INFLUENCE OF CROP NUTRITION ON FRUIT, SEED YIELD AND QUALITY OF BRINJAL

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CERTIFICATE

This is to certify that the thesis entitled **“INFLUENCE OF CROP NUTRITION ON FRUIT, SEED YIELD AND QUALITY OF BRINJAL”** submitted to the **Institute of Seed Technology**, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **SEED TECHNOLOGY**, embodies the result of a piece of bonafide research work carried out by **AVIJIT GHOSH**, Registration No. **12-04769** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

June, 2018

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Dedicated to

My

Beloved Parents

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The Author

INFLUENCE OF CROP NUTRITION ON FRUIT, SEED YIELD AND QUALITY OF BRINJAL

By

AVIJIT GHOSH

ABSTRACT

The experiment was carried out to investigate the influence of crop nutrition on seed yield and quality of brinjal at the farm of Sher-e-Bangla Agricultural University, Dhaka during period from October 2017 to March 2018. Two factor experiment included 4 macro nutrients treatments *viz*. F_0 (Control: N_0 P_0 K_0 kg ha^{-1}), F_1 (N_{150} P_{30} K_{100} kg ha^{-1}), F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) and F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) and 3 micro nutrients treatments *viz*. N_0 (Control; Zn_0, B_0), N_1 ($Znso_4$; 0.2%) and N_2 (Borax; 0.2%) were delineated in Randomized Complete Block Design (RCBD) with three replications. Results showed that macro nutrients, micro nutrients treatments and their combination showed significant variation among the treatments on growth and yield parameters. In case of macronutrients, the highest fruit yield ha^{-1} (31.56 t), and seed weight ha^{-1} (1673.00 kg) were obtained from the treatment F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) where the lowest results on respected parameters were found from control treatment F_0 (N_0 P_0 K_0). Regarding, micronutrient application the highest fruit yield ha^{-1} (13.91 t) and seed weight ha^{-1} (1608.00 kg) were attained from the treatment N_2 (Borax; 0.2%) where the lowest results on respected parameter were achieved from the control treatment of N_0 (Control, Zn_0, B_0). In terms of combined effect of macro and micro nutrients, the highest number of fruits $plant^{-1}$ (19.09), highest single fruit weight (60.58 g), highest fruit yield $plant^{-1}$ (1157.00 g), highest fruit yield $plot^{-1}$ (13.88 kg), highest fruit yield ha^{-1} (42.84 t), number of seeds $fruit^{-1}$ (711.40), seed weight $fruit^{-1}$ (3.18 g), seed weight $plant^{-1}$ (60.72 g), seed weight $plot^{-1}$ (728.60 g) and seed weight ha^{-1} (2249.00 kg) were found from the treatment combination of F_2N_2 where the lowest results were obtained from the treatment combination of F_0N_0. Regarding seed viability test, F_3N_2 produced seed gave the highest seed vigor index (1013.6) where the lowest (425.8) was found from the seeds achieved from the treatment combination of F_0N_0.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United State of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Brinjal or Eggplant (*Solanum melongena* L.) is also known as Aubergine or Guinea squash an economically important vegetable crop widely cultivated in the tropics, subtropics and warm temperate regions (Sihachakr *et al*. 1994). It was originated in South East Asia (Lester and Hasan, 1991) and belongs to the family Solanaceae. Plant is herbaceous, annual with erect or semi-spreading in habit and flowers are solitary or in 2-5 flowered cymes white colour. Fruits become yellow on ripening. Seeds are small, light brown and numerous.

The important brinjal growing countries in the world are India, Bangladesh, Pakistan, China, Cyprus, Egypt, Japan, Philippines, Syria and Western Europe (Anon., 2001).

The fruits are known for being low in calories and having a mineral composition beneficial for human health. It is also a rich source of Potassium, Magnesium, Calcium and Iron (Zenia and Halim, 2008). Per 100 g of edible portion it contains the following proportion of food values- Water- 93 g, Vit-A- 70 IU, Protein – 1.2 g, Thiamine- 0.05 mg, Fat – 0.1 g, Riboflavin – 0.08 mg, Carbohydrate- 4.0 g, Niacin – 0.09 mg, Fibre – 1.2 g, Calories- 20, Calcium- 16 mg, Fe – 0.9 mg (Bose and Some, 1986).

The world production was estimated at 32 million tons in 2009 with China (18 million tons) and India (8.4 million tons) as the greatest producers (FAO STAT 2009). Brinjal is locally known as "Begoon" the most popular and preferred vegetable, widely grown in Bangladesh. It is the second most important vegetable crop next to potato in Bangladesh in respect of acrease and production (BBS, 2011). It is grown round the year both as Rabi and Kharif crops (Rashid, 1993). It is largely cultivated in almost all districts of Bangladesh. A number of cultivars are grown in Bangladesh, consumer preference being dependent upon fruit color, size and shape (Gopalan *et al*.

2007). About eight million farm facilities are involved in eggplant cultivation (Islam, 2005). This gives small, marginal and landless farmers a continuous source of income and provides employment facilities for the rural people.

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 (Satpal and Saimbhi, 2003). 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 (Satpal and Saimbhi, 2003 and Suthar *et al*., 2005). Potassium functions mainly on regulation and maintenance of electrochemical equilibrium in cells and other compartments and regulation of enzyme activities. It also involved in carbohydrate metabolism, protein synthesis, regulation of activities of various essential elements, adjustment of stomatal functions and water relations (Sharma and Brar, 2008).

Besides the major nutrients, micronutrients also have a good role in plant growth. Micronutrients like iron, zinc and boron are necessary for plant development and metabolism. Foliar spray of micronutrients facilitates efficient consumption of nutrients straightly through leaves, the effect of which can show its importance soon (Tawab *et al*., 2015). Micronutrients like zinc and boron are essential for plant growth and metabolism. Boron is an essential and important micronutrient for the vegetative and reproductive growth of vegetable crops. Due to lack of boron, there is hypertrophy, degeneration and disintegration of cambium cells in the meristematic tissues. Thus, necrosis of tissues is the most important symptom of boron deficiency (Gentz and Grace, 2006). Boron deficiency symptoms generally appear first on the younger leaves at the top of the plants; plants fail to produce functional flowers and may produce no seeds. Plants subjected to boron deficiency have been observed to result in sterility or low germination of pollen. Failure to set fruit is common, and the fruit may be ridged, show corky patches, and ripens unevenly (Gupta and Philip, 2006).

Seed is the basic and crucial input in agriculture and timely supply of high quality seeds at reasonable price to the grower assumes greater importance. The quality of seed either for seed production or of general cultivation depends on several factors, which influence the planting value of seed. High quality seed is the key to successful agriculture. The high seed quality in terms of viability and vigour are the essential factors which determine the seedling development in the field to get maximum seed yield besides high quality. As such only seed of high quality genetically pure, pathologically free and physiologically sound is needed to increase the productivity. The fruit yield of brinjal per unit area is very low in Bangladesh compared to western countries. So, it is urgently needed to develop improved technologies for higher production of brinjal regarding fruit and seed yield. Considering the above fact the present study entitled ‘Influence of crop nutrition on seed yield and quality of brinjal was undertaken with the following objectives:

1. To determine the effect of N, P and K fertilizer on fruit and seed yield and quality of brinjal
2. To investigate the possibility of the increasing production of brinjal seed by applying foliar application of micronutrient
3. To find out the combined effect of N, P and K fertilizer with foliar application of micronutrients on improving brinjal seed yield and quality

CHAPTER II

REVIEW OF LITERATURE

A good deal of research work has been done in Bangladesh and also all over the world to evaluate the response of brinjal seed production to applied macro and micronutrients. This has encouraged generating information for farmers and vegetable growers. In view of these facts, the literature available on these aspects has been reviewed in this chapter on following heads.

2.1 Effect of Macro nutrients on growth, yield and seed quality

Patidar *et al*. (2018) conducted an experiment was to see the effect of INM on yield of Brinjal (*solanum melongen*a L.) cv. NDBH-6. Nine treatments of integrated nutrient management *viz*., 100% RDF (100:60:40 kg/ha) (T_1), 100% FYM (20 t/ha) (T_2), 100% VC (3 t/ha) (T_3), 50% FYM (10 t/ha) + 50 % VC (1.5 t/ha) (T_4), 50% RDF (50:30:20 NPK kg/ha) + 50 % VC (1.5 t/ha) (T_5), 25% RDF (25:15:10 NPK kg/ha) + 75% VC (2.25 t/ha) (T_6), 50% RDF (50:30:20 NPK kg/ha) + 50% FYM (10 t/ha) (T_7), 25% RDF (25:15:10 NPK kg/ha) + 50% FYM (10 t/ha) (T_8) and control (T_9) (no use of fertilizer) were evaluated. Significantly higher values of yield attributes such as number of fruits per plant, fruit yield/plant, fruit yield/plot and fruit yield/ha were observed under T_7. However, significantly minimum values of yield attributes were observed under control T_9 (no use of fertilizer). The economic point of view maximum gross and net return was found with treatment T_7. However, the minimum gross and net return was achieved with control T_9 (No use of fertilizer) and the highest B:C ratio of 4.24 was obtained with T_7. Whereas, the lowest B:C ratio of 1.77 was obtained under control T_9 (No use of fertilizer).

Sollapur *et al*. (2017) conducted an experiment to know the effect of spacing and fertilizer levels on growth, yield, nutrient uptake and available soil nutrients in hybrid brinjal. Application of higher fertilizer levels (F_3 = 187.5:150:75 kg N, P_2O_5 and K_2O/ha) improved the vegetative characters, yield and nutrient uptake significantly. Among interaction effects of spacing and higher fertilizer levels S_5F_3 (90 cm × 90 cm + 187.5:150:75 kg N, P_2O_5 and K_2O/ha) recorded significantly maximum plant height, number of branches per plant, number of leaves per plant, canopy spread, total dry matter production, yield and nutrient uptake.

Rajasekar *et al*. (2017) stated that macronutrients play a very important role in plant growth and development. Three main elements are nitrogen, phosphorus, and potassium (N, P, K) and are required in abundance. They must be readily available through soil medium or fertilizer. The secondary elements are sulfur, calcium, and magnesium (S, Ca, Mg). The quantities required are much less than the macro elements but they are needed in reasonably large quantities. Vegetables are rich and comparatively cheaper source of vitamins and minerals. Their consumption in sufficient quantities provides taste, palatability and increase appetite and provides fair amount of fibres. Proper plant nutrition is essential for successful production of vegetable crops. Every macronutrient has its own character, and is therefore involved in different metabolic processes of plant life. The present review is an attempt to provide basic information about the role of macronutrients in the production and quality of vegetables.

Thingujam *et al*. (2016) found that the growth, yield and fruit quality of brinjal are largely dependent on number of interacting factors. On the other hand egg plant is a long duration crop with high yield which removes large quantities of nutrients from the soil. An egg-plant crop yielding 60t ha^{-1} of fruit removes 190 kg N, 10.9 kg P and 12 8kg K from soil. Now-a-days demands for brinjal as a fruit vegetable is increasing rapidly among the vegetable consumers in view of its better fruit color, size and taste only one source of nutrients like chemical fertilizers, organic manures and biofertilizers cannot improve the production or maintain the production sustainability and soil health. The integrated nutrient management is very useful in this context. Integrated plant nutrient management is the intelligent use of optimum combination of organic, inorganic and biological nutrient sources in a specific crop, cropping system and climatic situation so as to achieve and to sustain the optimum yield and to improve or to maintain the soil's physical, biological and chemical properties. Such a crop nutrition package has to be technically sound, economically attractive, practically feasible and environmentally safe.

Thingujam *et al*. (2016) carried out a field experiment to study the effects of integrated nutrient management on the nutrient accumulation (dry weight recoveries) in brinjal and plant nutrient status of the post- harvest soil of brinjal. The results revealed that the treatment consisting of 75% RDF (RDF i.e. N:P:K:: 125:100:50) + Azospirillum + phosphate solubilising bacteria (PSB) + Borax @ 10 kg ha^{-1} recorded the highest brinjal yield (14.96 t ha^{-1}). Meager information was available regarding the performance of integrated application of organics and micronutrient on brinjal in the experimental location. The present study may enlighten this unexplored section of nutrient management in brinjal.

Lawal *et al*. (2015) carried out two field experiments to evaluate the combined effects of age of transplant and NPK fertilizer on the growth, fruit yield and quality of *Solanum melongena* var.' long purple'. Four levels of NPK fertilizer (0, 200, 300 and 400 kg NPK/ha) and three ages of transplanting (5, 6 and 7 weeks after sowing) in 12 factorial combinations were the treatments. All the growth parameters and fruit attributes assessed increased with increasing levels of NPK. Application of 300 kg NPK/ha produced the best growth while plants that received 200 kg NPK/ha and non-fertilized plants had least performance. The fruit and seed attributes such as fruit length and girth, number of fruits/plant, number of seeds/fruits, seed weight, and fruit and seed yield and also seed viability were all significantly influenced by the fertilizer levels. The number of fruits/plant ranges from 4.3 in non- fertilized plants to 8.2 in 300kg NPK/ha treatment. There was no significant difference in fruit yield produced by 300 (26.88 t/ha) and 400 kg (28.78 t/ha) NPK/ha treatments. It can be concluded that application of 300 kg NPK/ha in combination with transplanting of seedlings at 6 weeks are good agronomic practices that could ensure optimum performance of *Solanum melongena*.

Uddin *et al*. (2014) evaluated the growth, dry matter and yield of eggplant under varying levels of NPK 15:15:15 in both pot and field trials. Results from the pot trial showed a significant enhancement in fruit yield with increasing fertilizer level up to 200 kg/ha while other shoot's characteristics (stem number, plant height and stem length) were favored up to 300kg/ha. Unexpectedly, a significant flower number increment at 300 kg/ha did not lead to a significant yield increase. Field trial's results showed that growth, yield and other shoot's characteristics greatly increased up to 200 kg NPK/ha application after which there was either insignificant increment or a decline. Increment of dry weight towards maturity suggests that there was no cessation in eggplant growth even when partitioning of assimilates towards fruit development took place. The study concluded that 200kg NPK/ha is adequate for optimum growth, dry matter production (pre- anthesis and anthesis stages) and yield in both field and greenhouse conditions.

Nafiu *et al*. (2011) evaluated growth, dry matter and yield of eggplant under varying levels of NPK 15:15:15 were in both pot and field trials. Results from the pot trial showed a significant enhancement in fruit yield with increasing fertilizer level up to 200 kg/ha while other shoot's characteristics (leaf number, branch number and stem length) were favoured up to 300 kg/ha. Unexpectedly, a significant branch number increment at 300 kg/ha did not lead to a significant yield increase. Field trial's results showed that growth, yield and other shoot's characteristics greatly increased up to 200 kg NPK/ha application after which there was either insignificant increment or a decline. Increment of dry weight towards maturity suggests that there was no cessation in eggplant growth even when partitioning of assimilates towards fruit development took place. The study concluded that 200 kg NPK/ha is adequate for optimum growth, dry matter production (pre-anthesis and anthesis stages) and yield in both field and greenhouse conditions.

Akanbi *et al*. (2010) carried out two field experiments to evaluate the combined effects of age of transplant and NPK fertilizer on the growth, fruit yield and quality of *Solanum melongena var*.' long purple'. Four levels of NPK fertilizer (0, 200, 300 and 400 kg NPK /ha) and three ages of transplanting (5, 6 and 7 weeks after sowing) were the treatments. All the growth parameters and fruit traits assessed were increased with increasing levels of NPK. Application of 300 kg NPK/ha produced the best growth while plants that received 200 kg NPK/ha and non fertilized plants had least performance. The fruit and seed attributes such as length, girth, number of fruits /plant, number of seeds/fruits, seed weight and fruit yield were all significantly different across the fertilizer levels. The number of fruits/plant ranges from 4.3 in non-fertilized plants to 8.2 in 300 kg NPK/ha treatment. There was no significant difference in fruit yield produced by 300 (26.88 t/ha) and 400 kg (28.78 t /ha) NPK/ha treatments.

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 plant^{-1} 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^{-1}) as well as during rabi season (55.29 t ha^{-1}). This was closely followed by 175:100 kg NP per ha, with 58.42 t per ha during kharif and 55.14 t kg ha^{-1} during rabi in brinjal hybrid COBH-1.

Satpal and Saimbhi (2003) observed nitrogen at 125 kg and phosphorus at 60 kg ha^{-1}, significantly increased early yield. However, nitrogen 187.5 kg ha^{-1} and phosphorus 60 kg ha^{-1} 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 FYM + 100:50:50 kg NPK ha^{-1}+biofertilizers (Azospirillum and phosphobacteria at 2 kg ha^{-1}), resulted in the greatest number of fruits (26.6), fruit length (10.8 cm), fruit girth (10.03 cm), fruit weight (54.11 g) and fruit yield (1.43 kg ha^{-1}) in brinjal cv. Annamalai.

Shahi *et al*. (2002) reported that N levels at 50 to 150 kg ha^{-1}, significantly increased fruit yield, while further addition reduced in both brinjal hybrids (Pusa hybrid-5 and Pusa hybrid-6).

Naidu *et al*. (2002) reported that NPK at 75:35:0 kg ha^{-1} + FYM at 25 t ha^{-1} recorded the highest fruit girth and the highest mean fruit yield (161.6 q ha^{-1}) in brinjal cv. JB-64.

Akhilesh-Sarraf *et al*., (2002) reported that K at 20 ha^{-1} resulted in the highest fruit yield (103.57 t ha^{-1}), fruit weight (1317.40 g), number of fruits plant^{-1} (34.71), fruit length (13.81 cm), fruit diameter (8.40 cm) in brinjal cv. Pusa Bindu.

Nanthakumar and Veeraragavathatham (1999a) 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.

