INFLUENCE OF NITROGEN AND PHOSPHORUS ON GROWTH AND YIELD OF BRINJAL

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CERTIFICATE

This is to certify that thesis entitled, **"INFLUENCE OF NITROGEN AND PHOSPHORUS ON GROWTH AND YIELD OF BRINJAL"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE IN HORTICULTURE**, embodies the result of a piece of bona fide research work carried out by **Rabeya Rahaman**, Registration No. **12-04817** 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: June, 2018
Place: Dhaka, Bangladesh

Prof. Dr. Md. Ismail Hossain
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DEDICATED
TO
MY BELOVED MOTHER
AND FATHER

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ABSTRACT

The field experiment was carried out during the period from October 2017 to February 2018 at Sher-e-Bangla Agricultural University, Dhaka. There were four nitrogen levels, No: no nitrogen (control), N_1: 75 kg N ha^{-1}, N_2: 125 kg N $ha^{-1}$and N_3: 175 kg N ha^{-1} and four phosphorus levels: P_0: no phosphorus (control), P_1: 30 kg P ha^{-1}, P_2: 40 kg P ha^{-1} and P_3: 50 kg P ha^{-1}. The experiment was laid out in randomized complete block design with three replications. The highest value of different parameters were observed in nitrogen fertilizer levels N_3 (175 Kg N ha^{-1}) and lowest in nitrogen fertilizer levels N_o (control) . On the other hand, the highest value was observed for individual fruit weight and fruit yield per plant in nitrogen dose N_2 (125 kg N ha^{-1}) and lowest in nitrogen dose N_0 (control). The highest value of different parameters were observed in phosphorus fertilizer levels P_2 (40 Kg P ha^{-1}) and lowest in phosphorus fertilizer levels P_0 (control). The highest yield of individual plant was obtained as 1.18 Kg and 1.15 Kg with the application of 125 Kg N ha^{-1} and 40 Kg P ha-^{1} respectvely. The combined effect of nitrogen and phosphorus fertilizers has positive effect on growth and yield related traits. Maximum fruit weight (62.14 g) and fruit yield per plant (1.25 kg) was produced by the treatment combination N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}). It was concluded that the treatment combination N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}) were found to the most suitable treatment combination for the highest yield of brinjal.

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ABBREVIATIONS		ELABORATIONS
%	:	Percent
^{0}C	:	Degree Celsius
@	:	At the rate
AEZ	:	Agro Ecological Zone
Agric.	:	Agriculture
Agril.	:	Agricultural
ANOVA	:	Analysis of variance
BBS	:	Bangladesh Bureau of Statistics
CV%	:	Percentage of coefficient of variation
Df	:	Degrees of freedom
et al.	:	And others
etc.	:	Etcetera
FAO	:	Food and Agricultural Organization
HI	:	Harvest Index
J.	:	Journal
DMRT	:	Duncan's Multiple Range Test
DAT	:	Date After Transplanting
MS	:	Mean sum of square
Sci.	:	Science
MoP	:	Murate of Potash
MoA	:	Ministry of Agriculture
RCBD	:	Randomized Complete Block Design
SAU	:	Sher-e-Bnagla Agricultural University
TSP	:	Triple Super Phosphate

CHAPTER I
INTRODUCTION

Eggplant (*Solanum melongena*, L.) is one of the most important and popular vegetable crops in Bangladesh and is considered as a national diet in many other tropical and sub-tropical countries. The important brinjal growing countries in the world are India, Bangladesh, Pakistan, China, Cyprus, Egypt, Japan, Philippines, Syria and Western Europe (Anon., 2014). The world acreage under brinjal was estimated to be 3.2 million ha with production of 50.02 million tonnes and the productivity of 20.67 tonnes per ha in 2012-13 (Anon., 2014).

Brinjal belongs to the family Solanaceae. Plant is herbaceous, annual with erect or semi-spreading in habit. It also behaves like a perennial herb. Flowers are solitary or in 2-5 flowered cymes; pedicel 1-2 cm long, thickening and lengthening as fruit develops, calyx persistant, gamosepalous approximately 2 cm long, 5-6 lobed, often with purple tinge, dense hairs, enlarging with fruit development, corolla rotate with 5-6 with triangular lobes, 3-5 cm in diameter, violet or purple within tubes, 5-6 stamens, 0.5-1.0 cm long, erect, yellow anther, styles variable in length, short styles do not normally have fertile ovaries, ovary superior, 2 celled, ovoid, 2-locular, variable in size (oval or egg shape to oblong) and size vary from 5-12 cm long, 3-6 cm in diameter, smooth and shiny, purple-black, green and white colour. Fruits become yellow on ripening. Seeds are small, light brown and numerous.

It is quite high in nutritive value and can be well compared with tomato. Brinjal fruit contains high amount of carbohydrates (6.4%), protein (1.3%), fat (0.3%), calcium (0.02%), phosphorus (0.02%), iron (0.0013%) and other mineral matters. Apart from these, it also contains β-carotene (34 mg), riboflavin (0.05 mg), thiamine (0.05 mg), niacine (0.5 mg) and ascorbic acid (0.9 mg) per 100 g of fruit

(Choudhary, 1976). The brinjal plant contains an alkaloid called "solanine" found in roots and leaves. Some medicinal use of eggplant tissues and extract include treatment of diabetes, asthama, cholera, bronchitis and diarrhea, its fruit and leaves are reported to lower certain levels of blood cholesterol.

Increasing the productivity and quality of eggplant crop can be achieved through improving the cultural practices, particularly, the utilization efficiency of applied fertilizers. Plant nutrition plays an important role for enhancing yield and quality in brinjal. Nitrogen is one of the major components of nucleic acid, co-enzymes and cell membranes and it is involved in many of the metabolic processes viz., cell division, photosynthesis, protein synthesis and expansion of shoot and root growth in plants and has active role during vegetative growth. Nitrogen, as essential part of proteins and nucleic acids, as well as of the chlorophyll molecule, is particularly important for plant growth and product final quality (Marschner, 1995). The absence of N in nutritive solution negatively affected stem and new leaves growth in eggplants (Haag and Homa, 1981).

Nitrogen is the most important nutrient in any fertilization program. In this respect, nitrogen requirements of eggplant are relatively high (Oliveira *et al.*, 1971); but the excessive application of mineral N fertilizer creates pollution of agro-ecosystem and leads to some adverse effects on soil fertility (Fischer and Richter, 1984), as well as increasing production cost (EL-Shobaky, 2002 ; Rizk, 2002).

Phosphorus is an important constituent of nucleoproteins, involved in high energy transfer compounds such as ATP and plays a key role in energy transfer in the metabolic processes. P deficiency may significantly reduce productivity, as it induces flower abscission. This nutrient plays an important role on energy transfer in cells, respiration, and photosynthesis, besides being a structural component of

nucleic acids, as well as of several coenzymes, phosphoproteins, and phospholipids.

Considering the above facts, the present research work carried out with the following objectives-

I. To investigate the effect of nitrogen on growth and yield of brinjal;
II. To investigate the influence of phosphorus on growth and yield of brinjal; and
III. To find out the combined effect of nitrogen and phosphus on growth and yield of brinjal.

CHAPTER II

REVIEW OF LITERATURE

The literature on effect of nitrogen and phosphorus fertilizer on growth and yield of brinjal are presented in this chapter. Since limited reviews are available on these aspects in brinjal, reviews on other related crops are also included.

2.1 Role of nutrients

Nitrogen is the major components of nucleic acid, co-enzymes and membranes. It is involved in many of the metabolic processes *viz.,* cell division, photosynthesis, protein synthesis and expansion of shoot and root growth in plants and has active role during vegetative growth.

Phosphorus is an important constituent of nucleoproteins, involved in high energy transfer compounds such as ADP, ATP and plays a key role in energy transfer in the metabolic processes.

2.2 Literatures of nitrogen and phosphorus

Among the factors that affect crop production, fertilizer is one of the most crucial factors, which ultimately increase the total yield of any crops. Now a days fertilizer holds the key to success of the crop productin system of Bangladesh. Nitrogen and phosphorus fertilizer is one of the most used fertilizer, which has influence the physiological activity on plant body. Nitrogen (N) is an important macronutrient to high yield of eggplant during vegetative growth, flowering and seed set. While phosphorus (P) influence fruiting habits, hasten maturity, increase

disease resistance, improves palatibilty of fruits, increase protein levels and lower fat content of seeds of eggplant.

Nathulal and Pundnik (1971) conducted NP trial on chilli at Vallabhnagar, Udaipur in Rajasthan. The levels of N were 0, 60, 80 and 100 kg per ha and P were 0, 70 and 90 kg per ha. Among these different combinations, the highest plant height (63.62 cm) was obtained in the chilli plants which received 100 kg N and 70 kg P_2O_5.

Shukla *et al.* (1987) observed maximum plant height with maximum nitrogen (180 kg/ha) level, while the response to P application was non-significant in bell pepper cv. California wonder.

Dharmatti (1986) found that increased level of nitrogen and phosphorus had increased the number of branches per plant in bell pepper.

According to Srinivas (1983) combined effect of application of nitrogen and phosphorus were non-significant with respect to plant height and number of branches per plant in chillies.

Chougule and Mahajan (1979) observed significant increase in number of branches per plant (9.91, 10.81 and 11.15 at 30, 60 and 90 days after transplanting, respectively) with application of 200:120 kg NP per ha in chilli. While, lower number of branches (8.33, 8.82 and 9.81) were noticed with application of 100:60 kg NP per ha at 30, 60 and 90 days after transplanting, respectively.

Hanchinamani (1980) observed that increased levels of nitrogen and phosphorus at 200:150:100 kg per ha, respectively increased the plant height in brinjal.

According to Prabhakar *et al.* (1987) maximum plant height was noticed with the highest N (90 kg/ha) level, while P application showed non-significant response in respect of plant height in chilli cultivar G-3.

Kulvinder Singh and Srivastava (1988) observed the tallest (58.70 cm) plants with highest N (120 kg/ha), while the effect of P application was non-significant in chilli variety Pant-C1.

Sharma (1995) in a study for the determination of optimum doses of nitrogen, phosphorus and potassium fertilization in tomato revealed that increase in the levels of nitrogen application showed increase in plant height and number of branches per plant. Significantly highest plant height (126 cm) and number of branches (10.4/plant) were noticed with the application of 120:60:30 kg NPK per ha compared to 30 and 60 kg nitrogen per ha in tomato.

Balaraj (1999) recorded significantly higher plant height and number of branches per plant with the application of 150:75:75 kg NPK per ha compared to 100:50:50 and 125:62.5:62.5 kg NPK per ha in two chilli varieties (Byadagi kaddi and Dyavanoor local).

