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Research paper

Response of Different Weed Management Practices on Yield, Quality and Nutrient Uptake of Kharif Drilled Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was carried out at Jai Prakash University Chapra campus during the kharif season of 2024 to assess the effects of several weed management strategies on the production, quality, and nutritional absorption of kharif rice (*Oryza sativa* L.). The experiment employed a randomized block design featuring six treatments administered three times. The treatments included Bispyribac-Na (T1), Pendimethalin applied to the soil followed by Bispyribac-Na post-planting (T2), Pendimethalin in soil combined with Bispyribac-Na after planting (T3), three mechanical weedings with a rotavator at 20, 40, and 60 days after sowing (T4), a weed-free control achieved through hand weeding at 20, 40, and 60 days after sowing (DAS) (T5), and a weedy control (T6). The results demonstrated that the treatments comprising a weed-free control, pendimethalin applied to the soil with hand weeding, and pendimethalin in conjunction with bispyribac-Na post-planting yielded superior outcomes in this study. Manual weeding produced enhanced growth and yield attributes relative to the other treatments assessed. The weed-free treatment achieved the highest yields of grain and straw in rice cultivation.

1. Introduction

India contributes only 45% to the total global output of rice among food grains. The crop is cultivated on approximately 44 million hectares. Approximately 60% of the global population relies on rice as their primary food supply, rendering it the most crucial staple grain crop globally. India ranks as the second-largest producer and consumer of rice globally, following China. Rice cultivation employs one of two methods: direct seeding or transplanting. In Bihar, rice is predominantly cultivated by the transplanting method. However, drilled and dibbled rice are also used in certain regions. These regions are quite uncommon.

The proliferation of weeds constitutes the principal issue. Moreover, during the initial phase of crop development, competition for space, light, moisture, and nutrients intensifies when weed and crop seeds germinate concurrently. This competition markedly diminishes the yield. In the case of transplanted rice, seedlings aged three to four weeks are relocated to puddled soil. This approach is performed to eradicate initial competition and ensure that the seedlings can effectively withstand competition in later phases.

Laborious and time-consuming weed management methods encompass manual weed removal and the use of sickles. These techniques also result in an expensive operation. The required labour

for such operations may range from sixty to seventy during the peak season. Weeds are substantial, inconspicuous, and detrimental organisms that markedly diminish agricultural output.

The enhanced agricultural productivity necessitates efficient weed management. Consequently, it prioritizes the development of herbicides and rationalizes their use to provide swift and effective weed management. While hand weeding is regarded as the most effective method, it can be expensive and labour-intensive. During the initial thirty days post-direct rice seeding, it is especially important that the field remains devoid of weeds. Consequently, in the initial phases, the use of herbicides either prior to or shortly after plant emergence is both efficient and cost-effective. The herbicide is applied prior to or shortly after the emergence of weeds to either obstruct seed germination or impede seedling development. Consequently, it has been decided to conduct a systematic study to generate data on herbicide efficacy. Consequently, the existence of weeds constitutes the primary biological impediment to direct-seeded rice farming.

2. Materials and Methods

The experiment took place in rice fields located near Sonpur, Saran (Bihar), during the Kharif season of 2024. The site selection was based on the land's suitability for direct-seeded rice cultivation. The experiment used a random block design featuring six treatments, each replicated three times. The treatments included Bispyribac-Na (T1), Pendimethalin in soil followed by Bispyribac-Na after planting (T2), Pyrazosulphuron in soil combined with Bispyribac-Na after planting (T3), three mechanical weedings using a rotavator at 20, 40, and 60 days after sowing (T4), a weed-free control with hand weeding at 20, 40, and 60 days after sowing (DAS) (T5), and a weedy control (T6).

The gross plot size measured 5.00 m by 3.00 m, while the net plot size was 4.60 m by 2.70 m. The experimental plot's soil exhibited a sandy clay loam texture, an alkaline pH, and a medium level of organic carbon content. The nitrogen content was low, while phosphorus and potassium levels were medium. The seed of the rice variety Mansuri was treated with thiram at a rate of 3 g per kg of seed used for sowing.

The Mansuri rice variety has growth duration of 110-115 days and produces a yield of approximately 35-40 quintals per hectare. The rice was sown in the experimental plot using the drilling method in early June, with a spacing of 20 cm between the rows. The crop received fertilization of 100 kg N, 50 kg P_2O_5, and 50 kg K_2O per hectare. During sowing, a basal dose of 40 kg N ha^{-1} was applied, along with the complete dosage of P_2O_5 and K_2O. There 40kg of nitrogen per hectare were applied at 30 days after sowing, followed by an additional 20kg at the panicle initiation stage. Nitrogen was provided via urea (46%N), while phosphorus and potassium were supplied through single superphosphate (16% P_2O_5) and muriate of potash (60% K_2O). Occasionally, the other common package of practices was implemented, and periodic growth observations were documented.

3. Results and Discussion

3.1 Impact of various weed management strategies on rice yield and quality

The weed-free check (T5) demonstrated the highest grain and straw yield (q ha^{-1}), followed by the weed-free treatment with triple weed removal at 20, 40, and 60 days after sowing (DAS) (T4), and the application of pendimethalin in soil combined with bispyribac-Na post-planting (T3). These treatments demonstrated significant superiority over all other treatments, yet they were equivalent to one another. Dixit et al. (2008) found that pendimethalin effectively controlled weeds in the later growth stages of rice, thereby reducing weed competition, improving resource use, and increasing crop yield. Rawat et al. (2012) showed that crops in weed-free plots exhibited enhanced growth due to the removal of weeds from inter-row and intra-row spaces. This procedure improved aeration by modifying the surface soil, thereby increasing the availability of space, water, light, and nutrients essential for optimal growth and development. The approach led to improved growth and yield, ultimately achieving maximum crop output.

