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Response of short duration monsoon rice varieties to nitrogen fertilization

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during 5 July to 21 November, 2017 to find out the effect of nitrogen rates on the yield performance of two short duration transplant monsoon (Aman) rice varieties. The experiment included two rice varieties viz. Binadhan-7 and BRRI dhan49 and six rates of nitrogen *viz*. 0, 30, 60, 90, 120 and 150 kg N ha^{-1} in a split-plot design with three replications. The result revealed that grain yield was significantly influenced by rate of nitrogen but not by variety and interaction between variety and nitrogen rates. The highest yield was achieved at 120 kg N ha^{-1} which was similar with 90 kg N ha^{-1}. The highest yield was attributed to higher number of effective tillers hill^{-1} at higher nitrogen rates. The field trial showed the highest grain yield for Binadhan-7 and BRRI dhan49 for 90-120 kg N ha^{-1}. However, the estimated optimum rate of nitrogen from response analysis for Binadhan-7 and BRRI dhan49 were 107 and 103 kg N ha^{-1}, respectively. Present study reveals that the highest yield of the two short duration rice varieties Binadhan-7 and BRRI dhan49 could be obtained by applying 107 and 103 kg N ha^{-1}, respectively.

Keywords: Monsoon rice, nitrogen rate optimization, short duration variety, quadratic response model

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1 Introduction

Rice (*Oryza sativa*) is the staple food grain for more than one third of the world population. In Bangladesh, more than 95% food grain consumed is rice. The yield of rice unit^{-1} area is much lower in Bangladesh as compared to other rice growing countries of the world. However, the potential for increasing rice production strongly depends on the ability to integrate better crop management for the different varieties into existing cultivation systems. In Bangladesh, rice is grown in three seasons namely Aus (summer), Aman (monsoon) and Boro (winter). In Aman season, rice covers an area of 5.68 million hectares with a production of 13.99 million tons (AIS, 2019). Long duration high yield rice varieties are traditionally cultivated in Aman season and their management practices are well documented. Very recently short duration rice varieties for Aman season has been developed to fit into the new cropping pattern for increasing the cropping intensity and diversity by shifting it from double cropping to triple cropping. Triple cropping will allow cultivation of many short duration crops such as mustard, potato, lentil etc. in rabi (winter) season between aman and boro rice. A huge body of research work has been reported earlier stating the response of long duration high yield rice varieties to the management practices.

Fertilizer is the most expensive input for crop production. The efficient fertilizer management gives higher yield of crop and reduces fertilizer cost. Among various nutrients, nitrogen has the strongest influence on the growth and yield of rice (Fillery et al., 1984).

Nitrogen is required in adequate amount at early and mid tillering stage, panicle initiation and ripening stages for better grain development (Balcha and Yesuf, 2014). Nitrogen increases tillering and vegetative growth, increases plant height, grain and straw yield, and number of heads usually are proportionally to the amount of nitrogen added (Islam et al., 2013). Many research works have been done to know the response of long duration aman rice varieties to various nitrogen levels and the farmers of Bangladesh generally use higher amount of nitrogen fertilizer than the recommended rates to get higher yield. Nitrogen use efficiency for rice crop largely ranges between 25% and 35% and seldom exceeds 50% (Singh and Gangwer, 1989). Nonetheless, nitrogen management is a very important factor because excessive use of nitrogen results in lodging of plant, reduction of yield and also has negative implications for the environment (Jiang et al., 2005; Fageria et al., 2008). On the other hand, deficiency of nitrogen also hampers the production of rice. Thus, farmers are advised to use nitrogen properly for better yield. Optimum rate of nitrogen for a variety is necessary to attain potential yield. Optimization of nitrogen rate is also necessary for ensuring high quality product, optimum yield, more net profit and less environmental pollution. Therefore, it is imperative to fine tune fertilizer application rate as per the crop demand to make it more judicious, environment friendly and economical (Antoniadou and Wallach, 2002). However, research on optimization of nitrogen rate for different long duration Aman rice varieties are plenty while that for short duration Aman rice varieties have not been well studied yet.

