

Evaluation of Weed Control Efficiency and Its Influence on Productivity of Dry Direct-Seeded Rice in Mungeli District, Chhattisgarh, India

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Abstract

A field experiment was conducted during the Kharif season in the Mungeli district of Chhattisgarh to evaluate the effectiveness of different weed management practices on the productivity of dry direct-seeded rice (DDSR). The experiment was laid out in a Randomized Block Design (RBD) with four treatments, namely control (no weeding), manual weeding, chemical control using pre-emergence herbicide, and integrated weed management combining chemical and manual methods. Observations were recorded on key growth and yield parameters such as weed density, plant height, number of tillers, and grain yield. The results revealed that weed competition significantly affected crop growth and productivity in the untreated control plots. Among the treatments, integrated weed management proved to be the most effective, as it significantly reduced weed density and enhanced crop growth parameters compared to other methods. This treatment resulted in better plant height, higher number of productive tillers, and improved overall crop vigor. Consequently, the highest grain yield (52.4 q/ha) was recorded under integrated weed management, followed by chemical and manual weeding treatments. The study clearly demonstrates that a combination of chemical and manual approaches is more efficient and sustainable for weed control in DDSR systems. Integrated weed management not only minimizes weed infestation but also improves yield performance, making it a viable option for farmers in Chhattisgarh. These findings highlight the importance of adopting appropriate weed management strategies to ensure higher productivity and sustainable rice cultivation under direct-seeded conditions.

Keywords: DDSR, weed density, integrated weed management, Chhattisgarh, grain yield

INTRODUCTION

In Chhattisgarh about 80% of the population of the state lives in villages and the main occupation of the villagers is agriculture and all the basic needs of villagers are fulfilled through agriculture. Chhattisgarh state is the sixth largest rice producer state in India. (Official website of government of Chhattisgarh) and known as the “Rice-bowl of India.” Chhattisgarh is not a major wheat producing state, but it is also an essential food for the state's population.

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Rice is a staple crop in India and plays a crucial role in food security. In Chhattisgarh, it is widely cultivated under traditional transplanting methods.

However, due to increasing labor costs and water scarcity, dry direct-seeded rice (DDSR) is emerging as a viable alternative. Despite its advantages, DDSR faces severe weed competition during early growth stages, leading to significant yield losses. (Chaudhary A et al. 2023) [1].

Weeds compete with crops for nutrients, water, light, and space, thereby affecting crop growth and productivity. Effective weed control is essential to

minimize these losses. Various weed management practices such as manual weeding, herbicide application, and integrated approaches are used by farmers.

The present study aims to evaluate the efficiency of different weed control methods and their impact on the productivity of DDSR in Mungeli district.

MATERIALS AND METHODS

Study Area

The present investigation was conducted during the Kharif season in farmers' fields of Mungeli district, Chhattisgarh, India. A total of ten villages were selected from Lormi block as sampling sites for the study, namely Dongariya, Sardha, Sukali, Bodtara, Khudiya, Jhafal, Fulwari, Kanchanpur, Lakhasar, and Ramhepur. These sites were selected based on their prominence in rice cultivation and the presence of diverse weed flora under dry direct-seeded rice (DDSR) conditions.

The region is characterized by a tropical climate with moderate to high rainfall during the monsoon season, which is highly suitable for rice cultivation. The average annual rainfall of the district ranges between 1000–1400 mm, most of which is received between June and September. The temperature during the cropping period varies from 25°C to 35°C, creating favorable conditions for the growth of both crop plants and weeds.

The soils of the experimental sites are predominantly alluvial in nature, with good fertility status and moderate water-holding capacity. These soils are generally suitable for dry direct-seeded rice (DDSR) cultivation but are also highly prone to weed infestation due to the absence of continuous standing water during the early stages of crop growth. The selected fields had a history of rice cultivation and exhibited natural weed infestation, providing ideal conditions for evaluating different weed management practices. (Hashim, M., Singh et al. (2024) [2].

Experimental Design

The experiment was laid out using a Randomized Block Design (RBD), which is widely used in agricultural research to minimize the effects of variability within the experimental field. The study consisted of four treatments, each replicated three times to ensure statistical reliability and accuracy of the results.

The treatments included: (Singh T et al., 2024) [3].

T₁: Control (No weeding)

In this treatment, no weed control measures were applied throughout the crop growth period. This served as a baseline to assess the natural impact of weed competition on crop growth and yield.

