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RESEARCH ARTICLE

EFFICACY OF CHEMICAL HERBICIDES ON MANAGEMENT OF WEED AND YIELD OF WHEAT AT DANG NEPAL

Prabal Pokharel*, Civir Shrestha, Prabin Poudel, Mohan Mahato, Kabita Shah

Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Nepal.
****Corresponding Author Email: ceavitashah2@gmail.com***

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ABSTRACT

Weed infestation is a significant factor contributing to low wheat yields, particularly in developing regions like Nepal. This study evaluates the efficacy of various chemical herbicides in controlling weeds and their impact on wheat yield in Dang District during the 2022-2023 growing season. Eight treatments were tested, including weedy, weed-free, and various herbicide combinations, using a Randomized Complete Block Design (RCBD) with three replications. Results indicated that chemical treatments significantly affected weed diversity, plant height, grain yield, and economic returns. The combination of Metribuzin + 2, 4-D showed the lowest weed diversity and highest grain yield (2.31 t/ha), while Sulfosulfuron + 2, 4-D yielded the highest net return (14.71 thousand Rs/ha) and B:C ratio (1:1.19). These findings underscore the importance of effective weed management strategies in enhancing wheat production and ensuring food security in Nepal.

KEYWORDS

Wheat, Sulfosulfuron, Metribuzin, weed management, yield.

1. INTRODUCTION

Wheat (Triticum aestivum L.) is a staple food crop globally, with significant importance in Nepal's agricultural landscape. It is the third most produced cereal in Nepal, following rice and maize, and plays a crucial role in food security and economic stability. It occupies 20.68% of total cereal area and contributes 19.98% of the total cereal production (MOALD, 2022). In Nepal, the total production of wheat in 2079 is 21, 44, 568 in an area of 7, 16,978 metric tons (MOALD, 2022). It is grown in Terai, river basins, mid hills, and high hills of Nepal in winter season. In Dang, wheat has been cultivated in 12,690 ha area with an annual production of 39,694 metric tons with productivity of 3.13 mt ha-1 (MOALD, 2022). Despite its potential, wheat production in Nepal is hindered by various factors, particularly weed infestation, which can lead to yield losses of up to 66% (Kumar et al., 2011; Jabran et al., 2017). Weeds compete with crops for essential resources such as light, water, and nutrients, ultimately affecting crop growth and yield.

Infestation of weed in wheat field can be controlled by physical, chemical and biological methods. Physical method demands for high labour and is comparatively expensive as well as time consuming (Akbar et al., 2011). Chemical method involves application of various selective as well as non-selective herbicides. Herbicides are chemical agents designed to control or eradicate unwanted weed species, thereby improving crop yield and quality. The introduction of chemical herbicides has emerged as a promising strategy for effective weed management, offering rapid and significant results compared to traditional methods. However, the efficacy of these herbicides can vary based on the type of herbicide, application timing, and local environmental conditions. This research aims to assess the effectiveness of different chemical herbicides in managing weeds and their subsequent impact on wheat yield in Dang District, where wheat is a crucial crop for food security and economic stability.

2. MATERIALS AND METHODS

2.1 Experiment site

This experiment was conducted during spring season (November 2022 – March 2023) in Lamahi Municipality in Dang district of Lumbini province. Geographically, it is located at 27.52' N latitude and 82.32' E longitude at the elevation of 300 Masl. The experimental region falls on the plain of Inner Terai which is characterized by Tropical environment with good facility of irrigation. The soil type was found to be sandy loam.

2.2 Experiment design and treatment factors

The experiment was conducted in Agronomy farm of Prithu Technical College with single factor Randomized Complete Block Design (RCBD) with three replications and 8 treatments (Table). The newly released variety NL-971 was planted.