Jayaraj *et al.* (1999) revealed that plant height and number of branches per plant were significantly higher with higher doses of NPK application to PLR-1 chillies. A dosage of 180:100:100 kg NPK per ha showed significant increase in plant height (41.3 cm).

Nanthakumar and Veeraragavathatham (2000) stated that the results clearly indicated that combining organic fertilizer, namely 12.5 t per ha of farmyard manure and 2 kg each of *Azospirillum* and phosphobacteria, with inorganic fertilizers at 75 per cent of the recommended dose of N and P and 100 per cent of

K (namely 75 kg N, 37.5 kg P and 22.5 kg K/ha) favourably influenced the growth parameters in brinjal cv. Palur-1.

Anburani and Manivannan (2002) reported that FYM + PM at 12.5 t per ha each along with 100 per cent NPK + biofertilizers recorded the highest values for plant height (108.90 cm), number of primary branches (11.66) and number of leaves (94.05) per plant, whereas FYM at 25 t per ha along with 100 per cent NPK + biofertilizers (*Azospirillum* + phosphate solubilizng bacteria) recorded the highest values for number of secondary branches (15.58) per plant in brinjal cv. Annamalai.

Prabhu *et al.* (2003) reported that increased N and P rates increased the plant height. N:P at 200:100 kg per ha produced the tallest plants followed by N:P at 175:100 kg per ha. Branch number per plant increased with increasing N and P rates. N:P at 200:100 kg per ha produced the highest branch number per plant followed by N and P at 175:100 kg per ha in brinjal hybrid COBH-1.

Wange and Kale (2004) reported that the results revealed significant improvement in vegetative characters such as plant height and number of leaves per plant in brinjal over the recommended rate of N fertilizer due to inoculation with mixture of Azotobacter + *Azospirillum* and followed by application of 75 kg N per ha.

Gnanakumari and Satyanarayana (1971) observed that fertilizer application hastened the initiation of flowering in brinjal. The plants which received 234 kg each of N, P and K flowered 27 days earlier than in control.

In Sweet pepper cv. Yolo Wonder, Gill *et al.* (1974) tried different combinations of N at 0, 125, 250 and 375 kg per ha and P_2O_5 at 0, 125, 187.5 and 250 kg per ha.

Among the combinations, 125 N + 250 P2O5 kg per ha recorded minimum number of days required for 50 per cent flowering.

Nagarajaswamy (1982) noticed that fertilizer levels did not significantly influence the number of days taken for 50 per cent flowering in bell pepper. However, he observed the decreasing trend with increase in the levels of fertilizers.

Dod *et al.* (1989) noticed that G-3 variety of chilli took more number of days for flowering with increased N levels.

Balasubramani *et al.* (1997) reported that application of nitrogen 20 kg per ha reduced the days to first flowering (30.1) compared to control (35.5 days). Further, increase in the nitrogen level showed numerical increase but that was not significant in bhendi cv. Pusa sawani.

An investigation with graded levels of N (60, 120 and 180 kg/ha) and K in irrigated chilli crop revealed that the number of days taken for 50 per cent flowering increased significantly with the increase in N fertilizer levels (Subhani *et al.*, 1990).

Khan and Suryanarayana (1979) noticed that the highest level of N (120 kg) and P2O5 (90 kg) per hectare resulted in early flowering (45.22 days) in chilli variety NP-46A. Naidu *et al.* (2002) reported that NPK at 75:35:0 kg per ha + farmyard manure at 25 t per ha recorded the earliest 50 per cent flowering in brinjal cv. JB-64. Anburani and Manivannan (2002) reported that FYM at 25 t per ha along with 100 per cent NPK + biofertilizers (*Azospirillum* + phosphate solubilizing bacteria) recorded the lowest number of days to first flowering and days to 50 per cent flowering as well as the most number of flowers in brinjal cv. Annamalai.

Sat pal and Saimbhi (2003) observed nitrogen significantly delayed flowering in two brinjal hybrids (BH-1 and BH-2). Suthar *et al.* (2005) opined that the highest fertilizer level (150:75:75:25 kg N:P:K:Zn/ha) delayed the flowering in the plots when the crop was planted on 26 May in brinjal.

Feleafel (2005) conducted two field experiments with eggplant (cv. Black beauty) during the successive summer seasons of 2001 and 2002, at the Agricultural Experimental Station farm, Alexandria University. The objective of these experiments was to determine the effects of N rates (60, 90 and 120 kg N fed-1) and their application systems (three, four, five and six split applications), on growth, yield and quality of eggplant. The obtained results, of the two seasons, indicated that increasing N applied rate was accompanied with significant increases in vegetative growth characters; i.e., plant height, number of branches and leaves, leaf area and dry weight plant^{-1}. Moreover, early and total fruits yield, fruits number plant^{-1} and fruits firmness as well as leaf N, P and K contents were significantly increased with increasing N applied rate up to 120 kg N fed^{-1}. Increasing number of split N applications up to six equal split doses, significantly increased the previous mentioned vegetative growth characters as well as total yield, fruits number plant^{-1} and average fruit weight. The interaction between the two studied factors showed significant increments on most of the studied characters. Application of 120 kg N fed^{-1} at six equal split doses, during the growing season, appeared to be the most efficient combination treatment, which gave the best results on growth and yield characters of eggplant.

Mohammad hossein aminifard (2010) carried out a study to evaluate the effect of nitrogen fertilizer on growth of eggplant (*Solanum melongena* L.) under field conditions. Nitrogen was applied in four rates (0, 50, 100 and 150 Kg/ha). Average plant height, lateral stem number, leaf chlorophyll content were determined, Increasing rates of Nitrogen significantly affected plant vegetative

growth (plant height, lateral stem number, and leaf chlorophyll content).The highest lateral stem number and leaf chlorophyll content were obtained in plants receiving 150 Kg N ha^{-1}. Our results showed that nitrogen fertilization has strongly influenced vegetative growth of eggplant plants grown under field conditions.

2.3 Effect of nitrogen and phosphorus on fruit yield and yield components

Nathulal and Pundrik (1971) reported significant increase in fruit length (10.11 cm) of chilli and gave maximum (72.2 q/ha) fruit yield with application of 100:90:50 kg NPK per ha compared to control (9.58 cm and 32.70 q/ha), respectively.

Khan and Suryanarayana (1979) noticed that increased level of N (120 kg/ha) significantly increased the fruit length (13.1 cm) of chilli variety NP-46A. They also reported the linear increase in fruit length with increased levels of P application.

According to Chougule and Mahajan (1979) more number of chilli fruits per plant were observed with the application of highest level of N (200 kg/ha), P and K (each 150 kg/ha).

Pandey *et al.* (1980) observed significantly higher number of fruits per plant (15), fruit length (12.5 cm) and fruit girth (5.2 cm) with the application of 120:50 kg nitrogen and phosphorus per hectare over control in okra. Lysenko (1980) reported that plants of capsicum at highest dose of N:P:K at 360:360:180 kg per ha gave the highest seed yield per ha.

Maximum seed yield of bell pepper was highest (84.89 kg/ha) at 200:112.5:75 kg NPK per ha (Dharmatti, 1986). In chilli, Shukla *et al.* (1987) recorded significantly more (11.24) number of fruits per plant with application of 180 kg N per hectare over control (3.60), while P and K (100 and 80 kg/ha, respectively) application had no significant influence on number of fruits per plant in chilli.

Belichki (1988) recorded more number of fruits per plant (43.30) in chilli with application of N, P and K each at 320:320 and 80 kg per ha, respectively. Kulvinder Singh and Srivastava (1988) noticed that length of chilli fruit was maximum (6.01 cm) with 120 kg N per ha and was minimum in control (4.6 cm). But application of P and K (60 and 50 kg/ha, respectively) had no influence on length of chilli fruit.

Surlekor and Rankow (1989) obtained the highest yield of green chilli (257.50 q/ha) which was 73.4 per cent over control with the application of 100, 80 and 100 kg NPK per ha.

Thiagarajan (1990) observed significant increase in fruit yield of chilli. The data showed maximum fruit yield (5268 kg/ha) with the application of 140:70:35 kg NPK per hectare, which was significantly superior over other fertilizer doses. In the same year, the highest seed yield (195.4 kg/ha) was obtained with the application of 140, 35 and 0 kg NPK per ha, respectively in capsicum.

Parashetti (1991) reported that the highest fertilizer level of 250:100:50 kg NPK per ha recorded maximum seed yield (645.75 kg/ha) and minimum (607.24 kg/ha) was with recommended dose of fertilizer (125:100:50 kg NPK/ha) in brinjal.

Gulshan Lal (1992) observed maximum (5.99 cm) fruit length and higher seed yield (6.98 – 10.63/plant and 35.4 – 5.25 q/ha) in chilli cv. Pant C-1 with the

application of 150:50:50 kg NPK per ha, respectively. The minimum fruit length (4.54 cm) was recorded in control.

Revanappa (1993) recorded more number of chilli fruits per plant (203.53) at higher level of N (250 kg/ha) and basal dose of P and K (each 75 kg/ha). While, less number of fruits per plant (155.68) were noticed with 150:75:75 kg NPK per ha, respectively.

Subhani *et al.* (1990) observed linear increase in number of seeds per fruit of chilli (36.0 – 55.6) with increased levels of N (0 – 180 kg/ha) and K (0 – 120 kg/ha) and a basal dose of P (80 kg/ha).

Jeyaraman and Balasubramanian (1991) reported that number of seeds per fruit significantly increased from 50.61 to 61.00 and 52.68 to 58.70 with increased level of 75 to 125 kg NPK per ha and 0 to 105 kg K per ha, respectively and a basal dose of 35 kg P per ha in chilli.

Dharmatti *et al.* (1992) reported that number of seeds per fruit was highest (100.1) with 120:100:60 kg NPK per ha in tomato. Shrivastava (1996) noticed maximum number of fruits per plant and highest fruit yield per ha in chilli with the application of 250:200:200 kg NPK per ha. Revanappa *et al.* (1997) stated that increased application of N levels (150 – 250 kg/ha) with P and K (each 75 kg/ha) as a basal dose had showed significant influence on fruit girth and the number of seeds per fruit (60.03 – 73.18) in chilli.

Singegol (1997) reported that increased fruit length of chilli in all pickings and fruit yield was maximum (120.56 q/ha) with highest fertilizer levels (150:75 kg NP/ha) and with a basal dose of 50 kg K per ha compared to control (49.92 q/ha). Patil (1998) noticed that the highest dose of fertilizer (200:100:100 kg NPK/ha)

resulted in maximum fruit yield (19.2 q/ha) as compared to control (13.86 q/ha) in chilli. Naik *et al.* (1996) reported that plant height and fruit and seed yield (q/ha) increased with increasing rates of N. The highest seed yield (7.32 q/ha) was observed following application of 200 kg N per ha. Splitting the N dose had no beneficial effects on seed yield in brinjal cultivars Arka Keshav and Arka Neelkant.

