EFFECTS OF FOLIAR APPLICATION OF UREA FERTILIZER AND MAGIC GROWTH LIQUID FERTILIZER ON THE GROWTH, YIELD AND NUTRIENT CONTENT OF AMAN RICE CULTIVARS

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CERTIFICATE

This is to certify that the thesis entitled "EFFECTS OF FOLIAR APPLICATION OF UREA FERTILIZER AND MAGIC GROWTH LIQUID FERTILIZER ON THE GROWTH, YIELD AND NUTRIENT CONTENT OF AMAN RICE CULTIVARS (Bina-sail and BRRI dhan46)" submitted to the DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (M.S.) in AGRICULTURAL CHEMISTRY, embodies the results of a piece of bona fide research work carried out by MOMINUL HAQUE RABIN, Registration. No. 07-02494, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation has duly been acknowledged.

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DEDICATED TO

MY

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ABSTRACT

An experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Aman season from July to December, 2013 to find out the effect of foliar application of urea along with magic growth spray on the growth, yield and nutrient content of two Aman rice cultivars. The two factorial experiment was laid out in a RCBD design with three replications. Factor A: two varieties [V_1-Bina-sail, V_2-BRRI dhan46], and factor B: different nitrogen doses and application methods[$\mathbf{T_0}$=N_0 (No nitrogen applied), $\mathbf{T_1}$=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), $\mathbf{T_2}$=$N_{50+5\%}$ (50% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_3}$=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_4}$=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_5}$=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_6}$=N_{100} (100% of RD of N applied as Urea topdressing), $\mathbf{T_7}$=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray)]. BRRI dhan46 showed better performance than Bina-sail and 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave higher results in most growth, yield and yield related parameters. In case of interaction, BRRI dhan46 and 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave higher number of effective tillers hill^{-1}, longer panicle, higher number of filled grains panicle^{-1} & total grains panicle^{-1}, higher 1000-grain weight, higher grain yield and straw yield. N, P and K content in grain showed statistically non-significant difference due to the varietal effect. 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave higher N, P and K content in grain. Interaction of BRRI dhan46 and 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave higher N, P and K content in grain. Moreover, 75% Urea top dressing and 10% Urea of the recommended dose with magic growth as foliar spray increased 8.27% grain yield with a saving of 15% of the recommended nitrogen fertilizer compared to recommended practice.

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LIST OF ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro- Ecological Zone
@	=	At the rate
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
BINA	=	Bangladesh Institute of Nuclear Agriculture
BRRI	=	Bangladesh Rice Research Institute
cm	=	Centi-meter
CV	=	Coefficient of Variance
cv.	=	Cultivar (s)
DAT	=	Days After Transplanting
^0C	=	Degree Centigrade
et al.	=	And others
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
DMRT	=	Duncan's Multiple Range Test
IRRI	=	International Rice Research Institute
hr	=	Hour(s)
K_2O	=	Potassium Oxide
Kg	=	Kilogram (s)
L SD	=	Least Significant Difference
LAI	=	Leaf area Index
m	=	Meter
m^2	=	Meter squares
mm	=	Millimeter
MOP	=	Muriate of Potash
N	=	Nitrogen
No.	=	Number
NS	=	Non significant
%	=	Percentage
P_2O_5	=	Phosphorus Penta Oxide
S	=	Sulphur
SAU	=	Sher-e- Bangla Agricultural University
t ha^{-1}	=	Ton per hectare
TSP	=	Triple Super Phosphate
var.	=	Variety
Wt.	=	Weight
Zn	=	Zinc

CHAPTER I

INTRODUCTION

CHAPTER 1
INTRODUCTION

Rice (Oryza sativa L.) belongs to the cereal crops under Gramineae family. It is one of the world's most widely consumed grains which play a unique role in combating global hunger. It is the staple food of Bangladesh. Almost all the people depend on rice and have tremendous influence on agrarian economy of Bangladesh. Rice is intensively cultivated in Bangladesh covering about 80% of arable land. Rice alone constitutes 95% of the food grain production in Bangladesh. Unfortunately, the yield of rice is low in Bangladesh as compared to that of other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t/ha, respectively (FAO, 1999). Bangladesh is an agro-based country with population of about 160 millions living in 14.84 million hectares of land. According to the estimate of World Bank, the population will have possibly increased to 230 million by the year 2030 with almost half of the people living in cities and towns (BBS, 2010). Rice is the staple dietary item for the people and per capita rice consumption is about 166 kg/year (BBS, 2010). Rice alone provides 76% of the calorie intake and 66% of total protein requirement (Bhuiyan *et al.*, 2002). It employs about 43.6% of total labor forces (BBS, 2010, HIES, 2009). Rice covers about 81% of the total cropped area (BBS, 2010). Rice alone shares about 96% of the total cereal food supply. Furthermore, rice alone contributes about 9.5 % of the total agricultural GDP in the country. Among all crops, rice is the driving force of Bangladesh agriculture (MoFDM, 2012).On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population of this country.

Rice is grown in three seasons namely Aus (mid March to mid August), Aman (mid June to November) and Boro (Mid December to mid June). The largest part of the total production of rice comes from Aman rice. T. aman (Transplanted Aman) rice covers about 50.92% of the rice areas of Bangladesh of which modern T. aman varieties covers 60% (BBS, 2005). In ganges tidal floodplain Agro ecological zone-13 T. aman is the main crop. Agro ecological condition of this area favours the large-scale cultivation of T. aman rice.

In Bangladesh total cultivable land is 10 million hectare and near about 70 per cent of this land is occupied by rice cultivation. In the year 2011, the total production of rice was 33.5 million metric ton. Hybrid rice varieties was cultivated in 0.653 million hectare of land and total production is 2.9 million metric ton in the year of 2010-2011. On the other hand, HYV (High Yielding Varieties) was cultivated in 4.06 million hectare land and the total production of rice was 15.6 million metric ton. The average rice production of hybrid varieties was 4.41 metric ton and HYV varieties were 3.84 metric ton in the year 2010 – 2011 (BBS, 2011). Variety is the key component to produce higher yield of rice depending upon their differences in genotypic characters, input requirements and response, growth process and off course the prevailing environmental conditions during the growing season. The growth process of rice plants under a given agro-climatic condition differs with variety. Variety is the most important factor in rice production. Selection of potential variety, planting in appropriate method and application of optimum amount of nutrient elements, can play an important role in increasing yield and national income. Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. Yield components are directly related to the variety and neighboring environments in which it grows. In the year 2010 among the *aman* rice varieties modern varieties covered 69.15% and yield was 2.4 t ha^{-1} on the other hand local varieties covered 31.91% and yield was 1.37 t ha^{-1} (BBS, 2011). It was the farmers who have gradually replaced the local indigenous low yielding rice varieties by HYV of rice developed by BRRI only because of getting 20% to 30 % more yield $unit^{-1}$ land area (Shahjahan, 2007).

Nitrogen plays a key role in rice production and it is required in large amount. Nitrogen is the most important limiting nutrient in rice production and has heavy system losses when applied as inorganic sources in puddle field (Fillery *et al.*, 1984). Nitrogen has a positive influence on the production of effective tiller per plant, yield and yield attributes (Jashim *et al.*, 1984, BRRI, 1990). It is necessary to find out the suitable rate of nitrogen fertilizer for efficient management and better yield of rice. A suitable combination of variety and rate of nitrogen is necessary for better yield (BRRI, 1990). Rice plant cannot produce higher grain yield without addition of fertilizer in the crop field (BRRI, 2011). Among the nutrients, nitrogen is the kingpin in rice farming (Alam *et al.*, 2012a) for crop growth and development (Ahsan, 1996). Nitrogen is an essential constituent of chlorophyll and well-supplied nitrogen which enhanced crop growth vigorously (Dobermann and Fairhurst, 2000). On the contrary, nitrogen deficiency results reduced tillering, grains panicle^{-1} and ultimately decreases grain yield of rice (Peng *et al.*, 2003). However, only optimum dose of N applied can play a vital role on the growth and development of rice plant (Hasanuzzaman *et al.*, 2009). The absorption patterns of applied nitrogen vary with growth stages. About 52 to 60 % of total plant nitrogen in the high yielding plants has been absorbed by early panicle formation stage, and 70 to 80 % by heading stage; 20- 30 % nitrogen is absorbed during the ripening period (De Datta, 1981). Generally, the nitrogenous fertilizer (urea) is applied as basal and as top dressed at different growth stages for rice cultivation (BRRI, 2011). Unfortunately, N use efficiency in the wetland rice culture is very low, rarely exceeding 30-40 % (Alam *et al.*, 2000) and more than 50 % of the applied nitrogen is lost through denitrification, volatilization, leaching and runoff (Khan *et al.*, 2009) and ultimately affect on cash loss of farmers and sometimes causes environmental as well as ground water pollution (De Datta, 1981; IRRI, 1997). High price of urea fertilizer and its availability at the right time jeopardize rice production occasionally (BRRI, 2009). So, it is necessary to improve the efficiency of applied nitrogenous fertilizer utilization by rice plant (Miah and Panaullah, 1999). All the factors provide an indication of searching an effective alternate N application method for rice cultivation (BRRI, 2011). However, foliar application can improve nutrient utilization and lower environment pollution through reducing amount of fertilizers added to soil (Abou-El-Nour, 2002). In many cases aerial spray of nutrients is preferred and give quicker and better results than the soil application (Jamal *et al.*, 2006) which minimizes N losses to the environment without affecting rice yield (Millard and Robinson, 1990). Most plants absorb foliar applied urea rapidly and hydrolyze the urea in the cytosol (Nicoulaud and Bloom, 1996). The NH_3 released may be transported into the chloroplast and be assimilated by the chloroplastidic Glutamine synthetase (Lam *et al.*, 1996). Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants (Alam *et al.*, 2012a).

Many factors determine the fertilizer use efficiency for rice crop during cultivation such as soil, cultivar, season, environment, planting time, water management, weed control, cropping pattern, source, form, rate, time of application and method of application (De Datta, 1978). Therefore, there is an imperative need to provide the required nutrients over and above the regular soil application through foliar application as well. Foliar application is well recognized and is being practiced in agriculturally advanced countries. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application (Jamal *et al.*, 2006). Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants. Foliar feeding is an effective method for overcoming the flooded soil special condition. In case of foliar feeding, nutrients are absorbed directly where they are needed, the rate of the photosynthesis in the leaves is increased, nutrient absorption by plant roots is stimulated and foliar nutrition applied at critical times. Other advantages are low application rates, uniform distribution of fertilizer, reduction in plant stress, plant's natural defense mechanisms to resist plant disease and insect infestations, improvement of plant health and yield (Finck, 1982). Nitrogen fertilizer is more urgent for security rice production. Liquid fertilization might reduce the use of chemical fertilizer specially the nitrogenous fertilizer in soil. In this aspect, the present study was undertaken to find out the effect of liquid fertilization (Magic Growth) on performance of BRRI dhan46 and Bina-sail and to calculate how much urea can be saved by using liquid fertilization of Magic Growth without the reduction of grain yield.

In the light of the above discussion, the present study was under taken with the following objectives:

(I) To compare the yield and yield component of the two varieties under different nitrogen treatments,

(II) To observe the effectiveness of foliar application of urea fertilizer in the crop field and

(III) To find out the effect of magic growth and urea fertilizer on the nutrient content of rice cultivars.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

Growth and development of rice plants are greatly influenced by the environmental factors i.e. air, day length or photoperiod, temperature, variety and agronomic practices like transplanting time, spacing, number of seedlings, depth of planting, fertilizer management etc. Among the factors, which are responsible for the yield of rice, fertilizer management of aman rice is one of them. Yield and yield contributing characters of rice are considerably influenced by different doses of NPKS fertilizers and their combined application. Cultivar plays an important role in rice production by affecting the growth, yield and yield components of rice. Research works related to effect of foliar application of magic growth liquid fertilizer and urea fertilizer on the growth, yield and nutrient content of aman rice culivars (Bina-sail and BRRI dhan46) have been reviewed in this chapter.

2.1 Effect of variety

The successful production of any crop depends on manipulation of basic ingredients of crop culture. The variety of crop is one of the basic ingredients. Variation of yield and other crop growth characters due to different varieties. Variety itself is the genetic factor which contributes a lot in improving yield and yield components. Different scientists reported on the effect of rice varieties on grain yields. Some available information and literature related to the effect of variety on the yield and yield contributing characters of rice are furnished here.

An experiment was carried out by Alam *et al.* (2012b) during the kharif season to study the effect of variety, spacing and number of seedlings hill^{-1} on the yield potentials of transplant aman rice. Variety had significant effects on almost all the yield component characters and yield. Among the varieties BRRI dhan33 gave significantly the tallest plant (113.17 cm), which is statistically identical with BR11 (111.25 cm). The highest number of total tillers hill^{-1} (12.23) was produced by BR11 and the lowest number of total tillers hill^{-1} (10.17) was produced by BRRI dhan32. All the yield components characters (tillers hill^{-1}, effective tillers hill^{-1}, panicle length, weight of 1000-grain and grain yield) except number of fertile spikelets panicle^{-1} were highest in case of variety BR11 and hence it produced the highest grain yield (5.92 t ha^{-1}).

Nahar *et al.* (2009) was carried a field experiment during the Aman (monsoon) season of 2008 studied the effect of low temperature stress influenced by date of transplanting on yield attributes and yields of two rice varieties. The experiment consisted of two varieties (BRRI dhan46 and BRRI dhan31) and 4 transplanting dates (01, 10, 20 and 30 September, 2008). BRRI dhan46 had significantly higher values of yield attributes (effective tillers hill^{-1}, panicles hill^{-1}, panicle length, spikelets panicle^{-1}, filled grains panicle^{-1} and 1000-grain weight) and yields than the BRRI dhan31 in late transplanted conditions. There were significant reductions in yield attributes and yields after delayed transplanting. Spikelet sterility was increased by late transplanting due to low temperature at panicle emergence stage. Yield reduction of BRRI dhan46 due to late transplanting at 10 September, 20 September and 30 September were 4.44, 8.88 and 15.55%, respectively compared to 01 September transplanting. In case of BRRI dhan31 the reduction was more significant which were 6.12, 20.48 and 36.73%, respectively.

Leenakumari *et al.* (1993) found higher grain yield from the hybrid varieties over the modern varieties. They evaluated eleven hybrids of varying duration against controls Jaya, Rasi, IR20 and Margala, and concluded that hybrid OR 1002 gave the highest yield (7.9 t ha^{-1}) followed by IR 1000 (6.2 t ha^{-1}).

BRRI (1991) reported that the number of effective tillers produced by some transplant *aman* rice ranged from 7 to 14 tillers hill^{-1} and it significantly differed from variety.

Main *et al.* (2007) reported that there was no significant variation of effective tillers hill^{-1}, total grains panicle^{-1}, filled grains panicle, straw yield and harvest index observed between the two varieties but hybrid variety showed higher panicle length, grain weight and grain yield compared to inbred variety. The variety Sonarbangla-1 gave the longer panicle (26.40 cm) compared to that of BR11 (25.66 cm). The higher weight of 1000 grains (28.32 g) was obtained from the hybrid variety and the lower (27.08 g) was obtained from the inbred variety. The higher grain yield (4.70 t ha^{-1}) was obtained from the hybrid variety Sonar bangla-1 and from inbred variety BR11 (4.43 t ha^{-1}).

A study was undertaken to evaluate the growth performance and grain quality of six aromatic rice varieties BRRI dhan34, BRRI dhan38, Kalizira, Chiniatop, Kataribhog and Basmati grown under rainfed conditions by Ashrafuzzaman *et al.*, (2009). They found that Kalizira was the tallest (107.90 cm) of all the studied varieties. It had shown no significant difference with BRRI dhan38 (107.80 cm) and BRRI dhan34 (106.70 cm). BRRI dhan34 showed the highest number of panicles per hill (11.67) followed by Kalizira (11.33).The rice varieties differed significantly ($P<0.05$) with respect to leaf chlorophyll content, plant height, internode length, thousand grain weight and grain and straw yields. Varieties differed in morphological and yield and yield contributing traits. Thousand grain weight and grain yield both were highest in BRRI dhan38. Basmati required shorter days to maturity and Kalizira longest days to maturity.

Islam *et al.* (2013) was conducted a field experiment during July- December, 2010 with a view to find out the varietal performance of *aman* rice as affected by different methods of urea application. The experimental treatments included four varieties i.e. BR11, BRRI dhan33, BRRI dhan39, BRRI dhan46 and four urea application methods. The results showed that urea fertilizer application method significantly influenced plant height, tillering production, leaf area index, effective tillers hill^{-1}, filled grains panicle^{-1}, unfilled grains panicle^{-1}, total grains panicle^{-1}, 1000-grain weight, grain yield, straw yield, and biological yield. Application of USG N as at 7 DAT gave highest yield (7.82 t ha-1) while application of 15 kg N ha^{-1} as PU 30 DAT+ 15 kg N ha^{-1} as PU at 50 DAT gave lowest yield (4.88 t ha^{-1}). Varietal influence were significant on tillering pattern, leaf area index, effective tillers hill^{-1}, filled grains panicle^{-1},1000-grain weight, grain yield, straw yield and biological yield. BR11 gave the highest yield (8.17 t ha^{-1}) which was statistically similar with BRRI dhan46 (7.3 t ha^{-1}) while the lowest yield obtained from BRRI dhan33 (2.87 t ha^{-1}).

A field experiment was conducted by Roy *et al.* (2014) to evaluate the growth, yield and yield attributing characteristics of 12 indigenous *Boro* rice varieties collected from South-Western regions of Bangladesh namely; Nayon moni, Tere bale, Bere ratna, Ashan boro, Kajol lata, Koijore, Kali boro, Bapoy, Latai balam, Choite boro, GS one and Sylhety boro. The plant height and number of tillers hill^{-1} at different days after transplanting varied significantly among the varieties up to harvest. At harvest, the tallest plant (123.80 cm) was recorded in Bapoy and the shortest (81.13 cm) was found in GS one. The maximum number of tillers hill^{-1} (46.00) was observed in Sylhety boro and the minimum (19.80) in Bere ratna. The maximum number of effective tillers hill^{-1} (43.87) was recorded in the variety Sylhety boro while Bere ratna produced the lowest effective tillers hill^{-1} (17.73). The highest (110.57) and the lowest (42.13) number of filled grains panicle^{-1} was observed in the variety Koijore and Sylhety boro, respectively. Thousand grain weight was the highest (26.35 g) in Kali boro and the lowest (17.83 g) in GS one. Grain did not differ significantly among the varieties but numerically the highest grain yield (5.01 t ha^{-1}) was found in the variety Koijore and the lowest in GS one (3.17 t ha^{-1}).

WenXiong *et al.* (1996) reported that Shnyou 63 (Zhenshan 97A x Minhui 63) and Teyou 63 (Longtepu A x Minhui 63) showed significant grain yield increase over Minhui 63 of 35.2 and 48%, respectively, in China in 1993. The higher number of productive tillers plant^{-1} had the largest direct effect on grain yield, resulting in increased sink capability. The higher tiller number and number of grains panicle^{-1} were attributable to higher leaf areas, higher net photosynthesis in individual leaves (particularly in the later stages) and favorable partitioning of photosynthesis to plant organs. Compared with Minhui 63, hybrids showed slight heterosis in relative growth rate but significant heterosis in crop growth rate, especially at later growth stages, with increases of 160.52 and 97.62% in shanyou 63 and Teyou 63, respectively.

BINA (1993) evaluated the performance of four varieties- IRATOM 24, BR 14, Binadhan-13 and Binadhan-9. It was found that the varieties differed significantly in respect of plant height, number of unproductive tillers hill^{-1}, panicle length and sterile spikelets panicle^{-1}.

Number of panicles was the result of the number of tillers produced and the proportion of effective tillers, which survived to produce panicle (Hossain *et al.*, 2008).

Zohra *et al.* (2013) was carried a field experiment during July- December, 2011 with a view to find out the yield performance of three transplant *aman* rice namely, Binadhan-7, BRRI dhan46 and Kalizira were evaluated under five levels of urea super granules (USG) viz. control (no USG), one, two, three and four pellet(s) of USG/4 hills providing 0, 30, 60, 90 and 120 kg N ha^{-1}, respectively, and recommended dose of prilled urea were evaluated. Variety exerted significant influence on yield of transplant *aman* rice. Grain yield was highest (5.46 t ha^{-1}) in BRRI dhan46 and straw yield was highest (6.58 t ha^{-1}) in Kalizira. It was observed that in most of the cases, all the varieties performed better for their yield contributing characters with 2 pellets of USG/4 hills compared to any other levels. The findings suggest that BRRI dhan46 can be cultivated to obtain high rice yield in transplant *aman* season.

Obaidullah (2007) stated that variety significantly influenced panicle length, number of total grains panicle', filled grains panicle1, 1000 grains weight, grain yield and straw yield but not for effective tillers hill' and harvest index. The varietial effects on yield and other yield attributes where hybrid variety gave numerically maximum tillers $hill^{-1}$ (10.08), and significantly highest panicle length (27.36 cm), grains $panicle^{-1}$ (196.75), filled grains $panicle^{-1}$ (156.84), 1000 grain weight (27.40 g) which eventually elevated the grain yield (5.58 t ha^{-1}). These parameters were 9.8, 25.17 cm, 112.83, 86.77, 20.09 g and 3.88 t ha^{-1}, respectively as lowest measurements from inbred varieties.

Bhuiya (2000) reported that plant height varied variety to variety *viz.* Binasail, Binadhan 4 and Binadhan 19 with different plant spacing *viz.* 20 cm x 10 cm, 20 cm x 15 cm and 20 cm x 20 cm.

BRRI (1985) concluded that BR4 and BR10 were higher yielders than Rajasail and Kajalsail.

Kamal *et al.* (1988) observed that among three rice varieties BR3 produced the highest the grain yield and pajam yielded the lowest. The superiority of promising line over the high yielding varieties in respect of grain yield was recorded.

Miller (1978) from a study of 14 rice cultivars observed that grain yields ranged from 5.6 to 7.7 t ha^{-1}. He also reported that grain yield was significantly influenced by rice cultivars.

Sultana (2008) observed that number total of tillers $hill^{-1}$ was not significantly affected by variety. Apparently more number (11.07) of total tillers was produced by the variety BR14 than BR26 (10.90).

Akbar (2004) stated that variety, seedling age and their interaction exerted significant influence on almost all the studied crop characters of rice. Among the varieties, BRRI dhan4l performed the best in respect of number of bearing tillers hill^{-1}, panicle length, total spikelets panicle^{-1}, and number of grains panicle^{-1}. BRRI dhan41 also produced the maximum grain and straw yields, Sonarbangla-1 ranked first in respect of total tillers hill^{-1} and 1000 grain weight but produced the highest number of non-bearing tillers hill and sterile spikelets panicle^{-1}. Grain, straw and biological yields were found highest in the combination of BRRI dhan41 x 15 day-old seedlings. Therefore, BRRI dhan4l may be cultivated using 15 day-old seedlings in *aman* season following the SRI technique to better grain and straw yields.

Idris and Matin (1990) reported that number of total tillers hill^{-1} was identical among the varieties studied.

