Effect of weed management practices on yield and economics of wheat (*Triticum aestivum* L.)

Commented [B.1]: Research article is very short. It should have a minimum of 4000-6000 words (including everything)

Abstract

A field experiment was conducted at the Instructional cum Research Farm, IGKV, Jagdalpur, Chhattisgarh, India, to evaluate the effect of different weed management practices on yield and economic returns of wheat during the *Rabi* season of 2020-21. The experiment, laid out in a Randomized Complete Block Design (RCBD) with four replications, included five treatments: hand hoeing at 30 days after sowing (DAS) (T_1), metribuzin application @ 175 g a.i. ha^{-1} at 20 DAS (T_2), one hand weeding at 20 DAS (T_3), two hand weeding at 20 and 40 DAS (T_4), and an absolute control (T_5). Results revealed that two hand weeding at 20 and 40 DAS registered highest grain yield (21.38 q ha^{-1}) and straw yield (45.63 q ha^{-1}), followed closely by metribuzin application (grain yield of 18.60 q ha^{-1} and straw yield of 43.26 q ha^{-1}). Economic analysis revealed that two hand weeding yielded highest gross returns (73,624 ₹ ha^{-1}) and net returns (53,768 ₹ ha^{-1}) but incurred a higher cost of cultivation (19,165 ₹ ha^{-1}) due to increased labor requirements. Metribuzin, though slightly less effective in terms of yield, provided a cost-effective alternative with a lower cost of cultivation (15,110 ₹ ha^{-1}) and a high net return (48,260 ₹ ha^{-1}), making it suitable for situations with labor scarcity. In conclusion, two hand weedings maximize yield and returns in labor-available areas, while metribuzin offers practically cost-effective alternative when labours are scarce.

Introduction

Commented [B.2]: Add latest references

Wheat (*Triticum aestivum* L.) is a staple crop of the world contributing as a food source for more than 40% of the world's population thus considering as principal cereal crop [1] playing a vital role in food security. In India, wheat is cultivated on 31.83 million hectares area and produced 113.29 million tonnes with average productivity of 35.59 q ha^{-1}. In Chhattisgarh, wheat occupies 0.134 million hectares with a production of 0.181 million tonnes and an average productivity of 13.5 q ha^{-1} [2]. The productivity of wheat is influenced by various factors, including soil fertility, water availability, and notably, weed competition. Across the world, research studies revealed that crop yield losses were greater than the combined effects of insect pests and diseases because of weed competition [3]. Weeds compete with wheat for essential resources such as water, nutrients, and light, often leading to significant reductions in yield by 37-50% (Waheed *et al.* 2009).

Effective weed management is crucial in wheat cultivation to minimize competition and optimize resource use efficiency. Several weed control strategies including mechanical, chemical, and manual methods are widely employed to reduce the negative impact of weeds on wheat production. Among these hand weeding, herbicide application, and hoeing are commonly practiced due to their efficacy in maintaining weed-free conditions during critical growth stages. Beyond yield impacts, weeds increase production costs due to the need for manual or chemical weed control, further affecting the economic returns from wheat farming. Without effective weed management practices, these factors together threaten both yield stability and farm profitability. Among different weed management practices, chemical control of weeds is preferred due to less labor requirement and economic losses due to mechanical damage to the wheat crops during the manual weeding process (Shivran *et al.*, 2020). Considering all the above facts, an attempt was made to determine the efficacy of different weed management practices, including mechanical control (hand weeding) and application of herbicides against complex weed flora, to improve wheat productivity and profitability.