Nanthakumar and Veeraragavathatham (1999) opined that crops which were treated with combined application of organic fertilizers (FYM), biofertilizers (*Azospirillum* and phosphobacteria) and inorganic NPK had increased plant yield and fruit weight compared to crop which were treated with inorganic fertilizers alone. Fruit set increased in the crop fertilized with both organic and inorganic sources compared to the crop treated with NPK, in brinjal.

Shahi *et al.* (2002) reported that N levels at 50 to 150 kg per ha, significantly increased fruit yield, while further addition reduced in both brinjal hybrids (Pusa hybrid-5 and Pusa hybrid-6).

Akhilesh-Sarraf *et al.* (2002) reported that K at 20 kg per ha resulted in the highest fruit yield (103.57 t/ha), fruit weight (1317.40 g), number of fruits per plant (34.71), fruit length (13.81 cm), fruit diameter (8.40 cm) in brinjal cv. Pusa Bindu.

Naidu *et al.* (2002) reported that NPK at 75:35:0 kg per ha + FYM at 25 t per ha recorded the highest fruit girth and the highest mean fruit yield (161.62 q/ha) in brinjal cv. JB- 64.

Satpal and Saimbhi (2003) observed nitrogen at 125 kg and phosphorus at 60 kg per ha, significantly increased early yield. However, nitrogen 187.5 kg per ha and

phosphorus 60 kg per ha were found to be the most optimum level for obtaining the highest marketable and total fruit yield of brinjal hybrids (BH-1 and BH-2).

Anburani *et al.* (2003) reported that application of 25 t farmyard manure + 100:50:50 kg NPK per ha + biofertilizers (*Azospirillum* and phosphobacteria at 2 kg/ha), resulted in the greatest number of fruits (26.64), fruit length (10.77 cm), fruit girth (10.03 cm), fruit weight (54.11 g) and fruit yield (1.43 kg/ha) in brinjal cv. Annamalai.

Singh (2004) obtained maximum (132.96 q/ha) mean yield was recorded in B1, which was statistically at par with B3 treatment. The minimum yield was recorded in B2 treatment in brinjal var. Pusa purple cluster.

Prabhu *et al.* (2004) reported the number of fruits per plant and fruit weight were significantly increased with increasing levels of N and P, under 200:100 kg NP per ha, the highest yield was obtained during *kharif* (58.51 t/ha) as well as during *rabi* season (55.29 t/ha). This was closely followed by 175:100 kg NP per ha, with 58.42 t per ha during *kharif* and 55.14 t per ha during *rabi* in brinjal hybrid COBH-1.

Suthar *et al.* (2005) opined that the number of fruits per plant and fruit yield per ha were recorded statistically higher when the crop was transplanted in 10th June and supplied with 125:62.5:62.5:25 kg N:P:K:Zn per ha in brinjal cv. BR-112.

Aminifard *et al*. (2004) carried out experiment to evaluate the effect of nitrogen fertilizer on growth and yield of eggplant (*Solanum melongena* L.) under field conditions. Nitrogen was applied in four rates (0, 50, 100 and 150 Kg/ha). Average plant height, lateral stem number, leaves chlorophyll content, flower number, fruit weight and plant yield were determined, increasing rates of Nitrogen

significantly affected plant vegetative growth (plant height, lateral stem number, and leaf chlorophyll content). The highest lateral stem number and leaf chlorophyll content were obtained in plants receiving 150 Kg N ha^{-1}. Nitrogen fertilizer affected flower number and the days to first flowering. Nitrogen application decreased the days to first flowering and treated plants flowered early than control. It was observed that fertilization with 100 Kg N ha-1 resulted in the highest average fruit weight and fruit yield. Our results showed that nitrogen fertilization has strongly influenced vegetative and reproductive growth of eggplant plants grown under field conditions.

Aswani *et al*. (2005) Conducted an field experiment on sandy loam soil during rabi season to study the effect of four levels of nitrogen (25, 50, 75 and 100 kg ha-1) and two sources of Bio-fertilizer viz., Azotobacter (AI) and Azospirillum (A2) on yield and quality of onion bulb (Allium cepa L). Results indicated that the application of nitrogen @100 Kg N ha-1 significantly increased bulb yield and quality attributes. The treatment combination N4AlS2 (100 kg N hal + Azotobacter with seedling dipping) gave highest bulb yield and fresh weight of bulb, followed at par by N:AIS2 (75 Kg N ha-1 + Azotobacter with seedling dipping). In economics, the maximum B: C ratio (2.26:1) was recorded with the treatment combination of N: AIS2 as compared to N4AlS2 with a lower B:C ratio (2.24:1) due to additional cost of urea and non significant difference between these two treatments regarding yield of bulbs. Thus, the treatment combination N3AlS2 was the best.

Pant *et al.* (2010) investigated the performance of Taro (Colocasia esculenta) under poplar (Populus deltoides) tree spacing (5m x 4m, 5m x 3m and open) and six nitrogen levels (0, 50, 75, 100, 125 and 150 kg/ha) in subtropical zone of Himachal Pradesh. The overall relative illumination below 5m x 4m and 5m x3m poplar spacing was 48 and 40%, respectively. The nitrogen application induced

improvement over control but failed to obtain significant difference in growth and yield parameters of the crop except number of leaves per plant. The nutrient content (N, P and K) in corm as well as leaf depicted an improvement with increase in nitrogen level. The shade of trees brought drastic reduction in growth and yield of crop compared to open. Among N, P and K contents in corms, only P and K were influenced significantly due to poplar spacing, both registered only significant influence on plant height and number of leaves per plant.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the information on the subject of materials and methods that were used in conducting the experiment. It consists of a short explanation of locations of the experimental site, soil characteristics, climate, materials used in the experiment, layout and design of the experiment, land preparation, manuring and fertilizing, seed sowing, intercultural operation, harvesting, data recording procedure and statistical analysis etc., which are presented as follows:

3.1 Experimental site

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during October 2017 to February 2018. The location of the experimental site was situated at $23^0$74' N latitude and $90^0$35' E longitude with an elevation of 8.6 meter from the sea level. Photograph showing the experimental site (Appendix I).

3.2 Soil characteristics

The soil of the experimental site lies in Agro ecological region of Madhupur Tract (AEZ no. 28) of Noda soil series. Soil of the experimental site belongs to the general soil type, Shallow red brown terrace soils under Tejgaon Series. The soil was loam in texture. The experimental site was medium high land and the pH was 6.5 and organic carbon content was 0.45%. Experimental area was flat which facilitated irrigation and drainage system easily. Physicochemical properties of the soil are presented in Appendix II.

3.3 Climate

The experimental site was situated under the subtropical climatic zone, characterized by three distinct seasons**,** the monsoon or rainy season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October (Edris *et al.,* 1979) and also characterized by heavy precipitation during the month of May to August and scanty precipitation from October to March. The mean of air, temperature, humidity and rainfall during the period of experiment were recorded from the Bangladesh Metrological Department, Agargaon, Dhaka (Appendix VI).

3.4 Plant materials

The variety of brinjal used for the experiment was BARI begun 1 (Uttara). The seeds of this variety was produced by Bangladesh Agricultural Research Institute, Gazipur. It is cultivated in winter season. It is a popular variety to farmer because they found a good yield from this variety. So i selected this variety for my experiment.

3.5 Raising of seedlings

For raising of seedlings, the soil was well ploughed and converted into loose friable and dried masses to obtain good tilth. All weeds, stubbles and dead roots were removed. Well rotten cowdung manure was applied to the seedbed at the rate of 5 kilogram per seedbed.

Brinjal seedlings were raised in seedbeds situated in relatively high land in the Horticulture farm. 10 gram seeds were sown in the seedbed of 3 m x 1 m size on 27 October, 2017. After sowing, the seedswere covered with a thin layer of soil. Complete germination take place within 10 days after sowing seeds. When the seeds were germinated, shade by bamboo mate (chatai) was

provided to protect the young seedlings from scorching sun shine and rain.The seedbed was watered daily during evening hours. Seedlings were not attacked by any kind of insect and diseases.

3.6 Land preparation

The experimental plot was opened first on 27 October, 2017 by power tiller for growing the desired crops. It was then thoroughly prepared by ploughing and cross ploughing with power tiller followed by laddering to bring about a good tilth suitable for establishing the seedlings and left exposed to sunlight for 7 days. Then the land was leveled and the experimental plot was shaped and the clods were broken into pieces. The was clean of weeds and stables and was finally leveled.

3.7 Design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with two factors. Factor A was four nitrogen levels and Factor B was four phosphorus levels. Total plots were 48. Length of unit plot was 2.0 m and breadth 1.4 m. Plot area was 2.8 m^2. Total experimental land length was 29.5 m and breadth 7.6 m.There were sixteen (16) treatment combinations. The treatments were randomly distributed to each replication.

3.8 Treatments

Two factors were considered for this experiment. Factor A was nitrogen fertilizers levels with dose of 0, 75, 125 and 175 Kg N ha^{-1}. Factor B was phosphorus fertilizer levels with dose of 0, 30, 40, 50 Kg P ha^{-1}.

Plate 1: Experimental field at vegetative stage

Factor A: Nitrogen

N_o = 0 Kg N ha^{-1}
N_1 = 75 Kg N ha^{-1}
N_2 = 125 Kg N ha^{-1}
N_3 = 175 Kg N ha^{-1}

Factor B: Phosphorus

P_0 = 0 Kg P ha^{-1}
P_1 = 30 Kg P ha^{-1}
P_2 = 40 Kg P ha^{-1}
P_3 = 50 Kg P ha^{-1}

3.9 Operational practices

3.9.1 Plot preparation

The experimental plot was prepared by several ploughing and cross ploughing followed by laddering and harrowing to bring about good tilt. Weeds and other stubbles were removed carefully from the experimental plot and leveled properly. Individual plot area was 2.8 m^2 and the distance between plots was 0.4 m.The land was deep ploughed once and the land was brought to fine tilth by repeated harrowing and levelling. Then FYM was incorporated at the rate of fivetonnes per ha into the soil. The ridges and furrows were opened at a distance of 40 cm and one meter wide irrigation channels were opened between the plots. The land was levelled with wooden plank to bring the soil to fine tilth. The total experimental area was 224.2 m^2 (29.5 m x 7.6 m).

