



## Effect of Nitrogen on the Growth and Yield of Local Aman Rice Cultivar

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### Authors' contributions

This work was carried out in collaboration among all authors. Author MKHT designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors MB and Md. RAF managed the analyses of the study. Author MNHM, MH and APC managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

To identify suitable nitrogen management practices for local fine and aromatic rice cultivars an experiment was carried out at Farmer's field at Jointapur, Sylhet region of Bangladesh during the period from August 2017 to December 2017. The experiment was replicated thrice in randomized complete block design assigning factor A: rice cultivars viz. Beruin ( $V_1$ ), Moinsail ( $V_2$ ), Nagrasail ( $V_3$ ) and, BRRI dhan49 (Control, check variety) ( $V_4$ ) and factor B: N sources viz. N 100% chemical ( $F_1$ ), 50% N from FYM + 50% from Urea ( $F_2$ ), 50% N from Vermicompost+ 50% from Urea ( $F_3$ ) and farmers practice ( $F_4$ ). Nutrients P, K, S and Zn (100%) were supplied from chemical sources of triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. Only N was supplied from different organic and inorganic (urea) sources. Fertilizers were applied at the rate of 140-33-38 kg ha<sup>-1</sup> of NPK for farmers' practice, 90-15-60-12-1 kg ha<sup>-1</sup> N, P, K, S and Zn for the variety of BRRI dhan49 and 45-9-33-9-1 kg ha<sup>-1</sup> N, P, K, S and Zn for 3 local rice varieties. The results indicate that,

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BRR1 dhan49 ( $V_4$ ) gave the highest yield ( $2.97 \text{ t ha}^{-1}$ ) among the varieties. Among the local varieties Nagrasail ( $V_3$ ) gave the highest yield ( $2.24 \text{ t ha}^{-1}$ ). In case of farmers practice, highest grain yield was obtained  $F_4$  ( $3.50 \text{ t ha}^{-1}$ ) followed by  $F_1$  ( $2.32 \text{ t ha}^{-1}$ ). Interaction effect also revealed, the highest grain yield ( $3.23 \text{ t ha}^{-1}$ ) in ( $V_4 \times F_4$ ). Among the local varieties Nagrasail gave highest grain yield ( $2.58 \text{ t ha}^{-1}$ ) along with  $F_4$ . Farmer's practice fertilizer management is a promising option, and Nagrasail is the best one for local T. *aman* cultivars cultivation in Sylhet region of Bangladesh.

**Keywords:** Rice cultivars; N sources; nutrient management; FYM; vermicompost.

## 1. INTRODUCTION

Rice is the staple food for over half the world's population of an estimated 3.5 billion people worldwide and approximately 480 million metric tons of milled rice is produced annually [1][2]. Rice production and consumption are among the highest in Asian people. Rice provides up to 50% of the dietary caloric supply and a substantial part of the protein intake for about 520 million people in Asia. World population is increasing day by day and more foods need to be produced to meet up the food demand. In Sylhet region of Bangladesh, there is a great genetic diversity of local rice cultivars which can be able to cope-up with climate changes. Still a good number of indigenous genotypes of fine, aromatic and glutinous rice remain under cultivation in Sylhet region competing with HYV's due to special qualities fetches high price locally and good demand in the ethnic market in UK and USA. Local cultivars cover about 2478 ha (5.23%) of Aus rice area, 50890 ha (36.3%) of Aman rice area and 10990 ha (13.82%) of Boro rice area in the Sylhet district only [3]. Yield of these varieties is low because of unavailability of recommended agronomic management packages like organic and inorganic fertilizer management, planting geometry, seedling age etc. which needs to be developed to boost-up yield and productivity. Nitrogen (N) is an important component of many essential structural, genetic and metabolic compounds in plant cells, which normally produces the greatest yield response in crop plants, promoting rapid vegetative growth and giving the plant a healthy green color. Application of nitrogen (N) fertilizers is the main source of reactive nitrogen in the environment [4]. This agricultural intensification has led to a strong homogenization of agricultural landscapes and the biodiversity depending on them as well as soil biodiversity [5][6][7].

Biodiversity based ecological agriculture needs extension and establishment in the interest of

farmers and against the present overwhelming environmental situation also. Nitrogen (N) is the most limiting nutrient of rice based cropping system in Bangladesh. Continuous use of chemical fertilizers without organic sources will lead to gradual decline of organic matter content and change of native N status in the soils, which results in lower productivity in the rice based system [8][9]. Although rice is a heavy N consumer, the N fertilizer utilization efficiency in rice is very low under tropical conditions where it rarely exceeds 50% and usually ranges from 15% to 35% [10]. N use efficiency is important for the economic sustainability of a cropping systems [11][12]. Adequate N sources and rates are very important, which can not only increase yield but also reduce the cost of production and environmental pollution [13]. The difference in nutrient absorption from different N source combinations greatly influences rice growth and yield potential [14].

