VARIABILITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN BRINJAL (*Solanum melongena* L.)

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VARIABILITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN BRINJAL (*Solanum melongena* L.)

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*This is to certify that thesis entitled “**Variability, Correlation and Path Coefficient Analysis in Brinjal**” submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN Genetics and Plant Breeding,** embodies the result of a piece of bonafide research work carried out by **Sithi Saha, Registration no. 08-02804** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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ABSTRACT

A pot experiment was conducted during October, 2013 to March, 2014 to study the genetic variability, correlation and path coefficient analysis for 10 quantitative traits with 12 genotypes of Brinjal in Completely Randomized Design (CRD) design with three replications. All the genotypes varied significantly with each other for all the studied characters indicated the presence of inherent genetic variations among the genotypes. The phenotypic coefficient of variation (PCV) was slightly higher than the respective genotypic coefficient of variation (GCV) for all the characters under study indicating that the characters were less influenced by the environment. Moderate PCV and GCV were estimated in secondary branches per plant, fruits per plant, fruit length and fruit diameter. High heritability coupled with high genetic advance presents in plant height, days to maturity, fruit per plant, average fruit weight, fruit diameter and fruit length that were normally more helpful in predicting the genetic gain under selection. High heritability along with low genetic advance presents in plant height (91.99%), days to maturity (93.93%), fruits per plant (83.17%) and fruit diameter (95.37%). High heritability suggested the major role of genetic constitution in the expression of characters, and such traits were considered to be dependable from breeding point of view. Genotypic correlation coefficients were of higher in magnitude than the corresponding phenotypic correlation coefficients, which might be due to masking or modifying effect of environment. Very close values of genotypic and phenotypic correlations were also observed between some character combinations, such as days to maturity with fruits per plant, plant height with fruit length, days to maturity with fruit length etc., which might be due to reduction in error (environmental) variance to minor proportions. Secondary branches per plant (0.333) showed significant positive correlation with fruit yield per plant at genotypic level. Highly significant and negative correlation found in days to maturity comparing with fruit yield per plant both the genotypic (-0.648) and phenotypic (-0.608) level. Path analysis revealed that primary branches per plant, secondary branches per plant, fruit length and average fruit weight showed positive direct effects on yield per plant at genotypic level. On the other hand, secondary branches per plant, fruit length and average fruit weight showed positive direct effects on yield per plant at phenotypic level. Considering the present study, secondary branches per plant, fruit length and average fruit weight could be consider important yield contributing characters for future hybridization program.

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SOME COMMONLY USED ABBREVIATIONS

ABBREVIATION	FULL WORD
%	Percent
℃	Degree Celsious
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Agron.	Agronomy
BARI	Bangladesh Agricultural research Institute
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
BSMRAU	Bangabandhu Sheikh Mujibur Rahaman Agricultural University
Cm	Centi-meter
DAS	Days after Sowing
Df	Degrees of Freedom
etc.	Etcetera
et al.	And others
FAO	Food and Agricultural Organization
Fig.	Figure
(g)	Gram
h2b	Heritability in broad sense
j.	Journal
Kg	Kilo grams
M	Meters
MoP	Muriate of potash
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SE	Standard error
TSP	Triple super phosphate
Var.	Variety

CHAPTER I

INTRODUCTION

Brinjal (*Solanum melongena* L.) is an admired vegetable crop that grown all over the world though there is a heavy concentration in Asia. It also called eggplant. Brinjals are genetically well studied crop. It belongs to the family Solanaceae and is a diploid species (2n = 24). Owing to its diversified nature and wide use it is often described as the 'king of vegetables' with an annual worldwide production of more than 41.84 million t. (FAO, 2010).

Thus they are highly beneficial for regulation of blood sugar levels and also helps to control the absorption of glucose. It also recommended for the remedy of liver problems (Shukla and Naik, 1993). Per 100g of edible portion of Brinjal contains water (93 g), protein (1.2 g), Vit. -a (70 IU), Thiamin (0.05 mg), Fat (0.1 g), Riboflavin (0.08 g), Carbohydrate (4.0g), Niacin (0.09mg), fibre (1.2g), Calories-(20) (Bose and Some, 1986). It is also a rich source of Calcium (6mg/100g) and Iron (0.9mg/100g) (Zenia and Halim, 2008).

It has been originated in South East Asia since prehistory (Lester and Hasan, 1991). The leading brinjal growing countries of the world are the China, India, Egypt, Iran, Turkey, Indonesia, Iraq etc. (FAO, 2010). It is also a well known vegetable crop in France, Italy, USA and Mediterranian areas (Bose and Som, 1986). In Bangladesh brinjal is mostly cultivated in the Bogra, Chittagong, Comilla, Dhaka, Dinajpur, Faridpur, Jamalpur (BBS, 2011). Asia has the largest eggplant production, which comprises more than 90% of the world production area and 87% of the world production (Chowdhary and Gaur, 2009).

It is grown in tropics and sub tropics (Sihachakr *et al.*, 1994). It is cultivated round the year both as Rabi and Kharif crops (Rashid, 1993). The demand for its use is increasing irrespective of season. It is the 2nd most valuable vegetable crop next to potato in Bangladesh in respect to acreas and production (BBS, 2011). The statistical information revealed that Bangladesh produced 3.40 lac metric tons of Brinjal on an area of 46.57 thousand ha of land (BBS, 2011). It is cultivated on about 15% of total vegetable cultivated land and contributes about 8% of total vegetable production (BBS, 2011) in Bangladesh. About 8 million farm facilities are involved in Brinjal cultivation (Islam, 2005)

In spite of obvious importance in our daily life, little attention has made in the past for the better yield improvement of the crop. Use of traditional varieties, less variability, affected by disease and pest is the important constraint for low yield potentiality. Collection of germplasm and its genetical analysis can help to get the suitable genotype for higher yield or any other desirable character.

However, heritability is the heritable portion. It is an important index of the transmission of characters from parents to offspring (Falconer, 1981). Knowledge on genetic information obtained through the analysis of genetic variability and relatedness between or within different species of population and individuals is a pre-requisite towards effective utilization and conservation of plant genetic resources (Chaudhuri *et al*. 1976, Weising *et al*. 1995). Better knowledge on genetic variabilityty or genetic similarity could help to sustain long term selection gain (Chowdhary *et al.,* 2002). The domestication and evolution of Brinjal has been the subject of a number of studies in which historical, morphological data have been used.

According to Sharma and Jana (2002), assessment of genetic variation is a prerequisite for initiating efficient breeding programme, as it provides a basis for tailoring desirable genotypes. Correlation coefficient analysis measure the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield.. In developing suitable variety for yield and stability, assessment of variability present in the crop helps for successful utilization of characters as stated by Singh *et al.* (1985).

The aim of the present study was to assess the genetic variability, association between yield and yield contributing characters with their direct and indirect effects on fruit yield of Brinjal. Hence variability analysis in respect of yield contributing characters is essential to design proper breeding strategy. Therefore, the present investigation was carried out with the following objectives:

Objective:

- To study the variability and character association in the existing germplasm;
- To categorize the Brinjal genotypes on the basis of morphological details ;
- To know the yield potentiality of genotype and
- To select suitable parents for future hybridization programme.

CHAPTER II

REVIEW OF LITERATURE

Appropriate genetical knowledge of different traits are prerequisites for improving vegetable breeding programs for getting desired yield. Although success of vegetable breeding depends on heritable variation found in the traits. In spite of having huge popularity of eggplants now more attention has been given for genetical analysis on Brinjal. Different scientists carried out different researches for yield improvement of Brinjal as yield is the main object for a grower.

Yield is a quantitative character controlled by many genes. Selections on multiple traits for yield are always better than the alone selection for yield as yield is prime importance of a crop production. The magnitude and degree of significance of yield attributing characters have immense importance for breeders. Eggplants have great impact in terms of breeding and genetic research. According to objectives of present research work, review of literature related to this research work has been discussed bellow.

2.1 Variabilty:

Nayak *et al.* (2014) conducted an experiment comprised of 20 genotypes. This experiment was done on variability. The study recorded highly significant differences among the varieties for all characters. Correlation and path analysis indicated the fruit length, diameter; weight influenced the yield of fruits associated with high direct effect and significant positive correlation.

Balaji *et al.* (2013) evaluated fourteen quantitative characters among 60 germplasms. High variability indicating high GCV and PCV values in plant height, plant spread, no. of branches per plant, no. of fruits per cluster, average fruit diameter, average fruit weight, shoot and fruit borer incidence on shoot and fruit yield per plant. Values of PCV higher than values of GCV showing influence of environment but differences between GCV and PCV values were minimum showing the traits were less influenced by the environment. The traits can be improved by phenotypic selection. High genetic advance accompanied with high heritability found in plant height, plant spread, average fruit weight and shoot and fruit borer incidence on shoot indicating that for fixing and improving such traits, simple selection can be effective.

Chaudhary *et al.* (2013) studied genetic variability in terms of yield per plants and its attributing traits in 16 Brinjal germplasm. Values of higher GCV was observed by fruit weight, number of leaves per plant, number of fruits per plant. Values of higher PCV were observed by plant height, fruit length, fruit diameter.

Experimental works was done by Kumar *et al.* (2013) where in local types to identify suitable varieties with high yield for cultivation and quality traits under Madurai (Southern Indian) condition. This research work revealed that highly significant differences were observed among most of the characters. Mean observation value of EP 27 (1.93 kg) was the highest fruit yield per plant. Earliness was one of the vital trait under rainfed condition ranged from 75.00 (Kerikai local) to 85.00 (EP 28). The traits could be utilized for further improvement of fruit yield in breeding programs.

Shekar *et al.* (2012) studied 31 accessions of Brinjal to assess heritability and genetic divergence for 14 characters. High genotypic and phenotypic coefficient of variation was observed in leaves per plant, leaf index, average fruit length, average fruit diameter, fruit per plant, fruit yield per plot. Almost all the characters showed high heritability except plant height.

Karak *et al.* (2012) investigated the experiment using 70 Brinjal germplasms. In this study both GCV and PCV corresponded closely for the growth characters. Among most of the characters this was reflected by very high broad sense heritability. For fruit yield and other fruit characters heritability was high except fruit wt. Significant positive correlation among total phenol content and fruit yield/plant with significant negative correlation among sugar and protein content and fruit yield/plant was observed. Most important fruit yield contributing characters of plant was fruit no. per plant, fruit weight, fruit girth and leaves/plant. These characters contributed important selection parameters due to their additive gene action.

Kumar *et al.* experimented in 2011 to determine variability in segregating generations of brinjal (*Solanum melongena* L.). The crosses between L5xT4 (Palamedu local x EP65) and L4 x T1 (Alagarkovil local x Annamalai) exhibited highest variability for individual fruit weight and fruit yield per plant. These crosses were resulted for best as a base population for further improvement in yield and fruit weight as they had high variability with high genetic advance. Direct selection may be done for the development of early in flowering and high yielding eggplant varieties considering these genotypes for selection.

Muniappan *et al.* (2010) did an experiment on the variability, association, direct and indirect effect of thirty four eggplant (*Solanum melongena* L.) genotypes. High GCV and PCV were recorded by the character viz. no. of branches per plant, fruit length, fruit breath, no. of fruits per plant, average fruit weight and fruit yield per plant.

