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Effect of Sowing Methods and Weed Management Practices on Crop Nutrient Uptake and Weed Nutrient Removal in Rice (*Oryza sativa* L.)

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ABSTRACT

Field Experiments were conducted at Agronomy Research farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh, India), during *Kharif* season of 2024 and 2025.The study was carried in a split plot design with 3 replications. In main plot 3 rice establishment methods and in sub plot 5 weed management practices were included. The results revealed that transplanting methods of sowing registered the highest nitrogen, phosphorous and potassium uptake by rice crop and lowest nutrient removal through weeds. Among weed management practices, maximum uptake by rice with respect to nitrogen, phosphorous and potassium and minimum removal by weed regarding N, P and K was recorded in treatment hand weeding at 15, 30, 45 and 60 DAS/DAT which was observed statistically at par with pre application of pendimethalin @ 1000 g a.i. ha^{-1} *f/b* brown manuring by bispyribac sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT. Among different weed management practices, combined application of pendimethalin @ 1000 g a.i. ha^{-1} *f/b* brown manuring by bispyribac sodium @ 25 g a.i. ha^{-1} or hand weeding 15, 30, 45 and 60 DAS/DAT was found effective in controlling weeds and increase in the quality and quantity of rice. Among the establishment method transplanting was found effective in increase in the yield, nutrient content of the crop and substantially reduction of nutrients removed by weed in rice field.

Keywords Brown manuring, Nutrient uptake, Nutrient removal, Rice and Weed.

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INTRODUCTION

Rice (*Oryza sativa* L.) is referred to as "Global Food" because half of the world's population depends on it for daily energy needs. Rice grown in India and Southeast Asia is a plant of Asian origin. Archaeological findings of the Indus- Saraswati civilization point out that rice was eaten in the advanced Mesolithic or pre-Neolithic period at Chopani Mando. In India, about 441.70 lakh hectares of area come under

rice cultivation with a production of 1245.04 lakh tonnes and a productivity of 2819 kg ha^{-1} (MoA and FW 2026). Weeds are commonly regarded as pests and pose a significant threat to agriculture because they create substantial challenges by competing for nutrients, moisture, solar energy, and space with crop plants. The degree of damage inflicted by weeds on a specific crop is influenced by factors such as the type of weed flora, the intensity of weed presence, and the growth rate of the weeds. Uncontrolled weeds cause yield reduction up to 30-40% under transplanted conditions and 70-80% under direct-seeded rice. Therefore, timely weed control is imperative for realizing a desired level of productivity (Yakadri *et al.* 2016). Besides yield reduction, weed deplete nutrient from soil to an extent of 42.07 kg nitrogen, 10 kg phosphorous and 21.08 kg potassium per hectare respectively (Puniya *et al.* 2007). These weed factors not only affect the extent of damage but also influence the weed control measures to be adopted in a crop or crop sequence. Weed control is an essential plant protection aspect that can be carried out using cultural, mechanical, and chemical methods. Of these three, the chemical method is the most effective and rapid way to control weeds in time. A lot of escape or regeneration has been observed despite the use of many herbicidal combinations. Consequently, a onetime application of herbicides cannot solve the long gap of the proliferation of different forms of weeds alone. In view of this, many herbicides may be used in combination or in series in the management of diverse complex weed flora. Alternative option for weed management to avoid future problem of only herbicide use may be integration of herbicides with cultural practices like brown manuring practice, cover crop, mulching etc for better suppression of weeds in eco-friendly way. Brown manuring of sesbania has been reported to smother weeds by nearly half its population without any adverse impact of rice grain yield (Chongtham *et al.* 2015).

