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# Effect of Age of Seedling and Level of Nitrogen on the Growth and Yield of Transplant Aman Rice CV. Binadhan-15

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors MDH and MAS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors NS and SR managed the analyses of the study. Author SR managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from July 2016 to December 2016 to find out the effect of seedlings age and different nitrogen (N) levels on the yield performance of transplant *Aman* rice (cv. Binadhan-15). The experiment comprised four ages of seedlings viz., 15 , 20 , 25, 30 day old and four levels of nitrogen viz., 0 ,55 , 75 and 95 kg N $ha^{-1}$ following randomized complete block design (RCBD) with three replications. The effect of age of seedling, nitrogen levels and their interactions were significant on growth, yield and yield contributing characters of transplant *Aman* rice. The highest plant height at harvest (92.67 cm), number of effective tillers $plant^{-1}$ (8.70), grain (4.55 t $ha^{-1}$) and straw yields (5.49 t $ha^{-1}$) were obtained from 75 kg N $ha^{-1}$. By using optimum seedling age at 15 DAT the highest plant height (102.7cm at harvest), number of effective tillers $plant^{-1}$ (8.29), grain (4.01 t $ha^{-1}$) and straw (5.06 t $ha^{-1}$) yields. In interaction, 75 kg N and 15 days old seedling produced highest plant height (106.3 cm at harvest), number of effective tillers $plant^{-1}$ (9.42), grain (5.0 t $ha^{-1}$) and straw yields (6.10 t $ha^{-1}$). From the above results of the present study, it may be stated that Binadhan-15 is grown successfully for obtaining maximum yield with 75 kg N $ha^{-1}$ and 15-day old seedling age individually or in combination.

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*Keywords: Age of seedlings; nitrogen fertilizer rate; Aman rice (Binadhan-15).*

## 1. INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food and major cereal crop of Bangladesh. It is the extensively cultivated crop for half of the world's population. About 77.07% of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million tons from 11.41 million ha of land which contributes about 19.70% of the country's GDP BBS [1]. Bangladesh has a bright prospect for export of fine rice thereby earning foreign exchange Sarkar et al. [2]. The population of Bangladesh is still growing by two millions every year and may increase by another 30 million over the next 20 years which will require about 27.26 million tons of rice for the year 2020 BBS, [3]. To ensure better rice yield, it is essential to transplant healthy seedling with optimum age. When seedlings are transplanted at right time, tillering and growth proceed normally. Plant height, tiller production, panicle length, grains panicle$^{-1}$ and other yield contributing characters were heavily influenced by the seedling age (Islam and Ahmed, 1981). Therefore, it is an urgent need of the time to increase rice yield in Bangladesh. Age of seedling is an important factor to obtain higher yield of rice because it has tremendous influence on the tiller production, grain formation and other yield attributes. N application has tremendous effect on tiller formation and survival of tillers (Rahman et al., 2002). Nitrogen is a major essential plant nutrient and a key input for increasing crop yield. Yield increase (70-80%) of field rice could be obtained by the application of nitrogen fertilizer. For uniform stand establishment of rice, age of seedling at the time of transplanting is important factor Ginigaddara and Ranamukhaarachchi [4]. The use of over aged seedlings retards the general performance of crop and reduces the yield of crop Bozorgi et al. [5].