Table 1: Different treatments used in experiment

S.N.	Treatments	Symbol	Rate ha^{-1} (a. i.)
1	weedy	T1	-
2	weed free	T2	-
3	Pendimethalin	T3	1.5 l
4	2,4-D	T4	1 l
5	Sulfosulfuron	T5	30 g
6	Metribuzin	T6	250 g
7	Metribuzin + 2,4-D	T7	125 g +0.5 l
8	Sulfosulfuron + 2,4-D	T8	30 g + 0.5 l

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2.3 Field Preparation

The field was ploughed twice using a tractor, and manual removal of weeds and residues was performed one week before sowing. The field was divided into different experimental plots according to the experimental layout plan, with each plot measuring 4 m x 3 m. The space between blocks and treatments was 0.5m. Two boarder rows in each side were treated as non-sampling rows and the third rows in each side were used as destructive sampling, and for biometrical and phonological observations. The remaining central rows were treated as net plot and used for final harvesting.

2.4 Sowing and Fertilization

Seeds of the NL-971 variety were sown on November 9, 2022, at a rate of 120 kg/ha. Seeds were manually sown in a 25 cm x 10 cm spaced line. Fertilizers were applied at a ratio of 100:50:50 kg/ha of Nitrogen, Phosphorus, and Potassium, respectively, using urea, DAP, and MOP. Half of the nitrogen and the full doses of phosphorus and potassium were applied before final land preparation, with the remaining nitrogen applied in two split doses during the tillering and panicle initiation stages.

2.5 Herbicide Application

Herbicides were applied as pre-emergence and post-emergence treatments. Pre-emergence (Pendimethalin) was applied 24 hours after sowing, while post-emergence herbicides (Sulfosulfuron, Metribuzin, 2, 4-D, and their combinations) were applied 45 days after sowing.

2.6 Data Collection

Plant height was measured at 30, 45, 60, 75 days after sowing (DAS), and at harvest by selecting five random plants per plot, excluding border plants. Before tasseling, height was measured from the soil surface to the first leaf node, and after tasseling, it was measured to the node below the tassel, with the mean height of five plants recorded for each plot. Yield and yield-attributing parameters included the number of effective tillers per square meter, counted from one square meter per plot before harvest; the length of spikes or panicles, measured from the base of the rachis to the tip of ten randomly selected panicles and averaged; and the test weight, determined by weighing 1000 grains adjusted to 12% moisture content. Biological yield, calculated as the sum of grain yield and straw yield, was obtained by weighing harvested produce, threshing, and cleaning manually. Grain yield was computed from net plot yields and adjusted to 12% moisture content using a moisture meter and a standard formula.

Grain yield at 12% moisture = Wi × 100 – Mi 100–12 × 1000$(m)^2$ *net plot area*$(m)^2$

Where, Wi = initial weight in kg and Mi = initial moisture content in percentage of the grain.

Straw yield was derived by subtracting grain yield from total biomass yield.

The harvest index, representing the ratio of grain yield to total biomass yield, was expressed as a percentage.

2.7 Weed parameters

Weed parameters were recorded through systematic observations. Weed sampling was conducted every 15 days starting from 30 days after sowing (DAS) until harvest. Weeds were collected from a sampling area of 0.5 m^2 per plot and identified, then classified into three groups—broad-leaf weeds, grasses, and sedges—based on their morphology.

The weed index (WI), which measures yield reduction due to weed presence compared to a weed-free plot, was calculated using the formula:

Weed Index (%) = (A - B) / A × 100,

Where A represents the yield from a minimum weed competition plot, and B represents the yield from the treatment being evaluated. This approach provided insights into weed impact on crop yield.

2.8 Economic Analysis

Economic analysis was performed to assess the profitability of each treatment. The cost of cultivation, gross income, net income, and benefit-cost (B:C) ratio were calculated based on local market prices.

2.9 Statistical analysis

Statistical analysis of the experimental data was conducted using ANOVA. When the F-test showed significance at p=0.05, Duncan's Multiple Range Test (DMRT) was applied to compare mean differences, as outlined by (Gomez and Gomez, 1984). Microsoft Word 2016 was used for word processing, MS Excel for creating tables, graphs, and basic statistical analysis, and the R-package for advanced statistical computations.

