

Original Research Article

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Effect of Nutrient Management on Physiological Growth of Rice (*Oryza sativa* L.)

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ABSTRACT

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The field experiment was conducted at AICRP IFS Research Farm, Krishi Nagar, Jawaharlal Nehru Krishi Vishwa Vidyalaya, and Jabalpur (MP), India during *Kharif* season of 2016. The results revealed that plant height, number of tillers/hill, dry matter accumulation, leaf area index, crop growth rate, relative growth rate and net assimilation rate were higher with application of 100% NPK through fertilizers as compared to 100% N through vermicompost, 75% N through Vermicompost, Farmers practice N:60, P:30 through fertilizers + 3 tonne FYM/ha, 50% N through Vermicompost + 50% NPK through fertilizers, 75% N through vermicompost + 25% NPK through fertilizers and absolute control.

Introduction

Rice (*Oryza sativa* L.) is the staple food crop of the world. It is major source of calories for 40 % of the world population. India is the second most populous nation and the largest producer of rice in the world after China. In India, rice is covered 43.79 million ha acreage and contributing 116.42 million tonnes grain production with productivity of 2659 kg/ha (GOI, 2019). Cultivation of high yielding

dwarf varieties high responsive to fertilizer and excess use of inorganic fertilizers has depleted the inherent soil fertility. Enhancing the rice productivity through the appropriate nutrient management has been the main thrust of Indian rice policy.

The decline or stagnation in yield has been attributed to nutrient mining and reduced use of organics (John *et al.* 2001). Inorganic fertilizer is one of the key factors to increase

the rice productivity. Rice yield and biomass increased rapidly due to increased use of chemical fertilizers. Several long-term experiments conducted all over India showed that a decrease in rice productivity due to continuous use of imbalanced chemical fertilizers. As a result, agricultural ecosystems remain in a state of chemical nutrient saturation, leading to huge nutrient losses through leaching, runoff, volatilization, emissions, immobilization and subsequent low nutrient use efficiency (Zang *et al.*, 2012).

Integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production (Prasad *et al.*, 1995). Singh and Kumar (2014) reported increased yield and nutrient use efficiency in rice with organics. Organic supply of nutrients at the peak period of nutrient absorption also provide micro nutrients and modify soil-physical behavior as well as increase the efficiency of applied nutrients (Pandey *et al.*, 2007). The integrated use of use of organic and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also has been found to sustain large scale productivity goals (Yadav and Meena 2014).

In view of above fact study on nutrient management was carried out for identifying most effective nutrient source and their optimum dose for harvesting higher physiological growth of rice.

Materials and Methods

The field experiment was conducted at AICRP IFS Research Farm, Krishi Nagar, Jawaharlal Nehru Krishi Vishwa Vidyalaya, and Jabalpur (MP), India during *kharif* season of 2016. The soil of experimental field was sandy clay loam, neutral in reaction (pH 7.2) having 269.83 kg/ha available N (Alkaline

permanganate method (Subbiah and Asija, 1956), medium in available phosphorus (12.7 kg/ha, Olsen's method (Olsen *et al.*, 1954 and medium in available potassium (283.3 kg/ha, Flame photometric method (Metson, 1956) in 0-15 cm soil depth at the start of the experiment.

The experiment was laid out in randomized block design with three replications. There were seven nutrient management treatments viz. 100% N through Vermicompost, 75% N through Vermicompost, 100% NPK through fertilizers, Farmers practice N:60, P:30 through fertilizers + 3 tonne FYM/ha, 50% N through Vermicompost + 50% NPK through fertilizers, 75% N through Vermicompost + 25% NPK through fertilizers and absolute control.

The Recommended dose of fertilizer was 120 kg N, 60 P₂O₅ and 40 kg K₂O per hectare. Rice "Pusa Sugandha 1" Seedling was transplanted in first week of July with 2 to 3 seedlings/hill of 21 day of age at spacing of 20 cm × 20 cm. Rice was irrigated frequently to maintain 2 – 3 cm standing water in all the plots. The irrigation was stopped 10 days before harvesting of crop.

