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Performance of Transplant *Aus* Rice Varieties under Different Nitrogen Management Practices

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Management of applied nitrogen in rice field is one tool that could lead to increase in rice yield, but often ignored by most farmers. The experiment was carried out from April to July 2015 at the Agronomy Field Laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali to find out the influence of different nitrogen management and variety on the yield performance of transplant *Aus*rice. The study consisted of four levels of nitrogen *viz.* Control (without N), 30 kg N ha^{-1}, 60 kg N ha^{-1} and urea super granule @ 52 kg N ha^{-1} and four Transplanted *aus* rice varieties *viz. KaliHitta*, *ChaitaBoro, Abdul Hai and Gota IRRI,* and was laid out in a split-plot design with three replications. The levels of nitrogen were assigned in the main plot and varieties were allocated in the sub-plots. Nitrogen management, variety and their interactions exerted significant (P ≤ 0.05) influence on plant characters, yield contributing characters and yield of transplanted *Aus* rice. In the case of nitrogen management, the tallest plant was 161.60 cm, maximum leaf area index(2.97, the highest number of effective tillers hill^{-1}15, longest panicle 24.30 cm with the maximum number of

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filled grains as94.73, 1000-grain weight gave 29.97 g. Grain yield of 2.48 t ha^{-1} were obtained from USG @ 52 kg N ha^{-1} and the shortest plant height of 136.90 cm with lowest leaf area index of 1.78, lowest number of effective tillers $hill^{-1}$ (8.43), shortest panicle (18.84 cm) with the lowest numbers of filled grains $panicle^{-1}$ (53.18), 1000-grain weight (24.33 g) and grain yield (1.40 t ha^{-1}) were obtained in control ($N_{1=O,}$ kg N ha^{-1}). Among the varieties, *ChaitaBoro* gave the tallest plant height (151.60 cm) and maximum leaf area index (2.54). While the highest number of effective tillers $hill^{-1}$ (12.20), longest panicle (22.42 cm) with the maximum number of filled grains $panicle^{-1}$ (73.50), highest 1000-grain weight (27.41 g) and highest grain yield (2.39 t ha^{-1}) were recorded from *Gota IRRI* than other varieties. In case of interaction, *Gota IRRI F*ertilized with USG at 52 kg N ha^{-1} produced the highest number of effective tillers $hill^{-1}$ (16.87), panicle length (25.13 cm), number of grains $panicle^{-1}$ (105.70) and grain yield (3.13 t ha^{-1}). The lowest number of effective tillers $hill^{-1}$ (8.13), lowest panicle length (17.47 cm) with minimum numbers of filled grains 47.67) and grain yield (1.12 t ha^{-1}) were produced by the interaction of control ($N_{1=O,}$ kg N ha^{-1}) and *Kali Hitta*. So, cultivation of transplant *Aus* rice (*Gota IRRI)* appeared to be the best performance with USG @ 52 kg N ha^{-1} and recommended to the end users.

Keywords: Aus rice; nitrogen management; variety; yield.

1. INTRODUCTION

Rice (*Oryza sativa* L.) plays an important role in the food security of the world and it is the staple food of more than fifty percent people of the world's population [1]. At present a hectare of rice field can feed 27 people, it must feed 43 people by 2050 [2]. In Bangladesh rice is the staple food of about 17 million people which covers about 75% of the total-cropped area [3]. To increase yield in rice, high yielding varieties combine with appropriate management practices are needed. Among management practices, nitrogen fertilizer management is a key nutrient element that plays a vital role in rice production(vegetative growth, development of yield components and yield of rice) [4]. Efficient fertilizer management will lead to a higher yield. the [5]. Like other rice-growing countries, Bangladesh also needs to increase production to feed her increasing highits population since rice is the staple food, though the country occupies 4^{th} position in the world to rice area and production [6]. Aman season is rainfed but Boro is an exhaustive season where a considerable amount of electric power is used for irrigation. Again, sub-soil water is mining for irrigation which exerts a negative impact on our natural resources. But the main drawback is that the average yield of aus rice (2.16 t ha^{-1}) is lower than aman and boro season . Besides that, in the southern region of Bangladesh, most of the farmers cultivate aus rice with local varieties whose yield potential is very low. Out of the total Aus area (1.05 mha), local varieties covers about 0.26 mha with an average yield of only 1.27 t ha^{-1} [7]. This lower yield in aus rice is characterized by local low yielding varieties.Also,varieties; most of the farmers prefer it and couple with poor nitrogen fertilizer management practice that is still a challenge with the local aus rice varieties. The optimum dose of N is one of the most effective means to obtain maximum yield of rice which could increase about 70– 80% yield in rice. Nitrogen fertilizer increases tilleringvegetative growth, plant height, grain and straw yield and number of heads usually are proportional to the amount of nitrogen added to the soil. Application of N fertilizer in several splits matching the demand of the crop for N at critical stages of growth, deep placement of N in the reduced zone of the soil or thorough incorporation in the soil, use of coated/modified (e.g. USG) fertilizers are some of the useful techniques which improve N-use efficiency in rice. As N fertilizer is the main promoter of crop growth and yield, it is important to improve management practices that minimize N losses and increase the recovery of applied N by the crop.