BRRI (2006) studied the performance of BR14, Pajam, BR5 and Tulsimala and reported that Tulsimala produced the highest number of filled grains panicle^{-1} and BR14 produced the lowest number of filled grains panicle^{-1}.

Kabir *et al.* (2009) was carried an experiment in transplant *Aman* season 2008 to find out the effect of urea super granules (USG), prilled urea (PU) and poultry manure (PM) on the yield and yield attributes of transplant *Aman* rice varieties. Two transplant *Aman* rice varieties viz. BRRI dhan41 and BRRI dhan46 and ten levels of integrated nutrient management encompassing USG, PU and PM were tested. In case of varietal effect plant height, total tillers hill^{-1}, effective tillers hill^{-1}, length of panicle, grains panicle^{-1}, unfilled spikelets panicle^{-1}, grain yield, straw yield and harvest index were significantly influenced at different levels of significance. Variety BRRI dhan41 produced higher grain and straw yield and harvest index than that of BRRI dhan46. Higher grain yield in BRRI dhan41was due mainly to higher of effective tillers hill^{-1} and grains panicle^{-1}.

BRRI (2004) reported that the filled grains panicle^{-1} of different modern varieties were 95-100 in BR3, 125 in BR4, 120-130 in BR22 and 110-120 in BR23 when they were cultivated in transplant *Aus* season. They reported that three modern upland rice varieties namely, BR20, BR21 and BR24 were suitable for high rainfall belts of Bangladesh. Under proper management, the grain yield was 3.5 ton for BR 20, 3.0 ton for BR21 and 3.5 ton for BR24 ha^{-1}. They also reported that grain yields of the modern rice varieties in *Aus* season under transplant condition ranged from 4.0-4.5 t ha^{-1} for BR3, 5.5 - 6.5 t ha^{-1} for BR4, 2.5-5.5 t ha^{-1} for BR23 and 4.0-4.5 t ha^{-1} for IR20.

Takita (2009) reported that Nerica rice has erect panicles even after maturity which can favor high canopy photosynthesis with less light interception by these panicles than droopy panicles.

Debnath *et al.* (2012) observed that variety had significant effect on all the agronomic parameters except number of effective tillers, ineffective tillers, total tillers, grain straw ratio and biological yield. BRRI hybrid dhan2 produced the highest dry grain yield (5.92 t ha^{-1}) and the lowest straw yield (4.97 t ha^{-1}), whereas, BRRI dhan29 produced the lowest grain yield (4.16 t ha^{-1}) and the highest straw yield (6.70 t ha^{-1}).

Jesy (2007) observed that weight of 1000-grains was not significantly affected by variety. Apparently BRRI dhan4l produced the higher weight of 1000-grains (23.42 g) than BRRI dhan40 (23.39 g).

Hasanuzzaman *et al.* (2009) in a study found that the length of panicle in late transplanted Aman rice ranged from 23.59 to 21.30 cm.

Refey *et al.* (1989) reported that weight of 1000-grains differed among the cultivars studied.

Hossan (2005) observed that grain yield was significantly differed due to variety. It was evident from the result that BRRI dhan4l produced the higher grain yield (5.02 t ha^{-1}) than BRRI dhan31.

In a trial, varietal differences in harvest index and yield were examined using 60 Japanese varieties bred in Asian countries. It was reported that harvest index varied from 36.8% to 53.4%. Mean values of harvest index were 43.5% in the Japanese group and 48.8% in high yielding group. Yield ranged from 22.6 g $plant^{-1}$. The mean value of yield in Japanese group was 22.8 g plant^{-1}, and that in high yielding group was 34.1 g plant^{-1}. They also reported that a positive correlation was found between harvest index and yield in the yielding group (Cui *et al.*, 2000).

Om *et al.* (1999) conducted a field experiment with four varieties (3 hybrids: ORI 161, PMS 2A, PMS 10A and one inbred variety HKR 126) during rainy season and observed that hybrid ORI 161 exhibited superiority to other varieties in grain yield and straw yield.

Tac *et al.* (1998) conducted an experiment with two varieties, Akitakomachi and Hitombore in tohoku region of Japan. It was found that Hitombore yielded the higher (710 g m^{-2}) and Akitakomachi the lowest (660 g m^{-2})

Miah *et al.* (1993) reported that plant height differed significantly among BR 3, BR 11, BR 22, Nizershail, Pajam, and Badshabhog varieties in Aman season (Jul-Dec). Tiller number varied widely among the varieties and the number of tillers/plant at the maximum tiller number stage ranged between 14.3 and 39.5 in 1995 and 12.2 and 34.6 in 1996.

Mahato *et al.* 2014. was carried a field experiment during July-December, 2010 to find out the allelopathic effect on growth and yield of three aman rice varieties. Aman rice varieties were viz. BRRI dhan 46, Guti Swarna and Ranzit. Results showed significantly higher in grain yield of ranzit with ariach (6.5 t ha-1).Araiach and Razit also exhibited the higher number of tillers hill-1 (13.6), filled grains panicle-1 (256.0) and 1000-grain weight (23.8 g). As a result, BARI- 46 and Ranzit considered as the most important variety and the most effective plant residue was ariach for growth and yield of aman rice.

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Chang and Vergara (1972) stated that the tillering pattern of rice varied with the varieties. In general tall cultivars showed a tendency to have small number of tillers and shorts on showed a large number. Tiller number and panicle number were positively correlated. *Japonica* cultivars that produced few tillers under tropical conditions were vigorous and produced more tillers when grown under temperate conditions. *Indica* cultivars, which were vigorous under tropical conditions, showed few tillers under temperate conditions.

2.2 Effect of foliar application of urea fertilizer along with magic growth (liquid fertilizer)

Alam *et al.* (2015) conducted an experiment at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Banglaadesh during the period of August 2013 to January 2014 to find out the efficacy of liquid fertilization (Magic Growth) on the performance of Kataribhog rice and to calculate how much urea can be saved without the reduction of grain yield. The experiment was accommodated with the split plot design with two levels of liquid fertilization viz., no liquid fertilization (Lo), Liquid fertilization with Magic Growth applied at 30, 45 and 60 DAT (L_1), and four levels of nitrogen fertilizer viz., no nitrogen fertilizer (N_0), 50% recommended nitrogen fertilizer (N_{50}), 75% recommended nitrogen fertilizer (N_{75}) and 100% recommended fertilizer (N_{100}). The liquid fertilizer and nitrogen fertilizer doses were assigned to the main plot and sub-plot, respectively. Liquid fertilization (L_1) treatment provided greater grain yield compared to no liquid fertilization treatment (L_0) in all nitrogen levels. Furthermore, with the increment of nitrogen level the grain yield was increased up to N_{100} compared to no liquid fertilization treatment (L_0), but in the application of liquid fertilization treatment (L_1), grain yield was increased up to N_{75} and thereafter decreased in N_{100} dose application. Moreover, Liquid fertilization with Magic Growth along with 75% of the recommended nitrogen fertilizer increased 10.5% grain yield with a saving of 25% of the recommended nitrogen fertilizer compared to recommended practice.

Shafiee *et al.* (2013) conducted an experiment of during off-seasons of 2007 through 2009 in Sungai Besar, Selangor's North West Project, Malaysia to assess the enhancing effect of SBAJATM (formerly known as BIPOMIXTM) on the growth and yields of rice (*Oryza sativa* L. var. MR 220). The clonal growth of SBAJATM -treated rice crop based on plant height and tiller numbers plant^{-1}, albeit temporal inconsistencies, did not register any significant difference from each other at $p<0.05$, save for those in the control plots at 45, 75 DAT, and at harvest with measurably lower tiller numbers plant^{-1}. The mean panicle length plant^{-1} and mean number of panicles m^{-2} were significantly ($p<0.05$) longer and higher, respectively in plots treated with SBAJATM *vis-à-vis* the control. While no significant differences were recorded in the 1000 grain weight, the percentage of filled grains panicle^{-1} and the number of grains panicle^{-1} were higher among rice plants in plots receiving the SBAJATM treatments. Invariably, the Crop Cutting Tests (CCT) in plots subjected to foliar applications of SBAJATM registered measurable increase in rice yields from 15 to 29% *vis-à-vis* the equivalent foliar-applied fertilizer subsidy from the government, and the conventional NPK fertilizer applications of 100:30:20 (here served as the control), respectively. The SBAJATM treated plots registered a mean yield of 9.66 tons ha^{-1} compared with 7.49 tons ha^{-1} in the control plots. The parallel average yield from the equivalent foliar-applied fertilizer subsidy from the government was 8.38 tons ha^{-1}. In monetary terms, a yield increase of 1 ton ha^{-1} is translated as an extra net profit of RM 1,000 ha^{-1} $season^{-1}$.

Parvin *et al.* (2013). was conducted an experiment to investigate the effect of weeding and foliar application of urea on the yield and yield components of *Boro* rice *cv.* BRRI dhan 29. The experiment included four weedings e.g. no weeding (W_0), one weeding (W_1), two weedings (W_2) and three weedings (W_3) and six methods of urea application viz. foliar spray @ 0, 60, 80,100 and120 kg ha^{-1} and soil application @ 220 kg ha^{-1} . Yield and yield contributing characters of *Boro* rice *cv.* BRRI dhan 29 were significantly influenced by foliar application of urea. The highest grain yield was obtained from five times foliar urea spray @ 100 kg ha^{-1}. This highest grain yield was the resultant effect of highest number of effective tillers $hill^{-1}$ and grains $panicle^{-1}$ in this treatment. The interaction of weeding and foliar application of urea also influenced grain yield of *Boro* rice *cv.* BRRI dhan29. The highest grain yield was obtained from the five times foliar spray of urea @ 100 kg ha^{-1} with three weedings regime.

Alam *et al.* (2010) was conducted An experiment during Boro season of 2008 with a view to examining the effect of soil and foliar application of urea on the yield and nutrient uptake of BRRIdhan 29 and to evaluate whether urea foliar application (FA) could replace its soil application (SA) in the rice cultivation. The treatments were: T_1 (control), T_2 (282 kg urea ha^{-1} SA), T_3 (1% urea solution FA), T_4 (2% urea solution FA), T_5 (3% urea solution FA), T_6 (94 kg urea ha^{-1} SA + 1% urea solution FA), T_7 (94 kg urea ha^{-1} SA + 2% urea solution FA) and T_8 (94 kg urea ha^{-1} SA + 3% urea solution FA). The results showed that soil and foliar application of nitrogen significantly influenced the growth and yield of crop. The treatment T_2 (282 kg urea ha^{-1}) produced the highest grain yield (5.34 t ha^{-1}). The T_6 (94 kg urea ha^{-1} + 1% urea solution FA) produced the highest straw yield (6.58 t ha^{-1}) of the crop.

Sarandon and Asborno (1996) was carried a field trial to study the effect of foliar urea spraying on biomass production, harvest index, grain yield and grain protein content on three rice cultivars. Nitrogen (30 kg/ha), was applied as foliar urea spraying at the end of tillering, heading or postanthesis. Spraying N at heading increased grain yield due to higher grain number/m^2 and a more efficient dry matter partition to the grain (harvest index), without changes in the biomass production. The effect of urea sprayings on grain N content and protein percentage varied according to the cultivars and time of application (positive interaction cultivar x time). Both grain N content and grain protein percentage increased significantly with postanthesis spraying in two of the three cultivars studied but it had no effect on the grain yield. The efficiency of N fertilization for grain yield was higher when applied at heading. No apparent N recovery in the grain was observed when urea spraying was done at tillering; but it rises to 70% when applied at heading and to 47% when applied at postanthesis. In all cultivars N spraying at heading increased grain protein production per ha due to an increase of both grain yield and grain protein percentage. It has been concluded that N spraying in rice, even at low doses, could be effective to increase grain yield and grain protein content depending on rice cultivars and time of application.

Bhuyan *et al.* (2012) was observed that bed planting with foliar nitrogen fertilizer application of rice production systems is very new, and research on it is still at introductory phase. Influence of foliar application of nitrogen fertilizer on growth and yield of transplanted aman rice and evaluation of water and fertilizer application efficiency of rice-fallow-rice cropping system were investigated under raised bed cultivation method. Results showed that foliar spray in bed planting method increased grain yield of transplanted aman rice up to 9.33% over conventional method. Foliar nitrogen fertilizer application in bed planting method increased the number of panicle m^{-2}, number of grains panicle^{-1}, and 1000-grain weight of rice than the conventional method. Sterility percentage and weed infestation were lower at foliar nitrogen fertilizer application in bed planting method than the conventional method. Thirty-nine percent of irrigation water and time for application could be saved through foliar nitrogen spray in bed planting than conventional method.Water use efficiency for grain and biomass production was higher by foliar nitrogen fertilizer application in bed planting than conventional method. Likewise, agronomic efficiency of foliar nitrogen fertilizer application in bed planting method was higher than the conventional method. This study concluded that foliar nitrogen spray in bed planting method is a new approach to get fertilizer and water use efficiency as well as higher yield compared to existing agronomic practice in Bangladesh.

Akhand *et al.* (2013) was conducted an experiment at the Bangladesh Rice Research Institute Farm, Gazipur, during aman and boro seasons of 2009-2012. One observational and two replicated trials were conducted to find out the suitability of urea spraying of nitrogen management for rice cultivation. One observational trial, urea solution was sprayed at different concentration levels with or without addition of prilled urea. In this trial, 12 treatments were applied. Two replicated where applied treatments were; Urea at 266 kg ha^{-1} in boro and 175 kg ha^{-1} in aman, urea top dressed at 20, 30 DAT (date after transplanting) and at panicle initiation stage, 2/3rd of recommended N, top dressed at 20, 30 DAT along with 3.5% urea spraying at PI stage, 2/3rd of recommended N, top dressed at 20, 30 DAT along with 3.5% urea solution spraying at PI and booting stage, 2/3rd of recommended N along with 3.5% urea spraying at maximum tillering, PI and booting stage, and compared with without N. It was found that urea could be saved by 22% in aman and 27% in boro seasons without scarifying grain yield when 2/3rd of recommended N, top dressed at 20 and 30 DAT along with urea solution spraying with 3.5% concentration at tillering, panicle initiation and booting stages.

Asif *et al.* (2000) reported that NPK levels significantly increased the panicle length, number of primary and secondary branches panicle^{-1} when NPK fertilizers were applied at the dose of 180-90-90 kg ha^{-1}.This might be attributed due to the adequate supply of NPK.
Amin *et al.* (2004) conducted an experiment to evaluate the effect of increased plant density and fertilizer dose on yield of rice variety IR-6. They found that increased fertilizer dose of NPK increase plant height.

Islam *et al.* (2008a) conducted an experiment in 2001-2002, 2002-2003 and 2003-2004 to determine the response and the optimum rate of nutrients (NPK) for Chili- Fallow-T. *aman* cropping pattern. He found that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties in respect of yield and economics.

Ahmed *et al.* (2005) was carried a field experiment during aman season, 2003 at the experimental field of Agrotechnology Discipline, Khulna University, Khulna to study the effect of nitrogen on different characteristics of transplanted local aman rice variety, Jatai .The levels of nitrogen used in this study were 0, 20, 40, 60 and 80 kg ha^{-1}. Results of this study reveled that different agronomic characteristics varied significantly among the treatments. Higher N dose produced higher plant height. The highest effective tiller $hill^{-1}$, panicle length, filled grains $panicle^{-1}$, 1000-grain weight and grain yield was obtained with 40 kg N ha^{-1}. The highest and lowest biological yield was produced with 40 kg N $ha^{-1}$and 0-kg N ha^{-1} respectively.

Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties (WAB340- 8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1, WAB224-8-HB, WAB189-B-B-B-8-HB) and four rates of NPK (15:15:15) fertilizer (0, 200, 400 and 600kg/ha). The results showed that 600kg/ha NPK (15:15:15) fertilizer rate significantly ($P < 0.05$) increased plant height, number of leaves and tillers per plant in two years. The 400kg/ha rate increased the number of panicles per plant, length of central panicle per plant and the overall grain yields, straw yield over other rates by 4-32% and 2-21% in 2005 and 2006, respectively.

Rahman *et al.* (2007) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during T. Aman season, 2002 to study the effect of different level of nitrogen on growth and yield of transplant Aman rice. The experiment included four treatments viz. 0, 60, 80 and 100 kg N/ha. Nitrogen level significantly influenced growth and yield components. The highest number of effective tillers/hill (9.20), maximum grains/panicle (100.80) and the highest grain yield (5.34 t/ha) were obtained with 80 kg N/ha. The highest straw yield (6.98 t/ha) was obtained at the highest nitrogen level (100 kg N/ha). The highest harvest index (44.50%) was observed at 80 kg N/ha. Results showed that 80 kg N/ha was optimum to produce maximum yield of transplant Aman rice cv. BRRI dhan32.

Saha *et al.* (2004) conducted an experiment in 2002-2003 to create and compare a suitable fertilizer recommendation model for lowland rice. Five different fertilizer recommendation models were tested and compared with one check plot. Results show that the application of different packages estimated by different fertilizer models significantly influence panicle length, panicle numbers, spikelet number per panicle, total grains panicle^{-1}, number of filled grain and unfilled grain per panicle. The combination of NPK that gives the height result was 120-13-70-20 kg/ha NPKS.

Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon. They found that all the treatments significantly increase the grain and straw yield of BRRI dhan30 rice over control. 90 kg N + 50 kg P_2O_5 + 40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the height grain and straw yield.

Islam *et al.* (2008b) conducted a field experiment to find out the effect of nitrogen levels and transplanting dates on the yield and yield components of aromatic rice cv. Kalizira. The experiment was laid out in a randomized complete block design with three replications using four (0, 50, 100, and 150 kg N/ha) levels of nitrogen and three transplanting dates (10 August, 22 August and 04 September, 2007) along with the basal doses of triple super phosphate (TSP), muriate of potash (MOP) and gypsum. The study revealed that most of the yield and yield contributing characters with few exceptions were significantly influenced by nitrogen levels and transplanting dates. They had significant positive effect on tillers, grains/panicle and straw yield. The highest grain yield (2.63 t/ha) was observed in 100 kg N/ha with 10 August transplanting treatment and straw yield (6.43 t/ha) was found highest in 150 kg N/ha with same date of transplanting and the lowest grain (1.83 t/ha) and straw yields (5.14 t/ha) were found in N control treatment with transplanting date of 04 September. The highest grain length (4.68 mm), grain breadth (2.49 mm) and imbibition ratio (6.93) were observed with 100 kg/ha N rate coupled with 10 August transplanting, and for length-breadth ratio, the same rate recorded the highest result, but with different transplanting date i.e. 22 August.

Rasheed *et al.* (2003) reported that the effect of different NP levels i.e., 0-0, 25-0, 50-25, 75-50, 100-75 and 125-100 kg ha^{-1} on yield and yield attributes of rice Bas-385. Yield attributes (No. of effective tillers per hill, spikelet per panicle, normal kernels per panicle, 1000-grain weight) were improved linearly with increasing NP levels up to 100-75 kg/ha. The NP level of 100-75 kg/ha resulted in the highest grain yield of 4.53 t/ha with minimum kernel abnormalities (Sterility, abortive kernels and opaque kernels) as against the minimum of 2.356 t/ha in the control (0-0) followed by 25-0 kg NP/ha with maximum kernel abnormalities.

Bahmanyar and Mashaee (2010) conducted this research to investigate the effects of topdressing of different rates of nitrogen (N) and potassium (K) on grain yield and yield components of rice (*Oryza sativa cv. Tarrom*) and to observe N and K content of upper leaves analyzed at ten different times. A pot experiment was carried out on a completely randomized design with seven replications under greenhouse conditions at the Experiment Station of Sari Agricultural Sciences and Natural Resources University, Iran, during the growing season in 2008. Nitrogen was applied in the form of urea (46% N) at the rates of 0, 23 and 46 kg N/ha and potassium in the form of potassium chloride (60% K_2O) at the rates of 0, 30 and 60 kg/ha K_2O. Results indicated that panicle length, plant height, number of tiller, number of grain per panicle, hollow grain percentage, grain and biological yield were significantly affected by N and K fertilization. Maximum grain yield (75.46 g/pot) occurred at 23 kg N/ha and 30 kg/ha K_2O. At flowering stage, K content of stems were higher than leaves, and N content in flag leaves was higher than other plant parts.

Singh *et al.* (2003) also reported that crop growth rate and relative growth rate such as total dry matter production was significantly influenced by NPK. The tiller number and total dry matter production are closely correlated with yield depending on the rice cultivar which can be greatly enhanced by applying proper nutrient.

Mishra *et al.* (1994) carried out a field experiment with rice cv. Sita giving 0 or 80 kg N ha^{-1} as urea, USG and neem, lac, rock phosphate or karanj coated urea and showed that the highest grain yield was (3.39 t ha^{-1}) obtained by urea in three split applications.

2.3 Combined effect of variety and urea fertilization method on the growth and yield of rice

Honjyo *et al.* (1980) was observed that using the 5 varieties grown on the field with sufficient nitrogen fertilizer as the basal dressing, to investigated the effect of nitrogen topdressing and foliar application of urea at full heading time on the translocation of nitrogen from the leaves and culms to the ears and the protein content of brown rice. 1. The amount of dry matter production increased 40% by topdressing and 36% by foliar application compared with non-topdressing on the average of 5 varieties. 2. The recovery rates of nitrogen applied at full heading time were 53~73% on the topdressing plots and 74~84% on the foliar application plots. The recovery rates of nitrogen on the foliar application plots were higher than those of the topdressing plots. 3. The distribution ratio of nitrogen to ears was about 50% of the nitrogen recovered on the topdressing plots and about 60% of the nitrogen recovered on the foliar application plots. 4. On the topdressing plots, 9~17% of the nitrogen of the ears at harvest time was translocated from the leaf blades and little or nothing from the leaf sheaths or the culms, and the nitrogen absorbed from the soil was 68~76%. On the foliar application plots, the translocation of nitrogen from the other organs and the soil to the ears showed almost the same tendency as the topdressing plots. 5. The protein content of brown rice increased 23% by nitrogen topdressing and 48% by foliar application of urea at full heading tinle on the average of 5 varieties compared with the non-topdressing plots. The foliar application of urea was more effective than the nitrogen topdressing on the increase of protein of brown rice when the same amount of nitrogen was applied.

Russo (1996) was carried an experiments in order to compare the effects from slow-release N-fertilizers (ISODUR) and pro-ducts integrated with diciandiamide (DCD), a nitrification inhibitor, with the N splitting method applied in two or three times on the rice growth and yield. The effect of increasing N rate at preplant time compared with the top-dressing application was also determined. Fertilizers treatments were applied on two commercial rice cultivars, Baldo and Panda. Different types of N fertilizers were compared with N split applications based on two or three times. Plant growth (height), plant development (days to heading and ripening), rice yield, yield components, and quality were monitored. Results showed that split fertilization with N topdressed at panicle initiation stage was more effective in rice yielding than preplant only application, independently from the N rate. Commercial "slow-release" fertilizer and ammonium sulphate were less effective in rice production. Compared to urea, inhibitor of nitrification, Diciandiammide (DCD) was the top yielding treatment, when applied with the split method. The fertilization method, based on three split N applications, showed no significant yielding differences compared to the two times method. Application of slow-release fertilizers (110 kg/ha N) produced a significant decrease of rice yield. Thus, the effect on rice production of the Isodur N release pattern appears insufficient due mainly to the lack of synchronism with the peaks of plant nitrogen demand. The interaction between varieties and treatments resulted statistically insignificant ($p<0.05$).