Rice plant response to nitrogen fertilization is site-specific because there exists large spatial and temporal variability in soil nitrogen supply, which is in part due to historical differences in management. Use of nitrogen (N) for crop production influences soil health primarily through changes in organic matter content, microbial life, and acidity in the soil [15]. In the cropping system based on modern rice (*Oryza sativa* L.), low productivity [16] [17][18] and low soil fertility are the consequences of unbalanced use of N fertilizers. Repeated application of high fertilizer N doses may lead to soil acidity whereas management strategies based on principles of synchronization of N demand by crops with N supply from all sources could ensure high yields, along with maintenance of soil health [15]. Hence, research is needed to develop appropriate agronomic management organic and inorganic sources of nutrient specially N for the local T. *aman* rice cultivars traditionally grown in the Sylhet region. Therefore, the present study was conducted for the following objectives.

- i. To identify suitable nutrient management practices for local fine and aromatic rice cultivars.
- ii. To increase local fine and aromatic T. *aman* rice productivity through development of cultivar specific nutrient management practices for Sylhet region of Bangladesh.

## 2. MATERIALS AND METHODS

An experiment were conducted as the farmer's field at Chicknagul, Jointapur, Sylhet region of Bangladesh which geographical position was 23<sup>0</sup> to 25<sup>0</sup>1' North and 90<sup>0</sup>57' to 92<sup>0</sup>28' East longitude and latitude, respectively with the elevation of 34 meters above the mean sea level to evaluate the effect of organic and inorganic N nutrients on the growth and yield of local rice cultivars during the period from August 2017 to December 2017. The treatments included in the experiment were four (04) variety viz., i) Beruin, (V<sub>1</sub>), ii) Moinasail (V<sub>2</sub>), iii) Nagrasail (V<sub>3</sub>), iv) BRRI dhan49 (HYV & Control) (V<sub>4</sub>) and four (04) sources of N nutrients: 4 viz., i) 100% N from Urea (F<sub>1</sub>), ii) 50% N from FYM + 50% N from Urea (F<sub>2</sub>), iii) 50% N from Vermicompost + 50% N from Urea (F<sub>3</sub>), iv) Farmers practice. (F<sub>4</sub>). Four varieties (V<sub>1</sub>, V<sub>2</sub>, V<sub>3</sub>, V<sub>4</sub>) of T. *aman* rice were considered as Factor A while four sources of N nutrient (F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub> and F<sub>4</sub>) were considered as Factor B treatments in the experiment and combinations of these two factors were assigned in the plots randomly without biasness. There were 16 treatment combinations in the experiment. Each combination replicated thrice and the experiment was laid out in a split plot design assigning variety in the main plot and N nutrient sources in the sub-plot. The unit plot size was (3m X 2m). There was a bund of 0.50 m width between two experimental plots. Nutrients, PKS & Zn (100%) were supplied from chemical sources of triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. Only N was supplied from different organic and inorganic (urea) sources. In case of farmers' practice 140-33-38 kg ha<sup>-1</sup> of N, P, K, respectively were applied as per opinion of the local farmers. Nitrogen composition in FYM and Vermicompost was considered 0.5% and 0.7%, respectively during calculation of N dose from organic and inorganic sources. Fertilizers like urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied according to recommended dose (BRRI, 2011). The fertilizers were applied @ 90-15-60-12-1 kg

