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Assessment of weed management practices of wheat (*Triticum aestivum* L.) under different treatments and its economic feasibility in the Eastern U.P.

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Abstract

Background: Wheat (*Triticum aestivum* L.) is a crucial staple crop globally, particularly in developing countries like India, where it significantly contributes to food security and economic stability. This study aims to evaluate the effectiveness and economic feasibility of various weed management practices in wheat cultivation, given the substantial yield losses attributed to weeds.
Methods: the study was conducted during the rabi season of 2021-22 in a subtropical climate, this research utilized a randomized block design to assess twelve different treatments, including various herbicide combinations and manual weeding methods.
Results: Findings of the study indicated that weed-free plots yielded the highest grain and straw outputs, while specific herbicide combinations, such as Clodinafop + Metsulfuron, also demonstrated significant efficacy in weed suppression and yield enhancement. The economic analysis revealed that although weed-free management incurred the highest costs, herbicidal treatments provided better net returns and benefit-cost ratios, highlighting their potential for sustainable wheat production. This investigation underscores the necessity for integrated weed management strategies to optimize wheat yields and ensure economic viability, thereby supporting food security in the face of rising demand.

Keywords: Grain yield, straw yield, cost of cultivation, gross income, net income, B:C ratio, etc.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the worlds and has great effect on the economic stability of the developing countries like India. It is a reliable food source for over one billion people in 43 nations across the world (Kumar *et al*., 2021) [9]. It supplies around 20%of a human's total calorie intake. It is primarily grown in temperate region and also at higher altitude under tropical climate areas in winter season.

On a global scale, India is the second largest producer of wheat, accounting for approximately 12%of global wheat production. It is also the second largest consumer of wheat after China, with a rapidly growing demand. Wheat occupied an area of 224.49million hectare, with a total production of 792.40 million tones and productivity of 3.52 ton/ha in world. In India, it is grown by 31.61 million hectare (13.43% global area) with a production of 109.52 million tons (1.3% rise from previous year) and productivity of about 3464 Kg/ha.

The prominent weeds noted in wheat field *are Phalaris minor, Chenopodium Toalbum, Anagallis arvensis, Avena fatua, Convolvulus arvensis, Cyperus rotundus, and Cynodon dactylon*, etc. Which alone cause 33percent reduction in wheat yield. Rice-wheat is one of the most important cropping -system in eastern up. The magnitude of weed induced losses in agriculture systems in influenced by several factors, including weed species, density, duration of infestation, crop competition, and prevailing climatic conditions. To effectively manage a diverse and intricate array of wees, it is often necessary to utilize different weed management practices. This practices not only enhances the overall efficacy of weed management against particularly challenging weed species, but also serves to mitigate the development and onset of herbicide resistance, as evidenced by previous research (Singh *et al.*, 2011) [8]. Recent findings have demonstrated that both broad-leaved and grassy weeds process the potential to drastically wheat grain production by as much as 40-52.2% and 55.7-57%, respectively.

Another study conducted by Sharma *et al.*, (2011) [8] reported a significant reduction of 47.5% in wheat grain yield in the weedy check as compared to other treatments. The heavy infestation with complex weed flora in wheat has become serious threat in increasing the yield and productivity. Thus a suitable combination of new herbicides like sulfosulfuron, metsulfuron, fenoxaprop, clodinafop and metribuzin, reported to be very effective against associated weed species in wheat crop (Verma *et al.*, 2017) [12], is required for effective broad-spectrum control of weeds (Pal *et al.*, (2016) [15] as continuously rely on single herbicide to a longer period not only results herbicidal resistant but also creates weed shifts. In addition to herbicides combinations, cultural practices, being economical and eco-friendly (Sharma and Singh 2011) [8], also play a significant role in weed suppression particularly during the initial stages of crop establishment. As such combinations are typically more effective in terms of controlling composite weed populations and serve to delay the emergence of herbicide resistance.

Therefore, for sustaining food-grain production to feed ever increasing population, ensuring food security, and effective weed management is very essential. The management practices chosen for the study were based on their readily availability at affordable costs and also on weed species infesting the farmer's wheat fields. The current investigation was caried out with the objective of identifying the most appropriate weed management practices to achieve optimum broad-leaved weed suppression in wheat, while simultaneously evaluating the economic feasibility of various treatments in relation to wheat productivity in the region.