Thiswillincrease productive efficiency and reduce negative impact of N use on the environment. In the light of the above points, the present study was undertaken to, evaluate the effect of Aus rice varieties on growth and yield performance, observe the effect of nitrogen fertilizer on Aus rice, and the interaction effect of Aus rice varieties and nitrogen management practices.

2. MATERIALS AND METHODS

2.1 Location and Site

The experiment was carried out at the Agronomy experimental field of Patuakhali Science and Technology University, Patuakhali, Bangladesh during the period from April 2015 to July 2015.The area is located at 22.26^0N latitude and

90.22^{0}E longitude at an elevation of 1.5 m above sea level.

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The experimental field was medium high land with silty clay textured soil with a pH value of 6.5 belonging to the Ganges Tidal Flood Plain (AEZ 13) in the coastal non-saline zone of Bangladesh. The experimental field was more or less neutral in reaction, low in organic matter content and its general fertility level was also low.

2.2 Experimental Material

Four popular Transplanted *aus* rice varieties *viz.* Kali Hitta,ChaitaBoro, Abdul Hai and Gota IRRI were used as experimental materials. The seeds were collected from local “trusted” farmers.

2.3 Experimental Treatments

The experiment was a two factor factorial experiment consisted of four Transplanted *aus* varieties and four doses of Nitrogen fertilizers. The details of treatments are

Factor A: Nitrogen management -4 (Main plot) Control (No Nitrogen) $N_{1,}$ Nitrogen @ 30 Kg ha^{-1} (N_2), Nitrogen @ 60 Kg ha^{-1} (N_3), Urea super granule @ 52 Kg ha^{-1} (N_4)

Factor B: T. Aus Variety -4 (subplot) Kali Hitta (V_1)**,** Chita Boro (V_2), AbduiHai (V_3), Gota IRRI (V_4).

2.4 Experimental Design and Layout

The experiment was laid out in a split-plot design with three replications. Where N-fertilizer levels were assigned in the main plot and varieties were in the sub-plot. The treatments were randomly assigned in each replication. There were 48 unit plots in the experiment. The size of each plot was 4 m × 2.5 m. Each unit plot and block was separated from each other by 50 cm and 1m, respectively. A High border was maintained to control the movement of fertilizers to the adjacent plots.

2.5 Raising Seedlings

Healthy seeds were selected by a specific gravity method and then sprouted by immersing in water in the bucket for 24 hours. Then the seeds were taken out of the water and kept thickly in a gunny bag. After 48 hours the seeds started sprouting and sown after 72 hours in the nursery bed. A piece of high land was selected for raising seedlings. The nursery plot was irrigated 12 days before sowing seeds to hasten germination of *Kharif*annual weeds. After that nursery plot was ploughed first by soil turning plough followed by cross ploughing with a cultivator. The sprouted seeds were sown gently and uniformly in the wet nursery beds on 1 April 2015. Proper care was taken to raise the seeding in the nursery. Weeds were removed and irrigation was given in the nursery beds as and when necessary.

The experimental land was prepared by a tractor drawn disc plough on 27 April, 2015. Then the land was puddled thoroughly by repeated ploughing and cross ploughing with a country plough and leveled by laddering. Weeds and stubble of the previous crop were removed from individual plots and finally plots were leveled so properly by wooden plank that no water pocket could remain in the puddled field.