ha<sup>-1</sup> N, P, K, S and Zn for the variety of BRRI dhan49. For 3 local rice varieties 45-9-33-9-1 kg ha<sup>-1</sup> N, P, K, S and Zn, respectively were applied. Unit plot size was 6 m<sup>2</sup> (3m X 2m). For BRRI dhan49, in each plot, 20g TSP, 60g MoP, 40g Gypsum and 1.7 g Zinc Sulphate were applied as basal: urea was applied into three equal splits- 1/3<sup>rd</sup> at final land preparation, 1/3<sup>rd</sup> at 21 DAT (tillering stage) and 1/3<sup>rd</sup> at 36 DAT (active tillering stage) in each plot. For Beruin, Moinasail and Nagrasail 12 g TSP and 40 g MoP, 30 g Gypsum and 1.8 g Zinc sulphate were applied as basal. 60 g Urea was also applied into three equal splits- 1/3<sup>rd</sup> at final land preparation, 1/3<sup>rd</sup> at 21 DAT (tillering stage) and 1/3<sup>rd</sup> at 36 DAT (active tillering stage) in each plot. All P, K, S, Zn, FYM and Vermicompost were applied during final land preparation. Seeds of BRRI dhan49 were collected from Bangladesh Agricultural Development Corporation (BADCO), Sylhet and seeds of other local varieties of Beruin, Moinasail, and Nagrasail were collected from local farmers. Seed was used @ 10 kg ha<sup>-1</sup> for each variety having germination percentages 93%, 95%, 92% and 95% for Beruin, Moinasail, Nagrasail and BRRI dhan49, respectively. Weeding, gap filling, controlling insect-pest and irrigation were done according to necessary. Data were recorded on the growth, yield attributes and yield from the sample plants during the course of experiment. Observations were made on plant height (cm), number of effective tillers hill<sup>-1</sup>, number of non-effective tiller shill<sup>-1</sup>, number of panicles hill<sup>-1</sup>, number of filled grains panicle<sup>-1</sup>, number of unfilled spikelets panicle<sup>-1</sup>, 1000-grain weight, percentage of filled spikelet, grain weight plot<sup>-1</sup>.

Percentage of filled spikelet: Number of filled spikelet and unfilled spikelet panicle<sup>-1</sup> constitutes total number of spikelets. From these data percentage of filled grains were calculated by using the following formula.

$$\text{Percentage of filled spikelet} = \frac{\text{No. of filled spikelets per panicle}}{\text{No. of total spikelets per panicle}} \times 100$$

Collected data were analyzed by using computer software R. Mean separations were done at 5% level of significance by Least Significant Difference (LSD) Test wherever F values were significant at either 1% or 5% level of probability.

### 3. RESULTS AND DISCUSSION

#### 3.1 Plant Height of Rice Varieties at 15-day Intervals Irrespective of Organic and Inorganic N Nutrient

Plant height at 15-day intervals varied significantly among the varieties (Table 1). Plant height at 30 DAT varied significantly among the varieties. The tallest plant (62.30 cm) was obtained from the local variety Moinasail ( $V_2$ ) and the shortest plant (42.50 cm) was obtained from BRR1 dhan49. Both the local varieties Beruin ( $V_1$ ) and Nagrasail ( $V_3$ ) produced moderate plant height (57.15 cm and 56.30 cm, respectively). Like 30 DAT, plant height also differed significantly at 45 DAT and the tallest plant (99.333 cm) was obtained from the same variety of  $V_2$  as in case of 30 DAT. The high yielding variety BRR1 dhan49 produced the shortest plant (64.78 cm). A significant variation was observed for plant height at 60 DAT among the varieties. The same variety  $V_2$  had the tallest plant (106.52 cm) while the HYV BRR1 dhan49 had the shortest plant (67.17 cm). Other two varieties  $V_1$  and  $V_3$  had moderate plant height (99.6 cm & 104.07 cm, respectively). Plant height at 75 DAT differed significantly and the tallest plant (113.15 cm) was obtained from the local variety  $V_2$ . The shortest plant (71.63 cm) was obtained from BRR1 dhan49. Finally, plant height at harvest differed significantly and the results revealed that the same variety Moinasail ( $V_2$ ) always had the highest values in respect of plant height at 15-day intervals. The variety  $V_2$  had the tallest plant (115.73 cm) followed by the variety  $V_3$  (112.73 cm). The variety BRR1 dhan49 produced the shortest plant (77.17 cm). It was observed that plant increased sharply from 30 DAT to 45 DAT and thereafter increment was sluggish and up to harvest plant height was found to be increased a very small even.

#### 3.2 Plant height of Rice Varieties as Influenced by Organic and Inorganic N Nutrient

There was no significant variation found in terms of plant height due to organic and inorganic N nutrient (Table 2). However, at 30 DAT the plant height varied from 52.92 cm in  $F_2$  to 55.58 cm in  $F_1$ . Like plant height at 30 DAT, it did not differ significantly at 45 DAT and plant height varied from 87.57 in  $F_3$  to 88.90 cm in  $F_1$  (Table 2). The plant height increment was sharp from 30 DAT to

45 DAT. There was no significant variation at 60 DAT and plant height ranged from 92.17 cm to 95.40 cm in  $F_1$ . The increment of plant height was not so much from 45 DAT to 60 DAT like 30 DAT to 45 DAT. Results revealed that plant height at 75 DAT did not differ significantly. However, plant height varied from 99.70 in  $F_4$  to 95.40 cm in  $F_1$ . Plant height variation at harvest varied from 102.82 cm in  $F_4$  (Farmer's) to 103.98 cm in  $F_2$ . Final plant height at harvest was found to be increased slightly from the previous plant height at 75 DAT.