MATERIALS AND METHODS

A field research study was carried out during *kharif* seasons of 2024 and 2025 at Agronomy Research farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh, India), It is located at 26°47' N latitude, 82°12' E longitude, and 113 meters above mean sea level. The experiment was performed with fifteen treatments in a split plot design. There were three different establishment method in the main plot, i.e. Transplanting (S_1), Drum seeded Rice (S_2) and Direct Seeded Broadcasting (S_3) and under the sub-plot, there were five weed management practices i.e. Pre application of Pendimethalin @ 1000 g a.i. ha^{-1} *f/b* Post application of Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/T (W_1), Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/T (W_2), Pre application of Pendimethalin @ 1000 g a.i. ha^{-1} *f/b* Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/T (W_3), Hand Weeding 15 DAS/T, 30DAS/T, 15 DAS/T & 60 DAS/T (Weed free) (W_4) and Weedy check (W_5) which were replicated thrice. As a test variety, the rice "NDR-2065" was used. Silty loam in texture with moderately alkaline reaction (pH 8.31), low in organic carbon (0.36%), available N (210.15 kg ha^{-1}), P_2O_5 (16.05 kg ha^{-1}). and K_2O (246.28 kg ha^{-1}). NDR-2065 rice variety was sown broadcasting and drum seeder method under well puddled, levelled and moist plots during both the years of the experiment. On the same day, nursery was sown for transplanting. Three seedlings per hill of 23 days old seedlings were transplanted at a spacing of 0.2 m^2 in the field. The crop was fertilized with 120 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1}, 40 kg K_2O ha^{-1} and 25 kg $ZnSO_4$ ha^{-1} based on RDF in different treatment plots.

The crop was harvested when the leaves turned brown and the ear-head produced a metallic sound in the wind. Five representative plants were collected from each plot, and the weed samples were shade-dried before being oven-dried for 48 hours at 65°C. After drying, the samples were ground and passed through a 0.5 mm sieve. The required quantity of sample was weighed out accurately on an electronic balance and subjected to acid digestion for carrying out the chemical analysis. Based on the nutrient content in straw and paddy grain at the harvest of the crop, the uptake of NPK of rice was worked out.

The weed samples collected from each plot at 60 days after sowing (DAS) or days after transplanting (DAT) were analyzed for nitrogen, phosphorus, and potassium content, with results expressed as a percentage. Nutrient uptake by rice and nutrient

removal by

$$\text{Nutrient depletion by weeds (kg ha}^{-1}) = \frac{\text{Nutrient content (\%) in weed} \times \text{Weed dry matter (kg ha}^{-1})}{100}$$

weeds were calculated by multiplying nutrient concentration by the respective dry weight of the crop and weed samples, with results expressed in kilograms per hectare (kg ha^{-1}).

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%) in grain or straw} \times \text{Grain/Straw yield (kg ha}^{-1})}{100}$$

The significance of the treatment impact was assessed using the F test. Standard errors of variances were calculated and recorded alongside the summary results. Critical differences among various treatment groups at a 5% level of significance were determined.

RESULTS AND DISCUSSION

Effect of sowing methods on nutrient uptake by rice

Observation on nutrient uptake by crop as affected by different sowing methods was calculated. The Statistically analyzed data concerning nutrient uptake by crop has been tabulated in Table.1. Among crop establishment methods, transplanting method resulted in significantly superior N, P and K uptake by grain, straw and total nutrient uptake, which was statistically better than drum seed rice and direct seed broadcasting during both the years. The minimum N, P and K uptake was recorded in the treatment where direct seed broadcasting method of sowing was practiced. It might be due to the fact that higher grain and straw yield were recorded under transplanting, and thus, there was a dilution effect in accordance with the Wilcox inverse yield relationship. In contrast to this, transplanting exhibited higher N, P and K in grain and straw owing to significantly lower grain and straw yield than the other treatments. The results corroborate the findings of Sahu *et al.* (2021) and Chaudhary *et al.* (2022).

Effect of weed management practices on nutrient uptake by rice

The effect of weed management practices sowed that the significant effect with regard to Nitrogen, phos-

Table 1. Total uptake nutrient by rice as influenced by different sowing methods and weed management practices of rice under puddled conditions.