3.9.2 Application of fertilizers

Fertilization was done manually with a row spacing of 75 cm. In the fertilization, fertilizers were placed as per the treatments and were thoroughly mixed with soil. Fertilizers were applied in the form of urea and triple super phosphate as a source

of nitrogen and phosphorus, respectively. The half of the dose of nitrogen were applied at the time of transplanting and other half of the nitrogen was applied at 30 days after transplanting. Total amount of well decomposed cowdung and Triple Super phosphate were applied during final land preparation

3.9.3 Transplanting and aftercare

The seedbeds were watered before uprooting the seedlings. At the time of uprooting care was taken so that root damage were minimum and some of soil remained with the roots. Healthy and uniform sized seedlings of 30 days were taken separately from the seedbed and transplanted in the experimental plot on 29 November 2017 at the rate of one seedlng per hill. After transplanting light irrigation was given to entire plot. Eight plants were transplanted per plot. Distance between two plot was 1.0 m. Planting was done in the evening. Light irrigation was given immediately after transplanting around each seedling and continued for several days for their better establishment. Seedlings were also transplanted around the border of the experimental plots for gap filling.

3.9.4 Gap filling

Seven days after transplanting the gap filling was done with fresh seedlings in order to maintain percent of plant population in all treatments.

3.9.5 Weeding

The experimental plot was kept free from weeds by regular hand weeding. Weeding was done as and when necessary to keep the plots clean. Weeding was done every 15 days interval from planting to flowering stage. Spading was done from time to time specially to break the soil crusts and keep the land weed free after each irrigation.

3.9.6 Irrigation

Irrigation was given as and when required by observing soil moisture condition. Irrigation was done throughout the growing period. Generally, irrigation was given once in a week depending upon soil and climate. Each fertilizing was followed by irrigation. Irrigation was done in the afternoon.

3.9.7 Plant protection

To control the pest and diseases, necessary plant protection measures were taken as and when required. To control fruit and shoot borer (*Leucinodesar bonalis*) carbaryl was sprayed @ 4 g per litre at 15 days interval for 3 times.

3.9.8 Crop harvesting

The crop was harvested in different dates according to marketable maturity. First harvesting was done on 20 February 2018. Multiple harvest was maintained in every plant. Five plants were selected at randomly from each plot in each replication. The fruit were harvested from tagged plants by harvesting tools. Data were recorded on different parameters from tagged plants.

3.10 Parameter recorded

Eleven yield and yield components traits were taken into consideration for studying the effect of nitrogen and phosphorus fertilizer on growth and yield of brinjal. Five plants from each plot were selected at random and tagged for recording the observations on the following growth and yield parameters.

3.10.1 Plant height

The selected plants were used for measuring plant height. It was recorded in centimeters from the base of plant to the terminal growing point of the plant.

3.10.2 Number of leaves per plant

The number of leaves were counted in the tagged plants and recorded. The mean number of leaves was worked out. It was denoted by number.

3.10.3 Number of branches per plant

The marked plants were used for counting the total number of branches without classifying into primary and secondary branches. It was denoted by number.

3.10.4 Length of branch

The tagged plants were used for counting the length of branch. It was recorded in centimeters from the base of leaf to the tip of leaf. It was denoted by centimeters.

3.10.5 Days to first flowering

The plants were observed for flowering. The number of days taken from the date of transplanting to flowering of the 5 percent plants in each treatment was recorded.

3.10.6 No. of flowers per plant

The selected plants were used for counting the number of flowers per plant and average was done. The number of flowers per plant was counted in each plot. It was denoted by number.

3.10.7 Fruit length

Length of the five mature fruits at fully matured stage was measured individually in centimeters from the base of calyx to tip of fruit using Vernier Calipers and the average was calculated.

3.10.8 Fruit diameter

Fruit diameter was measured by using Vernier Calipers and later average was worked out and expressed in centimeters.

3.10.9 Number of fruits per plant

The mean fruit number per plant was worked out from the total number of fruits harvested over all the pickings.

3.10.10 Individual fruit weight

Fruit weight of five matured and fully ripened fruits was recorded individually and the average was worked out. It was denoted as gram.

3.10.11 Fruit yield per plant

The mean fruit weight per plant was calculated from the fruits harvested over all the pickings. It was denoted as Kilogram.

3.10.12 Statistical analysis

Data recorded for growth and yield contributing characters were compiled and tabulated in proper form for statistical analyses. Analysis of variance was done following the RCBD design with the help of MSTAT–C computer package programme. Duncan's Multiple Range Test (DMRT) was performed for all the characters to test the differences between the means of the treatments.

CHAPTER IV

RESULTS AND DISCUSSIONS

In the present investigation the data was collected from three replications on eleven traits related to growth and yield components. The data were subjected to biometrical analysis and results obtained are presented below according to parameters:

4.1 Plant height

Plant height varied significantly due to different levels of nitrogen (Appendix III). Nitrogen application increased plant height with increased the level (Figure 1). The level of 175 kg N ha^{-1} produced the tallest plants (49.27 cm) and the shortest plants (42.87 cm) formed in the control (0 Kg N ha^{-1}). The obtained results were in agreement with Prabhu *et al.* (2003), and Wange and Kale (2004). The plant height can be considered as one of the indices of plant vigour ordinarily and it depends upon vigour and growth of the plant. Soil nutrients are also very important for the height of plants (Pervez. *et al.* 2004). This variation might be due to the availability of nutrients especially nitrogen and could be due to the improvement of soil water holding capacity as mentioned earlier by Roe and Cornforth (2000). By increasing the nitrogen fertilizer rate the leaf dry matter content increased.

Analyis of variance showed that phosphorus levels were significantly influence for plant height (Appendix III). Highest plant height (47.36 cm) was observed in P level P_2 (40 Kg P ha^{-1}) (Figure 2). The lowest (42.47) plant height was found in Po (Figure 3).

Interaction of nitrogen and phosphorus was highly significantly affected on plant height of brinjal (Appendix III). The maximum plant height (57.40 cm) was measured for the combination of N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}), which was not significantly different from the treatment N_2P_3 (125 Kg N ha^{-1} and 50 Kg P ha^{-1}). While the minimum plant height (42.87 cm) was recorded for the control (Figure 3). A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients (Brady and Weil, 2002). The application of phosphorus fertilizer alone was not increased plant height, while plant height increased when phosphorus fertilizer applied with nitrogen. Increasing the rates of both N and P from zero to the maximum has increased plant height. This effect might be due to the obvious role of nitrogen in enhancing vegetative growth and seemed to be more enhanced due to the presence of phosphorus.

Results of the experiment are in agreement with the finding of Sharma *et al.* (2014) who have reported that plant height increased with increasing fertilizer levels of nitrogen and phosphorus. This could be attributed to the enhanced availability of nutrients to the crop which may have resulted in increased photosynthetic efficiency and increased metabolic activities of the plant with an increase in fertilizer level. Similarly, Jamaati-e-Somarin *et al.* (2009) have also reported that, the highest rate of nitrogen gave the highest plant height, as it was observed in the present experiment that application of the highest nitrogen and phosphorus rate gave the highest plant height (57.40 cm) than those of nitrogen rates applied alone. Mulubrhan (2004) and Zelalem et al. (2009) have also reported that increasing application of nitrogen and phosphorus highly significantly increased the height of plants.

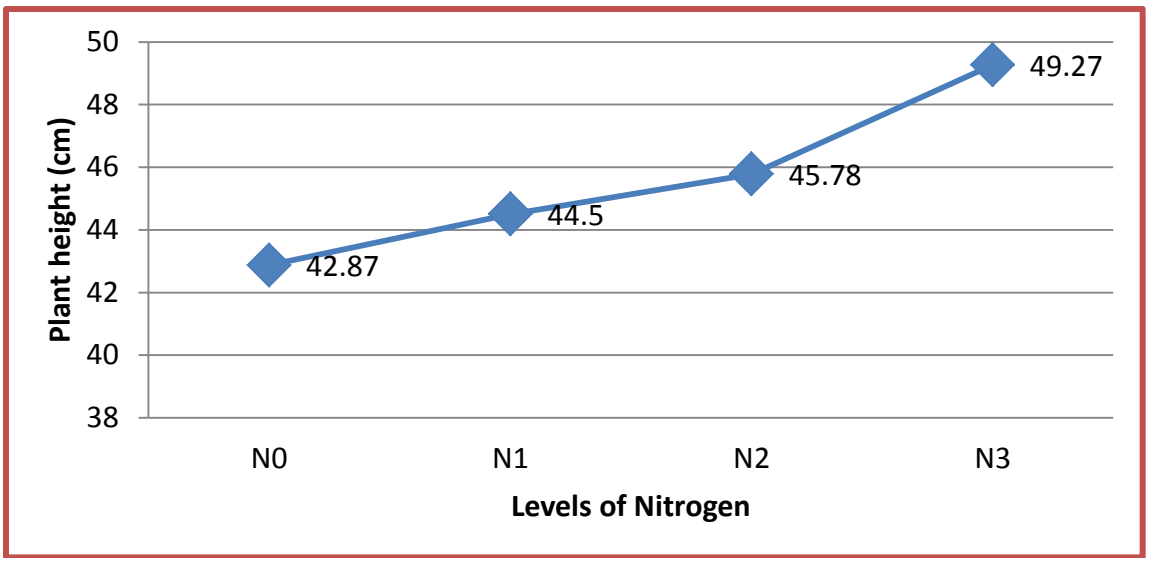

Figure 1. Effect of nitrogen on the plant height of brinjal

Here, N_0 = 0Kg N ha^{-1}, N_1 = 75 Kg N ha^{-1}, N_2 = 125 Kg N ha^{-1} and N_3 = 175 Kg N ha^{-1}.