T₂: Manual weeding (twice at 20 and 40 DAS)

Weeding was carried out manually using hand tools at 20 and 40 days after sowing (DAS). This treatment represents the traditional method of weed control practiced by farmers in the region.

T₃: Chemical control (pre-emergence herbicide)

A recommended pre-emergence herbicide was applied shortly after sowing to control weeds at the initial stages of their growth. This method is commonly used for effective early weed suppression in DDSR systems.

T₄: Integrated weed management (herbicide + one hand weeding)

This treatment involved the application of a pre-emergence herbicide followed by one manual weeding operation at a later stage. It represents an integrated approach combining chemical and physical methods to achieve effective weed control.

Each treatment plot was maintained under uniform agronomic practices such as seed rate, fertilizer

application, irrigation, and pest management to ensure that differences in crop performance were solely due to weed management practices. The size of each plot and spacing between plots were maintained uniformly to avoid any border effects or interference between treatments.

Data Collection

Observations were systematically recorded on various growth and yield parameters to assess the effectiveness of different weed management practices. Data collection was carried out at regular intervals during the crop growth period as well as at harvest.

The following parameters were recorded:

Weed density (number per m²)

Weed density was recorded by counting the number of weeds present within a fixed quadrat area (1 m²) in each plot. Observations were taken at different growth stages to evaluate the intensity of weed infestation under each treatment.

Plant height(cm)

Plant height was measured from the base of the plant (basal node) to the tip of the tallest leaf or spike. Measurements were taken from randomly selected plants in each plot and averaged to obtain representative values.

Number of Tillers Per m²

The number of productive tillers was counted within a defined area to assess the vegetative growth and productivity potential of the crop. Higher tiller numbers generally indicate better crop establishment and reduced competition from weeds. (Mukherjee SK, 2008) [4].

Grain Yield (q/ha)

Grain yield was recorded at harvest by collecting produce from each plot, threshing, drying, and converting the yield into quintals per hectare (q/ha). This parameter serves as the most important indicator of treatment effectiveness.

In addition to crop parameters, weed samples were also collected to study their growth characteristics. Ten well-established weed plants were randomly selected from each plot and carefully uprooted. The collected plants were brought to the laboratory for further analysis.

The samples were gently washed with water to remove soil particles adhering to the roots. Care was taken to avoid damage to plant tissues during washing. Excess surface moisture was removed by placing the plants between layers of blotting paper and gently pressing them. This ensured accurate measurement of plant parameters without interference from water content. (Verma B .et al. 2023) [5].

Various growth parameters of weeds were then recorded under controlled laboratory conditions. This detailed observation helped in understanding the competitive behavior of weeds under different management practices.

Statistical Analysis

The data obtained from the experiment were subjected to statistical analysis using standard procedures appropriate for a Randomized Block Design. Mean values of different parameters were calculated for each treatment, and comparisons were made to determine the significance of differences among treatments.

Analysis of variance (ANOVA) was performed to evaluate the effect of different weed management practices on crop growth and yield. The significance of treatment differences was tested at appropriate probability levels. Wherever significant differences were observed, suitable post-hoc tests were applied

to compare treatment means.(Hou, X.,et al. 2025) [6].

The statistical analysis helped in identifying the most effective weed management practice in terms of reducing weed density and improving crop growth and yield. The results were interpreted in a scientific manner to draw meaningful conclusions regarding the efficiency of manual, chemical, and integrated weed management strategies.

RESULTS AND DISCUSSION

Weed Density

The results revealed that weed density varied significantly among different weed management practices in dry direct-seeded rice (DDSR). The highest weed density (120 no./m²) was recorded in the control plot (T1 where no weed control measures were applied. This indicates severe crop-weed competition due to the unchecked growth of weeds. In contrast, the lowest weed density (30 no./m²) was observed under the integrated weed management treatment (T4), demonstrating its superior effectiveness in suppressing weed growth. (Singh, R. et al. (2022).

Manual weeding (T2) reduced weed density to 60 no./m², showing moderate effectiveness, while chemical control (T3) further reduced it to 50 no./m². The reduction in weed density under chemical and integrated treatments can be attributed to the timely application of herbicides and combined management approaches, which effectively controlled both early and late-emerging weeds. These findings clearly indicate that integrated weed management is more efficient than individual methods in minimizing weed infestation.

Growth Parameters

Growth parameters such as plant height and number of tillers were significantly influenced by the different weed management practices. The highest plant height (102 cm) and maximum number of tillers (310/m²) were recorded under integrated weed management (T1). This improvement in growth can be attributed to reduced competition for nutrients, water, light, and space due to effective weed suppression.