The present study was therefore, undertaken to find out the optimum dose of nitrogen for the two popular short duration aman rice varieties for the Old Brahmaputra Floodplain Agroecological Zone of Bangladesh.

2 Materials and Methods

2.1 Site and soil

The field experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh (24°43′8.3″N, 90°25′41.2″E). The area was a medium high land belonging to the Sonatola series of non–calcareous dark grey floodplain soil under the Old Brahmaputra Floodplain (AEZ 9), (UNDP and FAO, 1988). The total nitrogen and organic matter contents were 0.160% and 1.11%, respectively. The land was fairly level with well drainage facilities. The soil of the land was silty clay loam with pH value of 7.30. The experimental site is located under sub tropical climate characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds during the monsoon. During the experimental period (July to November), the average maximum and minimum temperatures were 31.72 and 24.06 °C, respectively. The rainfall and relative humidity during this period were 1141 mm and 84.5%, respectively.

2.2 Experimental treatments and design

The experiment included two short duration rice varieties *viz*. Binadhan-7 and BRRI dhan49, and six nitrogen rates viz. 0, 30, 60, 90, 120 and 150 kg N ha^{-1} in a split-plot design with three replications. The nitrogen level was assigned to the main plot and the variety was allocated in the sub-plot randomly. The size of unit plot was 5.0 m $\times$ 3.0 m. The block to block and plot to plot distances were 1 m and 0.6 m, respectively.

2.3 Plant materials used

Binadhan-7 and BRRI dhan49 are short duration rice varieties for aman season having yield capacity of about 5.5 t ha^{-1}. Binadhan-7 and BRRI dhan49 were developed by the Bangladesh Institute of Nuclear Agriculture (BINA) and Bangladesh Rice Research Institute (BRRI), respectively. BRRI dhan49 requires 135-140 days to complete the life cycle (sowing to maturity) while Binadhan-7 requires only 110-120 days. Both the varieties produce medium slender rice grain.

2.4 Crop husbandry

Thirty days old seedlings of the two rice varieties were transplanted in the well puddle land on 05 August 2017 at 25 cm $\times$ 15 cm spacing with 3 seedlings hill^{-1}. The experimental plots were fertilized with triple supper phosphate, muriate of potash, gypsum at final land preparation @ 50, 70 and 70 kg ha^{-1}, respectively. Nitrogen was applied as per treatment specification in the form of urea as top dressing in three equal splits at 7, 21 and 35 days after transplanting (DAT). Weeding was done manually twice at 25 and 40 DAT. Supplemental irrigation was given in the experimental field. One irrigation was given to variety Binadhan-7 at 55 DAT and two irrigations were applied to variety BRRI dhan49 at 55 and 70 DAT. BRRI dhan49 were infested with rice bug (*Leptocorisa acuta*) which was controlled by applying Cup 50 EC @ 2 mL L^{-1} (86 6 mL ha^{-1}) at 87 DAT.

2.5 Harvesting and data recording

Growth parameters like plant height, number of tillers hill^{-1} and dry matter production were

recorded at 45, 55 and 65 days after transplanting (DAT).The crop was harvested at maturity (when 90% of the seeds became golden yellow in color) from the central 3 m × 1.5 m of each plot to record data on grain and straw yield. Five hills were randomly collected from each plot to record data on plant parameters and yield contributing characters. Binadhan7 was harvested on 30 October while BRRI dhan49 was harvested on 21 November 2017. The harvested crop of each plot was separately bundled, properly tagged, threshed and dried to 14% moisture level. Straws were oven dried properly. Final grain and straw yields plot–1 were recorded and expressed in t ha^{-1}. Grain yield and straw yield were altogether regarded as biological yield.

