EFFECT OF NITROGEN ON GROWTH AND YIELD OF BARI Tomato- 2 AND BARI Tomato- 14

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This is to certify that thesis entitled, ***"EFFECT OF NITROGEN ON GROWTH AND YIELD OF BARI Tomato -2 AND BARI Tomato - 14"*** *submitted to the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE*** *in* ***SOIL SCIENCE,*** *embodies the result of a piece of bona fide research work carried out by* ***KAZI AJAJUL KARIM****, Registration No:* ***06-02014*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

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DEDICATED
TO
MY BELOVED PARENTS

EFFECT OF NITROGEN ON GROWTH AND YIELD OF BARI Tomato- 2 AND BARI Tomato- 14

ABSTRACT

A field experiment was conducted to study the effect of nitrogen on the growth and yield of BARI Tomato-2 and BARI Tomato-14 at Sher-e-Bangla Agricultural University Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2014 to March 2015. There were five nitrogen levels, viz., 0, 80, 100, 120 and 140 kg N ha^{-1} on two varieties of tomato (BARI Tomato-2 and BARI Tomato-14). The experiment was laid out in a RCBD with three replications. Varieties showed significant influence on the growth and yield contributing characters of tomato. Between two varieties, the plant height, number of cluster per plant, flower per plant, fruit per plant, weight of fruit per plant and yield were found highest in BARI tomato 14 as compared to BARI Tomato-2. Nitrogen showed significant influence on the growth and yield contributing characters of tomato. The plant height, number of cluster per plant, flower per plant, fruit per plant, weight of fruit per plant and yield were the highest when 120 kg N/ha was applied. The combination of nitrogen and Varieties also exhibited significant variation in all the yield component and yield. The combination of 120 kg N/ha on BARI Tomato-14 was produced the highest yield (47.83 t/ha) and lowest (30.15 t/ha) from 0 kg N/ha on the BARI Tomato-2.

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CHAPTER I

INTRODUCTION

Tomato (*Solanum lycopersicum*) belonging to Solanaceae family is a vegetable crop grown in Bangladesh during winter. Its food value is very rich because of higher contents of vitamins A, B and C including calcium and carotene (Bose and Som, 1990). It is much popular as salad in the raw state and is made into soups, juice, ketchup, pickles, sauces, conserved puree, paste, powder and other products.

In Bangladesh, there is a great possibility of increasing tomato yield per unit area with proper use of fertilizer. Tomato requires large quantity of readily available fertilizer nutrient (Gupta and Shukla, 1997). To get one ton fresh fruit production, plant need to absorb on average 2.5-3 kg N. 0.2-0.3 kg P, and 3-3.5 kg K (Hedge, 1997). In absence of other production constraints, nutrient uptake and yield are very closely related. Nitrogen has the positive response (Koul, 1997, Omer, 1998, Gasim, 2001; Sawi, 1993) and essential for building up protoplasm and protein, which induce cell division and initial meristematic activity when applied in optimum quantity (Singh and Kumar, 1969). Nitrogen has largest effect on yield and quality of tomato (Xin *et al*. 1997). It also promotes vegetative growth, flower and fruit set of tomato (Bose and Som, 1990). It significantly increases the growth and yield of tomato (Banerjee *et al*. 1997). Nitrogen has a pronounced effect on growth and development of tomato. Application of N-fertilizer to the soil produces high tomato fruit yield and improves fruit quality (Adams *et al*., 1978) whereas excessive application leads to luxuriant development of vegetative parts of the plant at the expense of reproductive growth (Tisdale *et al*., 2003). It has been reported that tomato can grow on a variety of soils except worst soils

such as gravelly soils and water-logged soils (Simons and Sobulo, 1974) but better yields were obtained from some soil types than others even with the same management practices and environmental conditions (Pettygrove *et al.,* 1999).

Tomato is used as canned vegetable having multiple uses (Chowdhury, 1979). Tomato responds to liberal application of water and N (Gupta and Rao, 1978; Csizinsky, 1980: Vasantha Kumar, 1984). Nasreen and Islam (1990) reported that adequate N and P increased fruit yield more effectively than any other nutrients. However, increasing demands for water and high costs of N fertilizers necessitate their judicious use in tomato production. Mridha *et al.* (2003) reported seven days interval irrigation with standard doses of fertilizer application. But irrigation may not be required if soil moisture is available. So it is dependent on evapotranspiration rate. The specific dose of nitrogen may affect yield and storage behavior of tomato fruits.

Tomato plants are thin and upright in appearance when nitrogen is deficient. Leaves are small and pale green to yellow in color. Symptoms are first seen in the old leaves and gradually progress to new growth. If severe, the older leaves develop a purple color before dropping from the plant. Flowers may fall prematurely and fruit that develop are smaller than usual. Excess nitrogen results in dark leaves, luxuriant growth, less flowers and plants that are more susceptible to disease and moisture stress. Fruit set is reduced and fruit color is poor. Ripening is delayed due to a suppression of K and Mg.

In Bangladesh, the fertilizer especially nitrogenous is the most valuable input for increasing crop production and had aptly been recognized as the

central element for agricultural development (Mukhopadhyay *et al*., 1986). More than any other nutrient nitrogen influences vegetative growth and yield of tomato plant. Nitrogen is essential or building up of protoplasm and protein which induce cell division and initial meristematic activity when applied in optimum quantity (Singh and Kumer, 1969). Nitrogen had the largest effect on yield and quality of tomato (Xin et al., 1997). It also promotes vegetative growth and flower and fruit set of tomato (Bose, T.K. and Som, M.G. 1990). Adequate nitrogen increases fruit quality, fruit size, keeping quality, color and taste and acidity is also increased by excess nitrogen (Sharma and Thakur, 2002 and Banerjee et al., 1997). However, researches on the supply of N for physiological efficiency, apparent nitrogen recovery (%) and their relation to yield potentiality on tomato are scanty. So, the present study has been undertaken to investigate the effect of ample supply of N-fertilizer on the physiological efficiency and apparent nitrogen recovery (%) and to observe the growth and yield of tomato.

Usually the farmers of Bangladesh cultivate tomato without pruning and even they do not maintain proper plant density. Where it has been reported that the single stem tomato plants gave early yield but closely planted plants produced higher yield (Vesselinov, 1977).

The present study was undertaken in view of the following objectives:

- To study the effect of different levels of nitrogen on growth and yield of tomato.
- To evaluate varietal performance under different levels of nitrogen.

CHAPTER II
REVIEW OF LITERATURE

Tomato is one of the most important vegetable crops grown under field and greenhouse condition, which received much attention of the researchers throughout the world. The response of tomato to different levels of nitrogen and pruning practices for its successful cultivation has been investigated by numerous investigators in various parts of the world. In Bangladesh, there have not enough studies on the influence of either nitrogen or pruning or both in combination on the growth and yield of tomato. However, the available research findings in this connection over the world have been reviewed in this chapter under the following headings.

2.1 Nitrogen on growth, yield contributing characters and yield of tomato

Effects of nitrogen on the growth, yield and yield attributes of tomato has been presented below:

Tomato has higher contents of vitamins A, B and C including calcium and carotene (Bose and Som, 1990). It is much popular as salad in the raw state and is made into soups, juice, ketchup, pickles, sauces, conserved puree, paste, powder and other products (Ahmed et al., 1986; Thompson and Kelly, 1983 and Bose and Som, 1990). In Bangladesh, there is a great possibility of increasing tomato yield per unit area with proper use of fertilizer. Tomato requires large quantity of readily available fertilizer nutrient (Gupta and Shukla, 1997). To get one ton fresh fruit, plant need to absorb on average 2.5-3 kg N. 0.2-0.3 kg P, and

3-3.5 kg K (Hedge, 1997). In absence of other production constraints, nutrient uptake and yield are very closely related.

Nitrogen is an important nutrient for plant growth and yield but is difficult to optimize because it is susceptible to leaching, immobilization, denitrification and volatilization (Andersen et al. 1999a; Tremblay et al. 2001).

High fertilizer N rates may increase plant growth (Andersen et al. 1999b; Tei et al. 2002), decrease tomato fruit colour (Seliga and Shattuck 1995), increase the amount of green fruit at harvest (May and Gonzales 1994; Herrero et al. 2001) and increasesusceptibilities to blossom-end rot (BER) (Saure 2001) and diseases (Tremblay et al. 2001). Nitrate contamination of surface and ground water from excessive N application is also a concern (MacDonald 2000a, b; Krusekopf et al. 2002). On the other hand, under-fertilization with N may reduce yield and quality (Locascio et al. 1997; Tremblay et al. 2001). Nutrient management legislation should regulate N application (Ministry of Agriculture). Therefore, improvement of N use efficiency is essential to sustain crop production while minimizing adverse effects on environmental quality.

Tomato yields are highly responsive to the application of N (Locascio *et al.* 1997; Andersen et al. 1999a, b; Tei *et al*. 2002) and growers have a tendency to apply excess N fertilizer rather than risk under-fertilization and reduced yields

(Andersen *et al.* 1999b; Tremblay *et al.* 2001). In California, for example, processing tomato growers have applied fertilizer in excess of crop requirements in many fields (Hartz et al. 1998; Krusekopf et al. 2002). Nitrogen fertilization must be carefully managed to attain high

marketable yield while minimizing the adverse effects of excessive vine growth and green fruit.

