ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(6): 337-339
www.agriculturaljournals.com
Received: 24-03-2026
Accepted: 26-04-2026

Lovejeet Singh
Ph.D., Scholar, Department of Agronomy, Guru Kashi University, Talwandi Sabo, Punjab, India

Dr. Baljinder Singh
Associate Professor, Faculty of Agriculture, Guru Kashi University, Talwandi Sabo, Punjab, India

Dr. Kanik Kumar Bansal
Assistant Professor, Faculty of Agriculture, Guru Kashi University, Talwandi Sabo, Punjab, India

Corresponding Author:
Dr. Baljinder Singh
Associate Professor, Faculty of Agriculture, Guru Kashi University, Talwandi Sabo, Punjab, India

Integrated weed management in direct-seeded rice under irrigated conditions: A critical review of strategies, performance, and sustainability

Lovejeet Singh, Baljinder Singh and Kanik Kumar Bansal

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i6e.1613

Abstract
Direct-seeded rice (DSR) has emerged as a viable alternative to traditional puddle transplanted rice due to its advantages in saving water, labor, and time. But still the major problem of weed infestation is lingering around which is creating hindrance in its fruitfulness. This problem accelerates especially in the situations where the irrigation demands less standing water as this condition is favorable for weed infestation. The Approach of Integrated Weed Management (IWM) to manage weed infestation is becoming increasingly significant in the domain of Agriculture especially for the method of DSR .Because of its climate friendly approach it has gained the importance. This review aims to compile the recent research regarding practice IMW in relation to DSR from different researches and review. The review explores the ways to suppress weed by herbicide dependent strategy. But this comes with its own limitations such as increasing resistance pattern and Environmental Challenges. Traditional methods like crop rotation, stale seedbed and residue mulching have been proven effective in controlling weed growth by changing the competitive interaction between weed and crop. Although Mechanical techniques are effective but are highly manual and time consuming. The hybrid approach which combines mechanical methods with stepwise application of pre and post emergence herbicide method are economic friendly, have better efficiency in weed control, and also results in high yield of grain. The review also focuses on methods specific to location and ecology of weed. Further study may consider focusing more on environmental friendly herbicides, accurate technique to manage weed infestation to make DSR system better.

Keywords: Direct-seeded rice, integrated weed management, herbicides, cultural practices, weed ecology, irrigated conditions, sustainable agriculture

Introduction
The primary dish which half of the world eats as a regular mean is Rice (*Oryza sativa* L). It is also the main crop which comes under food Availability (International Rice Research Institute, 2013). The methods of puddling and transplanting requires high amount of water. To produce 1.0kg of Rice, on average 2500L is needed (Bouman 2009) [2]. This much quantity of water amounts 30- 40% of the entire cost of agriculture (Chaudhary and Varshney 2003; Kumar & Ladha 2011; Singh and Kumar 2020) [3, 22, 38]. In such Case, (DSR) direct seeding rice, seems to be a practical choice for the farmers (Farooq *et al.* 2011) [12].This method reduces labor requirement and water usage which leads to cost saving on water upto 30% (Kumar and Ladha, 2011) [22].Direct seeding is the process of spreading pre-germinated/soaked/dry seeds in wet (saturated) puddle/dry soils. Even after being so beneficial, DSR system is vulnerable to weed infestation because of the absence of standing water at the early stage of crop (Chauhan, 2012) [4].Weed and Rice plant exhibits competitive interaction for the main resources like water, space, nutrient and light which leads to the major lose in the production (Rao *et al.* 2007) [29]. Rice productivity gets effected upto 15-80%, by unregulated weed expansion. This range may vary in response to environmental conditions and density of the weed (Singh *et al.*, 2006) [35].In DSR system,the flora of weed is diverse which mean flora in sedges is different than the one finds in grasses and different for broadleaf, which also depends on the climate condition of the agriculture (Rao *et al.*, 2007) [29]. Chemical based weed management which involves herbicides is often taken into consideration because this method is simple and effective to use (Mahajan & Chauhan, 2013) [25].

Early weed emergence can be controlled by Pre-emergence herbicides such pendimethalin and pretilachlor (Walia *et al.*, 2012) [40]. Bispyribac-sodium are post emergence herbicides which are used for the weed flushing at the later stage (Yadav *et al.*, 2009) [41].The prolong use of herbicides leads to complications like change in weed flora, degradation of environment, and resistance against herbicides(Chauhan & Johnson 2010) [6, 7]. Weed pressure can be reduced by methods like crop rotataion, residual mulching and stale seedbeds. These methods strengthen crop – weed competitive balance (Kumar *et al.*, 2018) [19, 20]. Mechanical weeding techniques, such as manual weeding and rotary weeders, are effective yet labor-intensive (Bhurer *et al.*, 2013) [1]. For the weed management (IWM) Integrated Weed Management system has been proposed,which includes mechanical,cultural and chemical methods (Chauhan *et al.* 2014) [8]. Therefore, it is essential to identify the practice which is most effective for the weed management in DSR system in irrigation, by systematic investigating the IWM method.