All the recommended package of practices was followed to raise the crop. The crop was harvested during first week of November, 2016. Leaf area index, crop growth rate, relative growth rate and net assimilation rate calculated by following the formula:

Leaf Area Index

Leaf area index is the ratio of leaf area to the area of ground cover. Leaf area index is calculated by dividing the leaf area plant⁻¹ by land area occupied by the plant. The leaf area index plant⁻¹ was calculated at 30, 60 and 90 DAT. After computing the leaf area (cm²), leaf area index was calculated by using the

following formula as suggested by Watson (1952).

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Unit land area (cm}^2\text{)}}$$

Crop growth rate

The crop growth rate is defined as the increase in rate of dry weight per unit land area per unit time. It is also represents dry weight gained by a unit area of crop in a unit time. It is expressed in $\text{g m}^{-2} \text{ day}^{-1}$. The average crop growth rate was calculated as suggested by Enyi (1962). It is given as:

$$\text{CGR} = \frac{W_2 - W_1}{P(t_2 - t_1)}$$

Where, W_2 and W_1 are the dry matter weight of the plant at time t_2 and t_1 , respectively and P is the ground area occupied by the plant in m^2 .

Relative growth rate

It is an index of the amount of growing material per unit dry weight of plant per unit time. The relative growth rate represents the dry weight gained in time interval in relation to initial weight. The mean RGR is calculated from dry weight measurement at time t_1 and t_2 suggested by Blackman (1919).

$$\text{RGR} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

Where, W_2 and W_1 are the dry matter production of the plant at time t_2 and t_1 respectively, and it is expressed in $\text{mg g}^{-1} \text{ day}^{-1}$.

Net assimilation ratio

The term NAR was used by Williams (1946). NAR is defined as dry matter increment per unit leaf area or per unit leaf dry weight per unit of time. The NAR is a measure of average photosynthetic efficiency of leaves in a crop community.

$$\text{Net assimilation rate (NAR)} = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{(\log_e L_2 - \log_e L_1)}{(L_2 - L_1)}$$

Where,

W_1 and W_2 is dry weight of whole plant at time t_1 and t_2 , respectively

L_1 and L_2 are leaf weights or leaf area at time t_1 and t_2 , respectively

t_1 and t_2 are time interval in days

Results and Discussion

Growth parameters

The results (Table 1) revealed that growth parameters *viz.*, plant height, number of tillers and dry matter accumulation of rice influenced significantly by the different fertility level. Application of 100% NPK through fertilizers recorded significantly highest plant height (19.09, 39.05, 75.53 & 74.52 cm), number of tillers/hill (8.73, 14.40, 18 & 17.78 cm) and dry matter accumulation (2.95, 9.73, 14.35 & 15.40 g/plant) of rice at 30, 60, 90 DAT and harvest as compared to rest of treatments.

The results showed that application organic manure was not helpful in increasing plant height, tiller production and dry matter accumulation of hybrid rice; rather it reduced the plant height, tiller production and dry matter accumulation.

Table.1 Effect of nutrient management on plant height, number of tillers and leaf area index of rice

Treatments	Plant height (cm)				Number of tillers/hill				Dry matter production (g/plant)			
	30 DAT	60 DAT	90 DAT	Harves t	30 DAT	60 DAT	90 DAT	Harves t	30 DAT	60 DAT	90 DAT	Harvest
100% N through Vermicompost	15.45	35.30	71.47	69.88	6.30	11.73	15.89	15.56	2.40	8.48	13.45	14.70
75% N through Vermicompost	14.59	33.45	70.64	69.03	5.83	11.20	15.22	15.11	1.90	8.33	13.29	14.35
100% NPK through fertilizers	19.09	39.05	75.53	74.42	8.73	14.40	18.00	17.78	2.95	9.73	14.35	15.40
Farmers practice N:60, P:30 through fertilizers + 3 tonne FYM/ha	13.67	32.03	68.76	67.43	5.40	9.97	14.66	14.55	1.58	7.34	12.34	13.24
50% N through Vermicompost + 50% NPK through fertilizers	16.92	37.37	74.40	72.49	7.73	13.17	17.11	16.78	2.76	9.19	14.07	15.34
75% N through Vermicompost + 25% NPK through fertilizers	16.25	35.89	73.01	71.04	7.07	12.50	16.34	16.22	2.35	9.02	13.60	14.50
Absolute control	10.94	25.62	63.27	61.81	3.50	7.63	10.55	10.33	1.08	6.65	11.36	12.88
SEm±	0.36	0.60	0.62	0.69	0.152	0.254	0.530	0.498	0.10	0.40	0.50	0.70
CD at 5%	1.12	1.84	1.91	2.15	0.469	0.782	1.635	1.535	0.33	1.25	1.54	2.18

