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Effect of Integrated Nutrient Management on Nutrient Content, Available Nutrients and Nutrient Uptake of Aromatic Rice Cultivars

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ABSTRACT

A field experiments were carried out during the *kharif* and *rabi* at the farm of UBKV Pundibari, West Bengal to find out effects of integrated sources of nutrient management on the achievements of aromatic rice cultivar. The nutrient uptake studies revealed that among the aromatic rice varieties, the Gobindobhog variety recorded the highest nutrient content and uptake (N, P and K) compared to Kalonunia variety with respect to root, shoot and grain. In this experiment pooled analysis showed that the plot treated with 50% RDN through fertilizer + 50% RDN through vermicompost (T_6), 50% RDN through fertilizer + 25% RDN through vermicompost + 25% N through FYM (T_8) and 75% RDN through fertilizer + 25% RDN through vermicompost (T_7) recorded highest or at par uptake of nutrients by rice plant. The nutrient N, P and K content was found to be maximum in the plot treated with 50% RDN through fertilizer + 50% RDN through vermicompost (T_6) and 75% RDN through fertilizer + 25% RDN through VC (T_9). Soil available N, P, K and organic carbon observed maximum in the varieties Kalunonia compared to Gobindobog. The investigations revealed a significant variation among different treatments of nutrient management for various available soils N, P, K, organic carbon and soil pH.

Keywords Farm yard manure (FYM), Vermicompost, Aromatic Rice, rice- lentil cropping System, residual effect.

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INTRODUCTION

Internationally, area under rice cultivation is 163.2 Mha and the production is about is 719.7 mt. In comparing among the rice grown countries, China ranks first in area and production and next is India. According to the data of FAO stat (2014), an area of 43 M ha produces about 120.3 mt.

In the current data of Ramakrishna and Degaokar (2016) reported that India is the country holds the major position of exporting rice. Among the rice varieties grown in our country, aromatic rice is justified is have outstanding characters and quality. Because of this reason, it is known to have high potential in the export area of rice. In our country, aromatic rice is only an agricultural crop that clutch a chief portion in the export area. In the Indian community, aromatic rice is regarded as an important not because of its quality but it is considered auspicious. The most specific characters of aromatic rice is that it releases aroma at the stage of panicle initiation, at harvesting and storage age (Heisnam *et al.* 2020). Considering the growing demand of aromatic rice in present day, there is a vast scope to bring more area under these aromatic rice varieties in this part. Aromatic rice varieties of North Bengal and other part of North Eastern states are playing a vital role in a global rice trading system (Jayanta and Gautam 2014).

In North Eastern hilly region, decline in the productivity of rice is mainly due to faulty sowing time, improper agronomic practices, inadequacy in the selection of variety and unbalance nutrient management, So, selection of the appropriate variety and proper nutrient management are important factors for maximizing quality rice production. Extra addition of low-cost organic source of nutrients is the only solution to promotes the soil from deteriorating and to avoid the used of high-cost inorganic fertilizers. Integrating varied source of nutrients is not only the option that enhance the productivity of preceding crop but it also helps in conserving more residual effects to the succeeding crop. Among inorganic fertilizers, nitrogen fertilizer is considered to be major input affecting the yield and quality of aromatic rice. Excess amount of nitrogen application can result in lodging of plant and reduction of yield and similarly deficiency of nitrogen may affect rice yield. So, judicious use of nitrogen fertilizer along with organic manures may be the best option for improving the growth and obtaining satisfactory yield of aromatic rice in Terai zone of West Bengal.

In intensive cropping system organic manure such as farm yard manure (FYM), vermicompost show an important part in maintaining of soil physical, chemical and biological properties and source of macro and micro nutrients to the crop. It is well known that application of organic manures to the preceding crop, leaves beneficial residual effect and it is harvested by the succeeding crop to an excessive amount (Nadarajah and Seran 2013). Residual effect of organic manures enhances microbial activity in the soil and thus increases the soil biomass. To exploit residual fertility right after the rice harvest and enriching the soil in dry season, growing of subsequent pulse crop like lentil seems to be appropriate (Prasanta *et al.* 2018). Hence, an attempt was made to study the residual effect of different sources of nitrogen on succeeding lentil crop.