Lenuta and Nedelea (2010) showed that most important breeding objectives are complex traits consisting of multiple components. In that direction, he existing variability within eggplant breeding programs taking consideration in the increment of the yield.

Reena and Mehta (2009) carried out an experiment to study the genetic variability in 20 genotypes of brinjal. Phenotypic coefficient of variation was greater than genotypic coefficient of variation for all characters. These were high in weight of fruit and no. of fruits per plant.

Kumar *et al*. (2008) stated that Brinjal (*Solanum melongena* L.) is an important solanaceous vegetable in many countries of Asia and Africa. It is a good source of minerals and vitamins in the tropical diets. Assessment of genetic resources is the starting point of any crop improvement programme. In India, the National Bureau of Plant Genetic Resources the nodal institute for management of germplasm resources of crop plants and holds more than 2500 accessions of brinjal in its gene bank. In the present study, morphological diversity in a set of 622 accessions from indigenous sources and 79 accessions of exotic origin was assessed. Wide range of variations for 31 descriptors, 13 quantitative and 18 qualitative traits were recorded. The wide regional variations for plant, flower and fruit descriptors revealed enough scope for improvement of yield characters by selection. The genetic differences among the land races are potentially relevant to breeding programmes in that the variability created through hybridization of the contrasting forms could be exploited.

Naliyadhara *et al. (2007)* conducted an experiment to evaluate 21 genotypes of brinjal during late kharif season. It revealed that PCV was slightly higher than GCV for all characters. High heritability with moderate to high GCV and genetic gain was observed for all characters except fruit yield which could be improved by simple selection method. The GCV were higher than corresponding PCV reflecting predominant role of heritable factors. Fruit yield displayed significant positive GCV and PCV with fruit weight.

Ram *et al.* (2007) carried out an experiment, studied the variability and selection parameters was under taken during kharif 2003-2004 in Uttar Pradesh, India. For all the studied characters phenotypic coefficient of variation was higher than genotypic coefficient of variation. The high GCV and PCV were observed for yield per plant, plant spread and no. of fruits per plant, suggesting the improvement by selection.

Variability and correlation analysis for 13 traits of eggplant were conducted in Tehri Garhwal, Uttarabchal, India by Kushwah and Bandhyopadhya (2005). Highly significant variation among the genotypes was recorded for all traits. High GCV and PCV with high genetic advance were recorded for fruit weight, no. of flowers per cluster and fruit diameter.

Chaudhary and Pathania (1999) studied genetic variability, heritability and genetic advance in 8 genotypes of eggplant. These traits also showed high heritability estimates coupled with moderate to high genetic advance. Sufficient variability was observed for no. of branches per plant, plant height, and yield per plant, days to 50% flowering and days to first picking. PCV was greater than GCV for all traits.

Sharma and Swaroop (2000) conducted and field experiment on genetic variability with 27 genotypes. Considerable variations were observed for all characters. The GCV estimates were high for no. of fruits per plant, mean fruit weight and yield per plant. Heritability estimates were high for fruit length, no. of fruits per plant, mean fruit weight and fruit yield. Most of the characters were positively correlated with yield except for days to 50% flowering. Path coefficient analysis revealed that no. of fruits per plant, mean weight of fruits and fruit diameter had maximum direct effect at GCV. Maximum direct effect at phenotypic level was showed no. of fruits per cluster, plant height, no. of fruits per plant and fruit diameter.

Das *et al.* (2002) conducted an experiment with 11 genotypes of eggplant. The data revealed that traits like average fruit weight, fruits per plant, leaf width, leaves per plant, leaf length and leaf girth showed high heritability values. It suggested that phenotypic selection will be better for improvement of yield of the crops.

2.2 High heritability and genetic advance:

Patel *et al.* (2013) conducted an experiment with 68 accessions of brinjal at IIVR, Vanarasi. High heritability and high genetic advance were found among the characters except days to 50% flowering. All the traits contain highly significant mean squares due to genotypes. In this case it could be inferred that simple selection will be effective for improving this traits as the characters were mostly controlled by additive genes.

Muniappan *et al.* (2010) did an experiment on the variability, association, direct and indirect effect of thirty four eggplant (*Solanum melongena* L.) genotypes. All the characters were accompanied by high heritability and high genetic advance excepting days to 50% flowering. The characters were mostly controlled by additive gene action; hence it would be interfered that simple selection will be effective for these characters. Path analysis indicated that fruits per plant and average fruit weight had high direct effects and were the major factors that determine fruit yield per plant.

Naik *et al.* (2010) conducted experiment using 61 genotypes with randomized block design. High heritability values and high percentage of genetic advance were recorded in fruit length, no. of fruits per plant, yield per plant. This indicated yield could be improved by selection.

An investigation was undertaken by Sherly and Shanthi (2009) with 24 genotypes of brinjal for variability, heritability and genetic advance. The study indicated that high estimate of phenotypic coefficient of variation was observed for fruit length, no. of fruits per plant, fruit weight and fruit yield per plant. High heritability coupled with high genetic advance was registered for all the characters except total no. of harvest and ascorbic acid. The characters can be effectively improved through selection.

Reena and Mehta (2009) carried out an experiment to study the genetic variability in 20 genotypes of brinjal. High heritability accompanied by high genetic advance was observed for weight of fruit indicating negligible environmental effects and this trait will be more amenable to environment though mass selection, progeny selection etc. aiming at exploiting the additive variance.

A study was conducted by Pravu *et al.* (2007) with four interspecific crosses of augbergine in generation: EP 45 x Solanum viarum, CO2 x *Solanum viarum* and MDU 1 x Solanum viarum. Data were recorded on plant height, no. of branches per plant, mean fruit weight, fruit length, fruit girth, no. of fruits per plant, fruit and shoot borer (*Leucinodes orbonalis*) infestation, calyx length and marketable yield per plant. The genotypic coefficient of variation was found to be high for fruit and shoot borer infestation. High heritability with high genetic advance was noted for fruit and shoot borer infestation, branches per plant and marketable yield per plant indicating the predominant role of additive gene action. High heritability with moderate genetic advance was observed for plant height, mean fruit weight, length and girth of fruits, no. of fruits per plant indicating both additive and non additive gene action.

Ram *et al.* (2007) carried out an experiment, studied the variability and selection parameters was under taken during kharif 2003-2004 in Uttar Pradesh, India. High heritability coupled with high genetic advance indicating additive gene action was exhibited by plant height, days to marketable maturity, plant spread, and yield per plant and fruit weight.

Golany *et al.* (2007) studied 23 genotypes of brinjal to determine the genetic variability and genetic diversity for fruit yield and its contributing characters like plant height, plant spread, fruit length, fruit girth and fruit weight. The GCV, heritability and genetic advance as percentage of mean were high for fruit length, fruit girth and fruit weight, indicating gene action.

Prasad *et al*. (2006) conducted an investigation in Raipur, Chattisgarh, India during the kharif season on genetic variability in 52 eggplant genotypes. Moderate to high estimation of GCV, heritability, and genetic advance was recorded for fruit weight, fruit yield, fruit girth, no. of fruits per plant and fruit length. Low estimates were done for no. of days to 50% flowering, fruit set and no. of primary branches.

Prasad *et al.* (2004) conducted an experiment during kharif 2002-2003 with 52 augbergine cultivars. Highly significant differences were observed for all traits except fruit yield. Moderate to high estimates of genotypic coefficient of variation, heritability and genetic advance were observed for average fruit weight, fruit yield, fruit girth, no. of fruits per plant and fruit length. The low estimates were observed in first flowering, fruit set and no. of primary branches per plant.

Panda *et al.* (2005) investigated 13 traits of eggplant during the winter of 2001-02 and autumn- winter of 2002-2003 in 5 round fruited augbergine cultivars and 10 crosses grown in Pantnagar, Uttaranchal, India. Heritability in narrow sense was greatest for no. of days of first flowering, whereas the genetic advance was highest for weight of marketable fruits per plant. The no. of flowers per inflorescence, no. of marketable fruits per plant, fruit diameter and total no. of fruits per plant were characterized by high genetic advance and high heritability. Fruit length and no. of flowers per inflorescence showed complete dominance.

Mohanty (2003) observed that high heritability with high genotypic coefficient of variation was for fruit weight, plant height, number of fruits and number of branches per plant. Since, the approximation of heritability gives suggestion of the amount of progress expected from selection, as they are most meaningful when accompanied by estimate of genetic advance.

Vedivel and Bapu (1990) studied 19 genotypes of eggplant for observation on growth and yield traits. Plant height coupled with high genetic gain from fruit yield/plant and length indicated the predominance of additive gene effects.

Doshi *et al.* (1999) conducted an experiment using 41 genotypes of brinjal. The highest GCV was observed for no. of fruits/plant, fruit weight, fruit yield. High heritability was observed in fruit yield, fruit length, fruit girth.

Patel *et al.* (1999) estimated 41 eggplant genotypes that indicated the highest genetic coefficient of variation for fruit volume. High heritability was observed for most of the traits. Further, traits like fruit weight, fruit volume, plant height had high genetic advance as a percentage of mean.

Chaudhary and Pathania (1999) studied genetic variability, heritability and genetic advance in 8 genotypes of eggplant. These traits also showed high heritability estimates coupled with moderate to high genetic advance. High heritability accompanied with Moderate to high genetic gain and GCV were recorded for average fruit weight, no. of fruits/plant. This could be improved by simple selection methods.

Rajesh *et al.* (1998) studied 40 cultivars of eggplant. Plant spread, days to 1^{st} flowering, flowers/plant, fruits/plant, and yield/plant gave comparatively lower values of heritability indicating environmental influence of this traits.

Mittal *et al*. (1996) expected heritability and genetic advance in 27 genotypes of brinjal. High heritability related with high genetic advance was observed by them representing the character, predominantly under the control of additive gene, could be improved through selection.

Heritability estimates high for plant height, number of fruits per plant and individual fruit weight. But Islam and Khan (1991) considered Brinjal genotypes and showed that heritability values were high for most of the characters for days to first flowering, maturity and plant height

2.3 Correlation:

Shende *et al.* (2014) carried out an experiment with fifteen f2ss and 8 parents of brinjal durin Rabi 2012-13. Association of fruit yield per plant showed positive correlation fruit per plant and plant spread.

Ahmed *et al.* (2013) stated about an experiment containing 35 genotypes of brinjal. This experiment revealed that phenotypic and genotypic association of fruit yield was significantly positive with no. of fruits per plant, fruit weight, fruit width whereas plant height, plant spread, no. of primary branches and fruit length was insignificantly negatively correlated.

Rekha *et al.* (2013) stated that correlation provides information on the nature and extent of relationship among all pair characters. They conducted an experiment containing 27 accessions. This reveled that yield per plant provided positive correlation with percent of long and medium styled flowers, number of primary branches, fruit length, number of secondary branches, plant height, canopy spread and fruits per plant. It exhibited negative correlation with fruit infestation.

Raita *et al*. (2013) showed that there was a strong positive significant correlation between numbers of branches per plant with fruit number per plant. This was because the more the branch number in a plant, such plant will produce more fruits in a plant.

