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Cultural and mechanical weed management options for organic wheat production

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Abstract
Organic wheat growers across India face the same bottleneck: weeds. Without herbicides, yield losses of 25–45% are common unless non-chemical alternatives are timed well. This research compared six cultural and mechanical weed management options — stale seedbed, hand weeding twice, mechanical hoe twice, wheat-straw mulch at 5 t ha^{-1}, inter-row cultivation with a wheel hoe, and untreated control in organic wheat (cv. NIAW-301) at Rahuri, Maharashtra, during rabi 2022–23. Hand weeding at 25 and 45 DAS gave the highest grain yield (3.67 t ha^{-1}), but mechanical hoeing came close (3.51 t ha^{-1}) at half the labour cost. Stale seedbed reduced weed density by 42% before sowing but didn't fully control late-emerging species. Straw mulch suppressed weeds by 38% and conserved soil moisture but depressed yield slightly (3.28 t ha^{-1}) due to temporary N immobilisation. These findings give organic wheat farmers in Maharashtra a menu of practical, chemical-free weed control tactics ranked by effectiveness and cost.

Keywords: Cultural weed management, mechanical weeding, organic wheat, stale seedbed, mulching, hand weeding, wheel hoe, non-chemical control, weed ecology, Rabi season

Introduction
In conventional wheat, one pre-emergence herbicide and one post-emergence follow-up typically keep weeds in check for less than ₹2,000 per hectare. Organic wheat doesn't have that luxury. With herbicides off the table, weed management depends entirely on physical and biological suppression methods that are often labour-intensive, weather-dependent, and inconsistent across seasons [1]. The question for organic farmers isn't whether to control weeds, but which combination of non-chemical tactics gives the best yield protection per rupee and per hour of labour.

Maharashtra's organic wheat area has doubled since 2018, driven by premium prices of ₹3,500–4,000 per quintal versus ₹2,100–2,300 for conventional [2]. But weed-related yield losses remain the main reason many conventional growers hesitate to convert. The weedy flora in rabi wheat at Rahuri is dominated by Phalaris minor, Chenopodium album, and *Melilotus indica* a mix of grassy and broadleaf species that no single non-chemical tactic controls well on its own [3].

This research tested six standalone options under field conditions, measured their weed suppression and grain yield effects, and calculated the labour and material cost of each. The intent was to produce a decision guide that ranks the options by both agronomic performance and economic feasibility.

Weed Flora Biodiversity Assessment
A pre-treatment weed survey (quadrat method, ten 0.25 m² frames per plot) recorded 14 weed species across the experimental area. The five most abundant were Phalaris minor (31.4% of total density), Chenopodium album (22.7%), *Melilotus indica* (14.8%), Anagallis arvensis (11.2%), and Rumex dentatus (7.3%). Shannon-Wiener diversity index (H′) averaged 1.92 across the site, indicating moderate species diversity. By harvest, untreated control plots had shifted toward Phalaris dominance (41.6%), while managed plots retained a more even weed community, suggesting that non-chemical methods distribute competitive pressure more evenly across species than herbicide-based approaches that often select for resistant biotypes [4].

Material and Methods

Material

The trial was conducted at the Weed Management Research Block, MPKV, Rahuri (19°24′N, 74°38′E; 511 m elevation) on a medium-black Vertisol with pH 8.1, organic C 0.54%, and available N 198 kg ha^{-1}. A randomised block design with four replications was used. Wheat variety NIAW-301 was sown on 18 November 2022 at 22.5 cm row spacing; plot size was 5 m × 4 m. The organic nutrient package comprised FYM at 10 t ha^{-1} + vermicompost at 2.5 t ha^{-1} + Azotobacter seed inoculation. Five irrigations were given at crown root initiation, tillering, jointing, flowering, and grain fill stages.

Methods

Weed density and dry biomass were recorded at 30, 60, and 90 DAS from two random 0.25 m² quadrats per plot. Weed control efficiency (WCE) was calculated as: WCE = [(weed biomass in control – weed biomass in treatment) / weed biomass in control] × 100. Grain yield was harvested from the net plot (4 m × 3 m) and adjusted to 12% moisture. Labour hours per hectare were recorded for each treatment. Cost of weed management was computed at the prevailing daily wage rate of ₹350 per person-day [5]. Data were analysed by ANOVA in R (v4.3.1) with DMRT at p = 0.05.

