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Influence of integrated weed management on growth and yield of in rice (*Oryza sativa* L.)

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Abstract

The present study was conducted to evaluate the effects of integrated weed management practices on rice crop growth, yield, and economic returns. The research aimed to assess weed interference, growth parameters, and the economic viability of various weed control treatments. A range of treatments including manual weeding, chemical control with Pendimethalin and Bispyribac-Na, and their combinations were analyzed. The results demonstrated that frequent hand weeding at 15, 30, and 45 days after transplanting (DAT) significantly improved plant height, tiller number, panicle production, and grain yield, while reducing weed population. This approach yielded the highest grain output per hectare (5,200 kg/ha), gross monetary returns (₹ 1,10,240 ha⁻¹), and net returns (₹ 59,935.7 ha⁻¹). In contrast, the control weedy check, with no weed management, resulted in the poorest crop performance across all parameters, emphasizing the detrimental effect of weed competition. Chemical treatments, especially Pendimethalin as pre-emergence, also enhanced crop performance but were slightly less effective than intensive hand weeding. The combination of Pendimethalin with hand weeding provided the best economic efficiency with a benefit-cost (B:C) ratio of 2.23, indicating the advantages of integrated weed management for optimal rice production and profitability.

Keywords: Integrated, weed, grains, herbicide, seed index and straw yield

Introduction

Rice (*Oryza sativa* L.) is belonged to the family Poaceae and its chromosome no is 2n= 24. The origin place of rice is Indo-Burma region. It is the primary source of nutrition for more than 60% of the world's population. Paddy is grown on an estimated 162.06 million hectares worldwide, with production and productivity of 505.00 million metric tonnes and 6.71 t ha⁻¹, respectively, throughout the growing season (Acc. to USDA, 2019). Paddy was grown over an area of roughly 44.00 million hectares in India, with production and productivity of 117.94 million tonnes and 26.63 q ha⁻¹, respectively, during the year (Anonymous, 2019). The major rice production countries are China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Japan, Philippines, Brazil, Cambodia, Pakistan, Egypt, Afghanistan, Nepal, Sri Lanka and Chile. About 80 million hac. of irrigation lowland paddy provide 75% of the world production.

Weed manage has always been a major factor in paddy production throughout monsoonal Asia, because huge amount of labour has been required in old rice culture for weeding. Hand weed control is rapidly being replaced by chemical weed control in many Asian countries., However, use of weedicide is still limited in countries like Bangladesh, India and Indonesia because of limited availability and more cost. At the even time, many farmers are not fully aware about their proper and correct use against diverse weed flora. However, in recent times, herbicides are becoming most popular amongst farmers. The selection of chemical herbicides depends upon the weed type and degree of weed infestation in rice field and it is often determined by the type of paddy culture (irrigated, un-irrigated lowland, deep water and tidal wet lands), stand establishment methods (transplanting, direct seeded), moisture regime (irrigated, rain fed), field preparation (lowland, upland) and cultural operation (De Datta, 1981). Thus, influential weed control often requires a combination of cultural, mechanical and chemical control measures, such as an integrated weed management approach to delay herbicide resistance and lower the herbicide burden on the agro-ecosystem (Rao *et al.*, 2007)^[12].

The maximum weed dry matter lower was cognizable under herbicide butachlor 1.5 kg/ha + 2 HW in transplanted paddy. Singh *et al.* (2008)^[13] found that the treatment combination uses in drum sowing with application of the pre-emergence herbicide Pretilachlor + Safener at 1.0 liters/ha at 4 days after sowing, followed by one manual weeding at 30 DAS found significantly low total weed count (4.19/0.25 m²) and total weed dry weight (35.1 kg/ha) resulting in better grain yield (7061 kg/ha), straw yield (9265 kg/ha) and net income (Rs. 25208/ha).