#### 3.3. Number of Tillers $\text{hill}^{-1}$ of Rice Varieties Irrespective of Organic and Inorganic N Nutrient

Number of tillers  $\text{hill}^{-1}$  at 30 DAT differed significantly and the highest of number of tillers (15.63  $\text{hill}^{-1}$ ) was found in the variety BRR1 dhan49 ( $V_4$ ). The lowest number of tillers (13.25  $\text{hill}^{-1}$ ) was found in the variety Moinasail ( $V_2$ ) while the other two varieties  $V_1$  and  $V_3$  produced moderate number of tillers (14.45 & 14.17  $\text{hill}^{-1}$ , respectively) (Table 3). Number of tillers  $\text{hill}^{-1}$  at 45 DAT differed significantly among the rice varieties. It was found that the highest of number of tiller (18.58  $\text{hill}^{-1}$ ) was produced by the variety BRR1 dhan49 ( $V_4$ ) which was statistically similar to that of Beruin ( $V_1$ ) and Nagrasail ( $V_3$ ) (17.71 & 17.46  $\text{hill}^{-1}$ , respectively) (Table 3). Local variety Moinasail ( $V_2$ ) gave the lowest number of tillers (13.08  $\text{hill}^{-1}$ ) at 45 DAT. Number of tillers  $\text{hill}^{-1}$  at 60 DAT did not differ significantly among the varieties irrespective of organic and inorganic N nutrient. The highest of number of tillers (18.83  $\text{hill}^{-1}$ ) was found in the variety BRR1 dhan49 ( $V_4$ ) while the lowest number of tillers (15.79  $\text{hill}^{-1}$ ) was found in the local variety Moinasail ( $V_2$ ) (Table 3). Other two varieties Beruin ( $V_1$ ) and Nagrasail ( $V_3$ ) produced number of tillers 18.50 and 17.29  $\text{hill}^{-1}$ , respectively. Number of tillers  $\text{hill}^{-1}$  at 75 DAT differed significantly and the highest of number of tillers (17.21  $\text{hill}^{-1}$ ) was found in the variety BRR1 dhan29. Other three varieties produced statistically similar while the lowest number of tillers (13.46  $\text{hill}^{-1}$ ) was found in the variety Moinasail ( $V_2$ ) (Table 3). Finally at harvest, number of tiller  $\text{hill}^{-1}$  among the varieties differed significantly having the highest of number of tillers (17.82  $\text{hill}^{-1}$ ). The variety BRR1 dhan49 gave the lowest number of tillers (11.07  $\text{hill}^{-1}$ ). The results revealed that at later stage from 75 DAT to harvest mortality rate of tillers  $\text{hill}^{-1}$  was much higher in the HYV BRR1 dhan49

(Table 3). In other two varieties V2 and V3 number of tiller hill<sup>-1</sup> reduced to some extent at harvest than the earlier date of 75 DAT.

### 3.4 Number of Tillers hill<sup>-1</sup> of Rice Varieties as Influenced by Organic and Inorganic N Nutrient

Number of tillers hill<sup>-1</sup> at 30 DAT did not differ significantly by organic and inorganic N nutrient. Number of tillers hill<sup>-1</sup> varied from 14.00 in F2 to 14.63 in F1 (Table 4). Number of tillers hill<sup>-1</sup> at 45 DAT also did not differ significantly. Maximum number of tillers (17.25 hill<sup>-1</sup>) was obtained from F<sub>1</sub> and minimum number of tillers (16.33 hill<sup>-1</sup>) was obtained from F<sub>3</sub> (Table 4). Unlike 30 and 45 DAT, number of tillers hill<sup>-1</sup> at 60 DAT differed significantly and the highest of number of tillers (19.00 hill<sup>-1</sup>) was found in F1 (Table 4). Nutrient

treatment F3 produced the lowest number of tillers (16.46 hill<sup>-1</sup>). Treatments F2 and F4 produced number of tillers hill<sup>-1</sup> similar with that of F1 and F3. Number of tillers hill<sup>-1</sup> at 75 DAT also differed significantly like 60 DAT and the highest of number of tillers (16.58 hill<sup>-1</sup>) was found in the treatment F1. The treatments F2 and F4 produced similar number of tillers hill<sup>-1</sup> to that of F1 while the lowest number of tillers (14.17 hill<sup>-1</sup>) was produced in F3 (Table 4). Number of tillers hill<sup>-1</sup> at harvest differed significantly at harvest and finally the highest of number of tillers (17.40 hill<sup>-1</sup>) was found in F4 (farmer's practice). The lowest number of tillers (12.37 hill<sup>-1</sup>) was obtained from F3 which was similar to that of F2. The treatment F1 produced similar number of tillers (13.87 hill<sup>-1</sup>) to that of the highest number of tillers hill<sup>-1</sup> produced by the treatment F4 (Table 4).