2.6 Statistical analysis

Data recorded for growth, yield and yield contributing characters were compiled and tabulated in proper form for statistical analyses. Analysis of variance was done with the help of Statistix 10 computer package programme. The mean differences among the treatments were evaluated with DMRT test. The relationship between grain yield and fertilizer dose werefitted by the following quadratic model using 'R' statistical programme:

$$Y = a + bX + cX^2 \quad (1)$$

Where, Y = seed yield (t ha^{-1}), X = the dose of the nitrogen applied (kg ha^{-1}), a, b and c are the parameters of the model. The optimum dose of nitrogen for each of rice varieties were then determined using the parameters of the quadratic equation [Equation (1)]:

$$\text{Optimum dose} = \frac{(-b)}{2c} \quad (2)$$

3 Results and Discussion

3.1 Plant height

The effect of variety and nitrogen level was significant for plant height but the interaction between variety and nitrogen level was not significant. The two short duration aman rice varieties differed significantly in their plant height at 45, 65 days after transplanting (DAT) and at harvest but not at 55 DAT (Table 1). The height of BRRI dhan48 was higher at 45DAT (75.38 cm) than Binadhan-7 (68.59 cm) while the height of Binadhan-7 became higher at later growth stages and also at harvest. Plant height of rice varieties vary significantly due to genetic variation (Islam et al., 2013). The nitrogen level has significant effect on plant height of rice at 45, 55 and 65 DAT (Table 2). The plant height was the highest with 150 kg N ha^{-1} which was statistically similar with that of 90 and 120 kg N ha^{-1} at 45, 55 and 65 DAT while at harvest the plant height was the highest at 90 kg N ha^{-1} which was similar to that for 120 and 150 kg N ha^{-1}. Thus the result clearly showed that the plant height responded to the rates of nitrogen and the highest values are attained at 90 kg N ha^{-1}. Rice plant height increased with increased rate of nitrogen application and then declined with further increase of nitrogen rate (Singh et al., 2014). Rahaman (2004) reported the maximum plant height of the variety Taroari Basmati at 100 kg N ha^{-1} and the minimum with 200 kg N ha^{-1}. In another study Somasundaram et al. (2002) found the maximum plant height of variety SSRC91216 at 150 kg N ha^{-1} and the minimum with no nitrogen application. This increase of plant height at higher nitrogen rates may be attributed to the role of nitrogen in improving rice growth, internode elongation, photosynthesis, and metabolism and assimilate production (Ghoneim et al., 2018).

3.2 Tiller production

Number of total tillers hill^{-1} differed significantly due to nitrogen level but not by variety and interaction between variety and nitrogen level (Table 3). The tiller production increased with increase of nitrogen level and the highest value was attained at the highest level of nitrogen applied (150 kg N ha^{-1}). The number of tillers hill^{-1} with 150 kg N ha^{-1}at 45, 55 and 65 DAT were 19.66, 18.12 and 15.83, respectively. The lowest number of tillers hill^{-1} was found in control plots, which were 11.91, 12.33, and 10.79 at 45, 55 and 65 DAT, respectively. The highest number of effective tillers hill^{-1} was found with 90 kg N ha^{-1} (12.83) and the lowest was found with control (10.3). The result of the present study showed that the tiller production increased with increased rate of nitrogen application. Similar result was reported by Jisan et al. (2016) where they found the highest tillers hill^{-1} at the highest nitrogen rate of 75 kg N ha^{-1}. On the other hand, Sultana and Ali (2014) found that the tiller production of rice increased up to 90 kg N ha^{-1} and then declined with further increased nitrogen rate. In the present study, the highest value was achieved at 150 kg N ha^{-1} for the two varieties. The application of nitrogen made more nitrogen available to the plants which played a vital role in cell division and tiller production (Singh et al., 2014). Therefore, the tiller production capacity increases with the nitrogen nutrition of the crop.