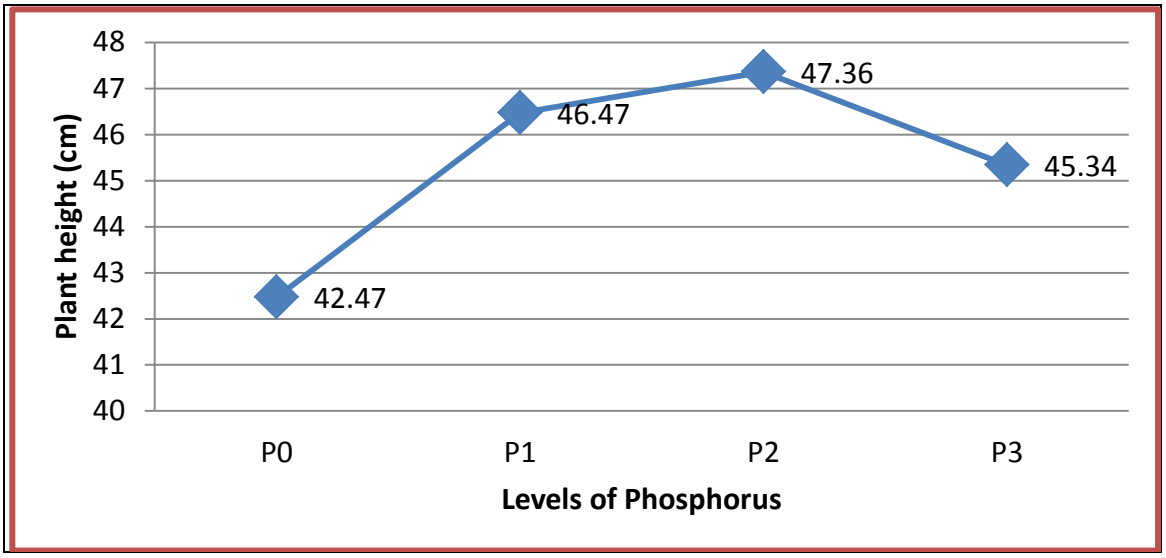

Figure . Effect of phosphorus on the plant height of brinjal

Here, P_0 = 0 Kg P ha^{-1}, P_1 = 30 Kg P ha^{-1}, P_2 = 40 Kg P ha^{-1} and P_3 = 50 Kg P ha^{-1}.

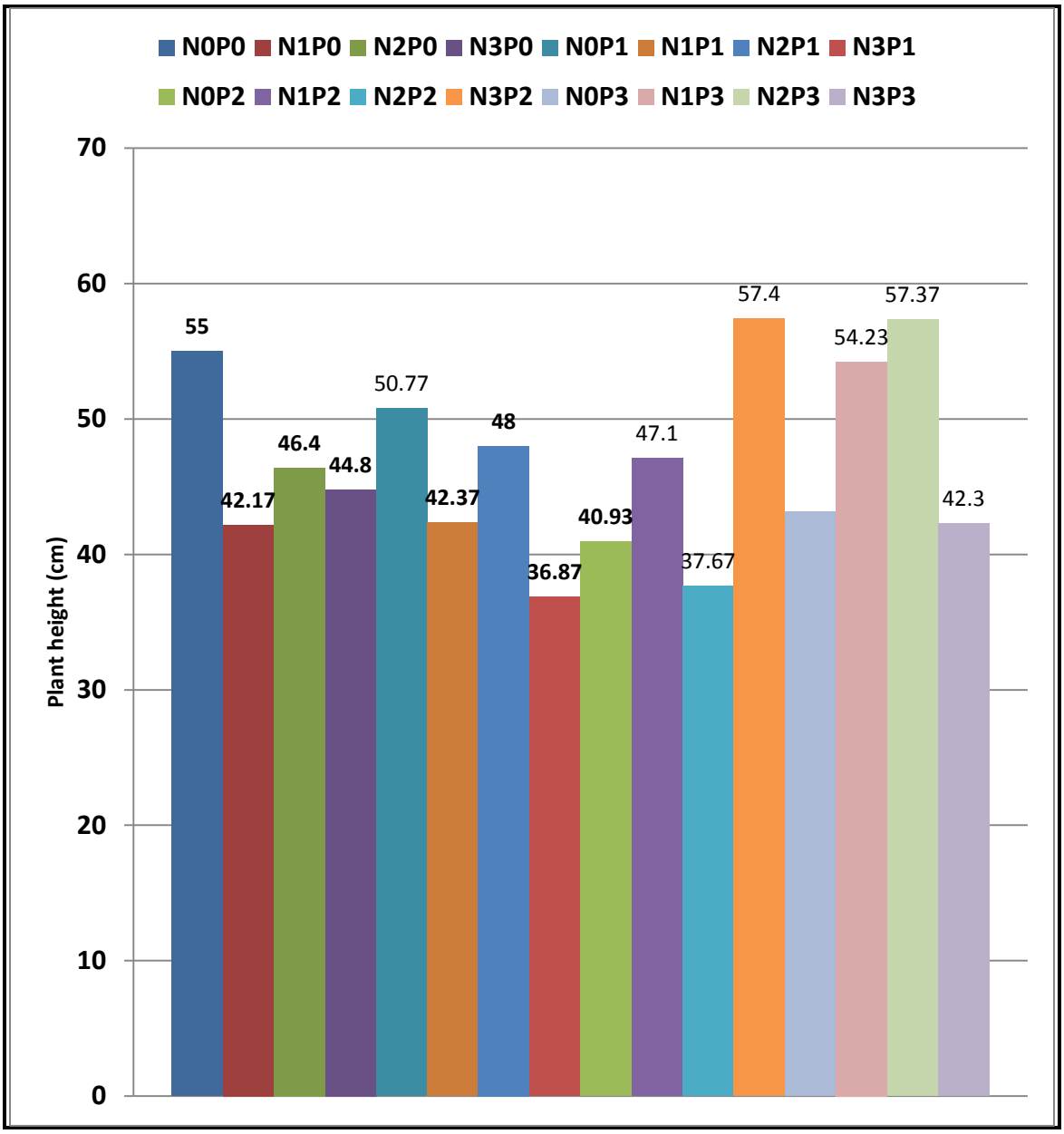

Figure 3. Interaction effect of nitrogen and phosphorus on the plant height of brinjal

Here, N_0 = 0Kg N ha^{-1}, N_1 = 75 Kg N ha^{-1}, N_2 = 125 Kg N ha^{-1} and N_3 = 175 Kg N ha^{-1}
P_0 =0 Kg P ha^{-1}, P_1 =30 Kg P ha^{-1}, P_2 = 40Kg P ha^{-1} and P_3 = 50 Kg P ha^{-1}.

4.2 No. of leaves per plant

Number of leaves per plant was showed significantly varied due to different nitrogen levels (Appendix III). The effect of nitrogen fertilization level on leaf number was shown in Table 2. The highest number of leaves per plant was obtained as a result of the higher rates of 175 Kg N ha^{-1} with 103.92 leaves per plant which was significantly different than other treatments. While the lowest values were observed at the control and showing the average value of 89.25 leaves. The results were in agreement with the observations of Wange and Kale (2004).

Number of leaves per plant varied significantly due to different levels of phosphorus (Appendix III). Increases in phosphorus fertilizer additions tended to increase number of leaves per plant compared with the unfertilized control. The contribution of application of phosphorus fertilizer alone in increasing number of leaves per plant was almost none i.e. insignificant.

Interaction effect of nitrogen and phosphorus was highly significant ($P < 0.01$) for number of leaves per plant (Appendix III). The maxim number of leaves per plant (109.00 cm) was recorded for the combination of N_2P_3 (125 Kg N ha^{-1} and 50 Kg P ha^{-1}), which was followed by the treatment N_1P_3 (75 Kg N ha^{-1} and 50 Kg P ha^{-1}). While the minimum number of leaves per plant (79.67 cm) were recorded from the control (Table 2). A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients.

Table 1. Influence of nitrogen and phosphorus fertilizer levels on number of leaves per plant in brinjal

Nitrogen level	Number of leaves per plant	Number of branches per plant	Length of branch (cm)	Days to first flowering
N_0	89.25 c	11.75 c	42.27 d	61.56 a
N_1	95.25 b	13.80 bc	44.83 c	55.55 b
N_2	90.08 c	16.87 ab	48.28 b	55.32 b
N_3	103.92 a	20.48 a	53.38 a	54.25 c
LSD (0.05)	1.38	0.38	0.84	0.15
CV (%)	3,56	2.67	7.54	5.77
Phosphorus level				
P_0	92.12	15.25 b	50.04 a	57.52 b
P_1	95.17	15.56 b	47.92 a	62.09 a
P_2	95.75	17.09 a	47.55 a	57.55 b
P_3	95.17	15.76 b	43.18 b	54.52 c
LSD (0.05)	1.38	0.384	0.84	0.154
CV (%)	7.22	4.88	9.66	4.77

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-1})

Table 2. Interaction effect of nitrogen and phosphorus fertilizer levels on plant height and number of leaves per plant in brinjal

Treatments	Number of leaves per plant	Number of branches per plant	Length of branch (cm)	Days to first flowering
N_0P_0	79.67 k	9.67 j	47.50 ef	63.00 c
N_1P_0	91.33 gh	11.00 i	43.10 hi	63.17 c
N_2P_0	88.00 hi	12.00 hi	40.07 jk	66.00 a
N_3P_0	98.00 d-f	14.33 g	38.40 k	54.07
N_0P_1	95.00 fg	12.15 h	46.16 fg	56.00 h
N_1P_1	96.67 ef	15.00 fg	40.61 jk	65.00 b
N_2P_1	94.00 fg	16.73 de	50.17 cd	53.21 k
N_3P_1	87.33 hi	11.33 hi	42.40 ij	48.00 m
N_0P_2	85.00 ij	17.33 d	58.20 a	57.078
N_1P_2	83.00 jk	20.17 c	49.40 c-e	60.21 e
N_2P_2	96.00 ef	15.97 ef	44.87 gh	59.00 f
N_3P_2	96.33 ef	14.00 g	40.67 i-k	61.00 d
N_0P_3	95.00 fg	21.83 b	48.31 d-f	54.00 j
N_1P_3	105.67 b	16.07 ef	58.55 a	60.00 ej
N_2P_3	109.00 a	23.67 a	55.10 b	52.00l
N_3P_3	99.00 c-e	20.33 c	51.26 c	55.00 i
LSD (0.05)	1.38	0.38	0.84	0.15
CV (%)	2.54	4.23	3.10	0.46

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-1})

4.3 Number of branches per plant

Analysis of variance performed was significant for number of branches per plant due to different nitrogen levels (Appendix III). The effect of nitrogen fertilization level on branches number was shown in Table 2. The highest number of branches per plant was obtained in N_3 (20.48) i.e. application of 175 Kg N ha^{-1} which was statistically similar with N_2 (125 Kg N ha^{-1}) and the value was 16.87. The lowest number of branches per plant was obtained from the control. Data in Table 2 showed that the application of nitrogen, in successive amounts, to the growing eggplant plants, resulted in corresponding and significant increases in growth characters, i.e. number of branches per plant. The enhancing effect of N on vegetative growth characters of eggplant can be explained on the basis of the physiological fact that N plays a major role in protein and nucleic acids synthesis and protoplasm formation. Moreover, it stimulates the meristametic activity for producing more tissues and organs. These results, generally, agreed with those obtained by Abd Allah *et al.*, (2001), who mentioned that the number of branches per plant of eggplant, increased with N application.