Perez *et al.* (1996) was observed that Rice yields of 10 and 6 t/ha can be achieved in the humid tropics during the dry and wet seasons, respectively. At these high yield levels, late nitrogen (N) fertilizer application at flowering at the International Rice Research Institute (IRRI) farm often results in increased rough rice yield of IR cultivars and is accompanied by higher milled rice protein and increased total and head-milled rice contents. The combined effects of N application at flowering resulted in a 30-60% increase in head-rice protein yield in three field experiments. In general, milled rice translucency improved, but Kett whiteness decreased with late N fertilizer application.Brown-rice weight was not affected by late N application. In most cases, there was a significant positive correlation between head rice content, milled rice protein and translucency. Thus, when crop management seeks to achieve yields that approach yield potential levels, late N fertilizer application provides an option to improve milling and nutritional quality of rice grain.

Ghaley (2012) was observed that the uptake of urea fertilizer (NDFF), applied with 150 kg nitrogen (N) ha^{-1}, topdressed in five splits of 30 kg N ha^{-1} (30 N) each at 7, 26, 45, 70 and 83 days after transplanting (DAT) of rice (Oryza sativa L.), was investigated in an improved (Khangma Maap, KM) and a traditional (Janam, JN) cultivar in Bhutan highlands, using enriched 15N stable isotope. Although cultivar differences were not recorded in soil N accumulation and in total dry matter N, KM produced 21% higher grain yields compared to JN due to higher grain harvest index and partial factor productivity of N. Irrespective of the cultivars, topdressing timing had significant effects on NDFF, with highest mean N recovery (REN) of 29% of applied 30 N at 45 DAT during active tillering stage, resulting in mean NDFF total (grain + straw) uptake of 8.71 kg N ha−1 compared to least effective topdressing timing at 7 DAT with mean

REN of 12% and NDFF total of 3.51 kg N ha−1. In similarity to topdressing at 45 DAT, topdressing at 70 DAT (panicle initiation stage) was equally effective with mean REN of 27% across the cultivars. Hence, fertilizer N topdressing recommendations that combine use of improved cultivars with N applications timed to coincide with maximum crop demand at 45 and 70 DAT, could enhance N fertilizer use efficiency for increased rice yields as well as reduce N losses downstream, which can cause adverse off-site environmental effects.

Pal *et al.* (2008) were carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during July to December 2006 to study the root growth of four Transplant Aman rice varieties as influenced by NPKS fertilization. The experiment was laid out in a split-plot design with three replications. The experiment consisted of four varieties viz. BRRI dhan 30, BRRI dhan 3l, BRRI dhan 40 and BRRI dhan 4l; and four levels of fertilizers viz. 0, 50%, 100% and 150% of the recommended dose of NPKS. BRRI dhan 4l had better performance in all root parameters. All root parameters except number of roots/hill performed better at high level of fertilizer. The interaction effect between variety and fertilizer level was significant in respect of number of roots/hill, fresh weight of root (except at 30 days after transplanting (DAT) and 90 DAT), dry weight of root, fresh weight of above ground plant part (except at 30 DAT and 90 DAT) and dry weight of above ground plant part (except at 90 DAT).

Haque (1988) reported that spikelet sterility induced by low temperature at the reproductive stage of rice increased further with the increase of nitrogen supply. Spikelet sterility in Fujisaka-5 did not increase due to low temperature when nitrogen supply was increased from 10 to 40 ppm and at 80 ppm nitrogen supply it was less affected than IR36. Total nitrogen content in the leaves increased with the increase of nitrogen supply and was forced to be associated with the spikelet sterility induced by low temperature. Based on auricle distance between the last two leaves, the most sensitive stage to low temperature damage differed in Fujisaka-5 and IR36. Spikelet sterility induced by low temperature for 10 days was very high in both the varieties and the effect of nitrogen was not clear. The effect of phosphorus on the spikelet sterility induced by low temperature at reproductive stage was not clear except that at the highest phosphorus (p) level (10 ppm) the spikelet sterility increased both in Fujisaka-5 and IR 36. Spikelet sterility induced by low temperature at the reproductive stage of rice decreased with the increase of potassium (K) supply in both Fujisaka-5 and IR36. With an increase of potassium supply, nitrogen (N) content decreased in the leaves and panicles and spikelet sterility induced by low temperature decreased with an increase of the K to N ratio in the leaves and panicles. The results suggest that potassium might play a major role to counteract the low temperature damage at the reproductive stage of rice.

Azam *et al.* (2012) was conducted a field experiment at the agronomy field of Sher-e-Bangla Agricultural University, Dhaka during with the objectives to find out the influence of variety and different urea fertilizer application method on growth and yield of *boro* rice. Result showed that variety and urea fertilizer application method had significant effect on plant height, tillers hill^{-1}, dry weight hill^{-1}, leaf area index, grain panicle^{-1}, 1000-grain weight, grain yield, straw yield and harvest index. BRRI hybrid dhan2 showed the highest plant height (108 cm), number of tillers hill^{-1} (23.98), dry weight hill^{-1} (84.14 g), leaf area index (7.12), grains panicle^{-1} (131.20), 1000-grain weight (26.12 g), grain yield (4.79 t ha^{-1}), straw yield (6.80 t ha^{-1}) and harvest index (41.25%) at harvest. With the combined effect of different boro rice variety and methods of urea application the highest number of tillers hill^{-1} (28.00 at harvest), dry weight hill^{-1} (90.59 g at harvest), leaf area index (7.87 at harvest), grains panicle^{-1} (146.20), 1000-grain weight (26.79 g), grain yield (5.41 t ha^{-1}) and straw yield (7.20 t ha^{-1}) was at $V_3 T_1$. So, $V_3 T_1$ (BRRI hybrid dhan2 × 2.7 g size USG placement at 8 DAT) was the best treatment.

Alim (2012) was carried an experiment was conducted to study the effect of different sources and doses of nitrogen application on the yield formation of *boro* rice. Two *indica* modern *boro* rice varieties (BRRI dhan28 and BRRI dhan36) and 21 nitrogen fertilizer combinations were used in the experiment. Among the two varieties BRRI dhan28 produced higher grain and straw yield. Grain and straw yields were increased with the increase of nitrogen rate up to 120 kg ha^{-1} at all the sources. In general, organic manures alone could not produce higher grain yield but the combination of organic and inorganic fertilizers produced higher yield. The application of 60 kg N ha^{-1} as urea with 60 kg N ha^{-1} as mustard oil cake (MOC) produced maximum grain and straw yield which was statistically similar to the yield of 50 kg N ha-1 as urea with 50 kg N ha-1 as MOC. The lowest values were found in control nitrogen application. The results suggest that replacement of 50% urea N by MOC was the best source of nitrogen considering higher yield of *boro* rice. Therefore, fertilization of BRRI dhan28 and BRRI dhan36 varieties of rice with 60 kg N ha^{-1} as urea and 60 kg N ha^{-1} as MOC or 50 kg N ha^{-1} as urea with 50 kg N ha^{-1} as MOC was found to be the best nitrogen rate among all the treatment combinations in respect of grain and straw yields.

From the above reviews it is cleared that foliar application of magic growth liquid fertilizer and urea fertilizer has profound influence on the yield and yield contributing characters of Aman rice. Thus there may have enough scope investigating the effect of magic growth liquid fertilizer and urea fertilizer in favour of yield improvement of Aman rice cv. Bina-sail and BRRI dhan46.

CHAPTER III

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, during the period from July to December 2013. This chapter deals with a detail description of the site, soil, land preparation, intercultural operations, data recording and procedure of statistical analysis etc.

3.1 Description of experimental site

3.1.1. Location and site

The experimental field is located at the Sher-e-Bangla Agricultural University (SAU), Dhaka-1207. The experimental area belongs to Modhupur Tract (Agro-Ecological Zone 28). The land area was situated at 23°41' N latitude and 90°22' E longitude at an altitude of 8.6 meter above the sea level.

3.1.2 Soil

The soil of the experimental field belongs to the general soil type, shallow red brown terrace soil under Tejgaon series. Top soils were clay loam in texture, olive gray with common fine medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period.

3.1.3 Climate

The experimental area was under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (November-March).

3.2 Planting materials

Rice variety Bina-sail and BRRI dhan46 were taken as test crop for this experiment. The variety "Bina-sail" is Transplanted Late Aman in type. The plant grows up to 125 cm height. Seed to seed duration is 135-140 days. The appropriate time for seed sowing is late June to late July and transplanting should be done with in August to early September. The variety is harvested from Mid November to Mid December and approximate yield is 4.2-5 t/ha (BINA, 1987).

The variety "BRRI dhan46" is also a Transplanted Late Aman type. The plant grows up to 115-125 cm height. Seed to seed duration is 150 days. The appropriate time for seed sowing is mid July to mid August and transplanting should be done within August to early September. The variety is harvested from Mid November to Mid December and approximate yield is 5 t/ha (BRRI, 2010).

3.3 Experimental treatment

The treatments included in the experiment were two factorials.

Design: RCBD with two factorials

Factor A: Variety: 2

V_1 = Bina-sail

V_2 = BRRI dhan46

Factor B: Different nitrogen fertilizer's doses: 8

T_0=N_0 (No nitrogen applied),

T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray)

T_2=$N_{50+5\%}$ (50% Urea of the RD was applied as top dressing and 5% Urea of the RD was applied with magic growth as foliar spray)

T_3=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray)

T_4=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray)

T_5=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray)

T_6=N_{100} (100% of RD of N applied as Urea topdressing)

T_7=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray).

P, K and S was applied as per recommended dose.

Treatment combination = 2 x 8 = 16

Replication: 3

3.4 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each block was divided into 16 plots. The total numbers of unit plots were 48. The plot size was 3.0 m x 2.0 m. The distances between plot to plot and block to block were 0.5 m and 0.5 m, respectively. The layout of the experimental plot has been shown in Appendix IV.

3.5 Raising of seedlings

Seeds of Bina-sail were collected from BINA (Bangladesh Institute of Nuclear Agriculture), Mymensingh and Seeds of BRRI dhan46 were collected from BRRI (Bangladesh Rice Research Institute), Gazipur. The seedlings were raised at the wet seed bed in SAU farm. The seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed in 16 July, 2013.

3.6 Land preparation

The experimental field was opened with a power tiller and later on, the land was ploughed and cross-ploughed three times by country plough followed by laddering to obtain the desirable tilth. The corners of the land were spaded. All kinds of weeds and stubbles were removed from the field and the land was made ready. Whole experimental land was divided into sub plots. Finally basal doses of phosphorus, potassium and sulphur fertilizers were applied in sub plots and the plots were made ready by thorough spading and leveling before transplantation. Doses of nitrogen were applied as per treatments.

3.7 Fertilizer application

At the time of first ploughing cow dung at the rate of 1 t/ha was applied. The recommended dose of fertilizers are 175, 97, 67and 67 kg/ha urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum respectively for BRRI dhan46 (BRRI, 2010) and the recommended dose of fertilizers are 87, 60, 50, and 16 kg/ha urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum respectively for Bina-sail (BINA, 1987). All the fertilizers except urea were incorporated with the soil one day before transplanting. Nitrogen was applied as urea with magic growth as per the treatments. Magic Growth is a liquid fertilizer invented by Md. Arif Hossain Khan, Joint Director (Seed Marketing), Bangladesh Agricultural Development Corporation

(BADC) which is ready for government recognition and it contains 10.51% total Nitrogen, 5.58% Phosphorous, 6.33% Potassium, 0.10% Sulphur, 0.16% Zinc, 0.04% Copper, 0.0006% Iron, 0.006% Manganese, 0.25% Boron, 0.07% Calcium and 0.007% Magnesium, pH = 1.0

3.8 Transplanting of seedlings on the main field

Thirty days old seedlings of Bina-sail and BRRI dhan46 were carefully uprooted from the seed bed and transplanted in well puddled plots. Two seedlings per hill were used following a spacing of 15 cm × 25 cm. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.9 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the crop.

3.9.1 Weed control

During plant growth stage hand weedings were done according to needs.

3.9.2 Irrigation and drainage

Irrigation water was applied keeping a standing water of about 2-3 cm during the whole growing period.

3.9.3 Plant protection measure

During the growing period some plants were infested by rice stem borer (*Scirpophaga incertulus*) which was successfully controlled by applying Diazinon 60 EC @ 20 mL per 10 Liter of water for spraying. No prominent infestation of insect-pests and diseases were observed in the field.

3.10 Harvest and post harvest operation

The crop was harvested after the grains attained maturity. The grains were threshed, cleaned and sun dried to record grain yield per plot.

3.11 Sampling and data collection

Data collections from the experiment on different growth stages were done under the following heads as per experimental requirements.

3.11.1 Plant height

The heights (cm) of the pre-selected 10 hills were taken by measuring the distance from base of the plant to the tip of the flag leaf after 30, 60 and 90 days after transplanting (DAT). The collected data were finally averaged.

3.11.2 Number of tillers

Number of tillers hill^{-1} was counted from 10 preselected hills at 30, 60 and 90 DAT and finally averaged.

3.11.3 Number of leaves

Number of leaves plant^{-1} was counted three times at 30 days interval such as 30, 60 and 90 DAT of rice plants. Mean value of data were calculated and recorded.

3.11.4 Number of effective and non-effective tillers

Number of effective and non-effective tillers hill^{-1} was counted from 10 preselected hills after harvesting and finally averaged.

3.11.5 Panicle length

The panicle length (cm) was measured with a meter scale from 10 selected plants and the average value was recorded as per plant.

3.11.6 Number of filled grains and unfilled grains

Number of filled grains and unfilled grains panicle^{-1} were counted from 10 panicles from each plot. Lack of any food materials inside the spikelets were denoted as unfilled grains.

3.11.7 Weight of 1000 grain

One hundred grains (g) were randomly collected from each plot and were sun dried and weighed by an electronic balance and then multiplied by 10.

3.11.8 Grain yield

Six square meter (m^2) area (each plot) were harvested. The grains were threshed, cleaned, dried and then weighed in kg. Thereafter it was converted as ton per hectare ($t\ ha^{-1}$).

3.11.9 Straw yield

Straw obtained from each unit plot were sun-dried and weighed carefully. The dry weight of straw of the respective unit plot yield was converted to ton per hectare ($t\ ha^{-1}$).

3.11.10 Determination of total Nitrogen

The macro Kjeldahl method was used to determine the total nitrogen in grain of plant samples. Three steps were involved in this method. These are as follows:

1. Digestion : In this step the organic nitrogen was converted to ammonium sulphate by sulphuric acid and digestion accelerators (Catalyst Mixture) at a temperature of 360-440^{0}C.

$$N + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

2. Distillation : In this step, the solution was made alkaline for the distillation of ammonia. The distillated ammonia was received in boric acid solution.

$$(NH_4)_2SO_4 + NaOH \longrightarrow Na_2SO_4 + NH_3 + H_2O$$

$$NH_3 + H_3BO_3 \longrightarrow (NH_4)_2BO_3 + H_2O$$

3. Titration : To determine the amount of NH_3, ammonium borate was titrated with standard sulfuric acid.

$$(NH_4)_2BO_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_3BO_3$$

Reagents : 4 % Boric Acid solution, Mixed Indicator (Bromocresol Green And Methyl Red), 4 % Sodium Hydroxide solution, standard Sulfuric Acid solution and 0.05 N Na_2CO_3 solution.

Procedure :

About 0.25 g of oven-dried grain sample was weighed and then transferred into a 250 mL Kjeldahl flask. Then 5.0 g catalysts mixer (K_2SO_4: $CuSO_4.5H_2O$: Se =100: 10: 1) was added in to the flask. About 25 mL concentrated H_2SO_4 was also added in to the flask. The flask was heated until the solution become clear and then allowed to cool. After digestion, 40% NaOH was added in to the conical flask and attached quickly to the distillation set. Then the flask was heated continuously. In the meantime, 25mL of 4% boric acid solution and 2-4 drops of mixed indicator was taken in receiver conical flask. After distillation, the distillate was collected into receiver conical flask. The distillate was titrated with standard H_2SO_4 taken from a burette until the green color completely turns to pink. The same procedure was followed for a blank sample. The result was calculated using the following formula –

$\% N = (T\text{-}B) \times N \times 1.4/S$

T = Titration value for sample (ml.), B -= Titration value for blank (ml)

N = Normality of H_2SO_4, S = Weight of the sample (g),

1.4 = Conversion factor

3.11.11 Determination of Phosphorus

Principle:

By ascorbic acid blue color method the phosphorus (P) content in rice grain was determined. This method is based on the principle that in an acid molybdate solution containing orthophosphate ($H_2PO_4^-$) ions, a phosphomolybdate complex forms that can be reduced by ascorbic acid and other reducing agents to a molybdenum blue color.

$(NH_4)_6Mo_7O_{24}.4\,H_2O + H_2SO_4 = (NH_4)_2MoS_4$

$(NH_4)_2MoS_4 + H_2PO_4^- = (NH_4)_3PMo_{12}O_{40}$ [Ammonium phosphorus molybdate, oxidized, colorless]

$(NH_4)_3PMo_{12}O_{40} + C_6H_8O_6$ = Ammonium phosphorus molybdate

(Reduced, Blue color)

Reagents:

1. Mixed reagent:

Solution A: About 12.0g ammonium molybdate [$(NH_4)_6Mo_7O_{24}.4\ H_2O$] was dissolved in 250 ml distilled water.

Solution B: At first 0.2908g antimony potassium tartarate [$K(SbO)C_4H_4O_6.1/2H_2O$] was dissolved in 1000 mL of 5N H_2SO_4 (148 ml conc. H_2SO_4/Liter) the two solutions were mixed together thoroughly. Then the volume was made to 2000 ml distilled water.

2. Color developing reagent:

About 0.53g (or.1.06g or 2.65g) of ascorbic acid was added to 100 ml (or 200 ml or 500 ml) of the mixed reagent.

Preparation of plant extract:

0.25 g of dry rice straw/grain were weighed, and then transferred into 250 ml Pyrex conical flasks. Then 10 ml 2:1 nitric-perchloric acid mixture was added into each flask and allowed to stand overnight or until the vigorous reaction phase is over. After the preliminary digestion, the conical flasks were placed on a hot plate in digestion chamber and then temperature was raised to 150°C for 1 hour. The temperature was increased slowly upto 300^0C After the digestion the conical flasks were lifted out of the digester and allowed to cool at room temperature. The solution was taken in 100 ml volumetric flask through funnel and volume with distilled water upto the mark (Jackson, 1973).

Procedure:

20 ml of the extract was pipette out in a 100 ml volumetric flask. Then 20 ml color developing reagent was added slowly and carefully to prevent loss of sample due to excessive foaming. After the evolution of CO_2; has ceased the flask was shake gently to mix the contents. Distilled water was added to make the volume up to the mark of the flask. By spectrophotometer, the color intensity (% absorbance) was measured at 660 nm.

3.11.12 Determination of Potassium

Procedure:

Plant samples (for grain) were prepared by digestion as for phosphorus. Then the amount of potassium (K) was estimated from prepared sample with the help of a flame photometer at 589 nm.

3.12 Statistical Analysis

The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance was done following the computer package MSTAT-C program developed by Russel, 1986. The mean differences among the treatments were adjusted by least significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV
RESULTS AND DISCUSSION

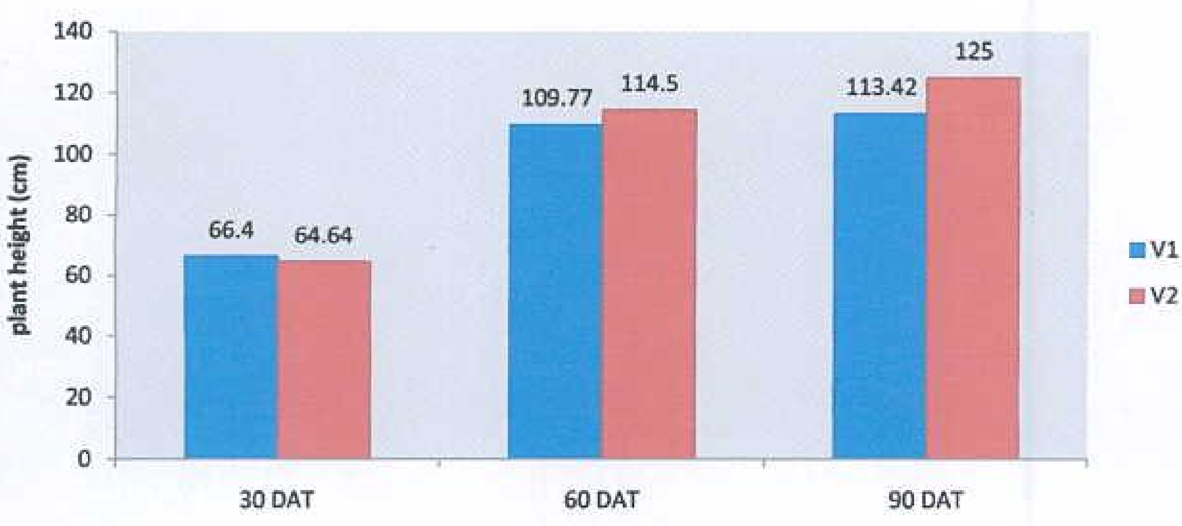
CHAPTER 4

RESULTS AND DISCUSSION

The results of the study regarding the effect of foliar application of urea fertilizer and magic growth liquid fertilizer on growth, yield and nutrient content of T. *aman* rice cultivars (Bina-sail and BRRI dhan46) have been presented with possible interpretations under the following headings:

4.1 Plant Height

The plant height (cm) of T. *aman* rice was significantly influenced by varieties at 30, 60 and 90 days after transplanting (DAT) (Figure 1 and Appendix VIII). The results revealed that at 30 DAT, the variety Bina-sail produced the tallest plant (66.40 cm) and the variety BRRI dhan46 gave the shortest plant (64.64 cm). At 60 DAT and 90 DAT, BRRI Dhan46 gave higher plant height (114.50 cm and 125.00 cm respectively) than Bina-sail (109.77cm and 113.42cm respectively). Probably the genetic makeup of varieties was responsible for the variation in plant height. This confirms the reports of Shamsuddin *et al.* (1988) that plant height differed due to varietal variation.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 1. Effect of variety on plant height (cm) at different days after transplanting (mean of eight treatments)

Table 1. Effect of different doses of nitrogen fertilizer and application methods on plant height (cm) at different days after transplanting (mean of two varieties)

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
T_0	61.42 f	105.9 d	113.9 c
T_1	63.27 e	108.9 cd	115.9 c
T_2	64.63 de	110.5 bcd	117.8 bc
T_3	65.13 cd	111.4 bcd	117.8 bc
T_4	66.65 bc	112.6 abc	119.8 abc
T_5	68.77 a	118.0 a	126.4 a
T_6	66.83 bc	113.5 abc	118.0 bc
T_7	67.47 ab	116.4 ab	124.0 ab
$LSD_{(0.05)}$	1.792	6.220	6.681
Significant level	*	*	*
CV (%)	2.32	4.70	4.75

* - Significant at 5% level

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Nitrogen fertilizer doses and application methods had significant effect on plant height of rice at 30 DAT, 60 DAT and 90 DAT (Table 1). At 30 DAT, the highest plant height (68.77 cm) was observed from the T_5 treatment which was statistically similar with T_7 (67.47 cm) and the lowest (61.42 cm) was observed from T_0 treatment. At 60 DAT, the highest plant height (118.0 cm) was observed from the T_5 treatment which was statistically similar to T_4 (112.6 cm), T_6 (113.5 cm) and T_7 (116.4 cm) whereas, the lowest (105.9 cm) was observed from T_0 treatment. At 90 DAT, the highest plant height (126.4 cm) was observed from the T_5 treatment which was statistically similar with T_7 (124.0 cm) whereas, the lowest (113.9 cm) was observed from T_0 treatment which was statistically similar with T_1 (115.9 cm). It was observed that higher doses of nitrogen gave better plant height than those of no nitrogen or lower nitrogen. These results are similar to the findings of Ahmed *et al.* (2005) who studied the effect of nitrogen on different characteristics of transplanted local aman rice variety and found that higher N dose produced higher plant height.