2.6 Application of Fertilizers

Fertilizer with a uniform dose except for nitrogen of 80, 60, 21 and 8 kg per hectare P, K, S and Zn through TSP, MOP, gypsum and Zinc Sulphate was applied in all the plots. Full doses of phosphorus, potassium, gypsum and zinc sulphte were applied as basal applications just before transplanting. Nitrogen was applied as per treatment in the form of prilled urea and urea super granule (USG). Prilled urea was applied in three equal splits at 15, 30 and 45 days after transplanting (DAT) and USG were applied at a time at 10 DAT.

2.7 Transplanting of Seedlings

The seedlings were uprooted from the nursery bed on the day of transplanting. Thirty days old seedlings were transplanted on 5 May 2015 in the main field with 4 seedlings hill^{-1} spaced at 20 cm × 20 cm.

To ensure and maintain the normal growth and development of the crop, intercultural operations were done at proper time. The following intercultural operations were done.

2.8 Irrigation and Drainage

A thin film of water was maintained at the time of transplanting. The plots were kept in saturated condition for a week after transplanting. Two irrigation were applied during the first month of transplanting. At the latter stage, frequent rainfall occurred, so there was no need for further irrigation. Excess water was drained out from the plots before 15 days of harvest to enhance maturity of the crop.

2.9 Plant Protection Measures

Crops were mildly attacked by rice stem borer at tillering stage of crop and rice bug at the dough stage. Furadan @ 10 kg ha^{-1} were applied to control the stem borer and rice bug, respectively.

2.10 Sampling, Harvesting and Processing

Maturity of the crop was determined when 90% of the grain became golden yellow color. Five hills from each plot excluding border hills were selected at random prior to harvesting and taken out for studying yield attributes data. The crop of individual plots was harvested on 28 July 2015. These plants were taken out with respective tag levels. An area of central 5 m^2 in each plot excluding the crop sampling zone was harvested for measurement of grain and straw yields. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The crop was threshed by pedal thresher. Grain was sun dried and cleaned. Straw was also sun dried properly. Finally, grain and straw yields were adjusted to 14% moisture level and converted to ton per hectare.

2.11 Data Collection

Data was collected on plant height (cm), Leaf area index, days to 50% flowering, number of tillers per hill, number of effective tillers per hill, number of non-effective tillers per hill, panicle length (cm), number of grains per panicle, 1000-grain weight (g), Grain yield (t ha^{-1}), straw yield (t ha^{-1}) and Harvest index (%).

2.12 Statistical Analysis

The collected data on various plant characters were statistically analyzed using the 'Analysis of variance technique' with the help of a 'R' and the mean differences were adjusted by Duncan's Multiple Range Test [8].

3. RESULTS AND DISCUSSIONS

3.1 Effect of Nitrogen Management, Variety and Interaction (Nitrogen and Rice Variety)

3.1.1 Plant height

The plant height of transplant Aus rice varied significantly with different nitrogen management (Table 1). The plant height ranged from 136.90 cm to 161.60 cm. The tallest plant (161.60 cm) was recorded at USG 52 kg N ha^{-1}. Increased plant with the treatment of USG might be the availability of sufficient nitrogen amount for the rice plant throughout the life cycle, which might have favored increased cell division and cell enlargement. Faraji [9] recorded different plant heights due to different nitrogen rates.

The plant height at maturity of transplant Aus rice was significantly influenced by variety (Table 2). The tallest plant (151.60 cm) was recorded in *Chaita jm*d by *Kali Hitta* (149.37 cm) and *Abdul Hai*(147.45 cm). These differences are mostly due to the genetic variation among the varieties. These results were consistent with those of Om *et al.* [10], Khisha, [11] and Rahman, [12] who recorded variable plant height among the varieties.

Interaction of nitrogen management and variety, the highest plant height (165.30 cm) was found from the interaction between USG @ 52 kg N ha^{-1} × *ChaitaBoro* and the lowest plant height (135.60 cm) was found from *Gota IRRI (*V_4) with control (N_1) application, which was similar to 30 kg prilled urea × Abdul Hai interaction (135.80 cm) (Table 3)

3.1.2 Leaf area index ed

Leaf area edAusricewas varied significantly due to nitrogen management practices. Application of USG (52 kg N $ha^{-1)}$ produced maximum LAI (2.97), while the lowest LAI (1.78) was recorded from control treatment where no niter was applied. No significant variation was observed in the case of prilled urea at both N_{30} and N_{60} levels (Table 1).