Table.2 Effect of nutrient management on dry matter production, crop growth rate, relative growth rate and net assimilation rate of rice

Treatments	Leaf area index			Crop growth rate (g/m ² /day)			Relative growth rate (g/g/day)			Net assimilation rate (g/day/m ²)		
	30 DAT	60 DAT	90 DAT	0 – 30 DAT	30 – 60 DAT	60 – 90 DAT	30 – 60 DAT	60 – 90 DAT	90 DAT - harvest	0 – 30 DAT	30 – 60 DAT	60 – 90 DAT
100% N through Vermicompost	0.94	3.21	4.62	1.274	4.139	5.253	0.482	0.308	0.167	0.075	0.057	0.017
75% N through Vermicompost	0.85	3.03	4.24	1.060	4.113	5.111	0.465	0.233	0.156	0.060	0.055	0.016
100% NPK through fertilizers	1.18	4.00	5.91	1.703	5.033	5.650	0.656	0.390	0.193	0.099	0.063	0.020
Farmers practice N:60, P:30 through fertilizers + 3 tonne FYM/ha	0.71	2.78	3.89	0.918	3.513	4.800	0.435	0.166	0.137	0.053	0.052	0.015
50% N through Vermicompost + 50% NPK through fertilizers	1.09	3.55	5.56	1.561	4.174	5.516	0.555	0.367	0.188	0.092	0.059	0.019
75% N through Vermicompost + 25% NPK through fertilizers	1.07	3.39	5.40	1.362	4.155	5.489	0.534	0.314	0.170	0.079	0.058	0.018
Absolute control	0.33	1.37	1.96	0.606	1.941	2.970	0.416	0.120	0.127	0.042	0.041	0.014
SEm±	0.01	0.05	0.05	0.196	0.526	0.319	0.027	0.014	0.004	0.004	0.003	0.001
CD at 5%	0.03	0.17	0.17	0.610	1.638	0.994	0.084	0.044	0.014	0.012	0.010	0.003

This might be due to its inability to supply nutrients as per demand of hybrid rice because of its slow release particularly at the early vegetative stages.

Growth indices

The results (Table 2) revealed that leaf area index, crop growth rate, relative growth rate and net assimilation rate influenced by nutrient management. The LAI increased steadily up to 90 DAT. Significantly greater values of LAI were recorded in crop with 100% NPK through fertilizers (1.18, 4.0, and 5.91) at 30, 60 DAT and 90 DAT as compared to rest of treatments. The results showed that application organic manure was not helpful in increasing LAI of hybrid rice; rather it reduced the LAI values. This might be due to its inability to supply nutrients as per demand of hybrid rice because of its slow release particularly at the early vegetative stages.

The duration of LAI maintaining above 5.0 is more important than the maximum LAI on influencing the crop productivity (Wang *et al.*, 2001). Application of 100% NPK through fertilizers recorded significantly highest crop growth rate (1.73, 5.033, 5.650 g/m²/day) between 0 -30, 30 -60, 60 -90 DAT, relative growth rate (0.656, 0.390, 0.193 g/g/day) between 30 -60, 60 -90 DAT, 90 DAT -harvest and net assimilation rate (0.099, 0.063, 0.020 g/day/m²) between 0 -30, 30 -60, 60 -90 DAT. Application of 100% NPK through fertilizers had a tendency of producing higher crop CGR, RGR and NAR values than other treatments during most of the periods.

In conclusion on the basis of present experiment, it may be concluded that application of 100% NPK through fertilizers overall better than other treatments. It gives higher values of growth parameters

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