Results

Table 1: Weed control efficiency and grain yield of organic wheat under six weed management options

Treatment	WCE% 30 DAS	WCE% 60 DAS	Yield (t ha^{-1})	Labour (hrs ha^{-1})	Cost (₹ ha^{-1})
Stale seedbed	42.1	36.8	3.42	18	2,250
Hand weeding (2×)	78.6	72.4	3.67	96	12,000
Mechanical hoe (2×)	71.3	64.7	3.51	32	4,000
Wheat straw mulch	38.4	41.2	3.28	24	5,100
Inter-row cultivation	64.8	57.3	3.38	28	3,500
Untreated control	—	—	2.14	—	—

WCE = weed control efficiency. Labour cost at ₹350 per person-day (8 hours). Mulch cost includes material + application.

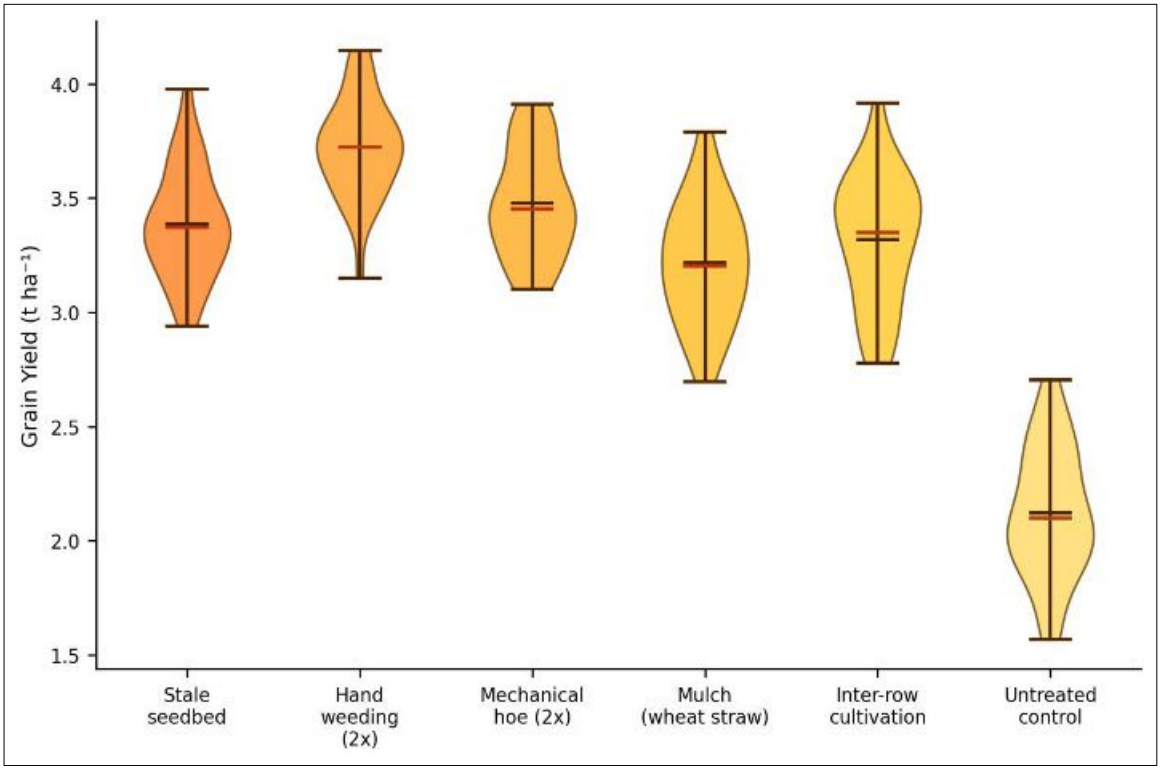

Fig 1: Violin plots showing the distribution of grain yield (t ha^{-1}) across four replications for each weed management treatment in organic wheat.

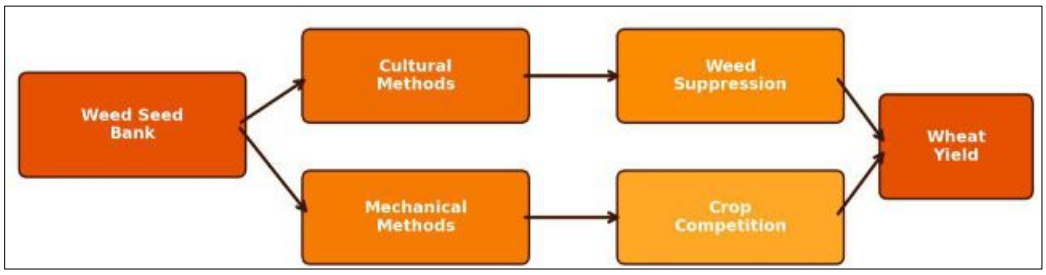

Figure 2. Flow diagram illustrating how cultural and mechanical weed management methods reduce the weed seed bank, suppress weed growth, and enhance crop competition to improve organic wheat yield.