Materials and Methods

The present field experiments conducted entitled "Effect of weed management practices on growth and yield of wheat (*Triticum aestivum* L.)'' was caried out the rabi season of 2021-22. The field was well levelled having good soil condition. Geographically, falls in subtropical climate and is situated at 24°47´. North latitude, 82°12´. East longitudes with an altitude of 84 meters above mean sea level. The experimental site is situated at main campus of College on Azamgarh to Ghazipur road at a distance of 08 km from Azamgarh district head- quarter. The details of materials are used and techniques adopted during the experiments described as; -

Table 1: Detail of treatments with their symbols

Symbol	Treatments
T_1	Sulfosulfuron @ 25g a.i./ha
T_2	Metsulfuron @ 4g a.i./ha
T_3	Clodinafop @ 60ga.i./ha
T_4	Carfentrazone ethyl @ 20g a.i./ha
T_5	Sulfosulfuron + Metsulfuron (30 + 2) @ 32 g a.i./ha
T_6	Sulfosulfuron + Carfentrazone ethyl (25 + 20) @ 45 g a.i./ha
T_7	Clodinafop + Metsulfuron (60 + 4) @ 64 g a.i./ha
T_8	Fenoxaprop –p – ethyl @ 120 g a.i./ha
T_9	Fenoxaprop-p-ethyl + Metsulfuron (120 + 4) @ 124 g a.i./ha
T_{10}	Two hand weeding (20 and 40 DAS)
T_{11}	Weedy check
T_{12}	Weed free

The treatments were laid out in Randomized Block Design (RBD) being treatments (12) with three replications and the basic principles of randomization were followed.

Table 2: Experimental design and layout

1	Design adopted	Randomized block design
2	Variety	NW-5054
3	Number of replications	3
4	Number of treatments	12
5	Total number of plots	3x12=36
6	Gross plot size	2.6 m x 6.5 m =16.90 m2
7	Net plot size	2.2 m x 5.5 m =12.10 m2
8	Plot border	0.5 m
9	Block border	1.0 m
10	Field border	2.0 m
11	Main irrigation Channel	1.5 m
12	Sub irrigation channel	1
13	Row to row spacing	20 cm

Observation recorded

Biological yield (q/ha)

After harvesting the crop, produce was sun dried for one week and then weight of total produce which was harvested from net plot area of each plot was recorded and converted into q/ha.

Grain yield (q/ha)

After taking the weight of total biomass, produce of each net plot was threshed separated and clean grains were sun dried to maintain 12% moisture. The grain yield was recorded in kg plot-1 and finally the values were converted into q/ha.

Straw yield (q/ha)

Weight of total produce per net plot was recorded before threshing. The straw yield was calculated by subtracting the grain yield from the weight of total produce of net plot and expressed in quintal per hectare.

Harvest Index (%)

Harvest index is the ratio between the economic yield and biological yield and calculated by formula as given by Donald (1962) [16]. It measures the partitioning of photosynthates towards grains, expressed in percentage and calculate by the formula:

Harvest index = Economic yieldx100/Biological yield

Economic Analysis

Cost of Cultivation (Rs./ha) Cost of cultivation of wheat crop was calculated including treatment cost on the basis of local market price of different inputs used in cultivation.

Gross returns (Rs./ha)

The monetary value of grain and straw yield was computed in rupees using support price of outputs. Gross return was obtained by adding monetary values of grains and straw. Material and Methods Gross Return (Rs./ha) = Grain yield (q/ha) × price ((Rs./ha) + Straw yield (q/ha) × price ((Rs./ha)

Net returns (Rs./ha)

CD = Critical difference Net return for each treatment combination was calculated by deducting the cost of cultivation from the respective grass return. Net Return (Rs./ha) = Gross return – Cost of cultivation

Benefit: Cost ratio

The net benefit: cost ratio was computed for the crop as well as for the system by the fallowing formula: Benefit: cost ratio = Net return (Rs./ha)/Cost of cultivation (Rs./ha)

Statistical Analysis

The data recorded on different observations were analyzed statistically by using the analysis of variance (ANOVA) technique as suggested by Gomez and Gomez (1984) [17]. Critical difference at 0.05 probability level was worked out to compare the treatments when F-test was found significant.