Weeds compete with paddy, resulting in yield losses of 50-65 percent for wet seeded paddy and up to 76 percent for transplanted rice. Weeding can be delayed during the height of the labour crisis and in the face of bad weather conditions. However, delaying weeding for more than 15-25 days reduces production by 43 kg per hectare per day between 25 and 45 days. Pre-emergence herbicides have been found to be effective in the early stages, however the second glow of weeds has been a concern at later stages. In such cases, herbicides should be applied in a sequential or mixed manner. such as pretilachlor or pretilachlor + bispyribac sodium is the only alternative. Sequential application of weedicides with varying selectivity is possible, but it raises the expense. As a result, combining two different herbicides and applying them simultaneously saves time and money while providing a broad range of weed control. Hand weeding showed the lowest weed dry weight of 4.0 and 3.0 kg ha⁻¹. In rice, hand weeding twice (20 and 40 days after planting) resulted in lower weed dry weight and increased mean grain and straw yield. (Jayadeva *et al.*, 2009)^[2]. The manual weeding was at par with bispyribac sodium at 20 g ha⁻¹ to 30 g ha⁻¹. The bispyribac sodium at 15 g ha⁻¹ reduced the weeds but not to the level of hand weeding or bispyribac sodium at 20 g ha⁻¹.

Effective weed management has always been one of the important production factors for securing higher yields from modern rice varieties grown with adequate fertilizers. Yield reduction of 30-60 per cent is caused by unchecked weed competition in rice. Non-availability of cheap labour in time and increasing cost of hand weeding have necessitated the use of chemical for weed control. Modern technological developments have enabled the researchers to see a critical examination of the existing weed management practices. The result of such an examination reported that complete weed control may not be possible by using any one method in isolation. Hence the integration of different control methods is suggested as the best weed management system in which, however, herbicides will continue to play a key role.

Weeds are the plants, which where they are not wanted. The rice fields are dominated various weeds the major weed species are *Echinochloa colonum*, *Echinochloa crusgalli*, *Cyprus rotundus*, *phylenthus niruri*, *Cynodon dactylon*, and others etc. Losing due to weeds varies with crop, weed species, location, and farming system reduction in the crop and production efficiency direct effect to weeds. It differs from the crop 34.3 percent to 89.8 percent depending upon the crop. Weeds are occupied every year in every field and require some point of management for optimum crop yields. Weeds can directly decrease crop yields, reduce crop quality, and increase harvesting costs. Weeds not only competition for nutrients, light, and H₂O and they are also shelter of pests (nematodes, insects, pathogens) and crop decreasing potential yields and quality. Weeds can also lower the value of the harvested crop such as reducing protein levels in seed and decreasing fruit or seed size. The presenting of weeds in the harvested crop may also reduce the value of the crop. As a result, using pesticide to control weeds in paddy is a viable

option.

Materials and Methods

The experiment was carried out at the Research farm of the Department of Agronomy, School of Agriculture Science, Technology & Research, Sardar Patel University, Balaghat (M.P.). The experiment was conducted in a randomized complete block design with three replications. Different Integrated Weed Management will be allocated to the plots as per treatments. The seed rate used as 40 kg/ha for sowing with 20.0 x 10.0 cm row-to-row and plant-to-plant distance. The treatments were Control weedy check (T₁), Hand weeding at 15 DAT (T₂), Hand weeding twice at 15 DAT and 30 DAT (T₃), Hand weeding thrice at 15 DAT, 30 DAT and 45 DAT (T₄), Pendimethalin @ 1 kg/ha as pre-emergence (T₅), Bispyribac -Na 20 g/ha as post-emergence at 25 DAT (T₆) and Pre-emergence (Pendimethalin @ 1 kg/ha) + Hand weeding at 15 DAT (T₇). The gross and net plot size was 684 m² and 578 m², respectively. The fertilizer grades were applied as per RDF. All the other agronomic practices were applied uniformly to all the treatments. The experiment will be consisting of the following factors along with their respective levels.