Sing *et al.* (2010) carried out an experiment containing 99genotypes of Brinjal to assess the character association and contribution of quantitative trait towards yield. Yield per hectare was positively correlated with no. of flowers per plant, no. of fruits per plant, fruit length, fruit weight, fruit volume, no. of fruit picking, plant height and plant girth.

According to Ara *et al*. (2009) there was a strong positive significant correlation between numbers of trusses per plant with fruit number per plant. This was because the more the number in a plant, such plant will grown more fruits ensuing in more fruit weight. This is supported by the observed strong positive association between fruit number per plant and fruit weight per plant.

Correlation and path analysis were studied in 50 F4 progenies and six parents of brinjal (*Solanum melongena* L.) by Jadhao *et al.* (2009) for 11 yield contributing characters. The phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the studied characters. Path coefficient analysis showed that plant height, no. of branches per plant, days to first flowering, gays to last picking, fruit length and fruit weight showed positive direct effect on fruit yield per plant indicating these characters direct association with yield.

Aramendiz *et al.* (2009) studied 24 cultivars of eggplant to know the phenotypic, genotypic and environmental correlations between six characters. The no. of fruits and yield showed a highly significant positive correlation. A negative and highly significant negative correlation was detected in between fruit length and fruit strength. It is suggested that the no. of fruits per plant could be used as selection parameters to get higher yielding cultivars.

The research work was conducted by Dharwad *et al.* (2009) containing 36types of brinjal germplasms. The work indicated strong correlation for branches per plant, fruit weight and flowers per inflorescence with fruit yield. It showed weak association for days to flowering and fruits per cluster.

Megha *et al*. (2006) observed correlation in exotic brinjal cultivars to determine the correlation of 26 brinjal cultivars for number of flowers per cluster, flower clusters at first picking, number of fruits per cluster, weight per fruit, yield per plant and total yield. They examined that enhancement in yield could be managed by selection for number of flowers per cluster, flower clusters at first picking, number of fruits per cluster and weight per fruit.

Manivannan *et al*. (2005) carried out correlation coefficient analysis in cherry and observed that fruit yield was significantly and positively correlated with the number of leaves and fruit weight.

Variability and correlation analysis for 13 traits of eggplant were conducted in Tehri Garhwal, Uttarabchal, India by Kushwah and Bandhyopadhya (2005). At the genotypic level, the no. of fruits per plant, fruit diameter and no. of picking showed a significant positive correlation with yield per plant. At the phenotypic level, fruit yield was positively correlated with the no. of pickinkgs, fruit diameter, and no. of fruits per plant. But it negatively correlated with the days to first picking.

Kumar *et al*. (2003) for thirty diverse brinjal genotypes and observed that correlation coefficients at the genotypic level were generally higher than the corresponding phenotypic ones. He also experimented that yield per plant was positively and significantly associated with plant height, fruit number per plant, fruit shape index and pericarp thickness.

Nesgea *et al*. (2002) calculated correlation coefficient analysis in 13brinjal genotypes and revealed that plant height, number of branches per plant, plant spread, fresh plant weight, number of fruiting clusters, number of days to 50% flowering, number of fruits per cluster and number of fruits per plant should be considered for the enrichment of the yield of brinjal. The negative correlation was observed between fruit weight and fruit number, plant height and fruit weight, fruit.

Susic (2002) observed that a significant negative correlation was between mean fruit mass and number of fruits per plant and a significant positive correlation was found between fruit length and fruit width.

Matin and Kuddas (2001) considered phenotypic and genotypic correlations of 13 qualitative and quantitative characters of 26 genotypes of brinjal and found that individual fruit weight had number fruits per plant and individual fruit weight.

Das *et al.* (1998) premeditated correlation co-efficient in fruit characters of brinjal. They observed significant positive correlation of fruit yield per plant with number of fruits per plant. of individual .

Aditya and Phir (1995) deliberated phenotypic and genotypic correlation co-efficient to find out the associations between eight characters of 44 genotypes of brinjal. He showed that yield of fruits per plant showed significant positive correlations with plant height and number of fruits per plant; and insignificant positive correlation with weight fruit (phenotypically) and number of seeds per fruit.

2.4 Path coefficient analysis:

Ahmed *et al.* (2013) carried out an experiment with 35 brinjal genotype. This research revealed direct effect of fruit weight, no. of fruits/plant, plant spread, fruit weight and no, of primary branches whereas plant height had indirect effect on fruit yield.

Patel *et al.* (2013) conducted an experiment with 68 accessions of brinjal at IIVR, Vanarasi.Path analysis showed average fruit wt. and no. of fruits per plant were the major factors to determine fruit yield per plant and had high direct effects. Hence, in this research work, it was evident that no. of branches, average fruit wt, (g) and no. of fruits per plant indicated direct contribution on yield of fruits.

Verma (2013) conducted experiment with 16 genotypes of eggplant. Significant positive genotypic correlation coefficient found in fruit weight, number of leaves per plant, number of fruits per plant. Over all observation of path coefficient analysis showed that direct contribution of fruit yield per plant, fruit yield per hectare, fruit weight, number of fruits per plant and number of flowers per plant was of higher magnitude on fruit yield.

Sing *et al.* (2010) carried out an experiment containing 99genotypes of brinjal to assess the character association and contribution of quantitative trait towards yield. The path analysis revealed that fruit weight and fruit per plant had high direct effect on fruit yield. However, indirect effect of fruit diameter, leaf area and plant spread were appreciable to affect fruit yield in brinjal.

Rani *et al*. (2010) conducted an experiment to study path coefficient for yield components and traits in 23 hybrids of brinjal and exhibited that fruit weight had the highest positive direct effect on yield per plant, while, fruit weight was also having high positive indirect effect on yield per plant.

The research work was conducted by Dharwad *et al.* (2009) containing 36 types of brinjal germplasms. Path analysis revealed high direct contribution of fruits per plant, fruit weight and flowers per inflorescence on fruit yield.

Naliyadhara *et al*. (2007) exhibited an experiment with 21 genotypes of brinjal. Path coefficient analysis showed that fruit length, fruit weight and plant spread exerted positive direct effect on fruit yield suggesting giving emphases on such fruit weight.

Mayavel *et al.* (2005) observed that number of branches per plant had the highest positive direct effect on fruit yield. Whereas, plant height, number of fruits per cluster and number of fruits per plants had negative direct effects on fruit yield.

Bodund (2002) conducted a field experiment on path coefficient analysis and observed that plant height and fruit diameter directly affected yield in brinjal.

Harer *et al*. (2002) did a field experiment to study path analysis of thirty-seven brinjal genotypes and reported that number of fruits per cluster, average fruit weight and number of fruits per plant had direct maximum effects on fruit yield.

In Orissa, India Mohanty (2001) conducted an experiment on 15 eggplant genotypes.PCV was high for no. of fruits per plant and average fruit weight. GCV was high for average fruit weight, no. of fruits per plant and yield. Estimates of heritability in broad sense were high for plant height and no. of fruits per plant.

Chaudhary and Pathania (1999) studied genetic variability, heritability and genetic advance in 8 genotypes of eggplant. Path coefficient studies explained that no. of fruits per/plant and plant height exerted maximum positive direct effect on yield.

Domini and Maya (1997) evaluated 18brinjal varieties for the relationship of six yield components to yield in two different seasons. They showed that fruit number per plant was the most important character having a direct effect on yield either in early sowing

Nainer *et al.* (1990) showed an experiment where observations were conducted on the yield related traits of inter varietal brinjal (*Solanum melongena* L.). For path coefficient analysis yield of fruits per plant was considered as dependent variable and earliness, plant height, spread, branches and fruit per plant, fruit weight, length and girth and yield were considered as independent variable. Among all crosses a positive association was found.

Alam *et al.* (1988) studied path co-efficient in 19 cultivars of tomato and found that maximum direct contribution towards yield was through individual fruit weight followed by number of fruits per plant.

CHAPTER III

MATERIALS AND METHODS

An experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during the period from October 2013 to March 2014 to study the variability, correlation and path coefficient analysis in brinjal (*Solanum melongena* L.). A brief description about the locations of the pot keeping site, characteristics of soil, climate, materials, land preparation, manuring and fertilizing, transplanting of seedlings, intercultural operations, harvesting, data recording procedure and statistical analysis etc., which are presented as follows:

3.1. Pot keeing site

The research work was conducted in the Sher-e-Bangla Agricultural University Farm, Dhaka-1207 during October, 2013 to March, 2014.

3.2 Geographical location

The experimental area was situated at 23°77' N latitude and 90°33' E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004). The experimental field belongs to the Agro-ecological zone of "The Madhupur Tract", AEZ-28 (Anon., 1988a). This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988b). The experimental site was shown in the map of AEZ of Bangladesh in (Appendix I).

3.3 Climate

Area contains subtropical climate, characterized by sufficient rainfall set aparted by plenty of sunshine result in moderately low temperature during the Rabi season (October-March). Weather information regarding temperature, relative humidity, rainfall and sunshine hours prevailed at the experimental site during the study period is presented in Appendix II

.3.4 Characteristics of soil

Soil of the experimental site belongs to under Tejgaon Series which consists of general soil type, Shallow Red Brown Terrace Soils. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 6.0-6.6 and had organic matter 0.84%. Experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resource and Development Institute (SRDI), Dhaka. Physicochemical properties of the soil are presented in (Appendix III).

3.5 Planting materials

Twelve (12) genotypes of Brinjal were used for the present research work. The genetically pure and physically healthy seeds of these genotypes were collected from Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI), Gazipur. The name and origin of these genotypes are presented in Table 1.

3.6 Design and layout of the experiment

The study was laid out in Completely Randomized Design (CRD) with two (2) replications as the experiment was conducted in pots. The genotypes were randomly distributed to each row within each line.

3.7 Seedbed preparation and raising seedling

The seeds were sown on 11 October 2013 in the seedbed after treated with Bavistin for 5 minutes. Seedlings of all genotypes were raised in seedbeds in the Sher-e-Bangla Agricultural University, Dhaka-1207 farm unit. Recommended cultural practices were taken up before and after sowing the seeds. 25 days old seedlings were transplanted in the pots.

Plate 1. Seven days old seedling raised in seedbed

3.8 Pot preparation

The experimental pot (10 L) was prepared by loamy soil free from any weeds.

Table 1 Name of twelve brinjal genotypes used in the present study

Sl. No.	Genotypes No.	Name/Acc No. (BD)
1	G_1	SM-259
2	G_2	SM-14
3	G_3	SM-257
4	G_4	SM-261
5	G_5	SM-255
6	G_6	SM-225
7	G_7	BARI Begun 6
8	G_8	SM-254
9	G_9	SM-260
10	G_{10}	SM-267
11	G_{11}	Singnath
12	G_{12}	Islampuri

SM= *Solanum melongena*

3.9 Manure and fertilizers application

The total amount of urea was divided by two splits. One third of the Urea along with total amount of TSP and one third of MoP was applied at the time of pot preparation. The rest of the urea and MoP was applied by three installments. The first, second and third installments was apply respectively after 21, 35 and 50 days of seedling transplanting. Doses of manure and fertilizers used in the study are showing in Table 2.

3.10 Transplanting of seedlings

As mentioned before the seedlings were raised in seedbed and 25 days old seedlings were trabsplanted in the pots on 05 October, 2013. Just after pot transplanting seedlings were watered regularly to make a firm relation with roots and soil to stand along.

