



Effect of Weed Management Practices and Fertilizer Levels on Crop Nutrient Uptake and Weed Nutrient Removal in the Hybrid Rice

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Authors' contributions

This work was carried out in collaboration among all authors. Author PN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RSS and PV managed the analyses of the study. Author YNMB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Comparative evaluation of weed management practices and fertilizer levels on crop nutrient uptake and weed nutrient removal in the hybrid rice.

Study Design: The experiment was laid out in split-plot design with weed management in main-plot and fertilizer levels in sub-plot and was replicated thrice.

Place and Duration of Study: Experiment was performed during the kharif period of 2017 at the Research Farm, TCA, Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (BIHAR).

Methodology: The experiment was performed with twelve treatments in a split plot design. The main plot comprised four different weed management practices and under the sub-plot there were three fertilizer levels. Rice hybrid "ARIZE-6444" was taken as the test variety. Observations of the crop and weeds during the experimental duration were recorded at regular intervals, to assess the probable relationship between growth attributes and the final yield. The significance of the treatment impact was examined by the F test.

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Results: Among weed management practices, maximum uptake by rice with respect to nitrogen (152.85 Kg/ha), phosphorous (45.79 Kg/ha) and potassium (187.13 Kg/ha) and minimum removal by weed regarding nitrogen (1.30 Kg/ha), phosphorous (0.54 Kg/ha) and potassium (1.85 Kg/ha) was recorded in treatment hand weeding twice which was observed statistically at par with Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 25 DAT.

Among fertilizer levels, application of 150 per cent RDF registered the highest portion of nitrogen (130.52 Kg/ha), phosphorous (40.40 Kg/ha) and potassium (164.49 Kg/ha) uptake by rice crop and nutrient removal through weeds is nitrogen (10.65 Kg/ha), phosphorous (4.84 Kg/ha) and potassium (15.59 Kg/ha) of, and respectively.

Conclusion: Among different weed management practices combined application of Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at @) DAT or hand weeding twice (20 and 40 DAT) was found effective in controlling weeds and increase in the quality and quantity of rice. Among fertilizer levels application of 125% RDF 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: Crop nutrient uptake; herbicide combination; weed nutrient removal; fertilizer levels.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop of India and also half of the world's population depends on it for food, calories and protein. The world's total area under paddy cultivation is 161.1 Mha and production was about 480.3 MT (2016-17), along with an average productivity of 2.98 t/ha (STATISTA-The statistics portal, 2016-17). The most tested technology available to dramatically improve rice production is hybrid technology. On average, the recently grown rice hybrids give 10 to 15 q/ha more yield than conventional varieties (about 20 per cent increase). General agriculture losses due to detrimental factors have been given below-Gupta, O. P. (2014).

Weeds are widely seen as pests of major agricultural threat because they pose serious challenges, causing serious nutrient, moisture, solar energy and space competition in crop plants. The extent of damage caused by weeds in a particular crop depends on weed flora, weed intensity and weed growth. Yield reduction in transplanted rice has been reported to be 28-45% due to uncontrolled weeds (Singh et al. 2003). 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 [1]. 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, a more effective and rapid control of weeds in time is the chemical method. 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.

In particular, several hybrid rice varieties respond to fertilization significantly. In order to sustainably achieve the production goal, nutrient management should be sound. The most rapid way of counteracting nutrient exploration is the use of chemical fertilisers. It encourages rice crop growth, production and accounts for more than 50% of crop yield. It responds to the proper application of nitrogen, phosphorous and potassium fertiliser and produces a high yield (HYV) yield at Singh and Virimani [2]. The main nutrient in rice production is nitrogen. It is one of the major and most essential nutrients that has a direct impact on rice growth, production, yield and quality. Phosphorus is the next limiting factor that decreases rice productivity, since it is essential for division of cells, seed formation, plant maturation, root growth and development. Potassium fertilisation affects the phenomenon of grain filling and seed lodging.

Taking the above facts into consideration, the present investigation was carried out to study the "Effect of weed management practices and fertilizer levels on crop nutrient uptake and weed nutrient removal in the hybrid rice".