Generally, farmers of Bangladesh do not give due attention to the age of seedlings at transplanting and use aged seedling. Many researchers have reported that the achievement of high grain yield of rice requires an optimal age of seedlings Alam et al. [6]; Mobasser et al. [7]; Mishra and Salokhe [8]. Mishra and Salokhe [8] observed greater root growth and establishment while transplanting younger seedlings than old ones. Furthermore, transplanting aged seedlings can lead to poor crop performance Rasool et al., [9]. Nitrogen is the key nutrient element, representing two-thirds or more of the total nutrient consumption. Accordingly the plant must absorb a larger amount of N to produce a higher grain yield. N plays a key role in supporting plant activity and increasing the rice yield BRRI, [10] and Behera, [11]. Tillering and growth of rice proceed normally when optimum aged seedlings are transplanted at the right time Mobassar et. al, [7]. Shen et al. [12] stated that transplanting at the appropriate seedling age followed by the application of fertilizer is the most important crop management that enhances rice performance. The length and dry weight of seedlings, number and length of roots, and growth of seedlings are also increased significantly by increasing the fertility level in the soil Singh et al. [13]. The farmers usually do not apply nitrogen in their fields properly and timely. To ensure higher yield of crop and reduced fertilizer cost, efficient fertilizer management can play a vital role (Hossain and Islam, 2006). Seedling age is rated high in rice cultivation because it has tremendous effect on rice growth and yield characters such as plant height, tiller production, panicle length, and grain formation Ali et al. [14]. On the flip side, lodging of plants, delaying in maturity, prolonging growth period, susceptibility to insect pests and diseases are the result of excess amount of nitrogen fertilizer application on the field Uddin [15]. Therefore, the objective of this experiment is to find out optimum age of seedling and optimum level of N fertilizer for maximum yield of Binadhan-15 and evaluate the interaction effect between age of seedling and level of N fertilizer on growth and yield of T. Aman rice.

## 2. MATERIALS AND METHODS

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from July to December 2016. High yielding rice variety Binadhan-15 was used for the present experiment as the test crop with different nitrogen levels and seedling ages. The experimental treatments were as follows: i) Ages of Seedlings viz. 15 days old ($A_1$), 20 days old ($A_2$), 25 days old ($A_3$), 30 days old ($A_4$) ii) Levels of Nitrogen viz. 0 Kg N ha$^{-1}$ ($N_0$), 55 Kg N ha$^{-1}$ ($N_1$), 75 Kg N ha$^{-1}$ ($N_2$), 95 Kg N ha$^{-1}$ ($N_3$). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Thus, total numbers of plots were 48. Unit plot size was (4 m × 2.5 m). One rice variety Binadhan-15 was selected for this study.

It was released from BINA in 2014. It is a transplanted T. *Aman* rice variety. This is recently released and famous rice variety in Bangladesh. A piece of land was selected for raising seedlings. The land was puddled well with country plough followed by leveling with a ladder. The sprouted seeds were sown in the nursery bed on 19 July 2016. Proper care was taken to raise the healthy seedlings in the nursery bed. The experimental plots were fertilized with urea as per treatment specification. In addition, triple super phosphate, muriate of potash, gypsum and zinc sulphate at the rate of 150, 110, 70, 55, 3 kg $ha^{-1}$, respectively. The entire amounts of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at the time of final land preparation. Urea was applied in three installments at 15, 30 and 45 days after transplanting (DAT). 15, 20, 25 and 30 days old seedlings were transplanted in the well prepared puddled field on 04, 09, 14 and 19 August 2016 accordingly at the rate of 3 seedlings $hill^{-1}$ maintaining 20 cm × 15 cm spacing. The experimental plots were irrigated as and when necessary.

Five hills were selected randomly for data collection. In order to evaluate collected samples, five sample plants were uprooted from each plot 15 day intervals up to 85 DAT. Maturity of crops was determined when 90% of the grains became golden yellow in color. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw $plot^{-1}$ were recorded and converted to t $ha^{-1}$. Data on yield and yield contributing characters were recorded from five randomly selected sample plants from each plot on plant height, number of total tillers $plant^{-1}$, number of effective tillers $plant^{-1}$, length of panicle, number of fertile grains $panicle^{-1}$, number of sterile grains $panicle^{-1}$, number of grains $panicle^{-1}$, weight of 1000 grains (g) , grain yield ($tha^{-1}$) , straw yield ($tha^{-1}$), biological yield ($tha^{-1}$), harvest index (%). Data on grain and straw yields were collected from an area of 1 $m^2$ in the middle of each plot. The data on other crop characters were randomly sampled from the region outside 1 $m^2$ area (excluding the border hills). The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package, MSTAT-C. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test Gomez and Gomez [16].

