ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(8): 249-252
www.agriculturaljournals.com
Received: 14-05-2025
Accepted: 17-06-2025

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Comparative study of weed control approaches on wheat performance and nutrient utilization

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DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i8d.618

Abstract
The present investigation aimed to find out the "Comparative Study of Weed Control Approaches on Wheat Performance and Nutrient Utilization" was carried out at Agronomy Research Farm, Faculty of Agriculture and Veterinary Science, Mewar University, Gangrar, Chittorgarh, Rajasthan. Geographically Chittorgarh. The experiment was laid out in Randomized Block Design. Replicated thrice with 13 treatment combinations, comprising like T_1 Weedy check, T_2 Hand weeding at 30 – 35 DAS, T_3 2, 4-D ester @ 0.5 kg/ha at 30 – 35 DAS, T_4 Sulfosulfuron @ 25 gm a.i./ha at 30 – 35 DAS, T_5 Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS, T_6 Sulfosulfuron 75% +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS, T_7 Piroxofop-Propargyl 15% WP 60 g a.i. /ha at 30 – 35 DAS, T_8 Clodinafop propargyl 15% +Metsulfuran methyl 1% @ 64 g a.i. /ha at 30 – 35 DAS, T_{10} Carfentrazone Ethyl 40% DF @ 20 g a.i./ha at 30 – 35 DAS, T_{11} Pendimethalin pre emergence and T_{13} Weed free. Wheat variety Raj 3077 used as test crop was selected for the experiment.
Significant observed on weed check, growth and yield due to different weedicide treatment in wheat parameter *viz*., reduce the weed dry matter weedicides applied all at 30-35 DAS were the most superior and equally effective treatments, hand weeding was the most superior treatment that recorded considerably lower weed index of 4.53 percent. Highest weed control efficiency (89.43 percent) was recorded at harvest stage with hand weeding and sulfosulfuran @ 25 g *a.i.* /ha (89.42 percent). weed free attained the maximum plant height of 37.96, 79.33 and 90.33 cm at 60, 90 DAS and at harvest stage, Maximum Grain yield (48.69 q ha^{-1}) Straw yield (58.40 kg ha^{-1}), Biological yield (107.09 kg ha^{-1}), Nitrogen content in gain and straw (1.810 and 0.312%) and Phosphorus content in grain and straw (0.450 and 0.138%) were receded in T_{13} Weed free.

Keywords: Weed control, approaches on growth, yield and nutrient content

Introduction
Wheat holds a crucial role as a staple food crop in temperate zones and is increasingly sought after in urbanizing and industrializing nations. Besides being a key source of starch and energy, wheat offers substantial quantities of essential or beneficial components for health, including protein, vitamins (notably B vitamins), dietary fiber, and phytochemicals. Among these, wheat is particularly noteworthy for its dietary fiber content, with bread alone accounting for 20 percent of the UK's daily intake.
India currently ranks second globally in wheat production, after China, with an extensive cultivation area of around 30 million hectares. This places India at the forefront of global wheat acreage, though there is a continued push to enhance productivity rates, which currently average about 3,279 kg/ha. The government and agricultural research institutions are focusing on productivity enhancements, aiming for a target production of up to 120 million tonnes by 2028 to meet rising domestic and international demand. Wheat contributes about 38% to India's total food grain production and is crucial for food security alongside rice. Most wheat grains (80-85%) are processed into flour (atta) for chapati consumption, while soft wheat is used for various bakery products and hard wheat for items like rawa and suji.
Chemical weed control has become increasingly popular due to its effectiveness and cost efficiency. Initially, herbicides like isoproturon will be widely used since the 1980s to combat grassy weeds like Phalaris minor. However, continuous usage led to resistant weed biotypes, particularly in North-Western India.

This led to the adoption of sulfonylurea herbicides like metsulfuron-methyl and sulfosulfuron, which effectively control both broad-leaf and grassy weeds with minimal mammalian toxicity (Singh *et al*., 1997) [9]. More recently, carfentrazone- ethyl, a contact herbicide from the triazolinone group, has shown efficacy against hard-to control weeds like Convolvulus arvensis and Malva parviflora, offering a targeted approach as a foliar spray.

Therefore, while conventional herbicides may become less effective, research is needed to identify new, broad-spectrum herbicides suited to evolving weed dynamics under changing climatic conditions So, this present study entitled "Comparative Study of Weed Control Approaches on Wheat Performance and Nutrient Utilization" is planned and undertaken during the rabi seasons of 2024-25 with the following objectives.