**Table 1. Plant height of T. aman rice varieties at 15-day intervals irrespective of organic and inorganic N nutrient during T. aman season**

Variety	Mean plant height (cm)				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
V1	57.15 b	93.58b	99.61b	106.50b	107.98b
V2	62.30 a	99.33a	106.52a	113.15a	115.73a
V3	56.30 b	95.03b	104.07ab	110.03ab	112.73a
V4	42.50 c	64.78c	67.17c	71.63c	77.17c
CV(%)	6.30	3.91	7.19	3.99	3.75
LSD0.05	3.43	3.45	6.78	3.40	3.87

NB: V1= Beruin, V2= Moinasail, V3=Nagrasail, V4= BRR1 dhan49

**Table 2. Plant height of T. aman rice varieties at 15-day intervals as influenced by organic and inorganic N nutrient during T. aman season**

N nutrient	Mean plant height (cm)				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
F <sub>1</sub>	55.88	88.90	95.40	100.57	103.18
F <sub>2</sub>	52.92	88.07	95.03	100.88	103.98
F <sub>3</sub>	54.13	87.57	94.77	100.17	103.63
F <sub>4</sub>	55.32	88.20	92.17	99.70	102.82
CV(%)	7.41	3.46	4.91	2.27	2.23
LSD0.05	3.41	2.57	3.91	1.92	1.95

NB: F<sub>1</sub>=N (100% chemical as per FRG, 2012), F<sub>2</sub>=50% N from FYM + 50% N from Urea (chemical as per FRG, 2012), F<sub>3</sub>=50% N from Vermicompost + 50% N from Urea (chemical as per FRG, 2012), F<sub>4</sub>=Farmers practice (140- 33-38 kg/ha of NPK, respectively)

**Table 3. Number of tiller hill<sup>-1</sup> of T. aman rice varieties at 15- day intervals irrespective of organic and inorganic N nutrient during T. aman season**

Variety	Mean number of tiller hill <sup>-1</sup>				
	30 DAT	45 DAT	60 DAT	75 DAT	At harvest
V1	14.45ab	17.71a	18.50	15.88ab	17.82a
V2	13.25b	13.08b	15.79	13.46b	12.33bc
V3	14.17ab	17.46a	17.29	15.08ab	13.01b
V4	15.63a	18.58a	18.83	17.21a	11.07c
CV(%)	11.06	12.50	17.51	17.78	13.48
LSD <sub>0.05</sub>	1.59	2.09	3.08	2.74	1.83

NB: V1= Beruin, V2= Moinasail, V3=Nagrasail, V4= BRRI dhan49

**Table 4. Number of tiller hill<sup>-1</sup> of T. aman rice varieties at 15-day intervals as influenced by organic and inorganic N nutrient**

N nutrient	Mean number of tiller hill <sup>-1</sup>				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
F <sub>1</sub>	14.63	17.25	19.00a	16.58a	13.87ab
F <sub>2</sub>	14.00	16.63	17.46ab	15.00ab	13.29bc
F <sub>3</sub>	14.37	16.33	16.46b	14.17b	12.37c
F <sub>4</sub>	14.50	16.63	17.50ab	15.88a	14.70a
CV(%)	9.59	8.69	11.16	12.77	9.42
LSD <sub>0.05</sub>	1.16	1.22	1.66	1.66	1.08

NB: F<sub>1</sub>= N (100% chemical as per FRG, 2012), F<sub>2</sub>=50% N from FYM + 50% N from Urea (chemical as per FRG, 2012), F<sub>3</sub>=50% N from Vermicompost + 50% N from Urea (chemical as per FRG, 2012), F<sub>4</sub>=Farmers practice (140-33-38 kg ha<sup>-1</sup> of NPK, respectively).

### 3.5 Yield Components and Yield

#### 3.5.1 Performance of rice varieties

Number of effective tillers hill<sup>-1</sup> differed significantly and the highest number of effective tiller (17.82 hill<sup>-1</sup>) was recorded from the local variety Beruin (V1) (Table 5). The lowest number of effective tillers (11.07 hill<sup>-1</sup>) was recorded from the variety BRRI dhan49 (V4). Other two varieties Moinasail (V2) and Nagrasail (V3) produced similar number of effective tillers hill<sup>-1</sup> but significantly lower than that of V1. The results revealed that non-effective tillers hill<sup>-1</sup>(%) was significantly highest in the variety V4 and the lowest in V1. The result clearly indicated that number of non-effective tillers hill<sup>-1</sup>(%) was considerably lower in all the local varieties. Both filled and unfilled spikelets panicle<sup>-1</sup> differed significantly among the varieties (Table 5). The highest number of filled spikelets panicle<sup>-1</sup> was found in the variety BRRI dhan49 (V<sub>4</sub>) while the lowest number was found in the variety Beruin (V<sub>1</sub>). Statically similar and moderate number of filled spikelet pabicle<sup>-1</sup> was found in the varieties V<sub>2</sub> and V<sub>3</sub>. These varieties were significantly different from the other two varieties. The variety