3.11 Intercultural operations

Intercultural operations were done when needed.

Table 2 Doses of manures and fertilizers used in the study

Sl. No.	Name of fertilizers	Fertilizer doses
01.	Cowdung	2 kg/pot
02.	Urea	250 g/pot
03.	TSP	75 g/pot
04.	MoP	100 g/pot

3.12 Pesticide application

During the cropping period, since there was no significant insect infestation in the field, hence no control measure was undertaken. In order to prevent disease infestation,‘ Ripcord 10EC’ was used for 5 times at an interval of 7 days from 06 December to 11 Janruary 2014. There were different types of weeds which were controlled effectively by hand weeding. Neem powder mixed with water @5.0% w/w & ashes were used to prevent bacterial and fungal diseases, which was really a helpful measure to protect the plants.

3.13 Harvesting:

Harvesting continued for about one month because fruits of different lines matured progressively at different dates and over long time. Fruits were picked on the basis of horticultural maturity, size, color and age being determined for the purpose of consumption as the fruit grew rapidly and soon get beyond the marketable stage. Picking was done throughout the harvesting period. Harvesting was started from 09 March and completed by 7 Ap. The fruits per entry were allowed to ripe and then seeds were collected for future use.

Plate 2. Growing seedling in the pot

3.14 Data recording

Ten plants in each entry were selected randomly and were tagged. The tagged plants were used for recording observations for the following characters.

3.14.1 Days to first flowering

The number of days was counted from the date of sowing to days to first flowering.

3.14.2 Days to fruit maturity

The number of days was counted from the date of sowing to first harvesting.

3.14.3 Plant height (cm)

The plant height was measured from ground level to tip of the plant expressed in centimeters and mean was computed.

3.14.4 Number of primary branches per plant

The number of branches arising from the main stem above the ground was recorded at 60 days after transplanting.

3.14.5 Number of secondary branches per plant

The number of branches arising from the primary branches was recorded at 60 days after transplanting.

3.14.6 Number of fruits per plant

The total number of marketable fruits harvested from the five plants. Total no. of fruits were counted and the average number of fruits per plant was calculated.

3.14.7 Average fruit weight (g)

The total number of marketable fruits was weighed and the fruit weight was worked out and expressed in grams (g).

3.14.8 Fruit length (mm)

It was measured from stalk end to blossom end by using vernier calipers.

3.14.9 Fruit diameter (mm)

It was measured from fruit breadth at highest bulged portion of the fruit by using vernier calipers.

3.14.10 Fruit yield per plant (g)

The weight of fruits from each picking was recorded from the five labeled plants of each experimental pot. Total yield per plant was worked out by adding yield of all harvests and was expressed in gram (g) per plant.

Plate 3. SM 259

Plate 4. SM 14

Plate 5. SM 257

Plate 6. SM 261

Plate 7. SM 255 **Plate 8. SM 225**

Plate 9. BARI begun 6 **Plate 10. SM 254**

Plate 11. SM 260

Plate 12. SM 267

Plate 13. Singhnath

Plate 14. Islampuri

3.15 Statistical analysis:

Univariate analysis of the individual character was done for all characters under study using the mean values (Singh and Chaudhury, 1985) and was estimated using MSTAT-C computer programme. Mean, range and co-efficient of variation (CV%) were also estimated using MSTAT-C.

3.15.1 Estimation of genotypic and phenotypic variances

Genotypic and phenotypic variances were estimated according to the formula given by Johnson *et al.* (1955).

Genotypic variance (σ^2_g) $= \dfrac{GMS - EMS}{r}$

Where,

GMS = Genotypic mean sum of squares

EMS = Error mean sum of square

r = number of replications

Phenotypic variance (σ^2_{ph}) $= \sigma^2_g + EMS$

Where,
σ^2_g = Genotypic variance

EMS = Error mean sum of square

3.15.2 Estimation of genotypic and phenotypic co-efficient of variation

Genotypic and phenotypic coefficient of variation were calculated by the formula suggested by Burton (1952)

Genotypic coefficient of variation (GCV %) = $\frac{\sqrt{\pm^{2}g}}{\bar{x}} \times 100$

Where,

σ^2_g = Genotypic variance

$\bar{x}$ = Population mean

Similarly,

The phenotypic co-efficient of variation was calculated from the following formula.

Phenotypic co-efficient variation (PCV) = $\frac{\sqrt{\pm^{2} ph}}{\bar{x}} \times 100$

Where,

σ^2_{ph}= Phenotypic variance

$\bar{x}$ = Population mean

3.15.3 Estimation of heritability

Broad sense heritability was estimated by the following formula, suggested by Johnson *et al.* (1955).

$h^2{}_b\%= \frac{\pm^{2}{}_{g}}{\pm^{2}{}_{ph}} \times 100$

Where,

$h^2{}_b$ = Heritability in broad sense

σ^2_g = Genotypic variance

σ^2_{ph} = Phenotypic variance

3.15.4 Estimation of genetic advance

The expected genetic advance for different characters under selection was estimated using the formula suggested by Lush (1943) and Johnson *et al.* (1955).

Genetic advance (GA) = K. h^2 b. $_{ph}$

$$GA = K.\frac{\pm^{2}{}_{g}}{\pm^{2}{}_{ph}}.\pm_{ph}$$

Where,

K = Selection intensity, the value which is 2.06 at 5% selection intensity

σ_{ph} = Phenotypic standard deviation

$h^2{}_b$= Heritability in broad sense

$\sigma^2{}_g$ = Genotypic variance

$\sigma^2{}_{ph}$ = Phenotypic variance

3.15.5 Estimation of genetic advance mean's percentage

Genetic advance as percentage of mean was calculated from the following formula as proposed by Comstock and Robinson (1952):

$$\text{Genetic advance (\% of mean)} = \frac{\text{Genetic Advance (GA)}}{\text{Population mean } (\bar{x})} \times 100$$

3.15.6 Estimation of simple correlation co-efficient:

Simple correlation coefficients (r) were estimated with the following formula

(Clarke, 1973; Singh and Chaudhary, 1985).

$$r = \frac{\sum xy - \frac{\sum x . \sum y}{N}}{\sqrt{[\{\sum x2 - \frac{(\sum x)2}{N}\}\{\sum y2 - \frac{(\sum y)2}{N}\}]}}$$

Where, $\sum$ = Summation

x and y are the two variables correlated

N = Number of observations

3.15.7 Estimation of genotypic and phenotypic correlation coefficient

For calculating the genotypic and phenotypic correlation coefficient for all possible combinations the formula suggested by Miller *et al.* (1958), Johnson *et al.* (1955) and Hanson *et al.* (1956) was adopted.

The genotypic co-variance component between two traits and had the phenotypic co-variance component were derived in the same way as for the corresponding variance components. The co-variance components were used to compute genotypic and phenotypic correlation between the pairs of characters as follows:

Genotypic correlation (r_{gxy}) = $\frac{GCOVxy}{\sqrt{GVx.GVy}}$ = $\frac{\sigma gxy}{\sqrt{(\sigma 2gx.\sigma 2gy)}}$

Where,

σ_{gxy} = Genotypic co-variance between the traits x and y

σ^2_{gx} = Genotypic variance of the trait x

σ^2_{gy} = Genotypic variance of the trait y

Phenotypic correlation (r_{pxy}) = $\frac{PCOVxy}{\sqrt{PVxPVy}}$

Where,

$PCOVxy$ = Phenotypic covariance between the traits x and y

PVx = Phenotypic variance of the trait x

PVy = Phenotypic variance of the trait y

3.15.8 Estimation of path coefficient

Path coefficient analysis was done according to the procedure employed by Dewey and Lu (1959) also quoted in Singh and Chaudhary (1985), using phenotypic correlation coefficient values. In path analysis, correlation coefficients between yield and yield contributing characters were partitioned into direct and indirect effects of yield contributing characters on grain yield per hectare. In order to estimate direct and indirect effects of the correlated characters, i. e. 1, 2, 3……………….and 13 on yield y, a set of simultaneous equations (eight equations in this example) is required to formulate as shown below:

$r_{1.y} = P_{1.y} + r_{1.2} P_{2.y} + r_{1.3} P_{3.y} + r_{1.4} P_{4.y} + r_{1.5} P_{5.y} + r_{1.6} P_{6.y} + r_{1.7} P_{7.y} + r_{1.8} P_{8.y} + r_{1.9} P_{9.y} + r_{1.10} P_{10.y}$

$r_{2.y} = r_{1.2} P_{1.y} + P_{2.y} + r_{2.3} P_{3.y} + r_{2.4} P_{4.y} + r_{2.5} P_{5.y} + r_{2.6} P_{6.y} + r_{2.7} P_{7.y} + r_{2.8} P_{8.y} + r_{2.9} P_{9.y} + r_{2.10} P_{10.y}$

$r_{3.y} = r_{1.3} P_{1.y} + r_{2.3} P_{2.y} + P_{3.y} + r_{3.4} P_{4.y} + r_{3.5} P_{5.y} + r_{3.6} P_{6.y} + r_{3.7} P_{7.y} + r_{3.8} P_{8.y} + r_{3.9} P_{9.y} + r_{3.10} P_{10.y}$

$r_{4.y} = r_{1.4} P_{1.y} + r_{2.4} P_{2.y} + r_{3.4} P_{3.y} + P_{4.y} + r4_{1.5} P_{5.y} + r_{4.6} P_{6.y} + r_{4.7} P_{7.y} + r_{4.8} P_{8.y} + r_{4.9} P_{9.y} + r_{4.10} P_{10.y}$

$r_{5.y} = r_{1.5} P_{1.y} + r_{2.5} P_{2.y} + r_{3.5} P_{3.y} + r_{4.5} P_{4.y} + P_{5.y} + r_{5.6} P_{6.y} + r_{5.7} P_{7.y} + r_{5.8} P_{8.y} + r_{5.9} P_{9.y} + r_{5.10} P_{10.y}$

$r_{6.y} = r_{1.6} P_{1.y} + r_{2.6} P_{2.y} + r_{3.6} P_{3.y} + r_{4.6} P_{4.y} + r_{5.6} P_{5.y} + P_{6.y} + r_{6.7} P_{7.y} + r_{6.8} P_{8.y} + r_{6.9} P_{9.y} + r_{6.10} P_{10.y}$

$r_{7.y} = r_{1.7} P1.y + r_{2.7} P_{2.y} + r_{3.7} P_{3.y} + r_{4.7} P_{4.y} + r_{5.7} P_{5.y} + r_{6.7} P_{6.y} + P_{7.y} + r_{7.8} P_{8.y} + r_{7.9} P_{9.y} + r_{7.10} P_{10.y}$

$r_{8.y} = r_{1.8} P_{1.y} + r_{2.8} P_{2.y} + r_{3.8} P_{3.y} + r_{4.8} P_{4.y} + r_{5.8} P_{5.y} + r_{6.8} P_{6.y} + r_{7.8} P_{7.y} + P_{8.y} + r_{8.9} P_{9.y} + r_{8.10} P_{10.y}$