Current recommendations for fertilizer N rates for processing tomatoes in Bangladesh were developed (Fertilizer recommendation Guid, 2012). Many new tomato cultivars have been bred which have a higher yield potential, and may also have a higher fertilizer N requirement. This study was conducted to determine whether higher-than-recommended fertilizer N rates will lead to optimum fruit yield and quality in four of the new processing tomato cultivars currently grown on sandy loam soil. New experiments on tomatoes were conducting in Bangladesh Agriculture Research Institute (BARI).

Nitrogen has the positive response (Koul, 1997, Omer, 1998, Gasim, 2001; Sawi, 1993) and essential for building up protoplasm and protein, which induce cell division and initial meristematic activity when applied in optimum quantity (Singh and Kumar, 1969). Nitrogen has largest effect on yield and quality of tomato (Xin *et al.* 1997). It also promotes vegetation growth, flower and fruit set of tomato (Bose and Som, 1990). It significantly increases the growth and yield of tomato (Banerjee et al. 1997).

Nitrogen has a pronounced effect on growth and development of tomato. It promotes both vegetative and reproductive growth and impacts the characteristic deep green color of leaves. Nitrogen application resulted in greater values of plant height, leaf area, number of leaves and stem diameter of fodder maize, fresh and dry forage yield were also increased due to addition of nitrogen (Koul, 1997). Leaf to stem ratio was found also to be increased by nitrogen (Duncan, 1980) that the increase in leaf

to stem ratio with nitrogen application is probably due to the increase in number of leaves and leaf area under nitrogen treatments, producing more and heavy leaves (Gasim, 2001).

Application of N-fertilizer to the soil produces high tomato fruit yield and improves fruit quality (Adams et al., 1978) whereas excessive application leads to luxuriant development of vegetative parts of the plant at the expense of reproductive growth (Tisdale *et al.,* 2003). It has been reported that tomato can grow on a variety of soils except worst soils such as gravelly soils and water-logged soils (Simons and Sobulo, 1974) but better yields were obtained from some soil types than others even with the same management practices and environmental conditions (Pettygrove *et al.,* 1999). The specific dose of nitrogen may affect yield and storage behavior of tomato fruits. The experiment objective is to find out amount of nitrogen for optimum growth and higher yield of tomato per unit area of land.

Fandi *et al.* (2010) concluded that high concentration of N, P and K in the nutrient solution gave higher total yield and tomato fruit weight than the control nutrient solution in tuff culture grown tomato. High phosphorus concentration (100 ppm) in the nutrient solution gave the highest total and marketable yield, number of marketable fruits and yield plant, while low phosphorus concentration (20 ppm) gave the highest total soluble solids and titratable acids content in tuff culture grown tomato. The control nutrient solution gave the least total soluble solids, titratable acidity content and the highest pH of tomato juice.

Ferreira et al. (2010) studied that nitrogen fertilization efficiency of the tomato crop, with organic fertilization, was evaluated in two experiments

conducted at two times: spring/summer and autumn/spring. The experiments were carried out at the Horticulture experimental field of the Universidade Federal de Vicosa in a Cambic Red-Yellow Argisol. In both times, the applied N doses, in the form of nitrocalcium, were 0.0, 93.3, 187.0, 374.0 and 748.0 kg ha^{-1} and the doses of organic fertilization, in the form of cattle manure compost, were 0 and 8 t ha^{-1} of dry matter. The weight and the number of marketed tomatoes plant-1 increased with the increase of N level in the soil. The percentage of commercially discarded fruits was larger in the spring/summer than in the autumn/spring. The nitrogen fertilization efficiency in tomato crop was higher in the autumn/spring than in the spring/summer. In the spring/summer, the efficiency was higher without the addition of organic matter to the soil, whereas in the autumn/spring the opposite took place.

Greenhouse field experiments on tomato were carried out at Shouguang by Tao Ren *et al.* (2010) in Shandong province, over four double cropping seasons between 2004 and 2008 in order to understand the effects of manipulating root zone N management (RN) on fruit yields, N savings and N losses under conventional furrow irrigation. About 72% of the chemical N fertilizer used in conventional treatment (CN) inputs could be saved using the RN treatment without loss of yield. The cumulative fruit yields were significantly higher in the RN treatment than in the CN treatment. Average seasonal N from irrigation water (118 kg N ha^{-1}), about 59% of shoot N uptake, was the main nitrogen source in treatments with organic manure application (MN) and without organic manure or nitrogen fertilizer (NN). N losses in the RN treatment were lowered by 54% compared with the CN treatment. Lower N losses were found in the MN and NN treatments due to excessive inputs of organic manure and fruit 10 yields were consequently substantially affected in the

NN treatment. The critical threshold of N min supply level in the root zone (0-30 cm) should be around 150 kg N ha^{-1} for sustainable production. April to May in the winter-spring season and September to October in the autumn-winter season are the critical periods for root zone N manipulation during crop growth. However, control of organic manure inputs is another key factor to further reduce surplus N in the future.
Kikuchi (2009) observed that growth and nitrogen content were different among nine tomato cultivars grown under three nitrogen levels (50, 100, 150 mg N/L). Applied nitrogen efficiency to growth was the highest in Odoriko', and the lowest in 'June Pink'. It was suggested that the difference in tomato growth was influenced not only by the difference of nitrogen uptake but also the difference of nitrogen efficiency ratio (dry weight per nitrogen content).

A positive correlation between the tomato growth and the content of assimilated nitrogen was observed. Therefore, it was suggested that the ability of nitrogen assimilation was different among the cultivars, and that the difference in ability of nitrogen assimilation influenced the difference in the nitrogen efficiency ratio and growth. They compared 'Odoriko' and 'June Pink' for nitrate (NO^{3-}) reduction, which is the most important step in nitrogen assimilation. It was shown that there were differences of nitrate reductase (NR) activity and rate of nitrate assimilation between the two cultivars.

An investigation was carried out by Bhadoria et al. (2007) to evaluate the effect of methods of Azotobacter inoculation in combination with nitrogen rates on the flowering and fruiting behavior of tomato cv. JT-99. Treatments comprised: three methods of inoculation (no inoculation, soil inoculation and seedling inoculation) and five nitrogen rates (0, 25, 50, 75

and 100 kg ha^{-1}). Seedling treatment with Azotobacter recorded the earliest flowering, fruit setting and picking of fruits, as well as higher number of flowers, fruits and yield ha^{-1}.

This was followed by soil inoculation with Azotobacter and no inoculation. The days to first 11 flowering, number of flowers cluster-1, days to first fruit setting, number of fruits cluster-1 and days to first picking of fruits increased with increasing nitrogen rate. The interaction effect of nitrogen rates and Azotobacter inoculation showed significant influence on days to first flowering, fruit setting and fruit picking in tomato. The maximum number of flowers, fruits $cluster^{-1}$ and yield ha^{-1} were recorded with the application of 75 kg N ha^{-1} + seedling inoculation with Azotobacter. However, the number of flowers and fruits $cluster^{-1}$ were at par with each other upon treatment with 100 kg N ha^{-1} + seedling inoculation with Azotobacter and 100 kg N ha^{-1} alone.

Hossain (2007) conducted a field experiment at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from October, 2006 to March, 2007 in order study the effects of nitrogen and stem pruning on the yield of tomato cv. Pusa Ruby.

The experiment consisted of four doses of nitrogen, viz., 85, 171, 256 and 342 kg N ha^{-1} and three levels of pruning, viz., single stem, double stem and triple stem. The experiment was laid out in RCBD with 12 treatment combinations and three replications. Nitrogen showed significant influence on the growth and yield contributing characters of tomato. The plant height at 50 DAT, number of flower clusters $plant^{-1}$, flowers $cluster^{-1}$, flowers $plant^{-1}$, fruit clusters $plant^{-1}$, fruits $cluster^{1}$, ripe fruits $plant^{-1}$, fruit diameter, weight of individual fruit, weight of fruits $plant^{-1}$ and fruit yield $plot^{-1}$ were the highest when 256 kg N ha^{-1} was applied.

The yield of tomato under this treatment was 84.36tha^{-1}. On the other hand, different pruning methods showed significant effects on most of the characters. Maximum yield (82.21 t ha^{-1}) was obtained from double stem pruned plants and the minimum yield (68.15 t ha^{-1}) was obtained from single stem pruned plants. The combination of nitrogen and stem pruning also exhibited significant variation in all the yield components and yield. The combination of 256 kg N ha^{-1} and double stem pruning produced the highest yield of tomato (90.70 t ha^{-1}).