2.2 Effect of micro nutrients on growth yield and seed quality

Uikey *et al*. (2018) conducted an experiment to find out the suitable micronutrient or their combinations for foliar sprays in brinjal. The experiment comprised of total eight treatments micronutrients and control. Application of

RDF and foliar spray of micronutrients treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) recorded significantly growth (*viz*., plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1} and leaf area index) and phonological parameters (i.e. earliest first flowering, first fruit set and first picking and highest number of flowers cluster^{-1} and number of fruits cluster^{-1}). All the growth and phenological attributes of brinjal *viz*., plant height (82.67 cm), no. of leaves (173.27), no of branches (12.60), leaf area (2431.12 cm^2), leaf area index (0.540), and days to 1st flower initiation (37.33), days to first fruit set (42.33), days to 1st picking (58.33), number of clusters/plant (3.6), no. of flowers per cluster (5.2), number of fruits/ cluster (3.3) were recorded best in treatment T_8 (RDF+ Borax (0.2%) + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%).

Wade and Jason (2016) revealed that the nanoparticles (NP) of CuO increased fresh weights by 64%, reduced AUDPC values by 69%, and had 32% more Cu in the roots. These same amendments were sprayed onto the foliage of tomato and eggplant transplants and set in field plots in soil heavily infested with the Verticillium wilt fungus. Compared to untreated controls, yields of tomato were 33% or 31% greater with NP of CuO or the bulked MnO, respectively. NP of CuO or $ZnSO_4$ increased eggplant yields by 34% or 41% when compared to controls, respectively. In vitro studies found NP of CuO were not inhibitory to the Fusarium wilt fungus, suggesting host defense was being manipulated.

Thingujam *et al*. (2016) reported that the treatment consisting of 75% RDF (RDF i.e. N:P:K:: 125:100:50) + Azospirillum + phosphate solubilising bacteria (PSB) + Borax @ 10 kg ha^{-1} recorded the highest oxidizable organic carbon (8.049 g kg-1), total nitrogen (1.05 g kg-1) , available nitrogen (212.67g kg-1), available phosphorus (76.20g kg-1) and available potassium (177.59 g kg-1) in the post harvest soils of brinjal. On the other hand, 75% RDF + Azospirillum + PSB + $FeSO_4$ @ 50 kg ha^{-1} recorded the highest available iron

(26.14 kg ha^{-1}) and the treatment consisting of 75% RDF + Azospirillum + PSB + $ZnSO_4$ @ 25 kg ha^{-1} recorded the highest soil available zinc (7.62 kg ha^{-1}) while 75% RDF + Azo + PSB + Borax @ 10 kg ha^{-1} recorded the highest available Boron content (0.78 kg ha^{-1}) of the post harvest soil of Brinjal. Highest brinjal yield (14.96 t ha^{-1}) was supported by the treatment consisting of 75% RDF + Azospirillum + PSB + Boron @ 10 Kg ha^{-1}.

Pandav *et al*. (2016) reported that the present investigation was carried out during autumn-winter season of 2014-15 The experimental treatments viz., T_1 (control-water spray), T_2 (zinc sulfate 0.3%), T_3 (zinc sulfate 0.4%), T_4 (zinc sulfate 0.5%), T_5 (iron sulfate 0.3%), T_6 (iron sulfate 0.4%), T_7 (iron sulfate 0.5%), T_8 (borax 0.3%), T_9 (borax 0.4%) and T_{10} (borax 0.5%) were laid out in a randomized block design (RBD). The plant height (cm) at 60, 90 and at maturity, the number of fruits per plant, fruit length and diameter (cm) and average fruit weight (g), increased significantly with increasing concentration of micronutrients (up to 0.4%). However, the character days to physiological maturity was found non-significant with the application of micronutrients. The study suggested that for getting maximum plant growth and yield of eggplant cv HLB 12, the crop should be sprayed with zinc sulfate 0.4%.

Kumar *et al*. (2016) reported that the foliar application of micronutrients shows better efficacy than soil application as the uptake and assimilation of micronutrients by later method takes more time. Owing to intensive agriculture and high yielding varieties of vegetables extra mining of nutrients takes place which leads to negative nutrient balance in the soil. Hence, to cope up with the needs of the crop, application of micronutrients in addition to macronutrients must be ensured in solanaceous vegetables.

Houimli *et al*. (2016) reported that the tomato plants were treated with foliar iron applications at different concentrations (0, 500, 1000, 1500 and 2000 mg.l^{-1}). Iron was applied with spraying eight times during the vegetation at 7-day intervals 40 days after planting. In the study, it was determined that foliar applications of iron showed positive effect on some fruit characteristics. Fruit number and yield of medium and large sized fruits were significantly increased in the 500 and 1000 $mg.l^{-1}$ treatments, which subsequently resulted in an increase of marketable yield. According to our results, applications of 1000 $mg.l^{-1}$ iron should be recommended in order to improve marketable yield in tomato production.

Tawab *et al*. (2015) observed that the four levels of zinc (0, 0.1, 0.2, and 0.3%) were applied to three brinjal cultivars (Purple, Shimla, Shamli). Both cultivars and zinc levels proved significantly different among growth parameters. Plant height, number of leaves per plant, numbers of fruits per plant, fruit weight and total yield were significantly increased by zinc levels. Maximum plant height (131.89 cm), number of leaves per plant (437.78), number of fruits per plant (9.00), fruit weight (280.11 g) and total yield (15.33 t/ha) were recorded for plants treated with 0.2% zinc, while least number of leaves per plant (231.33), number of fruits per plant (5.33), fruit weight (143.89 g) and total yield (4.51 t/ha) were recorded in control treatments.

Suganiya and Kumuthini (2015) results showed that foliar application of boron (H_3BO_3) at 150 ppm in brinjal increased the number of flower buds $plant^{-1}$ (70%), number of flowers $cluster^{-1}$ (141%), number of flower clusters $plant^{-1}$ (48%), total number of flowers $plant^{-1}$ (122%), percentage of flower set (30%), percentage of fruit set (46%), number of fruits $plant^{-1}$ (216%) and fresh weight of fruits $plant^{-1}$ (88%) than that of control.

Meena *et al*. (2015) reported that the vegetative growth in terms of plant height and number of branches at various stages (30, 60 and 90 Days after transplanting) was greatly influenced by the application of micronutrients Zn and B. Among them treatment T_5-Boron (100 ppm) significantly increased the plant height (61.23 cm at 90 DAT) and number of branches (16.17 $plant^{-1}$ at 90

DAT) compared to others. Whereas, application of zinc and boron each at 100 ppm (T_8) caused early flowering (31.95 DAT) as well as showed maximum number of flowers (75.21) and fruit yield (93.10 t ha^{-1}). Thus, the study indicated that application of boron and zinc either solely or in combination is quite beneficial for vegetative growth, flowering and fruiting as well as quality improvement of tomato fruits (Azad T-6) grown under high pH soil (pH 8.2) of Lucknow.

Harris and Mathuma (2015) results revealed that foliar application of Zn alone at 250 ppm resulted in the maximum plant height, total dry weight, number and fresh weight of fruits/ plant in tomato. Foliar application of B at 250 ppm increased dry weight of leaves/ plant and dry weight of stem/ plant, and dry weight of roots/plant were high in both B at 250 ppm and Zn at 150 ppm. In all parameters, the lowest performance was recorded in the control treatment. The results also revealed that under the conditions in the experiment, yield could be increased by the application of Zn at the rate of 250 ppm at flowering stage.

Singh *et al*. (2014a) reported that the two foliar sprays of B 10ppm + Zn 100 ppm over and above recommended NPK 150:80:100 kg ha^{-1} significantly enhanced the fruit production of chilli 231.09 q ha^{-1} (34%more), plant height (59.7 cm), fruit length (6.23 cm), fruit diameter (0.96 cm), number of fruits $plant^{-1}$ (95.7), green fruit yield $plant^{-1}$ (381.3 g) and ascorbic acid (143.25 mg /100g) over control (RDF- NPK only).

Singh *et al*. (2014) reported that the combined foliar application of Zn 100 ppm, B 100 ppm, Mo 50 ppm, Fe 100 ppm, Cu 100 ppm and Mn 100 ppm with the soil application of 120kg N, 60 kg P_2O_5, 80 kg K_2O, 10 t FYM, 25 kg S and 5 kg Azotobacter ha^{-1} (T_{18}) gave higher plant height (103.57 cm), number of branches $plant^{-1}$ (11.33), number of compound leaves $plant^{-1}$ (30.53), weight of marketable fruits $plant^{-1}$ (1.80 kg) and fruit yield of tomato ha^{-1} (308.73 q) and minimum weight of unmarketable fruits plant^{-1} (0.29 kg). The lowest yield as 176.09 q ha^{-1} was recorded at NPK RDF (T_1).

Kalroo *et al*. (2014) reported that the foliar zinc was applied at the concentrations of 1, 2, 3, 4 and 5 ml/L water and control was maintained to check the performance. The results revealed that all the growth and green chillies production traits were significantly ($P<0.01$) influenced under foliar zinc application at different concentrations. The highest Zinc concentration of 5 ml/L water resulted 85.66 cm plant height, took 56.33 days to flower emergence, 77 cm plant spread, 13.00 branches plant^{-1}, 481.33 fruits plant^{-1}, fruit length 5.50 cm, fresh fruit yield 705 g plant^{-1} and 16.350 tons fruit yield ha^{-1}. The foliar application Zinc at concentration of 4 ml/L water resulted 81.33 cm plant height, took 55.66 days to flower emergence, 74.33 cm plant spread, 11.93 branches plant^{-1}, 471.66 fruits plant^{-1}, 5.34 cm fruit length, 692.33 g fresh fruit yield plant^{-1} and 16.093 tons fruit yield ha^{-1}. Foliar zinc application at concentration of 3 ml/L water produced 75 cm plant height, took 54.33 days to flower emergence, 68.66 cm plant spread, 10.80 branches plant^{-1}, 429.00 fruits plant^{-1}, 4.84 cm fruit length, 641.33 g fresh fruit yield plant^{-1} and 15.294 tons fruit yield ha^{-1}. However, the fruit yield ha^{-1} did not increase significantly under 5 ml/L water Zn concentration when compared with 4 ml/L water; which indicates that Zn @ 4 ml/L water was an optimum level for obtaining economical fruit yield in chillies variety Talhari.

Gogoi *et al*. (2014) recorded results of treatment given as foliar spray at 30, 45, and 60 days after transplanting of seedlings of brinjal. The highest plant height (62.93 cm), number of branches (6.36) and number of leaves (55.67) plant^{-1} were recorded with boron (0.25%) + APSA-80, followed by multiplex (0.25%) + APSA-80.

Singh and Singh (2013) reported that the effect of integrated nutrient management on growth, yield and economics of tomato in eighteen treatments on variety NDT-6. The soil of experimental field was texturally sandy loam in nature, low in nitrogen, while, medium in phosphorus and potassium availability with slight alkaline in reaction. The results revealed that application of NPK@120:60:60 kg/ha + FYM@10t/ha + sulphur @ 25kg/ha + Azotobacter + mixture of all micronutrients (foliar application @ 100 ppm zinc sulphate, boric acid, ferrous sulphate, copper sulphate and manganese sulphate and molybdenum @ 50 ppm significantly influenced the growth and yield of tomato.

Shil *et al*. (2013) noted the response of chilli to zinc and boron and to find out the optimum dose of zinc and boron for maximizing the yield. Treatments for this study comprised of four levels each of zinc (0, 1.5, 3.0, and 4.5 kg/ha) and boron (0, 1.0, 2.0, and 3.0 kg/ha) along with a blanket dose of N130 P60 K80 S20 Mg10 kg/ha. The integrated use of zinc and boron was found superior to their single applications. The interaction effect between zinc and boron was significant in case of yield of dry chilli and weight of ripe chilli/plant. The highest yield (1138 kg/ha) was recorded from Zn3B1 kg/ha, which was closely followed by Zn3B2, Zn4.5B2 and the lowest (703 kg/ha) in control (Zn0B0). The yield benefit over control varied from 4.4 to 61.9 % due to interaction effect. Consecutive three years studies showed almost similar trend of results. However, from regression analysis, the optimum-economic dose of zinc was found to be 3.91 kg/ha whereas it was 1.70 for boron. Hence, a package of (Zn3.91 B1.70 kg/ha) along with the said blanket dose may be recommended for maximizing the yield of chilli in the study area.

Naga *et al*. (2013) evaluate the response of foliar application of micronutrients on vegetative and reproductive growth attributes, in two varieties of tomato viz- UtkalKumari and Utkal Raja. The treatments consisted of boron, zinc, molybdenum, copper, iron, manganese, mixture of all and control. All the Micronutrients except manganese at 50ppm were applied at 100ppm in three sprays at an interval of ten days starting from 30 days after transplanting. All the treatments resulted in improvement of plant growth characteristics viz. plant height, number of primary branches, compound leaves, tender and mature fruits per plant in both the varieties out of which application of micronutrients mixture showed the maximum effect. In tomato cv. UtkalKumari, maximum growth rate (85.70%) was observed with application of zinc, followed by application of micronutrients mixture (78.20%) and boron (77.50%). Tomato cv. Utkal Raja, maximum increase in branches per plant was observed with the application of manganese (148.7 %) followed by micronutrient combination (144.1 %). In UtkalKumari, the fruit yield per plant ranged from 1.34 kg to1.87 and in Utkal Raja, it ranged from 1.50 kg to 1.97 kg. In both the varieties, combined application of micronutrients produced the maximum fruit yield followed by application of boron and zinc.

Mohsen (2013) recorded the effects of the foliar application of zinc (50 and 100 mg/L) and iron (100 and 200 mg/L) and their combination on vegetative, reproductive growth, fruit quality and yield of tomato. The results showed that high Zn (100 mg/L) and Fe (200 mg/L) and their combination significantly promoted vegetative and reproductive growth. Foliar application of Zn (100 mg/L) + Fe (200 mg/L) resulted in the maximum plant height (124.14 cm), branches per plant (8.36), flowers per cluster (18.14), fruits per cluster (8), fruits per plant (90.14), fruit weight (95.14 g), chlorophyll content (22.14 SPAD) and yield (25.14 t ha–1).

Dubey *et al*. (2013) observed that the foliar application of borax @ 0.5% (T_3) was found effective in improving plant growth such as plant height (75.53 cm), days to 50% flowering (28.90 days), marketable fruits plant^{-1} (9.50) and yield hectare^{-1} (167.50 q) followed by T_{12} (i.e. mixture of zinc sulphate, borex, copper sulphate and manganese sulphate) was recorded early days to first picking of fruits (76.00), number of primary branches plant^{-1} (5.60) and fruit size (37.89 cm^2) of bell pepper.

Ali *et al*. (2013) studied the possible effect of some macro and micro nutrients with different concentration levels as a foliar application on the vegetative growth, flowering, and yield of tomato cv. 'Roma'. The important parameters encompassed in the study were plant height (cm), number of leaves plant^{-1}, leaf length (cm), days to flowering, number of flower clusters plant^{-1}, fruit set percentage, small fruits plant^{-1}, medium fruits plant^{-1}, large fruits plant^{-1}, length and width of fruit (cm), fruit weight (g), fruit yield plant^{-1} (kg), yield plot^{-1} (kg), and yield hectare^{-1}. Although all the treatments showed a positive effect on growth, flowering, and yield but, T_5 (nitrogen 5.5 g/100 mL + Boron 5 g/100 mL + Zinc 5 g/mL) and T_3 (Boron 5 g/mL) revealed most significant influence on all parameters under study as compared to T_1 (control). Therefore, foliar application is an appropriate way to feed the tomato crop to enhance the growth, flowering and marketable yield.

Kumar *et al*. (2012) recorded that the foliar application of micronutrients solution proved useful in case of mean values of transverse length, polar length, pericarp thickness, locule number, fruit weight and density and yield of tomato variety, Rupali. Three foliar applications of mixture of B, Zn, Cu, Fe and Mn each @ 100 ppm and Mo@ 50 ppm at 10 days interval starting from 40 DAT of tomato enhanced significantly and resulted the maximum mean fruit yield to the extent of 28.67% over control.

Singh and Mukherjee (2010) reported in brinjal cv. Bhagyamathi, soil application of 12.5 kg $ZnSO_4$ ha^{-1} along with 3 sprays of 0.2 % $ZnSO_4$ and 0.5% FeSo4 thrice at weekly interval stages recorded significantly highest fruit yield of 37.7 t ha^{-1} with 23.6 % increase over control.

Patel *et al*. (2010) found that the maximum plant height (89.33 cm) was observed in T_5 [NPK+FYM+ $ZnSO_4$ (0.5% FS) + $FeSO_4$ (0.5% FS)]. While, maximum plant spread (0.70 sq.m) and numbers of branches plant^{-1} (12.33) were observed in T_{10} [NPK+FYM+ Local formulation Grade-V (SA)].

Significantly maximum number of fruits plant^{-1} (25.00) and total yield hectare^{-1} (554.30q) were recorded in the same treatment. Maximum ascorbic acid (10.13 mg 100-1 g pulp in brinjal (Solanum melongena L.) var. Gujrat oblong Brinjal-1 was registered in T_5 [NPK+FYM+ $ZnSO_4$ (0.5% FS) +$FeSO_4$ (0.5% FS)].

Kiran *et al*. (2010) revealed that the application of 100:100:50 kg NPK ha^{-1} + Azospirillum + Phosphate solubilising bacteria (PSB) each @ 125 g ha^{-1} (root dipping) along with zinc sulphate (0.2%) spray recorded significantly higher plant height (89.47), number of branches (32), number of leaves (87), number of fruits (20), fruit yield (27.06 t ha^{-1}), number of seeds fruit^{-1} (1852), 1000-seed weight (7.90 g), seed yield (633 kg ha^{-1}) in brinjal.