Materials and Methods

The field experiment was conducted at Agronomy Research Farm, Faculty of Agriculture and Veterinary Science, Mewar University, Gangrar during 2024-25, which is situated at altitude of 394.5meter above mean sea level and at 24.88°N 74.63°E. It falls under the agro- climatic zone IV A i.e. Sub humid Southern Plain and the aravalli hills of Rajasthan. During the crop season, the minimum and maximum temperature at Gangrar fluctuates in between 15.7 0C to 24.30C and 26.8 0C to 35.30C, respectively. Total rainfall received during crop growing season was 1000 mm. Variety Raj 3077 was selected for the experiment. Post emergence application of herbicides was done at 30-35 DAS as per treatments. A foot sprayer was used for spraying the herbicides using a spray volume of 500 litres of water per hectare. Sulfonylurea herbicides were applied with their surfactants while pendimethalin 30 EC was applied as pre emergence. The treated seed were sown by kera method at about 5 cm depth in rows 20 cm apart behind the plough using 125 Kg seed/ha. After placing the seeds in furrows, it was covered with soil. Recommended seed rates were followed for succeeding crops.

Results and Discussion

Growth parameters

The showed in (Table 4.1) of mustard changed with the advancement of the weed growth period on all the observation the was found to be hand weeding, sulfosulfuran @ 25 g *a.i.*/ha, sulfosulfuran 75% + metsulfuron methyl 5% WG @ 32 g *a.i.* /haapplied all at 30-35 DAS were the most superior and equally effective treatments that reduced considerably lowest weight (172.41,172.55,180.11). lower weed index of 4.53 percent. Highest weed control efficiency (89.43 percent) was recorded at harvest stage with hand weeding and sulfosulfuran @ 25 g *a.i.* /ha (89.42 percent) than weedy check and emerged as the most effective herbicidal. significantly improved the plant height of wheat at different stages of growth in comparison to weedy check during year of investigation. Results showed (Table 4.2) that weed free attained the maximum plant height of 37.96, 79.33 and 90.33 cm which was statistically at par with hand weeding (37.39, 77.48 and 88.14 cm), sulfosulfuran 75% + metsulfuron methyl 5% WG @ 32 g *a.i.* /ha (37.70, 77.70 and 88.12 cm), All the weed control treatments led to significant reduction in dry weight of weeds at harvest. The mean weed dry weight of 1631 kg/ha was recorded at harvest stage from weedy check. The increase in dry weight of weeds under weedy check might be attributed to uninterrupted growth of weeds throughout the crop season. Heavy infestation of weeds and their dry matter accumulation under weedy check has also been reported by Agarwal and Jain (1998) [1], Sardana *et al.* (2001) [7] and Singh and Singh (2005) [8] in wheat. Similarly, hand weeding in wheat done at 30-35 DAS registered lowest monocot & dicot weed population as well as dry matter production reduction of weeds at harvest stage of crop growth. Hand weeding done at 30-35 DAS registered maximum reduction in dry matter production of weeds at harvest stage of crop growth. Sulfosulfuran @ 25g *a.i* /ha could retain the crop weed free for shorter period only and thereafter, population and dry weight of weeds increased progressively under this treatment with the advancement of crop growth due to later flushes of weeds and thus relatively higher dry weight was recorded at subsequent growth stages. The luxuriant crop growth observed in a weed free environment due to hoeing and aeration in rhizosphere during early stages that smothered weed growth altogether as against 1631 kg/ha recorded under control. These results are in close conformity with the findings of Nadeem *et al.* (2007) [5] and Pisal *et al.* (2009) in wheat.