Materials and methods

A field experiment was carried out during *rabi* 2020-21 at Instructional cum Research Farm, S.G. College of Agriculture and Research Station, IGKV, Kumhrawand, Jagdalpur, Chhattisgarh, India. Geographically lies at 19°5'17.79"N latitude and 81°57'44.99"E longitude with an altitude of 552 meters above mean sea level**.** The average annual rainfall and temperature of the area were recorded about 1665.4 mm and 24.6^{0}C, respectively during 2020-21. The soil at experimental site was sandy loam, characterized by low in available N (139.08 kg ha^{-1}), medium in available P (7.82 kg ha^{-1}), high in available K (359.92 kg ha^{-1}), low pH (6.7), EC (0.18 dS m^{-1}) and medium organic carbon (0.52%). Test variety GW- 273 was sown at spacing of 20cm × 5cm on 3rd December, 2020. Recommended dose of fertilizers (80:60:40 kg NPK ha^{-1}) were applied in the field. Basal application of fertilizers with 100% recommended dose of phosphorus and potassium, 50% nitrogen during sowing the seeds and remaining 50% nitrogen at 30 DAS. Experiment was laid out in RCBD (Randomize Complete Block Design) with four replications. The treatment comprised of five

Commented [B.3]: *Rabi*

weed management practices *viz*., one hand hoeing at 30 DAS (T_1), metribuzin @ 175 g a.i. ha^{-1} at 20 DAS (T_2), two hand weeding at 20 and 40 DAS (T_4), Absolute control (T_5).

Harvesting was done when the crop turned to golden yellow colour. The plants within the net plot area were manually harvested to the ground level, then dried, threshed, and winnowed to separate the grains from the straw. These separated grains were then subjected to sun drying until they reached to a moisture content of 14%. Finally, the dried grains were weighed to determine the grain yield, which is expressed in quintals per hectare (q ha^{-1}). Straw yield was calculated from the remaining biomass after grain separation and recorded as q ha^{-1}. The cost of cultivation (COC) included all the expenses for field preparation, seed sowing, fertilizer application, irrigation, weed management, and harvesting. Gross returns (GR) were calculated by multiplying the grain and straw yields with the prevailing market prices of wheat grain. Net returns (NR) were derived by subtracting the total cost of cultivation from the gross returns. The COC, GR and NR were expressed in Rs per hectare.

Net returns (Rs ha^{-1}) = Gross returns (Rs ha^{-1}) – Cost of cultivation (Rs ha^{-1}).

Results and discussion

Commented [B.4]: The results and discussion part can be described as separate, if appropriate.

Yield

The data related to yield consists of grain and straw yield was presented in Table 1. Statistically highest grain yield was recorded with two hand weeding at 20 and 40 DAS (21.38 q ha^{-1}) over all weed management practices but found statistically comparable with metribuzin @ 175 g a.i. ha^{-1} at 20 DAS (18.60 q ha^{-1}). Hand hoeing at 30 DAS (15.36 q ha^{-1}) and hand weeding once at 20 DAS (15.16 q ha^{-1}) were found statically similar with each other. Lowest grain yield was recorded with control plot (10.79 q ha^{-1}). The yield attributing characters provided better opportunity for higher yields. The minimum grain yield was recorded by control plot which was increased upto 49.53% under two hand weeding showed remarkable increase in grain yield might be due to two weedings at critical period of crop-weed competition. These findings were similar to Kulsoom and Khan (2015). Similar trend was followed by straw yield also. Statistically highest straw yield was recorded with two hand weeding at 20 and 40 DAS (45.63 q ha^{-1}) over all weed management practices but found statistically comparable with metribuzin @ 175 g a.i. ha^{-1} at 20 DAS (43.26 q ha^{-1}). One hand weeding at 20 DAS (38.15 q ha^{-1}) and hand hoeing at 30 DAS (37.87 q ha^{-1}) were found statistically similar with each other. Lowest straw yield was recorded with absolute control plot (10.79 q ha^{-1}). Two hand weeding effectively removed weeds during critical growth stages thus reducing competition in between crop and weeds for essential resources *viz.*, water, nutrients and sunlight. Manual weeding allows precise weed removal without causing crop injury or leaving residual effects, which can sometimes occur with chemical treatments. This level of precision ensures that weeds are consistently suppressed throughout the season, maintaining favorable conditions for crop growth and development. This encourages wheat crop to utilize resources efficiently, promoting healthy crop growth and accumulation of biomass further leading to higher grain and straw yield. Similar outcomes were obtained from the research work of Kumar *et al*. (2013).