Results and Discussion

The study shows a progressive increase in rice plant height from 15 to 60 DAT, with the growth slowing down as the crop matured. The most significant growth occurred between 30 and 60 DAT, the grand growth phase. Weed management practices had a notable impact on plant height, with hand weeding thrice (at 15, 30, and 45 DAT) resulting in the tallest plants. This treatment reduced competition for nutrients and resources, allowing for optimal growth. In contrast, the control weedy check produced the shortest plants, highlighting the negative effects of weed pressure. While chemical treatments like Pendimethalin and Bispyribac-Na showed moderate results, manual weed removal proved most effective in promoting plant height. This finding related with Kohle and Tripathi (1998)^[5], Ramachandiran and Balasubramanian (2012)^[10], and Mandal *et al.* (2021)^[7].

The number of tillers increased progressively with crop age, reaching its peak between 30 and 60 DAT before slowing down toward harvest. The weed management treatments had a significant influence on tiller production, with hand weeding thrice at 15, 30, and 45 DAT showing the best results, leading to the highest number of tillers. This treatment minimized weed competition, allowing plants better access to nutrients, water, and sunlight. On the contrary, the control weedy check treatment was the poorest performer, showing the lowest number of tillers due to intense competition from weeds. Pendimethalin as pre-emergence and Bispyribac-Na as post-emergence treatments also performed moderately but were less effective than hand weeding. This finding related with Sudhakar and Nair *et al.* (1986)^[17], Ramana *et al.* (2007)^[11], Ramachandiran and Balasubramanian (2012)^[10], and Mandal *et al.* (2021)^[7].

The weed population data show a notable decline with the application of various weed management treatments, particularly during the critical period from 15 to 60 DAT. Beyond this stage, the weed population remained relatively stable until harvest. Hand weeding thrice at 15, 30, and 45 DAT was the most effective treatment, leading to the greatest reduction in weed population compared to other treatments and the weedy check, which had the highest weed density.

Weed population dynamics are directly influenced by competition for nutrients, moisture, and light. During the crucial

growth period, differences between treatments became more apparent. The hand-weeding treatment effectively suppressed weeds throughout the crop's critical growth phases, significantly reducing competition for resources and allowing rice plants to flourish. Conversely, the weedy check plot, which had no weed control measures, experienced the highest weed population, resulting in heavy competition and reduced crop performance. Effective weed management, especially through consistent hand weeding, reduced weed density and minimized competition, leading to better crop establishment and growth. Among all treatments, hand weeding thrice provided the most sustained weed suppression, while the control plot exhibited the highest weed population, demonstrating the necessity of timely weed control for optimal crop development. This finding related with Sudhakar and Nair *et al.* (1986) ^[17], Ramana *et al.* (2007) ^[11], Ramachandiran and Balasubramanian (2012) ^[10], and Mandal *et al.* (2021) ^[7].

Test weight results underscore the impact of weed management on grain quality. The control weedy check, with no weed management, had the lowest test weight (22.5 g), reflecting how competition from weeds impairs nutrient and water availability, leading to poor grain development. In contrast, hand weeding thrice at 15, 30, and 45 DAT achieved the highest test weight (27 g), indicating that frequent weed removal improves resource availability and grain quality. Hand weeding twice and once also showed improved test weights, highlighting the benefits of regular weed control. While chemical treatments like Pendimethalin and Bispyribac-Na improved test weight to some extent, they were less effective than manual methods. The combined use of Pendimethalin and hand weeding resulted in a test weight of 26 g, demonstrating that integrating chemical and manual approaches enhances grain quality more effectively than chemical control alone. This finding related with Kandasamy and Chinnusamy (2020) ^[4] and Mishra and Singh (2008) ^[8].

Grain yield per hectare was significantly influenced by the weed management practices applied. The control weedy check, with

no weed management, yielded the least at 2,400 kg/ha, due to severe competition from weeds for essential resources. In contrast, frequent hand weeding proved highly effective, with the highest yield of 5,200 kg/ha observed when weeding was done thrice at 15, 30, and 45 DAT. This treatment minimized weed competition, optimizing growth conditions for rice plants. Hand weeding twice and once also led to higher yields (4,400 kg/ha and 3,600 kg/ha, respectively), showing that more frequent weed control enhances productivity. Chemical treatments, such as Pendimethalin and Bispyribac-Na, improved yields to a lesser extent, with the highest yield being 4,200 kg/ha. Combining pre-emergence Pendimethalin with hand weeding increased yield to 4,800 kg/ha, demonstrating that integrating methods can enhance weed management and crop productivity. This finding related with Singh *et al.*, (2008) ^[13], Juraimi *et al.*, (2010) ^[3] and Singh *et al.*, (2012) ^[15].

