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RESPONSES OF INTEGRATED NITROGEN MANAGEMENT ON THE PERFORMANCE OF AROMATIC RICE VARIETIES UNDER TERAI ZONE OF WEST BENGAL

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Abstract: A field experiment was conducted at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, during kharif season of 2011 to study the Responses of integrated nitrogen management on the performance of aromatic rice varieties. The experiment was laid out in split plot design, comprising of 3 varieties of aromatic rice (Badsha Bhog (V_1), Kalo Bhog (V_2) and Gobinda Bhog (V_3)] in main plots and 8 integrated management practices of nitrogen comprising N_1= Control, N_2= RDN (40:20:20 NPK kg ha^{-1}), N_3= 100 % N through Vermicompost (VC) + P + K, N_4= 50 % N through VC + 50 % N through FYM +P+K, N_5= 100 % N through FYM + P+K, N_6= 50 % N through urea + 50 % N through VC +P+K, N_7= 50 % N through urea + 25 % N through VC+ 25 % N through FYM+P+K and N_8= 50 % N through urea + 50 % N through FYM +P+K) in subplots and was replicated thrice. The results showed that the variety Badsha Bhog (V_1) was found to be highest yielding rice variety under all treatments. It showed yield advantage of 13.3 and 1.32 percent over KaloBhog (V_2) and Gobinda Bhog (V_3) respectively. The results further revealed that all the yield attributes and yield of rice also increased considerably due to application of 50% N through urea+50% N through vermicompost. Economic analysis revealed that Badsha Bhog recorded the highest net return (Rs. 26707.28) with 50% N through urea + 50% N through vermicompost, while highest B: C ratio of 1.51 was found when Badsha Bhog grown with 100% nitrogen is applied through urea followed by 50% N through urea +50% N through vermicompost.

Keywords: Aromatic rice, FYM, Nitrogen, Vermicompost and Economics.

Introduction

Rice (*Oryza sativa* L.) is one of the most important staple food crops, which supplies major source of calories for about 45 per cent of world population, particularly to the people of Asian countries. The production of rice in India has four fold increase from 1950–51 to 2001–02. This has enabled the country to attain self sufficiency in rice production. Never the less, India did not become a major rice exporting country for a long period of time. Its share in world rice trade mainly in the form of small volume of export of highly priced basmati rice is significant. Nowadays non-basmati quality rice has become a major item for export

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promotion to the tune of 42.33 thousand metric tonnes and value of Rs. 33.78 crores (Krishnaiah and Shobarani, 2003). Among the crop production tools, proper time, method of sowing and nutrient management is the prerequisites that allow the crop to complete its life phase timely and successfully under specific agro- ecology.

Since fertilizer is an expensive input, an economical and appropriate method of application needs to be determined to enhance productivity and profit of the growers under given situation. At present the world is facing shortage of major fertilizer nutrients especially nitrogen. Nitrogen is among the principal factors which limiting yield of lowland rice production around the world. This problem is more serious for developing countries like India because the fertilizer production in these countries is expensive and less than its demand. Nitrogen is the most important limiting nutrient in rice production and has heavy system losses when applied as inorganic sources in puddled field (Fillery *et al.*, 1984). It is necessary to find out the suitable rate of nitrogen fertilizer for efficient management and better yield of rice. A suitable combination of variety and rate of nitrogen is necessary for better yield (BRRI, 1990). Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. The demand for organic food is steadily increasing both in developed and developing countries with an annual growth rate of 20 – 25 per cent (Ramesh *et al.,* 2005). It brightens the prospects of export of organic food items. Now there are signs of change across the agriculture landscape of the country towards organic farming. Rice produced by organic farming had higher grain quality (Mendoza, 2004). Sustainability in crop yield and soil health could be achieved by the application of mineral fertilizers along with organic manures. Benefits of organic manures like farm yard manure, green manures, poultry manure and vermicompost are well known but the availability is reducing day by day. There is a heavy demand of aromatic fine rice in the world. Enough information on their varietal performance and nitrogen response are sporadic and scattered. Extensive research is necessary to find out appropriate variety and optimum rate of nitrogen to obtain satisfactory yield and quality of aromatic rice varieties. Integrated nitrogen management involving both the organic and inorganic source is essential to realize higher yield potential. The information on the effect of integrated nitrogen management on aromatic rice is meagre and scanty. Hence the present study was taken up to investigate the effect of integrated nitrogen management on the performance of aromatic rice variety.