Sharma and Brar (2008) recorded that in brinjal both vegetative as well as reproductive phases of growth proceed simultaneously there by, it becomes necessary to keep the plants supplied with the nutrients throughout the growing period. Scrupulous study of the available information shows that the brinjal gives variable response to the applied fertilizers under different agro-climatic condition. Response to nutrients varies from 75 to 300 kg nitrogen, 30 to 224 kg phosphorus and 0 to 80 kg potassium hectare^{-1}. Organic manures, bio-fertilizers and micronutrients have also been reported to improve the productivity. It has been observed that there is dire need of authentic fertilizer recommendation for high yielding F1 hybrids. This article reviews the innovation on these aspects.

Patil *et al*. (2008) revealed that the application of boric acid @ of 100ppm resulted in maximum number of primary branches (18.30), yield per plant (2.07kg) and fruit yield (30.50 t/ha) in tomato. Followed by best treatment was the mixture of micronutrients (Bo, Zn, Mn and Fe@ 100ppm and Mo@ 50ppm) recording fruit yield of 27.98 t/ha and differed significantly from the control as well as other treatments.

Patil *et al*. (2007b) carried out an experiment to find out the effect of micronutrients on seed production in okra. It was found that the seed yield of okra can be increased significantly by three sprays of mixture of all nutrients (i.e.Boric acid, Zinc sulphate, Ammonium molybdate, Copper sulphate, Ferrous sulphate, Manganese sulphate) at 100 ppm, first spray was given before flowering, second spray after third picking and third 15 days after second spray. The maximum seed germination, seed vigor and seed yield was recorded 86.33%, 6.78 and 4.53 q/ha. respectively, followed by commercial formulation (Multiplex), while the minimum germination percentage 86.33%, seed vigor 6.78 and seed yield 4.53 q/ha respectively was recorded in the treatment Control (water spray).

Patil *et al*. (2007a) carried out an experiment to find out the effect of micronutrients on seed production in Brinjal. It was found that the seed yield of Brinjal can be increased significantly by three sprays of mixture of all nutrients (i.e.Boric acid, Zinc suiphate, Ammonium molybdate, Copper sulphate, Ferrous sulphate, Manganese sulphate) at 100 ppm, first spray was given before flowering, second spray after third picking and third 15 days after second spray. The maximum seed germination, seed vigor and seed yield was recorded 84.00%, 12.09 and 4.52 q/ha respectively, followed by commercial formulation (Multiplex), while the minimum germination percentage 82.67 %, seed vigor 9.51 and seed yield 4.31 q/ha respectively was recorded in the treatment Control (water spray).

Natesh *et al*. (2005) reported that the effect of micronutrients and organic amendments on the growth, seed yield and quality of chilli (Capsicum annuum) seeds. The treatments comprised: 25 kg $ZnSO_4$/ha (T_1); 0.1% $ZnSO_4$ (T_2); 10 kg borax/ha (T_3); 0.1% borax (T_4); 10 kg $MgSO_4$/ha (T_5); 0.1% $MgSO_4$ (T_6); 10 kg S/ha (T_7); 2.5 kg mycorrhiza/ha (T_8); 2.5 t vermicompost/ha (T_9); 10 t farmyard manure/ha (T_{10}); and 150:75:75 kg NPK/ha (RDF; control). T_1 gave the highest 1000-seed weight. T_2 gave the highest plant height, number of branches per plant, number of fruits per plant, fruit set percentage, germination percentage and vigour index. T_7 gave the highest electrical conductivity of seed leachate (0.911) while T_9 gave the highest fruit length, fruit diameter, dry fruit yield, number of seeds per fruit, seed yield, seed recovery and seedling dry weight.

Karuppaiah (2005) stated that foliar application of borax (0.5 %) at 35, 50 and 65 DAT was found to be best in terms of number of flowers per plant, number of productive flowers per plant, number of fruits per plant, individual fruit weight and yield (32.15 t ha^{-1}), followed by copper sulphate (0.5%) and zinc sulphate (0.5%) sprayed at 35, 50 and 65 DAT in brinjal cv. Annamalai. 50 and 65 DAT in brinjal cv. Annamalai.

Khedr *et al*. (2004) find out that, spraying boron 50, zinc 100 and calcium 2000 mg lit.-1 singly three times at 20 days–interval started one month after transplanting enhanced earlines of flowering, fruit set, total yield and fruit quality of brinjal.

Yoganand (2001) found germination (64.81%), root length (4.86 cm) and shoot length (5.95 cm) with the application of $ZnSO_4$ (0.2%) at pre-flowering stage of bell pepper as compared to control (64.91%, 4.25 cm and 5.22 cm, respectively).

Yadav *et al*. (2001) studied that the effect of different concentrations of zinc and boron on the vegetative growth, flowering and fruiting of tomato. The treatment comprised five levels of zinc (0, 2.5, 5.0, 7.50 and 1.00ppm) and four levels of boron(0, 0.5, 0.75 and 1.00ppm) as soil application as well as 0.5%zinc and 0.3% boron as foliar application. The highest values for secondary branches, leaf area, fresh weight, fruit length, fruit breadth and fruit number were obtained with the application of 7.5ppmzinc and 1.0ppm boron.

Raj *et al.* (2001) observed that zinc application through 12.5 kg ha^{-1} $ZnSO_4$ to the soil along with 0.2 percent foliar spray of $ZnSO_4$ thrice at weekly interval starting from 30 days after planting recorded significantly higher fruit yield of 5 t ha^{-1} more with 16.4 per cent increase over control (No zinc). Significant increase in fruit yield of 1.5 t ha^{-1} was obtained with this treatment. Compared to 25 kg $ZnSO_4$ ha^{-1} to soil application thus by saving 9.5 kg $ZnSO_4$ ha^{-1}. But the combined application of zinc a 12.5 kg $ZnSO_4$ ha^{-1} soil initially along with three sprays of 0.2 per cent $ZnSO_4$ and 0.5 per cent $FeSO_4$. Thrice at weekly interval at later stages recorded significantly highest fruit yield of 37.7 t ha^{-1} with 23.6 per cent increase over control (No zinc and iron) in brinjal.

2.3 Combined effect of macro and micronutrients on growth yield and seed quality

Kadari, *et al.* (2015) reported that to study the influence of micronutrients and biofertilizers on growth, yield and quality attributes of tomato. Application of micronutrients and biofertilizers in combination with recommended dose of inorganic fertilizers had more pronounced effect on yield and yield attributing traits as compared to the application of inorganic fertilizers alone. In the present study, it has been observed that application of RDF (150:100:50 NPK kg ha^{-1}) + 0.3% $FeSO_4$ + B + $ZnSO_4$ (0.1%each) + Azotobacter + PSB (2 g $plant^{-1}$ hill) significantly enhanced the different growth i.e. plant height (104.24 cm), weight of fruit (71.69 g), fruit length (5.83 cm) and volume of fruit (68.58 ml), yield attributes of tomato viz., number of fruits per plant (30.86), yield $plant^{-1}$ (1.65 kg), yield $plot^{-1}$ (38.54kg) and fruit yield $hectare^{-1}$ (415.03 q).

Salam *et al.* (2011) reported that the effect of boron, zinc, and cow dung on quality of tomato. There were 16 treatments comprising four rates of boron and zinc viz., BoZno. B1.5Zn2 B2Zn4 and B2.5Zn6 kg/ha and four rates of cowdung viz., CDo, CD10, CD15, and CD20 t/ha. Every plot received 253 kg N, 90 kg P, 125 kg K, and 6.6 kg S per hectare. The results reflected that the highest pulp weight (90.24%), dry matter content (5.82%), ascorbic acid (11.2 mg/100g). lycopene content (147 µg/100g), chlorophyll-a (42.0 µg/l00g), chlorophyll-b (61.0 µg/100g), boron content (36 µg/g), zinc content (51 µg /g), marketable fruits at 30 days after storage (74%) and shelf life (17 days) were recorded with the combination of 2.5 kg B/ha + 6 kg Zn/ha, and 20 t/ha cowdung.

Kiran *et al*. (2010) conducted an experiment to study the effect of fertilizers, biofertilizers and micronutrients on plant growth, seed yield and quality of brinjal. The results indicated that, application of 100:100:50 kg NPK per ha + Azospirillum + Phosphate solubilizing bacteria (PSB) each @ 125 g per ha (root dipping) along with zinc sulphate (0.2%) spray recorded significantly higher plant height (89.47 cm), number of branches (32), number of leaves (87), number of fruits (20), fruit yield (27.06 t/ha), number of seeds per fruit (1852), 1000-seed weight (7.90 g), seed yield (633 kg/ha), percentage of germination (97), field emergence (91), seedling vigour index (2024) and seedling dry weight (48.84 mg) over 125:100:50 Kg NPK / ha (RDF) at Dharwad conditions.

Suthar *et al*. (2005) reported that the highest fertilizer level i.e. 150:75:75:25 kg N: P: K: Zn ha^{-1} delayed the flowering in plants when the brinjal crop was planted on 26 May. The number of fruits $plant^{-1}$ and fruit yield $hectare^{-1}$ were recorded statistically higher when the crop was transplanted on 10th June and supplied with 125:62.5:62.5:25 kg N: P: K: Zn ha^{-1}.

Selvi *et al*. (2004) reported that combination of N:P:K (100:50:50 kg ha^{-1}) + organic manures (CCP 25 t ha^{-1}) + micronutrients ($ZnSO_4$ @ 25 kg ha^{-1} and $FeSO_4$ @ 50 kg ha^{-1}) recorded the highest brinjal yield (212.90 t ha^{-1}) compared with NPK application alone (16.28 t ha^{-1}). Application of 0.3% per cent borax as foliar spray improved the fruit size, ascorbic acid content, TSS and also reduced the fruit cracking.

CHAPTER III

MATERIALS AND METHODS

This chapter describes the materials and methods which were used in the field to conduct the experiment during the period from 09 September 2017 to March 2018. It comprises a short description of the location of the experimental plot, climatic condition of the area where the plot was situated, materials used for experimental treatments, design of the experiment, method of cultivation, method of data collection, statistical analysis have been presented.

3.1 Experimental site

The research work was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 to study the influence of crop nutrition on seed yield and quality of brinjal during the period from October 2017 to March 2018. Experimental field was located at 90°22$^{/}$ E longitude and 23°41$^{/}$ N latitude and altitude of 8.2 m above the sea level. The experimental site is presented in Appendix I.

3.2 Climate

Experimental area belongs to subtropical climatic zone which is characterized by heavy rainfall, high temperature and relatively long day period during "Kharif-1" season (April-September) and scarce rainfall, low humidity, low temperature and short day period during "Rabi" season (October-March). This climate is also characterized by distinct season, *viz*. the monsoon extending from May to October, the winter or dry season from November to February and per-monsoon period or hot season from March to April (Edris *et al.*, 1979). The meteorological data in respect of temperature, rainfall, relative humidity, average sunshine and soil temperature for the entire experimental period have been shown in Appendix II.

3.3 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract in Agroecological Zone (AEZ)-28 (UNDP, 1988). It was medium high land and the soil series was Tejgaon (FAO, 1988). The soil was having a texture of sandy loam with pH and CEC were 5.6 and 2.64 meq/100 g soil, respectively. The characteristics of the soil under the experimental plot were analyzed in the Soil Testing laboratory, SRDI, Khamarbari, Dhaka and details of the recorded soil characteristics were presented in Appendix III.

3.4 Planting materials

The varieties of brinjal used in the present experiment was BARI begun 8. The seeds were collected from the Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5 Treatments of the experiment

Factor A: Macro nutrients - 4 levels

1. F_0 = Control
2. $F_1 = N_{150}\ P_{30}\ K_{100}$ kg ha^{-1}
3. $F_2 = N_{170}\ P_{50}\ K_{125}$ kg ha^{-1}
4. $F_3 = N_{190}\ P_{70}\ K_{150}$ kg ha^{-1}

Factor B: Micro nutrients - 3 levels

1. N_0 = Control
2. N_1 = $Znso_4$ (0.2%)
3. N_2 = Borax (0.2%)

There were 12 (3×4) treatment combinations given below:

F_0N_0, F_0N_1, F_0N_2, F_1N_0, F_1N_1, F_1N_2, F_2N_0, F_2N_1, F_2N_2, F_3N_0, F_3N_1, F_3N_2

3.6 Design and layout of the experiment

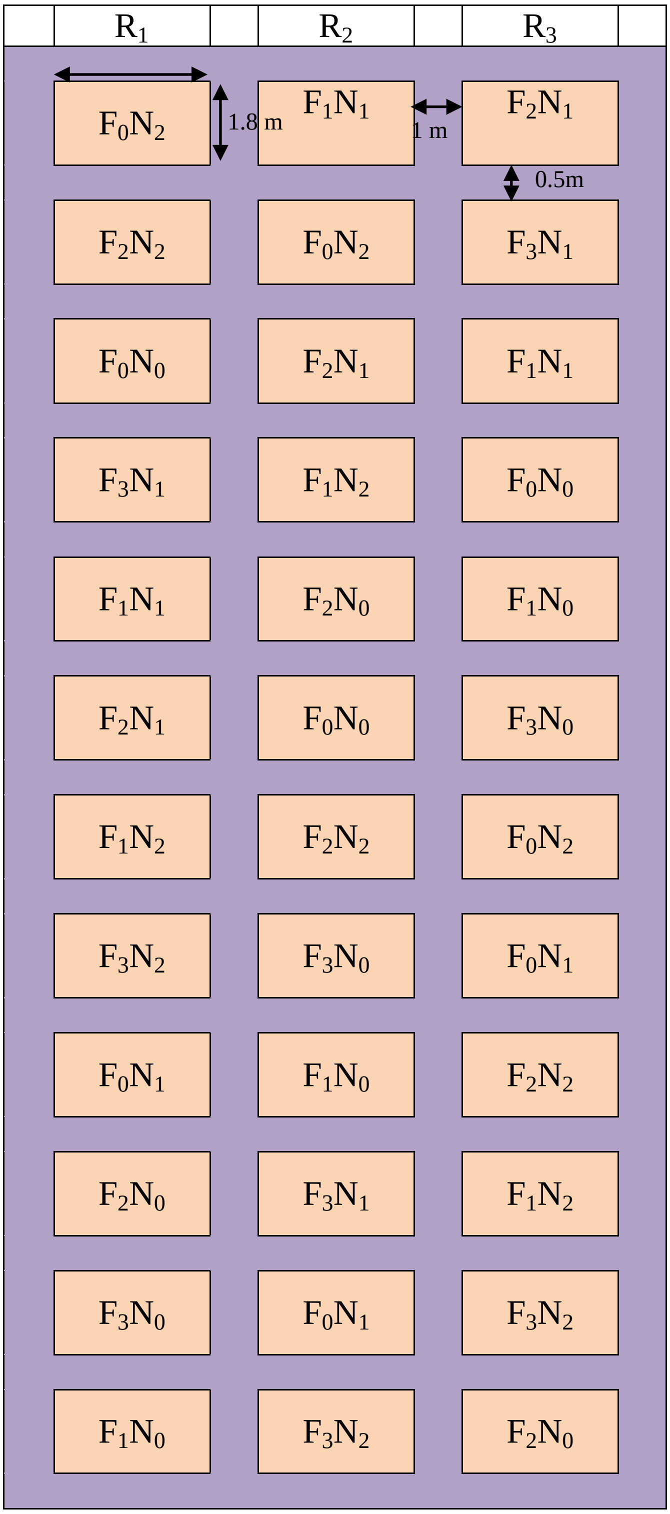
The two factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. There were 12 treatment combinations. In total 36 plots for 3 blocks. Each block consisted of 12 unit plots. The size of each unit plot was (1.8 m × 1.8 m). The distance maintained between two replications and two plots were 1 m and 0.5 m, respectively. The layout of the experiment is shown in Appendix IV.

3.7 Raising of seedlings

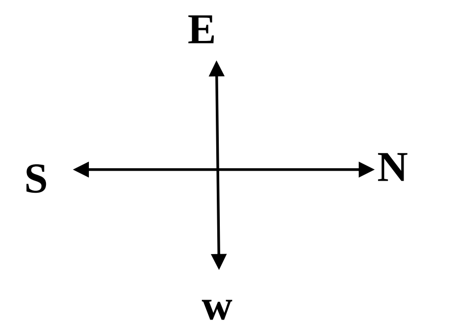
The land selected for nursery bed was well drained and were sandy loam type soil. The area was well prepared and converted into loose friable and dried mass to obtain fine tilth. All weeds and dead roots were removed and the soil was mixed with well rotten cowdung at the rate of 5 kg/bed. Seed bed size was 3m × 1m raised above the ground level. One bed was prepared for raising the seedlings. Five (5) grams of seeds were sown in the seed bed on 09 September 2017. After sowing, the seeds were covered with light soil. Complete germination of the seeds took place with 5 days after seed sowing. Necessary shading was made by bamboo mat (chatai) from scorching sunshine or rain. No chemical fertilizer was used in the seed bed.

3.8 Preparation of the main field

The plot selected for the experiment was opened in the first week of October, 2017 with a power tiller, and was exposed to the sun for a few days, after, which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed and finally obtained a desirable tilth of soil for transplanting. The land preparation was completed on 5 October 2017. The individual plots were made by making ridges (20 cm high) around each plot to restrict lateral runoff of irrigation water.



LEGEND



3.5 Treatments

Factor A: Macro nutrients - 4 levels

1. F_0 = Control
2. $F_1 = N_{150}\ P_{30}\ K_{100}$ kg ha^{-1}
3. $F_2 = N_{170}\ P_{50}\ K_{125}$ kg ha^{-1}
4. $F_3 = N_{190}\ P_{70}\ K_{150}$ kg ha^{-1}

Factor B: Micro nutrients - 3 levels

1. N_0 = Control
2. N_1 = $Znso_4$ (0.2%)
3. N_2 = Borax (0.2%)

Fig. 1. Layout of the experimental plot

3.9 Fertilizers and manure application

At first the whole experiment plot was fertilized with 10 ton per ha cowwdung and mixed with soils thoroughly. The macro nutrients as N, P and K and micro nutrients as B and Zn were applied through urea, Triple super phosphate (TSP), Muriate of potash (MoP) Borax and $ZnSO_4$, respectively. Micro nutrient solution was prepared with 2 g $ZnSO_4$ or Borax in 100 ml water and applied at three installments. All the macro and micro nutrients were applied as per treatment. The whole amount of TSP and half amount of MoP were applied as basal dose before seedling transplanting in the main field. First top dressing of urea was applied when seedling established in the main field about 10 days after seedling transplanting. Second top dressed of urea and rest amount of MoP were applied about 25 days after first top dressing. Then rest amount of urea was applied as third installment about 40 DAT.