Solaiman and Rabbani (2006) carried out a field experiment was at the Bangabandhu Sheikh Mujibur Rahman Agricultural University farm in Bangladesh, to assess the effects of inorganic and organic fertilizers on vegetative, flowering and fruiting characteristics as well as yield attributes and yield of Ratan variety of tomato. The plots were treated with three levels each of N (62, 100 and 200 kg ha^{-1}), P (11.7, 17.5 and 35 kg ha^{-1}), K (26.7, 40 and 80 kg ha^{-1}), S (5, 7.5 and 15 kg ha^{-1}) and cowdung (5, 10 and 15 t ha^{-1}). The highest plant height and dry weight of shoot, the maximum number of clusters of flowers and fruits plant^{-1} as well as the greatest fruit size and fruit yield plant^{-1}, fruit yield ha^{-1} were obtained from the application of the recommended dose of nutrients viz. 200 kg N + 35 kg P + 80 kg K + 15 kg S ha^{-1}, but similar results were obtained from the treatment receiving 5 t cowdung ha^{-1} along with half of the recommended doses of nutrients (100 kg N + 17.5 kg P + 40 kg K + 7.5 kg S ha^{-1}). The effect of 10 t cowdung ha^{-1}, along with one third of the recommended dose of nutrients, was also comparable to the effect of employing the recommended dose of nutrients.

It was further observed, from an economic standpoint, that the combination of 5 t cowdung ha^{-1} along with half of the recommended doses of nutrients appeared to be a viable treatment which would offer the

maximum benefit concerning cost ratio (4.38) for tomato production in the shallow red-brown terrace soil (AEZ-28) of Bangladesh.

Parisi et al. (2006) studied to influence of nitrogen supply (from 0 to 250 kg N ha^{1}) on yield and quality components of processing tomato grown in 2002-03 in Sele valley (Campania, Italy). Nitrogen fertilizer application from 50 to 250 kg ha^{-1} increased total yield but not marketable yield, because of a strong increase of unmarketable yield. Rates higher 150 kg ha^{-1} did not produce increase in total, ripe and unripe yield. The highest rate supply resulted in less concentrated ripeness, more phytosanitary problems and an increase of viral damage incidence on fruits. High nitrogen supply reduced some important processing 13 characteristics such as pH, soluble solids, glucose and fructose content, as well as sugar/total solids ratio.

Ingole et al. (2005) carried out an experiment to evaluate the effect of N and K fertilizers (muriate and sulfate of potash) on the fruit yield and quality of tomato cv. Arkas Vikas. The treatments included N at 75, 100 and 125 kg ha^{-1}; and K at 25, 50 and 75 kg ha^{-1}.

K levels did not significantly affect yield. Maximum yield was obtained from 100 kg N ha^{-1} (31.14 t ha^{-1}). Nitrogen @ 125 kg ha^{-1} produced the highest soluble solids content in fruits.

Nitrogen at 125 kg ha^{-1} + K at 25 kg ha^{-1} resulted in maximum titratable acidity. Ascorbic acid content was highest with 125 kg N ha^{-1} + 75 kg K ha^{-1} (as sulfate of potash), while lycopene content was highest with 125 kg N ha^{-1} + 50 kg K ha^{-1} (as muriate of potash).

Singh et al. (2005) conducted an experiment to study the effects of N, P, and K at 200:100:150, 350:200:250, and 500:300:350 kg ha^{-1} on the growth and yield of tomato hybrids Rakshita, Karnataka, and Naveen in

New Delhi, India during the early winter of 2000-02. Naveen had the highest number of flower clusters per plant and the earliest picking period and fruit setting. On the other hand, Karnataka produced the highest yield during both years (2.85 and 3.07 kg plant^{-1}). Plant height, number of leaves plant^{-1}, leaf length, stem thickness, number of flower clusters plant^{-1}, and picking period were the highest with the application of 500:300:350 kg NPK ha^{-1} during both years. Fruit yield (30.2 and 34.8 kg ha^{-1} in 2000-01 and 2001-02, respectively) and number of pickings (14 during both years) were the highest with the application of 350:200:250 kg NPK ha^{-1}.

A field experiment was conducted in Agra, Uttar Pradesh, India during the rabi season by Singh et al.(2005) in 1996-99 to determine the effects of different N rates (0, 100, 200 and 300 kg ha^{-1}) and plant spacing (75 x 50, 75 x 75 and 75 x 100 cm) on the yield and yield attributes of tomato cultivars Naveen (indeterminate and Rupali (determinate).The number of fruits plant^{-1}; fruit weight; fruit yield plant^{-1}; and total yield increased with increasing plant spacing and N rates up to 200 kg ha^{-1}, and decreased thereafter.The number of fruits plant^{1}, fruit yield plant^{-1} and total yield were higher in Naveen, whereas fruit weight, diameter and specific gravity were higher in Rupali.

Badruddin and Dutta (2004) reported that N requirement based on nitrate reductase

(NR) induction, N accumulation and productivity. N fertilizer was applied at 0, 75, 100, 125, 150 and 175 kg ha^{-1}, in 2 split-doses (24 and 40 days after transplanting). Fruit yield increased compared to the control. Nitrogen @ 175 kg ha^{-1} produced the highest straw yield.

Straw N content was the highest (3.11%) with 100 kg N ha^{-1} in Mymensingh, while the highest N content (3.07%) in Rangpur was

obtained with 125 kg N ha^{-1}. The highest fruit N accumulation (156 kg ha^{-1}) in Mymensingh was obtained with 175 kg N ha^{-1}, while 150 kg N ha^{-1} produced the highest fruit N accumulation (170 kg ha^{-1}) in Rangpur. There was a significant NR activity throughout the growing period of Bahar, which maintained the highest NR activity.

A field experiment was conducted by Basunia (2004) to study the effect of different levels of nitrogen and pruning on the growth and yield of tomato cv. BAR1Tomato-6 at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from October 2003 to March 2004. There was four nitrogen levels, viz., 0, 100, 200, 300 kg N ha^{-1} and three pruning levels, viz., no pruning, single stem and double stem pruning. The results of the experiment revealed that plant height, total number of leaves, number of green leaves $plant^{-1}$ at final harvest, days to first flowering, number of flower clusters, flower $cluster^{-1}$, flower $plant^{-1}$, fruits $cluster^{-1}$, fruits $plant^{-1}$, length and diameter of fruit, individual fruit weight and fruit yield were significantly influenced by the different levels of nitrogen.

The combined effect of nitrogen and pruning exhibited significant variation on plant height at 35, 50 and 65 DAT and at harvest, number of leaves, other yield contributing attributes and 15 fruit yield of tomato. The highest fruit yield (70.12 t ha^{-1}) was obtained from the highest level of nitrogen (300 kg ha^{-1}) followed by 200 kg ha^{-1} (59.58 t ha^{-1}), 100 kg N ha^{-1} (47.22 t ha^{-1}) and control (36.10 t ha^{-1}).

Kaur Harne et al. (2003) observed the effect of nitrogen and potassium application on the growth, yield and quality of spring crop of tomato cv. Punjab Upma. Treatments consisted of 16 combinations of 4 levels each

of N (100, 140, 180, 220 kg ha^{-1}) and K (40, 60, 80, 100 kg ha^{-1}). Increasing the N level from 100 to 140 kg ha^{-1} and the K level from 40 to 60 kg ha^{-1} significantly increased marketable and total yields. Significant increase in juice content, ascorbic acid content, N and K concentrations in leaves was observed when the N level increased from 100 to 140 kg ha^{-1}. There was also a significant increase in the concentration of K in leaves when K level was increased from 40 to 60 kg ha^{-1}.

A field experiment was conducted at Bhubaneswar, India by Sahoo et al. (2002) to

study the effects of nitrogen (50, 100, 150 or 200 kg N ha^{-1}) and potassium (75 or 150 kg ha^{-1}) on the growth and yield of tomato var. Utkal kumara during the rabi season of 1999-2000. The wide range of variation was marked by the application of nitrogen with respect to growth, development and yield of tomato fruit. The fruit yield increased with each increase in the levels of nitrogen from 50 to 150 kg but further increased of nitrogen beyond 150 kg ha^{-1} reduced the yield considerably. They also found that the highest value relating to yield attributing characters like number of fruits $plant^{-1}$ and single fruit weight were maximums when potassium was applied at the rate of 75 kg ha^{-1}. However, the combination of 150 kg N ha^{-1} along with 75 kg K ha^{-1} gave best result with respect to tomato from yield and other yield attributing characters.

Ceylan et al. (2001) conducted an experiment at Odemis, Izmir, Turkey to observe the effect of ammonium nitrate and urea fertilizers at 0, 12, 24, 36 kg N ha^{-1} on nitrogen uptake and accumulation in tomato plants. The total nitrogen, NO_2-N and NO_3-N contents of 16 leaves and fruits were determined. On the first and second harvest dates, the highest NO_3-N and NO_2-N amounts in tomato leaves and fruits were obtained upon treatment

with 36 kg N ha^{-1}. Ammonium nitrate application increased nitrate and nitrite accumulation compared to urea application. The highest yield was recorded upon treatments with 24 kg N ha^{-1}.