3. Results

The results demonstrated significant differences in plant height, effective tillers, and grain yield across treatments. The highest grain yield was recorded in the Sulfosulfuron + 2,4-D treatment (2.31 t/ha), while the weedy treatment yielded the least (1.75 t/ha).

3.1 Plant Height

Table 2: Effect of chemical weed management practices on plant height at different time interval, of wheat at Dang during 2022

Treatments	Plant height (cm)				
	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Weedy	12.08a	26.43ab	61.87a	79.23a	100.33ab
Weed free	12.01a	26.73ab	47.04b	72.19a	91.33b
Pendimethalin	10.52a	25.85ab	56.96ab	79.57a	97.76ab
2,4-D	11.85a	31.61a	64.86a	84.59a	107.23a
Sulfosulfuron	12.06a	23.05b	55.14ab	79.44a	97.78ab
Metribuzin	11.05a	25.66ab	58.74ab	85.87a	101.57a
Metribuzin + 2,4-D	11.61a	30.36ab	63.53a	86.56a	99.59ab
Sulfosulfuron + 2,4-D	11.47a	30.10ab	56.03ab	71.61a	102.80a
LSD	2.32	8.49	12.25	16.51	10.20
P-value	0.002	NS	<0.001	0.004	0.002
SEM (±)	1.11	2.03	7.32	6.99	4.70
CV%	11.45	17.64	12.05	11.80	5.84
Mean	11.58	27.47	58.02	79.88	99.80

Treatments means followed by the same letter(s) alphabet within column are non-significantly different among each other by DMRT at 5% level of significance. LSD= Least Significant Difference, SEM= Standard Error of Mean, CV= Coefficient of Variation and NS= non-significant.

The study found that herbicides significantly affected plant height at 30, 60, and 75 days after sowing (DAS) and at harvest, but had no significant effect at 45 DAS. The average plant height at harvest was 99.80 cm, with the 2,4-D treated plot yielding the tallest plants (107.23 cm) and the weed-free plot producing the shortest (91.33 cm). These results align with previous research by who also observed that herbicides effectively control weeds and enhance plant growth (Shivaran et al., 2020; Bhattarai and Gautam, 2019).

3.2 Number of Effective Tillers (m^2)

Table 3: Effect of chemical weed management practices on effective tillers, panicle length and number of grains per panicle of wheat at Dang during 2022.

Treatments	Effective tiller (m^2)	Panicle length (cm)	No of grain per panicle
Weedy	236.67d	7.51b	33.33c
Weed free	304.00bc	8.88ab	39.6a
Pendimethalin	253.00d	7.62b	34.67c
2,4-D	250.00d	7.55b	34.23c
Sulfosulfuron	334.00ab	10.03a	40.47a
Metribuzin	288.33c	7.82b	35.00c
Metribuzin + 2,4-D	292.33c	9.98a	36.00bc
Sulfosulfuron + 2,4-D	357.67a	9.85a	38.67ab
LSD	31.54	1.57	2.80
P-value	<0.001	0.004	<0.001
SEM (±)	1.54	0.80	2.55
CV%	6.22	10.33	4.38
Mean	289.50	8.66	36.50

The study found that different weed management practices significantly impacted the number of effective tillers per square meter. The average number of effective tillers was 289.50, with the highest count recorded in the Sulfosulfuron + 2,4-D treatment (357.67), and followed by Sulfosulfuron (334). The lowest count was in the weedy treatment (236.67). These results are consistent with who also observed the highest number of tillers in the Sulfosulfuron + 2,4-D treatment and the lowest in the weedy treatment (Bhattarai and Gautam, 2019).