Materials and Methods

Field experiment was carried out in the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during *Kharif* season of 2011. The farm is situated at 26^{0}19'86"N latitude & 89^{0}23'53" E longitude, at an elevation of 43 meter above mean sea label. The topography of the land where the experimental was under taken was medium high in situation endowed with good drainage facility. The soil of the experimental site was sandy loam having pH 5.34, organic carbon 0.95 %, available nitrogen 112.25 kg ha^{-1}, available phosphorus 18.21 kg ha^{-1} and available potassium 71.73 kg ha^{-1}. The experiment was laid out in split plot design, comprising of 3 varieties of aromatic rice (Badsha Bhog (V_1), Kalo Bhog (V_2) and Gobinda Bhog (V_3)] in main plots and 8 integrated management practices of nitrogen. N_1= Control, N_2= RDN (40:20:20 NPK kg ha^{-1}), N_3= 100 % N through Vermicompost (VC) + P + K, N_4= 50 % N through VC + 50 % N through FYM +P+K, N_5= 100 % N through FYM + P+K, N_6= 50 % N through urea + 50 % N through VC +P+K, N_7= 50 % N through urea + 25 % N through VC+ 25 % N through FYM+P+K and N_8= 50 % N through urea + 50 % N through FYM +P+K) in subplots and was replicated thrice.

Seedlings of 28 days old were transplanted in a shallow depth (2-3 cm) at a spacing of 20 x 10 cm @ 3 seedling $hill^{-1}$. The unit plot size was 6 m x 5 m. Nitrogen @ 40 kg ha^{-1} is applied through different combination of urea, vermicompost and farm yard manure; 20 kg P_2O_5 ha^{-1} in the form of single super phosphate and 20 kg K_2O ha^{-1} in the form of muriate of potash were applied as basal at the time of final land preparation in all the plots irrespective of variety and nutrient management treatment. Nutrient concentration of vermicompost and farm yard manure was N: 1.52 %, P: 0.45 % & K: 0.70 % and N: 0.50%, P: 0.22% & K: 0.18%, respectively. All the varieties were transplanted on 18^{th} July and harvested on 15^{th} December. First weeding was given at 19 days after transplanting and second weeding was given at 40 days after transplanting. Data were recorded on agronomic parameters including plant height (cm), leaf area index, Dry matter accumulation, number of tillers $hill^{-1}$, panicle length**,** 1000 grain weight (g), no. of filled and unfilled grain and grain and straw yield (t ha^{-1}). Standard statistical methods were used for comparing the treatment means. Treatments differences were found significant based on results of F test, critical differences were calculated at 5% level of probability. Economics was calculated with the prevailing market price.

Results and Discussions

Effect on growth attributes of rice:

Plant height, dry matter accumulation and leaf area index was recorded at 20, 40 and 80 days after transplanting and (Table 1). BadshaBhog recorded highest plant height in all dates of (V_1) taking observation though all are statistically at par**.** Among the level of nitrogen management, 50 % N through urea + 50 % N through VC (N_6) recorded significantly tallest plant (139.33 cm) at 80 days after transplanting followed by N_7. Dry matter accumulation and leaf area index continuously increased with the advancement of crop growth irrespective of variety and level of nitrogen. All the varieties are statistically at par in case of dry matter production and leaf area index. On the other hand treatment receiving 50 % N through urea + 50 % N through VC (N_6) recorded significantly highest values of dry matter in all the crop growth stages with the maximum values of 336.6 g m^{-2} at 80 days after transplanting. This was might be due to increased metabolic activities of the plant, which helped in meeting the energy requirement for nitrogenase activity and translocation of photosynthate in plant. Leaf area index was also found to be significantly highest in N_6 at 40 (1.23), 60 (2.13) and 80 (3.41) days after transplanting over control. Plot receiving no fertilizer recoded lowest values of dry matter and leaf area index.