MATERIALS AND METHODS

A field experiments were conducted during 2016-17 and 2018-2019 in the instructional farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Cooch Behar, West Bengal to study the direct and residual effect of integrated nutrient management on nutrient content, available nutrients and nutrient uptake of aromatic rice cultivars under rice (aromatic)-lentil cropping system in the terai region of West Bengal. The experiment was laid out in split plot design with three replications. The treatments comprised of 2 varieties (V_1- 'Kalonunia' and V_2-'Gobindabhog') and 12 nitrogen treatment (T_1 -control, T_2- 100% RDN through fertilizer, T_3- 25% RDN through fertilizer + 75% RDN through VC, T_4- 25% RDN through fertilizer + 75% RDN through FYM, T_5- 25% RDN through fertilizer + 37.5% RDN through VC + 37.5% RDN through FYM, T_6- 50% RDN through fertilizer + 50% RDN through VC, T_7- 50% RDN through fertilizer + 50% RDN through FYM, T_8- 50% RDN through fertilizer + 25% RDN through VC + 25% RDN through FYM, T_9- 75% RDN through fertilizer + 25% RDN through VC, T_{10}-75% RDN through fertilizer + 25% RDN through FYM, T_{11}-75% RDN through fertilizer + 12.5% RDN through VC + 12.5% RDN through FYM, T_{12}-50% RDN through VC + 50 % RDN through FYM). For available nitrogen of soil, alkaline potassium permanganate method was followed (Subbiah and Asija, 1956) to estimate available nitrogen. 5g soil sample was digested with 25 ml potassium permanganate and 25 ml alkali; ammonia was extracted on other end in dissolved form of boric acid after six minutes, which then was titrated with acid to obtain the amount of acid to neutralize alkali, thereafter was further calculated for available nitrogen. Total nitrogen content was estimated through CHNS instrument in percentage.

Available phosphorus was extracted using Bray and Kurtz method (1945) based on low pH of the soil. Soil was dissolved by ammonium fluoride and hydrochloric acid mix extractant in 1:10 ratio, shaken in mechanical shaker for exactly five minutes then filtered with whatman filter paper (no. 42). 5ml of collected aliquot was added with 15 ml boric acid, 8ml reagent (Ammonium molybdate, antimony potassium tartarate and glucose) and diluted with distilled water upto 50 ml. Solution was shaken until color appears blue, after which intensity of color was measured in spectrometer at 780 nm. Readings were further calculated for available phosphorus. For available potassium of soil, the soil samples were treated with neutral normal ammonium acetate solution (pH – 7.0) in 1:10 ratio, after one hour shaking, followed by filtration, the leachate was used for the determination of K+and measure by using a flame photometer (Baruah and Barthakur 1997). Soil was dissolved in ammonium acetate extractant in 1:5 ratio, shaken for exactly five minutes, then filtered with whatman filter paper (no. 1). Aliquot was diluted with distilled water in 1:1 or 2:3 ratio, as required, and absorbance values were noted for each sample. Readings were further calculated for available potassium.

For the estimation of total N, plant material was digested in the Conc. H_2SO_4 in the presence of a digestion mixture composed of K_2SO_4 (20 parts) +$CuSO_4$, HgO and Selenium powder in the ratio of 20:3:1 (1 part). Using Jackson (1973) method, determination of N was done using Micro – Kjeldahl right after the digestion. Calculation of total P and K, the wet digestion of plant sample was carried out in diacid mixture consisting of HNO_3 and $HClO_4$ in the ratio of 4:1 and the final volume was made to 100 ml. Total P in the digest was determined by vanado-molybdo-phosphoric yellow color method using spectrophotometer at 420 nm while K was determined by flame-photometer method as described by Jackson (1973).The total uptake of each major nutrient by an individual crop at harvest was determined on dry weight basis multiplying the total dry matter of the crop with its corresponding content of nutrients.The experimental data obtained were subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984).

Table 1. Effects of integrated nutrient management on the SPAD value of aromatic rice varieties.