Interaction of varieties and nitrogen fertilizer doses and application method showed significant variation on plant height of rice at 30 DAT, 60 DAT and 90 DAT (Table 2). At 30 DAT, the highest plant height (69.60 cm) was observed from the V_1T_5 treatment which was statistically similar with V_1T_7 (68.47 cm) whereas, the lowest (60.23 cm) was observed from V_2T_0 treatment. At 60 DAT, the highest plant height (123.0 cm) was observed from the V_2T_5 treatment which was statistically similar to V_2T_7 (66.47 cm) whereas, the lowest (105.8 cm) was observed from V_1T_0 treatment which was statistically similar with V_1T_2 (107.3 cm) and V_2T_0 (106.1 cm). At 90 DAT, the highest plant height (135.6 cm) was observed from the V_2T_5 treatment which was statistically similar to V_2T_7 (132.6 cm) whereas, the lowest (110.3 cm) was observed from V_1T_0 treatment which was statistically similar to V_1T_1 (110.3 cm), V_1T_2 (112.9 cm) and V_1T_3 (112.5 cm). Results showed that foliar application of urea along with liquid fertilizer "Magic growth" performed better than soil application. This may be due to higher nutrient use efficiency through foliar application. The results are in contradiction of Sarandon *et al.* (1996) who carried out a field trial to study the effect of foliar urea spraying on three rice cultivars and found that biomass production was not varied due to foliar application. But Amin *et al.* (2004) conducted an experiment to evaluate the effect of increased plant density and fertilizer dose on yield of rice variety IR-6. They found that increased fertilizer dose of NPK increase plant height.

Table 2: Interaction effect of variety and different doses of nitrogen and application methods on plant height (cm) at different days after transplanting

Treatments		Plant Height (cm)		
Variety	Nitrogen doses	30 DAT	60 DAT	90 DAT
V_1	T_0	62.60 fg	105.8 d	110.3 g
	T_1	63.80 ef	107.3 d	110.9 g
	T_2	65.40 cde	109.3 cd	112.9 fg
	T_3	65.93 bcde	109.7 cd	112.5 fg
	T_4	67.57 abc	110.7 cd	113.7 efg
	T_5	69.60 a	112.9 bcd	117.3 cdefg
	T_6	67.87 abc	110.7 cd	114.5 defg
	T_7	68.47 ab	111.7 cd	115.4 defg
V_2	T_0	60.23 g	106.1 d	117.6 cdefg
	T_1	62.73 fg	110.4 cd	120.9 cdef
	T_2	63.87 ef	111.8 cd	122.8 cde
	T_3	64.33 def	113.0 bcd	123.1 cd
	T_4	65.73 cde	114.4 abcd	126.0 bc
	T_5	67.93 abc	123.0 a	135.6 a
	T_6	65.80 cde	116.2 abc	121.4 cdef
	T_7	66.47 bcd	121.1 ab	132.6 ab
$LSD_{(0.05)}$		2.534	8.796	9.448
Significant level		*	*	*
CV (%)		2.32	4.70	4.75

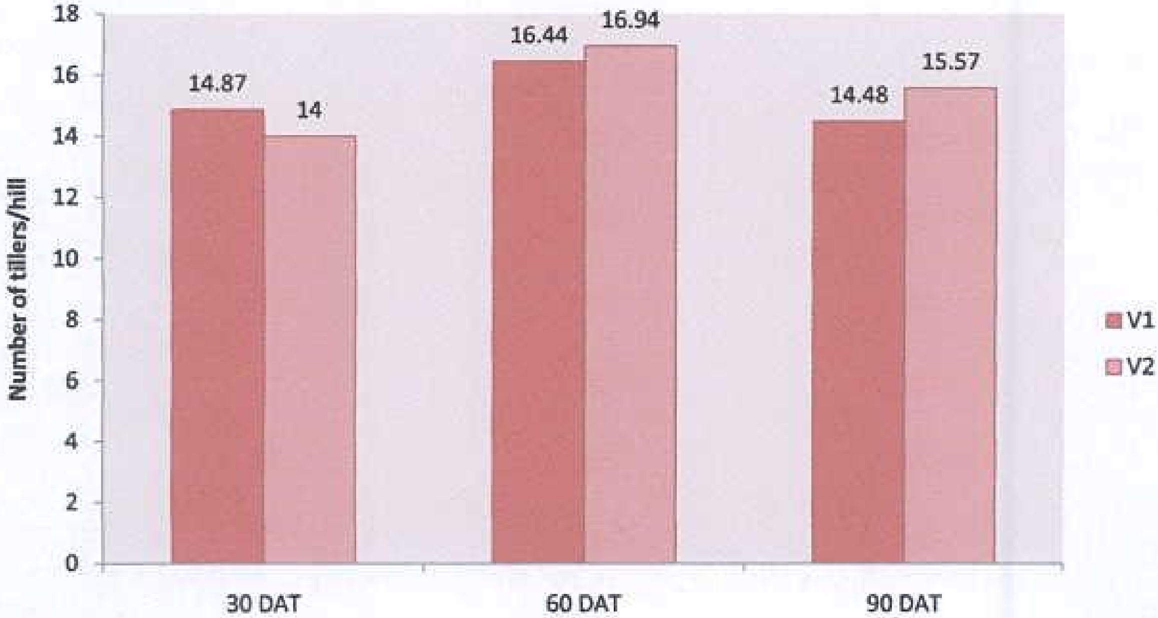
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.2 Number of tillers

The number of tillers hill^{-1} of T. *aman* rice was significantly influenced by different varieties at 30, 60 and 90 days after transplanting (DAT) (Figure 2 and Appendix VIII). The result revealed that at 30 DAT, the variety Bina-sail produced the highest number of tillers hill^{-1} (14.87) and the variety BRRI dhan46 gave the lowest number of tiller hill^{-1} (14.00). At 60 DAT, the variety BRRI dhan46 produced the highest number of tillers hill^{-1} (16.94) and the variety Bina-sail gave the lowest number of tillers hill^{-1} (16.44) and the same trend was observed for variety BRRI dhan46 (15.57) over Bina-sail (14.48) at 90 DAT. Number of tillers hill^{-1} can be different in different varieties due to genetical build-up. Roy *et al.* (2014) found that, number of tillers hill^{-1} at different days after transplanting varied significantly among the varieties up to harvest where maximum number of tillers hill^{-1} was observed in Sylhety boro and minimum in Bere ratna.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 2. Effect of variety on number of tillers hill^{-1} at different days after transplanting (mean of eight treatments)

Table 3. Effect of different doses of nitrogen fertilizer and application methods on number of tillers hill^{-1} at different days after transplanting (mean of two varieties)

Treatments	Number of tillers hill $^{-1}$		
	30 DAT	60 DAT	90 DAT
T_0	13.70 d	15.67 d	13.47 e
T_1	13.90 cd	16.22 cd	14.08 e
T_2	14.18 bcd	15.95 d	14.22 de
T_3	14.05 cd	16.33 cd	15.00 cd
T_4	14.32 bcd	16.95 bc	15.42 bc
T_5	15.80 a	18.13 a	16.67 a
T_6	14.58 bc	16.88 bc	15.50 bc
T_7	14.97 b	17.40 ab	15.88 ab
LSD $_{(0.05)}$	0.8101	0.9011	0.8576
Significant level	*	*	*
CV (%)	4.76	4.58	4.84

* - Significant at 5% level

T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Nitrogen doses and application methods had significant effect on number of tillers hill^{-1} of rice at 30, 60 and 90 DAT (Table 3). At 30 DAT, the highest number of tillers hill^{-1} (15.80) was observed from the T_5 treatment and the lowest (13.70) was observed from T_0 treatment which was statistically similar with T_1 (13.90) and T_3 (14.05). At 60 DAT, the highest number of tillers hill^{-1} (18.13) was observed from the T_5 treatment which was statistically similar to T_7 (17.40) whereas, the lowest (15.67) was observed from T_0 treatment which was statistically similar to T_2 (15.95). At 90 DAT, the highest number of tillers hill^{-1} (16.67) was observed from the T_5 treatment which was statistically similar to T_7 (15.88) whereas, the lowest (13.47 cm) was observed from T_0 treatment which was statistically similar with T_1 (14.08) and T_2 (14.22). Foliar application of Urea with Magic growth gave higher performances than soil application. Though 100% urea topdressing + 10% urea as foliar spray with Magic growth showed detrimental effect on number of tillers hill^{-1}. Ndaeyo *et al.* (2008) conducted an experiment where they found that higher rates of NPK resulted higher number of tillers per plant.

Interaction of varieties and nitrogen fertilizer doses and application methods showed significant variation on number of tillers hill^{-1} of rice at 30, 60 and 90 DAT (Table 4). At 30 DAT, the highest number of tillers hill^{-1} (16.13) was observed from the V_1T_5 treatment which was statistically similar to V_1T_7 (15.33) and V_2T_5 (15.47) whereas, the lowest (12.63) was observed from V_2T_0 treatment which was statistically similar to V_2T_1 (13.07). At 60 DAT, the highest number of tillers hill^{-1} (18.40) was observed from the V_2T_5 treatment which was statistically similar to V_1T_5 (17.87) whereas, the lowest (15.30) was observed from V_1T_2 treatment which was statistically similar to V_1T_0 (15.73), V_1T_3 (15.67) and V_2T_0 (15.6). At 90 DAT, the highest number of tillers hill^{-1} (17.13) was observed from the V_2T_5 treatment which was statistically similar with V_1T_5 (16.20) and V_2T_7 (16.13) whereas, the lowest (12.93) was observed from V_1T_0 treatment which was statistically similar with V_1T_1 (13.30) and V_1T_2 (13.53). Ahmed *et al.* (2005) found that higher N dose produced highest effective tiller hill^{-1} which ultimately lead to achieve higher total tiller per hill. Nitrogen is an essential plant nutrient and involves in enzymatic reactions, protein synthesis and is a major component of amino and nucleic acids but it is the most widely lost nutrients while applied in soil. Many studies showed that foliar urea application can reduce the nitrogen dose and increase the nutrient use efficiency.

Table 4: Interaction effect of variety and different doses of nitrogen and application methods on number of tillers $hill^{-1}$ at different days after transplanting

Treatments		Number of tillers $hill^{-1}$		
Variety	Nitrogen doses	30 DAT	60 DAT	90 DAT
V_1	T_0	14.77 bc	15.73 efg	12.93 f
	T_1	14.73 bc	16.50 cdefg	13.30 ef
	T_2	14.47 bc	15.30 g	13.53 ef
	T_3	14.17 cd	15.67 fg	14.30 de
	T_4	14.67 bc	16.83 bcdef	14.87 cd
	T_5	16.13 a	17.87 ab	16.20 ab
	T_6	14.70 bc	16.50 cdefg	15.10 bcd
	T_7	15.33 ab	17.13 abcd	15.63 bc
V_2	T_0	12.63 e	15.60 fg	14.00 def
	T_1	13.07 de	15.93 defg	14.87 cd
	T_2	13.90 cd	16.60 bcdef	14.90 cd
	T_3	13.93 cd	17.00 bcde	15.70 bc
	T_4	13.97 cd	17.07 bcd	15.97 abc
	T_5	15.47 ab	18.40 a	17.13 a
	T_6	14.47 bc	17.27 abc	15.90 bc
	T_7	14.60 bc	17.67 abc	16.13 ab
$LSD_{(0.05)}$		1.146	1.274	1.213
Significant level		*	*	*
CV (%)		4.76	4.58	4.84

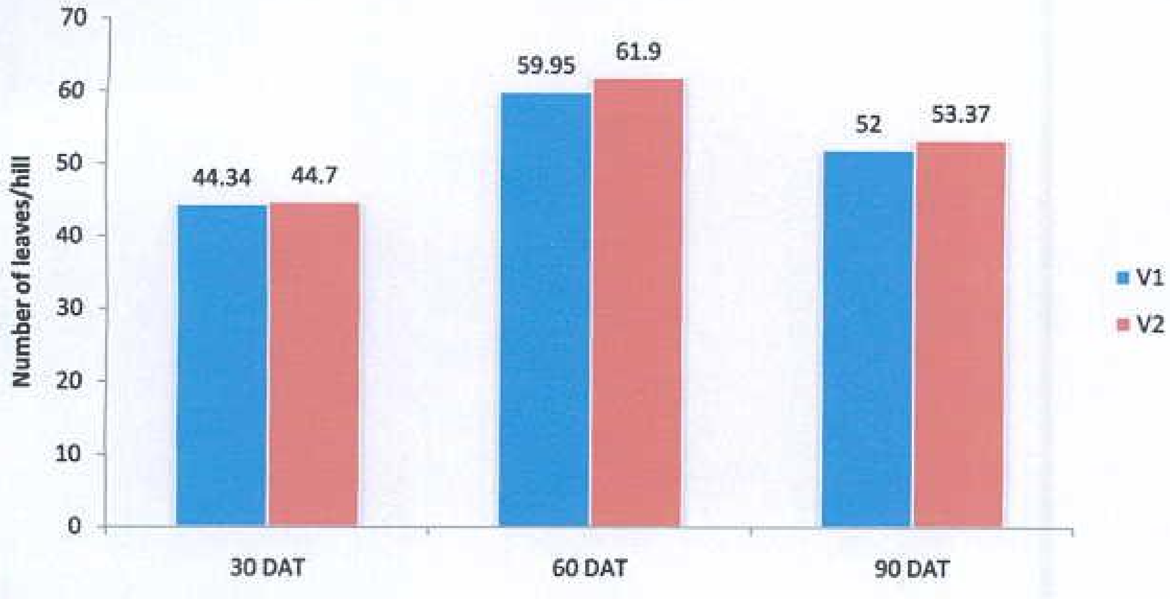
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.3 Number of leaves

The total number of leaves hill^{-1} of T. *aman* rice showed statistically insignificant variation among the two varieties (Figure 3 and Appendix VIII). Numerically maximum number of leaves hill^{-1} at 30, 60 and 90 DAT was observed in the V_2 (BRRI dhan46) and the minimum number of leaves hill^{-1} was obtained from the variety V_1 (Bina-sail).



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 3. Effect of variety on number of leaves hill^{-1} at different days after transplanting (mean of eight treatments)

Nitrogen fertilizer doses and application methods showed significant effect on number of leaves hill^{-1} of rice at 30, 60 and 90 DAT (Table 5). At 30 DAT, the highest number of leaves hill^{-1} (49.30) was observed from the T_5 treatment and the lowest (40.20) was observed from T_0 treatment. At 60 DAT, the highest number of leaves hill^{-1} (68.05) was observed from the T_5 treatment whereas, the lowest (57.97) was observed from T_0 treatment. At 90 DAT, the highest number of leaves hill^{-1} (58.00) was observed from the T_5 treatment which was statistically similar with T_4 (54.22) whereas, the lowest (49.03) was observed from T_0 treatment. Ndaeyo *et al.* (2008) conducted an experiment where they found that higher rates of NPK resulted higher number of leaves per plant.

Table 5. Effect of different doses of nitrogen and application methods on number of leaves hill^{-1} at different days after transplanting (mean of two varieties)

Treatments	Number of leaves hill^{-1}		
	30 DAT	60 DAT	90 DAT
T_0	40.20 e	57.97 d	49.03 c
T_1	42.83 d	59.67 bcd	50.93 bc
T_2	43.47 cd	58.23 cd	50.92 bc
T_3	43.77 cd	58.43 cd	52.05 bc
T_4	44.58 bcd	61.82 bc	54.22 ab
T_5	49.30 a	68.05 a	58.00 a
T_6	45.60 bc	60.38 bcd	52.80 bc
T_7	46.43 b	62.85 b	53.55 b
LSD $_{(0.05)}$	2.172	3.771	4.203
Significant level	*	*	*
CV (%)	4.14	5.25	6.77

* - Significant at 5% level

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Interaction of varieties and nitrogen fertilizer doses and application methods showed significant variation on number of leaves $hill^{-1}$ of rice at 30, 60 and 90 DAT (Table 6). At 30 DAT, the highest number of leaves $hill^{-1}$ (49.33) was observed from the V_2T_5 treatment which was statistically similar to V_1T_5 (49.27) whereas, the lowest (38.47) was observed from V_2T_0 treatment which was statistically similar to V_2T_1 (41.33). At 60 DAT, the highest number of leaves $hill^{-1}$ (70.03) was observed from the V_2T_5 treatment which was statistically similar to V_1T_5 (66.07) whereas, the lowest (55.90) was observed from V_1T_0 treatment. At 90 DAT, the highest number of leaves $hill^{-1}$ (59.00) was observed from the V_2T_5 treatment which was statistically similar to V_1T_5 (57.00) whereas, the lowest (47.27) was observed from V_1T_0 treatment. It revealed from the results that number of leaves $hill^{-1}$ was higher in treatments where 75% urea was applied as topdressing and 10% urea as foliar spray. Many studies have been showed that soil urea application cannot be fully replaced by foliar spray but combination of both can surely reduce the dose. Islam *et al.* (2008) conducted a field experiment to find out the effect of nitrogen levels and transplanting dates on Kalizira (aromatic rice) and the results revealed that most of the yield and yield contributing characters with few exceptions were significantly influenced by nitrogen levels.

Table 6. Interaction effect of variety and different doses of nitrogen and application methods on number of leaves hill^{-1} at different days after transplanting

Treatments		Number of leaves hill^{-1}		
Variety	Nitrogen doses	30 DAT	60 DAT	90 DAT
V_1	T_0	41.93 e	55.90 e	47.27 d
	T_1	44.33 bcde	59.27 cde	50.53 cd
	T_2	43.07 de	57.20 de	50.43 cd
	T_3	43.40 cde	58.13 de	51.67 bcd
	T_4	44.00 bcde	62.50 bcd	52.97 bcd
	T_5	49.27 a	66.07 ab	57.00 ab
	T_6	45.03 bcd	59.10 cde	52.47 bcd
	T_7	46.60 ab	61.43 bcd	53.67 abc
V_2	T_0	38.47 f	60.03 cde	50.80 cd
	T_1	41.33 ef	60.07 cde	51.33 bcd
	T_2	43.87 bcde	59.27 cde	51.40 bcd
	T_3	44.13 bcde	58.73 de	52.43 bcd
	T_4	45.17 bcd	61.13 bcde	55.47 abc
	T_5	49.33 a	70.03 a	59.00 a
	T_6	46.17 bc	61.67 bcd	53.13 abcd
	T_7	46.27 abc	64.27 bc	53.43 abc
$LSD_{(0.05)}$		3.071	5.333	5.944
Significant level		*	*	*
CV (%)		4.14	5.25	6.77

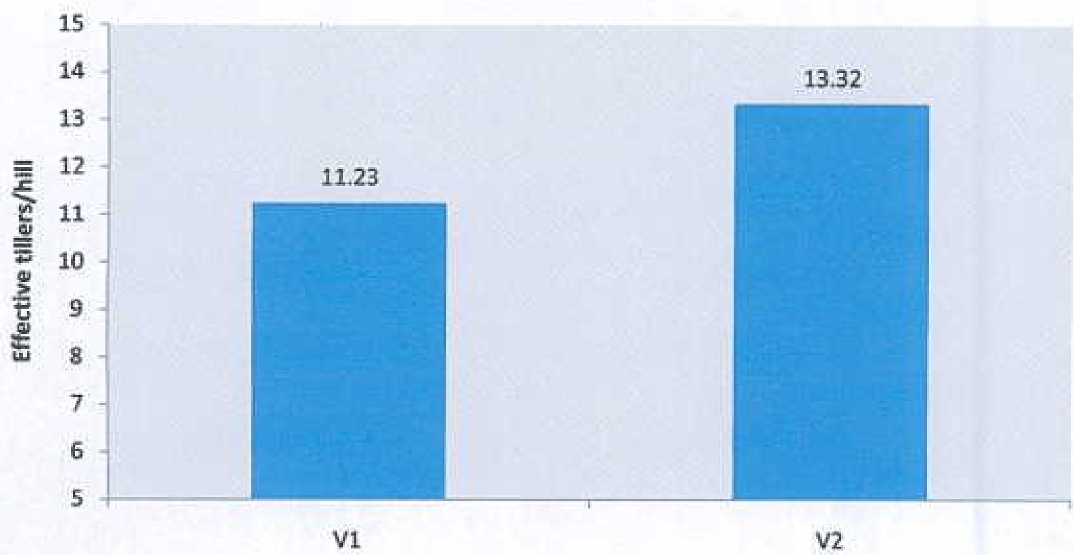
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.4 Number of effective tillers

The number of effective tillers hill^{-1} of T. *aman* rice was significantly influenced by the two varieties (Figure 4 and Appendix VIII). The result revealed that the variety BRRI dhan46 produced the highest number of effective tillers hill^{-1} (13.32) and the variety Bina-sail gave the lowest number of effective tillers hill^{-1} (11.23). The result is similar to that of Nahar *et al.* (2009) who reported that BRRI dhan46 had significantly higher effective tillers hill^{-1} than the BRRI dhan31 in late transplanted conditions. BRRI (1991) and Lockard (1958) also reported similar views that the number of effective tillers differed among different varieties.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 4. Effect of variety on number of effective tillers hill^{-1} (mean of eight treatments)

Nitrogen fertilizers doses and application methods had significant effect on the number of effective tillers hill^{-1} of rice (Table 7). The highest number of effective tillers hill^{-1} (14.43) was observed from the T_5 treatment which was statistically similar with T_7 (13.85) and the lowest (10.80) was observed from T_0 treatment. Rasheed *et al.* (2003) reported that the number of effective tillers per hill was increased when NP levels were increased.