3.3 Total dry matter (TDM) accumulation

Nitrogen level had significant effect on total dry matter accumulation at 45, 55 and 65 DAT but not variety and the interaction of variety and nitrogen level. The highest TDM was achieved at 150 kg N ha^{-1} (7.32, 18.87 and 26.26 g hill^{-1}) which was statistically at par

Table 1. Plant height of two short duration Aman rice varieties at different days after transplanting (DAT)

Variety	Plant height (cm)			
	45 DAT	55 DAT	65 DAT	At harvest
Binadhan-7	68.59 b	89.97	97.69 a	98.98 b
BRRI dhan49	75.38 a	88.53	93.13 b	103.60 a
Level of significance	***	NS	***	**

Table 2. Effect of nitrogen rate on plant height of two short duration Aman rice varieties at different days after transplanting (DAT)

N rate (kg ha^{-1})	Plant height (cm)			
	45 DAT	55 DAT	65 DAT	At harvest
0	65.60 d	80.70 c	87.08 d	95.47 d
30	71.17 c	86.45 b	92.88 c	100.07 c
60	72.52 bc	89.59 ab	95.52 bc	100.60 bc
90	73.89 ab	91.64 ab	99.33 a	105.57 a
120	73.13 bc	93.03 a	97.31 ab	102.50 abc
150	75.60 a	94.10 a	100.38 a	103.47 ab
Level of significance	***	**	***	***

Table 3. Effect of nitrogen rate on number of total tillers hill^{-1} of short duration Aman rice varieties at different days after transplanting (DAT)

N rate (kg ha^{-1})	Number of total tillers hill^{-1}			
	45 DAT	55 DAT	65 DAT	At harvest
0	11.91 c	12.33 c	10.79 c	11.43 c
30	15.83 ab	14.83 bc	13.25 bc	12.36 bc
60	15.58 bc	15.91 ab	13.45 ab	12.06 c
90	17.20 ab	17.33 ab	15.29 ab	14.16 a
120	19.04 ab	16.41 ab	15.04 ab	14.40 a
150	19.66 a	18.12 a	15.83 a	13.80 ab
Level of significance	*	*	*	**

Table 4. Effect of nitrogen rate on total dry matter of short duration Aman rice varieties at different days after transplanting (DAT)

N rate (kg ha^{-1})	Total dry matter hill^{-1} (g)		
	45 DAT	55 DAT	65 DAT
0	5.15 b	12.64 b	19.01 b
30	6.32 a	16.40 ab	23.28 a
60	6.63 a	14.89 ab	23.05 a
90	7.24 a	17.36 a	25.46 a
120	6.90 a	12.00 b	25.63 a
150	7.32 a	18.87 a	26.26 a
Level of significance	*	*	*

In a column, figures with the same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), ***, **, * = Significant at 0.1%, 1%, and 5% levels of probability, respectively

with all other rates from 30 to 120 kg N ha^{-1}at 45, 55 and 65 DAT, respectively (Table 4). The lowest TDM was found with control (5.15, 12.64 and 19.01 g hill^{-1} at 45, 55 and 65 DAT, respectively). Singh et al. (2014) reported that total dry matter (TDM) at active tillering and flowering stages increased with increase of nitrogen application. The TDM production is a genetic character and depends on the plant height and tiller production capacity of a variety (Panwar et al., 2012), and these parameters increase with increased levels of nitrogen application (Singh et al., 2014). Wilson et al. (2006) reported that nitrogen nutrition results in better root development and increased nitrogen absorption. Increased level of nitrogen increased the number of green leaves and leaf area index due to increased translocation of nitrogen to the leaves (Somasundaram et al., 2002). Thus, nitrogen application increases the total dry matter accumulation through increase of plant height and tiller production.

3.4 Yield contributing characters

Number of total spikelets panicle^{-1}, filled grains panicle^{-1}, panicle length and 1000-grain weight differed between the varieties but did not differ significantly for the number of effective tillers hill^{-1}, non-effective tillers hill^{-1} and unfilled spikelets panicle^{-1} (Tables 5 to 7). Table 5 showed that BRRI dhan49 produced higher number of filled grains (108.93) than Binadhan-7 (62.88) while 1000-grain weight was higher in Binadhan-7 (19.55 g) than BRRI dhan49 (18.42 g). Panicle was longer in Binadhan-7 (22.19 cm) than BRRI dhan49 (20.32 cm). The variation between two varieties regarding these yield contributing characters are mainly related to their genetic background (Ghoneim et al., 2018).