Treatments	Pooled (2016-17 and 2018-2019			
Main plot treatments	30 DAT	60 DAT	90 DAT	120 DAT
Kalonunia	38.2	42.7	34.3	32.0
Gobindobhog	39.7	43.5	35.0	32.8
SEm±	0.2	0.3	0.5	0.1
CD(P=0.05)	1.3	1.8	3.2	0.7
Sub-plot treatments				
T_1	36.1	40.3	30.7	27.6
T_2	38.5	43.1	33.8	31.7
T_3	38.5	43.2	34.7	32.9
T_4	37.5	42.0	32.8	30.8
T_5	38.8	43.3	36.4	33.2
T_6	40.8	44.3	37.0	34.8
T_7	38.9	43.9	34.9	32.4
T_8	41.4	44.0	35.1	34.4
T_9	41.3	44.7	37.1	34.7
T_{10}	38.6	43.2	33.8	31.4
T_{11}	39.3	43.4	35.7	33.7
T_{12}	37.7	41.9	33.5	30.9
SEm±	0.9	0.5	0.9	1.0
CD (P=0.05)	2.6	1.4	2.6	2.8
Interaction effect (A×B)				
SEm±	1.3	0.7	1.3	1.4
CD (P=0.05)	NS	NS	NS	NS.

RESULTS AND DISCUSSION

Effects of integrated nutrient management on the SPAD value of aromatic rice varieties

The results of the experiment show that the SPAD value was found to differ significantly in all stages of crop growth (Table 1). Statistically analysis pooled data shows that the variety Gobindobhog has found the highest value (38.2 at 30 DAT, 42.7 at 60 DAT, 34.3 at 90 DAT and 32.0 at 120 DAT) as compared to Kalonunia.

The crop fertilized under different treatments of nitrogen management has a significant effect on all stages of crop growth. At 30 DAT, highest SPAD value was recorded with T_8 (41.4) followed byT_9 (41.3) while at 60 DAT and 90 DAT recorded in T_9 (44.7 at 60 DAT and 37.1 at 90 DAT) which was at par with T_6 (44.3 at 60 DAT and 367.0 at 90 DAT) and at 120 DAT with T_6 (34.8) followed by T_9 (34.7). The lowest SPAD value was reported in the control plot (T_1) in all the stages i.e., 36.1 at 30 DAT, 40.3 at 60 DAT, 30.7 at 90 DAT and 27.6 at 120 DAT.

Effects of interaction between varieties and nitrogen management on the SPAD value was observed to be insignificant (Table 1).

Effects of integrated nutrient management on the N, P, K content of aromatic rice

Nitrogen content

Table 2a recorded that difference in N content in shoot, root and grain of rice of the two varieties were significant for both the years and pooled data. The pooled analysis of N content in the shoot (77.2 kg/ha), root (13.8 kg/ha) and grain (56.3 kg/ha) portion were higher in Gobindobhog and that of Kalonunia i.e., shoot (69.7 kg/ha), root (13.3 kg/ha) and Grain (52.1 kg/ha), respectively.

Significantly higher nitrogen (N) content by the rice shoot were recorded with the residual effect of 75% RDN through fertilizer + 25% RDN through vermicompost T_9 (77.5 kg/ha) which was at par with T_6 (77.4 kg/ha). Pooled data reflected 18.7 % increase with T_9 over control.The treatment T_6 significantly superseded rest of the treatment for the N content in the root and grain of rice crop i.e., 13.8 kg/ha and 60.1 kg/ha and pooled data closely followed by T_8 and T_9 (root) and again T_8 ($_G$rain) based on pooled data. The lower N content in the rice root, shoot and grain were recorded with T_1 i.e., control plot.

The interaction effect between Gobindobhog varieties with T_6 and T_9 had significant highest N content of rice shoot and rice root which was found to have statistically at par with each other (Table 2b). Pooled data shows that lowest were recorded in control treatment interacting with Kalonunia variety. Results indicated that N content in the grain of rice did

Table 2 (a). Effects of Integrated nutrient management on the N, P, K content of rice.