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Age of Seedlings on Yield and Yield Contributing Characters of Transplant *Aman* rice cv. Binadhan-15

Results showed that age of seedlings had significant effect on plant height, total tillers, effective tillers, non- effective tillers at harvest, leaf area index, total dry matter (Table 1). The highest plant height (102.70 cm at harvest), the highest total number of tillers (8.96 at harvest), maximum number of effective tillers $hill^{-1}$ (8.29), the highest leaf area index (2.76 at 45 DAT and 4.05 at 60 DAT), the highest total dry matter (2.57 at 45 DAT and 2.99 at 60 DAT) were recorded in 15-day old seedlings (Table 1). Likewise, highest panicle length (21.67 cm), number of grains $penicle^{-1}$ (112.1), 1000 grain weight (25.11 g) were recorded from 15-days old seedling (Table 3). However, maximum, non-effective tillers (0.89), Number of sterile spikelets $panicle^{-1}$ (10.53) and harvest index (45.72%) were recorded from 30-days (A4) old seedling. In case of grain yield, straw yield and biological yield , maximum number 4.01 t $ha^{-1}$, 5.06 t $ha^{-1}$ , 9.07 t $ha^{-1}$ respectively , were recorded from 15-day old seedling (Table 5). Similar result was found by Razzaque et al. [17], who reported that seedling age showed significant effect in respect of grains $panicle^{-1}$. Luna et al. [18] reported grain yield (4.07 t $ha^{-1}$), straw yield (5.17 t $ha^{-1}$) and biological yield (9.23 t $ha^{-1}$) from 30-day old seedlings. The higher number of effective tillers $hill^{-1}$ and the higher number of grains $panicle^{-1}$ were mainly responsible for the highest grain yield. The root establishment of younger seedlings is faster, as it may not suffer from damage of the roots during uprooting and transplanting and hence there is a better vegetative growth Ros et al. [19].

### 3.2 Effect of Nitrogen Rate on Yield and Yield Contributing Characters of Transplant *Aman* Rice cv. Binadhan-15

Results showed that nitrogen levels had significant effect on plant height, total tillers, effective tillers, non- effective tillers at harvest, leaf area index, total dry matter (Table 1). The highest plant height (101.10 cm at harvest), highest total number of tillers (9.34 at harvest), maximum number of effective tillers $hill^{-1}$ (8.70), highest leaf area index (2.46 at 45 DAT and 3.64

at 60 DAT), highest total dry matter (2.26 at 45 DAT and 2.75 at 60 DAT) were recorded from $N_2$ (75 kg N $ha^{-1}$) (Table 2). Likewise, highest, panicle length (21.65 cm), number of grains $penicle^{-1}$ (112.5), 1000 grain weight (25.25 g) harvest index (45.34%) were recorded from $N_2$ (75 kg N $ha^{-1}$) (Table 4). However, maximum, non- effective tillers (0.88), No. sterile spikelets $panicle^{-1}$ (10.88) were recorded from $N_0$. In case of grain yield, straw yield and biological yield, maximum values 4.55 t $ha^{-1}$, 5.49 t $ha^{-1}$, 10.05 t $ha^{-1}$ respectively, were recorded from 75 kg N $ha^{-1}$ (Table 6). This might be due to cumulative effect of longest panicle and higher number of grain $penicle^{-1}$. Similar trend was reported by Haider et al. [20]. Luna et al. [18] reported grain yield (4.37 t $ha^{-1}$), straw yield (5.59 t $ha^{-1}$) and biological yield (9.96 t $ha^{-1}$) from the application of 80 kg N $ha^{-1}$. Application of 75 kg N $ha^{-1}$ encouraged the vegetative growth of rice in terms of plant height, number of effective tillers $hill^{-1}$, which ultimately resulted in the increase of grain yield . Similar result was observed by Uddin et al. [21]. Younger seedlings produced more tillers than the older ones due to quick regeneration of seedlings, uptake of nutrients and plant vigor. On the other hand, application of nitrogen increased the number of effective tillers which ultimately increased the grain yield.

### 3.3 Interaction Effects of Age of Seedlings and Nitrogen Levels on Yield and Yield Contributing Characters of Transplant *Aman* rice cv. Binadhan-15

The highest plant height (106.3 cm) was obtained in 15-day old seedlings with treatment $N_2$ (75 kg N $ha^{-1}$) which was statistically similar with treatment $A_1$ x $N_1$ (15-day old seedlings x 55 kg N $ha^{-1}$) (103.9 cm).