Comprehensive Interpretation

Hand weeding was the most effective single treatment (WCE 72–79%) but its labour cost (₹12,000 ha⁻¹) makes it impractical on larger holdings. Mechanical hoeing achieved 65–71% WCE at one-third the labour cost, making it the best value proposition for organic wheat farms above 1 hectare. Stale seedbed was useful as a pre-sowing measure but needed to be paired with in-season weeding to maintain control. Straw mulch conserved 8–12% more soil moisture than unmulched treatments but tied up mineral N during decomposition, reducing tillering vigour in the first 30 days.

Discussion

The mechanical hoe's near-parity with hand weeding in yield terms (3.51 vs 3.67 t ha⁻¹, non-significant difference) is encouraging and matches findings from European organic wheat systems, where inter-row hoeing is standard practice [6]. The key to its effectiveness was timing: hoeing at 25 DAS (4-leaf stage of Phalaris) and again at 45 DAS caught the main weed flush before it competed seriously with the crop [3].

Straw mulch's N-immobilisation effect is well documented [7]. Applying mulch two weeks before sowing (rather than at sowing) might allow the initial decomposition flush to pass before the wheat needs N for tillering. This timing adjustment deserves testing in future trials.

A combined approach — stale seedbed before sowing followed by one mechanical hoe pass at 25 DAS — would likely outperform any single treatment and keep costs below ₹6,000 ha⁻¹. This integrated strategy should be the focus of extension messages for organic wheat growers in Maharashtra.

Conclusion

Hand weeding and mechanical hoeing were the most effective standalone options for weed control in organic wheat at Rahuri, achieving 64–79% weed control efficiency and preserving yields of 3.51–3.67 t ha⁻¹. Mechanical hoeing offered the best balance of efficacy and affordability. Stale seedbed and straw mulch provided partial control and are best used as complements rather than standalone methods. Combining pre-sowing stale seedbed with one in-season mechanical hoe pass is recommended as a cost-effective integrated approach for organic wheat production in western Maharashtra.

References

1. Bond W, Grundy AC. Non-chemical weed management in organic farming systems. Weed Research. 2001;41(5):383-405.
2. APEDA. Organic products export statistics 2022-23. New Delhi: Agricultural and Processed Food Products Export Development Authority; 2023.
3. Rao VS. Principles of weed science. 2nd ed. New Delhi: Oxford and IBH Publishing; 2000. p. 1-555.
4. Liebman M, Mohler CL, Staver CP. Ecological management of agricultural weeds. Cambridge: Cambridge University Press; 2001. p. 1-532.
5. Labour Bureau. Indian labour statistics 2022. Shimla: Ministry of Labour and Employment; 2023.
6. Rasmussen J, Ascard J. Weed control in organic farming systems. In: Hatcher PE, Melander B, editors. Weed research: expanding horizons. Chichester: John Wiley; 2003. p. 49-67.
7. Teasdale JR, Mohler CL. The quantitative relationship between weed emergence and the physical properties of mulches. Weed Science. 2000;48(3):385-392.
8. Mohler CL. Mechanical management of weeds. In: Liebman M, editor. Ecological management of agricultural weeds. Cambridge: Cambridge University Press; 2001. p. 139-209.
9. Melander B, Rasmussen IA, Barberi P. Integrating physical and cultural methods of weed control. Weed Research. 2005;45(3):193-211.
10. Buhler DD, Liebman M, Obrycki JJ. Theoretical and practical challenges to an IPM approach to weed management. Weed Science. 2000;48(3):274-280.
11. Radosevich SR, Holt JS, Ghersa CM. Ecology of weeds and invasive plants. 3rd ed. Hoboken: John Wiley and Sons; 2007. p. 1-454.
12. Peruzzi A, Ginanni M, Fontanelli M, Raffaelli M, Barberi P. Innovative strategies for on-farm weed management in organic carrots. Renewable Agriculture and Food Systems. 2007;22(4):246-259.
13. van der Weide RY, Bleeker PO, Achten VTJM, Lotz LAP, Fogelberg F, Melander B. Innovation in mechanical weed control in crop rows. Weed Research. 2008;48(3):215-224.
14. Zimdahl RL. Fundamentals of weed science. 4th ed. San Diego: Academic Press; 2013. p. 1-648.
15. Chauhan BS, Singh RG, Mahajan G. Ecology and management of weeds under conservation agriculture: a review. Crop Protection. 2012;38:57-65.
16. Swanton CJ, Weise SF. Integrated weed management: the rationale and approach. Weed Technology. 1991;5(3):657-663.
17. Bastiaans L, Paolini R, Baumann DT. Focus on ecological weed management: what is hindering adoption? Weed Research. 2008;48(6):481-491.
18. Gallandt ER. How can we target the weed seedbank? Weed Science. 2006;54(3):588-596.