3.10 Transplanting of seedlings

Healthy and uniform sized 30 days old seedlings were taken separately from the seed bed and were transplanted in the experimental field on 9 October, 2017. The plant spacing was maintained as 60 cm × 45 cm. The seed bed was watered before uprooting the seedlings so as to minimize the damage of the roots. This operation was carried out during late hours in the evening. The seedlings were watered after transplanting. Shading was provided by piece of banana leaf sheath for three days to protect the seedlings from the direct sun. A strip of the same crop was established around the experimental field as border crop to do gap filling and to check the border effect.

3.11 Intercultural Operation

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the brinjal.

3.11.1 Gap filling and weeding

When the seedlings were established, the soil around the base of each seedling was pulverized. A few gaps filling were done by healthy plants from the border whenever it was required. Weeds of different types were controlled manually as and when necessary.

3.11.2 Irrigation

Irrigation was done at three times. The first irrigation was given in the field at 25 days after transplanting (DAT) through irrigation channel. The second irrigation was given at the stage of maximum vegetative growth stage (35 DAT). The final irrigation was given at the stage of fruit formation.

3.11.3 Plant protection

The crop was infested with brinjal shoot and fruit borer, cutworm, leaf hopper and others. The insects were controlled successfully by spraying Malathion 57 EC @ 2ml /L water. The insecticide was sprayed fortnightly from a week after transplanting to a week before first harvesting. During foggy weather precautionary measures against fungal diseases of brinjal was taken by spraying Dithane M-45 @ 2 g/L.

3.12 Harvesting

Harvesting was started on the 10 December, 2017 and continued to 10 February, 2018. At each harvest the fruits of brinjal are allowed to mature beyond the edible stage when harvested for seeds. In order to ensure that seed development is complete. The fruits are usually hard picked at a later on ripen stage than for the market crop. The seed are extracted by fermentation methods. In this method, the harvested fruit are stored for 5-7 days at room temperature until they become soft. This allows the seed to mature fully. The fruits are crushed on cut into their slices. These are then softened by soaking till their seeds are separated from pulp. This process should be done in the evening. Then, the next morning they are washed, seeds which sink down should be separated and dried in a partial sunlight for few hours for one to two days up to moisture content of 8% or below. Different yield contributing data have been recorded from the means of five harvested plants which was selected at random of each unit plot of every harvesting stage.

3.13 Collection of data

Five representative plants were selected at random from each of unit plot to avoid border effect and tagged in the field. The details of data recording are given below:

3.13.1 Growth and yield parameters

1. Plant height
2. Number of leaves plant^{-1}
3. Number of branches plant^{-1}
4. Days to 1st flowering
5. Days to 50% flowering
6. Number of fruits plant^{-1}
7. Single fruit weight (g)
8. Fruit yield plant^{-1} (g)
9. Fruit yield plot^{-1} (kg)
10. Fruit yield ha^{-1} (t)

3.13.2 Seed parameters

1. Number of seeds fruit^{-1}
2. Seed weight fruit^{-1} (g)
3. Seed weight plant^{-1} (g)
4. 1000 seed weight (g)
5. Seed weight plot^{-1} (g)
6. Seed weight ha^{-1} (kg)

3.13.3 Seed viability test

1. Percent (%) seed germination
2. Root length (cm)
3. Shoot length (cm)
4. Seed vigor index

3.14 Procedure of recording data

3.14.1 Plant height

Plant height was considered as the height from ground level to the tip of largest leaf of the plants. The plant height was recorded at 30, 60 DAT and at harvest. Plant height of five randomly sampled plants were recorded and mean was calculated in centimeter (cm).

3.14.2 Number of branches plant^{-1}

The number of branches of five randomly selected plants from each plot at different days after sowing. Number of branches plant^{-1} was recorded at 30, 60 DAT and at harvest.

3.14.3 Number of leaves plant^{-1}

The number of leaves of five randomly selected plants was counted from each unit plot at and means were calculated.

3.14.4 Days to 1st flowering

Days to first flowering was counted from transplanting date to when 1st flower was appeared in the plant.

3.14.5 Days to 1st flowering

Days to 50% flowering was counted from transplanting date to when 50% flower was appeared in the plant.

3.14.6 Number of fruits plant^{-1}

Number of fruits from five randomly selected plants was counted and their mean values were calculated.

3.14.7 Fruit yield plant^{-1} (g)

Fruit weight of five sample plants were weighed and their average was taken in gram (g).

3.14.8 Single fruit weight (g)

Single fruit was taken from randomly selected 20 fruits from each unit plot. Average value was taken and expressed in gram (g).

3.14.9 Fruit yield plot^{-1} (kg)

Total fruit weight was taken from each unit plot from first harvest to last harvest and expressed in kilogram (kg).

3.14.10 Fruit yield ha^{-1} (t)

Total fruit weight obtained from each unit plot was converted to hectare yield and expressed in ton per hectare (t ha^{-1}).

3.14.11 Number of seeds fruit^{-1}

From randomly selected 10 fruits, seeds were taken and average value was calculated

3.14.12 Seed weight fruit^{-1} (g)

From randomly selected 10 fruits, seeds were taken and weighed and then average value was calculated and expressed in gram (g).

3.14.13 Seed weight plant^{-1} (g)

Seed weight fruit^{-1} obtained from each treatment was converted to seed weight plant^{-1} by using number of fruits plant^{-1} and expressed in gram (g).

3.14.14 Weight of 1000 seeds (g)

Randomly selected 1000 seeds were taken from each unit plot and weighed. Average value was calculated and expressed in gram (g).

3.14.15 Seed weight plot^{-1} (g)

Seed weight plot^{-1} was calculated from per plant seed weight using per plot plant population and expressed in gram (g).

3.14.16 Seed weight ha^{-1} (kg)

Per plot seed yield was converted to ton per ha and expressed in kilogram (kg).

3.14.17 Seed viability test

3.14.17.1 Percent (%) seed germination

The number of sprouted and germinated seeds was counted daily commencing. Germination was recorded at 24 hrs interval and continued up to 10 days. More than 2 mm long plumule and radicle was considered as germinated seed.

The germination rate was calculated using the following formula:

$$\text{Rate of germination (\%)} = \frac{Total\ Number\ of\ germinated\ seeds}{Total\ seed\ placed\ for\ germination} \times 100$$

3.14.17.2 Root length (cm)

The Root length of five seedlings from each sample was recorded finally at 10 DAS. Measurement was done using a meter scale and unit was expressed in centimeter (cm).

3.14.17.3 Shoot length (cm)

The shoot length of five seedlings from each sample was measured finally at 10 DAS. Measurement was done using the unit centimeter (cm) by a meter scale.

3.14.17.4 Seed vigor index

The vigor index (VI) of the seedlings can be estimated as suggested by Abdul-Baki and Anderson (1973):

$$VI = RL+SL \times GP,$$

Where

RL = root length (cm),

SL = shoot length (cm) and

GP = germination percentage.

3.15 Statistical analysis

The recorded data on different parameters were statistically analyzed using MSTAT computer package programme. The analysis of variance for the characters under study were performed by 'F' variance test. The differences between the pairs of treatment means was compared using least significant difference (LSD) test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was carried out to find the influence of crop nutrition on fruit and seed yield and quality of brinjal. For quality seed production of brinjal, nutrients are the major yield contributing factor. The effect of different macro and micro nutrients and their interaction on growth and yield contributing characters also seed viability have been presented and discussed in this chapter under the following heads.

4.1 Growth parameters

4.1.1 Plant height (cm)

Effect of macro nutrients (N, P, K)

Different macro nutrients (N, P, K) had significant influence on plant height of brinjal at different growth stages (Fig. 2 and Appendix IV). At harvest, the highest plant height (78.74 cm) was obtained from the macro nutrient F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment which was significantly different from all other treatments followed by F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment. Similarly, the lowest plant height (52.41 cm) at harvest was recorded from the F_0 (N_0 P_0 K_0 kg ha^{-1} kg ha^{-1}) treatment. The figure revealed that irrespective of macro nutrients application, plant height increased gradually with the advances of plant growth stages with increasing of nutrient doses. Similar findings were also observed by Sollapur and Hiremath, (2017) and Uddin *et al*. (2014) which supported the present study.

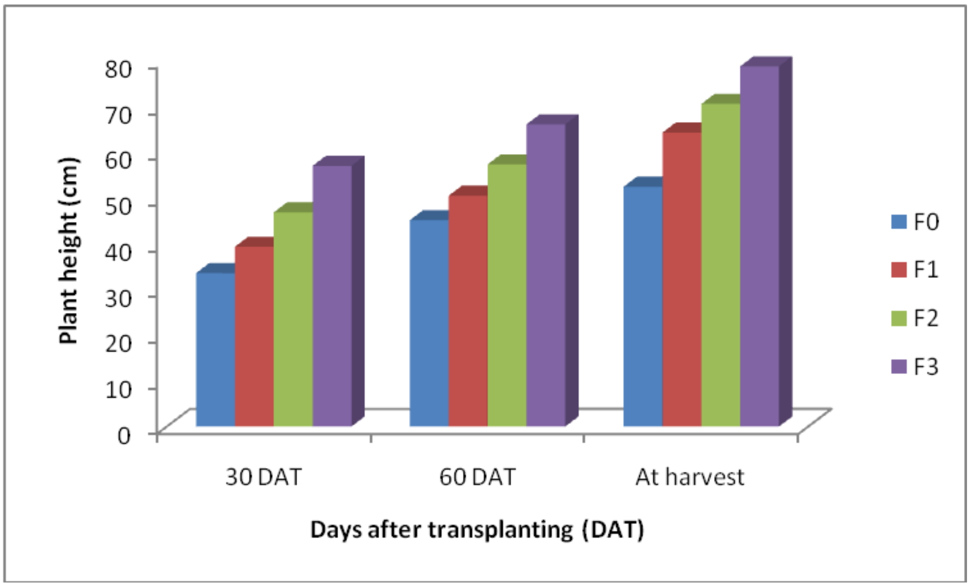


Fig. 2. Plant height of brinjal as influenced by different macro nutrients (N, P, K)

F_0 = Control, $F_1 = N_{150}\ P_{30}\ K_{100}$ kg ha^{-1}, $F_2 = N_{170}\ P_{50}\ K_{125}$ kg ha^{-1}, $F_3 = N_{190}\ P_{70}\ K_{150}$ kg ha^{-1}

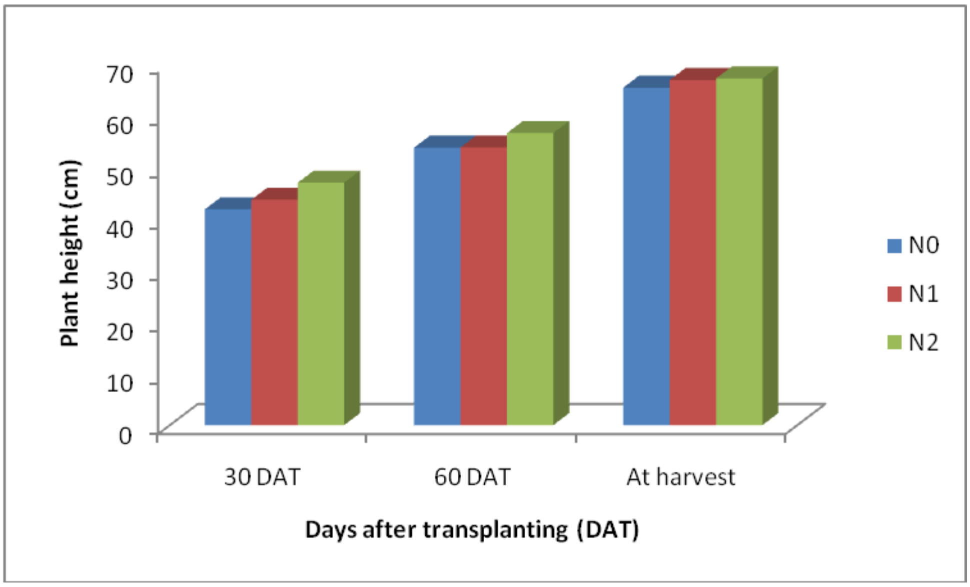


Fig. 3. Plant height of brinjal as influenced by different micro nutrients (Zn, B)

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Effect of micro nutrients (Zn, B)

There was a significant variation on plant height of brinjal at different growth stages influenced by different micro nutrients (Zn, B) (Fig. 3 and Appendix IV). At harvest, the highest plant height (67.18 cm) was achieved from the N_2 (Borax; 0.2%) treatment which was statistically identical to N_1 ($Znso_4$; 0.2%) treatment. on the other hand, the lowest plant height (65.38 cm) was obtained from the N_0 (Control) treatment. Foliar fertilizers immediately deliver nutrients to the tissues and organs of the crop. Improvement in growth characters as a result of application of micronutrients might be due to the enhanced photosynthetic and other metabolic activity which leads to an increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al*. (2003) which leads to produced tallest plant. The result obtained from the present study was similar with findings of Uikey *et al*. (2018), Pandav *et al*. (2016) and Tawab *et al*. (2015).

Combination of macro and micro nutrients

Plant height of brinjal at different growth stages was significantly influenced by application of different macro and micronutrient combinations (Table 1 and Appendix IV). Results revealed that the highest plant height (81.62 cm) was found from the F_3N_2 and the lowest plant height (51.72 cm) was identified from the treatment combination of F_0N_0 which was statistically identical to F_0N_1 and F_0N_2 treatment combination.

Table 1. Combined effect of macro and micro nutrients on plant height at different days after transplanting of brinjal

Treatments	Plant height		
	30 DAT	60 DAT	At harvest
F_0N_0	30.93 f	43.00 f	51.72 g
F_0N_1	32.46 f	43.14 f	51.74 g
F_0N_2	37.18 e	49.12 e	53.76 g
F_1N_0	39.81 de	50.95 e	62.02 f
F_1N_1	38.66 e	49.58 e	64.05 ef
F_1N_2	39.40 de	50.81 e	66.70 d
F_2N_0	41.75 d	53.60 d	66.16 de
F_2N_1	45.08 c	57.37 c	73.21 c
F_2N_2	53.60 b	60.90 b	72.14 c
F_3N_0	54.75 b	67.47 a	76.14 b
F_3N_1	58.48 a	65.11 a	78.46 b
F_3N_2	57.72 a	65.53 a	81.62 a
$LSD_{(0.05)}$	2.922	2.466	2.582
CV %	7.68	8.82	11.70

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.1.2 Number of leaves plant^{-1} at harvest

Effect of macro nutrients (N, P, K)

Significant variation was observed on number of leaves plant^{-1} at harvest at influenced by different macro nutrients (N, P, K) (Table 2 and Appendix V). At harvest, It was found that the highest number of leaves plant^{-1} at harvest (37.01) was obtained from the of F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) where the lowest number of leaves plant^{-1} at harvest (28.67) was obtained from the macro nutrient of F_0 (N_0 P_0 K_0 kg ha^{-1}) followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}). Sollapur *et al*. (2017) and Tawab *et al*. (2015) also observed similar result with the present finding.

Effect of micro nutrients (Zn, B)

Number of leaves plant^{-1} at harvest was significantly varied due to different micro nutrients (Zn, B) (Table 2 and Appendix V). Results indicated that the highest number of leaves plant^{-1} at harvest (35.31) was achieved from the micronutrient treatment of N_1 (Znso$_4$; 0.2%) treatment followed by N_2 (Borax; 0.2%) where the lowest number of leaves plant^{-1} at harvest (33.16) was achieved from the micronutrient treatment of N_0 (Control, Zn_0, B_0) treatment. Uikey *et al*. (2018) also found similar result on number of leaves plant^{-1} which supported the present finding.

Combination of macro and micro nutrients

Remarkable variation was observed on number of leaves plant^{-1} at harvest influenced by different macro and micronutrient combinations (Table 3 and Appendix V). The highest number of leaves plant^{-1} at harvest (37.94) was found from the treatment combination of F_2N_1 which was statistically similar to F_3N_1 treatment combination. The lowest number of leaves plant^{-1} at harvest (27.36) was found from the treatment combination of F_0N_0 which was significantly different from all other treatment combinations.

4.1.3 Number of branches plant^{-1}

Effect of macro nutrients (N, P, K)

Significant influence was noted on number of branches plant^{-1} affected by different macro nutrients (N, P, K) (Table 2 and Appendix V). The highest number of branches plant^{-1} at harvest (10.69) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) and F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) where the lowest number of branches plant^{-1} at harvest (7.75) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment. Significantly similar result on number of branches plant^{-1} was also observed by Sollapur *et al*. (2017) and Nafiu *et al*. (2011).

Effect of micro nutrients (Zn, B)

Number of branches plant^{-1} varied significantly due to different treatments of micro nutrients (Zn, B) (Table 2 and Appendix V). It was observed that the highest number of branches plant^{-1} at harvest (9.71) was achieved from the N_1 (Znso$_4$; 0.2%)treatment. The lowest number of branches plant^{-1} at harvest (9.01) was achieved from the N_0 (Control) treatment which was statistically identical to N_2 (Borax; 0.2%). The result obtained from the present study was similar with findings of Uikey *et al*. (2018), Meena *et al*. (2015) and Singh *et al*. (2014).