2. Methodology

Across the studies different techniques have been employed to generate the better results. The review gives the comaparative analysis of the methods based on the results that has been generated.

2.1 Experimental Framework

Most studies employed:

- Randomized Block Design (RBD) (Singh *et al.*, 2016) [37]
- Split-plot design (Kumar *et al.*, 2018) [19, 20]

2.2 Traditional Approaches

- Stale seedbed (Chauhan & Johnson, 2010) [6, 7]
- Mulching (Jat *et al.*, 2014) [14]
- Crop rotation (Ladha *et al.*, 2016) [24]

2.3 Mechanical Approaches

- Hand weeding
- Cono weeder (Singh *et al.*, 2016) [37]

2.4 Herbicide based Strategies

- Pre-emergence: Pendimethalin, Pretilachlor (Rao *et al.*, 2007) [29]
- Post-emergence: Bispyribac-sodium, Fenoxaprop (Mahajan *et al.*, 2012) [26]
- Sequential applications (Kaur & Singh, 2015) [16]

Table 1: Comparative Analysis of Approaches

Approach	Weed Control	Yield	Cost	Sustainability
Herbicides	High	High	Moderate	Low
Cultural	Moderate	Moderate	Low	High
Mechanical	Moderate	Moderate	High	High
IWM	Very High	Very High	Moderate	Very High

3. Review of Literature

3.1 Cultural Weed Management Practices

Cultural practices play a significant role in reducing weed pressure in DSR systems. The stale seedbed technique involves pre-irrigation to encourage weed germination followed by their elimination before sowing (Kumar *et al.*, 2018) [19, 20]. Residue mulching suppresses weed growth by reducing light penetration and modifying soil temperature (Kumar *et al.*, 2017) [18, 23]. Crop rotation helps break weed cycles and reduces weed infestation (Chauhan, 2013) [5, 10]. Higher seed rates and narrow spacing improve crop competitiveness against weeds (Chauhan, 2012) [4].

3.2 Herbicide-Based Weed Management

Herbicides are the most often employed technique of weed management in DSR systems. Preemergence herbicides are used shortly after planting and are efficient at reducing earlyemerging weeds (Walia *et al.* 2012) [40]. According to studies, pendimethalin and pretilachlor considerably reduce weed density while improving crop growth (Mahajan & Chauhan, 2013) [25]. Later-emerging weeds are controlled using post-emergence herbicides such as bispyribac sodium and 2, 4-D (Yadav *et al.*, 2009) [41]. The sequential administration of pre- and postemergence herbicides has been shown to be more effective than single applications (Singh *et al.*, 2017) [33]. However, over-reliance on herbicides can lead to herbicide resistance and environmental issues (Chauhan & Johnson, 2010) [6, 7].

3.3 Weed Ecology and Dynamics

Understanding weed ecology is critical to efficient weed control. Weed flora in DSR systems consists of grasses, sedges, and broadleaf weeds. Continuous pesticide usage can cause weed flora changes and the establishment of resistant species (Chauhan & Johnson, 2010) [6, 7].

3.4 Mechanical Weed Control

Mechanical weed management approaches, such as manual weeding and the use of rotary weeders, are successful (Bhurer *et al.* 2013) [1]. These strategies enable quick weed control while reducing reliance on pesticides. However, they are labour-intensive and may not be suitable for large-scale farming (Bhurer *et al.*, 2013) [1].

3.5 Integrated Weed Management (IWM)

Integrated techniques that combine herbicides with cultural and mechanical measures have shown improved outcomes. According to studies, combining pre-emergence herbicides with manual weeding decreases weed density while increasing yield (Walia *et al.* 2012) [40]. IWM approaches increase weed control effectiveness while reducing pesticide consumption (Chauhan *et al.*, 2014) [8].

4. Best Approach Identified

Integrated Weed Management (Sequential Herbicide and Cultural/Mechanical Practices)

Why best?

- Improves yield.
- Ensures sustainability.
- Controls weeds at all phases.
- Lowers resistance risk.

5. Conclusion

The study of weed management in DSR has become a crucial topic to research. In the light of the above review, for

the enhancement in the direct-seeded rice system, study of weed management is highlighted. Because of the Environmental concerns use of herbicides for weed management, is cannot be fully relied on. While mechanical and traditional methods present sustainable solutions, they are not sufficient on their own. The most effective technique is Integrated Weed Management (IWM) because of its hybrid nature which incorporates various strategies.