2. MATERIALS AND METHODS

A field research study was carried out at the Research Farm, TCA, Dholi, Dr. Rajendra

Prasad Central Agricultural University, in Pusa, Samastipur (BIHAR). during the *Kharif* season of 2017. The experiment was performed with twelve treatments in a split plot design. There were four different weed management practices in the main block, i.e. W₁ (Bispyribac-sodium @ 25 g/ha at 20 DAT), W₂ (Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT), W₃ (Hand weeding twice at 20 and 40 DAT), W₄ (Weedy check) and under the sub-plot, there were three fertilizer levels i.e. F₁ (100% RDF), F₂ (125 % RDF) and F₃ (150% RDF), which were replicated thrice. As a test variety, the rice hybrid "ARIZE-6444" was used. Sandy loam in texture with moderately alkaline reaction (pH 8.20), low in organic carbon (0.39%), available N (207.30 kg/ha), P₂O₅ (16.55 kg/ha). and K₂O (132.80 kg/ha). The treatments were randomized as per the procedure given by [3].

Good quality of seeds of cultivar, ARIZE-6444 @ 13 kg/ha was sown on well prepared nursery bed for transplanting method of establishment. Two seedlings per hill of 21 days old seedlings were transplanted at a spacing of 0.2 m² in the field. The crop was fertilized with 100 kg N/ha, 60 kg P₂O₅/ha, 50 kg K₂O/ha and 25 kg ZnSO₄/ha based on RDF in different treatment plots. Nitrogen was applied in the form of diammonium phosphate and urea (46%N), whereas, Phosphate, Potassium and Zinc were applied in the form of DAP (46% P₂O₅), Muriate of Potash (60% K₂O) and Zinc Sulphate (25% Zn), respectively. Nitrogen was applied in three splits i.e. 25 per cent at the time of sowing, 50 per cent at the active tillering stage and 25 per cent at the panicle initiation stage. The entire quantity of phosphorus and potassium was applied as basal. Before the last puddling process Zinc sulphate was provided @ 25 kg/ha. As per the treatments, herbicide Bispyribac-sodium @ 25 g/ha was applied at 20 days after transplanting in W₁. A combination of Bispyribac-sodium @ 25 g/ha and Pyrazosulfuron @ 25 g/ha was applied at 20 days after transplanting in W₂. Two hand weedings were done at 20 and 40 days after transplanting manually (using khurpi) in W₃. W₄ was kept as a weedy check. The crop was harvested when leaves turned brown and ear head gave a metallic sound when the wind blows. Harvested five representative plants from each plot and collected weed samples are shade dried, then oven dried for 48 hours at 65°C, were grinded and passed through 0.5 mm sieve. The powdered samples were stored in a container for nutrient content analysis. The required quantity of sample was weighed out accurately in an

electronic balance, subjected to acid digestion for carrying out the chemical analysis. Based on the nutrient content in straw and paddy grain at harvest of the crop, the uptake of NPK of rice was worked. The weed samples collected from each plot at harvest were subjected to analysis of Nitrogen, phosphorous and potassium content and expressed in per cent. Nutrient uptake by rice and nutrient removal by weed was calculated as the product of nutrient concentration and respective crop and weed dry weight sample and expressed as kg/ha.

$$\text{Nutrient removal (Kg/ha)} = \frac{[\text{Nutrient content (\%)} \times \text{weed drymatter}]}{100}$$

The significance of the treatment impact was examined by the F test. Standard errors of variances were calculated and recorded simultaneously with the summary results. Critical differences for various groups of treatments at a 5% level of significance were computed.