Effect on yield attributes and yields of rice:

The data pertaining to yield attributes viz. tiller m^{-2}, panicle m^{-2}, panicle length, no. of filled grains panicle-1 and 1000 grain weight are represented in Table 2 and 3. Badsha Bhog (V_1) perform best in respect of panicle length (28.31 cm), number of panicles m^{-2} (76), no. of grains panicle^{-1} (244) and test weight of grains (23.29 g) followed by Gobinda Bhog and Kalo Bhog. More yields in variety Badsha Bhog (V_1) were mainly due to maximum expression of these yield attributes.

In the different nitrogen management treatments where the productivity of rice was improved, the rice crop was showed improvements in plant height, number of tiller m^{-2}, number of panicles m^{-2}, number of grains panicle^{-1} and 1000 grain weight. The results revealed that application of 50% N through urea + 50% N through vermicompost improved yield attributes of aromatic rice over rest of the treatments. The vermicompost is known to modify the physical, chemical and biological properties of soil favourably, enhance nutrient cycling in the soil and increase the concentration of exchangeable Ca, Na, Mg, K and available N, P and Mo in the soil (Palaniappan and Annadurai, 1999).

The most important yield component of rice that was affected due to nitrogen management was the number of grains panicle^{-1}. Thus it is apparent that nitrogen management influences both number of panicles m^{-2} as well as number of grains panicle^{-1}, which resulted to increase the production. Similar results were also observed by several scientists (Banik and Bejbaruah, 2004 and Mishra *et al.,* 2003).

The results reported showed that the variety Badsha Bhog (V_1) was found to be highest yielding rice variety under all treatments. It showed yield advantage of 13.3 and 1.32 percent over Kalo Bhog (V_2) and Gobinda Bhog (V_3) respectively. The results of this experiment, which was mainly conducted to find out the optimum combination of inorganic fertilizers and organic manures for economizing inorganic fertilizers use without affecting the yield of rice, revealed that the highest grain yield of 2.72 tha^{-1} of aromatic rice was recorded where 50% N through urea and 50% N through VC (N_6) was applied. The increase was 27.7 percent over 100% recommended dose of nitrogen through urea (N_2), 50% N through urea and 50% N through VC (N_6) excelled 50% N through urea + 25% N through VC + 25% N through FYM (N_7), 50% N through urea + 50% N through FYM (N_8), 100% N through VC (N_3), 50% N through VC+ 50% N through FYM (N_4) and 100% N through FYM (N_5) by a margin of 12.86, 14.28, 28.38, 28.9 and 33.33 percent respectively. Application of vermicompost might help in improving soil physical condition on one hand and improving the nutrient availability in the soil on the other hand and there by improved the grain yield. Increase the grain yield of rice with the vermicompost was also reported by several workers (Banik and Bejbaruah, 2004 and Adhikari and Mishra, 2002). Straw yield was also appreciably higher in plot receiving 50% RDN through organic manure and 50% RDN through inorganic fertilizer as compared to inorganic fertilizer (100% N) and organic manure (100% N) applied plots. Among the organic sources vermicompost appreciably increased grain and straw yield of aromatic rice over farm yard manure.

Effect on Economics

The yield data of grain and straw on the effect of different nitrogen management were considered for economic analysis and presented in table 4.

It was revealed that Badsha Bhog fetches highest net return in all the nitrogen management treatments in comparison with Kalo Bhog and Gobinda Bhog. The highest net return of Rs. Rs.26707.28 was recorded when Badsha Bhog received 50% N through urea +50% N through vermicompost (N_6) followed by 100% N through urea (Rs.24666.33) and 50% N through urea +25% N through vermicompost+25% N through FYM (Rs.20410.91). Kalo

Bhog and Gobinda Bhog fetch highest net return of Rs.8360.33 and 12471.33 in the plot receiving 100% N through urea. Negative net return was found due to higher cost of treatments particularly when full amount of nitrogen is tried to replaced through organic sources. Highest B: C ratio of 1.51 was found when Badsha Bhog grown with 100% nitrogen is applied through urea followed by 50% N through urea +50% N through vermicompost.