Nitrogen rate has significant effect on number of effective tillers hill^{-1} and panicle length but not on other parameters. The number of effective tillers hill^{-1} was highest with 120 kg N ha^{-1} which was statistically similar with those for 90 and 150 kg N ha^{-1}. The lowest number of effective tillers hill^{-1} (10.30) was found in the control plots (Table 6). The increase in number of grain panicle^{-1} for increased nitrogen has been reported by Mendhe et al. (2002) and Salahuddin et al. (1970) which supports the present result. The number of effective tiller at higher rates of nitrogen could be attributed to increased photosynthate production and its translocation for panicle formation at the reproductive stage (Ghoneim et al., 2018).

3.5 Grain, straw and biological yield

Nitrogen level had significant effect on grain yield but variety and their interaction had no significant effect on it (Tables 5 to 7). The highest grain yield was obtained with 120 kg N ha^{-1} (5.40 t ha^{-1}) which is statistically at par with 90 kg N ha^{-1} (4.86 t ha^{-1}) and the lowest yield was found with control plot (2.56 t ha^{-1}). The present study showed that both the varieties showed similar response to nitrogen levels for grain yield and gave the highest yield for a nitrogen level between 90 and 120 N ha^{-1} (Table 6). Sultana and Ali (2014) obtained highest grain yield of an aromatic rice variety at 60 kg N ha^{-1} when the response of N was studied for up to 120 kg N ha^{-1} while Jisan et al. (2016) estimated that the highest yield of some transplant aman rice varieties (BRRI dhan49, BRRI dhan56, BRRI dhan57 and BRRI dhan52) at 75 kg N ha^{-1} where the highest nitrogen rate used was 75 kg N ha^{-1}. However, the short duration rice varieties used in the present study clearly showed that the rice varieties responded to the higher nitrogen rates of 90-120 kg N ha^{-1}.

Straw yield was affected by variety, nitrogen rate and their interaction. The straw yield was higher in BRRI dhan49 (6.34 t ha^{-1}) than Binadhan-7 (4.42 t ha^{-1}). The highest straw yield was also found with 120 kg N ha^{-1} (5.95 t ha^{-1}) which was statistically similar with those at 150, 90 and 60 kg N ha^{-1} (Table 6). The lowest straw yield was found in control plots (4.10 t ha^{-1}). Table 7 showed the highest straw yield (7.01 t ha^{-1}) in BRRI dhan49 with 60 kg N ha^{-1} while the lowest straw yield was found with Binadhan-7 at control treatment (3.21 t ha^{-1}). Table 5showed that the biological yield was higher in BRRI dhan49 (10.58 t ha^{-1}) than Binadhan-7 (8.76 t ha^{-1}). The highest biological yield was found with 120 kg N ha^{-1} (11.35 t ha^{-1}), which was statistically similar to those obtained with 90 and 150 kg N ha^{-1} (Table 6). The interaction effects of variety and nitrogen rate showed that the highest biological yield was with BRRI dhan49 at 120 kg N ha^{-1} (Table 7).

3.6 Optimum nitrogen dose

The yield response of two short duration Aman rice varieties in relation to nitrogen rates could be best explained by the quadratic equation (Fig. 1). The test analysis indicated that more than 96% and 92% of the variation in crop performance (grain yield) occurred due to nitrogen rate in variety Binadhan-7 and BRRI dhan49, respectively. The estimated coefficients of the polynomial regression models showed significant variation. The estimated optimum dose of nitrogen for Binadhan-7 and BRRI dhan49 are 107.04 and 102.73 kg ha^{-1}, respectively although both the varieties showed the highest yield when 90 to 120 kg ha^{-1} of nitrogen were applied.