Table 7. Effect of different doses of nitrogen and application methods on number of effective tillers hill^{-1} (mean of two varieties)

Treatments	Number of effective tillers hill^{-1}	Number of non effective tillers hill^{-1}
T_0	10.80 d	2.183 a
T_1	11.33 cd	1.908 ab
T_2	11.47 cd	1.767 bc
T_3	11.68 c	1.593 bcd
T_4	11.85 c	1.533 cd
T_5	14.43 a	0.9167 f
T_6	12.82 b	1.375 de
T_7	13.85 a	1.150 ef
LSD $_{(0.05)}$	0.7045	0.3710
Significant level	*	*
CV (%)	4.86	20.23

* - Significant at 5% level

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Interaction of varieties and nitrogen fertilizer doses and application methods showed significant variation on the number of effective tillers hill^{-1} of rice (Table 8). The highest number of effective tillers hill^{-1} (15.40) was observed from the V_1T_5 treatment which was statistically similar with V_1T_7 (14.90) whereas, the lowest (9.633) was observed from V_2T_0 treatment which was statistically similar with V_2T_1 (10.47), V_2T_2 (10.53), V_2T_3 (10.37) and V_2T_4 (10.57). Number of effective tillers hill^{-1} can vary from cultivar to cultivar. When 75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray then it may triggered the nutrient use efficiency and thus effective tiller became higher than other application methods. Parvin *et al.* (2013) conducted an experiment to investigate the effect of foliar application of urea on BRRI dhan29 and found that yield and yield contributing characters (i.e. highest number of effective tillers hill^{-1}) of *Boro* rice *cv.* BRRI dhan29 were significantly influenced by foliar application of urea.

Table 8. Interaction effect of variety and different doses of nitrogen and application methods on number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$ and panicle length (cm)

Treatments		Number effective tillers $hill^{-1}$	Number non-effective tillers $hill^{-1}$	Panicle Length (cm)
Variety	Nitrogen doses			
V_1	T_0	11.97 e	2.133 ab	22.80 b
	T_1	12.20 cde	1.733 abcd	23.37 b
	T_2	12.40 cde	1.700 bcd	23.44 b
	T_3	13.00 bcd	1.520 defg	23.47 b
	T_4	13.13 bc	1.483 defg	23.73 ab
	T_5	15.40 a	1.000 gh	25.80 a
	T_6	13.60 b	1.317 defgh	24.53 ab
	T_7	14.90 a	1.133 fgh	24.87 ab
V_2	T_0	9.633 f	2.233 a	22.84 b
	T_1	10.47 f	2.083 abc	23.10 b
	T_2	10.53 f	1.833 abcd	23.64 ab
	T_3	10.37 f	1.667 bcde	24.30 ab
	T_4	10.57 f	1.583 cdef	24.59 ab
	T_5	13.47 b	0.8333 h	25.90 a
	T_6	12.03 de	1.433 defg	24.70 ab
	T_7	12.80 bcde	1.167 efgh	24.87 ab
$LSD_{(0.05)}$		0.9963	0.5247	2.275
Significant level		*	*	*
CV (%)		4.86	20.23	10.609

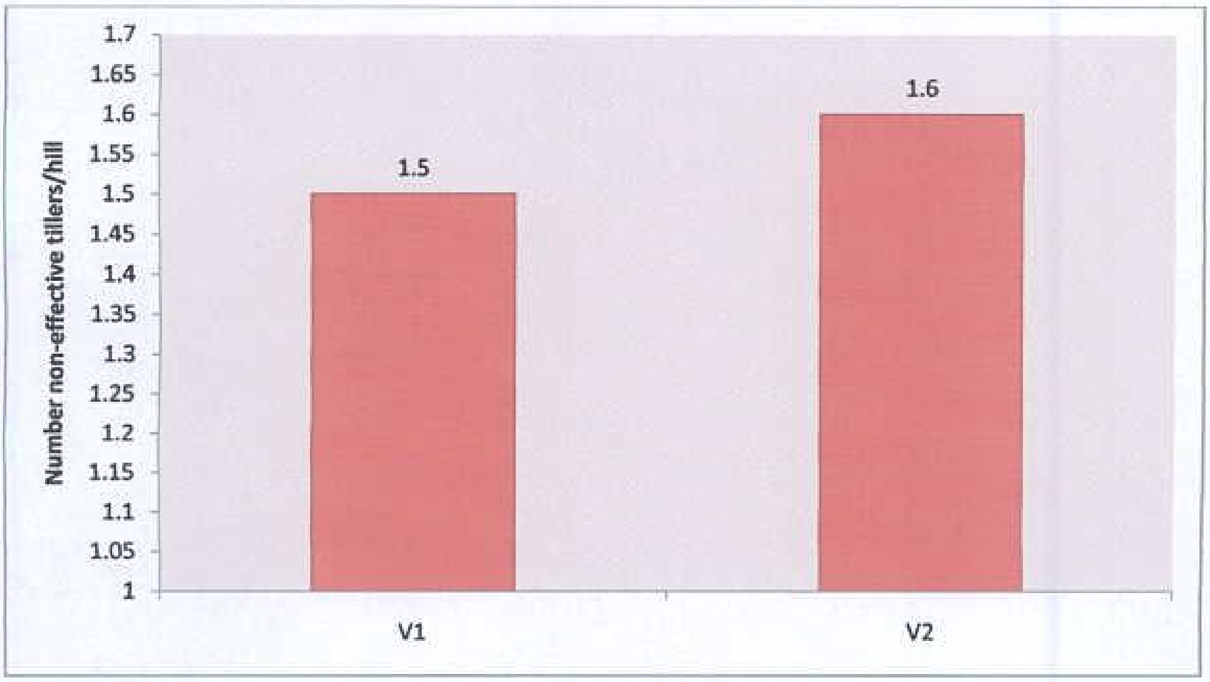
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

$T_0=N_0$ (No nitrogen applied), $T_1=N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), $T_2=N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), $T_3=N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), $T_4=N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , $T_5=N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), $T_6=N_{100}$ (100% Urea topdressing) , $T_7=N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.5 Number of non-effective tillers

The non-effective tillers hill^{-1} of T. *aman* rice was statistically insignificant among the two varieties (Figure 5 and Appendix VIII). Numerically maximum number of non-effective tillers hill^{-1} was observed in the V_2 (BRRI dhan46) and the minimum number of non-effective tillers hill^{-1} was obtained from the variety V_1 (Bina-sail). A. Tyeb *et al* (2013) observed that maximum number of total tillers hill^{-1} (16.02) and effective tillers hill^{-1} (13.19) were obtained from BRRI dhan52 followed by BRRI dhan51 while BRRI dhan41 produced the minimum number of total tillers hill^{-1} (13.08) and effective tillers hill^{-1} (9.29). Debnath (2010) and Ashrafuzzman (2006) observed that varieties differed insignificantly in respect of number of ineffective tillers m^{-2} though Ahmed (2006) found significant effect between inbred and hybrid varieties in respect of number of ineffective tillers m^{-2}.



V_1 – Bina-sail, V_2 – BRRI dhan46

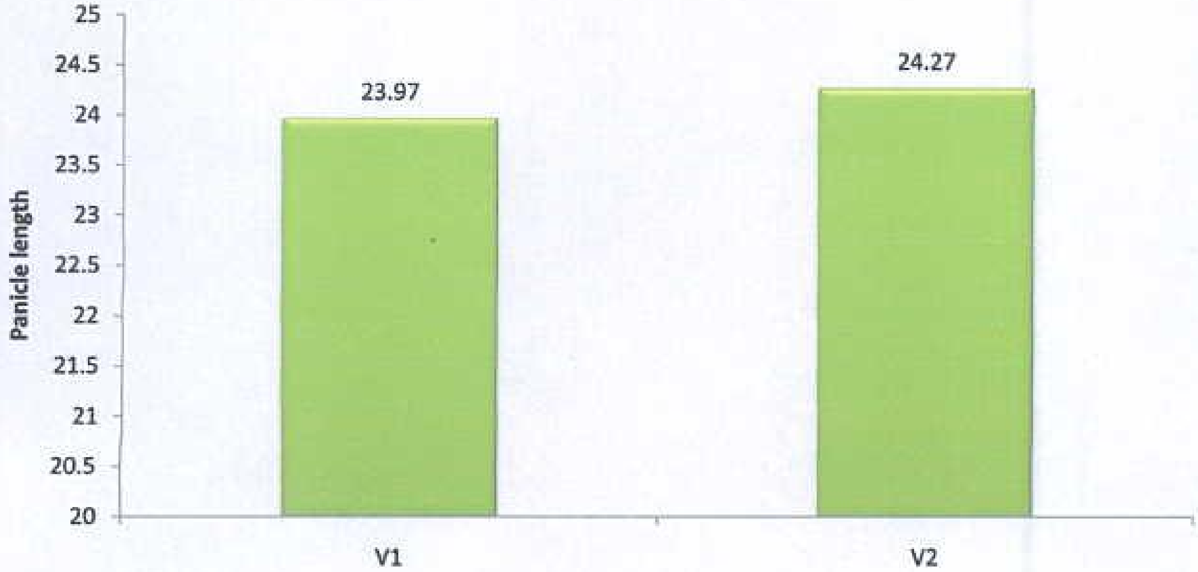
Figure 5. Effect of variety on number of non-effective tillers hill^{-1} (mean of eight treatments)

Number of non-effective tillers $hill^{-1}$ was significantly varied due to nitrogen fertilizer at all growth stages (Table 7). The highest number of non-effective tillers $hill^{-1}$ (2.183) was recorded from T_0 treatment which was statistically similar with T_1 (2.183) . In contrast the lowest number of non-effective tillers hill $^{-1}$ (0.9167) was recorded from T_5 treatment which was statistically similar with T_7 (1.150).

Number of non-effective tillers hill $^{-1}$ was significantly varied due to interaction of varieties and nitrogen fertilizer doses and application methods at all growth stages (Table 4 and Appendix VII). The highest number of non effective tillers $hill^{-1}$ (2.233) was recorded from treatment combination V_2T_0 which was statistically similar with V_1T_0 (2.133). In contrast the lowest number of non-effective tillers $hill^{-1}$ (0.8333) was recorded from the treatment combination V_2T_5.

4.6 Panicle length

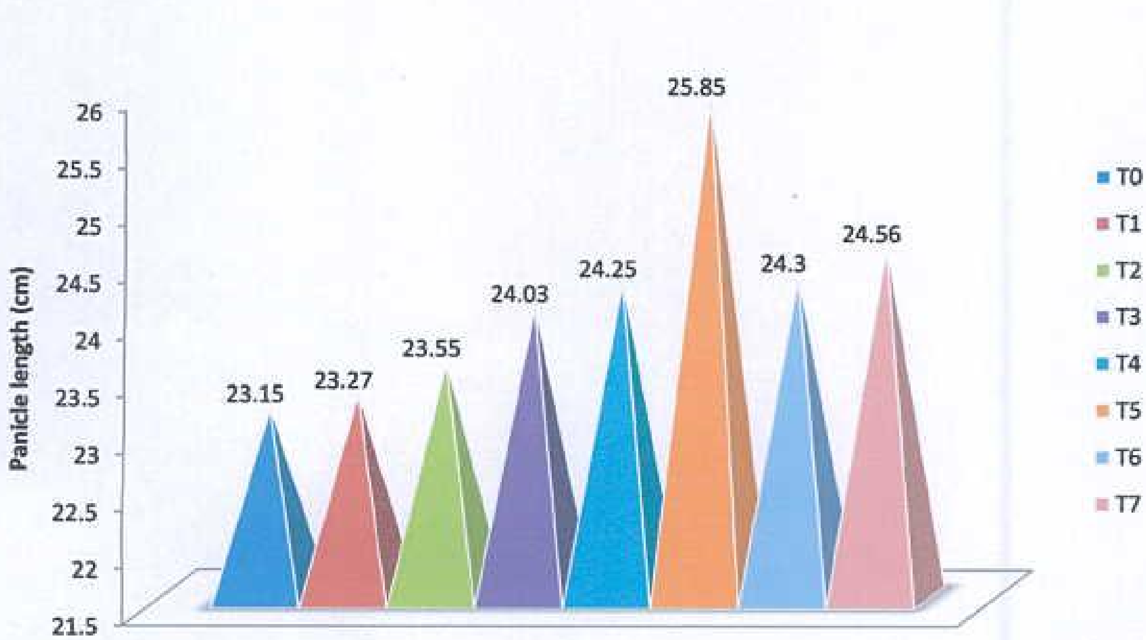
The panicle length (cm) of T. *aman* rice was statistically insignificant and hence was not influenced by different varieties (Figure 6 and Appendix IX). Numerically longest panicle was observed in the V_2 (BRRI dhan46) and the shortest was obtained from the variety V_1 (Bina-sail). Babiker (1986) observed that panicle length differed due to the varietal variation. Ahmed (2006) also observed maximum panicle length in BRRI dhan29 than hybrid variety and Debnath (2012) found the highest panicle length in BRRI dhan29 and lowest in BRRI hybrid dhan2 among other varieties. This finding is in contradiction with Ashrafuzzaman (2006) and Main (2006) who observed that varieties differed insignificantly in respect of panicle length.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 6. Effect of variety on panicle length (cm) (mean of eight treatments)

Nitrogen fertilizer doses and application methods had significantly influenced by the panicle length of rice (Figure 7 and Appendix X). The highest length of panicle (25.85 cm) was obtained from T_5 treatment which was statistically similar with T_4 (24.25 cm), T_6 (24.30 cm) and T_7 (24.56 cm) whereas, the lowest (23.15 cm) was observed from T_0 treatment which was statistically similar with T_1 (23.27 cm), T_2 (23.55 cm) and T_3 (24.03 cm). Ahmed *et al.* (2005) found that higher N dose produced higher panicle length. Shafiee *et al.* (2013) who conducted an experiment using liquid fertilizer SBAJATM (formerly known as BIPOMIXTM) and found the mean panicle lengths were significantly longer and higher, respectively in plots treated with SBAJATM *vis-à-vis* the control.



T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 7. Effect of different doses of nitrogen and application methods on panicle length (cm) (mean of two varieties)

Significant influence was observed on panicle length (cm) due to the different interaction of varieties and nitrogen fertilizer doses and application methods of T. *aman* rice (Table 8). The highest length of panicle (25.90 cm) was obtained from V_2T_5 which was statistically similar with V_1T_5 (25.80 cm). In contrast the lowest number of panicle length (22.80 cm) was recorded from the treatment combination V_1T_0 which was statistically similar with V_1T_1 (23.37 cm), V_1T_2 (23.44 cm) V_1T_3 (23.47 cm), V_2T_0 (22.84 cm) and V_2T_1 (23.10 cm). It is very obvious that panicle length can vary from variety to variety. Topdressing of urea along with foliar spray gave better results. Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties and found that higher N doses increased length of central panicle per plant.

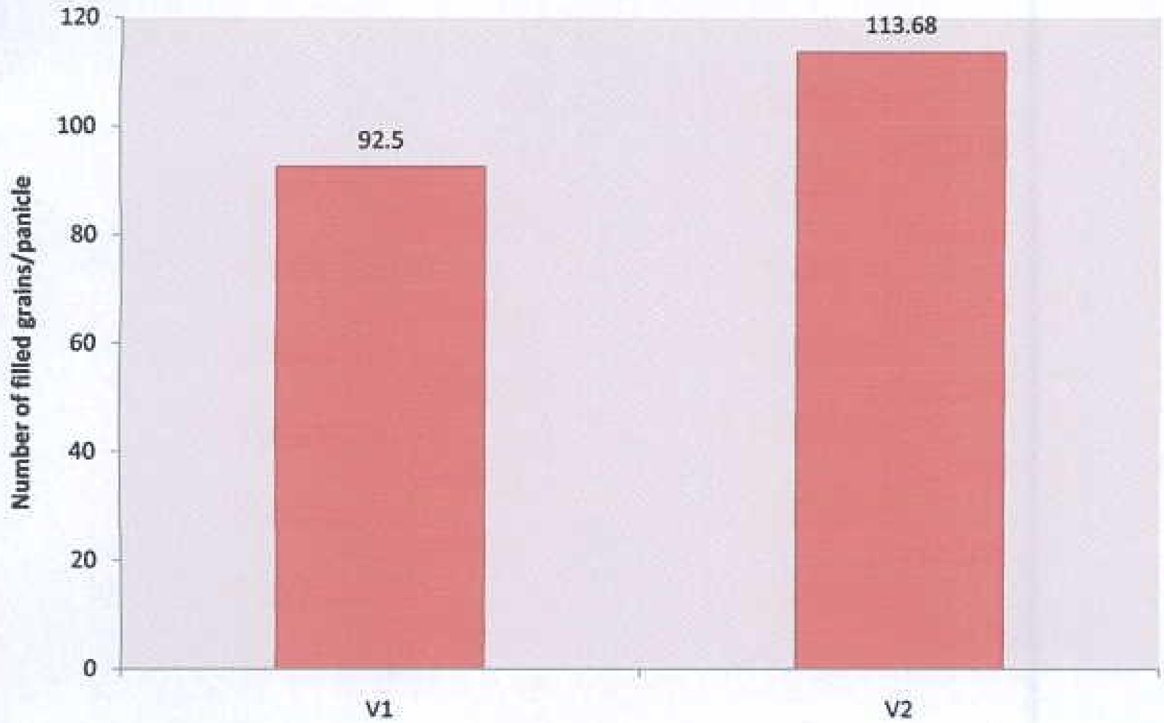
4.7 Number of filled grains

The number of filled grains panicle^{-1} of T. *aman* rice was significantly influenced by different varieties (Figure 8 and Appendix IX). The result revealed that the variety BRRI dhan46 produced the highest number of filled grains panicle^{-1} (113.68) and the variety Bina-sail gave lowest number of filled grains panicle^{-1} (92.50). This may be due to varietal difference. Singh *et al.* (1990) found that number of filled spikelets panicle^{-1} significantly differed among the varieties. BRRI (2006) studied the performance of BR14, Pajam, BR5 and Tulsimala and reported that Tulsimala produced the highest number of filled grains panicle^{-1} and BR14 produced the lowest number of filled grains panicle^{-1}.

A significant variation was recorded due to the different doses of nitrogen fertilizer for number of filled grains panicle^{-1} (Figure 9 and Appendix X). The maximum number of filled grains (131.4) panicle^{-1} was recorded for the T_5 treatment which was statistically similar with T_7 (120.1) and the lowest (78.63) was observed from T_0 treatment which was statistically similar with T_1 (88.50). Parvin *et al.* (2013) found that highest grains panicle^{-1} was obtained from five times foliar urea spray @ 100 kg ha^{-1} in BRRI dhan29.

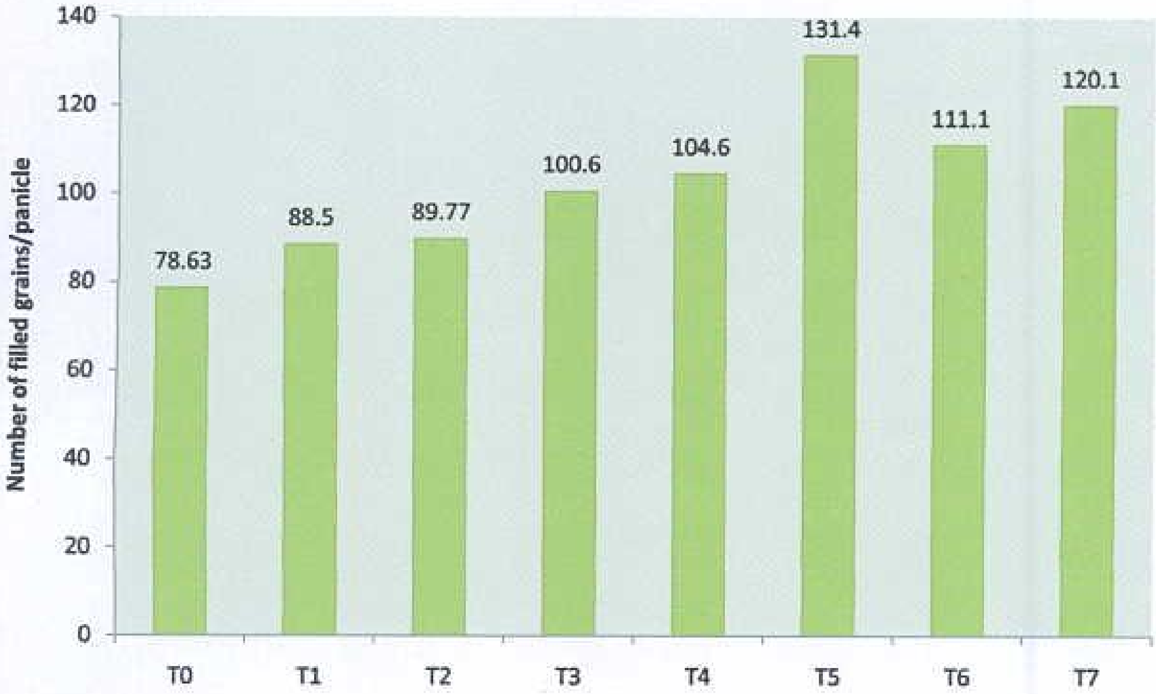
Significant influence was observed on number of filled grains panicle^{-1} due to the varieties and different nitrogen fertilizer doses (Table 9). The highest number of filled grains (142.5) panicle^{-1} was obtained from V_2T_5 which was statistically similar with V_2T_7 (132.4) and the lowest (71.33) was recorded from combination V_1T_0 treatment. Bhuyan *et al.* (2012) observed that bed planting with foliar nitrogen fertilizer produced higher number of grains panicle^{-1}.