3.3 Panicle/Spike length(cm)

The study showed that different weed management practices significantly affected spike length, with an average spike length of 8.66 cm. The longest spike was observed in the Sulfosulfuron treatment (10.03 cm), followed by Metribuzin + 2,4-D (9.98 cm) and Sulfosulfuron + 2,4-D (9.85 cm). The shortest spike length was recorded in the weedy plot (7.51 cm), followed closely by the 2,4-D treated plot (7.55 cm). These findings align with Singh et al. (2023), who reported a maximum panicle length of 8.91 cm in a combined treatment of Metribuzin and Pendimethalin, and a spike length of 7.25 cm in Sulfosulfuron-treated plots.

3.4 No. of grains per panicle

The study found that different weed management practices significantly affected the number of grains per panicle, with an average of 36.50 grains per panicle. The highest number of grains was observed in the Sulfosulfuron treatment (40.47), which was statistically similar to the weed-free treatment (39.6). The lowest number of grains was recorded in the weedy plot (33.33). These results align with who noted that herbicide application increased the number of grains per spike by enhancing spike length (Singh et al., 2023).

3.5 Grain Yield

Table 4: Effect of chemical weed management practices on grain yield, straw yield, biological yield, harvest index and thousand grain weight of wheat at Dang during 2022.

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)	Biological yield (t/ha)	Thousand grain weight (gm)
Weedy	1.75bc	2.80d	38.69a	4.55c	45.50ef
Weed free	2.07ab	3.58ab	36.57ab	5.65ab	51.57ab
Pendimethalin	1.59c	2.94cd	35.4ab	4.53c	48.43d
2,4-D	1.74bc	3.54abc	33.05b	5.28bc	44.46f
Sulfosulfuron	2.15a	3.56ab	37.74a	5.71ab	50.63bc
Metribuzin	2.04ab	3.29bcd	38.36a	5.33bc	46.16e
Metribuzin + 2,4-D	2.26a	3.78ab	37.50a	6.04ab	52.37a
Sulfosulfuron + 2,4-D	2.31a	3.93a	37.08ab	6.24a	49.40cd
LSD	0.36	0.62	4.41	0.85	1.59
P-value	0.005	0.018	NS	0.005	<0.001
SEM (±)	0.04	0.12	6.36	0.23	0.82
CV%	10.27	10.31	6.85	8.97	1.87
Mean	1.99	3.42	36.8	5.42	48.57

The grain yield of wheat is influenced by yield-attributing factors such as the number of effective tillers, grains per panicle, and panicle weight. A researcher explained that carbohydrates produced before heading are stored in the leaf sheath and stem, later translocating to the panicle during grain filling (Ma, 2021). The study showed a 22.55% reduction in wheat yield due to weed competition throughout the growth period.

Statistical analysis indicated that grain yield was significantly affected by herbicides and weed management practices. The average grain yield was 1.99 tons/ha, with the lowest yield from the Pendimethalin-treated plot (1.59 tons/ha) and the highest from the Sulfosulfuron + 2,4-D treatment (2.31 tons/ha), which was similar to the Metribuzin + 2,4-D treatment (2.26 tons/ha). A group researcher also observed yield reduction due to weed competition (Wara et al., 2020).

These findings agree with who reported higher wheat yield when Sulfosulfuron was combined with Isoproturon, and who found higher yields with the combined application of Sulfosulfuron + 2,4-D (Khokar and Nepalia, 2010; Bhattarai and Gautam, 2019). A group researchers also reported lower yields from Pendimethalin-treated plots and higher yields from combination treatments (Shah et al., 2019).

3.6 Straw yield

The study found that straw yield was significantly influenced by herbicide application, with an average yield of 3.42 tons/ha. The highest yield was recorded in the Sulfosulfuron + 2,4-D treatment (3.93 tons/ha), followed by Metribuzin + 2,4-D (3.78 tons/ha). The lowest yield was observed in the weedy plot (2.80 tons/ha) and the pre-emergence Pendimethalin-treated plot (2.94 tons/ha). These results align with who also reported high straw yield with combined herbicide treatments, and who found low straw yield in weedy and Pendimethalin-treated plots (Khokhar and Nepalia, 2010; Bhattarai and Gautam, 2019). A group researchers also observed variations in straw yield of Triticum aestivum under herbicide application (VanGessel et al., 2017).