The economic impact of various weed management practices is evident from the gross and net monetary returns. The control weedy check, with no weed management, resulted in the lowest returns due to severe weed competition, which suppressed both yield and grain quality. Hand weeding thrice at 15, 30, and 45 DAT produced the highest gross returns (₹1,10,240 ha⁻¹) and net returns (₹59,935.7 ha⁻¹), highlighting the substantial financial benefits of frequent, thorough weed control. Other hand weeding treatments also yielded higher returns compared to chemical methods, reflecting the direct relationship between effective weed management and economic gains. Chemical treatments like Pendimethalin and Bispyribac-Na offered moderate returns, with the combined chemical and manual approach providing a balanced solution, resulting in high gross returns (₹1,01,760 ha⁻¹) and net returns (₹56,207.2 ha⁻¹). This integrated method achieved the best B:C ratio (2.23), underscoring its economic efficiency. This finding is related with Gopinath and Kundu (2008) ^[1], Mahajan *et al.* (2009) ^[6], Singh and Singh (2010) ^[14] and Sudharni *et al.* (2019) ^[18].

Table 1: Influence of Integrated Weed Management in Rice (*Oryza sativa* L.)

Treatment	Plant height (cm)	Number of tillers/plant	Weed population/unit area	Number of grains/panicle	Test weight (g)	Grain yield /ha	B:C ratio
Control weedy check	71.20	241.6	200	76	22.5	2,400	1.19
Hand weeding at 15 DAT	78.50	296.40	30	80.5	24	3,600	1.68
Hand weeding twice at 15 DAT and 30 DAT	83.50	325.4	20	85	25.5	4,400	1.95
Hand weeding thrice at 15 DAT, 30 DAT and 45 DAT	83.80	345.00	10	88.3	27	5,200	2.19
Pendimethalin @ 1 kg/ha as pre-emergence	79.21	296.02	60	78	23.5	4,000	1.89
Bispyribac -Na 20 g/ha as post-emergence at 25 DAT	79.90	303.6	50	80	24.5	4,200	1.96
Pre-emergence (Pendimethalin @ 1 kg/ha) + Hand weeding at 15 DAT	82.82	332.5	20	86.7	26	4,800	2.23
Sem (±)	0.01	0.01	0.65	0.01	0.012	0.0001	0.0003
C.D (P=0.05)	0.04	0.03	2.01	0.03	0.038	0.001	0.0008

Conclusion

The study demonstrates the critical role of effective weed management in enhancing rice crop performance, both in terms of growth parameters and economic returns. Hand weeding thrice at 15, 30, and 45 DAT consistently yielded the best results, with the tallest plants, highest number of tillers, and the lowest weed population. This intensive weed management approach significantly boosted grain yield per plant, per plot, and per hectare, leading to the highest gross and net monetary returns, and an impressive B:C ratio of 2.19. In contrast, the control weedy check, where no weed management was

implemented, resulted in the lowest plant growth, grain yield, and financial returns, underscoring the negative impact of weed competition. Chemical weed control methods, particularly Pendimethalin as pre-emergence and Bispyribac-Na as post-emergence, also contributed to improved crop performance, but their effectiveness and profitability were slightly lower compared to intensive manual weeding. However, the integration of chemical and manual weed control, such as combining Pendimethalin with hand weeding at 15 DAT, provided a balanced approach with high yields, strong economic returns, and the highest B:C ratio of 2.23, indicating optimal

economic efficiency. This suggests that while both manual and chemical weed control methods are beneficial, an integrated approach offers the best combination of cost-effectiveness and crop productivity.

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