V<sub>4</sub> produced the highest percentage of unfilled spikelets panicle<sup>-1</sup> (33.48) while the lowest percentage of unfilled spikelet panicle<sup>-1</sup> (20.40) was found in the variety V<sub>3</sub>. The results revealed that 1000-grain weight varied significantly among the varieties (Table 5) where the variety V1 produced the highest (23.45 g). The variety V<sub>4</sub> produced the lowest 1000- grain weight (18.64 g) which was significantly different from the rest two varieties. The results specified that all local varieties produced the coarse grain compared to HYV BRRI dhan49. That is, BRRI dhan49 had the smaller grain size which is more preferable to the consumers. Results presented in Table 5 indicated that grain yield variation was significant among the rice varieties. The highest grain yield 2.97 t ha<sup>-1</sup> was obtained from the HYV, BRRI dhan49 which was significantly different from others. The highest grain yield in the HYV was mainly due to the highest number of filled spikelet panicle<sup>-1</sup> in spite of lower number of effective tiller hill<sup>-1</sup> and smaller grain size. The lowest grain yield 1.99 t ha<sup>-1</sup> was obtained from the local variety V<sub>1</sub>, Beruin because of the lowest number of filled spikelet panicle<sup>-1</sup>. Among the local varieties, V<sub>3</sub> i.e. Nagrasail performed better and yielded these condition highest grain yield

2.24 t ha<sup>-1</sup> attributed by the moderate number of filled spikelet panicle<sup>-1</sup>, effective tiller hill<sup>-1</sup> and bolder grain size. The variety V<sub>4</sub> had the highest percent 25.35 of non-effective tiller hill<sup>-1</sup> and 33.48 of unfilled spikelet panicle<sup>-1</sup>. This indicates the variety V<sub>4</sub> was under the low temperature stress as the crop was transplanted in the month of late September after recession of flood water.

### 3.5.2 Effect of organic and inorganic N nutrient

Both number of effective tillers hill<sup>-1</sup> and percent non-effective tillers hill<sup>-1</sup> did not differ significantly due to variation in organic and inorganic sources of N nutrient (Table 6). The results indicated that sources of N nutrient either organic or inorganic produced similar effect on the formation of effective tiller hill<sup>-1</sup>. The results revealed that number of filled spikelet panicle<sup>-1</sup> and per cent unfilled spikelet panicle<sup>-1</sup> differed significantly among the organic and inorganic N nutrient sources (Table 6). Farmers' practice i.e. F<sub>4</sub> produced the highest number of filled spikelet (61.45 panicle<sup>-1</sup>) which was statistically similar to that of F<sub>1</sub>. Both the organic sources of N nutrient produced significantly lower number of filled spikelet panicle<sup>-1</sup>. Inorganic sources of N also produced higher percentage of unfilled spikelet panicle<sup>-1</sup>. Thousand grain weights did not differ significantly among the organic and inorganic

sources of N (Table 6). The results revealed that sources of N either organic or inorganic have equal effect on the grain size of rice. The result presented in Table 6 showed that grain yield of rice was influenced significantly by different levels of nutrients. The nutrient level used in the farmers' practice (F<sub>4</sub>) gave the highest grain yield (2.50 t ha<sup>-1</sup>) which was significantly different from the other nutrient levels. The lowest grain yield 2.13 t ha<sup>-1</sup> was obtained from the nutrient level F<sub>3</sub> (50% N from Urea + 50% N from Vermicompost). Grain yields from F<sub>1</sub> and F<sub>2</sub> (2.32 and 2.26 t ha<sup>-1</sup> respectively) were statistically similar. Higher number of effective tiller hill<sup>-1</sup> and filled spikelet panicle<sup>-1</sup> were the main attributes to produce the higher grain yield. The results indicated that nutrient level F<sub>4</sub> had the highest 26.63% unfilled spikelet panicle<sup>-1</sup>. There was no significant difference among the nutrient levels in respect of 1000-grain weight. The increase in rice yield is associated with the increase in yield attributes. The increase in 1000-grain weight after the application of organic sources may be due to better nutrient availability and uptake by plants [19][20]. Combined application of organic and inorganic N is better than sole organic source on increasing rice yield components and grain yield [21][22][23]. Our results did not agree with this result. The difference in nutrient absorption from different N source combinations greatly influences rice growth and yield potential.