3.7 Biological yield

The study found that the biological yield of wheat was significantly affected by herbicide application and weed management practices, with an average yield of 5.42 tons/ha. The highest biological yield was recorded in the Sulfosulfuron + 2,4-D treated plot (6.24 tons/ha), while the lowest was in the pre-emergence Pendimethalin-treated plot (4.53 tons/ha). The poor yield in the Pendimethalin-treated plot aligns with findings (Bhattarai and Gautam, 2019).

3.8 Harvest Index

The harvest index, which reflects the efficiency of plants in allocating assimilates to economically important parts, was significantly influenced by herbicide application. The average harvest index was 36.8%. The highest harvest index was observed in the weedy check plot (38.69%), followed by Metribuzin (38.36%), Sulfosulfuron (37.74%), and Metribuzin + 2,4-D (37.50%). The lowest harvest index was recorded in the 2,4-D treated plot (33.05%).

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Total biomass yield (Grain yield + straw yield)}}$$

3.9 Thousand grain weight

The thousand grain weight was significantly affected by weed management practices, with an average weight of 48.57 g. The highest thousand grain weight was observed in the Metribuzin + 2,4-D treatment (52.37 g), which was similar to the weed-free treatment (51.57 g). The lowest weight was recorded in the weedy treatment (45.50 g). These findings align with who reported higher 1000-grain weight in Metribuzin-treated plots compared to other treatments, and who found similar results (Bhattarai and Gautam, 2019; Shah et al., 2019).

Table 5: Effect of chemical weed management practices on weed diversity at different time interval on wheat at Dang during 2022.

Treatments	Total Weed			
	30 DAS	45 DAS	60 DAS	75DAS
Weedy	18.92a	18.19a	17.67a	17.87a
Weed free	0.0	0.0	0.0	0.0
Pendimethalin	7.33b	5.20c	8.04bc	7.93bc
2,4-D	19.19a	12.05b	10.03b	7.71bc
Sulfosulfuron	17.93a	4.51c	6.56bc	5.03c
Metribuzin	16.71a	12.05b	7.81bc	9.52b
Metribuzin + 2,4-D	16.38a	4.44c	6.05c	8.73bc
Sulfosulfuron + 2,4-D	16.88a	5.47	6.97bc	7.47bc
LSD	3.49	2.97	3.60	4.47
P-value	0.001	0.001	0.01	0.001
SEM (±)	2.45	2.96	2.54	2.54
CV%	12.11	21.04	22.43	27.37
Mean	16.19	7.95	9.03	9.18

3.10 Weed Diversity

Table 6: List of weeds observed in experiment plot

S. N	Common Name	Scientific Name	Family
1.	Little seed canary grass	*Phalaris minor*	*Poaceae*
2.	Cockleburs	*Xanthium strumarium*	*Asteraceae*
3.	Lamb's quarters	*Chenopodium album*	*Amaranthaceae*
4.	Mazus	*Mazus pumilus*	*Mazaceae*
5.	Mint	*Mentha Spp*	*Lamiaceae*
6.	Bur clover	*Medicago denticulata*	*Fabaceae*
7.	Crab grass	*Digitaria anguinalis*	*Poaceae*
8.	Jungle rice	*Echinochloa colona*	*Poaceae*
9.	Coco grass	*Cyperus rotundus*	*Cyperaceae*
10.	Grass pea	*Lathyrus sativa*	*Fabaceae*
11.	Bermuda grass	*Cynodon dactylon*	*Poaceae*
12.	Asiatic Pennywort	*Citronella asiatica*	Apiaceae
13.	Billygoat weed	*Ageratum conyzoides*	*Asteraceae*
14.	Common vetch	*Vicia sativa*	*Fabaceae*
15.	White sweetclover	*Melilotus alba*	*Leguminosae*

Statistical analysis revealed that herbicide application significantly affected total weeds at 30 DAS, 45 DAS, and 60 DAS, with significant effects at 75 DAS. Overall, the weedy plot exhibited higher weed diversity throughout the crop period.