Treatment		Total N uptake (kg ha^{-1})		Total P uptake (kg ha^{-1})		Total K uptake (kg ha^{-1})	
		2024	2024	2024	2025	2024	2025
Sowing method							
Transplanting	S_1	97.52	101.30	30.46	31.52	114.21	118.79
Drum Seeded Rice (Sprouted seed)	S_2	77.66	80.92	24.07	25.02	94.38	98.31
Direct Seeded Broadcasting (Sprouted seed)	S_3	61.25	64.26	18.93	19.72	78.73	82.15
SEm±		2.60	3.14	0.871	0.900	2.34	2.71
CD (P=0.05)		10.20	12.34	3.42	2.13	9.18	10.64
Weed management practices							
Pre application of Pendimethalin @ 1000 g a. i. ha^{-1} *f/b* Post application of Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_1	85.77	89.37	26.71	27.67	102.70	106.76
Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_2	71.32	74.64	22.32	23.17	89.19	92.64
Pre application of Pendimethalin @ 1000 g a.i. ha^{-1} *f/b* Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_3	99.08	102.74	30.73	31.68	115.49	120.14
Hand Weeding 15DAS/DAT, 30DAS/DAT, 15DAS/DAT & 60 DAS/DAT (Weed free)	W_4	101.28	105.42	31.59	32.82	117.51	122.46
Weedy check	W_5	36.61	38.63	11.08	11.75	53.98	56.75
SEm±		2.73	3.08	0.907	0.85	2.82	2.95
CD (P=0.05)		7.97	9.00	2.65	2.49	8.23	8.61

phorous and potassium uptake. It is evident from the data that maximum N, P and K uptake in rice was observed with the treatment where hand weeding at 15, 30, 45 and 60 DAS/DAT was done being on par with pre application of pendimethalin @ 1000 g a.i. ha^{-1} *f/b* brown manuring by bispyribac sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT. This treatment produced significantly higher N, P and K uptake than other weed management treatments during both the years. The lowest N, P and K uptake by grain was recorded in weedy check treatment. maintaining weed free environment and favorable conditions created by combined application of selective herbicides and brown manuring might have turned advantageous for better growth of rice in the absence of competing weed flora which ultimately led to greater dry matter production. The uptake being the product of nutrient content and dry matter production. Availability of liberal amounts of nutrients due to reduced weed growth during the critical period of crop-weed competition might have enabled the rice crop to absorb and maintain significantly higher concentration in the plant and translocated in to sink. These findings are in agreement with Chongtham *et al.* (2016) and Nagarjuna *et al.* (2021),

Effect of sowing methods on nutrient removal by weeds

Observation on nutrient removal by weeds as affected by different sowing methods and weed management practicves was calculated. The Statistically analyzed data concerning nutrient uptake by crop has been tabulated in Table.2. Nutrient depletion by weeds was significantly affected by sowing methods during both years. Transplanting recorded the lowest nutrient depletion by weeds which was closely followed drum seeded rice recorded intermediate values. Whereas direct seeded broadcasting recorded the highest depletion of nutrient. The higher nutrient depletion

Table 2. NPK Depletion by weeds (kg ha^{-1}) as influenced by different sowing methods and weed management practices of rice.