**Table 5. Yield attributes and yield of rice varieties irrespective of nutrient fertilizers**

Variety	Tillers hill <sup>-1</sup>		Spikelets panicle <sup>-1</sup>		1000-grain weight (g)	Grain yield (t ha <sup>-1</sup> )
	Effective (no.)	Non-effective (%)	Filled (no.)	Unfilled (%)		
V1	17.82a	10.41c	44.33c	24.98b	23.45a	1.99c
V2	12.33bc	12.94b	55.10b	22.34c	20.80b	2.01c
V3	13.01b	14.19b	56.22b	20.40d	20.45b	2.24b
V4	11.07c	25.35a	71.50a	33.48a	18.64c	2.97a
CV(%)	13.48	14.92	7.82	5.30	5.08	8.69
LSD <sub>0.05</sub>	1.83	2.34	4.43	1.34	1.06	0.20

Figures in a column with same letter(s) did not differ significantly at 5% level of significant; V1= Beruin; V2= Moinsail; V3=Nagrasail; V4=BRRI dhan49

**Table 6. Yield attributes and yield as influenced by nutrient fertilizers irrespective of rice varieties**

Nutrient levels	Tillers hill <sup>-1</sup>		Spikelets panicle <sup>-1</sup>		1000-grain weight (g)	Grain yield (t ha <sup>-1</sup> )
	Effective (no.)	Non-effective (%)	Filled (no.)	Unfilled (%)		
F <sub>1</sub>	13.87	16.41	59.18a	25.66ab	21.33	2.32b
F <sub>2</sub>	13.29	16.36	53.88b	23.80b	20.43	2.26bc

Nutrient levels	Tillers hill <sup>-1</sup>		Spikelets panicle <sup>-1</sup>		1000-grain weight (g)	Grain yield (t ha <sup>-1</sup> )
	Effective (no.)	Non-effective (%)	Filled (no.)	Unfilled (%)		
F <sub>3</sub>	12.37	15.78	52.63b	25.12ab	21.03	2.13c
F <sub>4</sub>	14.70	14.34	61.45a	26.63a	20.54	2.50a
CV(%)	9.42	15.68	4.79	7.88	7.44	6.79
LSD 0.05	1.08	2.08	2.29	1.99	1.31	0.13

NB: F<sub>1</sub>=N (100% chemical as per FRG, 2012), F<sub>2</sub>=50% N from FYM + 50% N from Urea (chemical as per FRG, 2012), F<sub>3</sub>=50% N from Vermicompost + 50% N from Urea (chemical as per FRG, 2012), F<sub>4</sub>=Farmers practice (140- 33-38 kg ha<sup>-1</sup> of NPK, respectively).

**Table 7. Yield attributes and yield of rice varieties as influenced by the interaction of rice varieties and nutrient fertilizers**

Interaction (V x S)	Tillers hill <sup>-1</sup>		Spikelets panicle <sup>-1</sup>		1000-grain weight (g)	Grain yield (t ha <sup>-1</sup> )
	Effective (no.)	Non-effective (%)	Filled (no.)	Unfilled (%)		
V1F1	17.20a	11.8d-h	47.13g	28.50c	22.82ab	1.98ef
V1F2	17.80a	11.1e-h	40.47h	19.03def	24.30a	1.97ef
V1F3	17.20a	10.4fgh	40.00h	19.27ef	24.04a	1.92ef
V1F4	19.07a	8.4h	49.73fg	33.10ab	22.62ab	2.09def
V2F1	12.33cde	9.4gh	54.93cde	19.90de	24.59a	2.02def
V2F2	11.20def	14.4c-f	55.07cde	28.00c	19.71cde	2.04def
V2F3	11.20def	15.1cde	53.00def	22.07d	18.04e	1.89f
V2F4	14.60b	12.9c-g	57.40cd	19.40def	20.85bcd	2.08def
V3F1	14.01bc	16.4c	58.00c	20.60de	19.37de	2.26d
V3F2	13.34bcd	12.5c-h	50.60efg	16.13f	20.64b-e	2.16de
V3F3	11.61def	12.4c-h	49.07fg	27.20c	22.24abc	1.95ef
V3F4	13.07bcd	15.6cd	67.20b	17.67ef	19.54de	2.58c
V4F1	11.93cde	28.1a	76.67a	33.63ab	18.37de	3.00ab
V4F2	10.80ef	27.5a	69.40b	32.03b	18.14e	2.87b
V4F3	9.47f	25.3a	68.47b	31.93b	18.74de	2.76bc
V4F4	12.07cde	20.5b	71.47b	36.33a	19.31de	3.23a
CV(%)	9.42	15.68	4.79	7.87	7.43	6.79
LSD 0.05	1.08	4.15	4.58	3.36	2.61	0.26