Sharma and Thakur (2001) carried out a field trial at Nauni, India during the summer season of 1995 and 1996 to investigate the effect Azotobacter biofertilizer (M4 Strain and commercial formulation of Natrin) in combination with various levels of nitrogen (0, 50, 75 and 100 kg N ha^{-1}) on the growth and yield of tomato cv. Yashwant. They reported that among individual treatments, the application of Natrin results in significant improvement in plant height number of branches and fruits $plant^{-1}$, fruit yield $plot^{-1}$, yield ha^{-1}, nitrogen uptake at flowering stage and root biomass. Similarly the maximum values for all these parameters were recorded at 100 kg N ha^{-1}.

Among treatment combinations the maximum yield ha^{-1} was obtained when Natrin (Azotobacter) was applied in combination with 100 kg N ha^{-1}. From the above review of literature we can say that application of nitrogen has an undoubted immense importance on the growth and yield of tomato. Increasing rate of nitrogen up to a certain level significantly increase plant height, number of flowers and fruit $plant^{-1}$, fruit length, fruit diameter as well as yield ha^{-1}.

And it plays an important role for obtaining larger fruit size, individual fruit weight and ultimately yield ha^{-1}. In the most of the cases it was reviewed higher N applied plants showed better yield. So, it is necessary to select the proper dose of nitrogen level for better yield of tomato.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying outthe experiment. It includes a short description of location of the experiment, characteristicsof soil, climate, materials used, land preparation, manuring andfertilizing, transplantingand gap filling, staking, after care, harvesting and collection of data.

3.1 Location of the experiment field

The field experiment was conducted in the Sher-e-BanglaAgricultural University farm, Sher-e-Bangla Nagar, Dhaka-1207 during the period fromOctober 2014 to March 2015 to find out the effect of different doses of nitrogenon the growth and yield of BARI tomato 2 and BARI tomato 14. The location of the experimental site is at 23.75 N latitude and 90.34 E longitudes with an elevation of 4 meter from the sea level (Anon., 1989).

3.2 Climate

The climate of the experimental area was subtropical in nature. It is characterized by heavy and moderate rainfall, high temperature, high humidity and relatively long day during kharif season (April to September) and a scanty rainfall associated with moderately low temperature, low humidity and short day period during rabi season(October to March).

3.3 Soil of the experimental field

Soil of the study site was silty clay loam in texture. The area represents the Agro- Ecological Zone of Madhupur tract (AEZ-28) with pH 5.8-6.5, ECE 25.28 (Haider, 1991).

The analytical data of the soil sample collected from the experimental area were determined in the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka.

3.4 Plant materials used

The tomato variety BARI Tomato-2 and BARI Tomato-14were used in the experiment. These were high yielding, heat tolerant and semi-indeterminate type varieties, the seeds of which were collected from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5 Raising of seedlings

Tomato seedlings were raised in three seedbeds situated on a relatively high land at

Sher-e-BanglaAgricultural University farm. The size of the seedbed was 3 m x l m. The soil was well prepared with spade and made into loose friable and dried mass to obtain fine tilth. All weeds and stubbles were removed and 5 kg well rotten cowdung per bed was applied during seedbed preparation. The seeds were sown on the seedbed on 30 December,2014 to get 30 days old seedlings. Germination was visible 3 days after sowing of seeds. After sowing, seeds were covered with light soil to a depth of about 0.6 cm. Heptachlor 40 WP was applied @ 4 kg ha^{-1} around each seedbed as precautionary measure against ants and worm. The emergence of the seedlings took place within 5 to 6 days after sowing. Necessary shading by banana leaves was provided over the

seedbed to protect the young seedlings from scorching sun or unwanted rain.

3.6 Treatments of the experiment

The experiment consisted of two factors as follows:

Factor A: The experiment consisted of five different level of nitrogen which are mentioned below with alphabetic symbol.

Doses of N (kg ha^{-1})	Alphabetic symbol
Control treatment (No N fertilizer)	N_0
80 kg N fertilizer	N_1
100 kg N fertilizer	N_2
120 kg N fertilizer	N_3
140 kg N fertilizer	N_4

Factor B: It is consisted of two varieties which are mentioned below with alphabetic symbol

Varity	Alphabetic symbol
BARI Tomato 2	V_1
BARI Tomato 14	V_2

Total 10 treatment combinations were as follows:

V_1N_0: BARI Tomato 2 + 0 kg N ha^{-1}

V_1N_1: BARI Tomato 2 + 80 kg N ha^{-1}

V_1N_2: BARI Tomato 2 + 100 kg N kg ha^{-1}

V_1N_3: BARI Tomato 2 + 120 kg N kg ha^{-1}

V_1N_4: BARI Tomato 2 + 140 kg N kg ha^{-1}

V_2N_0: BARI Tomato 14 + 0 kg N ha^{-1}

V_2N_1: BARI Tomato 14 + 80kg N ha^{-1}

V_2N_2: BARI Tomato 14 + 100 kg N kg ha^{-1}

V_1N_3: BARI Tomato 14+ 120 kg N kg ha^{-1}

V_2N_4: BARI Tomato 14 + 140 kg N kg ha^{-1}

The experiment was laid out in Randomized complete Block Design (RCBD) having two factors with three replications. The treatment combinations were accommodated in the unit plots.

3.7 Layout of the experiment

An area of 31.5 m x 11.2 m was divided into three equal blocks. Each block consisted of 10 plots where 10 treatments were allotted randomly. There were 30 unit plots altogether in the experiment. The size of each plot was 2 m x 1.8 m. The distance between two blocks and two plots were l m and 0.5 m respectively. Seedlings were transplanted on the plots with 60 cm x 40 cm spacing (Appendix 5).

3.8 Cultivation procedure

3.8.1 Land preparation

The soil of the experiment field was first opened on 05 November, 2014 in order to get well prepare and good tilth for tomato crop production. The land of the experimental field was ploughed with a power tiller. Later on the land was ploughed three times followed by laddering to obtain

untill desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed. Finally, the unit plots were prepared as 15 cm raised beds. Fifteen pits were made in each plot with in row-to-row and plant to plant spacing of 60 cm X 40 cm.

3.8.2 Manuring and Fertilizing

Manure and fertilizers such as Cow dung, Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP) were applied in the experimental field as per recommendation of BARC,2012.

The entire amount of well-decomposed cow dung was applied just after opening the land and the total Amount TSP was applied as basal dose during final land preparation. Urea and MoP were applied in two installments by the ring placement. The first ring placement was done three weeks after transplanting and the remaining was done two weeks after the first ring placement.

3.8.3 Transplanting of seedlings

Healthy and uniform 30 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots in the afternoon of 25 November, 2014 maintaining a spacing of 60 cm x 40 cm between the rows and plants respectively.

This allowed an accommodation of 15 plants in each plot. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots.

The seedlings were watered after transplanting. Shading was provided using banana leaf sheath for three days to protect the seedling from the hot sun and removed after seedlings were established. Seedlings were

also planted around the border area of the experimental plots for gap filling.

3.8.4 Intercultural operations

After transplanting the seedlings, different intercultural operations were accomplished for better growth and development of the plants, which are as follows.

3.8.4.1 Weeding and mulching

Weeding was done whenever it was necessary. Mulching was also done to help in soil moisture conservation.

3.8.4.2 Gap filling

A few gap filling was done by healthy seedlings of the same stock where planted seedlings failed to survive. When the seedlings were well established, the soil around the base of each seedling was pulverized.

3.8.4.3 Irrigation

Light watering was given with water can immediately after transplanting the seedlings and then necessary irrigation was done as and when necessary throughout the growing period up to before 7 days of harvesting.

3.8.4.4 Plant protection

Insect pests: Melathion 57 EC was applied @ 2 ml L^{-1} of water against the insect pests like cut worm, leaf hopper, fruit borer and others. The insecticide application was made fortnightly after transplanting and stopped before second week of first harvest. Furadan lOG was also applied during final land preparation as soil insecticide.

Disease: During foggy weather precautionary measure against disease attack of tomato was taken by spraying Diathane M-45 fortnightly @ 2 gm per litre of water, at the early vegetative stage. Ridomil gold was also applied @ 2 g per litre of water against blight disease of tomato.

3.8.4.5 Harvesting

Fruits were harvested at 3-days interval during early ripe stage when they developed slightly red color. Harvesting was started from 19 April, 2015 and was continued up to May, 2015.

3.9 Parameters assessed

Five plants were selected at random and uprooted carefully at the time of collecting data of root from each plot and mean data on the following parameters were recorded:-

- Plant height (cm)
- Number of clusters per plant
- Number of fruits per cluster
- Number of fruit per Plant
- Fruit Weight (kg/ Plant)
- Fruit Yield (t/ha)
- N Content in Plant %

3.10 Data collection

Five plants were selected randomly from each plot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the period of experiment.

3.10.1Plant height (cm):

The plant height was recorded at 14 days interval starting from 28 days of transplanting up to 70 days. Plant height was taken at 28, 42, 56 and 70 days after transplanting to record the growth rate of plants.

3.10.2Number of clusters per plant:

The number of fruit clusters was counted from the sample plants and the average number of clusters borne per plant was recorded at the time of final harvest. The data of cluster/plant is presented only 45 and 63 DAT.