Number of branches per plant varied significantly due to different levels of phosphorus (Appendix III). Phosphorus fertilizer application increased number of branches per plant with increased the levels (Table 2). The level of 40 kg P ha^{-1} produced the highest number of branche per plant (17.09) and the lowest number of branches per plant (15.25) found from the control (0 Kg P ha^{-1}).

Interaction effect of nitrogen and phosphorus was highly significant ($P < 0.01$) for number of branches per plant of brinjal (Appendix III). The maxim number of branches per plant (23.67) was measured for the combination of N_2P_3 (125 Kg N ha^{-1} and 50 Kg P ha^{-1}). While minimum number of branches per plant (9.67) was recorded from the control (Table 2).

4.4 Length of branch

Length of branch varied significantly due to different levels of nitrogen (Appendix III). The effect of nitrogen fertilization level on length of branch was shown in Table 2. The highest length of branch was obtained in N_3 (53.38 cm) i.e. application of 175 Kg N ha^{-1}. Which was significantly followed by N_2 (125 Kg N ha^{-1}) and the value was 48.28 cm. The lowest length of branch was obtained from the control (42.27 cm).

Length of branch varied significantly due to different levels of phosphorus (Appendix III). Phosphorus fertilizer application increased length of branch decreased (Table 2). The highest level of P (50 kg P ha^{-1}) produced the lowest length of branch (43.18 cm) and the highest length of branch (50.04 cm) found from the control (0 Kg P ha^{-1}).

Interaction effect of nitrogen and phosphorus was highly significant ($P < 0.01$) for length of branch of brinjal (Table 2). The maximum length of branch (58.55 cm) was measured for the combination of N_1P_3 (75 Kg N ha^{-1} and 50 Kg P ha^{-1}). While minimum length of branch (38.40 cm) was recorded from the N_3P_0 (Table 3).

4.5 Days to first flowering

The effect of N fertilizers was found to be significant with respect to days taken for first flowering (Appendix IV). The data on days to first flowering as influenced by nitrogen fertilizer levels are presented in Table 2. The days to first flowering ranged from 54.25 days to 61.56 days in average (Table 4). With increase in the levels of fertilizer, time taken for first flowering was showed decreasing trend. Thus nitrogen treatments decreased the days to first flowering and treated plants flowered earlier than control plants. Nitrogen deficiency retarded the vegetative as well as reproductive growth, which resulted in more days to flowering and fruit setting. Similarly, more nitrogen lead to maximum days to flowering and fruit

setting. It means nitrogen enhanced vegetative growth and reduced reproductive growth (Jilani *et al.*, 2008) therefore, a fertilizer dose of 175 kg N per hectare proved better for minimum days to flowering, which leads to early fruit setting which were in agreement with findings of Sat and Saimbhi (2003)and Law – Ogbomo and Eghareba (2009).

The effect of P fertilizers was found to be significant with respect to days taken for first flowering (Appendix IV). Phosphorus fertilizer application increased days to first flowering decreased (Table 4). The highest level of P (50 kg P ha^{-1}) produced the lowest days to first flowering (54.52) and the highest days to first flowering (62.09) was obtained from P_1 (30 Kg P ha^{-1}). Significant differences were found between four P treatments.

The interaction effects were also significant between levels of N and P fertilizers with respect to days taken for first flowering (Appendix IV). However, the treatment combination of N_3P_1 recorded minimum number of days (48.00) for first flowering (Table 3). The maximum number of days to first flowering (66.00) was observed by the treatment N_2P_0 (Table 4).

4.6 Number of flowers per plant

Flower number at lateral stem was significantly affected by nitrogen fertilizer (Appendix IV**)**. The highest flower number was observed in 175 Kg N ha^{-1} having 171.64 flowers in average, while the least number of flowers was recorded at control having 152.27 flowers (Table 4). This result agrees with the finding by Bobadi and Van Damme (2003) and XU *et al.* (2001).

Flower number was significantly affected by phosphorus fertilizer (Appendix IV**)**. Phosphorus fertilizer application increased number of flowers per plant decreased (Table 4). The highest level of P (50 kg P ha^{-1}) produced the lowest number of

flowers per plant (158.51) and the highest number of flowers per plant (164.87) was obtained from P_1 (30 Kg P ha^{-1}) (Table 4).

The interaction effects of nitrogen and phosphorus were also significant with respect to number of flowers per plant (Appendix IV). The treatment combination of N_1P_3 recorded maximum number of flowers per plant (176.23) (Table 4). The minimum number of flowers per plant (145.96) was observed by the treatment N_3P_0 (Table 4).

Table 3. Influence of Nitrogen and Phosphorus levels on number of flower per plant and fruit length in brinjal

Nitrogen levels	Number of flower per plant	Fruit length (cm)	Fruit diameter (cm)	Fruits per plant
N_0	152.27 d	16.74 b	4.08	17.72
N_1	159.65 c	17.64 a	4.23	18.66
N_2	166.25 b	17.57 a	4.40	19.80
N_3	171.64 a	17.74 a	4.56	20.08
LSD(0.05)	1.025	0.15	0.22	1.30
CV (%)	3.78	2.76	6.43	3.65
Phosphorus levels				
P_0	161.87 a	17.82 a	4.40	18.75
P_1	164.87 a	16.72 c	3.94	19.09
P_2	164.55 a	17.85 a	4.68	19.66
P_3	158.51 b	17.81 b	4.34	18.74
LSD (0.05)	1.02	0.15	0.22	1.38
CV (%)	5.34	5.77	6.77	4.55

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-1})

Plate 2: Brinjal plant at flowering stage

Table 4. Interaction effect of nitrogen and phosphorus levels on days to first flowering and number of flowers per plant in brinjal

Treatments	Number of flowers per plant	Fruit length (cm)	Fruit diameter (cm)	Fruits per plant
N_0P_0	152.33 i	16.84 e	4.53 ab	17.13
N_1P_0	155.78 h	16.76 e	3.75 c-e	17.35
N_2P_0	154.99 hi	15.93 f	3.67 de	18.99
N_3P_0	145.96 j	17.41 cd	4.39 a-c	17.39
N_0P_1	158.97 g	18.28 ab	4.53 ab	18.39
N_1P_1	161.43 fg	16.25 f	3.49 e	18.86
N_2P_1	163.59 ef	18.57 a	4.40 a-c	19.43
N_3P_1	154.59 hi	17.47 c	4.50 ab	17.94
N_0P_2	166.66 cd	18.10 b	4.60 ab	19.73
N_1P_2	166.03 de	17.00 de	4.21 a-d	19.92
N_2P_2	169.21 bc	18.29 ab	4.74 a	19.57
N_3P_2	163.10 ef	16.91 e	4.05 b-e	19.98
N_0P_3	169.52 bc	18.17 a	4.74 a	19.77
N_1P_3	176.23 a	16.85 e	4.32 a-d	20.23
N_2P_3	170.41 b	18.50 a	4.71 a	20.65
N_3P_3	170.40 b	17.43 b	4.46 ab	19.65
LSD (0.05)	1.025	0.158	0.227	1.38
CV (%)	1.09	1.50	9.11	11.83

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-1})

4.7 Fruit length

The Statistical analysis for fruit length clearly revealed that there was observed significant variations for this trait (Appendix IV). Fruit length of brinjal cultivars is depicted in Table no. 3. Maximum fruit length (17.74 cm) was recorded in 175 Kg of N was applied, while minimum fruit length (16.74 cm) was noted at control (Table 3). Increase in the fruit length of brinjal by increasing nitrogen fertilizers might be due to more nutrient uptake and nutrients availability that helped in improving optimum reproductive growth that resulted in production of more photosynthates, more cell elongation and thus increased length of fruit. Results of present investigation are in analogy with Ullah *et al.* (2008) who reported that the increase in fruit length of eggplant could be due to combined application of fertilizers.

Phosphorus fertilizer with different levels was differing significantly for fruit length (Appendix IV). The more fruit length (17.85 cm) was observed by the P level P_2 (40 kg P ha^{-1}). Lowest fruit length (16.72 cm) was obtained from P_1 (30 Kg P ha^{-1}) (Table 3).

The combined effects of N and P with different levels were also significant respect to fruit length (Appendix IV). The treatment combination of N_2P_1 recorded maximum fruit length (18.57 cm) (Table 6). The minimum fruit length (15.93 cm) was observed by the treatment N_2P_0 (Table 3).

4.8 Fruit diameter

The Statistical analysis of fruit diameter in clearly revealed that there was significant variation (Appendix IV). A similar trend of results was also obtained in fruit diameter (cm) as was recorded in fruit length (cm).

Plate 3: Brinjal plant at fruiting stage

Maximum fruit diameter (4.56 cm) was recorded as 175 Kg of N was applied ha^{-1}, while minimum fruit diameter (4.08 cm) was noted under control (Table 5). Increased fruit diameter might be due to its maximum fruit volume and fruit weight could possibly be the profound effect of increasing nitrogen fertilizer on the eggplant fruit growth and development. The data obtained by Ghasem *et al*. (2014) regarding fruit diameter in cucumber is supported by the recent result who studied the effect of fertilizers on cucumber yield. Present results are also in conformity with the early findings of Ullah *et al*, (2008) who reported a positive impact of the combined fertilization on the fruit diameter of brinjal. Similarly, Suge *et al*. (2011) found a significant effect on the fruit diameter of eggplant under the fertilizer treatments.

Phosphorus fertilizer with different levels was differing insignificantly for fruits per plant (Appendix IV). The maximum fruit diameter (4.68 cm) was observed by P_2 level of P (40 kg P ha^{-1}) (Table 5). Lowest fruit diameter (3.94 cm) was obtained from P_1 (30 Kg P ha^{-1}) (Table 5).

The combined effects of N and P with different levels were significant respect to fruit diameter (Appendix IV). The treatment combination of N_2P_2 recorded maximum fruit diameter (4.74 cm) (Table 5). Which was identical with the fertilizer combination of N_2P_3 and N_0P_3. The minimum fruit diameter (3.49 cm) was observed by the treatment N_1P_1 (Table 5).

4.9 Fruits per plant

The statistical analysis of variance for fruits per plant clearly revealed that there was significant variation for nitrogen fertilizer (Appendix V). Fruits per plant of brinjal cultivar is depicted in Table 4. Maximum fruits per plant (20.08) was recorded in 175 Kg of N was applied ha^{-1}, while minimum fruits per plant (17.72)

was noted at control (Table 4). Increase in the fruits per plant of brinjal by increasing nitrogen fertilizers might be due to more nutrient uptake and nutrients availability that helped in improving optimum reproductive growth that resulted in production of more photosynthates, more cell elongation and thus increased fruits per plant.