NB: Figures in a column with same letter(s) did not differ significantly at 5% level of significant; V1= Beruin, V2= Moinasail, V3= Nagrasail, V4= BRRRI dhan49

### 3.6 Interaction of Rice Varieties and Sources of N Nutrient

Number of effective tillers hill<sup>-1</sup> differed significantly due to interaction of variety and organic and inorganic sources of N nutrient (Table 7). The results showed that V1 produced significantly higher number of effective tillers hill<sup>-1</sup> at all organic and inorganic sources of N. The combination (V<sub>4</sub> × F<sub>3</sub>) produced the lowest number of tillers hill<sup>-1</sup>. The variety V<sub>4</sub> produced higher percentage of non-effective tillers hill<sup>-1</sup> with all sources of organic and inorganic N sources. Both filled spikelets and unfilled spikelets panicle differed significantly due to interaction of variety and organic and inorganic

sources of N (Table 7). The highest number of filled spikelet (76.67 panicle<sup>-1</sup>) was obtained from the combination of (V<sub>4</sub> × F<sub>1</sub>) while the lowest number of filled spikelets (40.00 panicle<sup>-1</sup>) was obtained from the combination (V1 × F2). The results showed that both organic and inorganic sources of N had inferior effect compared to inorganic source of N on the number of filled spikelets panicle<sup>-1</sup>. Thousand grain weights were found significantly higher in the variety V1 in combination with all sources of nutrient N (Table 7). Other combinations except the combination of (V3 × F3) produced lower 1000-grain weight than all combinations of V1 with all sources of N nutrient. The lowest 1000-grain weight (18.04 g) was obtained from the combination (V2 × F3)



which was closely followed by the combination (V4 × F2). In general, V4 had the lower 1000-grain weight with all sources of N. This proved that grain size is smaller in V4 compared to all other varieties. Results presented in Table 7 revealed that the highest grain yield (3.23 t ha<sup>-1</sup>) was obtained from the interaction (V4 × F4) which was statistically similar to that of (V4 × F1) (3.00 t ha<sup>-1</sup>). Among the local variety V3 along with F4 i.e. (V3 × F4) produced the highest grain yield (2.58 t ha<sup>-1</sup>). The lowest grain yield (1.89 t ha<sup>-1</sup>) was found in (V2 × F3). Grain yield was determined by the number of effective tiller hill<sup>-1</sup>, number of filled spikelet panicle<sup>-1</sup> and 1000-grain weight in all interaction levels. Grain yield is the manifestation of yield attributing characters in rice [19]. It was found that the highest grain yield in (V4 × F4) was attributed by the combined effect of number of effective tiller hill<sup>-1</sup>, number of filled spikelet panicle<sup>-1</sup> and 1000-grain weight in spite of lower number of filled spikelet panicle<sup>-1</sup> in the interaction (V4 × F3). In (V4 × F3) the lower yield was mainly due to the lower 1000-grain weight and number of effective tiller hill<sup>-1</sup>. The combination of varieties and nitrogen rates were significantly affected to panicle length, filled grains panicle<sup>-1</sup> and grain yield of aromatic rice varieties [24]. The lowest grain in (V2 × F3) was due to the lower number of effective tiller hill<sup>-1</sup>, filled spikelet panicle<sup>-1</sup> and 1000-grain weight. The results showed that in case of all varieties, the nutrient F3 i.e. 50% N from Urea and 50% N from vermicompost produced the lowest grain yield. This indicated that organic source of N of vermicompost did not work properly to supply nutrient N for the growth and development of the rice varieties. The stocking density and type of earthworm species are very important as they affect the growth and reproduction of earthworms thus, directly influencing the biochemical processes taking place within the vermicompost [25]. The increase in rice yield is associated with the increase in yield attributes. Application of N through chemical fertilizer brought about significant improvement in grain yield and established superiority over the application of organic N source [26].

#### 4. CONCLUSION

The results of the experiment indicated that none of the local varieties produced better yield than the HYV rice BRRI dhan49. Among the local varieties Nagrasail showed better performance than the other local varieties. It may be

suggested to grow Nagrasail to obtain higher grain yield. Vermicompost did not perform well possibly due to slow release of N while nutrient level of farmers' practice was found better than the BARC recommended fertilizer dose. Further studies required to observed the performance of FYM and vermicompost and the experiment needs to be conducted in the next year for confirmation of the results.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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