The maximum number of total tillers $hill^{-1}$ (9.96) , effective tillers $hill^{-1}$ (9.42), grains $panicle^{-1}$ (114.5), 1000 grain weight (26.18 g) , grain yield (5.00 t $ha^{-1}$) were found in 15-day old seedlings with $N_2$ (75 kg N $ha^{-1}$). The highest straw yield (6.10 t $ha^{-1}$), biological yield (11.1 t $ha^{-1}$) were obtained from $A_1$ with $N_2$ (75 kg$ha^{-1}$ N + 15-day old seedling age). The highest harvest index (46.24%) was obtained from treatment combination 30-day old seedling age with the application of nitrogen 75 kg $ha^{-1}$ N. And the lowest number of unfilled grains $panicle^{-1}$ was in 15-day old seedling age and 75 kg $ha^{-1}$ N. Apparently the highest non–effective tillers $hill^{-1}$ (1.0) was observed in 30-day old seedlings with $N_0$ (0 kg N $ha^{-1}$). The lowest value of plant height (86.40 cm), total tillers (7.00), effective tiller $hill^{-1}$ (6.00), 1000-grain weight (22.8 g), straw yield (3.52 t $ha^{-1}$), biological yield (6.55 t $ha^{-1}$) was in ($A_4$×$N_0$) with 30-day old seedling and 0 kg $ha^{-1}$ N combination. The lowest number (0.54) of non–effective tillers $hill^{-1}$ and unfilled grains $panicle^{-1}$ was observed in 15-day old seedlings with 75 kg $ha^{-1}$ N. The lowest grain yield (3.03 t $ha^{-1}$) was obtained from 15-day old seedling ($A_1$) with the combination of 0 kg N $ha^{-1}$ ($N_o$). Luna et al. [18], reported grain yield (4.71 t $ha^{-1}$), straw yield (6.17 t $ha^{-1}$) and biological yield (10.08 t $ha^{-1}$) from the combination of 30-days old seedlings and 80 kg N $ha^{-1}$.

### 3.4 Relationship between Total Dry Matter Production at 60 DAT and Grain Yield of Transplant *Aman* Rice

Total dry matter production is an important parameter for the determination of yield of transplant *Aman* rice. Partitioning of dry matter in sink organs i.e. grains are responsible for the yield that were harvest from the rice plant. Experimental results revealed that grain yield showed significantly positive correlation (r = 0.492**) with total dry matter production at 60 DAT (Fig. 1). This means an increase in total dry matter production will result in the corresponding increase in the grain yield of transplant *Aman* rice. This indicates total dry matter production might be important characteristics in yield performance of transplant *Aman* rice.

### 3.5 Relationship between Leaf Area Index (LAI) and Grain Yield of Transplant *Aman* Rice

Leaf area index is an important character responsible for higher grain yield of transplant *Aman* rice. It is closely related to the amount of photosynthesis, surface available for plant for photosynthesis. Experimental results revealed that grain yield showed significantly positive correlation (r=0.427**) with leaf area index at 60 DAT (Fig. 2). This means an increase in leaf area index will result in corresponding increase in grain yield of transplant *Aman* rice. Similar relationship was reported by Ray et al. [22]. From the above discussion it has been found that the highest yield can be obtained from the interaction $A_1$ x $N_2$ (15-day old seedling x 70 kg N $ha^{-1}$) which gave higher number of tillers $hill^{-1}$, total spikelet $panicle^{-1}$, higher 1000-grain weight, lower number of non-effective tillers $hill^{-1}$ and sterile spikelet $panicle^{-1}$ which ultimately resulted in higher yield.

**Table 1. Effect of age of seedling on plant height, total tillers, effective tillers, non- effective tillers at harvest, Leaf area index, total dry matter of transplanting of *Aman* rice cv. Binadhan-15**

