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Effect of plant geometry and nutrient management on nutrient content and uptake of red rice cultivars

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Abstract
An experiment was carried out during *kharif* season of 2016 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment was laid out in split plot design with three replications keeping two red rice cultivars viz., Bantha luchai and Mokdo with two spacing 20 cm x 10 cm and 15 cm x 10 cm in main plots and four nutrient management i.e application of 100% RDF, 75% RDF, 50% RDF + 50% RDN through FYM and 100% RDN through FYM in sub plots. The recommended dose of fertilizers for red rice was 80: 60: 40 kg ha^{-1} N, P_2O_5 and K_2O, respectively. The result revealed that red rice variety Mokdo with spacing 20 x 10 cm obtained significantly maximum Nutrient content and uptake as compared to other varieties. As regards to nutrient management, soil application of 50% RDF + 50% RDN through FYM recorded maximum Nutrient content and uptake.

Keywords: nutrient, content, uptake

Introduction
Rice *(Oryza sativa* L.) is the most important cereal crop in Asia. In the world, 85% of the total rice area is in Asia. Rice production must increase 65% between the years 1990 and 2020 in order to keep pace with population growth in countries where rice is the main food crop (Fageria, 2007) [3]. India is the second largest producer and consumer of rice in the world. Area under rice crop in India is about 43.95 MT with production of 103 MT and productivity of 2424 kg ha^{-1} during 2013-14 (Anonymous, 2014) [2]. Chhattisgarh is known as "Rice bowl of India" and about 82% population of the state is dependent on agriculture for their livelihood. The total rice grown area in Chhattisgarh is 3.61 million hectares with production of 6.36 million tonnes and productivity of 2.0 tonnes ha^{-1} (Anonymous, 2013-14) [1]. Rice with a red bran layer is called red rice. Though the color is confined to the bran layer, a tinge of red remains even after a high degree of milling. The color of the bran range from light to dark red. The bran layer contains polyphenols and anthocyanin and possesses antioxidant properties. The inner portion of red and white rice is alike and white. The zinc and iron content of red rice is 2-3 times higher than that of white rice (Ramaiah and Rao. 1953) [6].

Materias and Methods
The experiment was conducted at IGKV, Raipur during kharif 2016 and was laid out in split plot design with three replications keeping two red rice cultivars viz., Bantha Luchai and Mokdo with two spacing 20 x 10 cm and 15 x 10 cm in main plots and four nutrient management i.e soil application of 100% RDF, 75% RDF, 50% RDF + 50% RDN through FYM and 100% RDN through FYM in sub plots. The soil of experimental field was '*Vertisols*', low in nitrogen (184.20 kg ha^{-1}), medium in phosphorus (10.12 kg ha^{-1}) and medium in potassium (252.6 kg ha^{-1}) contents with normal pH (6.8). The recommended dose of fertilizers for red rice was 80: 60: 40 kg ha^{-1} N, P_2O_5 and K_2O, respectively and applied through urea, single super phosphate and muriate of potash. Half dose of N, entire dose of P and K were applied after one week of transplanting and remaining half of the nitrogen through urea were top dressed at tillering and panicle initiation stage in equal amount. One seedling was transplanted in each hill at 20 cm x 10 cm and 15 cm x 10 cm spacing on 27 July 2016 and harvested on 7 November 2016.

Results and Discussion

Nutrient content and uptake

N, P and K content in grain and straw

N, P and K content in grain and straw were determined at harvest and data are presented in Table 1. Data showed that the N, P and K content in grain and straw varied of red rice cultivars significantly due to plant geometry and nutrient management except N content in grain due to nutrient management. The maximum N, P and K content in grain and straw was recorded with Mokdo + 20 cm x 10 cm. The minimum N, P and K content in grain and straw was observed with Bantha luchai + 15 cm x 10 cm.

The maximum N, P and K content in straw was obtained higher with 75% RDF as compared to other treatments. Minimum N, P and K content in grain and straw was recorded with100% RDN through FYM.

Table 1: Effect of plant geometry and nutrient management on nutrient content in grain straw of red rice cultivars