$r_{9.y} = r_{1.9} P_{1.y} + r_{2.9} P_{2.y} + r_{3.9} P_{3.y} + r_{4.9} P_{4.y} + r_{5.9} P_{5.y} + r_{6.9} P_{6.y} + r_{7.9} P_{7.y} + r_{8.9} P_{8.y} + P_{9.y} + r_{9.10} P_{10.y}$

$r_{10.y} = r_{1.10} P_{1.y} + r_{2.10} P_{2.y} + r_{3.10} P_{3.y} + r_{4.10} P_{4.y} + r_{5.10} P_{5.y} + r_{6.10} P_{6.y} + r_{7.10} P_{7.y} + r_{8.10} P_{8.y} + r_{9.10} P_{9.y} + P_{10.y}$

$r_{11.y} = r_{1.11} P_{1.y} + r_{2.11} P_{2.y} + r_{3.11} P_{3.y} + r_{4.11} P_{4.y} + r_{5.11} P_{5.y} + r_{6.11} P_{6.y} + r_{7.11} P_{7.y} + r_{8.11} P_{8.y} + r_{9.11} P_{9.y} + r_{10.11} P_{10.y}$

$r_{12.y} = r_{1.12} P_{1.y} + r_{2.12} P_{2.y} + r_{3.12} P_{3.y} + r_{4.12} P_{4.y} + r_{5.12} P_{5.y} + r_{6.12} P_{6.y} + r_{7.12} P_{7.y} + r_{8.12} P_{8.y} + r_{9.12} P_{9.y} + r_{10.12} P_{10.y}$

Where,

r_{1y} = Genotypic correlation coefficients between y and ith character (y = Grain yield)

P_{iy} = Path coefficient due to i th character (i= 1, 2, 3,……….,13)

1 = Days to first flowering

2 = Days to maturity

3 = Plant height

4 = Primary branches per plant

5 = Secondary branches per plant

6 = Average fruit weight

7 = Number of fruit per plant

8 = Fruit length (mm)

9 = Fruit diameter (mm)

10 = Fruit yield per plant (kg)

Total correlation, say between 1 and y i. e., r_{1y} is thus partitioned as follows:

$P_{1.y}$ = the direct effect of 1 on y

$r_{1.2}$ $P_{2.y}$ = indirect effect of 1 via 2 on y

$r_{1.3}$ $P_{3.y}$ = indirect effect of 1 via 3 on y

$r_{1.4}$ $P_{4.y}$ = indirect effect of 1 via 4 on y

$r_{1.5}$ $P_{5.y}$ = indirect effect of 1 via 5 on y

$r_{1.6}$ $P_{6.y}$ = indirect effect of 1 via 6 on y

$r_{1.7}$ $P_{7.y}$ = indirect effect of 1 via 7 on y

$r_{1.8}$ $P_{8.y}$ = indirect effect of 1 via 8 on y

$r_{1.9}$ $P_{9.y}$ = indirect effect of 1 via 9 on y

$r_{1.10}$ $P_{10.y}$ = indirect effect of 1 via 10 on y

Where,

$P_{1.y}$, $P_{2.y}$, $P_{3.y..}$……… $P_{8.y}$ = Path coefficient of the independent variables 1, 2, 3,……….,12 on the dependent variable y, respectively.

$r_{1.y,}$ $r_{2.y,}$ $r_{3.y,}$ …………., $r_{12.y}$ = Correlation coefficient of 1, 2, 3, ………., 12 with y, respectively.

After calculating the direct and indirect effect of the characters, residual effect (R) was calculated by using the formula given below (Singh and Chaudhary, 1985)

$$P^2_{RY} = 1- (r_{1.y}P_{1.y} + r_{2.y}P_{2.y} + \ldots\ldots + r_{12.y}P_{12.y})$$

Where,

$P^2_{RY} = R^2$

And hence residual effect, $R = (P^2_{RY})^{1/2}$

$P_{1.y}$ = Direct effect of the i th character on yield y.

$r_{1.y}$ = Correlation of the i th character with yield y.

CHAPTER IV

RESULTS AND DISCUSSION

The acquaintance of genotypic variation within genotypes in relation to morphology and yield would help to screen better genotypes for hybridization programme. The data on plant height, primary branches per plant, secondary branches per plant, days to first flowering, days to maturity, single fruit weight, fruit length, fruit diameter, number of fruit per plant, fruit yield per plant etc. were recorded. Therefore, Genetic parameters and more than one multivariate techniques were needed to represent the results more clearly and it was obvious from the results of many researchers.

4.1 Variability, heritability and genetic advance

The analysis of variance indicated that there were highly significant differences among the tested genotypes for all the studied characters (Table 3a) except primary branch per plant. The results suggested the presence of inherent genetic differences with respect to various traits among the genotype which can be exploited through selection.

The mean sum of square, mean, range, variance components, heritability estimates, genetic advance and genetic advance in percent of mean (GAPM) are presented in Table 3(a, b) and Table 4.

4.1.1 Plant height (cm)

The plant height ranged from 70.86 cm to 81.45 cm with a mean of 75.78 cm. (Table 3a). The analysis of variance revealed highly significant differences among the genotypes with respect to plant height. Naz *et al.* (2013), Shravan *et al.* (2004)

also reported similar results for plant height of Brinjal. The maximum plant height (81.45 cm) was recorded in “SM 225” and the lowest plant height (70.86 cm) was recorded in “SM 255” (Appendix- IV). The PCV and GCV were 4.48 and 4.30 percent respectively (Table 3b). There was little difference between the phenotypic and genotypic coefficient of variation indicating little environmental influence in the expression of this character. In the present study, the genotypic and phenotypic coefficient of variation was moderate for plant height. Similar observations were made by Matin and Kuddus (2001). Singh *et al.* (2002) showed that the phenotypic coefficient of variation was greatest for this character. The estimates of heritability was high at 91.99% with an expected genetic advance (6.43%) (Table 3b). Islam and Khan (1991) also found high heritability in Brinjal. High heritability will be effective being less influenced by environmental affect as it indicating the relative value of selection based on phenotypic expression of the character.

4.1.2 Number of Primary branches per plant

The grand mean number of primary branches per plant recorded was 11.8. It ranged from 10.72 to 13.2 (Table 3a). The maximum number of primary branches (13.2) was recorded in “SM 260” and the minimum number of primary branches (10.72) was recorded in “BARI Begun-6” (Appendix- IV). The PCV and GCV were 9.25 and 4.31 percent respectively (Table 3b). The PCV value was slightly higher than the respective GCV denoting little influence of environment for the expression of the character. This indicated that it may be attributed to non-additive gene effects controlling its expression and selection would not be rewarding (Taiana *et al*. 2015). Singh *et al.* (2002) also showed that phenotypic coefficient of variation was greater for primary branches per plant. The estimates of heritability was low at 21.72% with low genetic advance (0.49) (Table 3b) which is agreed with findings of Kumar *et al.* (2004).

Table 3a. Estimation of genetic parameters in ten characters of 12 genotype of Brinjal

Parameters	Range	Mean	MS	CV%	σ 2g	σ 2g	σ 2 e
PH	70.86-81.45	75.78	32.70**	1.27	11.52	10.59	0.92
DFF	110.44-126.97	120.80	56.17**	1.90	22.25	16.96	5.29
DM	170.95-182.99	176.26	53.99**	0.61	18.77	17.63	1.14
PBP	10.72-13.2	11.80	1.70	8.18	1.19	0.26	0.93
SBP	10.95-16.23	13.19	8.06**	9.13	3.66	2.21	1.45
FPP	13.5-23.50	18.24	40.90**	8.82	15.36	12.77	2.58
FL	102.4-146.81	21.47	659.95**	1.51	222.23	218.86	3.37
FD	60.87-88.43	71.23	149.56**	2.17	51.45	49.06	2.38
AFW	236.37-291.29	268.57	1,182.17**	0.97	398.57	391.75	6.82
FYP	418.02-980.63	793.37	92,977.98**	4.59	31876.07	30550.89	1325.18

**** Significant at l% level of significance.**

PH = Plant height (cm), DFF = Days to first flowering , DM = Days to maturity , PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g), MS = mean sum of square, CV (%) = Coefficient of variation, σ 2p= Phenotypic variance, σ2g = Genotypic variance and σ2 e = Environmental variance.

Table 3b. Estimation of genetic parameters in ten characters of 12 genotypes of Brinjal

Parameters	PCV	GCV	ECV	Heritability	Genetic advance (5%)	Genetic advance (% mean)
PH	4.48	4.30	1.27	91.99	6.43	8.49
DFF	3.91	3.41	1.90	76.22	7.41	6.13
DM	2.46	2.38	0.61	93.93	8.38	4.76
PBP	9.25	4.31	8.18	21.72	0.49	4.14
SBP	14.50	11.26	9.13	60.32	2.38	18.02
FPP	21.49	19.60	8.82	83.17	6.71	36.82
FL	12.27	12.18	1.51	98.48	30.24	24.90
FD	10.07	9.83	2.17	95.37	14.09	19.78
AFW	7.43	7.37	0.97	98.29	40.42	15.05
FYP	22.50	22.03	4.59	95.84	352.50	44.43

PH = Plant height (cm), DFF = Days to first flowering, DM = Days to maturity, PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g), PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation, ECV = Environmental coefficient of variation.

4.1.3 Number of secondary branches per plan

Secondary branches per plant were ranged from 10.95 to 16.23 with a great mean of 13.19 (Table 3a). The maximum (16.23) and minimum (10.95) number of secondary branches was recorded in genotype “BARI Begun-6” and “Islampuri” respectively. The PCV and GCV were 14.50 and 11.26 percent respectively (Table 3b). Coefficient of variation studies indicated that the estimates PCV were slightly higher than GCV indicated that the characters were less influenced by the environment. Therefore, selection as the basis of phenotype alone can be effective for the improvement of the trait. The estimate of heritability was high at 60.32 % with low genetic advance 2.38%. Islam and Khan (1991) also got similar findings.

4.1.4 Days to first flowering

The grand mean number of days to first flowering was recorded 121 days. It ranged from 110 days to 127 days (Table 3a). The maximum number of days to first flowering (127) was in “SM 225” and the minimum number (110) was recorded in “SM 14” (Appendix- IV). The PCV and GCV were 3.91 and 3.41 percent respectively (Table 3b). The PCV were slightly higher than the respective GCV denoting environmental factors influencing the expression to some degree or other. The estimates of heritability was high at 76.22 percent with low genetic advance (7.41%) (Table 3b).

4.1.5 Days to maturity

The grand mean number of days to maturity recorded was 176.26 where it ranged from 170.95 to 182.99 (Table 3a). The maximum number of days to maturity (182.99) was recorded in “Singnath” and the minimum number of days to maturity (170.95) was recorded in “SM 225” (Appendix- IV). The PCV and GCV were 2.46 and 2.38 percent respectively (Table 3b). Narrow difference between values of PCV and GCV indicating that they were less influenced by environment and can be convinced by looking of low values of ECV. Selection based on the phenotypic expression of this character would be helpful for improvement of this crop. The estimates of heritability were high at 93.93 percent with moderate genetic advance (8.38) (Table 3b). Islam and Khan (1991), Kumari *et al.* (2007) also found similar finding with days to maturity.