Varieties showed significant variation as the LAI ranged from 2.13 to 2.54 (Table 2). The maximum LAI (2.54) was recorded in *ChaitaBoro* and the lowest LAI (2.13) was recorded from *Gota IRRI*. This variation in LAI may be due to the genetic make of the varieties.

In interaction, the LAI of varieties*ChaitaBoro* and*Kali Hitta* were statistically similar (significantly at 5% level)with USG @ 52 kg N ha^{-1}, which were 3.26 and 3.07, respectively. On the other hand, *Gota IRRI* at zero N level gave the lowest (1.43) LAI (Table 3).

3.1.3 Days to 50% flowering and maturity

Response to flowering showed dependencies on the level of application of nitrogen fertilizer. A significant variation of days to 50% flowering was found. The highest was recorded at 104.80 days

Table 1. Effect of nitrogen fertilizer management on yield and yield contributing characters of Ausrice

Nitrogen fertilizer (dose)	Plant height (cm)	Leaf Area Index	50% flowering (days)	Maturity (days)	Effective tillers per hill(no.)	Non-effective tillers per hill (no.)	Panicle length (cm)	Filled grains per panicle (no.)	Un-filled grains per panicle (no.)	1000-seed weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Control (N_1)	136.90 d	1.78 c	62.83 d	104.42 d	8.43 c	2.86 a	18.84 d	53.18 c	24.88 a	24.33 d	1.40 d	2.39 d	36.69 d
N_{30}	142.4 c	2.16 b	92.00 c	115.83 c	9.70 c	1.58 b	20.95 c	59.06 c	19.93 b	25.63 c	1.65 c	2.67 c	37.98 c
N_{60}	153.60 b	2.46 b	103.00 b	126.25 b	11.43 b	1.28 b	22.47 b	67.73 b	15.65 c	27.06 b	2.19 b	3.34 b	39.34 b
USG_{52}	161.60 a	2.97 a	104.80 a	128.33 a	15.45 a	0.52 c	24.30 a	94.73 a	7.08 d	29.97 a	2.48 a	3.67 a	40.02 a
$LSD_{0.05}$	4.79	0.31	1.12	1.14	1.72	0.70	1.31	7.69	1.99	1.07	0.01	0.02	0.11
Significance level	**	**	**	**	**	**	**	**	**	**	**	**	**
CV (%)	1.33	5.23	1.21	0.82	5.68	11.82	1.63	4.87	5.37	1.01	0.73	0.57	0.28

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differs significantly (as per DMRT)

Table 2. Effect of variety on yield and yield contributing characters of *Aus*rice

Variety	Plant height (cm)	Leaf Area Index	50% flowering (days)	Maturity (days)	Effective tillers per hill (no.)	Non-effective tillers per hill (no.)	Panicle length (cm)	Filled grains per panicle (no.)	Un-filled grains per panicle (no.)	1000-seed weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Kali Hitta	149.37 b	2.42 b	83.67 d	111.00 d	10.50 c	1.85 a	20.93 d	63.12 c	18.92 a	25.94 d	1.52 d	2.70 d	35.73 c
ChaitaBoro	151.60 a	2.54 a	96.42 a	125.67 a	10.93 bc	1.67 b	21.32 c	68.06 b	17.50 b	26.61 c	1.71 c	3.01 c	35.95 c
Abdul Hai	146.07 c	2.28 c	88.83 c	115.83 c	11.38 b	1.48 c	21.88 b	70.03 b	16.06 c	27.03 b	2.10 b	3.04 b	40.74 b
Gota IRRI	147.45 c	2.13 d	93.67 b	122.33 b	12.20 a	1.24 d	22.42 a	73.50 a	15.07 d	27.41 a	2.39 a	3.32 a	41.61 a
$LSD_{0.05}$	1.41	0.10	0.92	0.82	0.54	0.16	0.30	2.06	0.76	0.23	0.03	0.03	0.14
Significance level	**	**	**	**	**	**	**	**	**	**	**	**	**
CV (%)	3.22	13.43	1.23	0.94	15.27	44.69	6.05	11.20	11.05	4.00	1.64	1.05	0.43

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differs significantly (as per DMRT)

Table 3. Combined effect of nitrogen management and variety on yield and yield contributing characters of *Aus*rice