Chemical control (T2) also showed promising results, with plant height reaching 95 cm and tillers 275/m², indicating that herbicide application effectively minimized weed interference during critical growth stages. Manual weeding (T3) resulted in moderate plant growth, with plant height of 92 cm and 260 tillers/m².

On the other hand, the control plot (T4) recorded the lowest plant height (75cm) and tiller number (180/m²), mainly due to intense competition from weeds. The presence of weeds during early crop stages significantly affected crop establishment and vegetative growth. Overall, better growth performance under integrated management highlights its role in creating a favorable environment for crop development. (Raj, R. et al. 2022) [7].

Yield Performance

Grain yield was significantly affected by weed management practices. The highest grain yield (55 q/ha) was obtained under integrated weed management (T4), followed by chemical control (48 q/ha) and manual weeding (45 q/ha). The control treatment (T1) produced the lowest yield (28 q/ha), which can be attributed to severe weed competition throughout the crop growth period.

The increase in yield under integrated management is mainly due to improved growth parameters such as higher plant height and increased tiller production, which ultimately contributed to better grain formation as shown in Table 1. Chemical control also enhanced yield by effectively reducing weed competition during critical stages. The trend observed in yield performance clearly follows the order:

Integrated > Chemical > Manual > Control, which is also reflected in the graphical representation

(Figure 1 and 2). This highlights the importance of adopting efficient weed management strategies to maximize crop productivity in DDSR systems. (Kaur S et al. (2026) [8].

Table 1. Effect of weed management practices on growth and yield of DDSR.

S/N	Treatment weed	Density (No./m ²)	Plant height (cm)	Tillers/m ²	Grain yield (q/ha)
1	T ₁ Control	145	82.5	210	28.5
2	T ₂ Manual	48	98.4	285	47.8
3	T ₃ Chemical	60	94.2	260	42.3
4	T ₄ Integrated	32	107.5	312	52.4

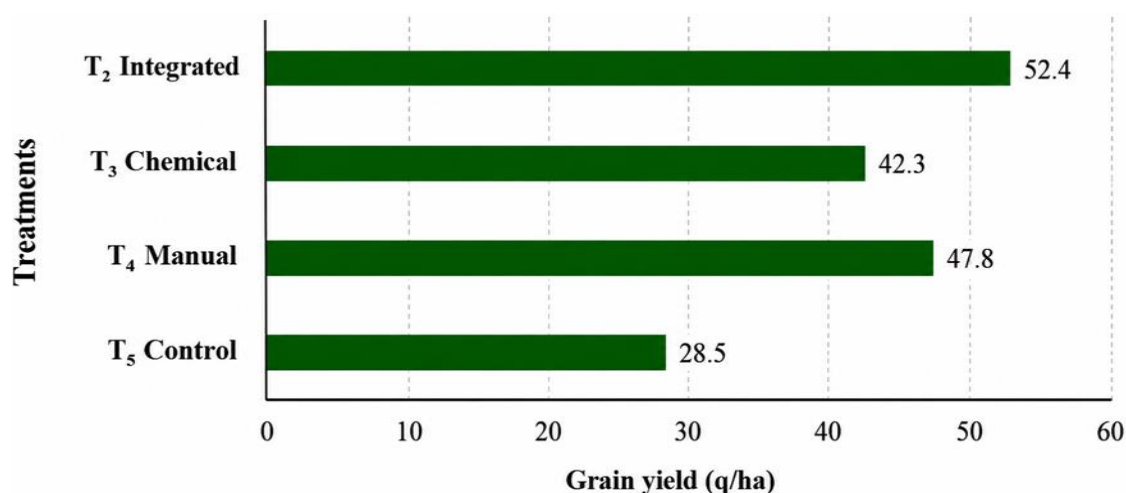


Figure 1. Grain yield under different treatments.