4.1.6 Number of fruit per plant

The grand mean of fruit per plant recorded as 18.24. It ranged from 13.50 to 23.50 (Table 3a). The maximum number of fruit per plant (23.50) was recorded in “SM 260” and the minimum number of flower per plant (13.50) was recorded in “SM 259” (Appendix- IV). The PCV and GCV were 21.49 and 19.60 percent respectively (Table 3b). The difference between GCV and PCV were relatively low which indicated that the character was comparatively stable and highly heritable. The estimate of heritability was high at 83.17 percent with low genetic advance (6.71) (Table 3b).

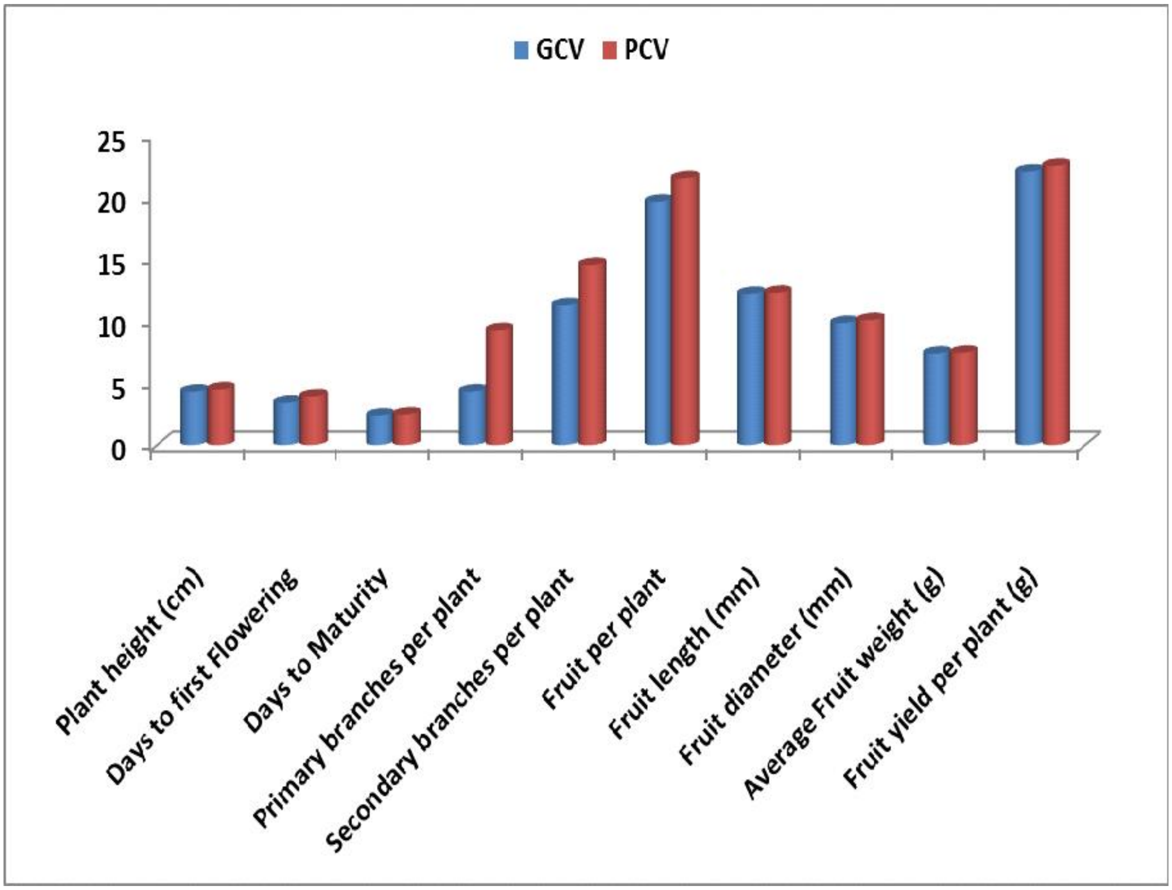

Fig 1. Genotypic and phenotypic coefficient of variation of ten morphological characters in Brinjal

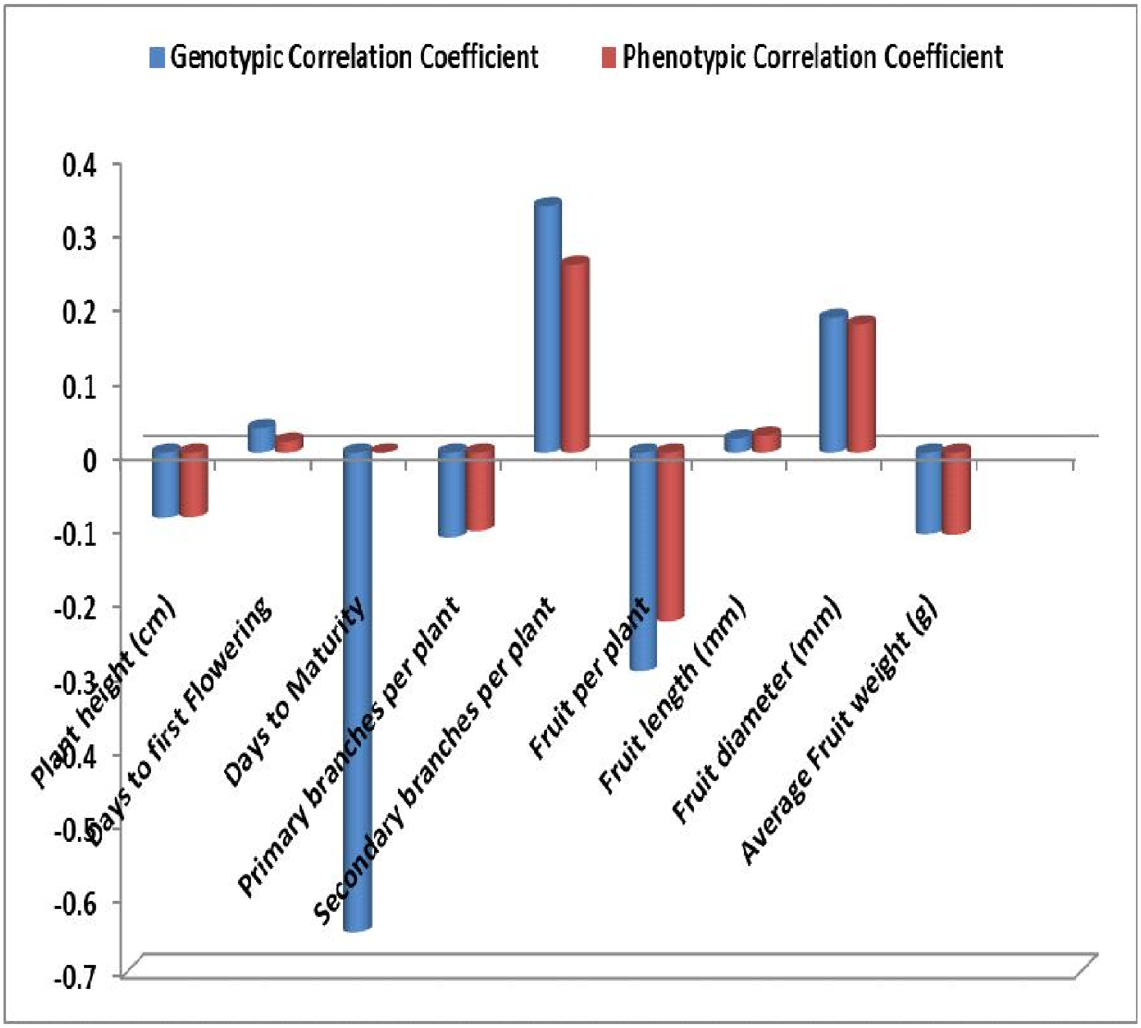

Fig 2. Heritability and genetic advance over mean in Brinjal

4.1.7 Fruit length (mm)

The fruit length varied among the genotypes ranging from 102.40 mm to 146.80 mm with an average of 121.47 mm. (Table 3a). The maximum fruit length (146.80 mm) was recorded in “Singnath” and the minimum fruit length (102.40 mm) was in “BARI Begun-6 (Appendix- IV). The PCV and GCV were 12.27 and 12.18 percent respectively (Table 3b). The difference between GCV and PCV was relatively low which indicated that the character was comparatively stable and highly heritable. The estimate of heritability was high at 98.48 percent with high genetic advance (30.24) (Table 3b). This indicates that the character controlled by polygenes might be useful to the plant breeder for making effective selection. Panda *et al.* (2010) found similar findings about this character.

4.1.8 Fruit diameter (mm)

The average fruit diameter recorded was 71.23 mm. It ranged from 60.87 mm to 88.43 mm (Table 3a). The maximum fruit diameter (88.43 mm) was recorded in “SM 255” and the minimum (60.87 mm) was in “SM 267” (Appendix- IV). The PCV and GCV were 10.07 and 9.83 percent respectively (Table 3b). Sing *et al.* (2002) showed greater phenotypic variation than genotypic one. Smallest difference observed between PCV and GCV values of fruit diameter suggest lesser influence of environmental factors on the expression of the trait. The estimate of heritability was high at 95.37% with moderate genetic advance (14.09) (Table 3b). This indicates the influence of non-additive gene action and considerable influence of environment in the expression of this trait. This trait could be exploited through manifestation of dominance and epistatic components through heterosis.

4.1.9 Fruit yield per plant (g)

The average fruit yield per plant recorded was 793.37 g. It ranged from 418.02 kg to 980.63 g (Table 3a). The maximum fruit yield per plant (980.63 g) was recorded in “SM 254” and the minimum fruit yield per plant (418.02 g) was recorded in “Singnath” (Appendix- IV). The PCV and GCV were 22.50 and 22.03 percent respectively (Table 3b). Manivannan *et al.* (2005) got similar results. There was little difference between the phenotypic and genotypic coefficient of variation indicating little environmental influence in the expression of this character. The estimate of heritability was high at 95.84 percent with high genetic advance (352.50) (Table 3b). Anupam *et al.* (2002) also observed high heritability for this trait. Very high heritability estimates for fruit yield per plant indicate possibility of improvement through selection.

4.1.10 Average fruit weight (g)

The grand average fruit weight per plant recorded was 268.57 g. It ranged from 236.37 g to 291.29 kg (Table 3a). The maximum fruit yield per plant (291.29 g) was recorded in “SM 254” and the minimum fruit yield per plant (236.37 g) was recorded in “SM 14” (Appendix- IV). The PCV and GCV were 7.43 and 7.37 percent respectively (Table 3b). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The estimates of heritability was high at 98.29 percent with high genetic advance (40.42%) (Table 3b). High heritability also found by Ara *et al.* (2009), Singh *et al.* (2006).