Table 1: Effect of integrated nitrogen management on growth attributes of aromatic rice varieties at different growth stages:

Treatments	Plant height (cm)			Dry matter accumulation (g m^{-2})			Leaf Area Index (LAI)		
	40 DAT	60 DAT	80 DAT	40 DAT	60 DAT	80 DAT	40 DAT	60 DAT	80 DAT
Main plot (Variety)									
V_1	96.44	111.31	124.34	163.06	235.88	301.60	1.27	2.27	3.56
V_2	95.83	118.69	128.32	146.28	218.38	287.40	1.11	1.92	3.06
V_3	93.23	108.13	123.28	152.84	232.25	300.96	1.16	2.00	3.15
S Em (±)	4.65	5.94	5.398	18.71	22.42	20.19	0.01	0.09	0.12
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.08	NS	NS
Sub plot (Nitrogen management)									
N_1	90.96	104.50	115.25	130.25	192.83	260.6	1.12	1.98	3.15
N_2	95.92	116.17	125.10	150.83	234.67	301.8	1.18	2.09	3.28
N_3	95.50	111.50	120.92	148.33	205.50	278.2	1.18	2.07	3.22
N_4	95.21	108.00	120.33	141.33	197.50	263.4	1.16	2.04	3.18
N_5	91.13	107.13	117.42	137.58	195.83	260.8	1.15	1.99	3.16
N_6	99.96	119.33	139.33	186.50	280.33	341.4	1.23	2.13	3.41
N_7	99.25	117.17	136.17	175.25	264.17	336.6	1.23	2.10	3.36
N_8	96.42	117.17	128.00	162.42	259.83	330.6	1.19	2.10	3.29
S Em (±)	2.41	4.43	3.43	18.35	17.15	20.26	0.06	0.07	0.11
CD (P=0.05)	7.09	NS	10.11	53.99	50.44	57.83	0.18	0.22	0.32

V_1 (Badsha Bhog); V_2 (Kalo Bhog) and V_3 (Gobinda Bhog) in main plots and N_1= Control, N_2= RDN (40:20:20 NPK kg ha^{-1}), N_3= 100 % N through Vermicompost (VC) + P + K, N_4= 50 % N through VC + 50 % N through FYM +P+K, N_5= 100 % N through FYM + P+K, N_6= 50 % N through urea + 50 % N through VC +P+K, N_7= 50 % N through urea + 25 % N through VC+ 25 % N through FYM+P+K and N_8= 50 % N through urea + 50 % N through FYM +P+K) in subplots.

Table 2: Effect of integrated nitrogen management on yield attributes of aromatic rice varieties

Treatments	Tiller hil^{-1}	No. of grains $panicle^{-1}$	Panicle m^{-2}	Panicle length (cm)	No. of filled grain $panicle^{-1}$
Main plot (Variety)					
V_1	29	300	76	28.31	244
V_2	24	203	59	26.34	131
V_3	27	225	69	28.31	181
S Em (±)	1.66	6.45	8.52	0.91	5.23
CD (P=0.05)	NS	39.29	NS	NS	31.87
Sub plot (Nitrogen management)					
N_1	25	195	60	26.61	155
N_2	26	245	65	27.85	196
N_3	26	241	65	27.32	181
N_4	25	236	63	27.06	168
N_5	25	213	61	26.61	158
N_6	32	286	90	28.88	224
N_7	30	263	71	28.50	200
N_8	27	261	69	28.40	198
S Em (±)	1.97	19.52	7.42	0.73	13.03
CD (P=0.05)	5.80	57.41	21.18	2.16	38.33

V_1 (Badsha Bhog); V_2 (Kalo Bhog) and V_3 (Gobinda Bhog) in main plots and N_1= Control, N_2= RDN (40:20:20 NPK kg ha^{-1}), N_3= 100 % N through Vermicompost (VC) + P + K, N_4= 50 % N through VC + 50 % N through FYM +P+K, N_5= 100 % N through FYM + P+K, N_6= 50 % N through urea + 50 % N through VC +P+K, N_7= 50 % N through urea + 25 % N through VC+ 25 % N through FYM+P+K and N_8= 50 % N through urea + 50 % N through FYM +P+K) in subplots