Note

Sem ±

The standard error of mean (SEm ±) for different main effects was calculate with the help of the following formula;

Sem± = √2VE rx100

Where,
VE= error variance,
r= number of observations

Critical difference (CD): It was calculated by the following formula,
CD = S.Em± ×√2×‘t’ value at error degree freedom at 5%

Coefficient of variance (CV) %

It was calculated by the following formula: CV = S. D. × 100/Mean

Where:
CV = Coefficient of variance
CD = Critical difference
SD = Standard deviation

Results and Discussion

A critical examination of data pertaining to grain yield, straw yield, biological yield and harvest index indicated that different weed management practices affected that these components significantly except harvest index (Table-3).

Effect of weed management practices on Grain yield of wheat

Weed free produce the highest grain yield (52.60 q/ha) which was at par with post emergence application of Clodinafop + Metsulfuron @ 60 + 4 g/ha (51.21 q/ha), Sulfosulfuron + Metsulfuron @ 30 + 2 g/ha (50.10 q/ha) and two hand weeding while significantly superior over rest of the weed Management practices. It might be due to the smothering effect of the respective weed management practices. Which resulted in more translocation of food from source to sink responsibly more yield. Almost similar result was reported by Malik *et al.*, (2008) [6] and Tomar & Tomar. (2014) [11].

Effect of weed management practices on Straw yield of wheat

The highest straw yield of (66.35) was recorded in weed free which were statistically at par with post emergence application of Clodinafop + Metsulfuron @ 60 + 4 g/ha (63.99), Sulfosulfuron + Metsulfuron @ 30 + 2 g/ha, and two hand weeding while significantly higher than rest of the weed management practices. The above findings may be due to effective control of weeds which contributed to better growth parameters and yield attributes, better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yield over rest of the weed management practices almost similar result was reported by Malik *et al.*, (2008) [6] and Tomar & Tomar. (2014) [11].

Biological yield of wheat under weed management practices

Biological yield is is the sum of grain and straw yield. Maximum biological yield recorded under weed free 118.95 q/ha was at par with post emergence application of of Clodinafop + Metsulfuron @ 60 + 4 g/ha (115.20 q/ha), Sulfosulfuron + Metsulfuron @ 30 + 2 g/ha, (114.70 q/ha). This might be due to effective weed control by such as to treatment enhancement more growth and development resulted more biological yield. Similar result was reported by Malik *et al.*, (2008) [6] and Tomar & Tomar. (2014) [11].

Effect of weed management practices on Harvest index of wheat

Harvest index is a function of grain and biological yield. Highest harvest index was noted in Clodinafop + Metsulfuron @ 60 + 4 g/ha (44.45%), closely followed by weed free (44.22%) this might be due to the fact that proper weed management increased the proportionate distribution of photosynthetic sink i.e. grain which resulted increase in harvest index.

Economical-feasibility of the weed management practices

Data presented in Table-4 pertaining to economics of different weed management treatments revealed that the highest cost of cultivation of (Rs. 48218/ha) was incurred under weed free against the lowest cost of cultivation (Rs. 37708/ha) of weedy check. In all weed management practices recorded higher gross return, net return and benefit cost ratio over weedy check. The maximum gross return of (Rs. 124354.5/ha) was obtained with weed free closely followed by Clodinafop + Metsulfuron @ 60 + 4 g/ha (Rs. 122178.5/ha) against lowest gross income of (Rs. 80375.5/ha) of weedy check. Clodinafop + Metsulfuron @ 60 + 4 g/ha recorded the highest net return of (Rs. 82510.5) closely followed by and Sulfosulfuron + Metsulfuron @ 30 + 2 g/ha (Rs. 80700/ha) and against lowest net return of (Rs. 42667.5/ha) noted with weedy 89 Discussion check. Clodinafop + Metsulfuron @ 60 + 4 g/ha treatments also recorded highest benefit cost ratio of (2.08), followed by Sulfosulfuron + Metsulfuron @ 30 + 2 g/ha, (2.04) while maximum under as weedy check of (1.13%). The weed free was not found to be economical in comparison to other herbicidal treatments because of its high expenditure involved in keeping the plots free of weeds. In the herbicides the better net return and net return per rupee investment was mainly due to less increase in cost of cultivation with these treatments compare to weed free. Similar result was reported by Singh & Saha. (2006) [10].