Combination of macro and micro nutrients

Significant variation was remarked on number of branches plant^{-1} as influenced by different macro and micronutrient combinations (Table 3 and Appendix V). At harvest the highest number of branches per plant (11.39) was found from the F_2N_1 treatment combination which was significantly different from all other treatment combinations followed by F_2N_0 and the lowest number of branches per plant (7.21) was found from the F_0N_0 treatment combination followed by the treatment combination of F_0N_1.

Table 2. Number of leaves plant^{-1} and number of branches plant^{-1} at harvest of brinjal as influenced by different macro and micro nutrients

Treatments	Number of leaves plant^{-1} at harvest	Number of branches plant^{-1} at harvest
Effect of macro nutrients (N, P, K)		
F_0	28.67 d	7.75 c
F_1	34.99 c	9.25 b
F_2	37.01 a	10.69 a
F_3	36.18 b	9.43 b
LSD $_{(0.05)}$	0.591	0.325
CV %	9.26	10.05
Effect of micro nutrients (Zn, B)		
N_0	33.16 c	9.01 b
N_1	35.31 a	9.71 a
N_2	34.18 b	9.13 b
LSD $_{(0.05)}$	0.512	0.281
CV %	9.26	10.05

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Table 3. Number of leaves plant^{-1} and number of branches plant^{-1} at harvest of brinjal as influenced by different combination of macro and micro nutrients

Treatments	Number of leaves plant^{-1} at harvest	Number of branches plant^{-1} at harvest
F_0N_0	27.36 g	7.21 j
F_0N_1	29.46 f	7.80 i
F_0N_2	29.19 f	8.24 hi
F_1N_0	32.91 e	8.75 gh
F_1N_1	36.90 b	9.63 cde
F_1N_2	35.18 d	9.38 def
F_2N_0	36.48 bc	10.76 b
F_2N_1	37.94 a	11.39 a
F_2N_2	36.62 bc	9.91 cd
F_3N_0	35.88 cd	9.32 ef
F_3N_1	36.93 ab	10.01 c
F_3N_2	35.74 cd	8.97 fg
LSD $_{(0.05)}$	1.025	0.563
CV %	9.26	10.05

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.2 Yield and yield contributing parameters

4.2.1 Days to 1st flowering

Effect of macro nutrients (N, P, K)

Days to 1st flowering was significantly influenced by the application of different macro nutrients (N, P, K) (Table 4 and Appendix VI). It was found that the highest days required for 1st flowering (74.12 days) was obtained from the F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment which was statistically identical to F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment. Again, the lowest days to 1st flowering (62.74) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}).

Effect of micro nutrients (Zn, B)

Days to 1st flowering of brinjal was significantly affected by different micro nutrients (Zn, B) treatments was significant (Table 4 and Appendix VI). The highest days to 1st flowering (69.76) was achieved from the N_1 ($Znso_4$; 0.2%) treatment which was statistically similar to N_0 (control) treatment. The lowest days to 1st flowering (68.19) was observed from the N_2 (Borax; 0.2%) treatment. Uikey *et al*. (2018) and Meena *et al*. (2015) also found similar result with the present study.

Combination of macro and micro nutrients

Variation on days to 1st flowering was significantly influenced by different macro and micronutrient combinations (Table 5 and Appendix VI). The highest days to 1st flowering (74.30) was found from the F_3N_1 treatment combination which was statistically identical to F_2N_0, F_2N_1, F_2N_2, F_3N_0 and F_3N_2. The lowest days to 1st flowering (62.06) was found from the F_0N_2 treatment combination which was statistically similar to F_0N_0, F_0N_1 and F_1N_2 treatment combinations.

4.2.2 Days to 50% flowering

Effect of macro nutrients (N, P, K)

Days to 50% flowering was significantly affected with the application of different macro nutrients (N, P, K) (Table 4 and Appendix VI). The highest days to 50% flowering (84.95) was obtained from the F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment followed by F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment. The lowest days to 50% flowering (75.12) was obtained from the F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment which was statistically identical to F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment.

Table 4. Effect of macro and micro nutrients on days to 1st flowering and 50% flowering of brinjal

Treatments	Days to flowering	
	Days to 1st flowering	Days to 50% flowering
Effect of macro nutrients (N, P, K)		
F_0	62.74 c	75.12 c
F_1	66.26 b	74.18 c
F_2	72.84 a	78.85 b
F_3	74.12 a	84.95 a
LSD $_{(0.05)}$	1.732	2.209
CV %	6.46	7.46
Effect of micro nutrients (Zn, B)		
N_0	69.03 ab	78.11 b
N_1	69.76 a	80.08 a
N_2	68.19 b	76.65 b
LSD $_{(0.05)}$	1.501	1.913
CV %	6.46	7.46

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

F_0 = Control, $F_1 = N_{150}\ P_{30}\ K_{100}$ kg ha^{-1}, $F_2 = N_{170}\ P_{50}\ K_{125}$ kg ha^{-1}, $F_3 = N_{190}\ P_{70}\ K_{150}$ kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Effect of micro nutrients (Zn, B)

Variation on days to 50% flowering was significantly influenced by different micro nutrients (Zn, B) (Table 4 and Appendix VI). The highest days to 50% flowering (80.08) was achieved from the N_1 ($Znso_4$; 0.2%) treatment where the lowest days to 50% flowering (76.65) was identified from the N_2 (Borax; 0.2%) treatment which was statistically identical to N_0 (Control, Zn_0, B_0) treatment.

Combination of macro and micro nutrients

Days to 50% flowering of brinjal was significantly affected by combined effect of macro and micronutrients (Table 5 and Appendix VI). Results revealed that the highest days to 50% flowering (87.90) was found from the F_3N_1 treatment combination which was statistically similar to F_3N_0 treatment combination. The lowest days to 50% flowering (72.23) was found from the F_1N_2 treatment combination which was statistically similar to F_0N_0, F_0N_1, F_0N_2, F_1N_0 and F_1N_1 treatment combinations.

Table 5. Combined effect of macro and micro nutrients on days to 1st flowering and 50% flowering of brinjal

Treatments	Days to flowering	
	1st flowering	50% flowering
F_0N_0	63.27 cd	75.57 cd
F_0N_1	62.90 cd	74.83 cd
F_0N_2	62.06 d	74.97 cd
F_1N_0	65.48 bc	75.18 cd
F_1N_1	68.45 b	75.14 cd
F_1N_2	64.85 cd	72.23d
F_2N_0	73.07 a	76.98 c
F_2N_1	73.78 a	82.45 b
F_2N_2	71.68 a	77.11 c
F_3N_0	73.92 a	84.69 ab
F_3N_1	74.30 a	87.90 a
F_3N_2	74.15 a	82.28 b
$LSD_{(0.05)}$	2.999	3.826
CV %	6.46	7.46

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, $F_1 = N_{150}$ kg ha^{-1} P_{30} K_{100} kg ha^{-1}, $F_2 = N_{170}$ P_{50} K_{125} kg ha^{-1}, $F_3 = N_{190}$ P_{70} K_{150} kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.2.3 Number of fruits plant^{-1}

Effect of macro nutrients (N, P, K)

The recorded data on number of fruits plant^{-1} was significant with the application of different macro nutrients (N, P, K) (Table 6 and Appendix VII). The highest number of fruits plant^{-1} (14.45) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest number of fruits plant^{-1} (6.24) was obtained from the F_0 (N_0 P_0 K_0 kg ha$^-$

^{1}) treatment. Similar findings were also observed by Uikey *et al*. (2018), Meena *et al*. (2015) and Patidar *et al*. (2018) which supported the present finding.

Effect of micro nutrients (Zn, B)

Considerable influence was observed on number of fruits plant^{-1} persuaded by different micro nutrients (Zn, B) (Table 6 and Appendix VII). The highest number of fruits plant^{-1} (13.19) was achieved from the N_2 (Borax; 0.2%) treatment followed by N_1 ($Znso_4$; 0.2%) where the lowest number of fruits plant^{-1} (9.17) was achieved from the N_0 (Control) treatment. The result obtained from the present study was similar with findings of Uikey *et al*. (2018), Pandav *et al*. (2016) and Houimli *et al*. (2016).

Combination of macro and micro nutrients

Remarkable variation was identified on number of fruits plant^{-1} due to the different macro and micronutrient combinations (Table 7 and Appendix VII). The highest number of fruits plant^{-1} (19.09) was found from the F_2N_2 treatment combination which was statistically identical to F_3N_2. The lowest number of fruits plant^{-1} (5.99) was found from the F_0N_0 treatment combination which was statistically identical to F_0N_1 and F_0N_2 treatment combination.

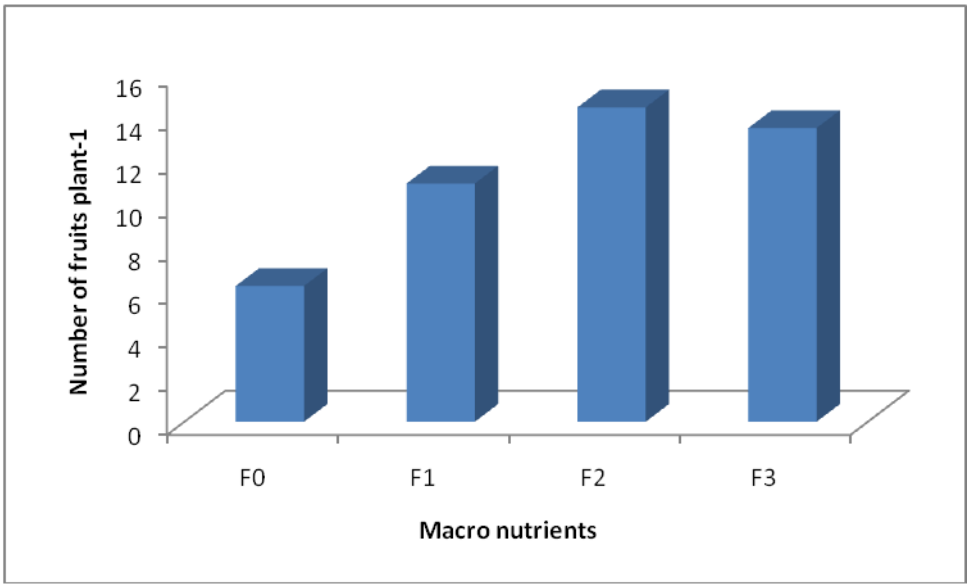


Fig. 4. Number of fruits plant^{-1} of brinjal as influenced by macro nutrients

F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

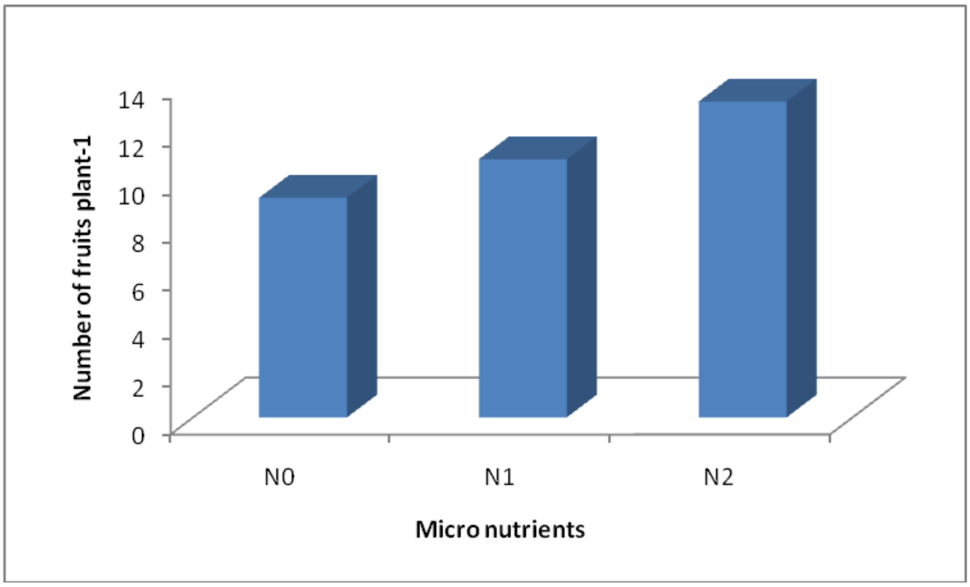


Fig. 5. Number of fruits plant^{-1}of brinjal as influenced by micro nutrients

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.2.4 Single fruit weight (g)

Effect of macro nutrients (N, P, K)

Significant variation was observed on single fruit weight influenced by different macro nutrients (N, P, K) (Table 6 and Appendix VII). The highest single fruit weight (58.52 g) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}), which was statistically identical to F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest single fruit weight (48.65 g) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment.

Effect of micro nutrients (Zn, B)

Single fruit weight was significantly varied due to different micro nutrients (Zn, B) (Table 6 and Appendix VII). Results indicated that the highest single fruit weight (57.30 g) was achieved from the N_2 (Borax; 0.2%) treatment where the lowest single fruit weight (53.77 g) was achieved from the N_0 (Control). Karuppaiah (2005) also found similar result which supported the present finding.

Combination of macro and micro nutrients

Remarkable variation was observed on single fruit weight influenced by different macro and micronutrient combinations (Table 7 and Appendix VII). Results reviewed that the highest single fruit weight (60.58 g) was found from the F_2N_2 treatment combination which was statistically identical with F_3N_2 treatment combination. The lowest single fruit weight (48.25 g) was found from the F_0N_0 treatment combination which was statistically identical to F_0N_1 and F_0N_2 treatment combination.

4.2.5 Fruit yield plant^{-1} (g)

Effect of macro nutrients (N, P, K)

Significant influence was noted on fruit yield plant^{-1} affected by different macro nutrients (N, P, K) (Table 6 and Appendix VII). The highest fruit yield plant^{-1} (852.00 g) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) where the lowest fruit yield plant^{-1} (303.60 g) was obtained from the F_0 (Control) treatment.

Effect of micro nutrients (Zn, B)

Fruit yield plant^{-1} varied significantly due to the effect of different micro nutrients (Zn, B) (Table 6 and Appendix VII). The highest fruit yield plant^{-1} (817.70 g) was achieved from the micronutrient treatment of N_2 (Borax; 0.2%) followed by N_1 (Znso$_4$; 0.2%). The lowest fruit yield plant^{-1} (499.40 g) was achieved from the micronutrient treatment of N_0 (Control, Zn_0, B_0)

Combination of macro and micro nutrients

Significant variation was remarked as influenced by different macro and micro nutrient combinations (Table 7 and Appendix VII). It was found that the highest fruit yield plant^{-1} (1157.00 g) was observed from the F_2N_2 treatment combination and the lowest fruit yield plant^{-1} (288.90 g) was found from the F_0N_0 treatment combination which was statistically identical with F_0N_1 treatment combination.

4.2.6 Fruit yield plot^{-1} (kg)

Effect of macro nutrients (N, P, K)

The recorded data on fruit yield plot^{-1} was significant with the application of different macro nutrients (N, P, K) (Table 6 and Appendix VII). The highest fruit yield plot^{-1} (10.22 kg) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment which was statistically identical to F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment.

The lowest fruit yield plot^{-1} (3.64 kg) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment.

Effect of micro nutrients (Zn, B)

Considerable influence was observed on fruit yield plot^{-1} persuaded by different micro nutrients (Zn, B) (Table 6 and Appendix VII). The highest fruit yield plot^{-1} (9.81 kg) was achieved from the micronutrient treatment of N_2 (Borax; 0.2%) followed by N_1 ($Znso_4$; 0.2%) where the lowest fruit yield plot^{-1} (5.99 kg) was achieved from the micronutrient treatment of N_0 (Control, Zn_0, B_0).

Combination of macro and micro nutrients

Remarkable variation was identified on fruit yield plot^{-1} due to the effect of different macro and micronutrient combinations (Table 7 and Appendix VII). The highest fruit yield plot^{-1} (13.88 kg) was found from the F_2N_2 followed by F_3N_2 treatment combination. The lowest fruit yield plot^{-1} (3.47 kg) was found from the F_0N_0 treatment combination which was statistically identical to F_0N_1 and F_0N_2 treatment combination treatment combination.

4.2.7 Fruit yield ha^{-1} (t)

Effect of macro nutrients (N, P, K)

Fruit yield ha^{-1} was significantly varied due to different macro nutrients (N, P, K) (Table 6 and Appendix VII). Results revealed that the highest fruit yield ha^{-1} (31.56 t) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment where the second highest fruit yield ha^{-1} was obtained from F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest fruit yield ha^{-1} (11.24 t) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment. The result obtained from the present study was similar with findings of Patidar *et al*. (2018), Sollapur *et al*. (2017) and Thingujam *et al*. (2016).

Effect of micro nutrients (Zn, B)

Significant variation was observed on fruit yield ha^{-1} influenced by different micro nutrients (Zn, B) (Table 6 and Appendix VII). It was observed that the highest fruit yield ha^{-1} (13.91 t) was achieved from the N_2 (Borax; 0.2%) treatment where N_1 ($Znso_4$; 0.2%) treatment showed second highest fruit yield ha^{-1}. The lowest fruit yield ha^{-1} (9.17 t) was achieved from the micronutrient treatment of N_0 (Control) treatment. The result obtained from the present study was conformity with findings of Pandav *et al*. (2016), Kumar *et al*. (2016) and Tawab *et al*. (2015).