At 30 DAS, the pre-emergence Pendimethalin plot showed the lowest weed diversity (7.33), likely due to the pre-existing chemicals before weed emergence. The highest weed diversity was observed in the 2,4-D treated plot (19.19). At 45 DAS and 60 DAS, the lowest weed diversity was found in the Metribuzin + 2,4-D plot, similar to the Sulfosulfuron-treated plot. The weedy plot and 2,4-D treated plot showed the highest weed diversity.

At 75 DAS, the Sulfosulfuron-treated plot had the lowest weed diversity (5.03), while the weedy plot showed the highest (17.87), followed by the Metribuzin-treated plot (9.52). These results align with who observed lower weed density in Metribuzin-treated plots at later growth stages (Singh et al., 2023).

A group researchers also found fewer weeds in wheat plots treated with Sulfosulfuron at 0.025 kg/ha at 75 DAS, which mirrors our findings (Choudhary et al., 2016). Additionally, 2,4-D showed low effectiveness, with maximum weed density recorded in those plots, similar to results by (Bhattarai and Gautam, 2019; Choudhary et al., 2016).

3.11 Weed Dry Weight

The analysis revealed highly significant effects of herbicide application on total weed dry weight throughout the crop growth stages. At 30 DAS, the minimum weed dry weight was observed in the pre-emergence Pendimethalin-treated plot, while the maximum was recorded in the Metribuzin-treated plot.

At 45 DAS, the Metribuzin-treated plot showed the lowest weed dry weight (1.64). The Metribuzin + 2,4-D treatment and Sulfosulfuron treatment showed the least weed dry weight at 60 DAS and 75 DAS, respectively. The weedy plot and 2,4-D treated plot exhibited the highest weed dry weight during 45 DAS, 60 DAS, and 75 DAS.

Metribuzin application effectively suppressed weeds at later stages, resulting in lower dry weight. Similar results were observed by most of researchers (Shah et al., 2019; Pandey et al., 2019; Bhattarai and Gautam, 2019).

Table 7: Effect of chemical weed management practices on weed dry weight and weed index at different time interval on wheat at Dang during 2022.

Treatments		Dry Matter			Weed Index
	30 DAS	45 DAS	60 DAS	75DAS	

Table 8 (cont): Effect of chemical weed management practices on weed dry weight and weed index at different time interval on wheat at Dang during 2022.

Weedy	2.81a	4.23a	4.31a	3.99a	14.71ab
Weed free	0.0	0.0	0.0	0.0	0.00
Pendimethalin	1.28b	2.04bc	2.19bc	2.42cd	22.55a
2,4-D	2.95a	2.46b	2.92b	3.22b	14.38ab
Sulfosulfuron	2.80a	2.24bc	1.93c	2.07d	-5.67a
Metribuzin	3.12a	1.64c	2.08c	2.40cd	0.07bc
Metribuzin + 2,4-D	2.79a	1.82c	1.66c	2.11cd	-10.62c
Sulfosulfuron + 2,4-D	2.85a	2.06bc	2.22bc	2.69bc	-13.59c
LSD	0.58	0.61	0.83	0.60	18.00
P-value	0.003	0.001	0.002	0.002	0.005
SEM (±)	0.37	0.60	0.60	0.45	1.54
CV%	12.27	14.66	19.03	12.63	17.54
Mean	2.65	2.36	2.47	2.70	2.73

3.12 Weed Index

The research showed a 22.55% reduction in wheat yield due to weed competition for light, moisture, and nutrients, with an average weed index of 2.73. The lowest weed index was observed in the Sulfosulfuron + 2,4-D treatment (-13.59), followed by Metribuzin + 2,4-D (-10.62), Sulfosulfuron (-5.67), and Metribuzin (0.07). The highest weed index was recorded in the pre-emergence Pendimethalin treatment (22.55). These findings are consistent with a group researcher who also reported the lowest weed index in the Sulfosulfuron-treated plot (Choudhary et al., 2016).