Treatments	Pooled (2016-17 and 2018-2019)								
	Nitrogen content			Phosphorus content			Potassium content		
Main plot treatments	Rice shoot (kg/ha)	Rice root (kg/ha)	Rice grain (kg/ha)	Rice shoot (kg/ha)	Rice root (kg/ha)	Rice grain (kg/ha)	Rice shoot (kg/ha)	Rice root (kg/ha)	Rice grain (kg/ha)
V_1	69.7	13.3	52.1	22.3	16.4	23.1	60.2	11.5	43.9
V_2	77.2	13.8	56.3	23.9	16.7	24.9	64.2	12.0	47.6
SEm±	0.20	0.10	0.40	0.30	0.10	0.30	0.80	0.10	0.10
CD(P=0.05)	1.40	0.40	2.30	1.80	NS	1.80	4.60	0.80	0.70
Sub-plot treatments									
T_1	65.2	13.0	42.2	17.6	15.4	17.6	49.0	10.1	33.9
T_2	73.2	13.6	52.0	21.7	16.4	23.5	59.9	11.6	44.0
T_3	74.4	13.6	54.8	23.8	16.8	25.2	63.9	12.2	47.4
T_4	70.3	13.5	47.5	18.7	16.2	19.8	52.9	10.6	38.6
T_5	74.3	13.6	57.0	24.4	16.8	25.0	65.1	12.2	47.2
T_6	77.4	13.8	60.1	26.7	17.1	27.2	68.8	12.5	51.5
T_7	74.9	13.7	56.5	24.2	16.8	25.2	64.6	11.9	48.1
T_8	76.6	13.7	58.7	26.6	17.1	27.3	67.6	12.4	51.4
T_9	77.5	13.7	59.0	26.1	17.0	26.9	68.8	12.4	50.9
T_{10}	72.2	13.5	55.0	22.7	16.6	23.4	61.6	11.6	44.1
T_{11}	75.2	13.7	57.5	25.0	16.9	25.7	66.1	12.3	49.3
T_{12}	70.2	13.4	50.6	20.1	15.8	21.7	57.9	11.3	42.0
SEm±	0.30	0.10	1.10	0.70	1.0	0.80	1.80	0.30	0.90
CD (P=0.05)	0.90	0.20	3.0	1.90	NS.	2.40	5.20	0.90	2.50
Interaction effect (A×B)									
SEm±	0.40	0.10	1.50	0.90	1.50	1.20	2.60	0.50	1.20
CD (P=0.05)	1.20	0.30	NS	NS	NS.	NS	NS	NS	NS

not influence significantly by the interaction between varieties and nitrogen management.

Phosphorus content

Table 2a shows that the Phosphorus content in the rice shoot and grain had varied significantly except plant extract of rice root was found to be non-significant. Pooled mean data reveals that among the two varieties, highest were recorded in Gobindobhog i.e., shoot (23.4 kg/ha), root (16.7 kg/ha) and grain (24.9 kg/ha) and lower in Kalonunia i.e., shoot (22.3 kg/ha, root (16.4 kg/ha) and grain (23.1 kg/ha), respectively.

The statistical analysis of the data on the P content in the shoot of rice crop revealed a significant variation due to the effect of organic and inorganic fertilizers Table 2. Pooled data revealed 52.022 % increase with T_6 (26.7 kg/ha) over T_1 i.e., control plot (17.6kg/ha).The results of the experiment show that the difference in P content in the root of the rice crop was found to be non-significant. Rice grain P content was found to be significantly highest in T_8 (27.3kg/ha) followed by T_6 (27.2 kg/ha) and lowest in T_1 (17.6 kg/ha). Interaction effect between varieties and nitrogen management was observed to be insignificant on P content of rice shoot and root. A non-significant variation was detected owing to the interaction effect of various treatments and varieties on P content of rice shoot, root and grain.

Table 2(b). Effects of interaction between rice shoot and root nitrogen content of aromatic rice.

Treatments	Pooled (2016-17 and 2018-2019)	
	Nitrogen shoot (kg/ha)	Nitrogen root (kg/ha)
V_1T_1	63.1	13.0
V_1T_2	69.5	13.3
V_1T_3	70.5	13.3
V_1T_4	67.7	13.2
V_1T_5	70.2	13.3
V_1T_6	72.7	13.5
$V1T_7$	71.6	13.4
V_1T_8	72.2	13.4
V_1T_9	73.1	13.4
V_1T_{10}	68.9	13.3
V_1T_{11}	70.9	13.3
V_1T_{12}	66.3	13.2
V_2T_1	67.3	13.1
V_2T_2	76.8	13.8
V_2T_3	78.2	13.9
V_2T_4	72.8	13.6
V_2T_5	78.9	14.0
V_2T_6	82.1	14.1
V_2T_7	77.6	13.9
V_2T_8	81.0	14.0
V_2T_9	81.7	14.1
V_2T_{10}	75.5	13.8
V_2T_{11}	79.6	14.0
V_2T_{12}	74.2	13.7
SEm±	0.40	0.10
CD (P=0.05)	1.20	0.30

Potassium content

The K content in rice shoot, root and grain was significantly influenced by the varieties. Analysis of pooled data showed that higher was observed in Gobindobhog i.e., shoot (64.2 kg/ha), root (12.00 kg/ha) and grain (47.6 kg/ha) than that of Kalonunia (shoot 60.2 kg/ha, root 11.5 kg/ha, grain 43.9 kg/ha, respectively).