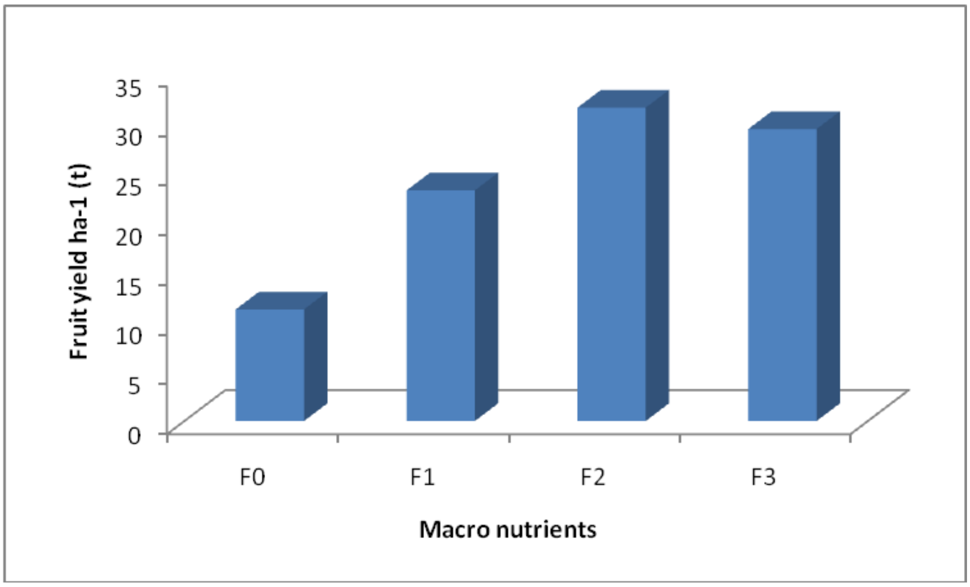


Fig. 6. Fruit yield ha^{-1} of brinjal as influenced by macro nutrients

F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

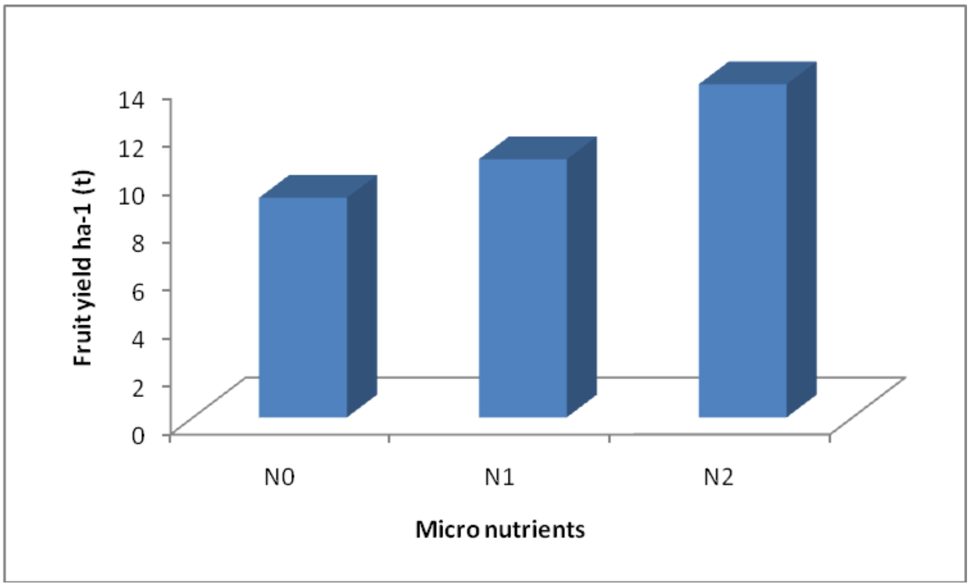


Fig. 7. Fruit yield ha^{-1} of brinjal as influenced by micro nutrients

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Combination of macro and micro nutrients

Remarkable variation was observed on fruit yield ha^{-1} influenced by different macro and micronutrient combinations (Table 7 and Appendix VII). Results indicated that the highest fruit yield ha^{-1} (42.84 t) was found from the F_2N_2 treatment combination where the second and third highest fruit yield ha^{-1} was obtained from the treatment combination of F_3N_2 and F_2N_1, respectively. The lowest fruit yield ha^{-1} (10.70 t) was found from the F_0N_0 treatment combination which was statistically identical F_0N_1 treatment combination followed by F_0N_2. Yield contributing parameters like number of fruits $plant^{-1}$, single fruit weight and Fruit yield $plant^{-1}$ were also highest from the treatment combination of F_2N_2, so, the highest fruit yield ha^{-1} was achieved with the same treatment combination.

Table 6. Fruit yield parameters of brinjal as influenced by different macro and micro nutrients

Treatments	Fruit yield and yield contributing parameters				
	Number of fruits $plant^{-1}$	Single fruit weight (g)	Fruit yield $plant^{-1}$ (g)	Fruit yield $plot^{-1}$ (kg)	Fruit yield ha^{-1} (t)
Effect of macro nutrients (N, P, K)					
F_0	6.240 d	48.65 c	303.60 d	3.640 c	11.24 d
F_1	10.95 c	57.05 b	627.10 c	7.530 b	23.23 c
F_2	14.45 a	58.52 a	852.00 a	10.22 a	31.56 a
F_3	13.50 b	58.48 a	794.20 b	9.530 a	29.41 b
LSD $_{(0.05)}$	0.9367	1.003	10.89	1.357	1.455
CV %	8.244	10.347	9.443	5.217	7.614
Effect of micro nutrients (Zn, B)					
N_0	9.170 c	53.77 c	499.40 c	5.990 c	9.170 c
N_1	10.78 b	55.96 b	615.60 b	7.390 b	10.78 b
N_2	13.19 a	57.30 a	817.70 a	9.810 a	13.91 a
LSD $_{(0.05)}$	0.9815	1.325	11.56	0.9413	0.3935
CV %	8.244	10.347	9.443	5.217	7.614

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Table 7. Fruit yield parameters of brinjal as influenced by different combination of macro and micro nutrients

Treatments	Fruit yield and yield contributing parameters				
	Number of fruits plant^{-1}	Single fruit weight (g)	Fruit yield plant^{-1} (g)	Fruit yield plot^{-1} (kg)	Fruit yield ha^{-1} (t)
F_0N_0	5.990 g	48.25 f	288.90 k	3.470 h	10.70 i
F_0N_1	6.020 g	48.47 f	291.90 k	3.500 h	10.81 i
F_0N_2	6.700 g	49.24 f	329.90 j	3.960 h	12.22 h
F_1N_0	9.110 f	54.65 e	497.60 i	5.970 g	18.43 g
F_1N_1	11.40 de	57.52 cd	655.60 f	7.870 e	24.28 e
F_1N_2	12.35 d	58.97 b	728.20 d	8.740 d	26.97 d
F_2N_0	10.69 e	55.48 e	593.20 h	7.120 f	21.97 f
F_2N_1	13.58 c	59.39 b	806.20 c	9.670 c	29.86 c
F_2N_2	19.09 a	60.58 a	1157.00 a	13.88 a	42.84 a
F_3N_0	10.90 e	56.68 d	617.80 g	7.410 ef	22.88 f
F_3N_1	12.12 d	58.46 bc	708.80 e	8.510 d	26.25 d
F_3N_2	17.78 b	60.41 a	1056.00 b	12.67 b	39.11 b
LSD $_{(0.05)}$	1.130	0.9855	12.46	0.4908	0.9458
CV %	8.244	10.347	9.443	5.217	7.614

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.3 Seed yield parameters of brinjal

4.3.1 Number of seeds fruit^{-1}

Effect of macro nutrients (N, P, K)

Different macro nutrients (N, P, K) had significant influence on number of seeds fruit^{-1} (Table 8 and Appendix VIII). The treatment F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) showed the highest number of seeds fruit^{-1} (701.70) followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) and F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest number of seeds fruit^{-1} (683.10) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment. Similar findings were also observed by Lawal *et al*. (2015) and Akanbi *et al*. (2010) which supported the present finding.

Effect of micro nutrients (Zn, B)

There was a significant variation on number of seeds fruit^{-1} influenced by different micro nutrients (Zn, B) (Table 8 and Appendix VIII). The highest number of seeds fruit^{-1} (699.90) was achieved from the N_2 (Borax; 0.2%) treatment which was statistically identical with N_1 (Znso$_4$; 0.2%) treatment where the lowest number of seeds fruit^{-1} (689.10) was achieved from the N_0 (Control) treatment. The result obtained from the present study was similar with findings of Kiran *et al*. (2010).

Combination of macro and micro nutrients

Number of seeds fruit^{-1} was significantly influenced by different macro and micronutrient combinations (Table 9 and Appendix VIII). Results indicated that the highest number of seeds fruit^{-1} (711.40) was found from the F_2N_2 treatment. The lowest number of seeds fruit^{-1} (677.50) was found from F_0N_0 treatment combination.

4.3.2 Seed weight fruit^{-1} (g)

Effect of macro nutrients (N, P, K)

Significant variation was observed on seed weight fruit^{-1} influenced by different macro nutrients (N, P, K) (Fig. 8 and Appendix VIII). The highest seed weight fruit^{-1} (3.11g) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment which was statistically identical to F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) and F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment where the lowest seed weight fruit^{-1} (2.96 g) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment. Lawal *et al*. (2015) Akanbi *et al*. (2010) also found similar result which supported the present finding.

Effect of micro nutrients (Zn, B)

Seed weight $fruit^{-1}$ was not significantly varied due to different micro nutrients (Zn, B) application (Fig. 9 and Appendix VIII). But the highest seed weight $fruit^{-1}$ (3.10 g) was achieved from the N_2 (Borax; 0.2%) treatment and the lowest seed weight $fruit^{-1}$ (3.02 g) was achieved from the N_0 (Control) treatment.

Combination of macro and micro nutrients

Remarkable variation was observed on seed weight $fruit^{-1}$ influenced by different macro and micronutrient combinations (Table 9 and Appendix VIII). The highest seed weight $fruit^{-1}$ (3.18 g) was found from the F_2N_2 treatment combination which was significantly different from all other treatment combinations followed by F_3N_2. The lowest seed weight $fruit^{-1}$ (2.920 g) was found from the F_0N_0 treatment combination which was also significantly different from all other treatment combinations followed by F_0N_1 and F_0N_2.

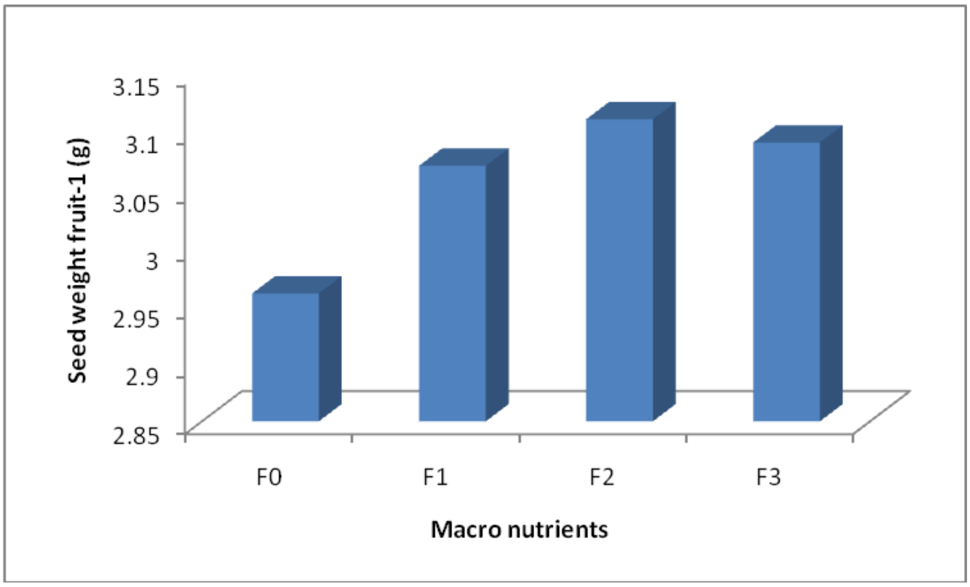


Fig. 8. Seed weight fruit^{-1} of brinjal as influenced by macro nutrients

F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

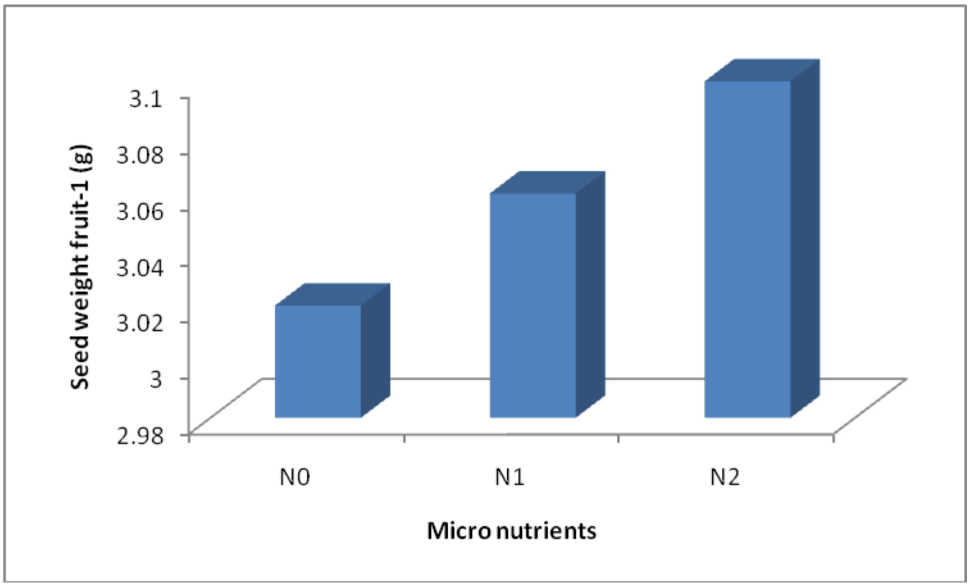


Fig. 9. Seed weight fruit^{-1} of brinjal as influenced by micro nutrients

N_0 = Control, N_1 = Znso$_4$ (0.2%), N_2 = Borax (0.2%)

4.3.3 Seed weight plant^{-1} (g)

Effect of macro nutrients (N, P, K)

Significant influence was noted on seed weight plant^{-1} affected by different macro nutrients (N, P, K) (Table 8 and Appendix VIII). The highest seed weight plant^{-1} (45.18 g) was obtained from F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest seed weight plant^{-1} (18.46 g) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment. Lawal *et al*. (2015) also found similar result with the present study.

Effect of micro nutrients (Zn, B)

Significant variation was remarked on seed weight plant^{-1} as influenced by different micro nutrients (Zn, B) (Table 8 and Appendix VIII). The highest seed weight plant^{-1} (43.42 g) was achieved from the N_2 (Borax; 0.2%) followed by N_1 ($Znso_4$; 0.2%) treatment. The lowest seed weight plant^{-1} (27.75 g) was achieved from the N_0 (Control) treatment.

Combination of macro and micro nutrients

Seed weight plant^{-1} was found significant with the application of different macro and micronutrient combinations (Table 9 and Appendix VIII). The highest seed weight plant^{-1} (60.72 g) was found from the F_2N_2 treatment combination which was significantly different from all other treatment combinations followed by F_3N_2. The lowest seed weight plant^{-1} (17.48 g) was found from the F_0N_0 treatment combination which was statistically identical to F_0N_1 and F_0N_2.

4.3.4 Weight of 1000 seeds (g)

Effect of macro nutrients (N, P, K)

Variation on 1000 seed weight was not found among the treatments influenced by different macro nutrients (N, P, K) (Table 8 and Appendix VIII). But the highest 1000 seed weight (4.44 g) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment where the lowest 1000 seed weight (4.33 g) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment.

Effect of micro nutrients (Zn, B)

The recorded data on 1000 seed weight was not significant affected by the application of different micro nutrients (Zn, B) application (Table 8 and Appendix VIII). But the highest 1000 seed weight (4.43 g) was achieved from the N_2 (Borax; 0.2%) treatment and the lowest 1000 seed weight (4.38 g) was achieved from the N_0 (Control) treatment. The result obtained from the present study was similar with findings of Kiran *et al.* (2010) and Natesh *et al.* (2005).

Combination of macro and micro nutrients

Considerable influence was observed on 1000 seed weight affected by different macro and micronutrient combinations (Table 9 and Appendix VIII). The highest 1000 seed weight (4.47 g) was found from the F_2N_2 treatment combination which was statistically similar with the F_3N_2 treatment combination. The lowest 1000 seed weight (4.31g) was found from the F_0N_0 treatment combination which was closely followed by F_0N_1 and F_0N_2 treatment combination.

4.3.5 Seed weight plot^{-1} (g)

Effect of macro nutrients (N, P, K)

Remarkable variation was identified on seed weight plot^{-1} due to the effect of different macro nutrients (N, P, K) (Table 8 and Appendix VIII). The highest seed weight plot^{-1} (542.2g) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment followed by F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. The lowest seed weight plot^{-1} (221.6g) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment.

Effect of micro nutrients (Zn, B)

Remarkable variation was observed on seed weight plot^{-1} influenced by different micro nutrients (Zn, B) (Table 8 and Appendix VIII). The highest seed weight plot^{-1} (521.00 g) was achieved from the N_2 (Borax; 0.2%) treatment followed by N_1 ($Znso_4$; 0.2%) treatment and the lowest seed weight plot^{-1} (333.00 g) was achieved from the N_0 (Control) treatment.

Combination of macro and micro nutrients

Significant influence was noted on seed weight plot^{-1} affected by different macro and micronutrient combinations (Table 9 and Appendix VIII). Results showed that the highest seed weight plot^{-1} (728.60g) was found from the F_2N_2 treatment combination which was significantly different from all other treatment combinations followed by F_3N_2 treatment combination. The lowest seed weight plot^{-1} (209.80 g) was found from the F_0N_0 treatment combination which was statistically identical to F_0N_1 treatment combination.

4.3.6 Seed weight ha^{-1} (kg)

Effect of macro nutrients (N, P, K)

Significant variation was remarked on seed weight ha^{-1} as influenced by different macro nutrients (N, P, K) (Fig. 10 and Appendix VIII). Results indicated that the highest seed weight ha^{-1} (1673.00 kg) was obtained from the F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) treatment. The lowest seed weight ha^{-1} (683.90 kg) was obtained from the F_0 (N_0 P_0 K_0 kg ha^{-1}) treatment followed by F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment. Similar findings were also observed by Lawal *et al.* (2015) which supported the present finding.