3. RESULTS AND DISCUSSION

3.1 Effect of Weed Management Practices on Nutrient Uptake by Rice

Observation on nutrient uptake by crop as affected by different treatments was calculated. The Statistical analyzed the mean data concerning nutrient uptake by crop has been summarized and tabulated in Table.1. Citation of data regarding nutrient uptake showed that weed management practices exerted significant effect concerning nitrogen, phosphorous and potassium uptake over weed check (67.60 Kg/ha), (23.30 Kg/ha) and (93.84 Kg/ha) respectively. Among the weed management practices the highest nitrogen, phosphorous and potassium uptake was recorded in hand weeding twice (152.85 Kg/ha), (45.79 Kg/ha) and (187.13 Kg/ha) which was found statistically at par over the combined application of Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha and significantly superior over-application of Bispyribac-sodium @ 25 g/ha alone and weed check.

Significantly higher values of nutrient uptake by rice in W₂ and W₃ could be attributed to the fact that in both the treatments there was effective suppression of weeds brought about by maintaining weed free environment and unfavorable conditions created by combined application of selective herbicides might have turned advantageous for better growth of rice in

the absence of competing weed flora which ultimately led to greater drymatter production. The uptake being the product of nutrient content and drymatter 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.

Severe weed competition noticed in the weedy check plots (W4) might have robbed away the available nutrients due to higher competitive ability of weed flora compared to rice to produce minimum plant drymatter and consequently lower uptake of nutrient by rice. The results are following those of Shekhar et al. [4], Yadav et al. (2007) and Singh et al [5].

3.2 Effect of Fertilizer Levels on Nutrient Uptake by Rice

The effect of fertilizer level turned out to be a significant effect with regard to Nitrogen, phosphorous and potassium uptake. Application of 150% RDF recorded high (130.52 Kg/ha),

(40.40 Kg/ha) and (164.49 Kg/ha) nitrogen, phosphorous and potassium uptake respectively, but was found at par with 125% RDF and significantly superior over 100% RDF. The cause may be a proportionately higher supply of nutrients and also as a direct biological feature of the nutrient uptake of a crop. The plot that produced higher biological yields had increased absorption rate of nutrients during its crop growth period. Significantly lower nutrient absorption by crop was attributed due inadequate availability of nutrient at the root zone, consequent effect on low nutrient content and poor drymatter production of rice reduced biological yield as extreme nutrient competition existed among rice plant. A similar finding was reported by Thomas et al. [6], Ramachandiran and Balasubramanian [7], Rishi raj et al. [8].

3.3 Effect of Weed Management Practices on Nutrient Removal by Weeds

Nutrient removal by weed was mainly influenced by weed flora and vigor. The Statistical analyzed the mean data concerning nutrient removal by weed has been summarized and tabulated in Table.2.

Table 1. Nutrient Uptake by rice from different treatments

Treatment	N uptake (Kg/ha)			P uptake (Kg/ha)			K uptake (Kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Weed Management									
Bispyriback sodium @ 25 g /ha at 20 DAT	70.92	39.57	110.49	18.08	17.72	35.80	33.39	111.86	145.25
Bispyriback sodium @ 25 g /ha + Pyrazosulfuron @25 g/ha at 20 DAT	91.39	51.90	143.28	22.12	21.27	43.39	40.51	138.23	178.74
Hand weeding twice (20 and 40 DAT)	98.71	54.14	152.85	23.33	22.46	45.79	42.10	145.04	187.13
Weedy check	44.14	23.46	67.60	11.76	11.54	23.30	21.78	72.06	93.84
S. Em.±	1.39	1.56	2.54	0.32	0.29	0.59	0.61	2.24	2.84
CD (P=0.05)	4.89	5.51	8.96	1.12	1.01	2.08	2.15	7.89	10.01
Fertilizer levels									
100 % RDF.	66.43	36.73	103.16	16.45	16.28	32.73	30.57	103.01	133.58
125 % RDF.	78.84	43.14	121.98	19.32	18.78	38.10	35.48	120.19	155.66
150 % RDF	83.59	46.93	130.52	20.70	19.70	40.40	37.29	127.20	164.49
S. Em.±	2.79	2.53	5.14	0.72	0.65	1.37	1.14	4.52	5.66
CD (P=0.05)	8.44	7.65	15.53	2.18	1.97	4.14	3.46	13.66	17.10