Phosphorus fertilizer with different levels was differing in significantly for fruits per plant (Appendix V). The maximum fruits per plant (19.66) were observed by P_2 level of P (40 kg P ha^{-1}) (Table 6). Lowest fruits per plant (18.75) were obtained from control (0 Kg P ha^{-1}) (Table 6).

The combined effects of N and P with different levels were also insignificant respect to fruits per plant (Appendix V). The treatment combination of N_2P_3 recorded maximum fruits per plant (20.65) (Table 6). While minimum fruits per plant (17.13) was observed by the treatment N_0P_0 (Table 6).

4.10 Individual fruit weight

This trial revealed that statistical analysis of variation differences existed among the treatments for individual fruit weight only for N fertilizer (Appendix V). Data revealed that the highest fruit weight (59.83 g) was observed from 75 Kg N ha^{-1}, while the lowest (56.04 g) related to control (0 Kg N ha^{-1}) (Table 6). These results are consistent with those reported by Ali and Kelly (1992), Devi *et al.* (2002) and Aujla *et al.* (2007) who also reported that increasing the rate of nitrogen fertilizers increased the average fruit weight in some extent.

Phosphorus fertilizer with different levels was differing insignificantly for fruit weight (Appendix V**)**. The maximum fruit weight (60.46 g) was observed by P_3

level of P (50 kg P ha^{-1}) (Table 6). Lowest fruit weight (56.01 g) was obtained from control (0 Kg P ha^{-1}).

The combined effects of N and P with different levels were significant respect to fruit weight (Appendix V). The treatment combination of N_3P_2 recorded maximum fruit weight (62.14 g) (Table 6). While minimum fruit weight (54.77 g) was observed by the treatment N_0P_0 (Table 6).

Table 5. Influence of nitrogen and phosphorus fertilizers levels on fruit weight in brinjal

Nitrogen levels	**Individual fruit weight (g)**
N_0	56.04
N_1	59.43
N_2	59.83
N_3	57.27
LSD (0.05)	1.48
CV (%)	2.55
Phosphorus levels	
P_0	56.01
P_1	57.56
P_2	58.35
P_3	60.46
LSD (0.05)	1.48
CV (%)	3.56

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-}

Table 6. Interaction effect of nitrogen and phosphorus fertilizers levels on fruits per plant and individual fruit weight in brinjal

Treatments	Individual fruit weight (g)	Yield per plant (Kg)
N_0P_0	54.77 d	0.99 b
N_1P_0	56.05 bc	1.04 b
N_2P_0	56.62 bc	1.08 b
N_3P_0	57.74 bc	1.00 b
N_0P_1	58.65 bc	1.08 b
N_1P_1	58.51 bc	1.10 b
N_2P_1	60.53 ab	1.17 ab
N_3P_1	60.87 ab	1.09 b
N_0P_2	57.80 bc	1.14 ab
N_1P_2	57.82 bc	1.15 ab
N_2P_2	59.97 ab	1.17 ab
N_3P_2	62.14 a	1.24 a
N_0P_3	57.82 abc	1.14 ab
N_1P_3	57.86 bc	1.09 b
N_2P_3	56.30 bc	1.16 ab
N_3P_3	61.08 ab	1.20 a
LSD (0.05)	1.48	0.238
CV (%)	4.40	12.81

Means followed by the same letter within a column for each treatment are not significantly different from each other at 5% level of significant.

Here, N_0: 0 Kg N ha^{-1}, N_1: 75 Kg N ha^{-1}, N_2: 125 Kg N ha^{-1}, N_3: 175 Kg N ha^{-1} and P_0: 0 Kg P ha^{-1}, P_1: 30 Kg P ha^{-1}, P_2: 40 Kg P ha^{-1}, P_3: 50 Kg P ha^{-1})

4.11 Yield per plant

The statistical analysis of yield per plant of eggplant showed significant differences among the treatments (Appendix V). Nitrogen fertilizer significantly increased yield per plant compared to control (Figure 4**)**. The highest yield in plant was obtained as (1.18 Kg) with application of 125 kg N ha^{-1} (Figure 4). The lowest yield was obtained as (1.03 Kg) in the zero nitrogen application. Rosati *et al.* (2002), Akanbi *et al*. (2007) and Aujla *et al.* (2007) reported that increasing the levels of nitrogen fertilizers increasing plant yield. Increasing the N levels of the fertilizers to 125 kg N ha^{-1} significantly increased the yield of eggplant while yield decreased at the highest rate of nitrogen. This decrease in yield might be due to excess levels of N in the plant. The marked effect of nitrogen on yield might be due to the cumulative stimulating effect of nitrogen on the vegetative growth which form the base for flowering and fruiting.

Phosphorus fertilizer with different levels was differing in significantly for yield per plant (Appendix V**)**. The maximum fruit yield (1.15 Kg) was observed by P_2 level of P (40 kg P ha^{-1}). Lowest fruit yield per plant (1.08 Kg) was obtained from control (0 Kg P ha^{-1}) (Figure 5).

The interaction between nitrogen and phosphorus fertilizer stated that the highest fruit yield per plant (1.25 kg) was observed in treatment combination N_3P_2 (175 Kg N ha^{-1} with 40 Kg P ha^{-1}), which was statistically similar with N_3P_3 (175 Kg N ha^{-1} with 50 Kg P ha^{-1}) (Table 6). whereas minimum fruit yield per plant was observed in control (N_0P_0) as zero kg of N and P. Highest fruit yield per plant found in treatment N_3P_2 might have been due to more number of fruits per plant or could be its better compatibility with the existence environment could be attributed to better biological and physical properties of the fertilizers resulting in improved supply of nutrients to the plants (Ekwu and Nwokwu, 2012). This result is supported by the early observations of Devi *et al*. (2002) in eggplant, Jablonska

(1990) and Hosmani (1993) in tomato, chilli and pepper who reported that the combined form of of fertilizers resulted in highest yield.

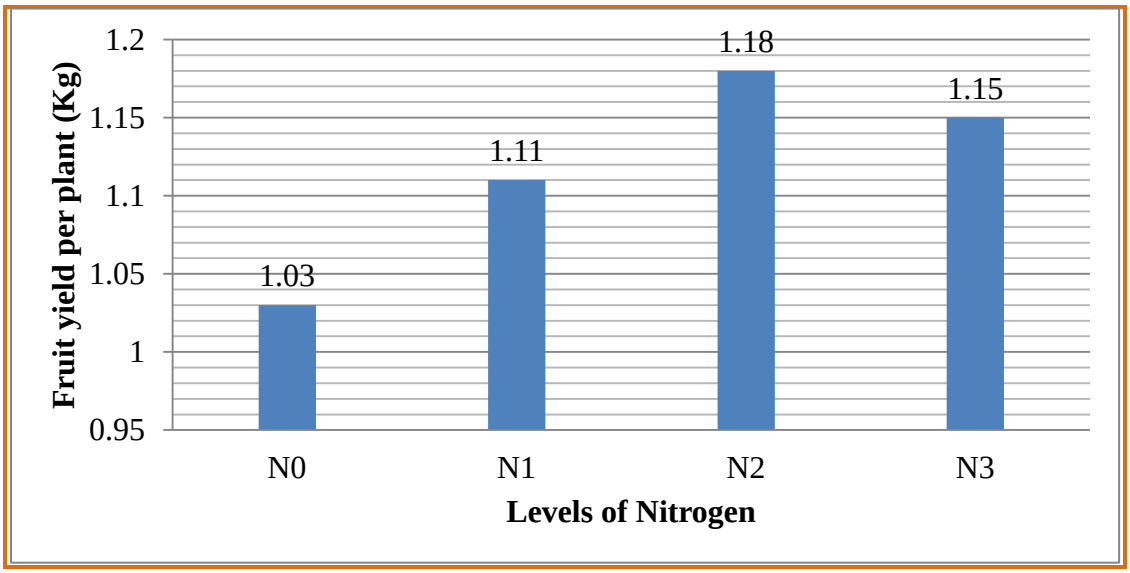

Figure 5. Effect of nitrogen on fruit yield per plant of brinjal

Here, N_0 = 0Kg N ha^{-1}, N_1 = 75 Kg N ha^{-1}, N_2 = 125 Kg N ha^{-1} and N_3 = 175 Kg N ha^{-1}

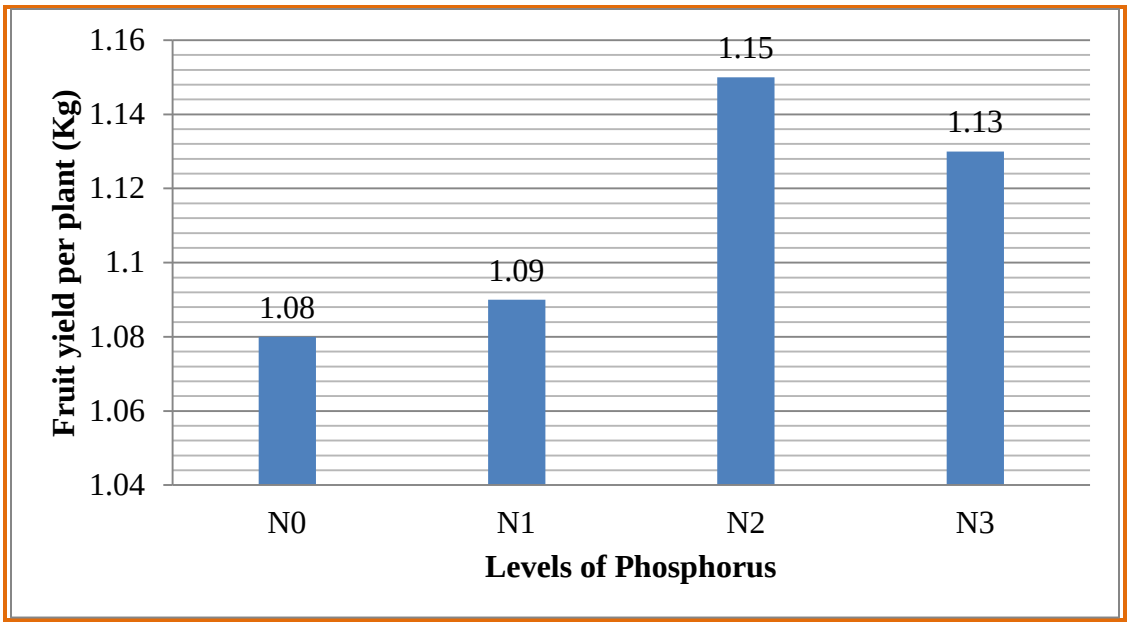

Figure 6. Effect of phosphorus on fruit yield per plant of brinjal

Here, P_0 = 0 Kg P ha^{-1}**,** P_1 = 30 Kg P ha^{-1}**,** P_2 = 40 Kg P ha^{-1} and P_3 = 50 Kg P ha^{-1}

CHAPTER V

SUMMARY AND CONCLUSION

The research work was conducted at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka (Tejgaon soil series under AEZ No. 28) during the Robi season of October to February, 2017 to study the effect of nitrogen and phosphorus fertilizers on the growth and yield of Brinjal. Two factor experiments with RCBD was followed with 16 treatments having unit plot size of 2.8 m^2 and three replication.