Data presented in Table 2a, revealed different nitrogen management influenced significantly on the K content in rice shoot. Pooled data recorded that T_6 and T_9 showed highest K content (68.8 kg/ha) while lowest in T_1 i.e., control treatment (49.0 kg/ha). The maximum K content in the root of rice also recorded significantly in similar trends with rice shoot. Highest were recorded in T_6 (12.5 kg/ha) which was followed by T_8 (12.4 kg/ha) and T_9 (12.4 kg/ha). Similarly lowest was found in T_1 plot. K content in rice grain of also showed similar trends to that of rice shoot and root. K content in the rice grain was recorded highest with T_6 (51.5 kg/ha) proved significant superiority than other treatments followed by T_8 (51.4 kg/ha). Pooled data showed 51.9 % enhanced with T6 over T_1 i.e., control plot. A non-significant variation was found due to the interaction effect of various nitrogen management and varieties on the K content of rice shoot, root and grain.

Higher nitrogen, phosphorus and potassium content in grain, as well as straw, were recorded in the variety Gobindobhog as compared to the variety Kalonunia. Among nitrogen management practices,

Table 3(a). Integrated nutrient management on the N, P, K uptake by Straw, Grain and Total uptake after rice harvest-

Treatments	Pooled (2016-17 and 2018-2019)								
	Nitrogen content			Phosphorus content			Potassium content		
Main plot treatments	Straw N uptake (kg/ha)	Grain N uptake (kg/ha)	Total N uptake (kg/ha)	Straw P uptake (kg/ha)	Grain P uptake (kg/ha)	Total P uptake (kg/ha)	Straw K uptake (kg/ha)	Grain K uptake (kg/ha)	Total K uptake (kg/ha)
V_1	65.0	49.0	80.0	21.0	22.0	30.0	57.0	41.0	68.0
V_2	74.0	53.0	90.0	23.0	24.0	33.0	62.0	45.0	75.0
SEm±	0.31	0.31	0.12	0.40	0.30	0.40	0.71	0.10	0.52
CD (P=0.05)	1.95	2.05	0.82	2.11	1.80	2.60	4.50	0.71	3.00
Sub-plot treatments									
T_1	52.0	44.0	67.0	14.0	18.0	23.0	39.0	36.0	52.0
T_2	69.0	49.0	82.0	20.0	22.0	30.0	56.0	41.0	68.0
T_3	72.0	51.0	87.0	23.0	23.0	33.0	61.0	44.0	73.0
T_4	64.0	46.0	77.0	17.0	19.0	25.0	48.0	38.0	60.0
T_5	71.0	53.0	87.0	24.0	23.0	33.0	63.0	44.0	75.0
T_6	78.0	56.0	93.0	27.0	25.0	36.0	69.0	48.0	82.0
T_7	73.0	52.0	88.0	24.0	23.0	33.0	63.0	44.0	75.0
T_8	76.0	54.0	91.0	26.0	25.0	36.0	67.0	47.0	80.0
T_9	77.0	55.0	92.0	26.0	25.0	36.0	68.0	47.0	81.0
T_{10}	68.0	51.0	84.0	22.0	22.0	30.0	58.0	41.0	70.0
T_{11}	74.0	53.0	89.0	25.0	24.0	34.0	65.0	46.0	78.0
T_{12}	65.0	48.0	80.0	19.0	21.0	28.0	54.0	40.0	66.0
SEm±	0.80	1.20	1.10	0.71	1.10	0.70	2.03	1.00	1.40
CD (P=0.05)	2.20	3.00	2.60	2.00	2.26	2.01	5.20	3.00	4.00
Interaction effect (A×B)									
SEm±	1.10	2.00	1.32	1.03	1.08	1.00	3.02	1.28	1.87
CD (P=0.05)	3.10	NS	3.62	NS.	NS	NS	NS	NS	NS

it was apparent that the highest N, P and K content in grain and straw were recorded under T_6, which was closely followed by T_9. Sathish *et al.* (2011) reported that application of organic manures improves the N, P and K uptake by the plant.