3.13 Economic Analysis

Table 9: Effect of chemical weed management practices on economics of wheat production at Dang during 2022.

Treatments	Economics parameters Rs ha^{-1} (,000)			
	Cost of cultivation	Gross Income	Net Income	BC ratio
Weedy	73.90g	70.38bc	-3.52cde	0.95cde
Weed free	82.90a	82.88ab	-0.02bcd	0.99bcd
Pendimethalin	79.30b	63.75c	-15.55e	0.80e
2,4-D	77.90c	69.84bc	-8.06de	0.89de
Sulfosulfuron	75.70f	86.35a	10.65abc	1.14ab
Metribuzin	75.70f	81.87ab	6.17abcd	1.08abc
Metribuzin + 2,4-D	76.80e	90.65a	13.85ab	1.18ab
Sulfosulfuron + 2,4-D	77.70d	92.42a	14.71a	1.19a
LSD	2.10	14.36	14.36	0.18
P-value	<0.001	0.005	0.003	0.003
SEM (±)	1.96	1.54	1.39	1.18
CV%	1.54	10.27	79.96	10.14
Mean	77.49	79.76	2.27	1.03

The cost of cultivation, gross return, net income, and B:C ratio were significantly influenced by different herbicidal treatments. The weed-free plot incurred the highest cost of cultivation, while the weedy check plot had the lowest.

The highest gross return was observed in the Sulfosulfuron + 2,4-D treatment, which was statistically similar to Metribuzin + 2,4-D and Sulfosulfuron, while the lowest gross return was found in the weedy plot.

Net income was highest in the Sulfosulfuron + 2,4-D treatment, which was comparable to Metribuzin + 2,4-D. The lowest net income was recorded in the weedy plot.

The highest B:C ratio was observed in Sulfosulfuron + 2,4-D, similar to Metribuzin + 2,4-D, while the lowest B:C ratio was found in the weedy plot.

4. Discussion

The herbicide combination Metribuzin + 2, 4-D was effective in weed control since post-emergence application efficiency was most efficient in weeds. The treatment had fewer weed counts (4.44 at 45 DAS, 6.05 at 60 DAS, and 8.73 at 75 DAS) and lower weeds dry weight (1.82 at 45 DAS, 1.66 at 60 DAS, and 2.11 at 75 DAS). Besides, it also provided a B:C ratio of 1:1.18. Pendimethalin pre-emergent application resulted in less weed growth (7.33) at 30 DAS. Treatment with Sulfosulfuron + 2,4-D provided the highest yield (2.31 t/ha) and was statistically at par with Metribuzin + 2,4-D (2.26 t/ha). Additionally, the highest thousand grain weight (52.37g), highest plant height at 60 DAS (64.86cm) and harvest (107.23cm), highest panicle length (10.03cm), and highest number of grains per panicle (40.47) were recorded for Sulfosulfuron treatment. The highest B:C ratio of 1.19 was recorded in Sulfosulfuron + 2,4-D plot, which was statistically at par with Metribuzin + 2,4-D (1.18) and Sulfosulfuron (1.14). This aligns with previous studies that highlight the importance of timely herbicide application in maximizing crop productivity (Singh et al., 2017; Pandey et al., 2006). The economic benefits observed suggest that adopting these herbicide treatments could be a viable strategy for farmers in Dang District to improve wheat production. The results also emphasize the need for integrated weed management strategies that combine chemical and cultural practices to sustain agricultural productivity in the long term.

5. Conclusion

The combination of Sulfosulfuron + 2,4-D emerged as the most effective treatment for weed control and yield enhancement in wheat cultivation, resulting in the highest grain yield, straw yield, and B:C ratio. Metribuzin + 2,4-D also demonstrated strong efficacy in weed management and provided excellent economic returns. These herbicide combinations proved to be beneficial for both weed control and maximizing wheat yield, making them highly recommended for farmers aiming to improve productivity and profitability.

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