Filled grains panicle^{-1} is one of the most important yield contributing parameter in case of grain crops. In this study it was observed that BRRI dhan46 gave higher filled grains panicle^{-1} among the two varieties. On the other hand, 75% Urea as top dressing and 10% Urea with magic growth as foliar spray performed better than other urea application methods and doses.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 8. Effect of variety on number of filled grains panicle^{-1} (mean of eight treatments)



T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 9. Effect of different doses of nitrogen and application methods on number of filled grains panicle^{-1} (mean of two varieties)

Table 9. Interaction effect of variety and different doses of nitrogen and application methods on number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, total number of grains panicle^{-1} and 1000 grain weight (g)

Treatments		Number of Filled Grains Panicle^{-1}	Number of Unfilled Grains Panicle^{-1}	Total Number of Grains Panicle^{-1}	1000 Grain Weight (g)
Variety	Nitrogen doses				
V_1	T_0	71.33 h	38.46 a	107.6 h	17.57 c
	T_1	77.97 gh	31.04 b	109.5 h	16.70 c
	T_2	81.13 gh	27.06 d	108.6 h	16.47 c
	T_3	91.23 efg	27.27 cd	118.4 g	16.00 c
	T_4	91.67 efg	16.22 e	129.1 de	15.93 c
	T_5	120.3 bc	9.573 g	130.1 cd	17.53 c
	T_6	98.60 def	10.35 g	118.0 g	15.87 c
	T_7	107.9 cde	9.610 g	117.6 g	16.37 c
V_2	T_0	85.93 fgh	32.06 b	109.1 h	24.50 ab
	T_1	99.03 def	30.09 bc	108.0 h	25.77 ab
	T_2	98.40 def	27.33 cd	125.3 ef	25.17 ab
	T_3	109.9 cd	13.63 ef	123.6 f	24.10 b
	T_4	117.6 bc	11.43 fg	129.1 de	25.60 ab
	T_5	142.5 a	9.440 g	152.1 a	26.17 a
	T_6	123.7 bc	10.35 g	134.2 c	24.80 ab
	T_7	132.4 ab	9.533 g	142.1 b	25.37 ab
$LSD_{(0.05)}$		16.69	2.785	4.360	1.837
Significant level		*	*	*	*
CV (%)		9.71	4.04	9.22	5.28

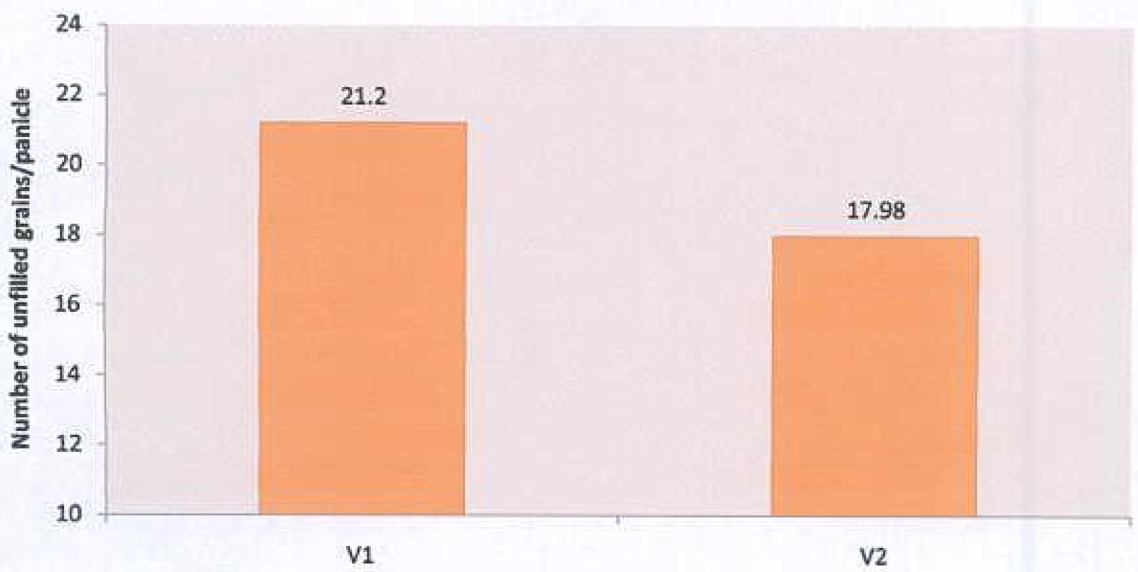
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.8 Number of unfilled grains

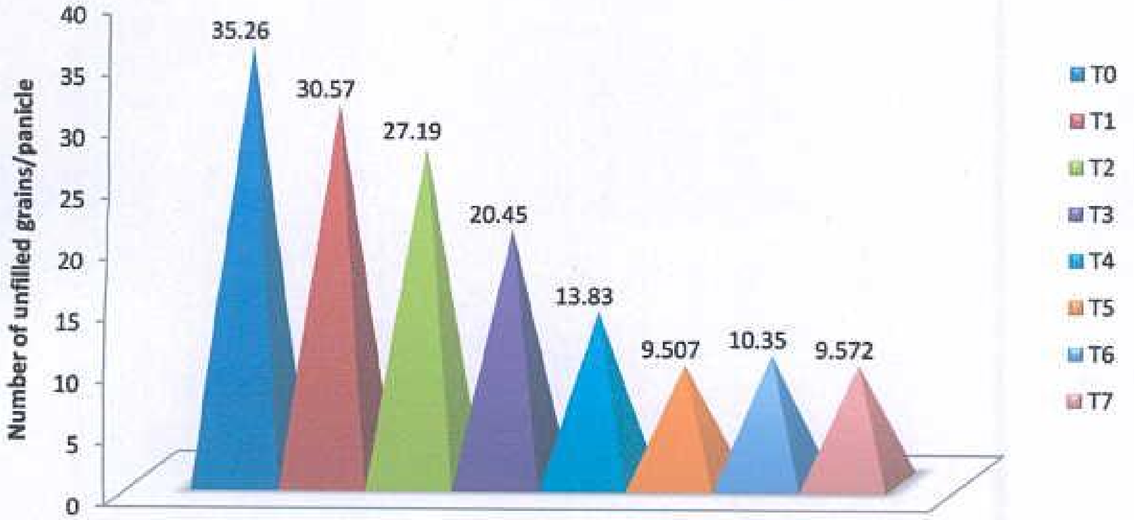
The number of unfilled grains panicle^{-1} of T. *aman* rice was significantly influenced by different varieties (Figure 10 and Appendix IX). The result revealed that the variety Bina-sail produced the highest number of unfilled grains panicle^{-1} (21.20) and the variety BRRI dhan46 gave lowest number of unfilled grains panicle^{-1} (187.98). A. Tyeb *et al* (2013) observed that BRRI dhan41 produced the highest number of unfilled grains panicle^{-1} (28.71) followed by BRRI dhan51 (24.88) and BRRI dhan46 (19.50). The lowest number of unfilled grains panicle^{-1} produced by BRRI dhan52 (14.17).



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 10. Effect of variety on number of unfilled grains panicle^{-1} (mean of eight treatments)

A clear difference was observed in case of number of unfilled grains panicle^{-1} of different nitrogen fertilizer doses (Figure 11 and Appendix X). The maximum number of unfilled grains (35.26) panicle^{-1} was recorded for the T_0 treatment whereas, the lowest (9.507) was observed from T_5 treatment which was statistically similar with T_7 (9.572).



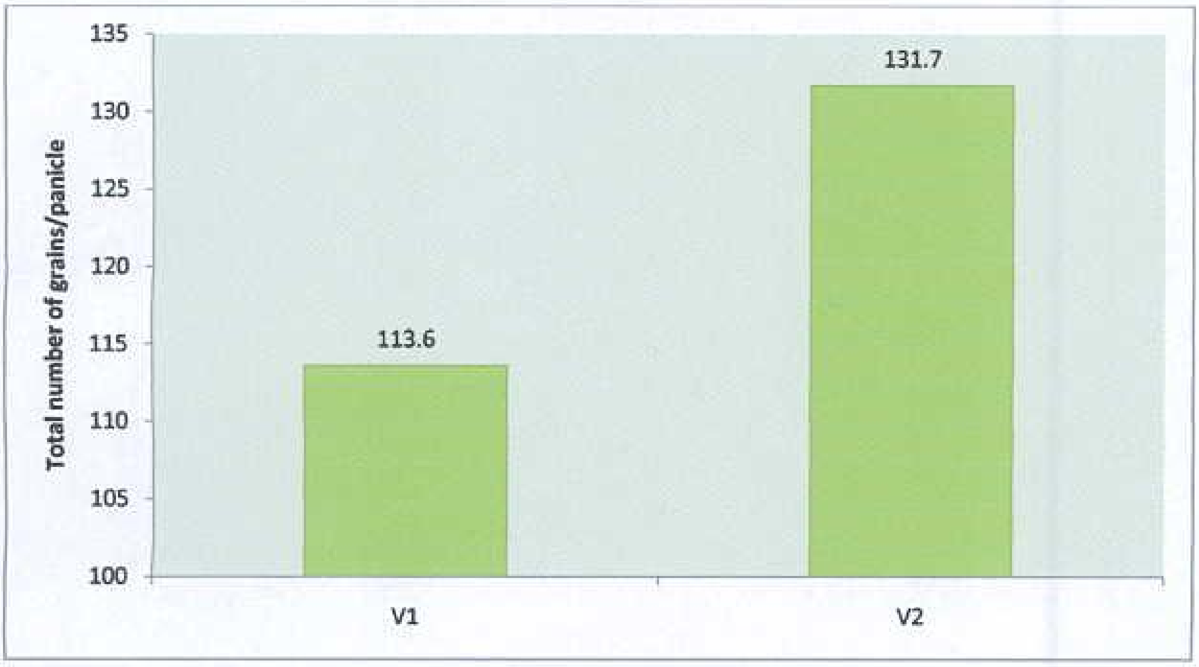
T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 11. Effect of different doses of nitrogen and application methods on number of unfilled grains panicle^{-1} (mean of two varieties)

Interaction of variety and nitrogen fertilizer doses and application methods showed significant influence on number of sterile or unfilled grains panicle^{-1} (Table 9). From V_1T_0, the highest number of unfilled grains panicle^{-1} (38.46) was obtained whereas the lowest (9.440) was recorded from V_2T_5 which was statistically similar with V_1T_5 (9.573), V_1T_7 (9.610) and V_2T_7 (9.533). BRRI dhan46 gave lower unfilled grains panicle^{-1} among the two varieties. On the other hand, 75% Urea as top dressing and 10% Urea with magic growth as foliar spray performed better than other urea application methods and doses. In case of interaction effect of both factors, BRRI dhan46 along with 75% Urea as top dressing and 10% Urea with magic growth as foliar spray gave lowest unfilled grains panicle^{-1}. This may be due to better nutrient use efficiency and better genetic characters.

4.9 Total number of grains

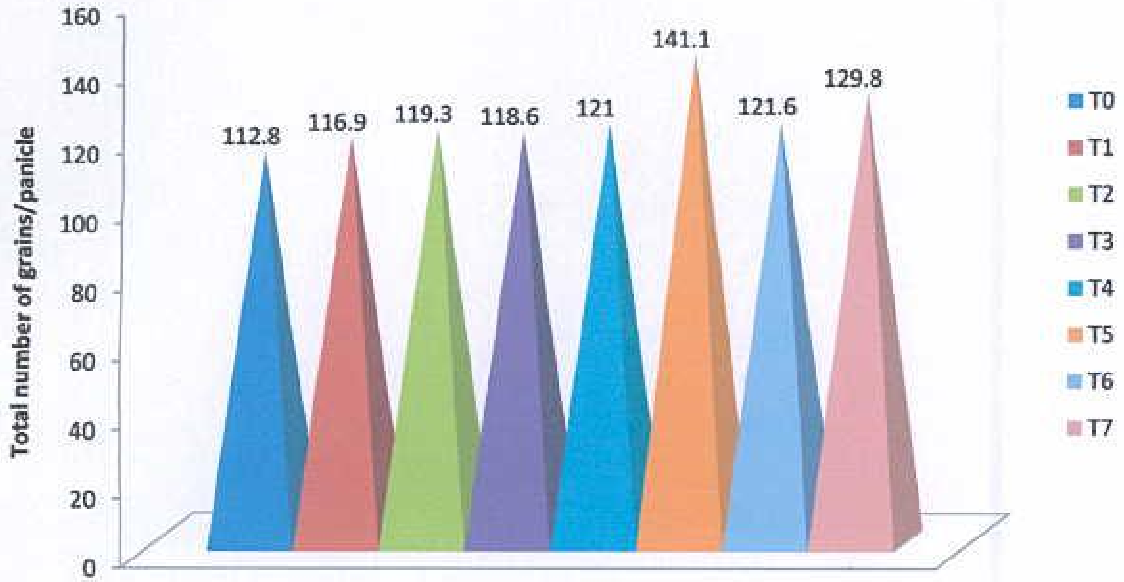
The total number of grains panicle^{-1} of T. *aman* rice was significantly influenced by different varieties (Figure 12 and Appendix IX). The result revealed that the variety BRRI dhan46 produced the highest total number of grains panicle^{-1} (131.7) and the variety Bina-sail gave lowest total number of grains panicle^{-1} (113.6). This finding agreed with Ashrafuzzaman (2006) who observed maximum number of total grains panicle^{-1} in inbred variety than that of hybrid variety though Obaidullah (2007) and Main (2006) were observed dissimilar findings where the number of total grains panicle^{-1} in hybrid variety was higher than that of inbred variety.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 12. Effect of variety on total number of grains panicle^{-1} (mean of eight treatments)

Nitrogen fertilizer doses had significant effect on total number of grains panicle^{-1} of rice (Figure 13 and Appendix X). The highest total number of grains panicle^{-1} (141.1) was observed from the T_5 treatment whereas the lowest (112.8) was observed from T_0 treatment. Bhuyan *et al.* (2012) observed that bed planting with foliar nitrogen fertilizer produced higher number of grains panicle^{-1}.



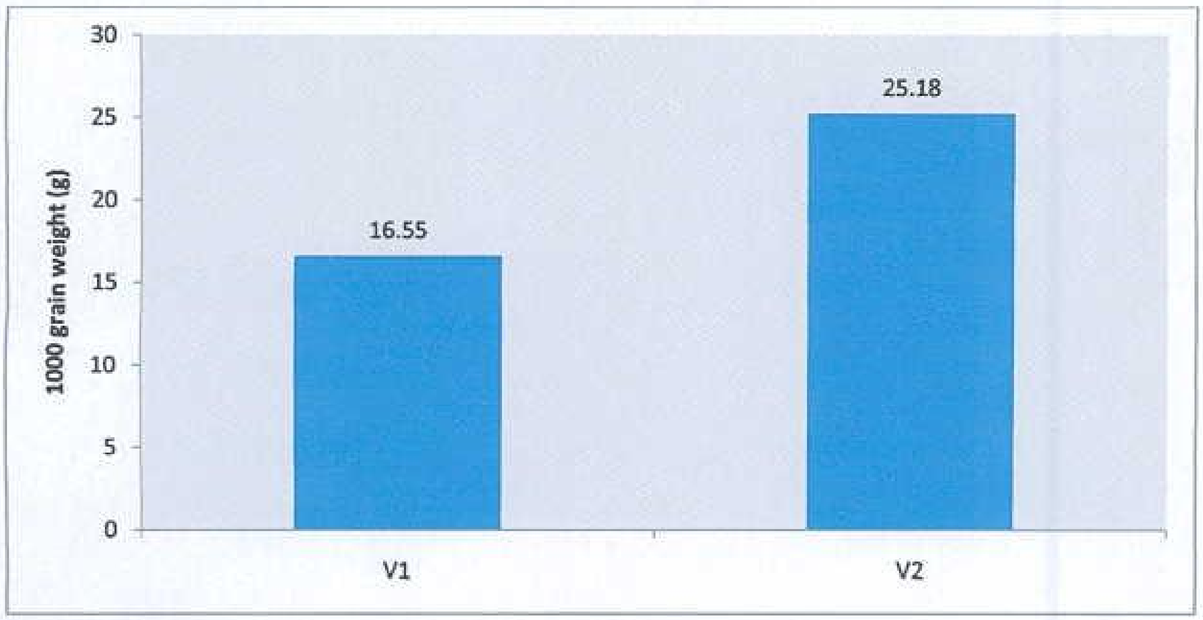
T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 13. Effect of different doses of nitrogen and application methods on total number of grains panicle^{-1} (mean of two varieties)

Interaction of variety and nitrogen fertilizer doses and application methods showed significant variation on total number of grains panicle^{-1} of T. *aman* rice (Table 9). The highest total number of grains panicle^{-1} (152.1) was observed from the V_2T_5 treatment and the lowest (107.6) was observed from V_1T_0 treatment which was statistically similar with V_1T_2 (109.5) and V_1T_4 (108.0). Rahman *et al.* (2007) conducted an experiment where the results showed that Nitrogen level significantly influenced growth and yield components and maximum grains/panicle was found from 80 kg N/ha.

4.10 weight of 1000-grain

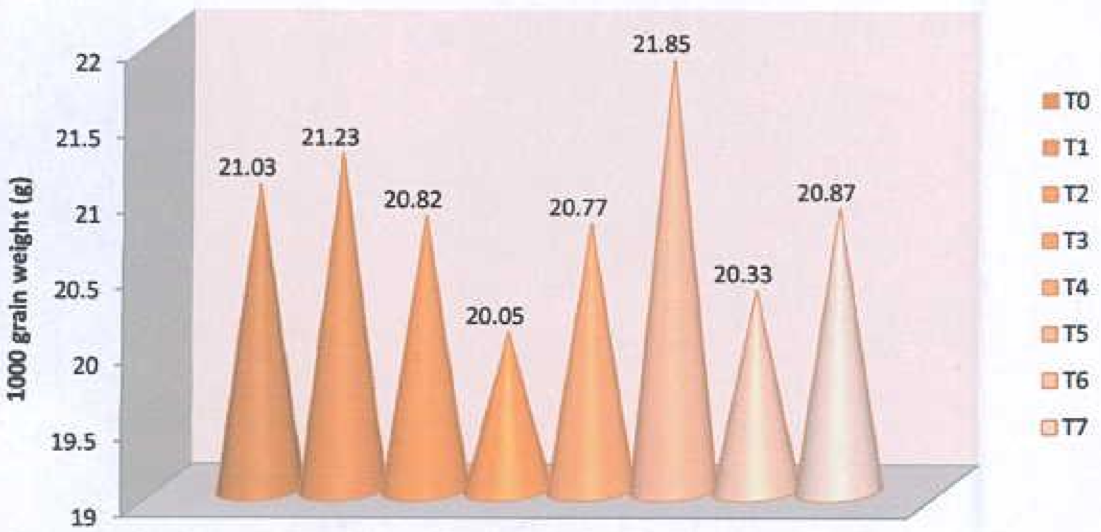
1000-grain weight (g) of T. *aman* rice was significantly influenced by different varieties (Figure 19 and Appendix IX). The result revealed that the variety BRRI Dhan46 produced the highest 1000-grain weight (25.18 g) and the variety Bina-sail gave lowest 1000 grain weight (16.55 g). M.B. Islam *et al.* (2013) observed that the highest 1000 grain weight recorded from BRRI dhan46 (28.17 g) and the lowest from BRRI dhan33 (24.19 g). BR11 and BRRI dhan39 showed statistically similar result.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 14. Effect of variety on 1000 grain weight (g) (mean of eight treatments)

1000-grain weight of aman rice significantly influenced by different doses of nitrogen fertilizers. (Figure 15 and Appendix X). The highest 1000-grain weight (21.85 g) was recorded from T_5 which was statistically similar with all except T_3 (20.05 g) and T_6 (20.33). On the other hand, the lowest result (20.05 g) was recorded from T_3 which was statistically similar with all treatment except T_5 (21.85 g). These results are in contradiction with Shafiee *et al.* (2013) who conducted an experiment using liquid fertilizer SBAJATM (formerly known as BIPOMIXTM) and found no significant differences in the 1000 grain weight.



T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 15. Effect of different doses of nitrogen and application methods on 1000 grain weight (g) (mean of two varieties)

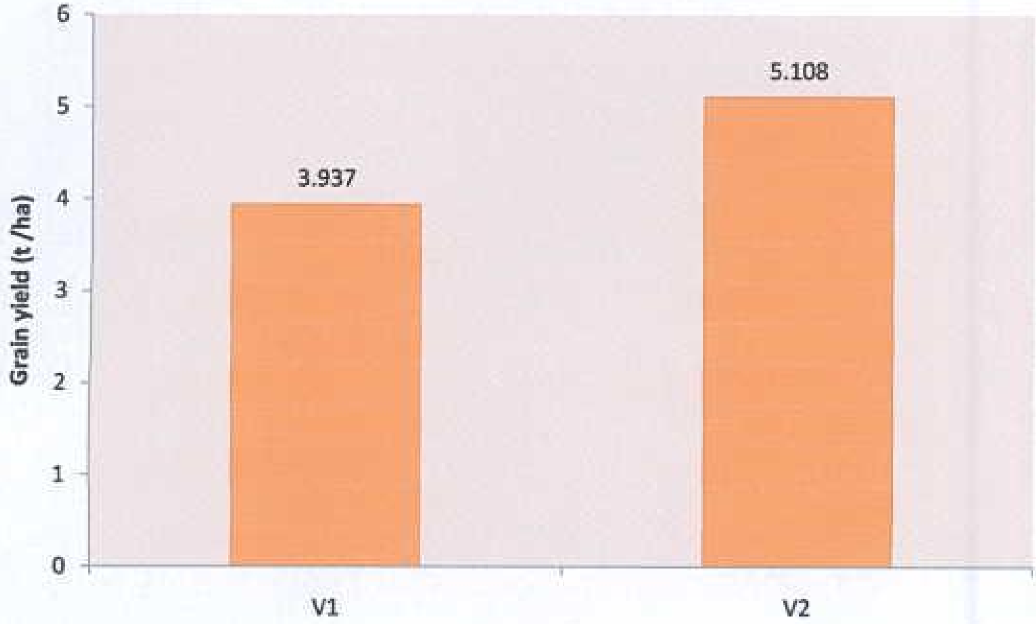
1000-grain weight of Aman rice significantly influenced by the interaction effect of variety and nitrogen fertilizer doses and application methods (Table 9). The highest 1000-grain weight (26.17 g) was recorded from V_2T_5 treatment. On the other hand, V_1T_6 showed the lowest result (15.87 g) which was statistically similar with V_1T_0 (17.57 g), V_1T_1 (16.70 g), V_1T_2 (16.47), V_1T_3 (16.00), V_1T_4 (15.93 g), V_1T_5 (17.53 g) and V_1T_7 (16.37 g). Azam *et al.* (2012) conducted an experiment to find out the influence of variety and different urea fertilizer application method on growth and yield of *boro* rice and result showed that variety and urea fertilizer application method had significant effect on 1000 grain weight.

4.11 Grain Yield

Grain yield (t ha^{-1}) of T. *aman* rice was significantly influenced by different varieties (Figure 16 and Appendix IX). The result revealed that the variety BRRI dhan46 produced the highest grain yield (5.108 t ha^{-1}) and the variety Bina-sail gave lowest grain yield (3.937 t ha^{-1}). Zohra *et al.*, *(2013)* observed that the highest number of effective tillers $hill^{-1}$ (11.42) which eventually contributed to higher grain yield (5.46 t ha^{-1}) of BRRI dhan46 compared to (4.44 t ha^{-1}) BINA dhan7 .

Nitrogen fertilizer doses had significant influenced on grain yield (Figure 17 and Appendix X). The highest grain yield (5.105 t ha^{-1}) was obtained from T_5 treatment which was statistically similar with T_4 (4.710 t ha^{-1}), T_6 (4.715 t ha^{-1}) and T_7 (4.872 t ha^{-1}) while the lowest result (3.762 t ha^{-1}) was recorded from T_0. Foliar spray along with top dressing though performed better, but still foliar spray can not completely replace the top dressing of urea. If 75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray then it can increased 8.27% grain yield compared to recommended practice ($N_{100\%}$) with a saving of 15% of the recommended nitrogen fertilizer per hectare of land.

It has been reported that a small amount of nutrients (nitrogen, potash or phosphate) by foliar spraying increases yield of crops (Asenjo *et al.*, 2000). Alam *et al.*, (2015) observed with the increment of nitrogen level the grain yield was increased up to N_{100} compared to no liquid fertilization treatment, but in the application of liquid fertilization treatment, grain yield was increased up to N_{75} and also observed that, liquid fertilization with Magic Growth along with 75% of the recommended nitrogen fertilizer increased 10.5% grain yield with a saving of 25% of the recommended nitrogen fertilizer compared to recommended practice. Parvin *et al.* (2013) found that highest grains yield was obtained from five times foliar urea spray @ 100 kg ha^{-1} in BRRI dhan29.