4 Conclusions

The rate of nitrogen application significantly influenced the yield of the two short duration Aman rice varieties. Field estimation showed the highest yield

Table 5. Yield contributing characters and yield of two short duration Aman rice varieties

Variety	ET hill^{-1}	NET hill^{-1}	Pan. L (cm)	TS pan.$^{-1}$	FG pan.$^{-1}$	US pan.$^{-1}$	WTS (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})
Binadhan-7	11.67	1.71	22.19 a	80.91 b	62.88 b	18.02	19.55 a	4.23	4.42 b	8.76 b
BRRI dhan49	11.38	1.177	20.32 b	119.32 a	101.83 a	17.53	18.42 b	4.24	6.34 a	10.58 a
Level of sig.	NS	NS	***	***	***	NS	***	NS	***	***

In a column, figures with the same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), *** = Significant at 0.1% level of probability, NS = not significant at 5% level of probability; ET = number of effective tillers, NET = number of non-effective tillers, Pan. L = panicle length, TS = number of total spikelets, FG = number of filled grains, US = number of unfilled spikelets, WTS = weight of 1000 grains, GY = grain yield, SY = straw yield, BY = biological yield

Table 6. Effect of nitrogen rate on yield contributing characters and yield of short duration Aman rice varieties

N rate (kg ha^{-1})	ET hill^{-1}	NET hill^{-1}	Pan. L (cm)	TS pan.$^{-1}$	FG pan.$^{-1}$	US pan.$^{-1}$	WTS (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})
0	10.30 b	1.13	20.90 bc	97.02	81.01	16.00	18.57	2.56 d	4.10 c	6.67 d
30	11.60 ab	0.76	20.92 bc	107.27	88.93	18.33	18.73	3.56 c	5.03 b	8.59 c
60	10.13 b	1.93	20.63 c	97.10	79.95	17.15	19.49	4.61 b	5.58 ab	10.20 b
90	12.83 a	1.33	21.58 ab	95.68	78.45	17.23	19.49	4.86 ab	5.68 ab	10.50 ab
120	12.43 a	1.96	21.83 a	100.72	82.98	17.85	19.33	5.40 a	5.95 a	11.35 a
150	11.90 ab	1.53	21.65 ab	102.90	82.80	20.10	18.29	4.40 b	5.93 a	10.60 ab
Level of sig.	*	NS	*	NS	NS	NS	NS	***	**	***

In a column, figures with the same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), ***, **, * = Significant at 0.1%, 1%, and 5% levels of probability, respectively, NS = not significant at 5% level of probability; ET = number of effective tillers, NET = number of non-effective tillers, Pan. L = panicle length, TS = number of total spikelets, FG = number of filled grains, US = number of unfilled spikelets, WTS = weight of 1000 grains, GY = grain yield, SY = straw yield, BY = biological yield

Table 7. Interaction effect of variety and nitrogen rate on yield contributing characters and yield of short duration Aman rice

Variety × N rate	ET hill^{-1}	NET hill^{-1}	Pan. L (cm)	TS pan.$^{-1}$	FG pan.$^{-1}$	US pan.$^{-1}$	WTS (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})
V1N0	9.66	1.66	21.01	72.83	58.83	14	19.01	2.44	3.21 f	5.65 f
V1N1	12.46	0.53	21.75	88.03	68.7	19.33	19.4	3.53	3.73 ef	7.27 e
V1N2	10	1.86	21.4	77.3	59.37	17.93	20.18	4.71	4.16 def	8.88 d
V1N3	13.13	1.46	22.8	83.13	66.2	16.93	20.31	4.8	4.63 cde	9.44 d
V1N4	13.33	2.93	22.96	78.7	61.57	17.13	20.21	5.35	5.27 c	10.63 bc
V1N5	11.46	1.8	23.2	85.43	62.63	22.8	18.19	4.54	5.51 bc	10.67 bc
V2N0	10.93	0.6	20.8	121.2	103.2	18	18.13	2.69	4.99 cd	7.68 e
V2N1	10.73	1	20.1	126.5	109.17	17.33	18.06	3.58	6.33 ab	9.92 cd
V2N2	10.26	2	19.86	116.9	100.53	16.36	18.8	4.51	7.01 a	11.52 ab
V2N3	12.53	1.2	20.36	108.23	90.7	17.53	18.66	4.92	6.73 a	11.65 ab
V2N4	11.53	1	20.7	122.73	104.4	18.56	18.46	5.45	6.63 a	12.08 a
V2N5	12.33	1.26	20.1	120.37	102.97	17.4	18.4	4.26	6.34 ab	10.61 bc
Level of sig.	NS	NS	NS	NS	NS	NS	NS	NS	*	**

