resultant of all the growth and yield attributes viz., plant heights, shoot m^{-2} are shown in Table 3. The dry matter accumulation increased significantly with the application of weed management practices at all the growth stages, except at 25 days where dry matter range unaffected. At harvest the highest dry

matter accumulation was recorded in T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) 786.76 which were statistically at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence) 711.19 and lowest T_1 Weed-free check (manual weeding throughout the crop period) 242.76. This might be attributed to more synthesis of food materials in plants under less weedy condition". Paswan *et al*. [13].

1.4 Leaf area index

The leaf area index (Table 4), shows that the leaf area increased with increase in age of crop up to 100th day stage and decline thereafter, mainly due to senescence. The leaf area index increased significantly with various weed management practices recording the highest leaf area index T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) in statistically superior over rest treatment while at par T_8 Sulfosulfuron @ 25 g/ha (post-emergence) and lowest T_1 Weed-free check (manual weeding throughout the crop period). Better LAI with best weed managed reported by plots" Pandey and Kumar [7].

2. Yield Attributes

From the yield attributes presented in Table 5 and 6, the resultant of all the yield attributes. The following standard procedures were used to record the yield and yield attribute characteristics: Number of earhead per m^2, Number of grains per earhead, weight of earhead (g) and Length of earhead (cm). The significantly highest values of all the yield contributing characters were recorded with T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence), which were at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence) and lowest T_1 Weed-free check (manual weeding throughout the crop period), while significantly higher than the rest of the weed management practices.

3. Yields

3.1 Grain yield (q/ha)

Table 6 shows the result of Grain yield while the maximum grain yield was recorded at T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) 46.83 q ha^{-1}. Which was at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence) 43.68 q ha^{-1} and lowest T_1 Weed-free check (manual weeding throughout the crop period) 19.80 q ha^{-1}, while significantly higher than the rest of the weed management practices. Almost similar findings were reported by Kumari *et al* [18], Malik *et al* [19] Tomar and Tomar [20] Singh *et al* [16] Sharma *et al* [21] Ashok *et al* [17].

3.2 Straw yield (q/ha)

The highest straw yield see (Table 6) of 109.7 q ha^{-1} was recorded in T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence). Which were statistically at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence) 102.25 q ha^{-1} and lowest T_1 Weed-free check (manual weeding throughout the crop period) 53.6 q ha^{-1}, while significantly higher than rest of the weed management practices. Almost similar finding reported by Malik *et al* [19]. Tomar and Tomar [20]. Ashok *et al*. [17]

3.3 Biological yield (q/ha)

The biological yield (Table 6) is the sum of grain yield and straw yield. Maximum biological yield recorded under T_9 Isoproturon @ 1.50 kg/ha (post and pre-emergence) 156.53 q ha^{-1} was at par with T_8 Sulfosulfuron @ 25 g/ha (post-emergence) 145.93 q ha^{-1} and lowest T_1 Weed-free check (manual weeding throughout the crop period) 73.4o q ha^{-1}. Similar finding reported by Sharma *et al*. [21]. Tomar and Tomar [20] Ashok *et al*. [17]

3.4 Harvest Index (%)

Harvest index in wheat exhibited a non-significant influence under various weed management treatments.

Table 1: Effect of weed management practices on plant height (cm) of wheat at different days after sowing.

Treatment		Plant height (cm)				
		25 DAS	50 DAS	75 DAS	100 DAS	At Harvest
T_1	Weed-free check (manual weeding throughout the crop period)	18.45	38.32	58.23	74.32	69.32
T_2	Integrated weed management (Pendimethalin 1kg/ha + one hand weeding at 30 DAS)	22.55	42.27	70.35	91.34	89.33
T_3	Pendimethalin @ 1.0 kg/ha (pre -emergence)	24.96	44.24	71.23	95.52	90.64
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	25.58	45.36	73.32	98.31	93.46
T_5	Metribuzin @ 250 g/ha (early post-emergence)	23.40	45.73	73.65	93.64	91.85
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	26.65	49.63	82.45	103.33	101.63
T_7	Clodinafop @ 1 kg/ha	24.42	47.13	77.62	99.36	92.34
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	23.36	46.27	78.25	104.52	99.73
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	27.24	51.24	84.15	105.65	101.67
F-test		NS	S	S	S	S
SEm(±)		0.74	1.44	2.39	2.99	3.14
CD at 5%		-	4.32	7.18	8.96	9.43