Table 1. Effect of weed management practices on grain and straw yield of wheat

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1: Hand hoeing at 30 DAS	15.36	37.87
T_2: Metribuzin @ 175 g a.i. ha^{-1}	18.60	43.26
T_3: One hand weeding (20 DAS)	15.16	38.15
T_4: Two hand weeding (20 and 40 DAS)	21.38	45.63
T_5: Control (Absolute control)	10.79	25.63
SEm±	1.09	2.33
CD (P=0.05)	3.11	5.90

4.4 Economics

The economical analysis was completed on the basis of prevailing market price of wheat including cost of cultivation, gross return and net return which were depicted in Table 2.

Cost of cultivation

Among all the weed management practices, two hand weeding at 20 and 40 DAS recorded significantly higher cost of cultivation (19165 ₹ ha^{-1}) over rest of treatments but statistically similar with one hand weeding at 20 DAS (17105 ₹ ha^{-1}). Two hand weeding has elicited by higher cost of cultivation as compared to other methods of weed control due to high requirement of human labour and their huge wages. Moreover, the labour inputs were offset with higher yields of wheat also compensated the gap of inputs as compared to other treatments that is a reason many farmers still adopted the hand weeding. This cost was reduced with application of metribuzin @ 175 g *a.i.* ha^{-1} at 20 DAS as post-emergence in controlling weeds effectively with minimizing human labours. These findings are in close vicinity with those reported by Sardana et al. (2006), Kalhapure et al. (2013) and Yadav et al. (2014). Whereas, the minimum cost of cultivation was analyzed under control plot (14997 ₹

ha^{-1}), Gopinath *et al*. (2007), Rahaman *et al*. (2009) and Safdar *et al*. (2011) found the higher returns with application of metribuzin.

Gross returns

Among all the weed management practices, two hand weeding at 20 and 40 DAS (73624 ₹ ha^{-1}**)** registered significantly highest gross monetary returns over rest of the treatments but being on par with metribuzin @ 175 g *a.i.* ha^{-1} at 20 DAS (63798 ₹ ha^{-1}) and one hand weeding at 20 DAS (60592 ₹ ha^{-1}). The higher weed control efficiency of two hand weeding contributed to increased grain and straw yields, resulting in higher gross returns. The lowest gross returns observed in control plot was due to the uncontrolled growth of weeds, which resulted in lowest yield associated with it. Similar results were found by Ramesh (2013).

Table 2. Effect of weed management practices on economics of wheat

Treatment	Cost of Cultivation (₹ ha^{-1})	Gross Monetary Returns (₹ ha^{-1})	Net Monetary Returns (₹ ha^{-1})
T_1: Hand hoeing at 30 DAS	16738	57949	41022
T_2: Metribuzin @ 175 g *a.i.* ha^{-1} at 20 DAS	15110	63798	48260
T_3: One hand weeding (20 DAS)	17105	60592	42870
T_4: Two hand weeding (20 and 40 DAS)	19165	73624	53768
T_5: Control (Absolute control)	14997	38710	21190
SEm±	710	4494	3758
CD (P=0.05)	2103	13303	11124

Commented [B.5]: Add B:C

Commented [B.6]: Cost of cultivation is very low for wheat per ha

Commented [B.7]: How only ₹113 more over control for both metribuzin cost per ha as well as labour cost for spray per ha. Check data

Net Returns

Among all the weed management practices, two hand weeding at 20 and 40 DAS recorded significantly highest net monetary return (53768 ₹ ha^{-1}) over rest of the treatments but being on par with metribuzin @ 175 g *a.i.* ha^{-1} at 20 DAS (48260 ₹ ha^{-1}) and one hand weeding at 20 DAS (42870 ₹ ha^{-1}). The higher net monetary return was due to higher grain and straw yield of wheat. Similar finding is announced by Saquib *et al.* (2014). Among all the weed management practices, plot without weed control (control) had lowest net monetary return (21190 ₹ ha^{-1}) as suggested by Shakya *et al*. (2017) in tuning of higher grain and straw yields.

Conclusion

Based on the results of experimentation, it can be concluded that all weed control practices proved effective in controlling the weeds and gave significantly higher grain yield over control plot. However, two hand weedings were associated with highest economic yields, suggesting that for farmers with access to labor, this method may be beneficial despite the higher cost of cultivation. Metribuzin application is a cost-effective alternative to labor-intensive two-hand weeding, as it can be applied at critical growth stages when labor is scarce, ensuring timely and effective weed control.