Table 3: Effect of various weed management practices on grain yield, straw yield, biological yield (q/ha) and harvest index of wheat

	Treatments	Grain Yield (q/ha)	Straw yield (q/ha)	Biological Yield (q/ha)	Harvest index (%)
T_1	Sulfosulfuron @ 25 g a.i./ha	46.10	60.55	106.65	43.22
T_2	Metsulfuron @ 4g a.i./ha	45.70	59.20	104.90	43.56
T_3	Clodinafop @ 60 g a.i./ha	44.40	58.30	102.70	43.23
T_4	Carfentrazone ethyl @ 20g a.i./ha	44.90	58.85	103.75	43.27
T_5	Sulfosulfuron + Metsulfuron (30 + 2) @ 32 g a.i./ha	50.10	64.60	114.70	43.67
T_6	Sulfosulfuron + Carfentrazone ethyl (25 + 20) @ 45 g a.i/ha	47.00	61.25	108.25	43.41
T_7	Clodinafop + Metsulfuron (60 + 4) @ 64 g a.i./ha	51.21	63.99	115.20	44.45
T_8	Fenoxaprop –p – ethyl @ 120 g a.i./ha	43.28	58.55	101.83	42.50
T_9	Fenoxaprop-p-ethyl + Metsulfuron (120 + 4) @ 124 g a.i./ha	47.60	61.40	109.00	43.66
T_{10}	Two hand weeding (20 and 40 DAS)	49.90	64.85	114.75	43.48
T_{11}	Weedy check	32.60	47.80	80.40	40.54
T_{12}	Weed free	52.60	66.35	118.95	44.22
SEm ±		1.33	1.03	1.48	1.19
CD (P ≥0.05%)		3.98	2.98	4.33	NS

Table 4: Economic feasibility weed management practices of wheat under different treatments

	Treatments	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1	Sulfosulfuron @ 25 g a.i./ha	38608	110424	71816	1.86
T_2	Metsulfuron @ 4g a.i./ha	38708	109095	70387	1.82
T_3	Clodinafop @ 60 g a.i./ha	38818	106349.5	67531.5	1.73
T_4	Carfentrazone ethyl @ 20g a.i./ha	38618	107492	68874	1.78
T_5	Sulfosulfuron + Metsulfuron (30 + 2) @ 32 g a.i./ha	39558	120288	80700	2.04
T_6	Sulfosulfuron + Carfentrazone ethyl (25 + 20) @ 45 g a.i/ha	39508	112336	72828	1.84
T_7	Clodinafop + Metsulfuron (60 + 4) @ 64 g a.i./ha	39668	122178.5	82510.5	2.08
T_8	Fenoxaprop –p – ethyl @ 120 g a.i./ha	38838	104284.3	65446.3	1.68
T_9	Fenoxaprop-p-ethyl + Metsulfuron (120 + 4) @ 124 g a.i./ha	39688	113204.5	73516.5	1.85
T_{10}	Two hand weeding (20 and 40 DAS)	44718	117420	72702	1.62
T_{11}	Weedy check	37708	80375.5	42667.5	1.13
T_{12}	Weed free	48218	124354.5	76136.5	1.57

Conclusions

In conclusion, the cultivation of wheat (*Triticum aestivum* L.) holds immense significance for the economic stability of developing countries like India, serving as a vital food source for over one billion people in 43 nations worldwide. With India ranking as the second largest producer and consumer of wheat globally, maintaining high productivity is essential. However, the challenges posed by weed infestation and varying climatic conditions have a substantial impact on wheat yield and overall agricultural sustainability. The comprehensive study conducted highlighted the significant influence of weed management practices on the various yield components of wheat. The findings revealed that weed-free plots and specific post-emergence herbicidal treatments, such as Clodinafop + Metsulfuron and Sulfosulfuron + Metsulfuron, exhibited promising results in terms of economic feasibility and net returns. Notably, these treatments demonstrated enhanced grain yield, straw yield, and biological yield, emphasizing their potential for optimizing wheat productivity and economic viability. The outcomes of this study align with previous research and underscore the critical importance of prioritizing sustainable weed control strategies to ensure food security and sustain food-grain production for the ever-increasing global population. By emphasizing the effectiveness of specific herbicidal treatments and sustainable weed management practices, this research contributes valuable insights for enhancing agricultural productivity and addressing the challenges associated with weed infestation in wheat cultivation.

Conflict of interest: None

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