Treatment	N content (%)		P content (%)		K content (%)		Zn content (ppm)		Fe content (ppm)	
	grain	straw	grain	straw	grain	straw	grain	straw	grain	straw
Variety + plant geometry										
Bantha luchai + 20 cm x 10 cm	1.08	0.38	0.44	0.41	0.48	0.27	10.84	16.16	20.05	32.33
Bantha luchai + 15 cm x 10 cm	1.06	0.36	0.43	0.37	0.46	0.24	10.52	15.16	18.74	31.88
Mokdo + 20 cm x 10 cm	1.25	0.66	0.55	0.18	0.76	0.18	11.44	18.17	22.29	33.18
Mokdo + 15 cm x 10 cm	1.12	0.40	0.47	0.16	0.50	0.23	11.05	16.78	20.73	32.50
SEm±	0.04	0.04	0.02	0.09	0.04	0.03	0.23	0.98	0.58	0.32
CD at 5%	0.12	0.15	0.08	NS	0.15	NS	NS	NS	1.99	NS
Nutrient management										
100% RDF	1.11	0.40	0.48	0.33	0.50	0.19	10.98	16.66	21.15	32.83
75% RDF	1.20	0.61	0.53	0.29	0.71	0.19	10.89	16.34	19.79	32.17
50% RDF + 50% RDN (FYM)	1.12	0.42	0.42	0.26	0.52	0.25	11.30	18.26	22.03	33.12
100% RDN (FYM)	1.09	0.36	0.46	0.24	0.46	0.28	10.69	15.01	18.84	31.78
SEm±	0.04	0.06	0.02	0.06	0.06	0.04	0.20	1.00	1.14	0.29
CD at 5%	NS	0.18	0.06	NS	0.18	NS	NS	NS	NS	0.84

Table 2: Effect of plant geometry and nutrient management on uptake N, P_2O_5, K_2O Zn and Fe (kg ha^{-1})) on red rice cultivars

	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			Zn uptake (kg ha^{-1})			Fe uptake (kg ha^{-1})		
Treatment	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Variety + plant geometry															
Bantha luchai +20 cm x 10 cm	41.9	26.7	68.5	17.9	24.8	42.7	18.7	16.4	35.14	40.9	105.7	146.6	75.4	208.2	281.77
Bantha luchai + 15 cm x 10 cm	39.5	24.7	64.1	16.8	26.4	43.2	17.2	15.1	32.27	40.5	97.8	138.3	73.6	206.4	281.81
Mokdo + 20 cm x 10 cm	56.0	33.9	89.9	21.7	15.3	37.0	36.0	14.8	50.77	51.3	155.0	206.3	104.2	284.2	388.36
Mokdo + 15 cm x 10 cm	48.1	30.7	78.7	19.0	13.4	32.5	20.8	18.9	39.71	48.3	129.4	177.7	76.7	264.7	341.35
SEm±	1.9	2.0	2.3	0.7	6.4	6.4	1.7	1.6	2.95	1.6	7.1	7.5	3.1	15.7	16.93
CD at 5%	6.7	6.9	7.8	2.4	NS	NS	6.0	NS	10.20	5.6	24.7	26.1	10.8	54.2	58.59
Nutrient management															
100% RDF	45.0	30.8	75.8	19.8	12.7	32.5	19.9	17.9	37.9	47.0	133.4	180.4	89.2	236.6	325.80
75% RDF	43.7	24.9	68.6	17.2	24.4	41.6	21.4	14.0	35.45	43.3	119.3	162.6	80.8	250.4	331.20
50% RDF + 50% RDN (FYM)	52.2	35.8	88.0	22.1	22.6	44.7	31.2	15.6	46.79	47.4	133.5	180.9	95.8	265.2	361.00
100% RDN (FYM)	44.5	24.4	68.9	16.3	20.2	36.5	20.0	17.8	37.80	43.2	101.9	145.1	64.0	211.2	275.20
SEm±	1.9	2.9	3.4	1.1	5.0	5.6	3.0	2.9	4.13	1.6	9.0	9.1	5.6	11.0	10.92
CD at 5%	5.7	8.6	9.9	3.3	NS	NS	8.8	NS	NS	4.5	26.3	26.5	16.2	32.0	31.88

Zn and Fe content in grain and straw

The data presented in Table 1. Revealed that zinc content (ppm) in grain and straw was not influenced significantly due to red rice varieties, plant geometry and nutrient management. The data with respect to iron content (ppm) in grain is presented in Table 1. Iron content in grain was significantly affected due to different varieties and plant geometry. The higher iron content in grain was recorded with Mokdo + 20 cm x 10 cm (22.29 ppm) and it was statistically at par with Mokdo + 15 x 10cm (20.73 ppm) Minimum iron content in grain was recorded with Bantha luchai + 20 cm x 10 cm (18.74 ppm). Iron content in straw did not show significant effect due to different variety and plant geometry. The minimum iron content in straw was recorded with application of 50% RDF + 50% RDN through FYM.

Nitrogen uptake in grain and straw

The data with respect to nitrogen uptake (kg ha^{-1}) by grain, straw and total (Grain + straw) uptake are presented in Table 2. Nitrogen uptake by grain, straw and total nitrogen uptake were significantly affected due to the varieties and plant geometry. The maximum nitrogen uptake in grain, straw and total (Grain + straw) was recorded with Mokdo + 20 cm x 10 cm. The minimum nitrogen uptake in grain, straw and total (Grain + straw) was recorded with Bantha luchai + 15 cm x 10 cm.