3.10.3Number of fruits per plant:

Total number of fruits was counted from selected plants and their average was taken as the number of fruits per plant at harvest.

3.10.4Length of fruit (cm):

The length of fruit was measured with slide-calipers from the neck to the bottom of

5 selected marketable fruits and their average was taken in cm as the length of fruit.

3.10.5Yield per plant (kg):

The fruits were harvested from 5 sample plants and they were measured with the help of measuring balance and average was taken by following formula:

Yield per plant (kg) = Total weight of fruits in 5 sample plants (kg) ÷ 5.

3.10.6Yield per hectare (ton):

The yield per hectare was calculated out from per plot yield data.

3.10.7N Content in Plant %

After harvesting tomato plants from each plot were taken for drying and proper processing. Processed plants were analyzed for N content in plant percentage from Soil Resource Development Institute (SRDI) Laboratory.

3.11 Statistical analysis

The data in respect of growth and yield components were statistically analyzed to find out the significance of the experimental results. The means of all the treatments were calculated and the analysis of variance for each of the characters under study was performed by F test. The difference among the treatment means was evaluated by Least Significant Difference (LSD) test (Gomez and Gomez, 1984) at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the experiment conducted under field conditions are presented in several Tables and Figures. The experiment was conducted to study the effect of different levels of Nitrogen on the performance of BARI Tomato 2 and BARI Tomato 14 in RCBD 2 factor. The results are presented and discussed under the following parameters.

4.1 Effect of varieties

4.1.1 Plant Height

Plant height of the present study was not significantly influenced due to the effect of varieties. The heights were varied from 96.92 to 101.79 cm (Table 1). Between the varieties BARI Tomato 14 was found with taller plant height (101.79 cm) than BARI Tomato 2. Where, BARI Tomato 2 produced shorter plant height (96.92 cm). Many scientists found such kinds of findings in their study. Due to non significant variation, BARI Tomato 14 is better than BARI Tomato 2.

Table 1: **Effect of varieties on plant height, cluster plant^{-1}, flower plant^{-1} and fruit cluster^{-1} at harvest**

Variety	Plant Height (cm)	Cluster Plant^{-1}	Fruit Cluster^{-1}
BARI Tomato 2	96.92 a	8.45 a	8.398 a
BARI Tomato 14	101.79a	8.768 a	8.734 a
NS **LSD $_{(0.01)}$**	NS	NS	NS
CV (%)	1.23%	12.07%	9.07%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.1.2 Cluster Plant^{-1}

Performance study of tomato varieties had non-significant effect on Cluster Plant^{-1}. The Clusters Plant^{-1} was varied from 8.45 to 8.768 (Table 1). Between the varieties BARI Tomato 14 was found with highest Cluster Plant^{-1} (8.768) than BARI Tomato 2. Where, BARI Tomato 2 produced shortest Cluster Plant^{-1} (8.45). Many scientists found such kinds of findings in their study. Due to significant variation, BARI Tomato 14 is better than BARI Tomato 2 in case of cluster plant^{-1}.

4.1.3 Number of Fruit Cluster^{-1}

The effect of varieties on fruit cluster^{-1} was non-significant. The fruit cluster^{-1} was varied from 8.398 to 8.734 (Table 1). Between the varieties BARI Tomato 14 was found with highest Cluster Plant^{-1} (8.734) than BARI Tomato 2. Where, BARI Tomato 2 produced more fruit cluster (8.398). Many scientists found such kinds of findings in their study. Due to significant variation, BARI Tomato 14 is better than BARI Tomato 2 in case of cluster plant^{-1}.

4.1.4 Number of Fruit Plant^{-1}

Performance study of tomato varieties had no significant effect on fruit Plant^{-1}. The fruit Plant^{-1} were varied from 14.672 to 15.648 (Table 2). Between the varieties BARI Tomato 14 was found with highest fruit Plant^{-1} (15.648) than BARI Tomato 2. Where, BARI Tomato 2 produced lowest fruit Plant^{-1} (14.672). Many scientists found such kinds of findings in their study. Due to significant variation, BARI Tomato 14 is better than BARI Tomato 2 in case of fruit plant^{-1}.

Table 2: Effect of varieties on fruit plant^{-1}, fruit weight^{-1} (kg/ Plant) and fruit Yield (t/ha) at harvest

Variety	Fruit Plant^{-1}	Fruit Weight(kg/ Plant)	Fruit Yield (t/ha)
V_1	14.672 a	2.23 a	38.61 a
V_2	15.648 b	2.79a	41.72 b
LSD $_{(0.01)}$	1.550	NS	0.1111
CV (%)	5.72%	0.23%	0.04%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.1.5 Fruit Weight (kg/ Plant)

Non Significant response was observed in fruit weight (kg/ Plant) due to effect of varieties. The fruit weight (kg/ Plant) were varied from 2.23 to 2.79 (Table 2). Between the varieties BARI Tomato 14 was found with higher fruit weight (2.79 kg/plant) than BARI Tomato 2. Where BARI Tomato 2 produced lowest fruit weight (2.23 kg/plant). Many scientists found such kinds of findings in their study. Due to non significant variation, BARI Tomato 14 is better than BARI Tomato 2 in case of fruit weight (kg/ Plant).

4.1.6 Fruit Yield (t/ha)

Performance study of tomato varieties had significant effect on fruit yield (t/ha). The fruit yield (t/ha) were varied from 38.61 to 41.72 t/ha (Table 2). Between the varieties BARI Tomato 14 was obtained higher yield (41.72 t/ha) than BARI Tomato 2. Where, BARI Tomato-2 was produced lowest fruit yield (38.61 t/ha). Many scientists found such kinds of findings in their study. Due to significant variation, BARI Tomato 14 is better than BARI Tomato 2 in case of fruit yield (t/ha). So BARI Tomato 14 can be recommended for better result.

4.1.7 N Content in Plant %

Varietals effect of the present study on N content in tomato plants had statistically non significant where N varied from 1.42 to 1.44% (Table 3). It was found highest value (1.44%) of N content in plant recorded from the variety BARI Tomato 14 whether lowest value (1.42%) was presented in BARI tomato 2. That shows BARI Tomato 14 can uptake more N than others which can responsible for better result always.

Table 3:Effect of varieties on N Content in Plant % at harveststage

Variety	N Content in Plant %
V_1	1.42 a
V_2	1.44 a
LSD (0.01)	NS
CV (%)	0.99%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.2 Effect of Nitrogen treatments

4.2.1 Plant Height:

Plant height of the present study was significantly influenced due to the effect of Nitrogen treatments. The height was varied from 78.29 to 111.7 cm (Table 4). Among the treatments N_3 was found with tallest plant height (111.7 cm) which was significantly similar with N_4 treatement.

Table 4: **Effect of different doses of Nitrogen treatment on plant height, cluster plant^{-1}, flower plant^{-1} and fruit cluster^{-1} at harvest**

Treatment	Plant Height	Cluster Plant^{-1}	Flower Plant^{-1}	Fruit Claster^{-1}
N_0	78.29 d	7.973 a	11.56 b	7.923 a
N_1	92.33 c	8.035 a	12.03 b	8.253 a
N_2	103.0 b	8.650 a	12.93 a	8.682 a
N_3	111.7 a	9.125 a	13.85 a	9.051 a
N_4	110.2 a	9.035 a	13.33 a	8.843 a
LSD $_{(0.01)}$	2.165	NS	1.024	NS
CV (%)	1.23%	12.07%	4.48%	9.07%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.2.2 Number of Cluster Plant^{-1}

Performance study of Nitrogen treatments had significant effect on Number of Cluster Plant^{-1}. The Clusters Plant^{-1} was varied from 7.973 to 9.125 (Table 4). Among the treatments N_3 was found with highest Cluster Plant^{-1} (9.125) which was significantly similar with N_4 treatment. Where N_0 was produced shortest clusters Plant-1 (7.973).

4.2.3 Number of Fruit Cluster^{-1}

The effect of treatments on fruit cluster^{-1} was highly significant. The fruit cluster^{-1} were varied from 7.923 to 9.051 (Table 4). Among the treatments N_3 was found with highest Fruit Cluster Plant^{-1} (9.051) than rest of treatments. Where, N_0 gave lowest result (7.923). Many scientists found such kinds of findings in their study. Due to significant variation, N_3 treatment was found suitable in case of cluster plant^{-1}.

4.2.4 Number of Fruit Plant^{-1}

Performance study of Nitrogen treatments had significant effect on fruit Plant^{-1}. The fruit Plant^{-1} were varied from 12.43 to 17.21 (Table 5). Among the treatments N_3 was found with highest number of fruit Plant^{-1} (17.21) which was significantly similar with N_4 treatment. Where N_0 was produced lowest fruit Plant^{-1} (12.43).