Interaction (Nitrogen X Variety)	Plant height (cm)	Leaf Area Index	50% flowering (days)	Maturity (days)	Effective tillers per hill (no.)	Effective tillers per hill (no.)	Panicle length (cm)	Filled grains per panicle (no.)	Filled grains per panicle (no.)	1000-seed weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$N_1 V_1$	137.20 jk	1.93 jk	57.00 l	98.67 l	8.13 i	3.47 a	17.47 j	47.67 j	27.47 a	23.52 k	1.12 n	2.28 l	32.97 l
$N_1 V_2$	138.90 ij	2.02 ij	68.67 i	110.70 i	8.20 i	3.20 a	18.43 i	54.13 i	26.07 a	24.40 j	1.23 m	2.44 j	33.61 k
$N_1 V_3$	135.80 k	1.75 k	60.33 k	101.30 k	8.67 hi	2.73 b	19.47 h	54.93 i	23.60 b	24.66 j	1.57 j	2.37 k	39.76 e
$N_1 V_4$	135.60 k	1.43 l	65.33 j	107.00 j	8.73 hi	2.03 c	20.00 gh	56.00 hi	22.40 bc	24.73 ij	1.67 i	2.46 j	40.42 d
$N_2 V_1$	143.30 gh	2.20 ghi	85.67 h	108.30 j	9.20 hi	1.80 cd	20.53 fg	57.13 hi	21.80 cd	25.18 hi	1.33 l	2.48 j	34.91 j
$N_2 V_2$	145.20 g	2.26 fgh	96.67 f	121.30 e	9.47 gh	1.60 de	20.73 f	57.77 ghi	20.33 de	25.36 h	1.47 k	2.68 i	35.42 i
$N_2 V_3$	141.70 hi	2.11 g-j	90.33 g	114.00 h	9.73 fgh	1.47 ef	21.13 ef	59.60 gh	18.93 ef	25.87 g	1.82 g	2.71 i	40.21 d
$N_2 V_4$	139.40 ij	2.06 hij	95.33 f	119.70 f	10.40 efg	1.47 def	21.40 e	61.73 fg	18.67 f	26.10 g	1.99 f	2.81 h	41.39 c
$N_3 V_1$	154.60 de	2.50 cde	95.33 f	117.70 g	10.60 efg	1.40 ef	22.00 d	64.67 ef	17.93 fg	26.58 f	1.76 h	2.97 g	37.28 g
$N_3 V_2$	157.10 cd	2.61 cd	109.00 b	133.70 b	10.87 ef	1.27 ef	22.13 d	67.00 de	16.47 gh	26.97 f	1.87 g	3.20 e	36.93 h
$N_3 V_3$	152.30 ef	2.44 def	101.30 e	123.30 d	11.47 e	1.27 ef	22.60 cd	68.67 de	15.00 h	27.03 f	2.36 d	3.34 d	41.44 bc
$N_3 V_4$	150.50 f	2.31 efg	106.30 c	130.30 c	12.80 d	1.20 f	23.13 c	70.60 d	13.20 i	27.67 e	2.75 b	3.85 b	41.72 b
$N_4 V_1$	162.30 b	3.07 a	96.67 f	119.30 f	14.07 c	0.73 g	23.73 b	83.00 c	8.47 j	28.47 d	1.85 g	3.05 f	37.76 f
$N_4 V_2$	165.30 a	3.26 a	111.30 a	137.00 a	15.20 b	0.60 g	24.00 b	93.33 b	7.13 jk	29.70 c	2.27 e	3.73 c	37.85 f
$N_4 V_3$	160.00 bc	2.83 b	103.30 d	124.70 d	15.67 b	0.47 gh	24.33 b	96.93 b	6.70 k	30.57 b	2.66 c	3.75 c	41.55 bc
$N_4 V_4$	158.80 c	2.71 bc	107.70 bc	132.30 b	16.87 a	0.27 h	25.13 a	105.70 a	6.00 k	31.13 a	3.13 a	4.17 a	42.92 a
$LSD_{0.05}$	2.82	0.21	1.84	1.64	1.08	0.31	0.59	4.12	1.53	0.46	0.05	0.05	0.28
Sig. level	*	*	*	**	*	**	*	**	*	**	**	**	**
CV (%)	1.33	5.23	1.21	0.82	5.68	11.82	1.63	4.87	5.37	1.01	1.64	1.05	0.43

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differs significantly (as per DMRT)

Where, V_1 = Kali Hitta, V_2 =ChaitaBoro, V_3= Abdul Haiand V_4= Gota IRRI

F_1 = Control (0 kg N ha^{-1}), F_2 = Prilled urea @ 30 kg N ha^{-1},F_3 = Prilled urea @ 60 kg N ha^{-1}, and F_4 = USG @ 52 kg N ha^{-1}

in USG @ 52 Kg N ha$^{-1.}$ The plots without N application evoked early flowering than other treatments, which took only 62.83 days (Table 1).