Effects of integrated nutrient management on the N, P, K uptake by straw, grain and total uptake after rice harvest

Nitrogen uptake

The results of the experiment (Table 3a) showed that the nitrogen uptake by straw and grain of aromatic rice was recorded to be highest with Gobindobhog i.e, straw (74.0 kg/ha) and grain (53.0kg/ha) and lower with Kalonunia i.e., straw (65.0 kg/ha) and grain (49.0 kg/ha). The pooled mean of total N uptake also shows a similar trend.

Table 3a revealed that rice straw and grain nitrogen uptake was influenced significantly by the different nitrogen management. The treatment T_6 recorded highest uptake of nitrogen by rice straw (78.0 kg ha^{-1}) and grain (56.0 kg/ha) followed by T_9 (straw 77.0 kg/ha grain 55.0 kg/ha). The lowest rice straw and grain nitrogen uptake pooled mean was observed in control plot (T_1). For Total N uptake, maximum uptake was observed in T6 treatment (93.0 kg/ha) followed by T_9 (92.0kg/ha) and lowest under control treatment T_1 (67.0 kg/ha). Munira *et al.* (2014) carried out experiments with organic manures and fertilizers and found significantly higher N uptake in grain over control.

The interaction effect between varieties and nitrogen management of nitrogen uptake by rice straw and total N uptake was found to be influenced significantly (Table 3b). The pooled data of the interaction between Gobindobhog variety and T_9 i.e., V_2T_9 (83.0kg/ha) was recorded highest rice straw N uptake.

Table 3(b). Interaction effect between varieties and nitrogen management on the straw and total uptake of aromatic rice.

Treatments	Pooled (2016-2017 and 2018-2019) Straw N uptake (kg/ha)	Total N uptake (kg/ha[1])
V_1T_1	50.0	66.0
V_1T_2	66.0	79.0
V_1T_3	67.0	82.0
V_1T_4	59.0	73.0
V_1T_5	67.0	81.0
V_1T_6	71.0	87.0
V_1T_7	69.0	83.0
V_1T_8	71.0	85.0
V_1T_9	71.0	86.0
V_1T_{10}	64.0	78.0
V_1T_{11}	69.0	84.0
V_1T_{12}	61.0	75.0
V_2T_1	53.0	69.0
V_2T_2	74.0	87.0
V_2T_3	76.0	92.0
V_2T_4	69.0	82.0
V_2T_5	76.0	92.0
V_2T_6	83.0	99.0
V_2T_7	78.0	93.0
V_2T_8	82.0	97.0
V_2T_9	83.0	98.0
V_2T_{10}	72.0	87.0
V_2T_{11}	79.0	94.0
V_2T_{12}	70.0	83.0
SEm±	1.10	1.30
CD (P=0.05)	3.10	3.60

The lowest was found in the interaction between Kalonunia variety (V_1) and Control treatment (T_1) i.e. V_1T_1 (50.0kg/ha). Again, the pooled data of the interaction between Gobindobhog variety (V_2) with T_6 treatments i.e. V_2T_6 (99.0 kg/ha) found highest in total N uptake of rice plant and the interaction between Kalonunia variety (V_1) and Control treatment (T_1) i.e. V_1T_1 (66.0 kg/ha) recorded lowest.Vermicompost along with inorganic fertilizer (Urea) showed significantly positive interaction with the varieties. Nutrient uptake is the resultant effect of nutrient content and dry matter accumulation and both were largely influenced by combined use of 50 % RDN through fertilizer + 50 % RDN through organic manures (VC/FYM/VC+FYM). This might be due to slow release of nutrient on decomposition of organic manures and partial supply of nutrients through available form of inorganic fertilizer that resulted in higher N, P and K uptake by rice. The result (Table 3a) revealed that N uptake by rice grain nitrogen was not found significant by interacting varieties and nitrogen management.