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 16. Effect of variety on grain yield (t ha^{-1}) (mean of eight treatments)

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 17. Effect of different doses of nitrogen and application methods on grain yield (t/ha) (mean of two varieties)

Interaction of varieties and nitrogen fertilizers doses and application methods have significant effect on grain yield of rice (Table 6 and Appendix VII). The highest grain yield (5.610 t ha^{-1}) was obtained from V_2T_5 treatment which was statistically similar with V_1T_5 (5.220 t ha^{-1}), V_1T_6 (5.273 t ha^{-1}), V_2T_4 (5.277 t ha^{-1}), V_2T_6 (5.320 t ha^{-1}) and V_2T_7 (5.350 t ha^{-1}). On the other hand V_1T_0 showed the lowest result (3.198 t ha^{-1}) which was statistically similar with V_1T_1 (3.743 t ha^{-1}), V_1T_2 (3.590 t ha^{-1}) and V_1T_3 (3.723 t ha^{-1}). Alam *et al.* (2015) observed that, liquid fertilization with Magic Growth along with 75% of the recommended nitrogen fertilizer increased 10.5% grain yield with a saving of 25% of the recommended nitrogen fertilizer compared to recommended practice. Shafiee *et al.* (2013) conducted an experiment using liquid fertilizer SBAJATM (formerly known as BIPOMIXTM) and found the highest yield of grains (9.66 tons ha^{-1}) compared with (7.49 tons ha^{-1}) in the control plots. Islam *et al.* (2008) observed that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties in respect of yield and economics.

Table 10. Interaction effect of variety and different doses of nitrogen and application methods on grain yield (t ha^{-1}) and straw yield (t ha^{-1})

Treatments		Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})
Variety	Nitrogen doses		
V_1	T_0	3.198 e	4.121 h
	T_1	3.743 cde	5.100 def
	T_2	3.590 de	4.810 efg
	T_3	3.723 cde	4.480 gh
	T_4	4.143 bcd	4.657 fgh
	T_5	5.220 a	6.170 ab
	T_6	4.110 bcd	4.900 defg
	T_7	4.393 b	5.097 def
V_2	T_0	4.327 bc	4.667 fgh
	T_1	4.487 b	5.427 cd
	T_2	4.600 b	6.460 a
	T_3	5.273 a	6.130 ab
	T_4	5.277 a	5.280 cde
	T_5	5.610 a	6.500 a
	T_6	5.320 a	5.750 bc
	T_7	5.350 a	6.240 ab
$LSD_{(0.05)}$		0.5760	0.5220
Significant level		*	*
CV (%)		15.24	19.12

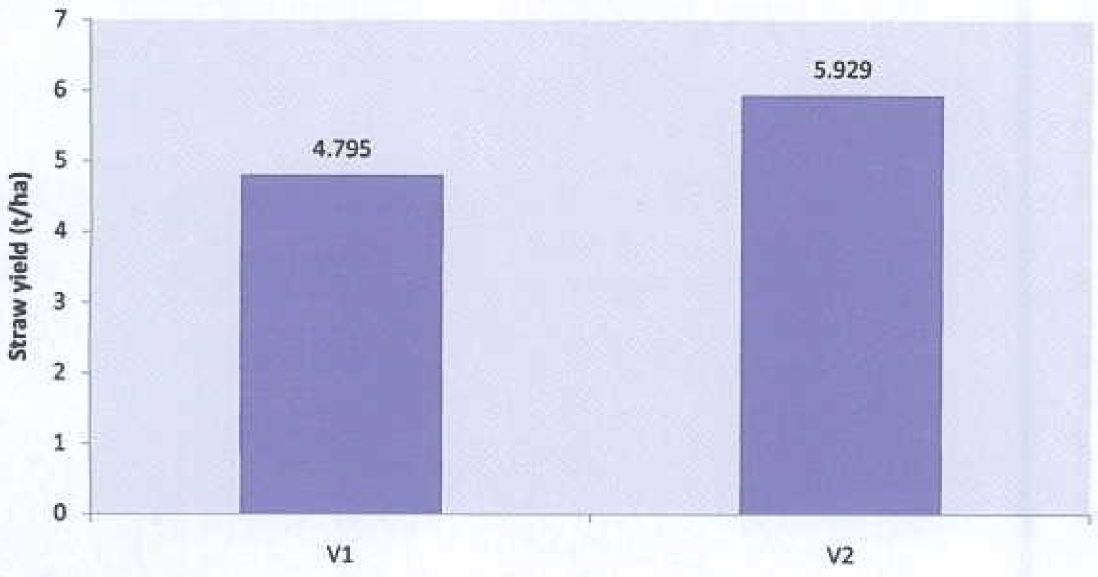
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.12 Straw Yield

Straw yield (t ha^{-1}) of T. *aman* rice was significantly influenced by different varieties (Figure 18 and Appendix IX). The result revealed that the variety BRRI dhan46 produced the highest straw yield (5.929 t ha^{-1}) and the variety Bina-sail gave lowest straw yield (4.795 t ha^{-1}). M.B. Islam *et al.* (2013) observed that the highest straw yield was found from BR11 and lowest from BRRI dhan33. BRRI dhan46 showed statistically similar result with BR11 for all cases. This result was in agreement with the finding of Patel (2000) who reported that yield performance varied with variety.

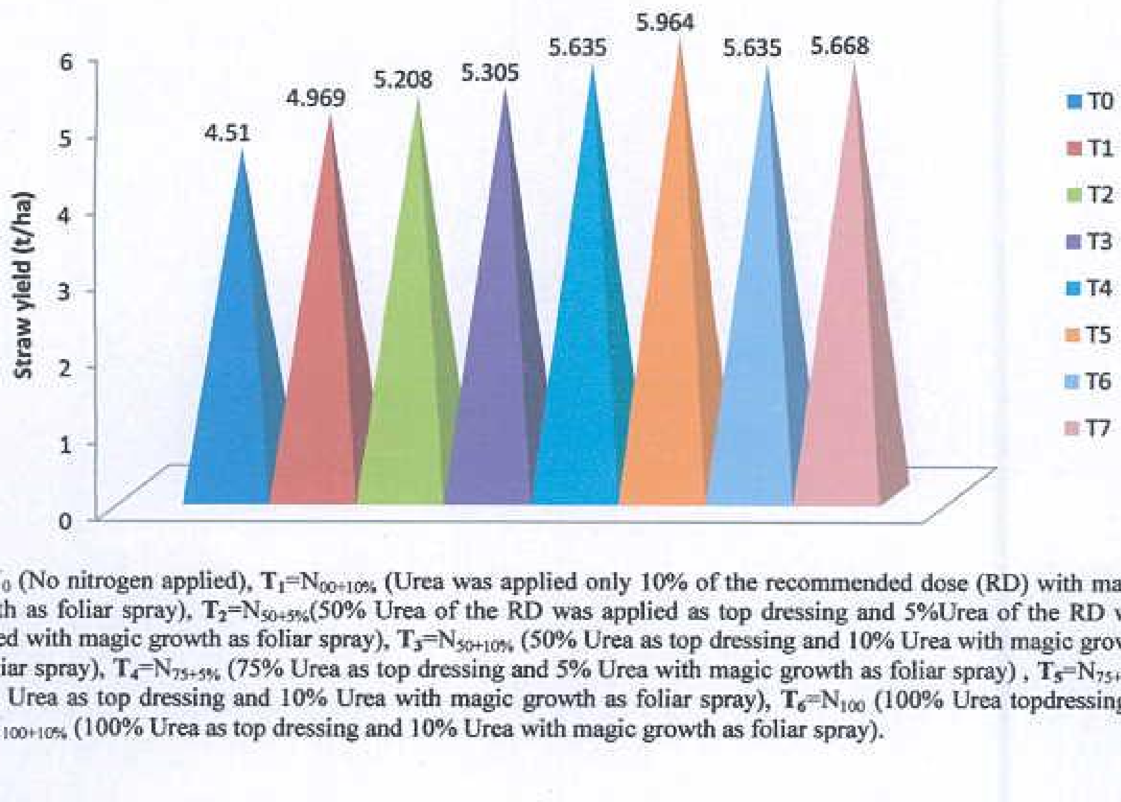


V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 18. Effect of variety on straw yield (t ha^{-1}) (mean of eight treatments)

Nitrogen fertilizer doses had significant influenced on straw yield (Figure 19 and Appendix X). The highest straw yield (5.964 t ha^{-1}) was obtained from T_5 treatment which was statistically similar with T_4 (5.635 t ha^{-1}), T_6 (5.635 t ha^{-1}) and T_7 (5.68 t ha^{-1}) while the lowest result (4.510 t ha^{-1}) was recorded from T_0 treatment. Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon and they found that all the treatments significantly increase the straw yield of BRRI dhan30 rice over control. Islam *et al.* (2008) conducted a field experiment to find out the effect of nitrogen levels and transplanting dates on the yield and yield components of aromatic rice cv. Kalizira and found that straw yield significantly influenced by nitrogen levels.

Interaction of variety and nitrogen fertilizer doses and application methods have significant effect on straw yield of rice (Table 10). The highest straw yield (6.500 t ha^{-1}) was obtained from V_2T_5 treatment which was statistically similar with V_2T_2 (6.460 t ha^{-1}). On the other hand, V_1T_0 showed the lowest result (4.121 t ha^{-1}) treatment. Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties where they found that higher rates of NPK resulted higher straw yield of rice. Azam *et al.* (2012) conducted an experiment to find out the influence of variety and different urea fertilizer application method on growth and yield of *boro* rice and result showed that variety and urea fertilizer application method had significant effect on straw yield.



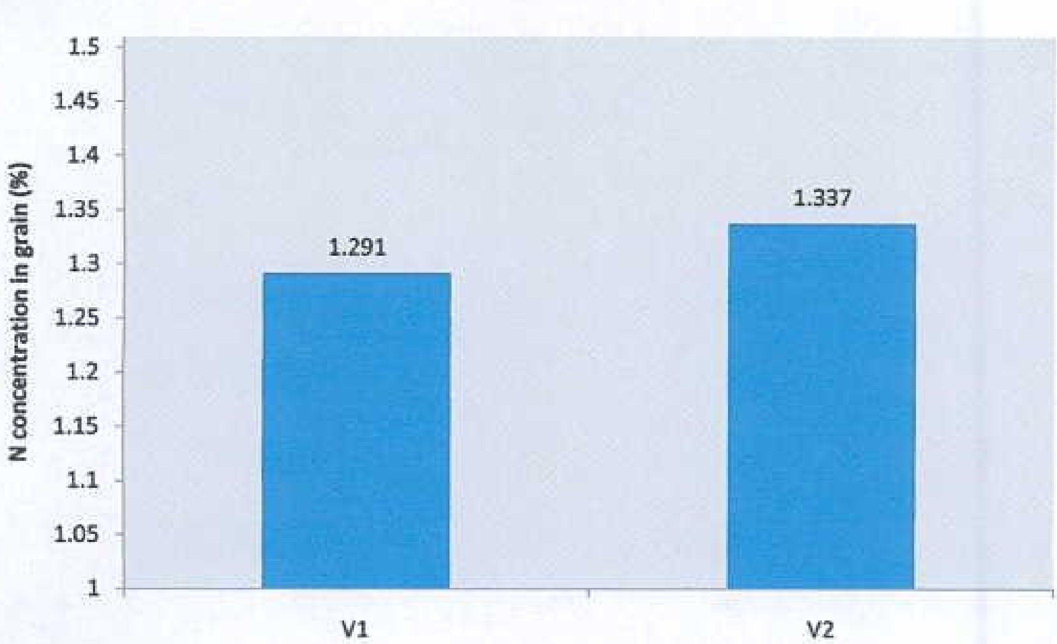
T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 19. Effect of different nitrogen doses and application methods on straw yield (t ha^{-1}) (mean of two varieties)

4.13 Chemical Composition

4.13.1 N content in grain

N content in grain showed statistically non-significant difference due to the varieties (Figure 20 and Appendix IX). Numerically the highest N content (1.337%) was observed in grain from the variety BRRI dhan46 (V_2) and the lowest amount of N (1.291%) found in grain for the variety Bina-sail (V_1).



V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 20. Effect of variety on N content in grain (mean of eight treatments)

It was observed from the results presented in Figure 21 and Appendix X that, different doses and application methods of nitrogen fertilizer have significant influence on N content in grain. The highest N content (1.524%) in grain was observed from T_5 treatment while T_0 gave the lowest result (1.096%).

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 21. Effect of different doses of nitrogen fertilizer and application methods on N content in grain (mean of two varieties)

N content in grain varied significantly due to the interaction effect of variety and nitrogen fertilizer doses and application methods (Table 11). The highest N content in grain (1.543%) was observed from V_2T_5 which is statistically similar with V_1T_5 (1.505%) and V_2T_6 (1.493%) while the lowest result (1.093%) was recorded from V_1T_0 which is statistically similar with V_2T_0 (1.099%).

Table 11. Interaction effect of variety and different doses of nitrogen fertilizer and application methods on N, P and K content in grain

Treatments		N concentration in grain (%)	P concentration in grain (%)	K concentration in grain (%)
Variety	Nitrogen doses			
V_1	T_0	1.093 g	0.1800 g	0.2371 i
	T_1	1.170 f	0.2215 f	0.2500 ghi
	T_2	1.285 e	0.2207 f	0.2500 ghi
	T_3	1.358 d	0.2537 e	0.2633 fgh
	T_4	1.376 d	0.2733 de	0.3600 d
	T_5	1.505 ab	0.3103 b	0.5000 a
	T_6	1.458 bc	0.2883 cd	0.4500 b
	T_7	1.450 bc	0.2050 f	0.4033 c
V_2	T_0	1.099 g	0.2050 f	0.2400 hi
	T_1	1.154 fg	0.2111 f	0.2800 f
	T_2	1.166 f	0.2183 f	0.3200 e
	T_3	1.190 f	0.2027 f	0.2728 fg
	T_4	1.287 e	0.2883 cd	0.4367 b
	T_5	1.543 a	0.3320 a	0.4900 a
	T_6	1.493 ab	0.3020 bc	0.4467 b
	T_7	1.392 cd	0.2837 cd	0.3600 d
$LSD_{(0.05)}$		0.06403	0.02025	0.02365
Significant level		*	*	*
CV (%)		2.35	2.65	2.57

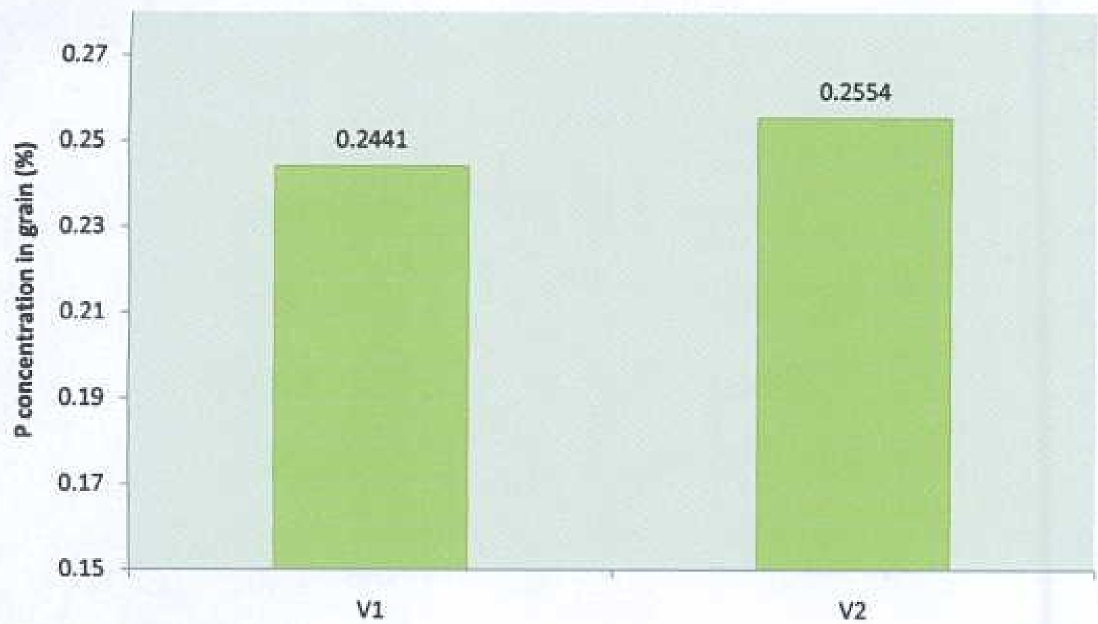
* - Significant at 5% level

V_1 – Bina-sail, V_2 – BRRI dhan46

T_0=N_0 (No nitrogen applied), **T_1**=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2**=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3**=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4**=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5**=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6**=N_{100} (100% Urea topdressing) , **T_7**=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

4.13.2 P content in grain

P content in grain showed statistically non-significant difference due to the varieties (Figure 22 and Appendix IX). Numerically the highest P content (0.2554%) was observed in grain from the variety BRRI dhan46 (V_2) and the lowest amount of P (0.2441%) found in grain for the variety Bina-sail (V_1).

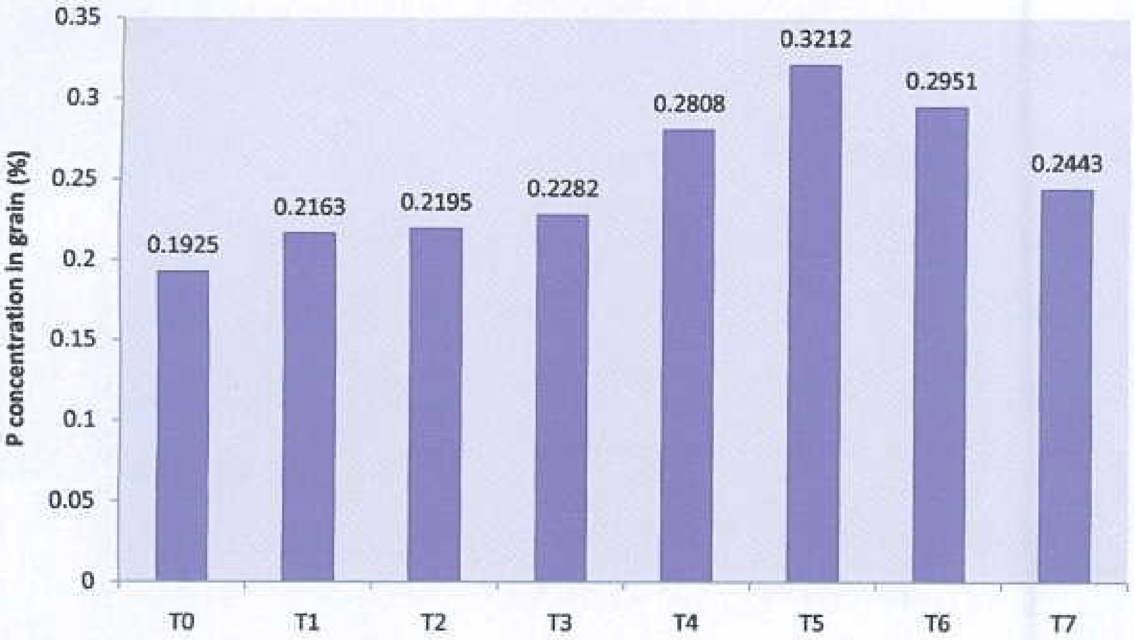


V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 22. Effect of variety on P content in grain (mean of eight treatments)

It was observed from the results presented in Figure 23 and Appendix X that, different doses and application methods of nitrogen fertilizer have significant influence on P content in grain. The highest P content (0.3212%) in grain was observed from T_5 treatment which is statistically similar with T_6 (0.2951%) while T_0 gave the lowest result (0.1925%).

From Table 11, it is clear that interaction effect of variety and nitrogen fertilizer doses and application methods have significant effect on P content in grain. The highest P content in grain (0.3320%) was observed from V_2T_5 while the lowest result (0.1800%) was recorded from V_1T_0.

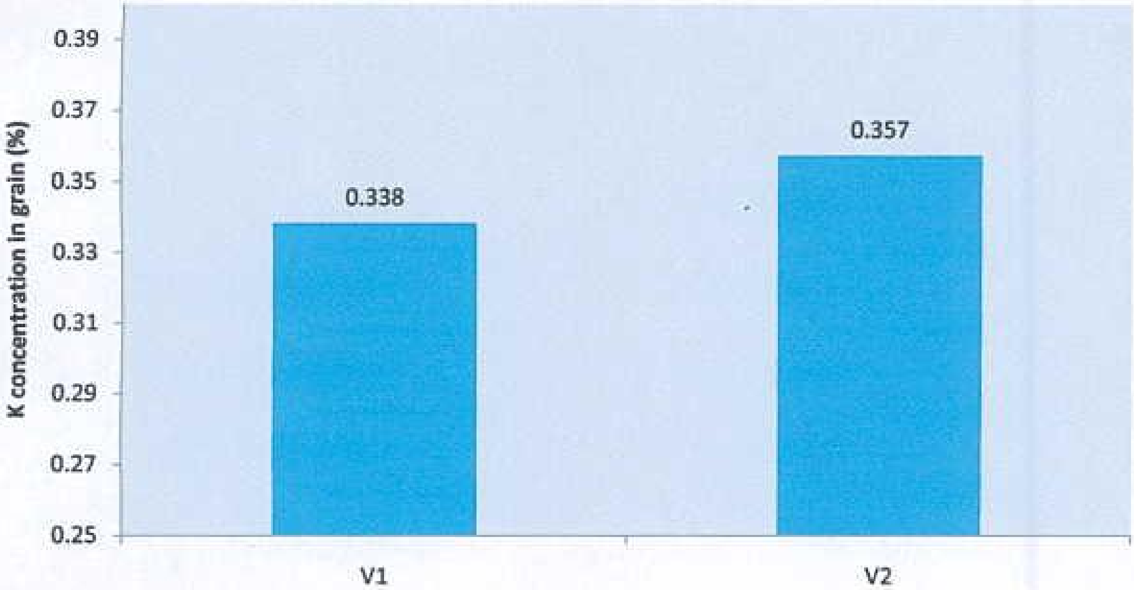


T_0=N_0 (No nitrogen applied), **T_1=$N_{00+10\%}$** (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), **T_2=$N_{50+5\%}$**(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), **T_3=$N_{50+10\%}$** (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_4=$N_{75+5\%}$** (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , **T_5=$N_{75+10\%}$** (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), **T_6=N_{100}** (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 23. Effect of different doses of nitrogen fertilizer and application methods on P content in grain (mean of two varieties)

4.13.3 K content in grain

K content in grain showed statistically non-significant difference due to the varieties (Figure 24 and Appendix IX). Numerically the highest K content (0.3570%) was observed in grain from the variety BRRI dhan46 (V_2) and the lowest amount of K (0.3380%) found in grain for the variety Bina-sail (V_1).