Treatment		NPK Depletion by weeds (kg ha^{-1})					
		N Depletion (kg ha^{-1})		P Depletion (kg ha^{-1})		K Depletion (kg ha^{-1})	
		2024	2025	2024	2025	2024	2025
Sowing method							
Transplanting	S_1	3.40 (11.05)	3.21 (9.79)	1.64 (2.20)	1.57 (1.97)	4.18 (17.00)	3.96 (15.19)
Drum Seeded Rice (Sprouted seed)	S_2	3.66 (12.89)	3.48 (11.60)	1.75 (2.56)	1.68 (2.31)	4.50 (19.77)	4.29 (17.87)
Direct Seeded Broadcasting (Sprouted seed)	S_3	3.90 (14.71)	3.71 (13.30)	1.84 (2.90)	1.77 (2.63)	4.79 (22.41)	4.57 (20.41)
SEm±		0.057	0.039	0.016	0.015	0.064	0.042
CD (P=0.05)		0.223	0.153	0.064	0.060	0.253	0.166
Weed management practices							
Pre application of Pendimethalin @ 1000 g a. i. ha^{-1} *f/b* Post application of Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_1	3.92 (14.85)	3.70 (13.17)	1.80 (2.76)	1.71 (2.42)	4.92 (23.70)	4.63 (20.90)
Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_2	5.06 (25.13)	4.82 (22.76)	2.26 (4.61)	2.17 (4.19)	6.24 (38.50)	5.97 (35.11)
Pre application of Pendimethalin @ 1000 g a.i. ha^{-1} *f/b* Brown manuring by Bispyribac Sodium @ 25 g a.i. ha^{-1} at 25 DAS/DAT	W_3	2.60 (6.27)	2.39 (5.23)	1.30 (1.19)	1.23 (1.01)	3.27 (10.22)	3.02 (8.62)
Hand Weeding 15DAS/DAT, 30DAS/DAT, 15DAS/DAT & 60 DAS/DAT (Weed free)	W_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Weedy check	W_5	5.97 (35.16)	5.71 (32.14)	2.65 (6.53)	2.56 (6.03)	7.31 (52.90)	7.05 (49.14)
SEm±		0.061	0.093	0.037	0.036	0.108	0.129
CD (P=0.05)		0.179	0.271	0.108	0.105	0.316	0.378

Data subjected to square root $\sqrt{(x + 0.5)}$ transformation and original values are given in parentheses.

under direct seeded broadcasting reflects greater weed biomass production and consequently higher nutrient removal by weeds. The lower NPK depletion under transplanting may be attributed to lower weed biomass and reduced weed density, resulting in less nutrient removal by weeds. In crop establishment methods the highest removal of N, P and K by weeds in direct seeded rice was due to the reason that weed growth was faster than crop in drum seeding and absorbed added nutrients more rapidly in larger quantities than crop. These results are in conformity with those of Shendage *et al.* (2024) and Parameswari and Srinivas (2017).

Effect of sowing methods on nutrient removal by weeds

Under different weed management practices, integrated weed management practices and sequential herbicide application were more efficient in reducing N, P and K depletion by weeds at 60 DAS/DAT than adoption of sole weed management practices. The weed-free treatment maintained through hand weeding at 15, 30, 45 and 60 DAS/T recorded zero nutrient depletion due to complete elimination of weeds. Pre application pendimethalin @ 1000 g ha^{-1} followed by brown manuring *fb* bispyribac sodium @ 25 g ha^{-1} at 25 DAS/DAT recorded the lowest N, P and K depletion by weeds at 60 DAS/DAT which were statistically superior over rest of treatments during 2024 and 2025. The highest nutrient depletion was recorded under weedy check. Among weed management practices, the highest NPK depletion by weeds was recorded under sole brown manuring practice. It was due to maximum total weed dry matter under the treatment as nutrient depletion is positively correlated with weed dry matter accumulation. Effective suppression of weed growth reduced weed biomass and consequently minimized nutrient uptake by weeds (Narolia *et al*. 2014).

CONCLUSION

In view of the present experiment conducted in only same place during both seasons, the following general conclusions concerning the absorption of nutrients by crop and the removal of nutrient by weed may be drawn. Among establishment method transplanting was found effective in increase in the yield, nutrient content of the crop and substantially reduction of nutrients removed by weed in rice field. Among different weed management practices pre application pendimethalin @ 1000 g ha^{-1} followed by brown manuring *fb* bispyribac sodium @ 25 g ha^{-1} at 25 DAS/ DAT or hand weeding at 15, 30, 45 and 60 DAS/T was found effective in controlling weeds and increase in the quality and quantity of rice.

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