Table 1 Effect of different weed management practices on yield and quality of rice

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Protein quantity in grain (q ha^{-1})
T1: Bispyribac-Na	27.62	48.09	6.40
T2: Pendimethalin PE fb Bispyribac-Na PoE	34.16	53.72	7.34
T3: Pyrazosulphuron PE fb Bispyribac-Na PoE	28.15	40.37	6.92
T4: Three mechanical weeding (20, 40, 60 DAS)	34.52	51.78	7.13
T5: Weed free check (20, 40, 60 DAS)	38.57	58.43	8.02
T6: Weedy check	18.86	33.24	6.11
SE±(C.D. at 5%)	0.26 (0.69)	0.51 (1.32)	0.04 (0.12)

Table 2 Effect of different weed management practices on nutrient uptake of rice

Treatments	Grain N Uptake (kg ha^{-1})	Straw N uptake (kg ha^{-1})	Grain P Uptake (kg ha^{-1})	Straw P uptake (kg ha^{-1})	Grain K Uptake (kg ha^{-1})	Straw P uptake (kg ha^{-1})
T1	29.21	17.42	7.86	3.46	8.98	54.16
T2	42.23	24.53	10.34	4.36	11.91	47.29
T3	33.72	16.43	9.32	3.65	10.26	46.12
T4	41.24	22.43	10.27	5.33	10.64	45.68
T5	51.27	35.09	15.32	9.31	19.28	56.32
T6	19.87	12.18	4.29	2.71	6.41	38.93
SE±C.D.	0.27	0.32	0.45	0.54	1.13	0.67
at 5%	0.73	0.93	1.29	1.53	3.14	1.87

The findings align with those reported by Veeraputhiran and Balasubramanian (2013) as well as Verma et *al*. (2013). The weedy check (T6) exhibited the lowest values for both grain and straw yield. The severe competition from grasses, sedges, and broad-leaved weeds for space, light, moisture, and nutrients during the growth period was the primary cause of this issue. Hussain et *al*. (2008) reported comparable findings. The data regarding grain yield and straw yield (q ha^{-1}) influenced by various treatments is presented in Table 1. The weed-free check (T5) produced the highest grain and straw yield, demonstrating significant superiority over all other treatments.

The quality aspects of protein content in rice grain were significantly affected by various weed control treatments. The protein content of rice grain showed a notable increase in the weed-free check (T5), with treatments T4 and T3 also demonstrating significant superiority compared to the other treatments. The weedy check (T6) exhibited significantly lower protein content in the grain compared to the other treatments. The findings align closely with those documented by Sawant (2003) and Tendulkar (2004).

3.2 Impact of various weed control methods on nutrient absorption in rice

These results are in confirmation with those obtained from Veeraputhiran and Balasubramanian (2013) and Verma et *al*., (2013). Weedy check (T6) recorded the lowest values of grain and straw yield. This was due to severe weed competition exerted by grasses, sedges and broad leaved weeds for space, light, moisture and nutrients throughout the growth period. Similar results were reported by Hussain et *al.,* (2008). Data pertaining to the grain yield and straw yield (q ha-1) is influenced by various treatments are presented in table 1 indicated that, the weed free check (T5) produced the highest grain and straw yield and was found significantly superior over all the treatments.

In respect of quality aspects protein content in grain of rice significantly influenced due to different weed control treatments. The protein content of rice grain increased significantly under weed free check (T5) followed by treatment T4 and T3 which were significantly superior over rest of the treatments. Weedy check (T6) recorded significantly the lowest protein content in the grain than the remaining treatments. These results are similar to those reported by Sawant (2003) and Tendulkar (2004).

3.3 Effect of different weed management practices on nutrient uptake of rice

The weed-free check (T5) showed a significantly greater uptake of N, P, and K in both grain and straw compared to the other treatments, while treatments T4 and T3 demonstrated comparable results. Ramamoorthy (1991) observed that the pre-emergence application of pendimethalin, along with a single hand weeding at 30 days after sowing, resulted in enhanced nutrient uptake by rice, attributable to a considerable reduction in weed-crop competition and weed density. The enhanced absorption of these nutrients by rice resulted from elevated grain and straw yields, as well as higher nitrogen, phosphorus, and potassium content in both grain and straw under treatments T5, T4, and T3 (Table 2). The findings align with those documented by Kolhe and Tripathi (1998), Choubey et *al*. (1999), and Verma et *al*. (2013). The weedy check (T6) exhibited a considerably lower uptake of the primary nutrients nitrogen (N), phosphorus (P), and potassium (K) compared to the other weed control treatments. This lower nutrient uptake occurred due to the increased proliferation of weeds beneath the weedy control treatment. These findings closely align with those of Singh et *al*. (2013), and Verma et *al*. (2013).

4. Conclusion

The results of the current investigation indicate that the integration of chemical and cultural/physical control measures has demonstrated superior effectiveness in achieving enhanced growth and yield in rice compared to the use of chemical herbicides, cultural practices, or mechanical control in isolation.

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