ChaitaBoro took a longer time (96.42 days) to reach 50% flowering followed by *Gota IRRI* (93.67 days), and variety *Kali Hitta*took shortest time (83.67 days) to reach 50% flowering. Time required to set flowers showed significant variation due to nitrogen management and variety interaction at a 5% level of significance (Table 3). *ChaitaBoro*with USG @ 52 Kg N ha^{-1} took a longer time (111.30 days) to reach 50% flowering and *Kali Hitta*at without N fertilizer reported earlier (57.00 days) in 50% flower production.

3.1.4 Days to maturity

Response to maturity also showed significant variation due to the level of application methods of nitrogen fertilizer. A significant variation of days to maturity was found highest (128.33 days) in USG @ 52 Kg N ha^{-1} and the lowest days to maturity (104.42 days) was recorded from without N application (Table 1). Among T. *aus* varieties *ChaitaBoro*took longer time (125.67 days) to reach maturity followed by *Gota IRRI* (122.33 days), and variety *Kali Hitta*took shortest time (111.00 days) to attain maturity (Table 2). In interaction, *ChaitaBoro*with USG @ 52 Kg N ha^{-1} took a longer time (137.00 days) to get matured and *Kali Hitta*without N fertilizer reported earlier in maturity (98.67 days) (Table 3).

3.1.5 Number of effective tillers hill^{-1}

Results showed that USG 52 kg N ha^{-1} produced the highest number of effective tillers hill^{-1} (15.45) and the lowest one (8.43) was obtained in control (N_1 kg N ha^{-1}) (Table 1). Adequacy of nitrogen as USG probably favored the cellular activities during panicle initiation and development which led to increased number of productive tillers hill^{-1}. Ahmed et al. [13] also reported that the number of effective tillers hill^{-1} increased with the better management of nitrogen.

The highest number of effective tillers hill^{-1} was produced by *Gota IRRI* (12.20) and the lowest one (10.50) was produced by *Kali Hitta* (Table 2). The probable reason for the differences in producing the effective tillers hill^{-1} is the genetic make-up of the variety which is primarily influenced by heredity. This finding corroborates with those reported by BINA, [14] Om *et al.* [10] and Bhowmick and Nayak, [15] who stated that the effective tillers hill^{-1} was varied with variety.

The effect of interaction between nitrogen management and variety was found to be significant in respect of number of effective tillers hill^{-1}(Table 3). The highest number of effective tillers hill^{-1} (16.87) was counted in the treatment combination of USG 52 kg N ha^{-1} with V_4.

3.1.6 Number of non-effective tillers hill^{-1}

A significant difference was found due to the level of nitrogen as a source of nitrogen in respect of the number of non-effective tillers hill^{-1} (Table 1). The total non-effective tillers hill^{-1} ranged from 0.52 to 2.86. The results show that the highest number (2.86) of non-effective tillers hill^{-1} was produced by the control (N_1 kg N ha^{-1}) treatment. The lowest number (0.52) of non-effective tillers was found at USG 52 kg N ha^{-1}. The observation in the formation of non-effective tillers hill^{-1} was decreased with an appropriate nitrogen level. The highest number of non-effective tillers hill^{-1} was produced by *Kali Hitta* (1.85) and the lowest one (1.24) was produced by *Gota IRRI.* The probable reason for the differences in producing the non-effective tillers hill^{-1} is the genetic make-up of the variety which is primarily influenced by heredity. Devarajau *et al*. [16] and Rahman, [17] also reported that the number of non-effective tillers hill^{-1} was significantly influenced by varieties.