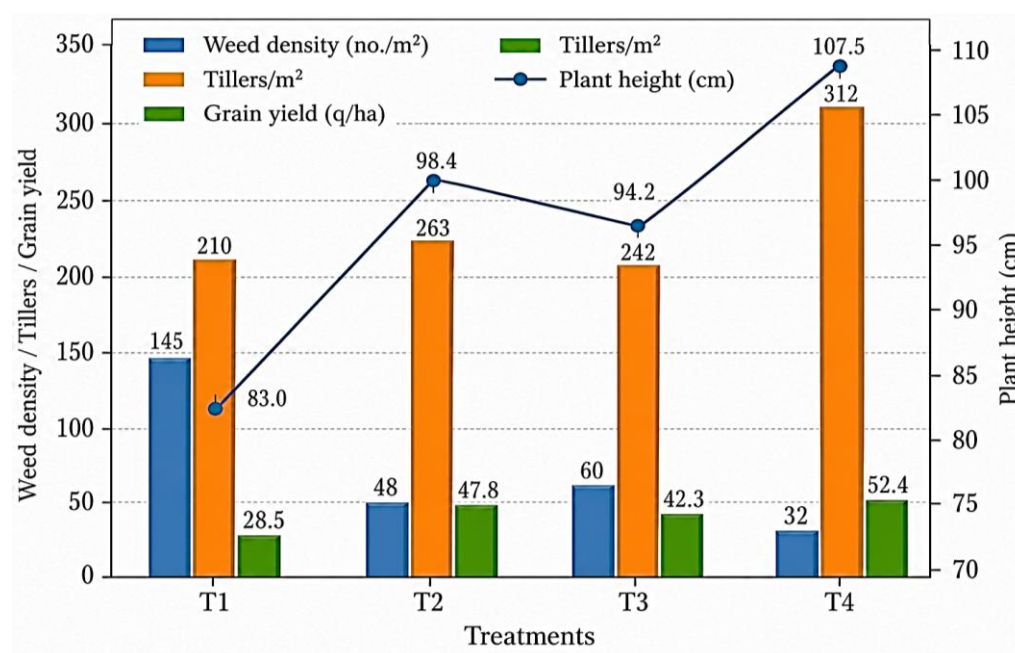


Figure 2. Effect of Weed Management Practices on Growth and Yield of DDSR

DISCUSSION

The present study clearly demonstrates that weed management plays a crucial role in determining the growth and productivity of dry direct-seeded rice. Among all treatments, integrated weed management proved to be the most effective approach, as it combines the benefits of both chemical and manual methods. This approach not only reduces weed density significantly but also enhances crop growth and yield. (Verma, N. K et al. 2025) [9].

Manual weeding, although effective, is labor-intensive and may not always be feasible due to labor scarcity and high costs. Chemical control provides quick and efficient weed suppression; however, its continuous use may raise environmental and ecological concerns, such as herbicide resistance and soil health deterioration. (Mir, M.S. et.al. 2024) [10].

Integrated weed management offers a balanced solution by reducing dependency on a single method and improving overall efficiency. It ensures sustainable crop production by optimizing resource use and minimizing environmental risks. Therefore, the adoption of integrated weed management practices is highly recommended for achieving higher productivity and sustainability in DDSR cultivation systems. (Shekhawat K. et al. 2020) [11].

CONCLUSION

The present study clearly demonstrated that weed management practices play a crucial role in improving the productivity and sustainability of dry direct-seeded rice (DDSR) cultivation in the Mungeli district of Chhattisgarh. Severe weed infestation in the untreated control plots significantly reduced crop growth, tiller production, and grain yield due to intense competition for nutrients, moisture, sunlight, and space. Effective weed control was therefore essential to achieve better crop establishment and higher productivity under DDSR conditions.

Among the different treatments evaluated, integrated weed management (IWM), which combined chemical and manual weed control methods, proved to be the most efficient and economical approach. The treatment substantially reduced weed density and improved important growth parameters such as plant height, number of productive tillers, and overall crop vigor. As a result, the highest grain yield of 52.4 q/ha was recorded under integrated weed management compared to manual weeding, chemical control alone, and the untreated control. The superior performance of IWM may be attributed to timely weed suppression during the critical stages of crop growth, resulting in improved nutrient uptake and enhanced crop development.

The findings of the study suggest that relying solely on one method of weed control may not be sufficient for sustainable rice production in DDSR systems. Instead, integrating chemical and manual methods offers better weed suppression, minimizes yield losses, and supports long-term sustainability of rice cultivation. Moreover, integrated weed management can help reduce excessive herbicide dependence and associated environmental risks.

Therefore, adoption of integrated weed management practices can be recommended to farmers of Chhattisgarh for improving rice productivity and profitability under dry direct-seeded conditions. Further research may focus on eco-friendly weed control technologies and location-specific weed management strategies to enhance sustainable rice production in the region.

Recommendations

Promote integrated weed management practices among farmers Provide training on herbicide use encourage sustainable agricultural practices.

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