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Nutrient Content and Uptake by Grain and Straw of different rice Varieties at Different moisture Regimes under direct Seeded Condition

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Abstract
A field experiment was carried out at Crop Research Centre of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar during Kharif (2018) in split plot design with three replications in order to evaluate the three different rice varieties at different moisture regimes. The treatments in main plot consisted of four moisture regimes i.e., M_1-AWD at 3 Days (Irrigation was applied at 3 days after disappearance of ponded water), M_2-AWD at 5 Days (Irrigation was applied at 5 days after disappearance of ponded water), M_3-Saturation level till physiological maturity (Irrigation was applied at zero soil moisture potential) and M_4-10 % of moisture depletion (Irrigation was applied at 10 % moisture depletion of Field capacity) and in sub plot consisted of three varieties i.e., V_1-Rajendra Neelam, V_2-Abhishek and V_3-Rajendra Saraswati. The results revealed that N, P and K content in grain and straw of all the three varieties were not significantly influenced due to moisture regimes and with the varieties. The N, P and K uptake were significantly influenced by rice grain and straw at different moisture regimes and also with the different rice varieties. However, maximum value of N, P and K uptake by grain and straw were recorded with the moisture regime of M_1-AWD at 3 Days which was significantly superior to M_2-AWD at 5 Days and M_4-10% of moisture depletion but was found statistically at par with moisture regime of M_3-Saturation level till physiological maturity. Among different rice varieties, maximum N, P and K uptake by grain and straw were recorded with V_1-Rajendra Neelam and it was significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati.

Keywords: Direct seeded rice, Moisture regimes, Varieties, Nutrient content, Uptake

1. Introduction
Rice (*Oryza sativa* L.) is one of the most essential cereal crops of the world, which grown in extensive range of climatic regions. Rice is the staple food for nearly half of the world's population, most of whom live in various developing countries. The crop occupies one-third of the world's total area cultivated to cereals and provides 35 to 60% of the calories consumed by 2.7 billions of people.

Rice has low water use efficiency and consumes about 5000 litres of water in order to produce 1 kilogram of rice under traditional method of rice cultivation. Irrigated low land receives 24-30 per cent of global fresh water resources (Bouman *et al*., 2007) [1]. Total area under rice cultivation has been declining due to increased rate of water scarcity at global level.

Conventional method of rice cultivation requires higher water requirement in order to flood the soil throughout crop growing period. Repeated puddling also damages the soil structure which abrupt the movement of gases. In order to preserve natural resources especially water, there is need to replace the practice of puddle transplanted rice to direct seeding technology. Direct seeded rice crop has a higher nutrient requirement as compared to a transplanted crop because of the higher plant density and greater production of biomass in the vegetative phase (Dingkuhn *et al*., 1990) [3].

Also, the advent of high yielding short duration upland rice varieties, which respond well to water management and nutrient application has shown some promise in this direction under upland condition as well. Therefore, to study the efficacy of different moisture regimes and varieties on direct seeded rice, the present investigation was undertaken.

Materials and methods:
A field experiment was carried out at Crop Research Centre of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar during Kharif (2018) in split plot design with three

Replications in order to evaluate the three different rice varieties at different moisture regimes. The treatments in main plot consisted of four moisture regimes i.e., M_1-AWD at 3 Days (Irrigation was applied at 3 days after disappearance of ponded water), M_2-AWD at 5 Days (Irrigation was applied at 5 days after disappearance of ponded water), M_3-Saturation level till physiological maturity (Irrigation was applied at zero soil moisture potential) and M_4-10 % of moisture depletion (Irrigation was applied at 10 % moisture depletion of Field capacity) and in sub plot consisted of three varieties i.e., V_1-Rajendra Neelam, V_2-Abhishek and V_3-Rajendra Saraswati.

The source of fertilizers used were urea (46% N) for nitrogen, DAP (18% N and 46% P_2O_5) for nitrogen and phosphorous and MOP (60% K_2O) for potassium. Application of half (50%) dose of nitrogen and total phosphorous and potash and $ZnSO_4$ (25 kg/ha) were applied as basal and remaining dose of nitrogen in two equal splits (25% active tillering stage and 25% N at panicle initiation stage).

Nitrogen content (%) in grain and straw was estimated by semi-microkjelhal apparatus as described by Jackson (1973). Content of phosphorous in plant was determined by Vanodomolybdate phosphoric yellow colour method by using spectrophotometer at 470 nm wavelength and the concentration was expressed in percentage. Content of potassium in plant was estimated using flame photometer (Jackson, 1973) and the concentration was expressed in percentage.