| Age of seedling | Plant height (cm) | | | Number of total tillers hill$^{-1}$ | | | No. of effective tillers hill$^{-1}$ | No. of non-effective tillers hill$^{-1}$ | Leaf area index (LAI) | | Total dry matter (TDM) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45 DAT | 60 DAT | At Harvest | 45 DAT | 60 DAT | At Harvest | At Harvest | At Harvest | 45 DAT | 60 DAT | 45 DAT | 60 DAT |
| A1 (15 days old) | 94.37 a | 94.68 a | 102.7 a | 9.300 a | 9.083 a | 8.967 a | 8.297 a | 0.6708 c | 2.76 a | 4.055 a | 2.570 a | 2.993 a |
| A2 (20 days old) | 88.02 b | 91.83 b | 99.92 a | 9.041 b | 8.795 b | 8.683 b | 7.927 b | 0.7550 bc | 2.567 b | 3.496 b | 2.388 b | 2.803 b |
| A3 (25 days old) | 76.89 c | 81.42 c | 93.58 b | 8.557 c | 8.483 c | 8.233 c | 7.405 c | 0.8275 ab | 2.049 c | 3.188 c | 1.665 c | 2.230 c |
| A4 (30 days old) | 73.00 d | 79.50 c | 90.57 b | 7.835 d | 7.730 d | 7.650 d | 6.753 d | 0.8967 a | 1.734 d | 2.553 d | 1.413 d | 2.058 d |
| $S\bar{x}$ | 0.778 | 0.797 | 1.43 | 0.081 | 0.071 | 0.068 | 0.070 | 0.043 | 0.016 | 0.022 | 0.022 | 0.024 |
| Level of significance | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| CV (%) | 3.25 | 3.18 | 5.14 | 3.21 | 2.87 | 2.80 | 3.20 | 19.02 | 2.34 | 2.28 | 3.89 | 3.28 |

*In a column, figures with the same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).*
*** =Significant at 1% level of probability*

**Table 2. Effect of age of seedling on plant height, total tillers, effective tillers, non- effective tillers at harvest, Leaf area index, total dry matter of transplanting of *Aman* rice cv. Binadhan-15**

| Level of nitrogen | Plant height (cm) | | | Number of total tillers hill$^{-1}$ | | | No. of effective tillers hill$^{-1}$ | No. of non-effective tillers hill$^{-1}$ | Leaf area index (LAI) | | Total dry matter (TDM) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45 DAT | 60 DAT | At Harvest | 45 DAT | 60 DAT | At Harvest | At Harvest | At Harvest | 45 DAT | 60 DAT | 45 DAT | 60 DAT |
| N0 (0 kg N/ha) | 76.54 d | 81.80 c | 91.95 c | 7.890 d | 7.742 d | 7.642 d | 6.755 d | 0.8883 a | 2.100 d | 2.979 d | 1.810 d | 2.220 d |
| N1 (55 kg N/ha) | 85.03 b | 87.30 b | 98.12 ab | 8.825 b | 8.640 b | 8.538 b | 7.742 b | 0.7950 a | 2.342 b | 3.406 b | 2.043 b | 2.678 b |
| N2 (75 kg N/ha ) | 88.40 a | 92.67 a | 101.1 a | 9.726 a | 9.500 a | 9.340 a | 8.706 a | 0.6342 b | 2.462 a | 3.640 a | 2.263 a | 2.755 a |
| N3 (95 kg N/ha) | 82.30 c | 85.66 b | 95.58 bc | 8.293 c | 8.208 c | 8.012 c | 7.180 c | 0.8325 a | 2.207 c | 3.268 c | 1.902 c | 2.431 c |
| S$\bar{x}$ | 0.778 | 0.797 | 1.43 | 0.081 | 0.071 | 0.068 | 0.070 | 0.043 | 0.016 | 0.022 | 0.022 | 0.024 |
| Level of significance | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| CV (%) | 3.25 | 3.18 | 5.14 | 3.21 | 2.87 | 2.80 | 3.20 | 19.02 | 2.34 | 2.28 | 3.89 | 3.28 |

*N0 = 0 kg N/ha, N1 = 55 kg N/ha, N2 = 75 kg N/ha, N3 = 95 kg N/ha*

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

*** =Significant at 1% level of probability * =Significant at 5% level of probability*

**Table 3. Effect of age of seedling on yield contributing characters and yield of *Aman* rice cv. Binadhan-15**

| Age of seedlings (days) | Panicle length (cm) | No. grains panicle$^{-1}$ | No. sterile spikelets panicle$^{-1}$ | 1000 grain weight (g) | Harvest index (%) |
|---|---|---|---|---|---|
| A1 (15 days old) | 21.67 a | 112.1 a | 9.295 b | 25.11 a | 44.16 b |
| A2 (20 days old) | 21.40 ab | 110.7 a | 9.729 b | 24.65 ab | 44.87 b |
| A3 (25 days old) | 21.24 ab | 109.1 ab | 10.26 a | 23.99 bc | 44.53 b |
| A4 (30 days old) | 21.04 b | 106.7 b | 10.53 a | 23.63 c | 45.72 a |
| Sx | 0.172 | 1.09 | 0.178 | 0.232 | 0.246 |
| Level of significance | NS | ** | ** | ** | ** |
| CV (%) | **2.80** | **3.45** | **6.19** | **3.30** | **1.90** |