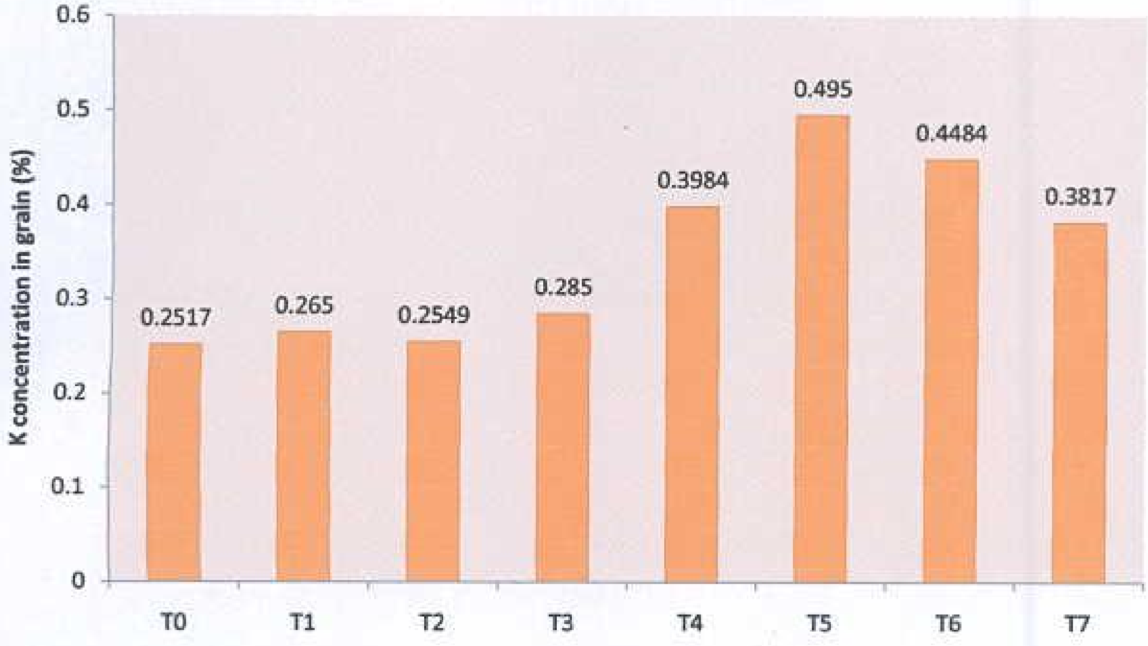


V_1 – Bina-sail, V_2 – BRRI dhan46

Figure 24. Effect of variety on K content in grain (mean of eight treatments)

It was observed from the results presented in Figure 25 and Appendix X that, different doses of nitrogen fertilizer have significant influence on K content in grain. The highest K content (0.4950%) in grain was observed from T_5 treatment while T_0 gave the lowest result (0.2517%) which is statistically similar with T_1 (0.2650%) and T_2 (0.2549%).

K content in grain varied significantly due to the interaction effect of variety and nitrogen fertilizer doses and application methods (Table 11). The highest K content in grain (0.5000%) was observed from V_2T_5 which is statistically similar with V_1T_5 (0.4900%) while the lowest result (0.2371%) was recorded from V_1T_0 treatment.



T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Figure 25. Effect of different doses of nitrogen fertilizer and application methods on K content in grain (mean of two varieties)

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from July to December, 2013 to find out the effect of foliar application of urea along with magic spray on the growth, yield and nutrient content of two aman rice cultivars. The two factorial experiment was laid out in a RCBD design with three replications. Factor A : two varieties [V_1-Bina-sail, V_2-BRRI dhan46], and factor B : different nitrogen doses and application methods [$\mathbf{T_0}$=N_0 (No nitrogen applied), $\mathbf{T_1}$=$N_{00+10\%}$ (Nitrogen applied only 10% of the recommended doses (RD) as magic growth), $\mathbf{T_2}$=$N_{50+5\%}$ (50% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_3}$=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_4}$=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_5}$=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_6}$=N_{100} (100% of RD of N applied as Urea topdressing), $\mathbf{T_7}$=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray)].

Different growth and yield parameters varied significantly due to varietal difference. At 30 DAT, the variety Bina-sail produced the tallest plant (64.64 cm) and the variety BRRI dhan46 gave the shortest plant (64.64 cm). At 60 DAT and 90 DAT, BRRI Dhan46 gave higher plant height (respectively 114.50 cm and 125.00 cm) than Bina-sail (respectively 109.77cm and 113.42cm). At 60 DAT, the variety BRRI dhan46 produced the highest number of tillers hill^{-1} (16.94) and the variety Bina-sail gave the lowest number of tillers hill^{-1} (16.44) and the same trend was observed for variety BRRI dhan46 (15.57) over Bina-sail (14.48) at 90 DAT though initially at 30 DAT comparatively Bina-sail gave better results. Number of leaves hill^{-1} of T. *aman* rice showed statistically insignificant variation among the two varieties. But numerically maximum number of leaves hill^{-1} at 30, 60 and 90 DAT was observed in the V_2 (BRRI dhan46). BRRI dhan46 produced the highest number of effective tillers hill^{-1}, longer panicle, highest number of filled grains panicle^{-1} & total grains panicle^{-1}, highest 1000-grain weight, highest dry grain yield, highest dry straw yield and the variety Bina-sail gave the comparatively lower results. N, P and K content in grain showed statistically non-significant difference due to the varietal effect.

Nitrogen fertilizer doses and application methods had significant effect on growth and yield of rice. At 30, 60 and 90 DAT, the highest plant height was observed from the T_5 treatment while the lowest was observed from T_0 treatment. At 30, 60 and 90 DAT, the highest number of tillers hill^{-1} was observed from the T_5 treatment and the lowest was observed from T_0 treatment. At 30, 60 and 90 DAT, the highest number of leaves hill^{-1} were observed from the T_5 treatment and the lowest results were obtained from T_0 treatment. The highest number of effective tillers hill^{-1}, longest panicle, highest number of filled grains panicle^{-1} & total grains panicle^{-1}, highest 1000-grain weight, highest dry grain yield, highest dry straw yield was observed from the T_5 treatment in most of the cases and the lowest was observed from T_0. The highest N content in grain was observed from T_5 treatment which is statistically similar with all treatment except T_0. The highest P content in grain was observed from T_5 treatment which is statistically similar with T_6 while T_0 gave the lowest result. Significantly highest K content in grain was observed from T_5 treatment while T_0 gave the lowest result.

At 30 DAT, the highest plant height was observed from the V_1T_5 treatment while at 60 and 90 DAT; V_2T_5 showed better results. Whereas, at 30 DAT, the lowest plant height was observed from V_2T_0 treatment and at 60 and 90 DAT, the lowest was observed from V_1T_0. At 30 DAT, the highest number of tillers hill^{-1} was observed from the V_1T_5 treatment while at 60 and 90 DAT; V_2T_5 showed significantly better results. At 30, 60 and 90 DAT, the highest number of leaves hill^{-1} were observed from the V_2T_5 treatment which was statistically similar to V_1T_5. At 30, 60 and 90 DAT, the lowest were observed from V_2T_0, V_1T_0 and V_1T_0 respectively. The highest number of effective tillers hill^{-1}, longest panicle, highest number of filled grains panicle^{-1} and total grains panicle^{-1}, highest 1000-grain weight, highest dry grain yield, highest dry straw yield was observed from the V_2T_5 or in some cases from V_1T_5 treatment whereas, the lowest was observed from V_1T_0 and V_2T_0 treatment. The highest N content in grain was observed from V_2T_5 which is statistically similar with V_1T_5 and V_2T_6 while the lowest result was recorded from V_1T_0. The highest P content in grain was observed from V_2T_5 while the lowest result was recorded from V_1T_0. The highest K content in grain was observed from V_2T_5 while the lowest result was recorded from V_1T_0.

From the above results it can be concluded that,

- BRRI dhan46 has better yield potential than Bina-sail in Aman season.
- When Urea was applied as foliar spray (10% of RD along with magic growth) and top-dressing (75% of RD) then it performed better than sole top-dressing or foliar spray.
- Foliar spray along with top dressing though performed better, but still foliar spray can not completely replace the top dressing of urea.
- If 75% Urea is top-dressed and 10% of the urea is applied as foliar spray along with magic growth then at least 8.27% grain yield increased and 15% urea can be saved.

The following recommendations can be made:

- ➢ Farmers can adopt BRRI dhan46 to get better yield in Aman season.
- ➢ Farmers can perform the combination of top dressing of urea as well as foliar application with magic growth liquid fertilizer to ameliorate the loss of urea.
- ➢ Studies are needed to find out the effect of other nutrients for foliar application like urea.
- ➢ Farmers can perform this technique to ameliorate urea loss in Aman season.
- ➢ Such study is needed in different agro-ecological zones (AEZ) of Bangladesh where T. *aman* rice is cultivated.

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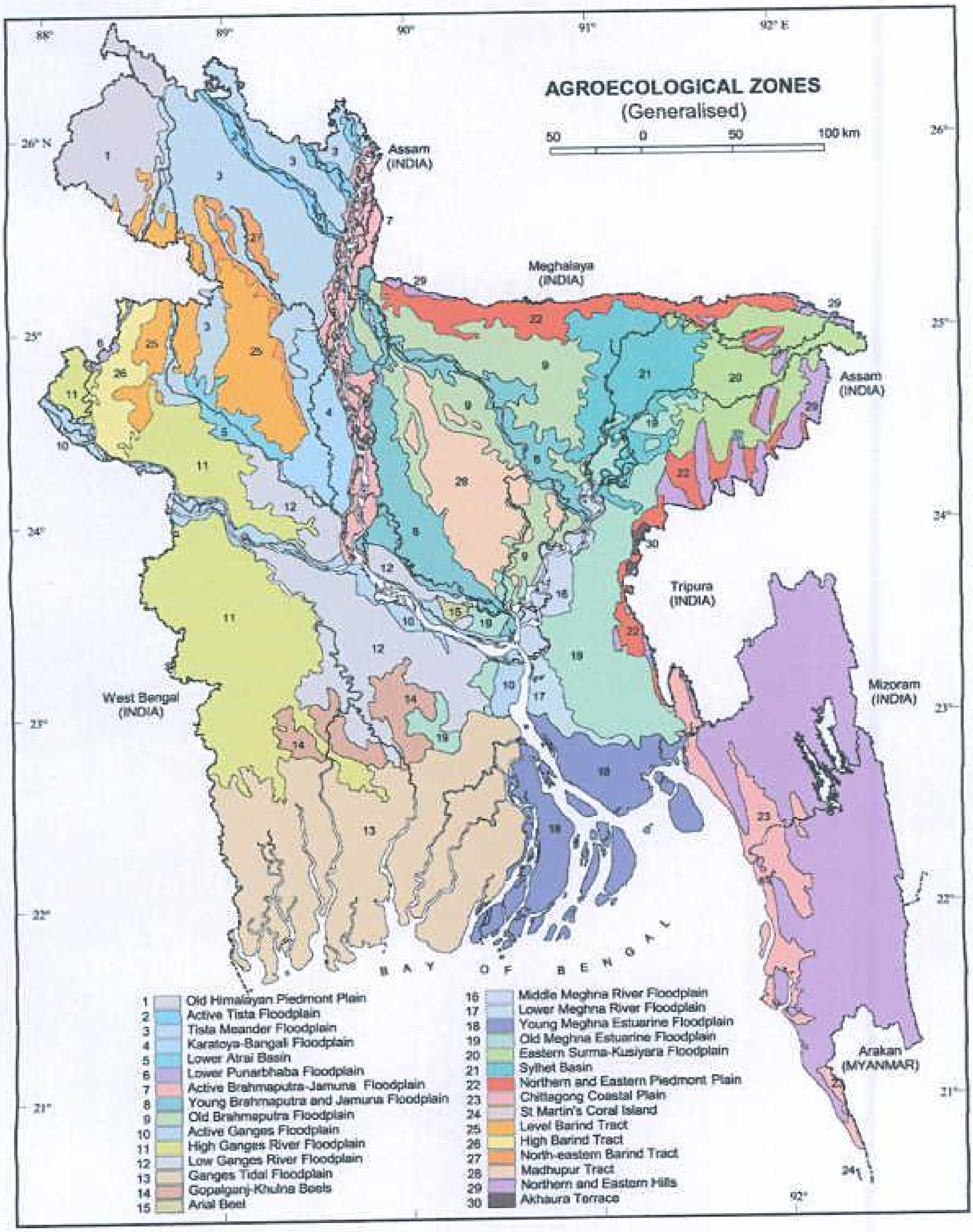
APPENDICES

APPENDICES

Appendix I. Experimental location on the map of Agro-ecological Zones of Bangladesh



Appendix II. Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm, Dhaka.
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Terrace.
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

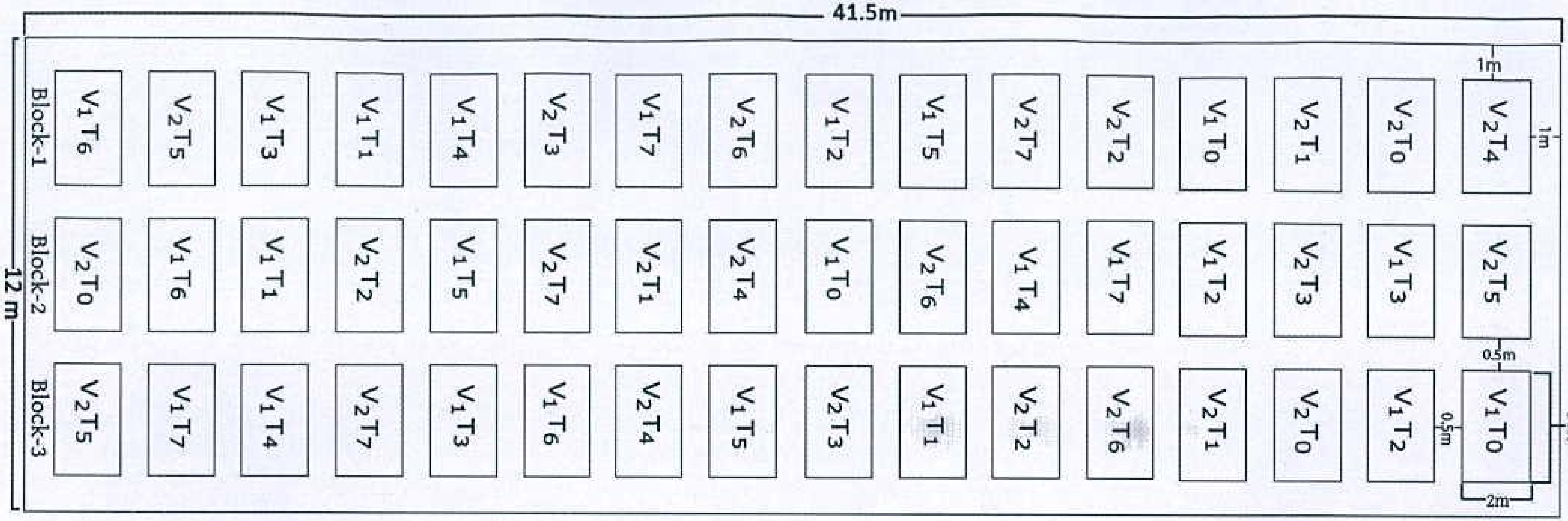
(SAU Farm, Dhaka)

Appendix III. Initial physical and chemical characteristics of the soil

Characteristics	Value
Mechanical fractions:	
% Sand (2.0-0.02 mm)	22.26
% Silt (0.02-0.002 mm)	56.72
% Clay (<0.002 mm)	20.75
Textural class	Silt Loam
pH (1: 2.5 soil- water)	5.9
Organic Matter (%)	1.09
Total N (%)	0.028
Available K (ppm)	15.625
Available P (ppm)	7.988
Available S (ppm)	2.066

(SAU Farm, Dhaka)

Appendix IV. Layout of the experimental field



V_1 – Bina-sail, V_2 – BRRI dhan46

$T_0 = N_0$ (No nitrogen applied),

$T_1 = N_{00+10\%}$ (Urea was applied only 10% of the RD* with magic growth as foliar spray),

$T_2 = N_{50+5\%}$ (50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray),

$T_3 = N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray),

$T_4 = N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray),

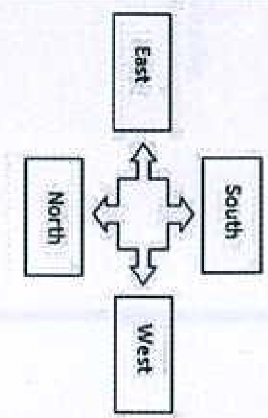
$T_5 = N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray),

$T_6 = N_{100}$ (100% Urea topdressing),

$T_7 = N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray)

*RD – Recommended Dose

Total Area- 498 m^2
Area of single plot- 6m^2
P2P Distance- 15cm
R2R Distance- 25cm



Appendix V. Analysis of variance of the data on plant height and number of tillers hill^{-1} of aman rice as influenced by varieties and different levels of nitrogen fertilizer

Sources of variation	Degrees of freedom	Mean square			Mean square		
		Plant height (cm)			Number of tillers hill^{-1}		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
Replication	2	13.821	34.168	5.908	12.152	5.365	3.939
Factor A (Variety)	1	37.453*	267.907*	1608.926*	9.013*	3.000*	14.301*
Factor B (Nitrogen doses)	7	34.442*	91.059*	102.535*	2.760*	3.976*	6.668*
A X B	7	0.234*	17.250*	26.555*	0.690*	0.647*	0.184*
Error	30	2.310	27.825	32.105	0.472	0.584	0.529

* Significant at 5% level

Appendix VI. Analysis of variance of the data on number of leaves hill^{-1} of aman rice as influenced by varieties and different levels of nitrogen fertilizer

Sources of variation	Degrees of freedom	Mean square		
		Number of leaves hill^{-1}		
		30 DAT	60 DAT	90 DAT
Replication	2	54.394	75.022	98.851
Factor A (Variety)	1	1.577^{NS}	45.630^{NS}	22.688^{NS}
Factor B (Nitrogen doses)	7	43.598*	68.013*	43.963*
A X B	7	5.123*	5.176*	2.201*
Error	30	3.392	10.230	12.706

* Significant at 5% level

NS – Non-Significant.

Appendix VII. Analysis of variance of the data for crop growth characters, yield and other crop characters of Bina-sail and BRRI dhan46 at harvest

Sources of Variation	Degrees of freedom	Mean square values											
		Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$	Pnicle length (cm)	Number of filled grains $panicle^{-1}$	Number of unfilled grains $panicle^{-1}$	Total number of grains $panicle^{-1}$	1000-grains weight (g)	Grain yield (t/ ha)	Straw yield (t/ha)	N (%) in grain	P (%) in grain	K (%) in grain
Replication	2	0.890	0.578	0.881	2027.885	5.711	32.488	0.593	0.003	0.002	0.002	0.000	0.000
Factor A (Variety)	1	52.501*	0.124^{NS}	1.098^{NS}	5380.567*	123.938*	3922.998*	893.550*	16.442*	15.428*	0.026^{NS}	0.002^{NS}	0.004^{NS}
Factor B (Nitrogen doses)	7	10.010*	1.003*	4.483*	1846.070*	638.666*	475.316*	1.794*	1.107*	1.296*	0.139*	0.012*	0.055*
A × B	7	0.227*	0.030*	1.419*	24.554*	36.064*	74.182*	0.998*	0.131*	0.199*	0.008*	0.002*	0.003*
Error	30	0.357	0.099	1.862	100.194	0.627	0.414	1.214	0.003	0.002	0.001	0.000	0.000

* Significant at 5% level

NS – Non Significant

Appendix VIII. Effect of variety on various growth and yield parameters of Aman rice cv. Bina-sail and BRRI dhan46 (mean of 8 treatments)

Treat-ments	Plant height (cm)			Number of tillers $hill^{-1}$			Number of leaves $hill^{-1}$			Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT		
V_1	66.40 a	109.77 b	113.42 b	14.87 a	16.44 b	14.48 b	44. 34	59.95	52.00	11.23 b	1.50
V_2	64.64 b	114.50 a	125.00 a	14.00 b	16.94 a	15.57 a	44.70	61.90	53.37	13.32 a	1.6
$LSD_{0.05}$	**0.896**	**3.109**	**3.34**	**0.404**	**0.450**	**0.428**	**3.340**	**1.903**	**2.101**	**0.352**	**0.185**
CV %	2.32	4.70	4.75	4.76	4.58	4.84	4.14	5.25	6.77	4.86	20.23
Significant level	*	*	*	*	*	*	NS	NS	NS	*	NS

V_1= Bina-sail, V_2= BRRI dhan46

* - Significant at 5 % level

NS- Non-significant

Appendix IX. Effect of variety on various growth, yield and nutrient content parameters of Aman rice cv. Bina-sail and BRRI dhan46 (mean of 8 treatments)

Treatments	Panicle length (cm)	Number of filled grains $panicle^{-1}$	Number of unfilled grains $panicle^{-1}$	Total number of grains $panicle^{-1}$	1000 grain weight	Grain yield	Straw yield	N conc. in grain (%)	P conc. in grain (%)	K Conc. in grain (%)
V_1	23.97	92.50 b	21.20 a	113.6 b	16.55 b	3.937 b	4.795 b	1.291	0.2441	0.3380
V_2	24.27	113.68 a	17.98 b	131.7 a	25.18 a	5.108 a	5.929 a	1.337	0.2554	0.3570
$LSD_{0.05}$	**0.804**	**1.882**	**2.412**	**2.808**	**0.649**	**0.9042**	**0.9701**	**0.3469**	**0.07757**	**0.1076**
CV %	1.609	9.71	4.04	9.22	5.28	15.24	0.83	2.35	2.65	2.57
Significant level	NS	*	*	*	*	*	*	NS	NS	NS

V_1= Bina-sail, V_2= BRRI dhan46

* - Significant at 5 % level

NS- Non-significant

Appendix X. Effect of different doses of nitrogen fertilizer and application methods on various growth, yield and nutrient content parameters of Aman rice cv. Bina-sail and BRRI dhan46 (mean of 2 varieties)

Treatments	Panicle length (cm)	Number of filled grains $panicle^{-1}$	Number of unfilled grains $panicle^{-1}$	Total number of grains $panicle^{-1}$	1000 grain weight	Grain yield	Straw yield	N conc. in grain (%)	P conc. in grain (%)	K Conc. in grain (%)
T_0	23.15 b	78.63 e	35.26 a	112.8 e	21.03 ab	3.762 c	4.510 c	1.096 b	0.1925 d	0.2517 e
T_1	23.27 b	88.50 e	30.57 b	116.9 d	21.23 ab	4.115 bc	4.969 bc	1.162 ab	0.2163 cd	0.2650 de
T_2	23.55 b	89.77 de	27.19 b	119.3 cd	20.82 ab	4.405 abc	5.208 abc	1.225 ab	0.2195 cd	0.2549 de
T_3	24.03 b	100.6 cd	20.45 c	118.6 cd	20.05 b	4.498 abc	5.305 abc	1.274 ab	0.2282 cd	0.2850 d
T_4	24.25 ab	104.6 c	13.83 d	121.0 c	20.77 ab	4.710 ab	5.635 ab	1.332 ab	0.2808 ab	0.3984 c
T_5	25.85 a	131.4 a	9.507 e	141.1 a	21.85 a	5.105 a	5.964 a	1.524 a	0.3212 a	0.4950 a
T_6	24.30 ab	111.1 bc	10.35 de	121.6 c	20.33 b	4.715 ab	5.635 ab	1.475 ab	0.2951 a	0.4484 b
T_7	24.56 ab	120.1 ab	9.572 e	129.8 b	20.87 ab	4.872 ab	5.668 ab	1.421 ab	0.2443 bc	0.3817 c
$LSD_{0.05}$	**5.66**	**11.80**	**3.640**	**3.341**	**1.299**	**0.7854**	**0.9158**	**0.3739**	**0.03885**	**0.02896**
CV %	10.609	9.71	4.04	9.22	5.28	15.24	0.83	2.35	2.65	2.57
Significant level	*	*	*	*	*	*	*	*	*	*

* - Significant at 5 % level

T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray) , T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing) , T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).