Table 3: Effect of integrated nitrogen management on yield attributes and yields of aromatic rice varieties

Treatments	No. of unfilled grain $panicle^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
Main plot (Variety)					
V_1	75	23.29	2.30	6.79	25.73
V_2	44	19.75	2.03	5.95	25.28
V_3	64	20.90	2.27	5.94	27.54
S Em (±)	1.66	0.33	0.15	0.35	0.85
CD (P=0.05)	10.10	2.02	0.95	2.18	5.17
Sub plot (Nitrogen management)					
N_1	44	20.16	1.70	5.33	24.35
N_2	63	21.42	2.13	6.30	25.43
N_3	60	21.37	2.12	5.86	26.33

N_4	59	21.32	2.11	7.33	21.80
N_5	48	21.17	2.04	5.66	26.76
N_6	81	21.95	2.72	6.05	30.73
N_7	70	21.63	2.41	6.07	29.51
N_8	66	21.49	2.38	7.24	24.55
S Em (±)	11.05	0.52	0.16	0.46	2.19
CD (P=0.05)	32.51	1.54	0.49	1.36	6.45

V_1 (Badsha Bhog); V_2 (Kalo Bhog) and V_3 (Gobinda Bhog) in main plots and N_1= Control, N_2= RDN (40:20:20 NPK kg ha^{-1}), N_3= 100 % N through Vermicompost (VC) + P + K, N_4= 50 % N through VC + 50 % N through FYM +P+K, N_5= 100 % N through FYM + P+K, N_6= 50 % N through urea + 50 % N through VC +P+K, N_7= 50 % N through urea + 25 % N through VC+ 25 % N through FYM+P+K and N_8= 50 % N through urea + 50 % N through FYM +P+K) in subplots

Table 4: Economics of aromatic rice as affected by integrated nitrogen management and varieties

Treatment	Common cost for Cultivation (Rs. ha^{-1}	Cost of the treatments (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B : C ratio
V_1N_1	15846.25	-	15846.25	32621.00	16774.75	1.06
V_1N_2	15846.25	490.42	16336.67	41003.00	24666.33	1.51
V_1N_3	15846.25	9210.53	25056.78	39493.00	14436.22	0.58
V_1N_4	15846.25	14605.26	30451.51	36725.00	6273.49	0.21
V_1N_5	15846.25	20000.00	35846.25	35278.00	-568.25	-0.02
V_1N_6	15846.25	4850.47	20696.72	47404.00	26707.28	1.29
V_1N_7	15846.25	7547.84	23394.09	43805.00	20410.91	0.87
V_1N_8	15846.25	10245.21	26091.46	41627.00	15535.54	0.60
V_2N_1	15846.25	-	15846.25	16829.00	982.75	0.06
V_2N_2	15846.25	490.42	16336.67	24697.00	8360.33	0.51
V_2N_3	15846.25	9210.53	25056.78	23880.00	-1176.78	-0.05
V_2N_4	15846.25	14605.26	30451.51	20835.00	-9616.51	-0.31
V_2N_5	15846.25	20000.00	35846.25	20638.00	-15208.25	-0.42
V_2N_6	15846.25	4850.47	20696.72	25547.00	4850.28	0.23
V_2N_7	15846.25	7547.84	23394.09	25382.00	1987.91	0.08
V_2N_8	15846.25	10245.21	26091.46	24805.00	-1286.46	-0.05
V_3N_1	15846.25	-	15846.25	27212.00	11365.75	0.72
V_3N_2	15846.25	490.42	16336.67	28808.00	12471.33	0.76
V_3N_3	15846.25	9210.53	25056.78	28165.00	3108.22	0.12
V_3N_4	15846.25	14605.26	30451.51	28000.00	-2451.51	-0.08
V_3N_5	15846.25	20000.00	35846.25	27508.00	-8338.25	-0.23
V_3N_6	15846.25	4850.47	20696.72	30724.00	10027.28	0.48
V_3N_7	15846.25	7547.84	23394.09	29094.00	5699.91	0.24
V_3N_8	15846.25	10245.21	26091.46	29085.00	2993.54	0.11

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