**Table 4. Effect of level of nitrogen on yield contributing characters and yield of aman rice cv. Binadhan-15**

| Level of nitrogen (Kg ha$^{-1}$) | Panicle length (cm) | No. Grains panicle$^{-1}$ | No. sterile grains panicle$^{-1}$ | 1000 grain weight (g) | Harvest index (%) |
|---|---|---|---|---|---|
| N0 (0 kg N/ha) | 20.91 b | 105.6 b | 10.88 a | 23.41 c | 45.03 ab |
| N1 (55 kg N/ha) | 21.51 a | 111.1 a | 9.586 bc | 24.67 ab | 44.53 b |
| N2 (75 kg N/ha ) | 21.65 a | 112.5 a | 9.359c | 25.25 a | 45.34 a |
| N3 (95 kg N/ha) | 21.28 ab | 109.3 a | 9.991 b | 24.05 bc | 44.38 b |
| Sx | 0.172 | 1.09 | 0.178 | 0.232 | 0.246 |
| Level of significance | * | ** | ** | ** | * |
| CV (%) | **2.80** | **3.45** | **6.19** | **3.30** | **1.90** |

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

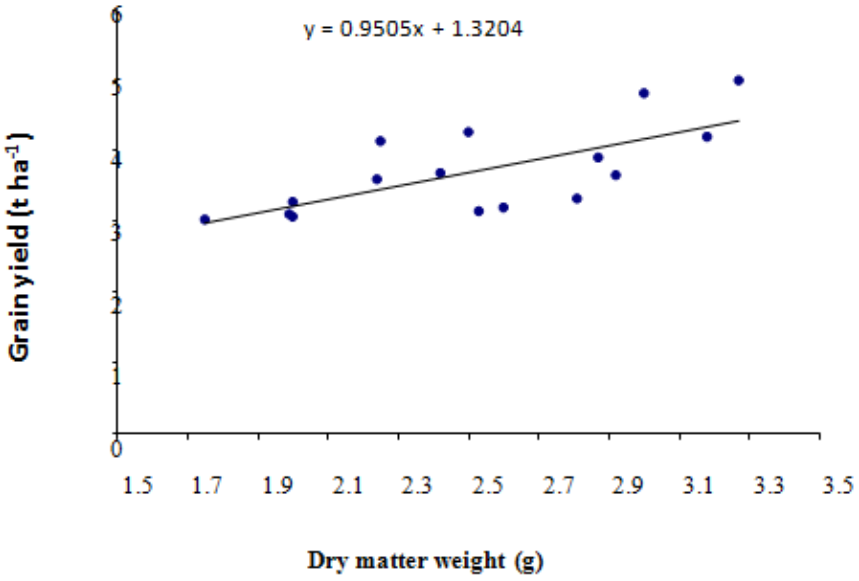


**Fig. 1. Relationship between total dry matter production and grain yield**

**Table 5. Effect of age of seedling on grain yield, straw yield, biological yield at harvest of transplanting of *Aman* rice cv.Binadhan-15**

| Age of seedling | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) |
|---|---|---|---|
| A1 (15 days old) | 4.017 a | 5.060 a | 9.077 a |
| A2 (20 days old) | 3.804b | 4.655 b | 8.457 b |
| A3 (25 days old) | 3.577c | 4.467c | 8.045c |
| A4 (30 days old) | 3.470d | 4.120d | 7.591d |
| Sx | 0.033 | 0.039 | 0.081 |
| Level of significance | ** | ** | ** |
| CV (%) | **3.07** | **2.93** | **3.38** |