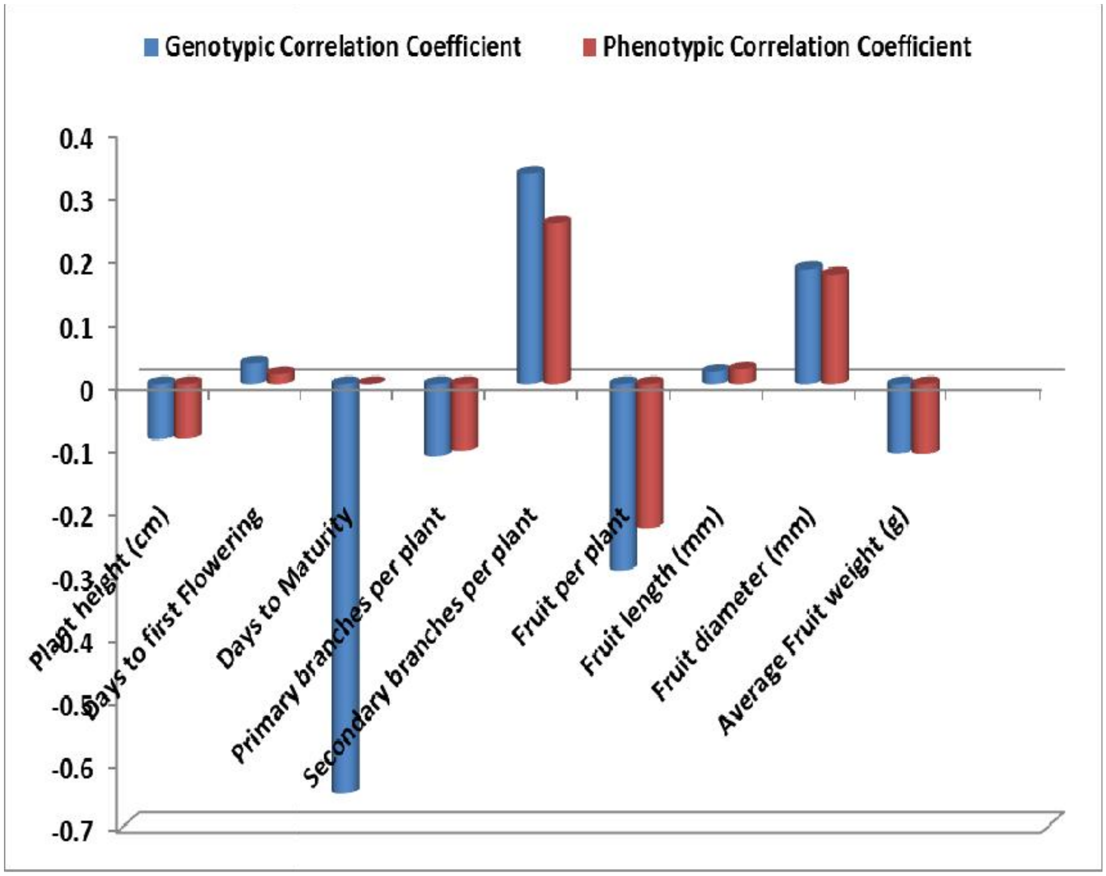

Fig 2 Genotypic and phenotypic correlation coefficient of 9 characters with yield of Brinjal

4.2 Correlation

Knowledge of correlation between yield and its contributing characters are basic and foremost endeavor to find out guidelines for plant selection. The existing relationships between traits are generally determined by the genotypic and phenotypic correlations. The phenotypic correlation measures the degree of association of two variables and is determined by genetic and environmental factors. The genotypic correlation on the other hand, which represents the genetic portion of the phenotypic correlation, is the only one of inheritable nature and therefore, used to orient breeding programs (Falconer, 1989). However, the correlation coefficient between two characters does not necessarily imply a cause and effective relationship. The inter-relationship could be grasped best if a coefficient could be assigned to each path in the diagram designed to measure the direct influence on it. Before placing strong emphasis on breeding for yield improvement trait, the knowledge on the association between yield and yield attributes would enable the breeder in the improvement of yield. The correlation coefficient may also help to identify characters that have little or no importance in the selection programme. The existence of correlation may be attributed to the presence of linkage or pleiotropic effect of genes or physiological and development relationship or environmental effect or in combination of all (Oad *et al*., 2002). The basic objective of most of the crop improvement programs is to realize a marked improvement in crop yield. But yield is a complex character which is controlled by association of various characters. Thus, information on association of yield attributes and their direct and indirect effects on grain yield are of paramount significance.

4.2.1 Genotypic correlation

4.2.1.1 Plant height (cm)

Plant height (cm) found to display highly significant positive and negative relationships with primary branches per plant (0.848**) at genotypic level (Table 4). The character reflected non significant negative association with days to maturity, fruit per plant, fruit length, average fruit weight and fruit yield per plant at genotypic level. Positive and non significant association found in days to first flowering, secondary branches per plant with plant height. Mohanty (2002) also reported similar kind results for Brinjal.

4.2.1.2 Days to first flowering

Days to first flowering showed highly significant positive relationship with average fruit weight (0.458**) at genotypic level (Table 4). It also showed non significant positive correlation with days to maturity (0.188), primary branches per plant (0.195), secondary branches per plant (0.153), fruits per plant (0.038), fruit yield per plant (0.033) at genotypic level. Samadia *et al.* (2006) also showed similar result but the findings of Jansirani (2000) were contradictory to the present findings. It also showed insignificant negative correlation with fruit length (-0.036), fruit diameter (-0.199) at genotypic level.

4.2.1.3 Days to maturity

Days to maturity showed highly significant positive and negative association with average fruit weight (0.647**) and fruit yield per plant (-0.648**) at genotypic level respectively. On the other hand, the trait demonstrated significant positive relationship with fruit per plant (0.356*). It also showed non-significant positive association with primary branches per plant and fruit length and non significant negative association with secondary branches per plant and fruit diameter.

Table 4. Genotypic correlation coefficients among different pairs of yield and yield contributing characters for different genotype of Brinjal

Characters	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	FYP
PH	0.197	-0.071	0.848**	0.270	-0.260	-0.173	-0.485**	-0.382	-0.088
DFF		0.188	0.195	0.153	0.038	-0.036	-0.199	0.458**	0.033
DM			0.123	-0.320	0.356*	0.246	-0.177	0.647**	-0.648**
PBP				0.982**	0.103	-0.141	-0.317	-0.291	-0.115
SBP					0.107	-0.393*	-0.026	-0.290	0.333*
FPP						-0.114	-0.446**	0.139	-0.295
FL							0.480**	0.641**	0.019
FD								0.276	0.182
AFW									-0.110

**** = Significant at 1%.**

*** = Significant at 5%.**

PH = Plant height (cm), DFF = Days to first flowering, DM = Days to maturity, PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g)

4.2.1.4 Number of primary branches per plant

The character showed highly significant positive relationship with secondary branches per plant (0.982**) at genotypic level (Table 4). Highly significant positive association between numbers of primary branches per plant and number of secondary branches per plant indicates that the traits are governed by same pleiotropic effect of gene and simultaneous improvement would be effective. It also showed non-significant positive genotypic correlation with fruit per plant (0.103). It showed non-significant negative correlation with fruit length (-0.141), fruit diameter (-0.317), average fruit weight (0.291), fruit yield per plant (-0.115) at genotypic level. Singh *et al.* (2002) also found non-significant negative correlation with fruit yield. Prabhu *et al.* (2008) also reported similar finding. Prasath (1997) also got similar result for trait.

4.2.1.5 Number of secondary branches per plant

Number of secondary branches per plant showed significant negative association with fruit length (-0.393*) and significant positive association with fruit yield per plant (0.333**) respectively at genotypic level. It also showed non-significant positive correlation with fruit per plant and non significant negative correlation with fruit diameter and average fruit weight at genotypic level. Ara *et al.* (2009) found positive correlation with yield per plant and Prabhu and Nataranjan (2008) observed negative association with yield/plant comparing with the secondary branches per plant

4.2.1.6 Fruit per plant

Fruit per plant showed significant negative correlation with fruit diameter (-0.446**). It also showed non-significant negative association with fruit length and fruit yield per plant but non-significant positive correlation with average fruit weight. Khanna (1978) observed similar negative relation for fruit/plant with fruit yield/plant. Prasath (1997) also showed positive correlation with fruit yield, which not resemble to the present findings

4.2.1.7 Fruit length (mm)

Fruit length showed highly significant positive relation with fruit diameter (0.480**) and average fruit weight (0.641**). On the other hand it showed non significant positive association with fruit yield per plant. Shinde *et al.* (2012) also reported positive correlation with fruit yield/plant

4.2.1.8 Fruit diameter (mm)

Fruit diameter exhibited non significant positive correlation (0.182) with yield per plant as well as average fruit weight (0.276). Dhaka and Soni (2014) reported that fruit diameter had positive correlation with yield/plant which resembles the present finding

4.2.1.9 Average fruit weight (g)

Average fruit weight exhibited non significant negative correlation (-0.110) with fruit yield per plant. Narendra kumar (1995) also reported negative association with fruit yield.

4.2.2 Phenotypic correlation

4.2.2.1 Plant height (cm)

Plant height demonstrated highly significant negative association with fruit diameter (-0.450**) at phenotypic level (Table 5). It also showed significant positive and negative correlation with primary branches per plant (0.360*) and average fruit weight (-0.354*). Plant height showed non-significant positive correlation with days to first flowering, secondary branches per plant and fruit yield per plant. Non significant negative correlation found in days to maturity, fruit per plant and fruit length.

4.2.2.2 Days to first flowering

Days to first flowering showed significant positive relationship with average fruit weight (0.400*) at phenotypic level (Table 5). Patil and Bojhappa (1993) also found similar observation about this trait. It showed non-significant negative correlation with fruit length and fruit diameter. The rest of the characters showed non significant positive correlation with days to first flowering. Jansirani (2000) got negative association with fruit yield which not resemble the present findings

4.2.2.3 Days to maturity

This trait demonstrated highly significant positive and negative relationship with average fruit weight (0.629**) and fruit yield per plant (-0.608**) phenotypically (Table 5). On the other hand, days to maturity showed significant positive correlation with fruit per plant (0.358*). It showed non significant positive relationship with primary branches per plant, and fruit length and non significant negative association with secondary branches per plant and fruit diameter.

4.2.2.4 Number of primary branches per plant

Numbers of primary branches per plant showed significant positive relationship with secondary branches per plant (0.341*) at phenotypic level. Fruit per plant, fruit length, fruit diameter, average fruit weight, fruit yield per plant showed non significant negative association with numbers of primary branches per plant.

4.2.2.5 Number of secondary branches per plant

This trait showed non-significant positive correlation with fruit per plant, fruit diameter and fruit yield per plant at phenotypic level. But it showed non significant negative correlation with fruit length and average fruit weight.

Table 5. Phenotypic correlation coefficients among different pairs of yield and yield contributing characters for different genotype of Eggplant

Characters	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	FYP
PH	0.189	-0.083	0.360*	0.147	-0.249	-0.170	-0.450**	-0.354*	0.087
DFF		0.204	0.046	0.216	0.023	-0.005	-0.114	0.400*	0.015
DM			0.034	-0.218	0.358*	0.244	-0.167	0.629**	-0.608**
PBP				0.341*	-0.066	-0.082	-0.190	-0.170	-0.106
SBP					0.047	-0.288	0.031	-0.223	0.254
FPP						-0.090	-0.415*	0.112	0.228
FL							0.471**	0.629**	0.023
FD								0.260	0.173
AFW									-0.111

** = Significant at 1%., * = Significant at 5%.

PH = Plant height (cm), DFF = Days to first flowering, DM = Days to maturity, PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g)

4.2.2.6 Number of fruits per plant

This trait exhibited significant negative correlation with fruit yield per plant (-0.415*). It showed non-significant negative association with fruit length. On the other hand, average fruit weight and fruit yield per plant showed non-significant positive association with number of fruits per plant. Thangamani (2012) also reported negative correlation with fruit yield per plant and Annatalaxmi (2001) got positive correlation with fruit yield per plant with number of fruits per plant.