Yield attributes and yield

The significantly effect of seed treatment on yield data presented in Table 4.3. The highest weed free produced the maximum grain yield of 48.69 q/ha, straw yield (58.40 q/ha), biological yield (107.09 q/ha) and Harvest index was found non significantly, which was statistically at par with grain yield under hand weeding, sulfosulfuran 75% + metsulfuron methyl 5% WG @ 32 g *a.i.*/ha, clodinafop propargyl 15% + metsulfuron methyl 1% @ 64 g *a.i.*/ha and carfentrazone ethyl 40% DF @ 20 g *a.i.*/ha and significantly superior over rest of the treatments. These treatments kept the crop almost weed free during 40 DAS to ripening that markedly reduced the competition for nutrients and other growth resources by weeds as a consequence of which reduction in dry matter and nutrient depletion by weeds occurred. slow growing short statured crops suffer more due to weed competition than fast canopy forming and taller crops. Reduced weed-crop competition under these superior treatments might have saved a considerable amount of nutrients for crop growth that led to enhanced growth by utilizing greater moisture and nutrients from deeper soil layers. These favorable effects in rhizosphere were more conspicuous in hand weeding treatment as this improved soil tilth by making it favourable for the plants to utilize water and air. All these favorable effects of weed control treatments led to significant improvement in various yield attributing characters of wheat by providing better source-sink relationship. The significantly higher values of yield attributes coupled with higher crop dry matter under superior treatments can be ascribed as the most probable reason of higher grain yield. Under weed infested condition, although, the vegetative growth reached a level but the sink was not sufficient enough to accumulate the meaningful photosynthates translocating towards grain formation. Similar findings were also reported by Nadeem *et al.* (2007) [5] and Surin *et al.* (2013) [10] in wheat and Kumar *et al.* (2010) [4] in wheat.

Weed-crop competition may reduce crop yield by suppressing yield attributes. In the present study, the yield

attributes increased significantly by adopting various weed control treatments as compared to weedy check, though, their efficacy varied with respect to yield attributing characters depending on the spectrum of their weed control. The better expression of yield attributes might be due to poor resurgence frequency and growth of weeds as evident from weed dry matter studies in these plots

Nutrient content

The maximum nitrogen concentration in grain and straw was observed in weed free treatment (1.810 and 0.312%) that was closely accompanied by hand weeding (1.795%), clodinafop propargyl 15% +metsulfuron methyl 1% @ 64 g *a.i.*/ha (1.786%), The maximum phosphorus in grain and straw was observed in weed free (0.450 and 0.138%). Nutrient concentration in grain and straw of wheat (Table 4.4) and uptake of major nutrients by crop (Table 4.6) were observed to be significantly influenced by different weed control treatments. The lowest concentration of N in grain and straw was found under weedy check. Whereas, highest concentration of N and P was observed in weed free treatment that was closely accompanied by hand weeding, sulfosulfuran 75% +metsulfuran methyl 5% WG @ 32 g *a.i.* /ha and clodinafop propargyl 15% +metsulfuran methyl 1% @ 64 g *a.i.* /ha treatments. however, the difference in concentrations among these four treatments was not upto the level of significance. Being at par with each other, sulfosulfuran @ 25 gm *a.i.*/ha, 2,4-D ester @ 0.5 kg/ha, metsulfuran Methyl @ 4 g *a.i.* / ha, piroxofop-propargyl 15% WP 60 g a.i. /ha, carfentrazone Ethyl 40% DF @ 20 g *a.i.*/ha and Pendimethalin pre-emergence also recorded significantly higher N and P concentration in grain and straw than weedy check and arose as the next better treatments. Higher concentration of nutrients in crop can be ascribed mainly to the greater availability of nutrients under reduced crop-weed competition under different weed control treatments as per their efficiency that would otherwise have been utilized by fast growing weeds under infested conditions. Such findings have also been reported by Khokhar and Nepalia (2010) [3] in wheat.

Table 1: Effect of weed control treatments on weed index, weed dry matter production and WCE

Treatments	Weed index (WI%)	Weed dry matter production (kg/ha)	Weed control efficiency (%)
Weedy check	27.75	1631.00	0.00
Hand weeding at 30 – 35 DAS	4.53	172.41	89.43
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	13.33	206.81	87.32
Sulfosulfuron @ 25 gm a.i./ha at 30 – 35 DAS	15.54	172.55	89.42
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	11.46	201.15	87.67
Sulfosulfuron 75% +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	8.82	180.11	88.96
Piroxofop-Propargyl 15% WP 60 g a.i. /ha at 30 – 35 DAS	22.33	213.73	86.90
Clodinafop propargyl 15% +Metsulfuran methyl 1% @ 64 g a.i. /ha at 30 – 35 DAS	6.85	180.25	88.95
Carfentrazone Ethyl 40% DF @ 20 g a.i./ha at 30 – 35 DAS	10.30	181.45	88.87
Pendimethalin pre emergence	20.54	208.45	87.22
Weed free	0.00	0.00	100.00

Table 2: Effect of weed control treatments on plant height of wheat at different stages

Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
Weedy check	16.69	34.73	62.73	76.05
Hand weeding at 30 – 35 DAS	17.39	37.39	77.48	88.14
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	16.77	36.77	75.11	85.11
Sulfosulfuron @ 25 gm a.i./ha at 30 – 35 DAS	17.16	37.16	75.49	85.48
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	17.33	37.33	67.66	77.66
Sulfosulfuron 75% +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	17.70	37.70	77.70	88.12
Piroxofop-Propargyl 15% WP 60 g a.i. /ha at 30 – 35 DAS	16.52	36.52	70.11	82.44
Clodinafop propargyl 15% +Metsulfuran methyl 1% @ 64 g a.i. /ha at 30 – 35 DAS	17.44	37.44	77.77	87.77
Carfentrazone Ethyl 40% DF @ 20 g a.i./ha at 30 – 35 DAS	17.06	37.06	76.09	83.43
Pendimethalin pre emergence	17.23	37.23	75.49	82.62
Weed free	17.96	37.96	79.33	90.33
SEm+	0.35	0.61	1.10	1.65
CD (P=0.05)	NS	1.28	2.30	3.44

Table 3: Effect of weed control treatments on yield and harvest index of wheat

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha-1)	Biological yield (q ha^{-1})	Harvest index
Weedy check	34.46	41.35	75.81	45.46
Hand weeding at 30 – 35 DAS	46.99	56.33	103.32	45.48
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	41.56	49.04	90.60	45.87
Sulfosulfuron @ 25 gm a.i./ha at 30 – 35 DAS	40.37	48.42	88.79	45.47
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	43.58	51.16	94.74	46.00
Sulfosulfuron 75% +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	45.71	55.43	101.14	45.19
Piroxofop-Propargyl 15% WP 60 g a.i. /ha at 30 – 35 DAS	37.56	46.09	83.65	44.90
Clodinafop propargyl 15% +Metsulfuran methyl 1% @ 64 g a.i. /ha at 30 – 35 DAS	46.19	55.94	102.13	45.23

Carfentrazone Ethyl 40% DF @ 20 g a.i./ha at 30 – 35 DAS	44.15	51.74	95.89	46.04
Pendimethalin pre emergence	39.11	48.22	87.33	44.78
Weed free	48.69	58.40	107.09	45.47
SEm±	1.60	2.34	3.13	1.84
CD (P=0.05)	4.62	6.76	9.35	NS

Table 4: Effect of weed control treatments on nitrogen and phosphorus content in grain and straw of wheat

Treatments	N content (%)		P content (%)	
	Grain	Straw	Grain	Straw
Weedy check	1.391	0.212	0.351	0.109
Hand weeding at 30 – 35 DAS	1.795	0.309	0.420	0.136
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	1.591	0.258	0.399	0.122
Sulfosulfuron @ 25 gm a.i./ha at 30 – 35 DAS	1.588	0.256	0.395	0.121
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	1.691	0.263	0.420	0.126
Sulfosulfuron 75% +Metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	1.777	0.301	0.440	0.133
Piroxofop-Propargyl 15% WP 60 g a.i. /ha at 30 – 35 DAS	1.466	0.222	0.371	0.117
Clodinafop propargyl 15% +Metsulfuran methyl 1% @ 64 g a.i. /ha at 30 – 35 DAS	1.786	0.305	0.440	0.135
Carfentrazone Ethyl 40% DF @ 20 g a.i./ha at 30 – 35 DAS	1.700	0.273	0.450	0.128
Pendimethalin pre emergence	1.582	0.254	0.391	0.120
Weed free	1.810	0.312	0.450	0.138
SEm±	0.065	0.014	0.013	0.004
CD (P=0.05)	0.189	0.041	0.038	0.011

Conclusion

Based on the results of experimentation, it is concluded that conventional method of weed free is the most effective followed by hand weeding for remunerative weed control measure in wheat securing with all paramenters. The next best option is use of clodinafop propargyl 15% + metsulfuran methyl 1% @ 64 g a.i /ha or sulfosulfuran 75% + metsulfuran methyl 5 WG @ 32 g a.i./ha.

The ready mixtures proved superior to existing herbicides. Above conclusions are based one season research and its needs further confirmation by repeating the trial for at least two seasons.

Acknowledgement

The authors are duly acknowledged the, Department of Agriculture (Agronomy), Faculty of Agriculture and Veterinary Science, Mewar University, Gangrar, Chittorgarh, Rajasthan for the support and laboratory facilities during experiment.

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