The number of non-effective tillers hill^{-1} was significantly affected by the interaction. The maximum number of non-effective tillers hill^{-1} (3.47) was produced by the combination of *Kali Hitta* and control (N_1kgN ha^{-1}), which was statistically similar with *ChaitaBoro*at control (3.20) and the minimum number of non-effective tillers hill^{-1} (0.27) was produced by the interaction of *Gota IRRI* and USG 52 kg N ha^{-1}, which was statistically similar to *Abdul Hai*at USG 52 kg N ha^{-1} (0.47) (Table 3).

3.2 Length of Panicle (cm)

Table 1 shows that the longest panicle length (24.30 cm) was found in treatment with USG 52 kg N ha^{-1} and the shortest one (18.84 cm) was found from control i.e. without N application (N_1).

Gota IRRI had the taller panicle length (22.42 cm) followed by *Abdul Hai* (21.88 cm), *ChaitaBoro* (21.32 cm) and *Kali Hitta* (20.93 cm), respectively. Variation in length of panicle due to variety as obtained in the study might be because of their genetic potentiality. This finding is also supportive to the findings of Bhuiyan *et al*. [18].

From Table 3 it is obvious that the longest panicle length (25.13 cm) was found in the interaction between *Gota IRRI* × USG @ 52 kg N ha^{-1} and the shortest panicle length (17.47 cm) was found in the interaction between *Kali Hitta*at without N. The variation in panicle length due to interaction of variety and integrated nitrogen management was also reported by Parvin [19].

3.2.1 Number of filled grains $panicle^{-1}$

The highest number of grains $panicle^{-1}$ (94.73) was obtained from the treatment USG @ 52 kg N ha^{-1} and the lowest number of grain $panicle^{-1}$ (53.18) was found in treatment without N, which was again similar to the treatment N_{30} (59.06). This finding is in contrast with the research findings of Rajarathinam and Balasubramanivan [20] where they found the application of N increased the number of filled grains per panicle.

Gota IRRI produced the highest number of grains $panicle^{-1}$ (73.50) and *Kali Hitta*produced the lowest number of grains $panicle^{-1}$ (63.12)(Table 2). This might be due to the differences in the genetic makeup of the varieties. The variable number of grain $panicle^{-1}$ among the varieties was reported by Kamal et al. [21].

The highest number of grains $panicle^{-1}$ (105.70) was observed in the interaction between *Gota IRRI* × USG @ 52 kg N ha^{-1} and the lowest (47.76) was found in the interaction between *Kali Hitta*with N_1. This finding of the study is also supportive with the research findings of Surendra *et al*. [22].

3.2.2 Number of unfilled grains $panicle^{-1}$

Different application methods of nitrogenous fertilizers exerted a significant effect on the number of unfilled grains $panicle^{-1}$. The maximum number of unfilled grains $panicle^{-1}$ (24.88) was found in treatment without N application and the lowest (7.08) was found in USG @ 52 kg N ha^{-1}(Table 1).

For variety, *Kali Hitta* produced the higher number of unfilled grains $panicle^{-1}$ (18.92) and the lowest (15.07) was recorded from *Gota IRRI*. The results are in agreement with the findings of Chowdhury, [23] who reported that varietal differences in the number of unfilled grains $panicle^{-1}$ might be due to genotypic variation.

The highest number of unfilled grains $panicle^{-1}$ (27.47) was observed in the interaction between *Kali Hitta* having no N, which was statistically identical with *Chaita Boro*at the same level of N (N_1) (26.07) (Table 3).

3.3 1000-grain Weight

The highest 1000-grain weight (29.97 g) was obtained from the treatment USG @ 52 kg N ha^{-1}. Baligar, [24] reported that the weight of 1000-grain increased significantly with increasing nitrogen levels. Variety *Gota IRRI* produced the highest weight (27.41 g) of 1000 grains followed by *Abdul Hai*(27.03 g), *Chaita Boro* (26.61 g) and *Kali Hitta* (25.94 g). This might be due to the differences in the genetic makeup of the varieties. These results are in agreement with Hasan, [25] and Thakur, [26] who reported differences in 1000-grain weight among the varieties. Significantly the highest weight of 1000 grains (31.13 g) was observed in combination between USG @ 52 kg N ha^{-1} × *Gota IRRI* and the lowest weight of 1000-grains (23.52 g) was observed in *Kali Hitta* at N_1 (Table 3).