Phosphorus uptake

From the Table 3a showed that the pooled data of the P uptake by aromatic rice straw and grain was found to be highest with Gobindobhog variety (straw, 23.0 kg/ha, grain 24.0 kg/ha) and lowest with Kalonunia variety (straw 21.0 kg/ha, grain 22.0 kg/ha). Pooled data of the total P uptake i.e., highest by Gobindobog variety than Kalonunia variety.

It is clearly shows that the rice straw and grainP uptake due to different nitrogen management (Table 3a) was found to be significant. Pooled data of straw P uptake, grain P uptake and total uptake was recorded to be highest with T_6 (straw, 27.0 kg/ha; grain, 25.0 kg/ha; total uptake, 36.0 kg/ha)which was at par with T_8 (straw, 27.0 kg/ha; grain, 25.0 kg/ha; total uptake, 36.0 kg/ha) and lowest with T_1 i.e. straw (14.0 kg/ha), grain (19.0 kg/ha) and total uptake (23.0 kg/ha). It was concluded that the data on interaction between varieties and nutrient management was not influenced significantly due that P uptake by rice straw, rice grain and total phosphorus uptake by aromatic rice (Table 3a).

Potasssium uptake

Potassium uptake by rice straw, grain and total uptake by plant was found to be significantly influenced by the different varieties of aromatic rice. It showed similar trends to that of phosphorus uptake of rice straw (Table 3a).

Sources of different nitrogen had a significant effect on potassium uptake by rice straw, grain and total uptake. Pooled mean of potassium uptake by rice straw, grain and total uptake shows maximum under T_6 treatment i.e., Straw (67.0 kg/ha), Grain (48.0 kg/ha) and total uptake (82.0 kg/ha) and lowest in T_1 treatment i.e., Straw (39.0 kg/ha), Grain (36.0 kg/ha) and total uptake (52.0 kg/ha). Table 3a shows the K uptake by aromatic rice straw, grain and the total uptake did not influence significantly between the interaction of varieties and nutrient management.

Increase nutrient uptake by continuous used of

Table 4(a). Effects of integrated nutrient management on the available nutrients (N,P,K, organic carbon and pH) after rice harvest.

Treatments	Pooled (2016-17 and 2018-2019)				
Main plot treatments	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	SOC (mg/kg)	Soil pH
V_1	197	27.9	122	14.9	5.48
V_2	190	26.1	115	13.7	5.46
SEm±	1.14	0.53	0.59	0.05	0.002
CD (P=0.05)	6.94	3.22	3.57	0.28	0.02
Sub-plot treatments					
T_1	157	14.9	85	7.1	5.44
T_2	217	36.1	137	8.0	5.43
T_3	192	25.3	122	13.8	5.43
T_4	207	29.7	132	12.4	5.48
T_5	173	21.5	96	10.6	5.48
T_6	199	26.9	126	18.1	5.49
T_7	213	36.3	141	16.8	5.48
T_8	180	23.0	108	18.4	5.49
T_9	184	23.8	114	17.8	5.46
T_{10}	213	33.5	132	14.8	5.46
T_{11}	167	18.5	93	14.7	5.49
T_{12}	217	34.3	132	19.2	5.46
SEm±	2.27	0.97	4.08	0.09	0.01
CD (P=0.05)	6.46	2.75	11.62	0.25	N.S.
Initial	126	12.2	109	7.3	5.37
Interaction effect (A×B)					
SEm±	3.21	1.37	5.77	0.12	0.02
CD (P=0.05)	NS	NS	NS	0.35	NS

organic sources (vermicompost/ FYM) and synthetic fertilizer is mainly due to steady and timely supply of nutrients to the crop and losses rate of nutrients may also be decreased during the progression of organic decompistion (Shipra *et al.* 2019).These results are also in good agreement with Sultana *et al.* (2015) who reported increased potassium uptake in rice grain due to the application of FYM/vermicompost along with NPK fertilizers.

Effects of integrated nutrient management on the available nutrients (N,P,K, organic carbon and pH) after rice harvest

Data in Table 4a, exposed that plot of Kalonunia variety recorded highest available soil N (197 kg/ha), P (27.9 kg/ha), K (122 kg/ha), organic carbon (14.9 kg/ha) and soil pH (5.48) as compared to the plot of Gobindobhog i.e., available soil N (189.5 kg/ha), P (26.09 kg/ha), K (114.8 kg/ha), organic carbon (13.70 kg/ha) and soil pH (5.46), significantly.