Plant height was significantly affected by different nitrogen and phosphorus treatments combination. Highest plant height (57.40 cm) was observed for the combination of N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}) and it was similar statistically fertilizer combination N_2P_3 (125 Kg N ha^{-1} and 50 Kg P ha^{-1}), which were higher over other treatments.

Application of nitrogen and phosphorus fertilizer showed positive effect on the number of leave per plant, number of branches per plant, fruit length, fruit diameter and fruits per plant. All the plant characters increased in increasing nitrogen fertilizer doses. Highest value of number of leave per plant (103.92), number of branches per plant (20.48), length of branches (53.38), number of flower per plant (171.64), fruit length (17.74), fruit diameter (4.56), fruits per plant (20.08) were observed by nitrogen fertilizer treatment N_3 (175 Kg N ha^{-1}). It was observed that growth and yield related traits were influenced significantly for increasing of nitrogen fertilizer.

Highest value of individual fruit weight (59.83) and yield per plant (1.18) were observed in nitrogen fertilizer treatment N_2 (125 Kg N ha^{-1}). It was observed that

fruit weight and yield was increased by increasing N fertilizer but decreased by the highest nitrogen dose.

Days to first flowering were decreased by the increasing of nitrogen fertilizer dose and highest value was observed by untreated control nitrogen fertilizer (61.56 days).

For the phosphorus fertilizer treatment highest value of number of leave per plant (95.75), number of branches per plant (17.09), length of branch (47.55), number of flower per plant (164.55), fruit length (17.85), fruits per plant (19.66), fruit diameter (4.68) and yield per plant (1.15) were observed fertilizer treatment P_2 (40 Kg P ha^{-1}). By increasing the P fertilizer dose these traits value were decreased. Highest individual fruit weight (60.46) was observed by the highest P fertilizer dose P_3 (50 Kg P ha^{-1}). In case of days to first flowering (62.09) the highest value was found by the P dose P_1 (30 Kg P ha^{-1}).

The combined effect of nitrogen and phosphorus fertilizers had positive effect on growth and yield related traits. In the combined application of N and P fertilizer the highest value of number of leaves per plant (109.00), number of branches per plant (23.67), fruit length (18.57), fruit diameter (4.71) and fruits per plant (20.65) were observed fertilizer treatment N_2P_3 (125 Kg N ha^{-1} and 50 Kg P ha^{-1}).

Highest value was observed for the trait length of branched (58.55) and number of flower per plant (176.23) in the fertilizer treatment combination N_1P_3 (75 Kg N ha^{-1} and 50 Kg P ha^{-1}). In case days to first flowering (66.00) treatment combination N_2P_0 for the highest value. Maximum fruit weight (62.14) and yield per plant (1.25) was found by the treatment combination N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}). Combined application of nitrogen and phosphorus fertilizers produced highest yield compared to untreated control treatment significantly.

Conclusion:

It was concluded from the above study that the treatment combination N_3P_2 (175 Kg N ha^{-1} and 40 Kg P ha^{-1}) were found to the most suitable treatment combination for the higher yield of brinjal.

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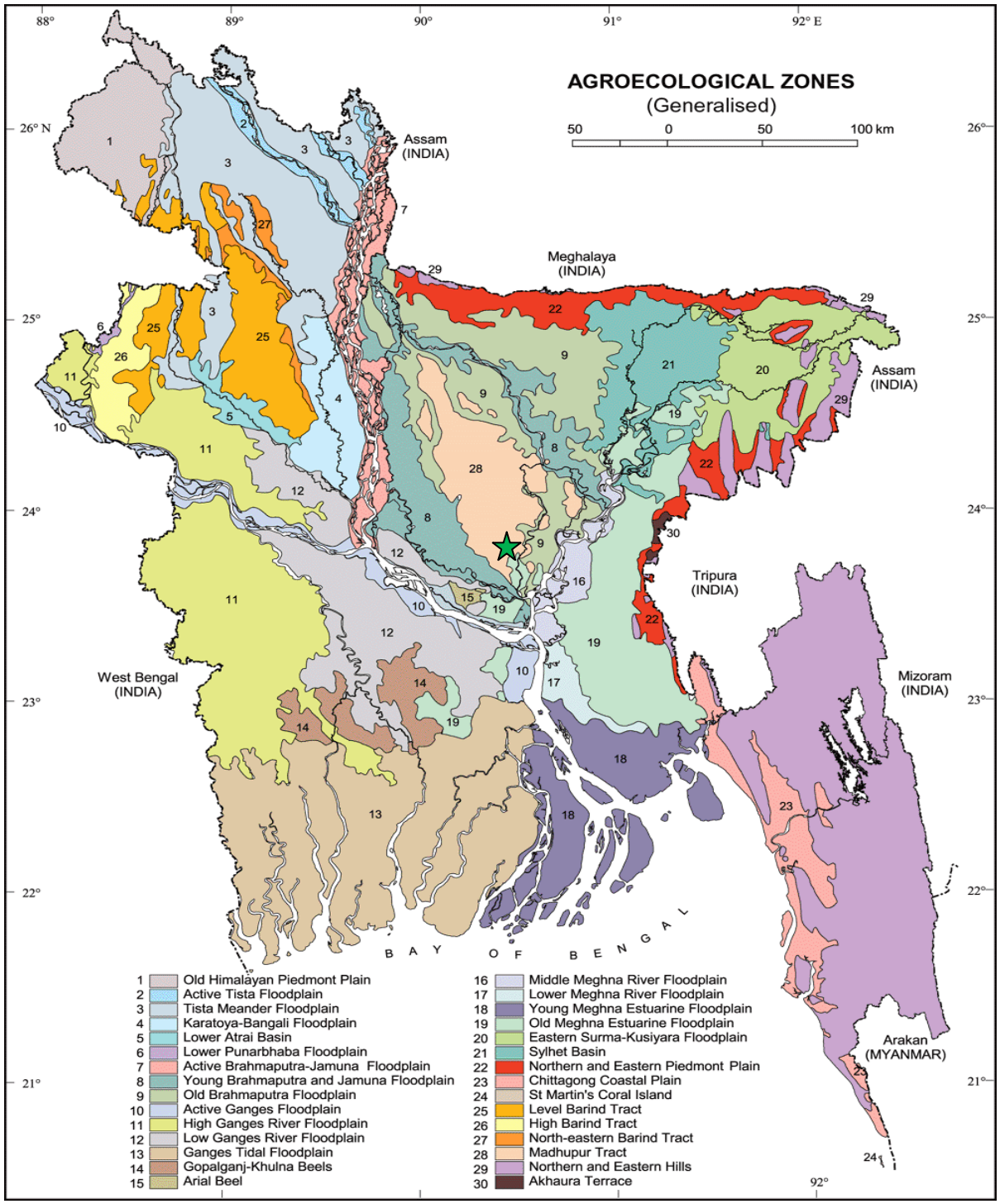
APPENDICES

Appendix I. Map showing the experimental site under the study



★ The experimental site under the study

Appendix II. Morphological, Physical and chemical characteristics of initial soil (0-15 cm depth) of the experimental site

A.Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Sher-e-Bangla Agricultural University Research Farm, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical composition of the soil

Characteristics	**Value**
% Sand	26
% Silt	45
% Clay	29
Texture class	Silty loam
p^H	6.5
Organic Matter %	1.28

C. Chemical composition of the soil

Sl. No.	**Soil characteristics**	**Value**
1	Organic carbon (%)	0.45
2	Total N (%)	0.03
3	Total S (ppm)	225.00
4	Total P (ppm)	840.00
5	Available N (kg/ha)	54.00
6	Available P (ppm)	20.54
7	Exchangeable K (me/100 g soil)	0.10
8	Available S (ppm)	16.00
9	pH (1:2.5 soil to water)	5.6
10	CEC	11.23

Source: Soil Resource and Development Institute (SRDI), Farmgate, Dhaka

Appendix III. Analysis of variance for plan height (cm), no. of leaves per plant, no. of branches per plant and length of branch (cm) in Brinjal

Source of variation	Mean sum of square				
	DF	Plan height (cm)	No. of leaves per plant	No. of branches per plant	Length of branch (cm)
Replication	2	78.766	121.188	42.419	119.680
Factor A (Nitrogen level)	3	49.71**	544.97**	173.43**	273.45**
Factor B (Phosphorus level)	3	11.65**	26.91**	10.60**	99.42**
AxB	9	199.10**	161.95**	23.83**	77.18**
Error	30	2.30	5.78	0.44	2.13

** denote significant at 1% level of probability

Appendix IV. Analysis of variance for days to first flowering, no. of flowers per plant, fruit length and fruit diameter in Brinjal

Source of variation	DF	Mean sum of square			
		Days to first flowering	No. of flowers per plant	Fruit length (cm)	Fruit diameter (cm)
Replication	2	15.293	706.370	7.619	0.295
Factor A (Nitrogen level)	3	111.73**	841.83**	2.56**	0.51*
Factor B (Phosphorus level)	3	117.21**	104.46**	3.42**	0.91**
A x B	9	52.94**	15.81**	1.38**	0.28
Error	30	0.07	3.15	0.06	0.15

Appendix V. Analysis of variance for no. of fruits per plant, Individual fruit weight (g) and Yield per plan (g) in Brinjal

Source of variation	DF	No. of fruits per plant	Individual fruit weight (g)	Yield per plan (g)
		1.489	0.037	0.006
Factor A (Nitrogen level)	3	14.16*	15.43	0.081*
Factor B (Phosphorus level)	3	2.22	19.73*	0.011
AxB	9	0.64	10.43	0.004
Error	30	5.08	6.64	0.020

* & ** denote significant at 5% 1% level of probability

Appendix VI. Monthly average temperature, relative humidity and total rainfall and sunshine of the experimental site during the period from November, 2017 to February, 2018.

Month	Air temperature (°c)		Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum			
November, 2017	34.23	18.0	77	227	5.8
December, 2017	32.4	16.3	69	0	7.9
January, 2018	29.1	13.0	79	0	3.9
February, 2018	28.1	11.1	72	1	5.7

Source: Bangladesh Meteorological Department (Climate & Weather Division), Agargoan, Dhaka – 1212