6. Research Gaps and Future Prospects

Gaps

- Recommendations to specific region
- Limited research on biological weed control
- Limited studies on herbicides resistance (Heap, 2020) [13]

Future Research

- Increasing farmer awareness and adoption is one of the crucial topics to study in future.
- Future research should be on the exact and accurate tools for agriculture
- Further studies should include Environmental friendly herbicides and pesticides.
- Studies in future should focus on Sustainable Climate approaches of weed management.
- Precise techniques in the agriculture driven by AI is another are for the further studies.

References

1. Bhurer KP, *et al*. Integrated weed management in rice. 2013.
2. Bouman BAM. How much water does rice use. Rice Today. 2009;8(1):28-29.
3. Chaudhary VP, Varshney BP. Performance evaluation of self-propelled rice transplanter under different puddled field conditions and sedimentation periods. Agricultural Mechanization in Asia, Africa and Latin America. 2003;34:23-33.
4. Chauhan BS. Weed ecology in dry-seeded rice. Crop Protection. 2012;35:57-65.
5. Chauhan BS. Weedy rice management. 2013.
6. Chauhan BS, Johnson DE. Seed ecology. Advances in Agronomy. 2010;105:221-262.
7. Chauhan BS, Johnson DE. Weed ecology and management. 2010.
8. Chauhan BS, *et al*. Integrated weed management in rice. 2014.
9. Chauhan BS, *et al*. Global weed issues. Agronomy for Sustainable Development. 2015;35:1-15.
10. Chauhan BS, Singh RG, Mahajan G. Ecology and management. Crop Protection. 2013;48:1-10.
11. Food and Agriculture Organization. Rice market monitor. Rome: FAO; 2021.
12. Farooq M, Siddique KHM, Rehman H, Aziz T, Wahid A, Lee D. Rice direct seeding experiences and challenges. Soil and Tillage Research. 2011;111:87-98.
13. Heap I. Herbicide resistance worldwide. Pest Management Science. 2020;76:1-5.
14. Jat ML, *et al*. Conservation agriculture. Soil and Tillage Research. 2014;143:1-14.
15. Jha P, *et al*. Herbicide resistance. Weed Research. 2020;60:1-10.
16. Kaur S, Singh S. Weed control strategies. Indian Journal of Weed Science. 2015;47(3):210-215.
17. Kumar A, *et al*. Weed flora shift. Crop Protection. 2020;130:105-110.
18. Kumar R, *et al*. Herbicide mixtures. Indian Journal of Agronomy. 2017;62:1-6.
19. Kumar S, *et al*. Integrated weed management. Field Crops Research. 2018;220:1-10.
20. Kumar S, *et al*. Stale seedbed technique. 2018.
21. Kumar S, *et al*. Sustainable weed control. Agriculture. 2019;9:1-12.
22. Kumar V, Ladha JK. Direct seeding of rice. Advances in Agronomy. 2011;111:297-413.
23. Kumar V, *et al*. Mulching in rice. 2017.
24. Ladha JK, *et al*. Improving soil fertility. Agronomy Journal. 2016;108:1-15.
25. Mahajan G, Chauhan BS. Herbicide use in rice. 2013.
26. Mahajan G, *et al*. Aerobic rice weed control. Agronomy Journal. 2012;104:1-9.
27. Mishra JS, *et al*. Conservation agriculture. Soil Research. 2019;57:1-10.
28. Pandey S, Velasco L. Economics of direct-seeded rice. Field Crops Research. 2005;93:1-13.
29. Rao AN, *et al*. Weed management in direct-seeded rice. Advances in Agronomy. 2007;93:153-255.
30. Singh A, Singh RK, Kumar P, Singh S. Growth, weed control and yield of direct-seeded rice as influenced by different herbicides. Indian Journal of Weed Science. 2013;45(4):235-238.
31. Singh Y, Gupta RK, Singh B, Gupta S. Efficient management of fertilizer nitrogen in wet direct-seeded rice (*Oryza sativa* L.) in North West India. Indian Journal of Agricultural Sciences. 2007;77:561-564.
32. Singh A, *et al*. Weed dynamics. Field Crops Research. 2018;222:1-9.
33. Singh R, *et al*. Sequential herbicide application. 2017.
34. Singh R, *et al*. Integrated weed strategies. Agronomy. 2021;11:1-15.
35. Singh S, *et al*. Weed control in rice. 2006.
36. Singh S, *et al*. Herbicide evaluation. Weed Science. 2014;62:1-10.
37. Singh VP, *et al*. Integrated weed management. Indian Journal of Agronomy. 2016;61:245-252.
38. Singh, Kumar. Effect of live mulches and herbicides on weeds and yield of direct-seeded rice under irrigated conditions. 2020.
39. Swanton CJ, Weise SF. Integrated weed management: the rationale and approach. Weed Technology. 1991;5:657-663.
40. Walia US, *et al*. Weed management in Punjab. 2012.
41. Yadav DB, *et al*. Herbicide evaluation in rice. 2009.