The investigations revealed a significant variation among different treatments of nutrient management for various available soils N, P, K, organic carbon and pH. Results reveal that for available N, the highest was recorded with T_2 (217 kg/ha) closely followed by T_{12} (217 kg/ha) and lowest with T_1 (157 kg/ha). The statistical analysis of the data on available P and K revealed a significantly highest value in the plot treated with T_7 (36.3 kg/ha available P and 141 kg/ha available K) which was at par with T_2 (36.1 kg/ha available P and 137 kg/ha available K) and lowest under T_1 treatment (14.9 kg/ha available P and 85kg/ha available K). Pooled data of available P in soil was reflected 43.03 % increase with T_7 (36.3 kg/ha) over T_1 i.e., control plot (14.9 kg/ha), respectively. The nutrient status of SOC was analyzed after harvest of rice crop and the availability was significantly affected by the varieties of nutrient sources. The data revealed that the organic carbon status over initial stage was higher significantly due to the residual effect with T_{12} (19.2 mg/kg) which was at par with T_8 (18.4 mg/kg)

Table 4(b). Interaction effect between varieties and nitrogen management on the rice soil organic content.

Treatments	Pooled (2016-2017 and 2018-2019) Rice SOC (mg kg^{-1})
V_1T_1	7.0
V_1T_2	7.6
V_1T_3	14.0
V_1T_4	12.4
V_1T_5	9.0
V_1T_6	17.5
V_1T_7	16.5
V_1T_8	17.1
V_1T_9	18.5
V_1T_{10}	15.0
V_1T_{11}	10.9
V_1T_{12}	19.0
V_2T_1	7.3
V_2T_2	8.5
V_2T_3	14.3
V_2T_4	12.1
V_2T_5	10.9
V_2T_6	18.9
V_2T_7	17.3
V_2T_8	19.0
V_2T_9	18.1
V_2T_{10}	14.9
V_2T_{11}	18.6
V_2T_{12}	19.5
SEm±	0.10
CD (P=0.05)	0.40

while it decreases in T_1 i.e. control plot (7.1 mg/kg). It was concluded (Table 4a) that pooled data of soil pH after crop harvest were recorded to be highest in a plot previously fertilized T_6 (5.49), T_8 (5.49) and T_{11} (5.49) while lowest in T_2 (5.43) and T_3 (5.43).

The data recorded from the Table 4b indicate that the interaction effect between varieties and nitrogen management did not influence significantly the available N, P, K and soil pH after rice harvest. It has been concluded that the SOC was significantly influenced by the interaction effect of the varieties and different nitrogen management. The pooled data showed that the interaction between Gobindobhog variety and the plot fertilized with T_{12} (19.5 mg kg^{-1}) over the interaction between Kalonunia variety (V_1) with control plot T_1 (7.0 mg kg^{-1}).

An available nutrient in soil was significantly influenced due to various level of vermicompost (Nazir *et al.* 2017). Among the organic manures, vermicompost is identified to alter soil physical, chemical and biological properties positively promoting soil nutrient cycle and enhance the attentiveness of exchangeable Na, Ca, Mg, Mo and also availability of soil N, P, K that are readily available to the crop plants which directly reflect the image on the better productivity, plant growth and lastly yield (Rekha *et al.*2018).

CONCLUSION

The results showed higher grain and straw nitrogen, phosphorus and potassium content were recorded in the variety Gobindobhog as compared to the variety Kalonunia. The variety 'Gobindobhog' recorded higher SPAD value of aromatic rice. Among nitrogen management practices, it was apparent that the highest N, P and K content in grain and straw were recorded under T_6, which was closely followed by T_9. The nutrient uptake studies revealed that the 'Gobindobhog' recorded the highest nutrient uptake (N, P and K) as compared to 'Kalonunia'. The highest amount of nutrient uptake was obtained with T_6, T_8 and T_9.

Therefore, balanced nutrition is recommended through combined use of 50 % RDN through fertilizer + 50 % RDN through organic manure (VC or FYM or VC + FYM) for improving rice productivity and the residual effect of conjunctive use of plant nutrients had a positive effect toward any succeeding crop.

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