Table 5: Effect of different levels of nitrogen treatments on fruit plant^{-1}, fruit weight (kg/ Plant) and fruit Yield (t/ha) at harvest

Treatment	Fruit Plant^{-1}	Fruit Weight(kg/ Plant)	Fruit Yield (t/ha)
N_0	12.43 c	2.261 e	31.25 e
N_1	14.10 b	2.430 d	35.16 d
N_2	14.93 b	2.691 c	44.95 c
N_3	17.21 a	2.850 a	46.45 a
N_4	17.00 a	2.723 b	46.30 b
LSD $_{(0.01)}$	1.550	0.05474	0.1111
CV (%)	5.72%	0.23%	0.04%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.2.5 Fruit Weight (kg/ Plant)

Significant response was observed in fruit weight (kg/ Plant) due to effect of treatments. The fruit weight (kg/ Plant) was varied from 2.261 to 2.850 (Table 5). Among the treatments N_3 was found with highest fruit weight (2.850 kg/plant) than any other treatments. Where N_0 treatment produced

lowest fruit weight (2.261 kg/plant). Due to significant variation, N3 treatment was found better in case of fruit weight (kg/ Plant).

4.2.6 Fruit Yield (t/ha)

Performance study of treatments had significant effect on fruit yield (t/ha). The fruit yield (t/ha) were varied from 31.25to 46.45 t/ha (Table 5). Among the treatments, highest yield (46.45 t/ha) was obtained from N_3 treatment. Where, N_0 was produced lowest (31.25 t/ha). So N_3 treatment can be recommended for better result.

4.2.7 N Content in Plant (%)

Treatment effect of the present study on N content in tomato plants had statistically significant where N varied from 0.9250 to 1.680 ppm (Table 6). It was found highest value (1.680) of N content in plant recorded from the N_3 treatment whether lowest value (0.9250) was obtained in N_0 treatment where no use of N fertilizer. That shows N_3 treatment can uptake more N.

Table 6: Effect of treatments on N Content in Plant % at harvest stage

Treatment	N Content in Plant %
N_0	0.9250 e

N_1	1.352 d
N_2	1.550 c
N_3	1.680 a
N_4	1.640 a
LSD (0.01)	0.05474
CV (%)	0.99%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14
** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.3 Combined effect of Variety and Treatment

4.3.1 Plant Height:

The interaction effect of varieties and nitrogen treatments showed significant effect on plant height (Table 7) where the range of plant height was 74.95 to 114.0 cm. From the result, it was observed that the highest plant height (114.0 cm) was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (112.5 cm) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of plant height (74.95 cm) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1}).

Table 7: **Combined effect of verities and nitrogen treatment on plant height, cluster $plant^{-1}$, flower $plant^{-1}$ and fruit $cluster^{-1}$ at harvest**

Combined effect of Variety and Treatment		Plant Height	Cluster Plant^{-1}	Fruit Claster^{-1}
V_1	N_0	74.95 d	7.790 b	7.780 a
	N_1	90.26 c	7.830 c	8.010 a
	N_2	100.0 b	8.580 b	8.550 a
	N_3	110.6 a	9.110 a	8.950 a
	N_4	108.8 b	8.920 b	8.700 a
V_2	N_0	82.53 d	8.225 b	8.220 a
	N_1	94.71 c	8.372 b	8.462 a
	N_2	105.2 b	8.865 b	8.780 a
	N_3	114.0 a	9.265 a	9.195 a
	N_4	112.5 a	9.115 a	9.013 a
LSD (0.01)		2.165	1.833	NS
CV (%)		1.23%	12.07%	9.07%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.3.2 Cluster Plant^{-1}

The interaction effect of varieties and nitrogen treatment showed significant effect on cluster Plant^{-1} (Table 7) where the range of cluster Plant^{-1} was 7.790 to 9.265. From the result, it was observed that the highest cluster Plant^{-1} (9.265) was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (9.115) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of cluster Plant^{-1} (7.790) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1}).

4.3.4 Fruit Cluster^{-1}

The interaction effect of varieties and nitrogen treatment showed significant effect on fruit cluster^{-1} (Table 7) where the range of fruit cluster^{-1} was 7.780 to 9.195. From the result, it was observed that the highest fruit cluster^{-1} (9.195) was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (9.013) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of fruit cluster^{-1} (7.780) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1}).

4.3.5 Fruit Plant^{-1}

The interaction effect of varieties and nitrogen treatment showed significant effect on fruit Plant^{-1} (Table 8) where the range of fruit Plant^{-1}was 11.96 to 17.84. From the result, it was observed that the highest fruit Plant^{-1} (17.84) was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (17.20) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of fruit Plant^{-1} (11.96) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1})) where no nitrogen application in BARI Tomato-2.

Table 8: Combined effect of verities and nitrogen treatments on fruit plant-1, fruit weight (kg/ Plant) and fruit Yield (t/ha) at harvest

Combined effect of Variety and Treatment		Fruit Plant^{-1}	Fruit Weight(kg/ Plant)	Fruit Yield (t/ha)
V_1	N_0	11.96 c	2.021 e	30.15 e
	N_1	13.81 b	2.110 d	33.75 d
	N_2	14.34 b	2.251 c	35.81 c
	N_3	16.80 a	2.430 a	46.91 a
	N_4	16.45 a	2.326 b	46.43 b
V_2	N_0	13.09 a	2.516 e	32.93 e
	N_1	14.88 a	2.661 d	39.13 d
	N_2	15.23 a	2.782 c	41.24 c
	N_3	17.84 a	3.080 a	47.83 a
	N_4	17.20 a	2.953 b	47.46 b
LSD $_{(0.01)}$		1.550	0.05474	0.1111
CV (%)		5.72%	0.23%	0.04%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

4.3.6 Fruit Weight (kg/ Plant)

The interaction effect of varieties and nitrogen treatment showed significant effect on fruit weight (Table 8) where the range of fruit weight was 2.021 to 3.080 kg/plant. From the result, it was observed that the highest fruit weight (3.080 kg/plant) was observed in V_2N_3 treatment (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (2.953) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of fruit weight(2.021 kg/plant) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1})) where no nitrogen application in BARI Tomato 2.

4.3.7 Fruit Yield (t/ha)

The interaction effect of varieties and nitrogen treatment showed significant effect on fruit yield (Table 8) where the range of fruit yield was 30.15 to 47.83 t/ha. From the result, it was observed that the highest fruit yield (47.83 t/ha) was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (47.46 t/ha) was observed in the combined treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest value of fruit yield (30.15 t/ha) was obtained from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1}) where no nitrogen application in BARI Tomato 2.

4.3.8 N Content in Plant (%)

The combined effect of varieties and nitrogen treatment showed significant effect on N Content in Plant % at the time of harvest (Table9). After post-harvest, the range of N Content in Plant % was observed from 0.92 to 1.70 ppm. From the result, it was observed that the highest N (1.70 ppm) content in plant % was observed in V_2N_3 (BARI Tomato 14 x 120 kg N ha^{-1}), second highest (1.65 ppm) was observed in the combined

treatment V_2N_4 (BARI Tomato 14 x 140 kg N ha^{-1}) whether the lowest N content (0.92 ppm) was observed from the combined effect of V_1N_0 (BARI Tomato 2 x 0 kg N ha^{-1}) where no nitrogen application in BARI Tomato 2.

Table 9:Combined effect of verities and nitrogen treatments on N Content in Plant % at harvest stage

Combined effect of Variety and Treatment		**N Content in Plant %**
V_1	N_0	0.9200 e
	N_1	1.330 d
	N_2	1.540 c
	N_3	1.690 a
	N_4	1.620 b
V_2	N_0	0.93 d
	N_1	1.360 c
	N_2	1.565 b
	N_3	1.700 a
	N_4	1.650 a
LSD (0.01)		0.05474
CV (%)		0.99%

*V_1= BARI Tomato 2, V_2=BARI Tomato 14

** N_0= 0 kg N ha^{-1}, N_1= 80kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 120 kg N ha^{-1}, N_4= 140 kg N ha^{-1}

CHAPTER V
SUMMERY AND CONCLUSION

This experiment was conducted at the Sher-e-Bangla Agricultural University Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October, 2014 to March, 2015 to find out the optimum levels of nitrogen and suitable variety between BARI Tomato 2 and BARI Tomato 14 for maximum growth and yield of tomato. The experiment included five different levels of nitrogen viz., 0, 80, 100, 120 and 140 N kg ha^{-1} and two varieties. The experiment consisted of ten treatment combinations and was laid out in Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 2.0 m x 1.8m, and 15 plants were accommodated in each plot following spacing of (60 cm x 40 cm). For raising the seedlings, tomato seeds cv. BARI Tomato-14 were sown in seed bed on 30 October, 2014 and seedling were transplanted on 29 November, 2014. Harvesting was done during 22 March to April 2015.

Data on growth and yield contributing parameters were recorded, and the collected data were statistically analyzed to evaluate the treatment effects. The summary of the results has been presented in this chapter. Varieties had significant effect on plant height. Highest heighted plant was found in BARI Tomato 14 (101.5 cm) other hand shortest one was found in BARI Tomato 2. In case of treatment, Nitrogen had significant effect on plant height. Plants grown with higher doses of nitrogen showed a gradual increase in plant height. The tallest plant was produced by 120 kg N ha^{-1}, while the shortest plant was recorded from 0 kg N ha^{-1} where no N was applied into the field according to experiment.