**Table 6. Effect of level of nitrogen on grain yield, straw yield, biological yield at harvest of transplanting of Aman rice cv. Binadhan-15**

| Level of nitrogen | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) |
|---|---|---|---|
| N0 (0 kg N/ha) | 3.112 d | 3.805 d | 6.919 d |
| N1 (55 kg N/ha) | 3.852 b | 4.80 b | 8.654 b |
| N2 (75 kg N/ha ) | 4.558 a | 5.493 a | 10.05 a |
| N3 (95 kg N/ha) | 3.345 c | 4.205 c | 7.548 c |
| Sx | 0.033 | 0.039 | 0.081 |
| Level of significance | ** | ** | ** |
| CV (%) | **3.07** | **2.93** | **3.38** |

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

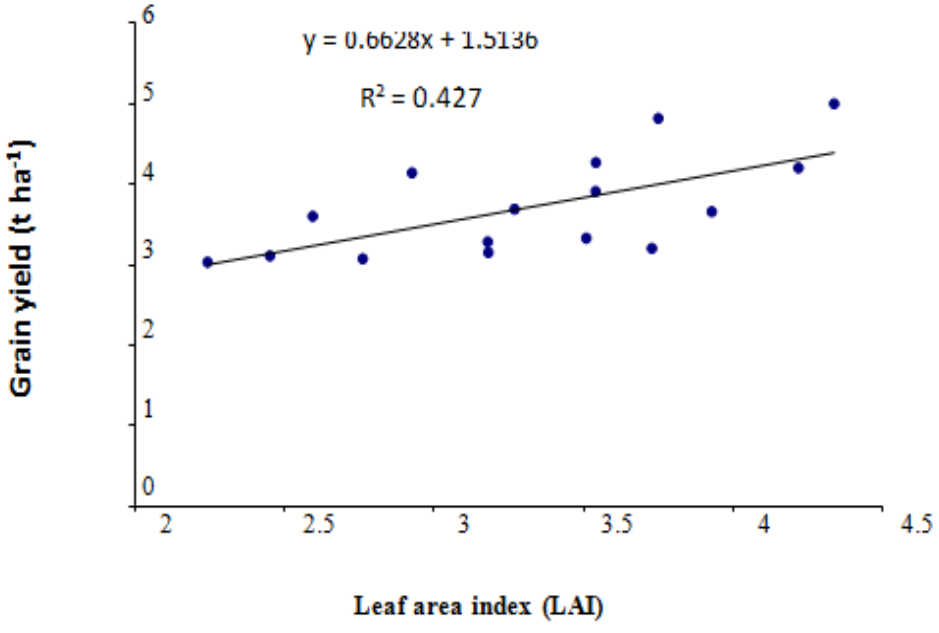


**Fig. 2. Relationship between leaf area index (LAI) and grain yield**

**Table 7. Interaction effects of age of seedling and level of nitrogen on yield contributing characters and yield of aman rice cv. Binadhan-15**