Table 2. Nutrients removal by weed as affected by different treatments

Treatment	N removal (Kg/ha)	P removal (Kg/ha)	K removal (Kg/ha)
Weed Management			
Bispyribac sodium @ 25 g /ha at 20 DAT	8.16	3.24	11.20
Bispyribac sodium @ 25 g /ha + Pyrazosulfuron @25 g/ha at 20 DAT	3.13	1.24	4.14
Hand weeding twice (20 and 40 DAT)	1.30	0.54	1.85
Weedy check	23.55	10.61	34.02
S. Em.±	1.11	0.60	1.73
CD (P=0.05)	3.92	2.11	6.10
Fertilizer levels			
100 % RDF.	7.10	2.75	9.43
125 % RDF.	9.40	4.13	13.39
150 % RDF	10.65	4.84	15.59
S. Em.±	0.75	0.40	1.14
CD (P=0.05)	2.26	1.22	3.46

Citation of data regarding nutrient removal by weed showed that weed management practices exerted a significant effect. Among the weed management practices the lowest nitrogen (1.30 Kg/ha), phosphorous (0.54 Kg/ha) and potassium (1.85 Kg/ha) removal was recorded in hand weeding twice, which was found statistically at par over the combined application of Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha and significantly superior over application of Bispyribac-sodium @ 25 g/ha alone and weedy check. Due to reduced weed density and weed dry matter production, lower nutrient extraction due to weeds was observed in hand weeding. Herbicidal mixture (Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha) also had significant impact in weed removal because of the broad-spectrum action of Bispyribac-Sodium and Pyrazosulfuron.

Significantly lower values of nutrient removal by weeds in W_2 and W_3 could be attributed to the fact that in both the treatments there was effective suppression of weeds brought about by maintaining weed free environment and an unfavorable condition had been created for weed growth due to combined application of selective herbicides in treatment W_2 . Hand weeding twice effectively controlled the weed population and late flushes of weeds nearly failed to emerge after second hand weeding which might be responsible for recording the lower weed dry weight. Herbicidal mixture (Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha) also showed significant effect in lowering weed dry matter production due to suppression of weed

population at early stage of crop growth because of their broad spectrum activity. These herbicides are absorbed and translocated in the whole weed plant by roots and foliage. After reaching the target site these herbicides destroy the weeds by inhibiting the synthesis of plant amino acid— acetohydroxyacide synthase AHAS, which contributed to lower production of weed dry matter. Since the nutrient removal being the product of nutrient content and drymatter production of weed. These treatments contributed to lower production of weed dry matter and led a least nutrient removal by weed. The results are following those of Moorthy [9], Payman and Singh [10].

3.4 Effect of Weed Management Practices on Nutrient Removal by Weeds

The effect fertilizer level turned out to be a significant effect regard nutrient removal by weeds. Among the fertilizer levels, application of 100% RDF recorded the lowest nitrogen (7.10 Kg/ha), phosphorous (2.75 Kg/ha) and potassium (9.43 Kg/ha) nutrient removal by weed, found statistically at par with treatment 125% RDF and significantly inferior over rest of the treatments. Higher nutrient removed by weed was recorded in 150% RDF with Nitrogen (10.65 Kg/ha), Phosphorous (4.84 Kg/ha) and Potassium (15.59 Kg/ha). Nutrient removal by weeds was strongly influenced by fertilizer levels. Increased in availability of nutrients to weeds from soil caused a greater absorption of nutrients by weeds, resulting greater extent of nutrient removal by weed. A similar finding was reported by Ramachandiran and

Balasubramanian [7], Singh et al. (2014). Rishi raj et al. [8].

4. CONCLUSION

In view of the present experiment conducted in only single place for one season, the following general conclusions concerning the absorption of nutrients by crop and the removal of nutrient by weed may be drawn. Among different weed management practices combined application of Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at @) DAT or hand weeding twice (20 and 40 DAT) was found effective in controlling weeds and increase in the quality and quantity of rice. Among fertilizer levels application of 125% RDF was found effective in increase in the yield, nutrient content of the crop and substantially reduction of nutrients removed by weed in rice field.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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