The treatment combinations demonstrated highly significant variation in plant height. In here highest result was obtained in V_2N_3 treatment and shortest one was found in V_1N_0 treatment.

Significant variation was obtained in respect of the number of cluster plant^{-1}, in case of varietal effect it was found highest result in BARI Tomato 14 and opposite result was found in BARI Tomato 2. Another case of treatment effect it was obtained highest number in N_3 treatment and lowest was observed in N0 treatment. Interaction of varieties and nitrogen treatment highest value was obtained from V_2N_3 and opposite one was found in V_1N_0 treatment respectively.

Varieties had significant effect on flower Plant^{-1} Highest number of flower was found in BARI Tomato 14 other hand shortest one was found in BARI Tomato 2. In case of treatment, Nitrogen had significant effect on flower Plant^{-1}. Plants grown with higher doses of nitrogen showed a gradual increase in number of flower Plant^{1}. The highest number was produced by 120 kg N ha^{-1}, while the lowest one was recorded from 0 kg N ha^{-1} where no N was applied into the field according to experiment. The treatment combinations demonstrated highly significant variation in flower Plant^{-1}. In here highest result was obtained in V_2N_3 treatment and shortest one was found in V_1N_0 treatment.

Significant variation was obtained in respect of the number of fruit Cluster^{-1}, in case of varietal effect it was found highest result in BARI Tomato 14 and opposite result was found in BARI Tomato 2. Another case of treatment effect it was obtained highest number in N_3 treatment and lowest was observed in N0 treatment. Interaction of varieties and nitrogen treatment highest value was obtained from V_2N_3 and opposite one was found in V_1N_0 treatment respectively.

The varieties had significant effect on fruit Plant^{-1} Highest number of flower was found in BARI Tomato 14 other hand shortest one was found in BARI Tomato 2. In case of treatment, Nitrogen had significant effect on fruit Plant^{-1}. Plants grown with higher doses of nitrogen showed a gradual increase in number of fruit Plant^{-1}. The highest number was produced by 120 kg N ha^{-1}, while the lowest one was recorded from 0 kg N ha^{-1} where no N was applied into the field according to experiment. The treatment combinations demonstrated highly significant variation in flower Plant^{-1}. In here highest result was obtained in V_2N_3 treatment and shortest one was found in V_1N_0 treatment. Significant variation was obtained in respect of the number of fruit weight (kg/ Plant), in case of varietal effect it was found highest result in BARI Tomato 14 and opposite result was found in BARI Tomato 2. Another case of treatment effect it was obtained highest number in N_3 treatment and lowest was observed in N_0 treatment. Interaction of varieties and nitrogen treatment highest value was obtained from V_2N_3 and opposite one was found in V_1N_0 treatment respectively.

Varieties had significant effect on fruit yield (t/ha). Highest number of flower was found in BARI Tomato 14 other hand shortest one was found in BARI Tomato 2. In case of treatment, Nitrogen had significant effect on fruit yield. Plants grown with higher doses of nitrogen showed a gradual increase in number of fruit yield. The highest number was produced by 120 kg N ha^{-1}, while the lowest one was recorded from 0 kg N ha^{-1} where no N was applied into the field according to experiment. The treatment combinations demonstrated highly significant variation in fruit yield (t/ha). In here highest result was obtained in V_2N_3 treatment and lowest one was found in V_1N_0 treatment.

Significant variation was obtained in respect of the number of N Content in Plant%, in case of varietal effect it was found highest result in BARI Tomato 14 and opposite result was found in BARI Tomato 2. Another case of treatment effect it was obtained highest number in N_3 treatment and lowest was observed in N_0 treatment. Interaction of varieties and nitrogen treatment highest value was obtained from V_2N_3 and opposite one was found in V_1N_0 treatment respectively.

Significant variation was obtained in respect of the number of N Content in postharvest Soil in case of varietal effect it was found highest result in BARI Tomato 14 and opposite result was found in BARI Tomato 2. Another case of treatment effect it was obtained highest number in N_3 treatment and lowest was observed in N_0 treatment. Interaction of varieties and nitrogen treatment highest value was obtained from V_2N_3 and opposite one was found in V_1N_0 treatment respectively. It was known that highest N application gives highest result but through this experiment it was observed that highest value was found in 120 kg N ha^{-1} in spite of 140 kg N ha^{-1} application.

It can be assumed after a certain level higher application does not impact remarkable in plant. Plant can give result till a mark line.

From the results of the present experiment it can be concluded that the increasing the nitrogen doses, increasing the yield of tomato but not at highest value of N application, it was 120 kg N ha^{-1} whichwas optimal dose, and it was given better performance in BARI Tomato 14 than BARI Tomato 2.

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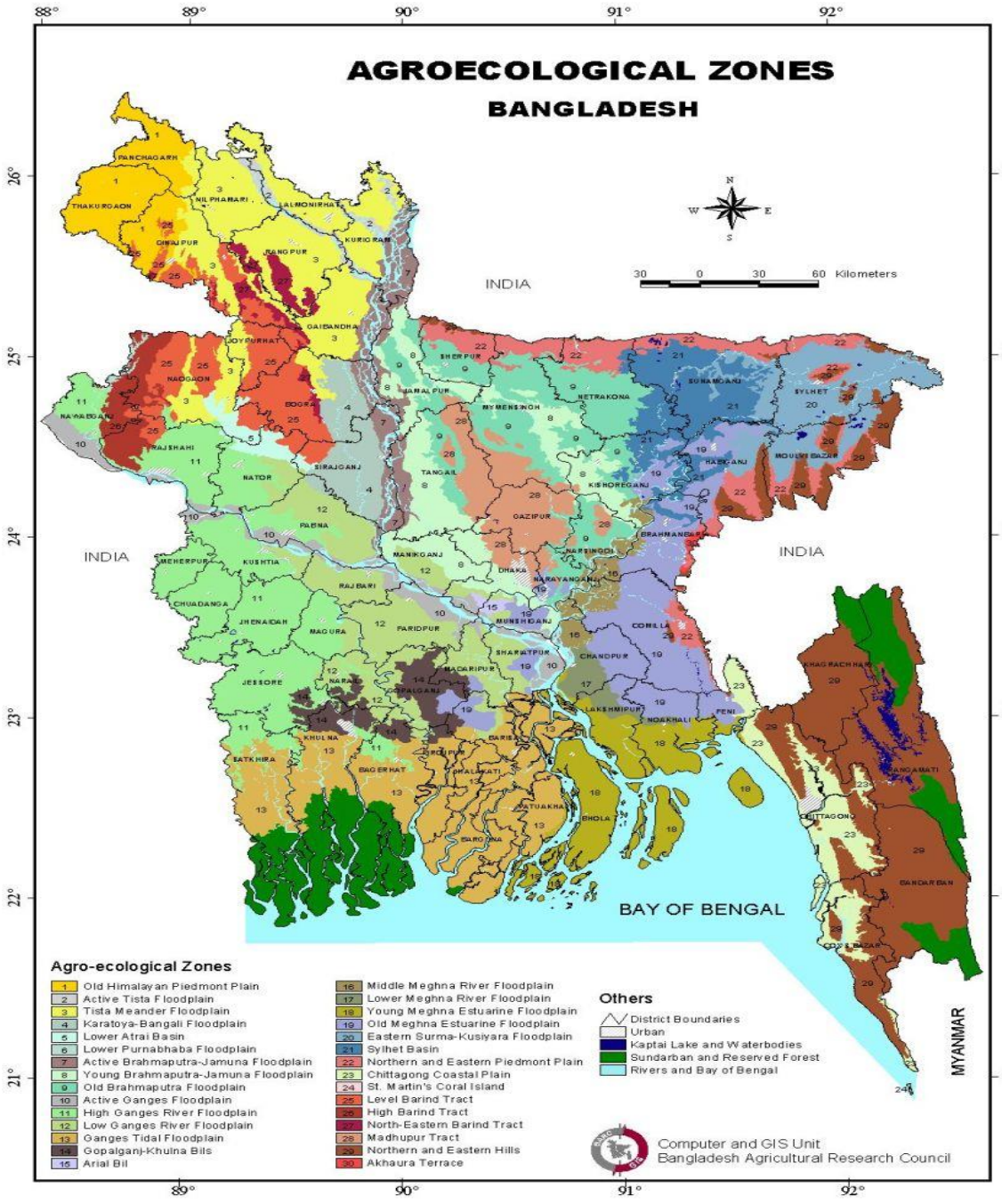
Appendices

Appendix I. Agro-Ecological Zone of Bangladesh



Appendix II. Morphological Characteristics of the Experimental field of Sher-e-Bangla Agricultural University, Dhaka

Morphological features	Characteristics
Location	Agronomic Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Fallow- Mustard

Source: SRDI, 2015

Appendix III. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from November, 2014 to March, 2015

Month	Average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total Sunshine per day (hrs)
	Maximum	Minimum	Mean			
October, 2014	34.8	18.0	26.4	77	5	5.8
November, 2014	29.7	20.1	24.9	65	0	6.4
December, 2014	26.9	15.8	21.35	68	0	7.0
January, 2015	24.6	12.5	18.7	66	0	5.5
February, 2015	33.7	23.8	28.81	69	0	5.8
March, 2015	34.8	25.0	26.4	70	2	5.9

Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan. Dhaka

Appendix IV. Physical and chemical properties of the initial soil sample

Characteristics	Value
Particle size analysis	
% Sand	30
% Silt	40
% Clay	30
Textural class	Clay loam
Consistency	Granular and friable when dry
pH	5.6
Bulk Density (g/cc)	1.45
Particle Density (g/cc)	2.53
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.06
Available P (ppm)	20.0
Exchangeable K (meq/100g soil)	0.12

Source: SRDI, 2015

Appendix V. ANOVA TABLES OF GROWTH AND YIELD ATTRIBUTING CHARACTERS OF BARI TOMATO 2 AND BARI TOMATO 14

i. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	3.982	1.991	0.5384	
2	Factor A	1	705.093	705.093	190.6666	0.0052
-3	Error	2	7.396	3.698		
4	Factor B	4	4180.652	1045.163	667.6714	0.0000
6	AB	4	67.329	16.832	10.7528	0.0002
-7	Error	16	25.046	1.565		
	Total	29	4989.499			

ii. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	7.540	3.770	1.0507	0.4876
2	Factor A	1	3.117	3.117	0.8687	
-3	Error	2	7.176	3.588		
4	Factor B	4	4.973	1.243	1.1093	0.3862
6	AB	4	0.638	0.160	0.1424	
-7	Error	16	17.930	1.121		
	Total	29	41.374			

iii. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	3.308	1.654	1.0157	0.4961
2	Factor A	1	12.610	12.610	7.7445	0.1085
-3	Error	2	3.257	1.628		

4	Factor B	4	20.064	5.016	14.3277
0.0000					
6	AB	4	4.548	1.137	3.2477
0.0395					
-7	Error	16	5.601	0.350	
	Total	29	49.387		

iv. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	3.298	1.649	0.9129	
2	Factor A	1	3.387	3.387	1.8749	0.3044
-3	Error	2	3.613	1.806		
4	Factor B	4	3.786	0.947	1.5088	0.2466
6	AB	4	0.265	0.066	0.1057	
-7	Error	16	10.037	0.627		
	Total	29	24.387			

v. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	5.794	2.897	1.0451	0.4890
2	Factor A	1	28.538	28.538	10.2948	0.0849
-3	Error	2	5.544	2.772		
4	Factor B	4	87.350	21.837	27.2392	0.0000
6	AB	4	3.224	0.806	1.0052	0.4337
-7	Error	16	12.827	0.802		
	Total	29	143.277			

vi. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	1.3262	0.4299
2	Factor A	1	9.763	9.763	169399.6045	0.0000
-3	Error	2	0.000	0.000		
4	Factor B	4	1.213	0.303	7625.1934	0.0000
6	AB	4	0.262	0.066	1649.4114	0.0000
-7	Error	16	0.001	0.000		
	Total	29	11.240			

vii. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.004	0.002	4.3338	0.1875
2	Factor A	1	289.790	289.790	673988.7627	0.0000
-3	Error	2	0.001	0.000		
4	Factor B	4	926.707	231.677	720245.1194	0.0000
6	AB	4	120.773	30.193	93866.0955	0.0000
-7	Error	16	0.005	0.000		
	Total	29	1337.279			

viii. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.002	0.001	21.0001	0.0455
2	Factor A	1	0.012	0.012	300.0008	0.0033
-3	Error	2	0.000	0.000		
4	Factor B	4	2.351	0.588	2901.8471	0.0000
6	AB	4	0.002	0.001	2.5926	0.0761
-7	Error	16	0.003	0.000		
	Total	29	2.370			

ix. ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.000	0.000	0.6400	
2	Factor A	1	0.000	0.000	49.0000	0.0198
-3	Error	2	0.000	0.000		
4	Factor B	4	0.002	0.001	195.6677	0.0000
6	AB	4	0.000	0.000	3.8775	0.0218
-7	Error	16	0.000	0.000		
	Total	29	0.003			

Appendix V: Lay out of the experiment

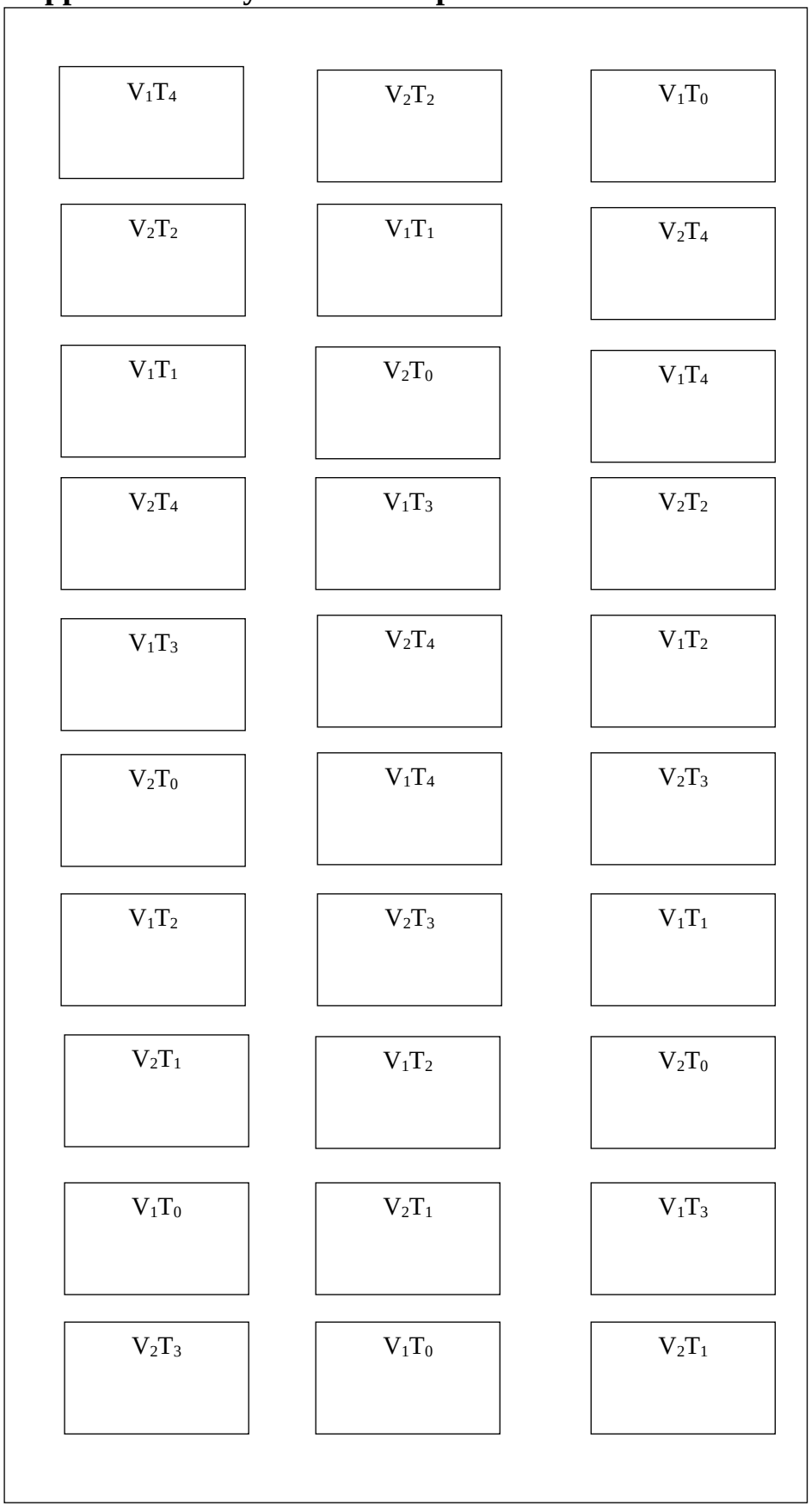


Figure: Lay out of the experiment

Factor A

Doses of N (kg ha^{-1})	Alphabetic symbol
Control treatment (No N fertilizer)	N_0
80 kg N fertilizer	N_1
100 kg N fertilizer	N_2
120 kg N fertilizer	N_3
140 kg N fertilizer	N_4

Factor B

Varity	Alphabeti symbol
BARI Tomato 2	V_1
BARI Tomato 14	V_2

Replication no: 3

Total 10 treatment combinations v
follows:

V_1N_0: BARI Tomato 2 + No N

V_1N_1: BARI Tomato 2 + 80kg N ha

V_1N_2: BARI Tomato 2 + 100 kg N

V_1N_3: BARI Tomato 2 + 120 kg N

V_1N_4: BARI Tomato 2 + 140 kg N

V_2N_0: BARI Tomato 14 + No N

V_2N_1: BARI Tomato 14 + 80kg N h

V_2N_2: BARI Tomato 14 + 100 kg ha^{-1}

V_1N_3: BARI Tomato 14+ 120 kg N ^{1}

V_2N_4: BARI Tomato 14 + 140 kg ha^{-1}