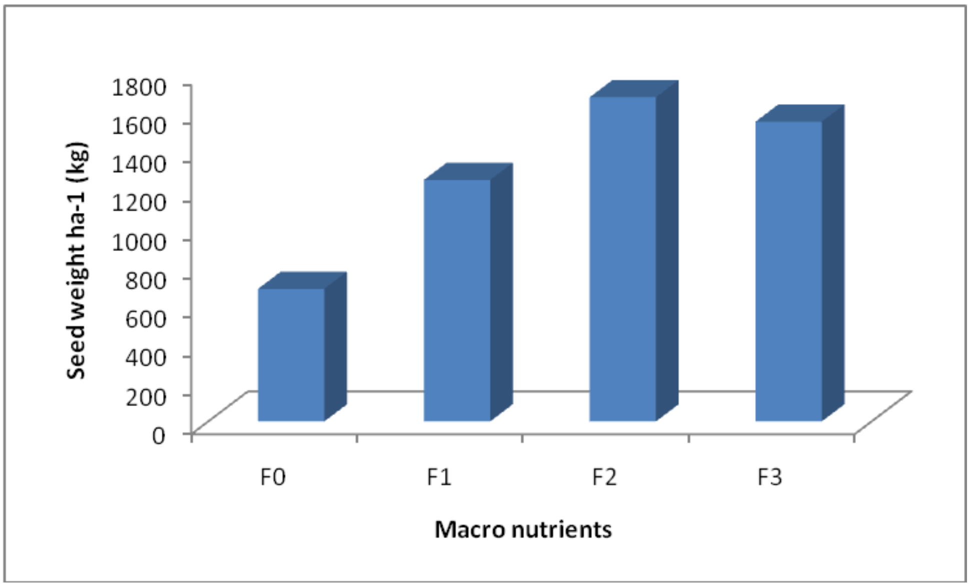


Fig. 10. Seed weight ha^{-1} of brinjal as influenced by macro nutrients

F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

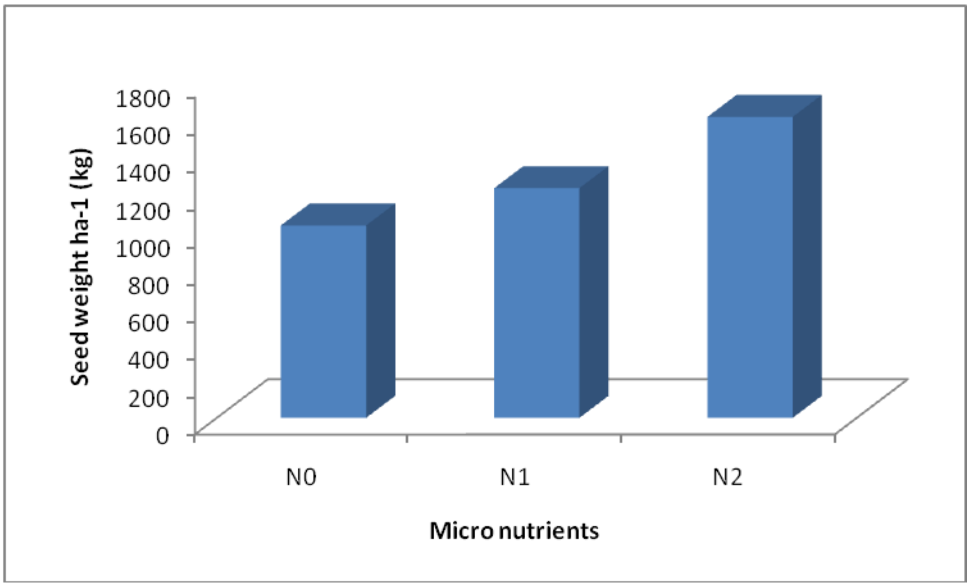


Fig. 11. Seed weight ha^{-1} of brinjal as influenced by micro nutrients

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Table 8. Effect of macro and micro nutrients on seed yield parameters of brinjal

Treatments	Seed yield parameters of brinjal					
	Number of seeds fruit^{-1}	Seed weight fruit^{-1} (g)	Seed weight plant^{-1} (g)	1000 seed weight (g)	Seed weight plot^{-1} (g)	Seed weight ha^{-1} (kg)
Effect of macro nutrients (N, P, K)						
F_0	683.10 c	2.960 b	18.46 d	4.330	221.6 d	683.90 d
F_1	697.20 b	3.070 a	33.65 c	4.400	403.8 c	1246.00 c
F_2	701.70 a	3.110 a	45.18 a	4.440	542.2 a	1673.00 a
F_3	698.30 b	3.090 a	41.76 b	4.420	501.2 b	1547.00 b
LSD $_{(0.05)}$	3.008	0.0928	2.949	0.308^{NS}	12.28	12.67
CV %	11.13	9.56	11.84	4.26	9.88	12.52
Effect of micro nutrients (Zn, B)						
N_0	689.10 b	3.020	27.75 c	4.380	333.00 c	1028.00 c
N_1	696.20 a	3.060	33.12 b	4.400	397.50 b	1227.00 b
N_2	699.90 a	3.100	43.42 a	4.430	521.00 a	1608.00 a
LSD $_{(0.05)}$	5.205	0.093^{NS}	4.264	0.093^{NS}	12.041	11.31
CV %	11.13	9.56	11.84	4.26	9.88	12.52

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Effect of micro nutrients (Zn, B)

Seed weight ha^{-1} was found significant with the application of different micro nutrients (Zn, B) (Fig. 11 and Appendix VIII). The highest seed weight ha^{-1} (1608.00 kg) was achieved from the N_2 (Borax; 0.2%) treatment and the lowest seed weight ha^{-1} (1028.00 kg) was achieved from N_0 (Control) treatment. Kiran *et al*. (2010) also found similar result which supported the present finding

Combination of macro and micro nutrients

The recorded data on seed weight ha^{-1} was significant with the application of different macro and micronutrient combinations (Table 9 and Appendix VIII). The highest seed weight ha^{-1} (2249.00 kg) was found from the F_2N_2 treatment combination which was significantly different from all other treatment combinations. The lowest seed weight ha^{-1} (647.50 kg) was found from the F_0N_0 treatment combination followed by F_0N_1 and F_0N_2 treatment combination.

Table 9. Effect of different combination of macro and micro nutrients on seed yield parameters of brinjal

Treatments	Seed yield parameters of brinjal					
	Number of seeds $fruit^{-1}$	Seed weight $fruit^{-1}$ (g)	Seed weight $plant^{-1}$ (g)	1000 seed weight (g)	Seed weight $plot^{-1}$ (g)	Seed weight ha^{-1} (kg)
F_0N_0	677.50 g	2.920 f	17.48 h	4.310 f	209.80 j	647.50 l
F_0N_1	686.60 ef	2.970 e	17.94 h	4.340 e	215.30 j	664.60 k
F_0N_2	685.10 f	2.980 e	19.97 h	4.350 e	239.60 i	739.50 j
F_1N_0	694.10 cd	3.040 d	27.68 g	4.380 d	332.20 h	1025.00 i
F_1N_1	697.70 bc	3.070 cd	34.99 ef	4.400 cd	419.90 f	1296.00 f
F_1N_2	699.80 b	3.100 bc	38.28 d	4.430 bc	459.40 d	1418.00 d
F_2N_0	691.60 de	3.050 d	32.61 f	4.410 cd	391.30 g	1208.00 h
F_2N_1	702.00 b	3.110 bc	42.22 c	4.430 bc	506.60 c	1564.00 c
F_2N_2	711.40 a	3.180 a	60.72 a	4.470 a	728.60 a	2249.00 a
F_3N_0	693.20 cd	3.050 d	33.24 f	4.400 cd	398.90 g	1231.00 g
F_3N_1	698.40 bc	3.080 cd	37.34 de	4.410 cd	448.10 e	1383.00 e
F_3N_2	703.40 b	3.130 b	54.71 b	4.450 ab	656.50 b	2026.00 b
$LSD_{(0.05)}$	5.228	0.04148	3.084	0.02933	10.21	11.94
CV %	11.13	9.56	11.84	4.26	9.88	12.52

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

4.4 Seed quality test

4.4.1 Percent (%) seed germination

Effect of macro nutrients (N, P, K)

Different macro nutrients (N, P, K) produced had no significant effect on percent (%) seed germination of brinjal (Table 10 and Appendix IX). However, the highest percent (%) seed germination (96.00%) was achieved from the treatment F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) produced seeds whereas the minimum percent (%) seed germination (90.78%) was found from F_0 (Control, N_0 P_0 K_0).

Effect of micro nutrients (Zn, B)

Seeds of brinjal obtained from different micro nutrients (Zn, B) treatment showed non-significant influence on percent (%) seed germination (Table 10 and Appendix IX). However, results indicated that the highest percent (%) seed germination (95.17%) was recorded from the N_2 (Borax; 0.2%) treated seeds whereas the lowest percent (%) seed germination (90.00%) was recorded from the seeds of control treatment N_0 (Control, Zn_0, B_0).

Combination of macro and micro nutrients

Non-significant variation was recorded on percent (%) seed germination affected by combined effect of different macro and micronutrient (Table 11 and Appendix IX). However, the highest percent (%) seed germination (98.00%) was recorded from seeds which were produced from the treatment combination of F_3N_2 and the lowest percent (%) seed germination (88.00%) was found from the seeds achieved from the treatment combination, F_0N_0.

4.4.2 Root length (cm)

Effect of macro nutrients (N, P, K)

Seeds obtained from different macro nutrients (N, P, K) had non-significant effect on root length of brinjal (Table 10 and Appendix IX). However, the highest root length (2.90 cm) was achieved from the treatment F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) produced seeds whereas the lowest root length (2.04 cm) was found from F_0 (Control, N_0 P_0 K_0).

Effect of micro nutrients (Zn, B)

Seeds of brinjal obtained from different micro nutrients (Zn, B) treatment showed non-significant influence on root length of brinjal seedlings (Table 10 and Appendix IX). However, results indicated that the highest root length (2.86 cm) was recorded from the N_2 (Borax; 0.2%) treated seeds whereas the lowest root length (2.30 cm) was recorded from the seeds of control treatment N_0 (Control, Zn_0, B_0).

Combination of macro and micro nutrients

Seeds obtained from combined effect of different macro and micronutrient showed non- significant variation on root length (Table 11 and Appendix IX). However, the highest root length (3.12 cm) was recorded from seeds which were produced from the treatment combination of F_3N_2 and the lowest root length (1.65 cm) was found from the seeds achieved from the treatment combination, F_0N_0.

4.4.3 Shoot length (cm)

Effect of macro nutrients (N, P, K)

Seed obtained from different macro nutrients (N, P, K) had significant effect on shoot length of brinjal (Table 10 and Appendix IX). Results revealed that the highest shoot length (6.92 cm) was achieved from the treatment F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) produced seeds followed by F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) whereas the lowest shoot length (4.09 cm) was found from F_0 (Control, N_0 P_0 K_0).

Effect of micro nutrients (Zn, B)

Seeds of brinjal obtained from different micro nutrients (Zn, B) treatment showed significant influence on shoot length of brinjal seedlings (Table 10 and Appendix IX). However, results indicated that the highest shoot length (6.15 cm) was recorded from the N_2 (Borax; 0.2%) treated seeds which was statistically identical with N_1 ($Znso_4$; 0.2%) whereas the lowest shoot length (5.41 cm) was recorded from the seeds of control treatment N_0 (Control, Zn_0, B_0).

Combination of macro and micro nutrients

Seeds obtained from combined effect of different macro and micronutrient showed significant variation on shoot length (Table 11 and Appendix IX). Results indicated that the highest shoot length (7.22 cm) was recorded from seeds which were produced from the treatment combination of F_3N_2 which was statistically identical with F_2N_2 and statistically similar with the treatment combination of F_3N_1. The lowest shoot length (3.81 cm) was found from the seeds achieved from the treatment combination, F_0N_0 followed by F_0N_1 and F_0N_2.

4.4.4 Seed vigor index

Effect of macro nutrients (N, P, K)

Seed obtained from different macro nutrients (N, P, K) had significant effect on seed vigor index (Table 10 and Appendix IX). Results revealed that the highest seed vigor index (943.49) was achieved from the treatment F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) produced seeds followed by F_2 (N_{170} P_{50} K_{125} kg ha^{-1}) whereas the lowest seed vigor index (528.18) was found from F_0 (Control, N_0 P_0 K_0). Lawal *et al.* (2015) also found similar result with the present study.

Table 10. Effect of macro and micro nutrients on seed quality test of brinjal

Treatments	Seed quality test			
	Percent (%) seed germination	Root length (cm)	Shoot length (cm)	Seed vigor index
Effect of macro nutrients (N, P, K)				
F_0	90.778	2.0389	4.0867 d	528.18 d
F_1	93.778	2.6789	5.7367 c	790.55 c
F_2	95.778	2.7222	6.7233 b	905.35 b
F_3	96.000	2.9000	6.9189 a	943.49 a
$LSD_{(0.05)}$	NS	NS	0.182	26.194
CV %	11.93	11.25	10.34	10.63
Effect of micro nutrients (Zn, B)				
N_0	90.000	2.2983	5.4100 b	694.78 c
N_1	94.333	2.6008	6.0400 a	819.82 b
N_2	95.167	2.8558	6.1492 a	861.08 a
$LSD_{(0.05)}$	NS	NS	0.158	22.684
CV %	11.93	11.25	10.34	10.63

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

Effect of micro nutrients (Zn, B)

Seeds of brinjal obtained from different micro nutrients (Zn, B) treatment showed significant influence on seed vigor index (Table 10 and Appendix IX). Results indicated that the highest seed vigor index (861.08) was recorded from the N_2 (Borax; 0.2%) treated seeds followed by N_1 ($Znso_4$; 0.2%) whereas the lowest seed vigor index (694.78) was recorded from the seeds of control treatment N_0 (Control, Zn_0, B_0). The result obtained from the present study was similar with the finding of Patil *et al.* (2007a) and Natesh *et al.* (2005).

Combination of macro and micro nutrients

Seeds obtained from combined effect of different macro and micronutrient showed significant variation on seed vigor index (Table 11 and Appendix IX). It was found that the highest seed vigor index (1013.6) was recorded from seeds which were produced from the treatment combination of F_3N_2 which was statistically similar with the treatment combination of F_2N_2. The lowest seed vigor index (425.8) was found from the seeds achieved from the treatment combination, F_0N_0 followed by the treatment combination of F_0N_1 and F_0N_2.

Table 11. Effect of different combination of macro and micro nutrients on seed quality test of brinjal

Treatments	Seed quality test			
	Percent (%) seed germination	Root length (cm)	Shoot length (cm)	Seed vigor index
F_0N_0	88.000	1.6533	3.8067 g	425.8 g
F_0N_1	88.000	2.1200	4.2767 f	562.0 f
F_0N_2	91.333	2.3433	4.1767 f	596.7 f
F_1N_0	91.333	2.3333	5.1300 e	682.0 e
F_1N_1	95.333	2.6700	6.0400 d	830.4 d
F_1N_2	94.667	3.0333	6.0400 d	859.3 d
F_2N_0	93.333	2.5833	6.1867 d	818.5 d
F_2N_1	97.333	2.6600	6.8233 bc	922.9 c
F_2N_2	96.667	2.9233	7.1600 a	974.7 ab
F_3N_0	93.333	2.6233	6.5167 c	852.9 d
F_3N_1	96.667	2.9533	7.0200 ab	964.0 bc
F_3N_2	98.000	3.1233	7.2200 a	1013.6 a
$LSD_{(0.05)}$	NS	NS	0.316	45.3
CV %	11.93	11.25	10.34	10.63

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differs significantly by LSD at 0.05 levels of probability

Note: F_0 = Control, $F_1 = N_{150}\ P_{30}\ K_{100}$ kg ha^{-1}, $F_2 = N_{170}\ P_{50}\ K_{125}$ kg ha^{-1}, $F_3 = N_{190}\ P_{70}\ K_{150}$ kg ha^{-1}

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)

CHAPTER V

SUMMARY AND CONCLUSION

In order to produce brinjal with macro and micro nutrient application for Bangladeshi farmers, a research was conducted to investigate the influence of crop nutrition on seed yield and quality of brinjal at, Sher-e-Bangla Agricultural University farm, Dhaka during the period October 2017 to March 2018. Two factor experiment included 4 macro nutrients treatments *viz*. F_0 = Control, F_1 = N_{150} P_{30} K_{100} kg ha^{-1}, F_2 = N_{170} P_{50} K_{125} kg ha^{-1}, F_3 = N_{190} P_{70} K_{150} kg ha^{-1} and 3 micro nutrients treatments *viz*. N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%) were outlined in Randomized Complete Block Design (RCBD) with three replications.