In case of nutrient management, maximum nitrogen uptake by grain, straw and total (Grain + straw) was recorded with 50% RDF + 50% RDN through FYM as compared to other treatment. Minimum nitrogen uptake in grain, straw and total was recorded with 75% RDF.

Increased uptake of nutrient may be attributed to improved nutrient availability as a consequence of synergetic relationship between the organic and inorganic source. These results are in conformity with the findings of Suresh and Ramasubba Reddy (2002) [7]. Similar result has been reported by Subramaniyam and Kumaraswamy (2007), Katyal and Sharma (1979) [5] and Jadhav *et al.* (2008) [4]. Significantly higher nutrient uptake of nitrogen, phosphorus and potassium were recorded with wider spacing as compared to other spacing. Higher nutrient uptake by rice plant was due to well developed root system.

Phosphorus uptake in grain and straw

The data with respect to phosphorus uptake (kg ha^{-1}) by grain, straw and total (Grain + straw) are presented in Table 2. Phosphorus uptake by grain, straw and total phosphorus uptake were significantly affected due to the varieties, plant geometry and nutrient management, except straw and total phosphorus uptake. The maximum phosphorus uptake in grain was recorded with Mokdo + 20 cm x 10 cm. The minimum phosphorus uptake in grain recorded with Bantha luchai + 15 cm x 10 cm.

In case of nutrient management, maximum phosphorus uptake by grain was recorded with 50% RDF + 50% RDN through FYM as compared to other treatment. Minimum phosphorus uptake in grain was recorded with 75% RDF.

Similar result has been reported by Subramaniyam and Kumaraswamy (2007), Katyal and Sharma (1979) [5] and Jadhav *et al.* (2008) [4].

Potassium uptake in grain and straw

The data with respect to potassium uptake (kg ha^{-1}) by grain, straw and total (grain + straw) are presented in Table 2. Potassium uptake by grain and total potassium uptake were significantly affected due to the varieties and plant geometry except straw. The maximum potassium uptake in grain and total (grain + straw) were recorded with Mokdo + 20 cm x 10 cm followed by Mokdo + 15 cm x 10 cm. Minimum potassium uptake in grain and total was recorded with Bantha luchai + 15 cm x 10 cm.

In case of nutrient management, maximum potassium uptake by grain and total (grain + straw) was recorded with 50% RDF + 50% RDN through FYM as compared to other treatment except straw. The maximum potassium uptake by grain was recorded with 50% RDF + 50% RDN through FYM. Minimum potassium uptake in grain, straw and total was recorded with 75% RDF.

Similar results has been reported by Subramaniyam and Kumaraswamy (2007), Katyal and Sharma (1979) [5] and Jadhav *et al.* (2008) [4].

Zinc uptake in grain and straw

The data with respect to zinc uptake (kg ha^{-1}) by grain, straw and total (grain + straw) are presented in Table 2. Zinc uptake by grain, straw and total zinc uptake were significantly affected due to the varieties and plant geometry. The maximum zinc uptake by grain, straw and total (grain + straw) were recorded with variety Mokdo + 20 x 10 cm. However, it was statistically at par with Mokdo + 15 cm x 10 cm in grain zinc uptake. Minimum zinc uptake in grain, straw and total zinc uptake was recorded with Bantha luchai + 15 cm x 10 cm.

In case of nutrient management, the plants fertilized with 50% RDF + 50% RDN through FYM recorded more zinc uptake by grain, straw and total (grain+ straw) as compared to other treatment and it was statistically at par with application of 100% RDF and 75% RDF. Minimum zinc uptake in grain, straw and total (grain + straw) recorded was under 100% RDN through FYM.

Similar results has been reported by Subramaniyam and Kumaraswamy (2007), katyal and Sharma (1979) [5] and jadhav *et al.* (2008) [4].

Iron uptake in grain and straw

The data with respect to iron uptake (kg ha^{-1}) by grain, straw and total (grain + straw) are presented in Table 2.Iron uptake by grain, straw and total iron uptake were significantly affected due to the varieties and plant geometry. Significantly higher iron uptake by grain, straw and total (grain + straw) were recorded with Mokdo + 20 cm x 10 cm and it was statistically at par with Mokdo + 15 cm x 10 cm in grain and total iron uptake. Minimum iron in grain, straw and total iron uptake was recorded with Bantha luchai + 15 cm x 10 cm.

In case of nutrient management, the plants fertilized with 50% RDF + 50% RDN through FYM recorded more iron uptake by grain, straw and total (grain+ straw) as compared to other treatment and it was statistically at par with 100% RDF and 75% RDF. Minimum iron uptake in grain, straw and total (grain + straw) was recorded with application of 100% RDN through FYM.

Similar results has been reported by Subramaniyam and Kumaraswamy (2007), Katyal and Sharma (1979) [5] and Jadhav *et al.* (2008) [4].

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