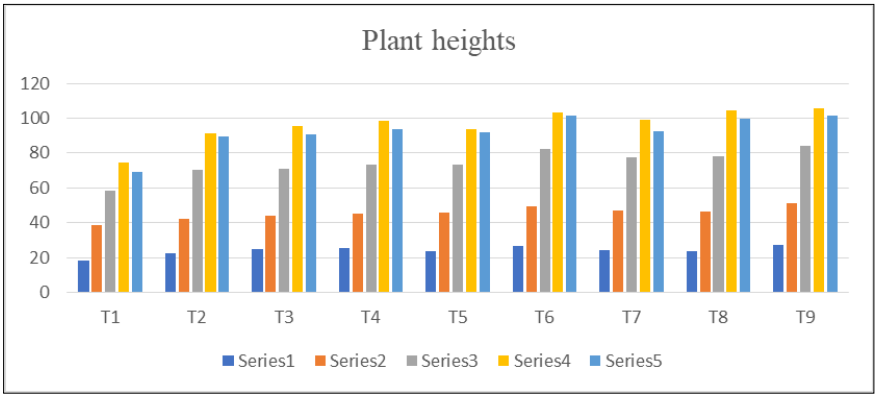

Table 2: Effect of weed management practices on Number of tillers per m^2 of wheat at different days after sowing

Treatment		Number of tillers per m^2				
		25 DAS	50 DAS	75 DAS	100 DAS	At Harvest
T_1	Weed-free check (manual weeding throughout the crop period)	60.26	115.46	186.48	181.58	179.54
T_2	Integrated weed management (Pendimethalin 1kg/ha + one hand weeding at 30 DAS)	68.57	120.52	215.74	220.53	218.59
T_3	Pendimethalin @ 1.0 kg/ha (pre-emergence)	72.46	143.65	235.79	243.60	238.49
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	70.83	146.57	238.77	243.61	231.50
T_5	Metribuzin @ 250 g/ha (early post-emergence)	74.66	168.47	252.38	278.53	253.25
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	70.34	175.73	264.29	295.73	273.47
T_7	Clodinafop @ 1 kg/ha	72.29	184.55	283.62	298.58	273.26
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	76.59	196.47	299.67	314.56	293.32
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	78.56	216.53	314.58	229.80	214.27
F-test		NS	S	S	S	S
SEm(±)		0.74	4.39	9.91	10.46	10.31
CD at 5%		-	13.17	29.71	31.38	30.91

Table 3: Effect of weed management practices on Dry matter accumulation (g m^{-2}) of wheat at different days after sowing.

Treatment		Dry matter accumulation (g m^{-2})				
		25 DAS	50 DAS	75 DAS	100 DAS	At Harvest
T_1	Weed-free check (manual weeding throughout the crop period)	5.70	20.60	72.10	123.62	242.76
T_2	Integrated weed management (Pendimethalin 1kg/ha + one hand weeding at 30 DAS)	7.78	28.40	75.30	227.83	381.89
T_3	Pendimethalin @ 1.0 kg/ha (pre-emergence)	8.63	29.95	76.67	238.19	411.67
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	8.98	30.35	79.78	239.36	431.66
T_5	Metribuzin @ 250 g/ha (early post-emergence)	7.48	29.70	85.50	247.98	501.26
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	6.82	32.50	86.18	248.61	561.24
T_7	Clodinafop @ 1 kg/ha	9.29	35.68	88.57	262.67	621.17
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	9.47	38.95	95.60	273.81	711.19
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	10.54	43.74	96.38	288.79	781.76
F-test		NS	S	S	S	S
SEm(±)		2.75	9.23	17.22	24.72	27.59
CD at 5%		-	27.69	51.62	74.13	82.73

Table 4: Effect of weed management practices on Leaf Area Index of wheat at different days after sowing.