In a column, figures with the same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), **, * = Significant at 1%, and 5% levels of probability, respectively, NS = not significant at 5% level of probability; ET = number of effective tillers, NET = number of non-effective tillers, Pan. L = panicle length, TS = number of total spikelets, FG = number of filled grains, US = number of unfilled spikelets, WTS = weight of 1000 grains, GY = grain yield, SY = straw yield, BY = biological yield;
V1 = Binadhan-7, V2 = BRRI dhan49; N0 = 0, N1 = 30, N2 = 60, N3 = 90, N4 = 120, and N5 = 150 kg N ha^{-1}.

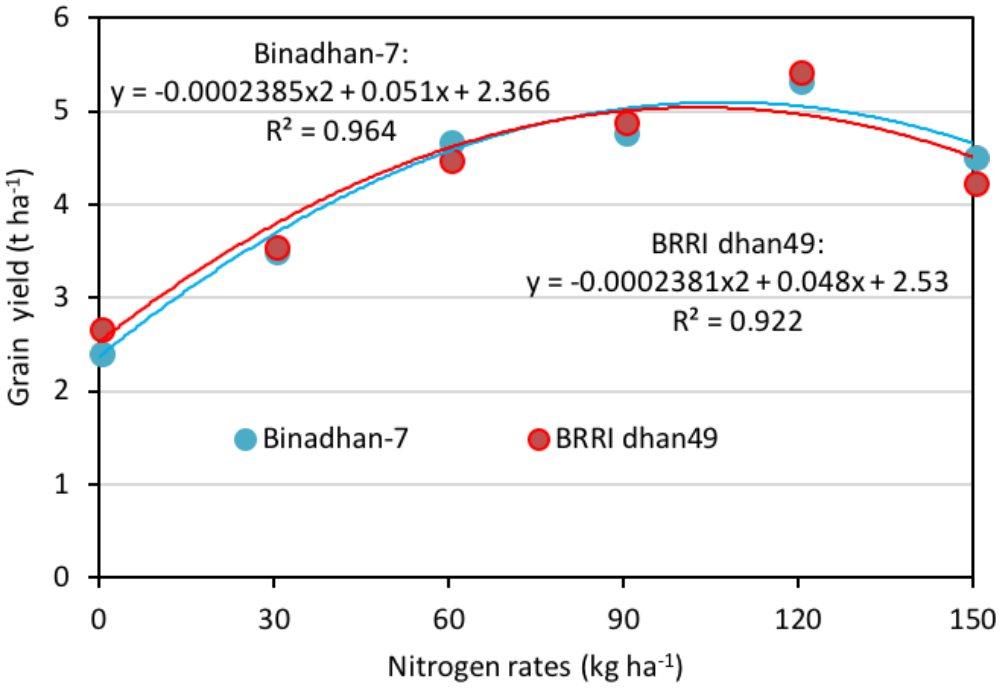

Figure 1. Yield response of Binadhan-7 and BRRI dhan49 to nitrogen rates in Aman season

for the application of 120 kg nitrogen ha^{-1} which was statistically similar with 90 kg nitrogen ha^{-1}. However, from the fitted quadratic response curve for Binadhan-7 and BRRI dhan49 the estimated highest yield of these two varieties were at 107 and 103 kg N ha^{-1}, respectively. Therefore, the present study reveals that the highest yield of short duration Aman rice varieties Binadhan-7 and BRRI dhan49 could be obtained by applying 107 and 103 kg N ha^{-1}, respectively.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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