Results showed that macro nutrient treatments showed significant variation among the treatments for all the studied parameters except 1000 seed weight. Results showed that the highest plant height (56.98, 66.04 and 78.74 cm at 30, 60 DAT and at harvest, respectively) was obtained from F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment whereas the lowest (33.52, 45.09 and 52.41 cm at 30, 60 DAT and at harvest, respectively) was obtained from Control treatment of F_0 (N_0 P_0 K_0 kg ha^{-1}). Again, the highest number of leaves $plant^{-1}$ (37.01) and number of branches $plant^{-1}$ at harvest (10.69) were obtained from the macro nutrient treatment of F_2 (N_{170} P_{50} K_{125} kg ha^{-1}). Similarly, the highest days to 1^{st} flowering (74.12) and days to 50% flowering (84.95) was obtained from F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment. But the highest number of fruits $plant^{-1}$ (14.45), single fruit weight (58.48 g), fruit yield $plant^{-1}$ (852.00 g), fruit yield $plot^{-1}$ (10.22 kg) and fruit yield ha^{-1} (31.56 t) were obtained from the treatment of F_2 (N_{170} P_{50} K_{125} kg ha^{-1}). The highest number of seeds $fruit^{-1}$ (701.70), seed weight $fruit^{-1}$ (3.11g), seed weight $plant^{-1}$ (45.18 g), 1000 seed weight (4.44 g), seed weight $plot^{-1}$ (542.2g) and highest seed weight ha^{-1} (1673.00 kg) were also obtained from the treatment of F_2 (N_{170} P_{50} K_{125} kg ha^{-1}). The lowest number of leaves $plant^{-1}$ at harvest (28.67) and number of branches $plant^{-1}$ at harvest

(7.75) were obtained from control treatment of F_0 (N_0 P_0 K_0 kg ha^{-1}). The lowest days to 1st flowering (62.74) was obtained from control treatment of F_0 (N_0 P_0 K_0) but the lowest days to 50% flowering (75.12) was obtained from F_1 (N_{150} P_{30} K_{100} kg ha^{-1}) treatment. Again, the lowest number of fruits $plant^{-1}$ (6.24), single fruit weight (48.65 g), fruit yield $plant^{-1}$ (303.60 g), fruit yield $plot^{-1}$ (3.64 kg) and fruit yield ha^{-1} (11.24 t) were obtained from control treatment of F_0 (N_0 P_0 K_0 kg ha^{-1}). In accordance with the lowest number of seeds $fruit^{-1}$ (683.10), seed weight $fruit^{-1}$ (2.96 g), seed weight $plant^{-1}$ (18.46 g), 1000 seed weight (4.33 g), seed weight $plot^{-1}$ (221.6g) and seed weight ha^{-1} (683.90 kg) was obtained from the control treatment of F_0 (N_0 P_0 K_0 kg ha^{-1}).

Regarding, micronutrient application, all the studied parameters were significantly influenced by different treatments except 100 seed weight. Results indicated that the highest plant height (46.98, 56.59 and 67.18 cm at 30, 60 DAT and at harvest, respectively) was achieved from the treatment of N_2 (Borax; 0.2%) where the lowest (41.81, 53.76 and 65.38 cm at 30, 60 DAT and at harvest, respectively) was achieved from control treatment N_0 (Zn_0, B_0). Results also revealed that the highest number of leaves $plant^{-1}$ (35.31) and number of branches $plant^{-1}$ at harvest (9.71), highest days to 1st flowering (69.76) and days to 50% flowering (80.08) were found from the treatment N_1 ($Znso_4$; 0.2%). But the highest number of fruits $plant^{-1}$ (13.19), single fruit weight (57.30 g), fruit yield $plant^{-1}$ (817.70 g), fruit yield $plot^{-1}$ (9.81 kg) and fruit yield ha^{-1} (13.91 t) were attained from the treatment N_2 (Borax; 0.2%). The highest number of seeds $fruit^{-1}$ (699.90), seed weight $fruit^{-1}$ (3.10 g), seed weight $plant^{-1}$ (43.42 g), 1000 seed weight (4.43 g), seed weight $plot^{-1}$ (521.00 g) and seed weight ha^{-1} (1608.00 kg) were also achieved from the treatment of N_2 (Borax; 0.2%). The lowest number of leaves $plant^{-1}$ (33.16) and number of branches $plant^{-1}$ at harvest (9.01) were achieved from the control treatment N_0 (Zn_0, B_0) but the lowest days to 1st flowering (68.19) and days to 50% flowering (76.65) were found from the treatment of N_2 (Borax; 0.2%). Again, the lowest number of fruits $plant^{-1}$ (9.17) single fruit weight (53.77 g), fruit yield plant^{-1} (499.40 g), fruit yield plot^{-1} (5.99 kg) and fruit yield ha^{-1} (9.17 t) were observed from the control treatment N_0 (Zn_0, B_0). The lowest number of seeds fruit^{-1} (689.10), seed weight fruit^{-1} (3.02 g), seed weight plant^{-1} (27.75 g), 1000 seed weight (4.38 g), seed weight plot^{-1} (333.00 g) and seed weight ha^{-1} (1028.00 kg) were also achieved from the treatment of N_0 (Control, Zn_0, B_0).

In terms of combined effect of macro and micro nutrients, different treatment combinations showed significant variation for all the studied parameters. Results showed that the highest plant height (58.48, 65.53 and 81.62 cm at 30, 60 DAT and at harvest, respectively) was found from the treatment combination of F_3N_2 where the lowest plant height (30.93, 43.00 and 51.72 cm at 30, 60 DAT and at harvest, respectively) was found from the treatment combination of F_0N_0. Again, the highest number of leaves plant^{-1} (37.94) and number of branches plant^{-1} at harvest (11.39) were found from the treatment combination of F_2N_1 but the highest days to 1st flowering (73.92) and days to 50% flowering (87.90) were found from the treatment combination of F_3N_1. Similarly, the highest number of fruits plant^{-1} (19.09), highest single fruit weight (60.58 g), highest fruit yield plant^{-1} (1157.00 g), highest fruit yield plot^{-1} (13.88 kg) and highest fruit yield ha^{-1} (42.84 t) were found from the treatment combination of F_2N_2. This treatment combination (F_2N_2) also showed highest number of seeds fruit^{-1} (711.40), seed weight fruit^{-1} (3.18 g), seed weight plant^{-1} (60.72 g), 1000 seed weight (4.47 g), seed weight plot^{-1} (728.60g) and seed weight ha^{-1} (2249.00 kg). The lowest number of leaves plant^{-1} (27.36) and number of branches plant^{-1} at harvest (7.21) were found from the macro and micro nutrient treatment combination of F_0N_0 but he lowest days to 1st flowering (62.06) was found from the treatment combination of F_0N_2 where lowest days to 50% flowering (72.23) was found from the treatment combination of F_1N_2. The lowest number of fruits plant^{-1} (5.99), single fruit weight (48.25 g), fruit yield plant^{-1} (288.90 g), fruit yield plot^{-1} (3.47 kg) and fruit yield ha^{-1} (10.70 t) were found from the macro and micro nutrient treatment combination of F_0N_0. This treatment combination (F_0N_0) also gave lowest number of seeds fruit^{-1} (677.50), seed weight fruit^{-1} (2.920g), seed weight plant^{-1} (17.48 g), 1000 seed weight (4.31g), seed weight plot^{-1} (209.80 g) and seed weight ha^{-1} (647.50 kg).

Regarding viability test of seed obtained from the present experiment was considerably affected by different macro and micro nutrient treatments. Results revealed that the seeds obtained from macro nutrients (N, P, K), micro nutrients (Zn, B) and their combination had no significant effect on percent (%) seed germination and root length but significantly influenced the shoot length effect seed vigor index. In terms of macro nutrients (N, P, K) effect, the highest percent (%) seed germination (96.00%), root length (2.90 cm), highest shoot length (6.92 cm) and seed vigor index (943.49) were achieved from F_3 (N_{190} P_{70} K_{150} kg ha^{-1}) treatment produced seeds whereas the lowest percent (%) seed germination (90.78%), root length (2.04 cm), shoot length (4.09 cm) and seed vigor index (528.18) were found the seeds obtained from F_0 (Control, N_0 P_0 K_0 kg ha^{-1}) treatment. Considering micro nutrients (Zn, B) effect, the highest percent (%) seed germination (95.17%), However, results indicated that the highest root length (2.86 cm), highest shoot length (6.15 cm) and highest seed vigor index (861.08) were recorded from the N_2 (Borax; 0.2%) treated seeds where the lowest percent (%) seed germination (90.00%), root length (2.30 cm), shoot length (5.41 cm) and seed vigor index (694.78) was recorded from the seeds of control treatment N_0 (Control, Zn_0, B_0). Regarding the effect of different macro and micronutrient combination the highest percent (%) seed germination (98.00%), root length (3.12 cm), shoot length (7.22 cm) and seed vigor index (1013.6) were recorded from seeds which were produced from the treatment combination of F_3N_2 where the lowest percent (%) seed germination (88.00%), root length (1.65 cm), shoot length (3.81 cm) and seed vigor index (425.8) were found from the seeds achieved from the treatment combination, F_0N_0

Based on the experimental results, it may be concluded that-

1. The effect of macro nutrient (N, P, K) application had positive effect on growth characters, yield and yield attributes of brinjal.
2. Two micro nutrients (Zn, B) had also positive effect on growth characters, yield and yield attributes of brinjal.
3. Application of macro nutrient F_2 (N_{170} P_{50} K_{125}) combination with micro nutrient N_2 (Borax; 0.2%) i.e. F_2N_2 combination seemed to be more suitable for getting higher fruit yield in brinjal.
4. Considering seed yield, the treatment combination F_2N_2 also showed best performance regarding seed yield ha^{-1}.
5. But the consideration of seed viability, the highest seed vigor index was achieved from F_3N_2 (N_{190} P_{70} K_{150}× Borax; 0.2%) treated seeds

Recommendation

Considering the above observations of the present study could be made the following recommendations.

1. Further study may be needed for ensuring the different levels of macro and micro nutrients in relation to growth, fruit yield and seed yield and quality performance of brinjal in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.
2. More another doses of macro and micro nutrients may be needed to include for future study as sole or different combination.

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

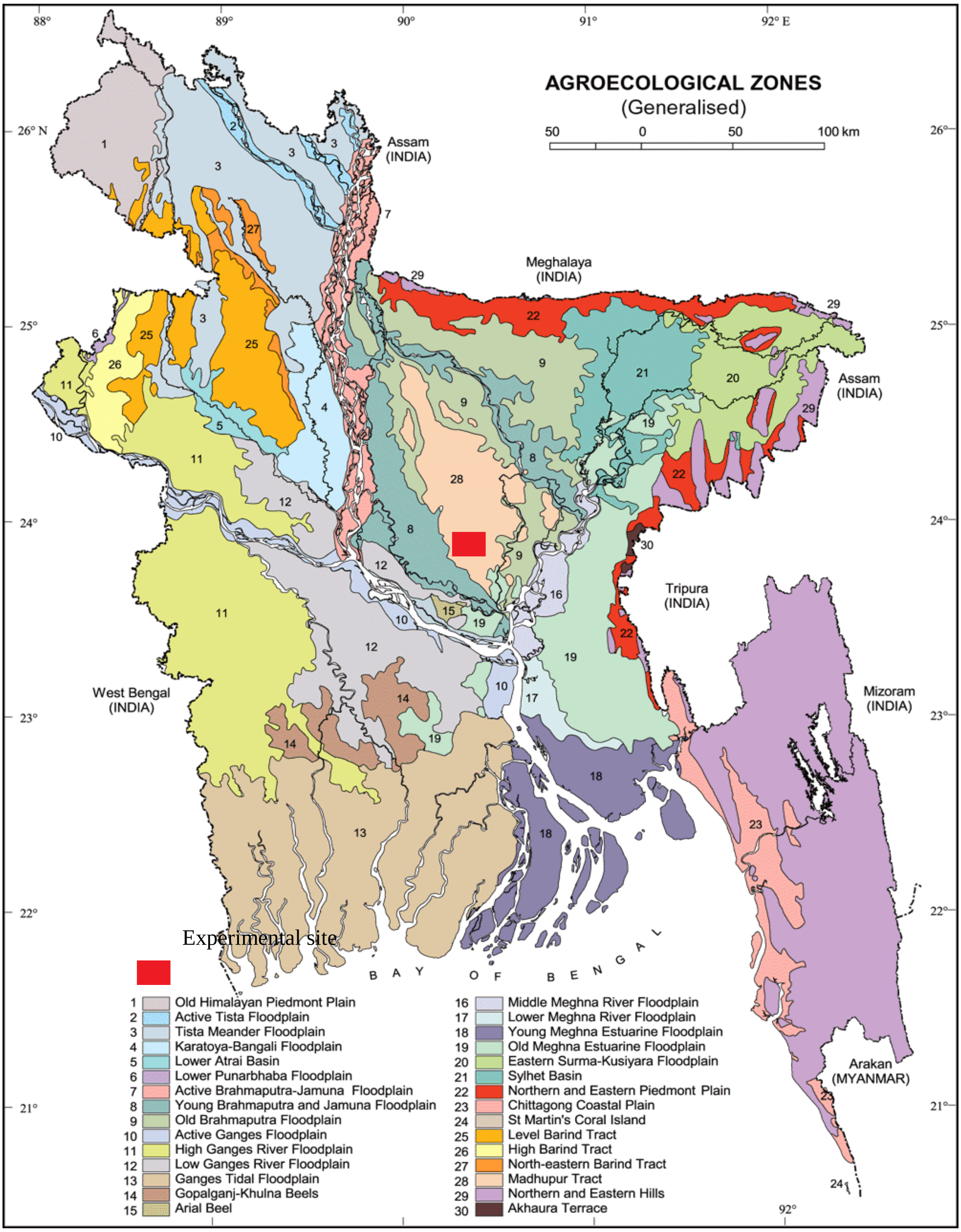

Fig. 12. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from October 2017 to March 2018.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2017	October	30.42	16.24	23.33	68.48	52.60
2017	November	28.60	8.52	18.56	56.75	14.40
2017	December	25.50	6.70	16.10	54.80	0.0
2018	January	23.80	11.70	17.75	46.20	0.0
2018	February	22.75	14.26	18.51	37.90	0.0
2018	March	35.20	21.00	28.10	52.44	20.4

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur 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	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Plant height of brinjal as influenced by different combination of macro and micro nutrients

Sources of variation	Degrees of freedom	Plant height		
		30 DAT	60 DAT	At harvest
Replication	2	1.103	3.084	44.559
Factor A	3	7.430*	25.671*	34.290*
Factor B	2	6.23*	11.907*	22.525*
AB	6	2.104**	6.889*	11.846 *
Error	22	1.122	3.614	3.447

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix V. Number of leaves plant^{-1} and number of branches plant^{-1} at the time of harvest of brinjal as influenced by different combination of macro and micro nutrients

Sources of variation	Degrees of freedom	Number of leaves plant^{-1} at harvest	Number of branches plant^{-1} at harvest
Replication	2	2.621	0.201
Factor A	3	23.534*	1.280*
Factor B	2	18.867*	0.214*
AB	6	8.179*	0.177**
Error	22	2.307	0.106

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Days to 1st flowering and 50% flowering of brinjal as influenced by different combination of macro and micro nutrients

Sources of variation	Degrees of freedom	Days to flowering	
		1st flowering	50% flowering
Replication	2	2.311	3.226
Factor A	3	13.802*	16.239*
Factor B	2	6.314*	8.274*
AB	6	2.457**	4.715*
Error	22	0.714	1.055

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Fruit yield parameters of brinjal as influenced by different combination of macro and micro nutrients

Sources of variation	Degrees of freedom	Fruit yield and yield contributing parameters				
		Number of fruits plant^{-1}	Single fruit weight (g)	Fruit yield plant^{-1} (g)	Fruit yield plot^{-1} (kg)	Fruit yield ha^{-1} (t)
Replication	2	1.146	1.05	7.194	1.509	3.033
Factor A	3	14.318*	22.91*	631.44*	13.29*	210.27*
Factor B	2	9.274*	52.36*	436.13*	7.536*	18.64*
AB	6	6.052**	14.47*	144.61*	5.116*	9.75*
Error	22	1.203	2.22	8.361	1.436	2.371

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Effect of different combination of macro and micro nutrients on seed yield parameters of brinjal

Sources of variation	Degrees of freedom	Seed yield parameters of brinjal					
		Number of seeds fruit^{-1}	Seed weight fruit^{-1} (g)	Seed weight plant^{-1} (g)	1000 seed weight (g)	Seed weight plot^{-1} (g)	Seed weight ha^{-1} (kg)
Replication	2	24.724	0.004	0.708	0.056	13.162	31.764
Factor A	3	153.38*	2.317*	6.648*	NS	114.54**	246.75*
Factor B	2	107.52*	0.414*	2.638*	NS	387.12*	148.34*
AB	6	48.844 *	1.716*	0.792**	0.252*	104.077*	57.36*
Error	22	9.485	01.106	1.371	0.133	4.319	12.67

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix IX. Effect of different combination of macro and micro nutrients on seed viability test of brinjal

Sources of variation	Degrees of freedom	Seed viability test			
		Percent (%) seed germination	Root length (cm)	Shoot length (cm)	Seed vigor index
Replication	2	0.52	00.47	0.518	17.192
Factor A	3	NS	NS	1.908*	631.45*
Factor B	2	NS	NS	3.249**	457.19*
AB	6	3.227**	4.662*	1.070**	48.024*
Error	22	1.068	0.304	0.176	10.836

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix X. Plant height of brinjal as influenced by different macro nutrients (N, P, K)

Treatments	Plant height		
	30 DAT	60 DAT	At harvest
F_0	33.52 d	45.09 d	52.41 d
F_1	39.29 c	50.45 c	64.26 c
F_2	46.81 b	57.29 b	70.51 b
F_3	56.98 a	66.04 a	78.74 a
LSD $_{(0.05)}$	1.687	1.423	1.491
CV %	7.68	8.82	11.70

F_0 = Control, F_1 = N_{150} P_{30} K_{100}, F_2 = N_{170} P_{50} K_{125}, F_3 = N_{190} P_{70} K_{150}

Appendix XI. Plant height of brinjal as influenced by different micro nutrients (Zn, B)

Treatments	Plant height		
	30 DAT	60 DAT	At harvest
N_0	41.81 c	53.76 b	65.38 b
N_1	43.67 b	53.80 b	66.87 a
N_2	46.98 a	56.59 a	67.18 a
LSD $_{(0.05)}$	1.461	1.233	1.291
CV %	7.68	8.82	11.70

N_0 = Control, N_1 = $Znso_4$ (0.2%), N_2 = Borax (0.2%)