Based on the nutrient content in grain and straw of rice crop, the uptake of N, P and K was worked out and expressed in kg/ha using the following formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Percent nutrient content in grain or straw x yield (kg/ha)}}{100}$$

Results and discussion

N, P and K content (%) in grain and straw

Mean data pertaining to N, P and K content in grain and straw has been summarized and presented in Table-1. N, P and K content were not significantly influenced due to moisture regimes and also with the rice varieties. However, the highest value of 1.158, 0.314 and 0.275 N, P and K content in grain and 0.582, 0.154 and 1.395 N, P and K content in straw, respectively were recorded with moisture regime of M_1-AWD at 3 Days. Similarly, N, P and K content were not significantly influenced due to varieties. However, the maximum value of 1.151, 0.310 and 0.258 N, P and K content in grain and 0.579, 0.147 and 1.384 N, P and K content in straw, respectively were recorded with the variety V_1-Rajendra Neelam.

Mean data related to N, P and K uptake by grain and straw was statistically analyzed and have been presented in Table-2. N, P and K uptake indicates that moisture regimes significantly influenced by rice grain and straw. However, maximum value of N, P and K uptake (48.67, 13.21 and 11.55 kg/ha by grain & 34.95, 9.29 and 83.70 kg/ha by straw) were recorded with the moisture regime of M_1-AWD at 3 Days which was significantly superior to M_2-AWD at 5 Days (38.94, 10.32 and 8.25 kg/ha by grain & 28.33, 6.31 and 67.80 kg/ha by straw) and M_4-10% of moisture depletion (34.00, 8.78 and 6.62 kg/ha by grain & 24.26, 5.25 and 57.76 kg/ha by straw) but was found statistically at par with moisture regime of M_3-Saturation level till physiological maturity (45.22, 12.13 and 10.30 kg/ha by grain & 32.63, 8.33 and 78.18 kg/ha by straw). This might be due to adequate supply of moisture leading to increase in total grain yield and also enhancing the nutrient content in grain and straw. The results are correlated with Parihar (2004) and Das *et al.* (2016) [5, 2].

Likewise, Citation of mean data pertaining to N, P and K uptake by rice grain and straw due to rice rice varieties were found to be significant. The maximum N, P and K uptake (46.26, 12.50 and 10.46 kg/ha by grain & 33.52, 8.57 and 80.01 kg/ha by straw) was recorded with V_1-Rajendra Neelam and was significantly superior to V_2-Abhishek (42.73, 11.45 and 9.33 kg/ha by grain & 30.69, 7.29 and 73.27 by straw) and V_3-Rajendra Saraswati (36.14, 9.38 and 7.76 kg/ha by grain & 25.92, 6.02 and 62.30 kg/ha). This might be due to the genetic makeup of the variety in terms of total biomass production and the responsiveness of the variety towards nutrients. The results are supporting with results of Mahajan *et al*. (2012) and Pradhan *et al*. (2014) [4, 6].

Table 1: N, P and K content (%) in grain and straw as affected by different moisture regimes and rice varieties

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Moisture regimes						
M_1-AWD at 3 days	1.158	0.582	0.314	0.154	0.275	1.395
M_2-AWD at 5 days	1.130	0.563	0.299	0.125	0.239	1.349
M_3-Saturation level till physiological maturity	1.145	0.574	0.306	0.146	0.260	1.374
M_4-10% of moisture depletion	1.125	0.553	0.289	0.119	0.219	1.319
SEm±	0.016	0.008	0.007	0.008	0.015	0.021
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Rice varieties						
V_1-Rajendra Neelam	1.151	0.579	0.310	0.147	0.258	1.384
V_2-Abhishek	1.141	0.568	0.305	0.134	0.247	1.357
V_3-Rajendra Saraswati	1.126	0.558	0.291	0.128	0.240	1.337
SEm±	0.007	0.008	0.006	0.005	0.006	0.013
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction M x V						
SEm±	**0.014**	**0.016**	**0.011**	**0.010**	**0.012**	**0.026**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2: N, P and K uptake (kg/ha) by grain and straw as affected by moisture regimes and rice varieties

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Moisture regimes						
M_1-AWD at 3 days	48.67	34.95	13.21	9.29	11.55	83.70
M_2-AWD at 5 days	38.94	28.33	10.32	6.31	8.25	67.80
M_3-Saturation level till physiological maturity	45.22	32.63	12.13	8.33	10.30	78.18
M_4-10% of moisture depletion	34.00	24.26	8.78	5.25	6.62	57.76
SEm±	1.36	0.96	0.38	0.49	0.45	1.37
CD (P=0.05)	4.69	3.33	1.31	1.70	1.55	4.75
Rice varieties						
V_1-Rajendra Neelam	46.26	33.52	12.50	8.57	10.46	80.01
V_2-Abhishek	42.73	30.69	11.45	7.29	9.33	73.27
V_3-Rajendra Saraswati	36.14	25.92	9.38	6.02	7.76	62.30
SEm±	0.89	0.69	0.30	0.32	0.29	1.49
CD (P=0.05)	2.67	2.06	0.91	0.96	0.86	4.47
Interaction M x V						
SEm±	**1.78**	**1.37**	**0.61**	**0.64**	**0.57**	**2.98**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

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