| Interaction (Age of seedling x Level of N) | Plant height (cm) | No. of total tillers hill$^{-1}$ | No. of effectiv e tillers hill$^{-1}$ | No. of non-effectiv e tillers hill$^{-1}$ | Panicle length (cm) | No. grains panicle $^{-1}$ | No. sterile spikele ts panicle -1 | 1000 grain weight (g) | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biologi cal yield (t ha$^{-1}$) | Harves t index (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $A_1xN_0$ | 97.80 | 8.26 de | 7.47 def | 0.793 | 21.48 | 108.1 | 10.14 | 23.92 | 3.20 efg | 4.12 g | 7.32 h | 43.73de |
| $A_1xN_1$ | 103.9 | 9.15 bc | 8.52 bc | 0.630 | 21.71 | 113.7 | 8.930 | 25.66 | 4.20 b | 5.18 c | 9.38 cd | 44.82 abcd |
| $A_1xN_2$ | 106.3 | 9.96 a | 9.42 a | 0.540 | 21.79 | 114.5 | 8.800 | 26.18 | 5.00 a | 6.10 a | 11.1a | 45.03 abcd |
| $A_1xN_3$ | 102.6 | 8.50 d | 7.78 d | 0.720 | 21.70 | 112.1 | 9.312 | 24.67 | 3.66 d | 4.84 de | 8.50 f | 43.06 e |
| $A_2xN_0$ | 96.53 | 7.98 e | 7.14 f | 0.840 | 21.02 | 107.4 | 10.70 | 23.77 | 3.15 efg | 3.93 g | 7.08 hi | 44.48 bcde |
| $A_2xN_1$ | 100.3 | 9.00 c | 8.23 c | 0.770 | 21.48 | 111.8 | 9.569 | 24.96 | 3.91 c | 4.95 d | 8.86 ef | 44.17 bcde |
| $A_2xN_2$ | 103.0 | 9.47 b | 8.87 b | 0.600 | 21.73 | 113.8 | 8.913 | 25.23 | 4.82 a | 5.57 b | 10.3 b | 46.42 a |
| $A_2xN_3$ | 99.87 | 8.28 de | 7.47 def | 0.810 | 21.37 | 109.7 | 9.733 | 24.64 | 3.33 e | 4.17 fg | 7.49 h | 44.40 bcde |
| $A_3xN_0$ | 87.00 | 7.33 fg | 6.41 gh | 0.920 | 20.88 | 104.5 | 11.04 | 23.15 | 3.07 fg | 3.65 h | 6.72 ij | 45.65 abc |
| A3xN1 | 95.40 | 8.43 d | 7.60 de | 0.830 | 21.43 | 110.1 | 9.840 | 24.33 | 3.69 d | 4.70 e | 8.39 fg | 43.98 de |
| A3xN2 | 99.47 | 9.00 c | 8.32 c | 0.680 | 21.50 | 112.9 | 9.812 | 24.93 | 4.27 b | 5.40bc | 9.67 c | 44.12 cde |
| A3xN3 | 92.47 | 8.17 de | 7.29ef | 0.880 | 21.17 | 108.9 | 10.33 | 23.55 | 3.28 ef | 4.12g | 7.40 h | 44.35 bcde |
| A4xN0 | 86.47 | 7.00 g | 6.00 h | 1.00 | 20.26 | 102.4 | 11.63 | 22.80 | 3.03 g | 3.52 h | 6.55 j | 46.24 a |
| A4xN1 | 92.87 | 7.57 f | 6.62 g | 0.950 | 21.42 | 108.8 | 10.00 | 23.74 | 3.60 d | 4.37 f | 7.97 g | 45.14 abcd |
| A4xN2 | 95.53 | 8.93 c | 8.21 c | 0.716 | 21.58 | 108.9 | 9.911 | 24.66 | 4.14 b | 4.90de | 9.04 de | 45.81 ab |
| A4xN3 | 87.40 | 7.10 g | 6.18 h | 0.920 | 20.89 | 106.6 | 10.59 | 23.33 | 3.11 fg | 3.69 h | 6.80 ij | 45.70 abc |
| Sx | 2.87 | 0.135 | 0.140 | 0.085 | 0.345 | 2.19 | 0.355 | 0.464 | 0.066 | 0.077 | 0.162 | 0.493 |
| Level of sig. | NS | * | * | NS | NS | NS | NS | NS | ** | ** | * | * |
| CV (%) | 5.14 | 2.80 | 3.20 | 19.02 | 2.80 | 3.45 | 6.19 | 3.30 | 3.07 | 2.93 | 3.38 | 1.90 |

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

** =Significant at 5% level of probability, NS = Not significant, ** =Significant at 1% level of probability*

*$A_1$ = 15 days old, $A_2$ = 20 days old, $A_3$ = 25 days old, $A_4$ = 30 days old*

*$N_0$ = 0 kg N/ha, $N_1$ = 55 kg N/ha, $N_2$ = 75 kg N/ha, $N_3$ = 95 kg N/ha*

## 4. CONCLUSION

From the above results of the present study, it may be stated that Binadhan-15 can be grown successfully for obtaining maximum yield with 75 kg $ha^{-1}$ N and 15- day old seedling individually or in combination along with recommended rates of TSP, $M_OP$ and gypsum fertilizers to ensure optimum requirement of nutrients for commercial rice cultivation. Further study should be undertaken on a priority basis because the fertility status and seedling age selection may vary from region to region. In order to obtain higher grain yield of rice, farmers may be advised to apply 75 kg N and 15-day old seedling.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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