References

1. Acevedo, M., Zurn, J.D., Molero, G., Singh, P., He, X., Aoun, M., Juliana, P., Bockleman, H., Bonman, M., El-Sohl, M., & Amri, A. (2018). The role of wheat in global food security. In *Agricultural development and sustainable intensification*, pp. 81-110. Routledge.
2. Anonymous,Indiastat. https://www.indiastat.com/Home/DataSearch?Keyword=Selected%20Statewise%20Area,%20Production%20and%20Productivity%20of%20Wheat%20in%20India%20(2023-2024)
3. Amare, T., Sharma, J.J., & Zewdie, K. (2014). Effect of weed control methods on weeds and wheat (*Triticum aestivum* L.) yield. *World journal of Agricultural Research*, 1(2), 124-128.
4. Waheed AR, Qureshi GS, Jakhar and Tareen H. (2009) Weed community A dynmics in wheat crop of district Rahim Yar khan, Pakistan. *Pakistan Journal of Botany*, 41(1): 247-254.
5. Shivran, A. C., Rita, S., Choudhary, J., & Bamboriya, J. S. (2020). Effect of different herbicides on growth and yield of wheat (*Triticum aestivum* L.). *International Journal of Current Microbiology and Applied Sciences*, 9(4), 438–448. https://doi.org/10.20546/ijcmas.2020.904.053
6. Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for Agricultural Research. A *Willey*.
7. Kulsoom, U.E. and Khan, M.A. 2015. Prediction of grain yield losses in wheat (*Triticum aestivum* L.) under different densities of wild oat (*Avena fatua* L.). *Pakistan Journal of Botany*, 47(SI): 239-242.
8. Kumar, S., Rana, S.S., Ramesh. and Chander, N. 2013. Herbicide combinations for broad-spectrum weed control in wheat. *Indian Journal of Weed Science*, 45(1): 29-33.
9. Sardana V, Singh S and Sheoran P. 2006. Efficacy and economics of weed management practices in blackgram (Vigna mungo L.) under rainfed conditions. *Indian Journal of Weed Science*, 38 (1&2): 77-80.
10. Kalhapure AH, Shete BT and Bodake PS. 2013. Integration of chemical and cultural methods for weed management in groundnut. *Indian Journal of Weed Science*, 45(2): 116– 119.
11. Yadav RS, Singh SP, Sharma Vikas and Bairwa RC. 2014. Herbicidal weed control in green gram in Arid zone of Rajasthan, p. 97. In: Proceedings of Biennial conference of Indian society of weed science on "Emerging challenges in weed management". *Directorate of Weed Research*, Jabalpur.

12. Gopinath, K.A., Kumar, N., Pande, H. and Bisht, J.K. 2007. Bio-efficacy of herbicides in wheat under zero and conventional tillage systems. *Indian Journal of Weed Science*, 39(3&4): 201-204.
13. Safdar, M.E., Asif, M., Ali, A., Aziz, A., Yasin, M., Aziz, M., Afzal, M. and Ali, A. 2011. Comparative efficacy of different weed management strategies in wheat. *Chilean Journal of Agricultural Research*, 71(2): 194-204.
14. Rahman, S. and Mukherjee, P.K. 2009. Effect of herbicide on weed-crop association in wheat. *Journal of Crop and Weed*, 5(2): 113-116.
15. Ramesh, N. 2013. Studies on weed control efficacy of metribuzin 70% WP in wheat (*Triticum aestivum* L.). *International Journal of Modern Research and Reviews*, 1(1): 62-65.
16. Saquib, M., Bhilare, R.L., Singh, R., Ansari, M.H., Singh, M.P. and Kumar, A. 2014. Weed management in wheat (*Triticum aestivum* L.). *Plant Archives*, 14(1): 77-79.
17. Shakya, N. and Dixit, J.P. 2017. Studies on weed management practices in wheat (*Triticum aestivum* L.). Plant archives, 17(2): 1543-1548.

Commented [B.8]: Italics