3.4 Grain Yield

Different levels of application methods of nitrogenous fertilizers exerted a significant effect on the grain yield of T. Ausrice at a 1% level of probability (Table 1). The highest grain yield (2.48 t ha^{-1}) was found in USG @ 52 kg N ha^{-1}. On the other hand, the lowest grain yield (1.40 t ha^{-1}) was recorded in treatment without N. The results also indicate that the application of USG performed better in terms of grain yield compared to the application of prilled urea. The highest grain yield was obtained in the study from the application of USG @ 52 kg N ha^{-1} was significantly higher than that of any other application levels of nitrogenous fertilizer application. The highest grain yield might be due to the resultant effect of the highest number of effective tillers $hill^{-1}$ and the highest number of grains $panicle^{-1}$ as obtained in the treatment. Budhar and Palaniappan, [27] reported that nitrogen use efficiency was highest in USG than any other levels of urea application.

The effect of variety on grain yield was significant at 1% level of probability (Table 2). The higher grain yield (2.39 t ha^{-1}) was recorded in the variety *Gota IRRI* and the lowest in *Kali Hitta* (1.52 t ha^{-1}). Varietal differences regarding grain yield were reported elsewhere [28, 11].

The interaction effect of different levels of nitrogenous fertilizers and variety was significant on grain yield at a 1% level of probability (Table 3). The highest grain yield (3.13 t ha^{-1}) was observed in combination between USG @ 52 kg N ha^{-1} × *Gota IRRI*. On the other hand, the lowest grain yield (1.12 t ha^{-1}) was observed in *Kali Hitta* at without N, which was again statistically similar to N_1 with V_2(1.23 t ha^{-1}).

3.5 Straw Yield

The traw yield was significantly influenced by the application of different levels of nitrogenous fertilizers (Table 1). The highest straw yield (3.67 t ha^{-1}) was found in USG @ 52 kg N ha^{-1} and the lowest straw yield (2.39 t ha^{-1}) was achieved without application of N. The result showed that the higher dose of nitrogen especially USG influenced vegetative growth in terms of plant height and total tillers $hill^{-1}$ which resulted in differences of straw yield. These findings corroborated with those of Pasha and Reddy, [29].

The effect of variety on straw yield was significant at a 1% level of probability (Table 2). The higher straw yield (3.32 t ha^{-1}) was recorded in the variety *Gota IRRI* and the lowest (2.70 t ha^{-1}) was in *Kali Hitta*. Hossain et al. [30] reported variable straw yields among the varieties.

Interaction of different level of nitrogenous fertilizers and variety exerted a significant influence on the straw yield of T. Aus*rice* varieties (Table 3). The highest straw yield (4.17 t ha^{-1}) was obtained from the interaction between USG @ 52 kg N ha^{-1}× *Gota IRRI*, and the lowest straw yield (2.28 t ha^{-1}) was observed in *Kali Hitta* with no nitrogen.

3.6 Harvest Index

The highest value of harvest index (40.02%) was obtained from USG @ 52 kg N ha^{-1} and the lowest harvest index (36.69%) was achieved from control (N_1) nitrogen application. A similar result was reported by Bhuiyan, [31] was found increasing harvest index with increasing N fertilizer.

Harvest index was significantly influenced by varieties at 1% level of probability (Table 2). The higher harvest index (41.61%) was obtained from *Gota IRRI* followed by *AbdulHai*(40.74%) and the lowest of 35.73% and 35.95% was obtained from *Kali Hitta*and and *ChaitaBoro*, respectively. Kabir et al. [32] reported variable harvest index among varieties.

The effect of interaction between levels of nitrogenous fertilizers and variety on harvest index was significant at 5% level of significance (Table 3). The highest value of harvest index (42.92%) was found in the interaction between USG (N_4) @ 52 kg N ha^{-1} × *Gota IRRI* (V_4) and the lowest value (32.97%) was found in interaction between control (N_1)treatment × *Kali Hitta*(V_1).

4. CONCLUSION

According to the result of the experiment, it can be concluded that the performance of *Gota IRRI* was significantly better than that of *Kali Hittra, ChaitaBoro*and*Abdul Hai*. Among different levels of nitrogen, USG @ 52 kg N ha^{-1} performed better than prilled urea. It can be suggested that USG @ 52 kg N ha^{-1} and T. *Aus*variety, *Gota IRRI,* could be a better combination for transplant Ausrice cultivation in terms of grain yield.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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