Treatment		Leaf Area Index			
		25 DAS	50 DAS	75 DAS	100 DAS
T_1	Weed-free check (manual weeding throughout the crop period)	0.85	1.9	2.6	2.4
T_2	Integrated weed management (Pendimethalin 1kg/ha + one hand weeding at 30 DAS)	1.1	2.45	3.4	3.1
T_3	Pendimethalin @ 1.0 kg/ha (pre-emergence)	1.15	2.55	3.55	3.25
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	1.18	2.6	3.65	3.3
T_5	Metribuzin @ 250 g/ha (early post-emergence)	1.13	2.5	3.45	3.2
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	1.25	2.75	3.8	3.5
T_7	Clodinafop @ 1 kg/ha	1.17	2.58	3.6	3.28
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	1.14	2.53	3.5	3.22
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	1.3	2.85	3.9	3.6
F-test		NS	S	S	S
SEm(±)		0.03	0.08	0.11	0.10
CD at 5%		-	0.24	0.33	0.30

Table 5: Effect of weed management practices on yield attributes of wheat at Harvest

Treatment		yield attributes				
		Number of earhead per m2	Number of grains per earhead	weight of ear head	Length of earhead (cm)	1000 grain weight (g)
T_1	Weed-free check (manual weeding throughout the crop period)	160.36	26.55	1.14	7.27	38.84
T_2	Integrated weed management (Pendimethalin 1kg/ha+ one hand weeding at 30 DAS)	280.65	36.84	2.26	8.29	39.56
T_3	Pendimethalin @ 1.0 kg/ha (pre-emergence)	310.73	39.68	2.45	8.85	39.52
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	318.89	40.65	2.39	9.12	40.24
T_5	Metribuzin @ 250 g/ha (early post-emergence)	345.64	42.75	2.63	9.35	41.89
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	350.34	44.98	2.76	9.67	42.34
T_7	Clodinafop @ 1 kg/ha	365.67	47.98	2.27	8.59	42.67
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	373.57	49.16	2.89	9.87	43.69
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	384.85	51.42	2.97	9.94	44.96
F-test		S	S	NS	NS	NS
SEm(±)		9.83	1.22	0.07	0.27	1.24
CD at 5%		29.48	3.66	-	-	-

Table 6: Effect of weed management practices on grain yield (q/ha), straw yield (q/ha), Biological yield (q/ha) and harvest index (%) of wheat.

Treatment		Grain Yield (q/ha)	Straw Yield (q/ha)	Biological Yield (q/ha)	Harvest Index (%)
T_1	Weed-free check (manual weeding throughout the crop period)	19.80	53.60	73.40	26.98
T_2	Integrated weed management (Pendimethalin 1kg/ha + one hand weeding at 30 DAS)	25.71	62.89	88.60	29.02
T_3	Pendimethalin @ 1.0 kg/ha (pre-emergence)	26.64	78.94	105.58	25.53
T_4	Metsulfuron methyl @ 4g/ha (post-emergence)	28.76	85.69	114.45	25.13
T_5	Metribuzin @ 250 g/ha (early post-emergence)	31.58	87.42	119.00	26.54
T_6	Carfentrazone-ETHYL 40% DF 20 g/ha	34.50	88.83	123.33	27.97
T_7	Clodinafop @ 1 kg/ha	40.99	93.23	134.22	30.54
T_8	Sulfosulfuron @ 25 g/ha (post-emergence)	43.68	102.25	145.93	29.93
T_9	Isoproturon @ 1.50 kg/ha (post and pre-emergence)	46.83	109.7	156.53	29.92
F-test		S	S	S	NS
SEm(±)		5.72	8.63	4.35	0.01
CD at 5%		16.92	25.54	12.45	-

Conclusion

Overall, T_9 (Isoproturon @ 1.50 kg ha^{-1}) had the highest plant height, leaf area index, dry matter accumulation, number of earheads, grains per earhead, grain yield (46.83 q ha^{-1}), straw yield (109.70 q ha^{-1}) and biological yield (156.53 q ha^{-1}). Which was at far T_8 Sulfosulfuron @ 25 g/ha (post-emergence) for of all the treatments.

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