4.2.2.7 Fruit length (mm)

Fruit length showed highly significant positive correlation with fruit diameter (0.417**) and average fruit weight (0.629**). It showed non-significant positive correlation with fruit yield per plant

4.2.2.8 Fruit diameter

Fruit diameter exhibited non significant positive correlation with average fruit weight and yield per plant. Sasikumar (1999) also reported similar findings.

4.2.2.9 Average fruit weight (g)

Average fruit weight showed non significant negative correlation with fruit yield per plant (-0.111) (Table 5). Thangamani (2014) also reported similar results.

4.3 Path co-efficient analysis

Genotypic and phenotypic path coefficient analysis was showing in Table 6 & 7.

4.3.1 Genotypic path co-efficient analysis

4.3.1.1 Plant height

Plant height employed direct negative effect (-0.381) on yield per plant as well as indirect positive effect via primary branches per plant (0.012), secondary branches per plant (0.133), fruits per plant (0.139) and fruit diameter (0.381) (Table 6). It also showed negative indirect effect of days to first flowering (-0.067), fruit length (-0.018) and average fruit weight (-0.361). Matin and Kuddus (2001) also got similar result with this trait.

4.3.1.2 Days to first flowering

Days to first flowering showed negative direct effect (-0.340) on yield per plant and positive indirect effect via means of primary branches per plant (0.033), secondary branches per plant (0.075), fruit diameter (0.156), average fruit diameter (0.433) (Table 6). Matin and Kuddus (2001) and Thangamani (2014) also found negative direct effect with this character. However, negative indirect effect of plant height (-0.075), days to maturity (-0.196), fruit per plant (-0.020), fruit length (-0.004) for days to maturity.

4.3.1.3 Days to maturity

Days to maturity showed negative direct effect (-1.040) on yield per plant and positive indirect effect by means of plant height (0.027), primary branches per plant (0.002), average fruit weight (0.612), fruit length (0.025) and fruit diameter (0.139) on yield per plant however, negative indirect effect of secondary branches per plant (-0.158) (Table 6), number of fruits per plant (-0.191), days to first flowering (-0.064) on yield per plant. Singh *et al.* (2004) also found negative direct effect on fruit yield.

4.3.1.4 Primary branches per plant

Primary branches per plant applied positive direct effect (0.014) and positive indirect effects by means of secondary branches per plant (0.484), fruit diameter (0.249) on yield per plant (Table 6). However, negative indirect effect of plant height (-0.323), number of fruits per plant (-0.066), days to maturity (-0.128), number of fruits per plant (-0.055), average fruit weight (-0.275) and fruit diameter (-0.014) curtailed it. Singh *et al.* (2006) and Islam and Khan (1991) found negative direct effect with this character. This does not support the present findings.

4.3.1.5 Secondary branches per plant

Secondary branches per plant showed positive direct effect (0.493) on yield per plant and positive indirect effect by means of days to maturity (0.333), primary number of branches (0.014), fruit diameter (0.020) on yield per plant (Table 6). It also showed negative indirect effect of plant height (-0.103), days to first flowering (-0.052), number fruits per plant (-0.57), fruit length (-0.040), average fruit weight (-0.274). Singh *et al.* (2006) found direct negative effect on this character. This does not resemble the present study.

4.3.1.6 No. of fruit per plant

Number of fruit per plant showed negative direct effect (-0.536) on yield per plant and positive indirect effect by means of plant height (0.099), primary number of branches (0.001), secondary branches per plant (0.053), fruit diameter (0.351), average fruit weight (0.131) on yield per plant (Table 6). It also showed negative indirect effect with days to maturity (-0.370) and days to first flowering (-0.013). It also showed negative indirect effect of days to first flowering, days to maturity and fruit diameter. Shinde *et al. (*2014) also reported negative direct effect with this trait.

Table 6. Genotypic Path coefficient analysis showing direct and indirect effects of different characters on yield of Brinjal

Characters	Direct effect	Indirect effect									Genotypic correlation with yield
		PH	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	
PH	-0.381	_	-0.067	0.074	0.012	0.133	0.139	-0.018	0.381	-0.361	-0.088
DFF	-0.340	-0.075	_	-0.196	0.003	0.075	-0.020	-0.004	0.156	0.433	0.033
DM	-1.040	0.027	-0.064	_	0.002	-0.158	-0.191	0.025	0.139	0.612	-0.648**
PBP	0.014	-0.323	-0.066	-0.128	_	0.484	-0.055	-0.014	0.249	-0.275	-0.115
SBP	0.493	-0.103	-0.052	0.333	0.014	_	-0.057	-0.040	0.020	-0.274	0.333*
FPP	-0.536	0.099	-0.013	-0.370	0.001	0.053	_	-0.012	0.351	0.131	-0.295
FL	0.102	0.066	0.012	-0.256	-0.002	-0.194	0.061	_	-0.377	0.606	0.019
FD	-0.786	0.185	0.068	0.184	-0.004	-0.013	0.239	0.049	_	0.261	0.182
AFW	0.946	0.146	-0.156	-0.673	-0.004	-0.143	-0.075	0.065	0.217	_	-0.110

Residual effect: 0.228 ,

**** = Significant at 1%. ,* = Significant at 5%.**

PH = Plant height (cm), DFF = Days to first flowering, DM = Days to maturity, PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g).

4.3.1.7 Fruit length (mm)

This character showed positive direct effect (0.102) on yield per plant and positive indirect effect by means of plant height (0.066), days to first flowering (0.012), fruits per plant (0.061) and average fruit weight (0.606) on yield per plant (Table 6). Rani et al. (2010) also had similar findings. It also showed negative indirect effect of days to maturity (-0.256), primary branches per plant (-0.002), secondary branches per plant (-0.194), fruit diameter (-0.377) on yield per plant. Nayak *et al.* (2014) observed similar finding.

4.3.1.8 Fruit diameter (mm)

This character showed negative direct effect (-0.786) on yield per plant and positive indirect effect by means of plant height (0.185), days to first flowering (0.068), days to maturity (0.0.184), fruits per plant (0.239), average fruit weight (0.261) (Table 6). It also showed negative indirect effect of primary branches per plant (-0.004), secondary branches per plant (-0.013) on yield per plant. Singh *et al.* (2004) also admit similar finding. Nayak *et al.* (2014) showed positive direct effect on yield/plant which not supports the present finding.

4.3.1.9 Average fruit weight

This character showed positive direct effect (0.946) on yield per plant and positive indirect effect by means of plant height (0.146), fruit length (0.065) and fruit diameter (0.217) on yield per plant (Table 6). It also showed negative indirect effect of primary branches per plant (-0.004), secondary branches per plant (-0.143), days to first flowering (-0.156), days to maturity (-0.673), number of fruits per plant (-0.075) on yield per plant. Singh *et al.* (2006) also had positive direct effect with yield. Nayak *et al.* (2014) reported similar observation.

4.3.2 Phenotypic path co-efficient analysis

4.3.2.1 Plant height (cm)

Plant height employed direct negative effect (-0.121) on yield per plant as well as indirect positive effect via days to maturity (0.074), secondary branches per plant (0.040), fruits per plant (0.028) and fruit diameter (0.129) (Table 6). It also showed negative indirect effect of days to first flowering (-0.013), primary branch per plant (-0.027), fruit length (-0.016) and average fruit weight (-0.180). Matin and Kuddus (2001) also got similar result with this trait.

4.3.2.2 Days to first flowering

Days to first flowering showed negative direct effect (-0.068) on yield per plant and positive indirect effect by means of secondary branches per plant (0.059), fruit diameter (0.0.033), fruit length (0.001) average fruit weight (0.204) (Table 7). However, negative indirect effect of plant height (-0.023), days to maturity (-0.182), primary branches per plant (-0.003), fruit per plant (-0.003). Islam and Khan (1991) also showed similar results in their findings.

4.3.2.3 Days to maturity

Days to maturity showed negative direct effect (-0.894) on yield per plant and positive indirect effect by means of plant height (0.010), average fruit weight (0.320), fruit length (0.240) and fruit diameter (0.048) on yield per plant (Table 7). However, negative indirect effect of days to first flowering (-0.014), primary branches per plant (-0.003), secondary branches per plant (-0.059), number of fruits per plant (-0.040) on yield per plant. Shindde *et al.* (2012) observed negative direct effect on yield/plant which supports the present finding.

4.3.2.4 Primary branches per plant

Primary branches per plant applied negative direct effect (-0.075) and positive indirect effects by means of secondary branches per plant (0.093), fruit diameter (0.054) on yield per plant (Table 7). However, negative indirect effect of days to first flowering (-0.033), plant height (-0.044), number of fruits per plant (-0.007), days to maturity (0.030), fruit length (-0.008), average fruit weight (-0.087) curtailed it. Randhwa *et al.* (1993) and Khurana *et al.* (1983) reported highest negative direct effect of primary branches per plant on yield of plant.

4.3.2.5 Secondary branches per plant

Secondary branches per plant showed positive direct effect (0.272) on yield per plant and positive indirect effect by means of days to maturity (0.195) and fruit length (0.028) on yield per plant (Table 7). It also showed negative indirect effect of plant height (-0.018), primary branches per plant (-0.026), days to first flowering (-0.015), number of fruits per plant, fruit length (-0.005), fruit diameter (-0.009), and average fruit weight (-0.114). Veldivel and Bapu (1990) also reported same findings.

4.3.2.6 No. of fruit per plant

Number of fruit per plant showed negative direct effect (-0.112) on yield per plant and positive indirect effect by means of plant height (0.013), secondary branches per plant (0.013), fruit diameter (0.119), average fruit weight per plant (0.057) on yield per plant (Table 7). It also showed negative indirect effect of days to first flowering (-0.002), days to maturity (-0.320), primary branches per plant (-0.005) and fruit length (-0.009). Kalda *et al. (1996)* reported negative direct effect of no. of fruits/plant which supports the present finding. Veldivel and Bapu (1990) observed positive direct effect of fruit/plant on fruit yield which not support the present finding

Table 7. Phenotypic Path coefficient analysis showing direct and indirect effects of different characters on yield of Brinjal

Characters	Direct effect	Indirect effect									Phenotypic correlation with yield
		PH	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	
PH	-0.121	_	-0.013	0.074	-0.027	0.040	0.028	-0.016	0.129	-0.180	-0.087
DFF	-0.068	-0.023	_	-0.182	-0.003	0.059	-0.003	0.001	0.033	0.204	0.015
DM	-0.894	0.010	-0.014	_	-0.003	-0.059	-0.040	0.024	0.048	0.320	-0.608**
PBP	-0.075	-0.044	-0.003	0.030	_	0.093	-0.007	-0.008	0.054	-0.087	-0.106
SBP	0.272	-0.018	-0.015	0.195	-0.026	-	-0.005	0.028	-0.009	-0.114	0.254
FPP	-0.112	0.030	-0.002	-0.320	-0.005	0.013	_	-0.009	0.119	0.057	-0.228
FL	0.097	0.021	0.001	-0.218	0.006	-0.078	0.010	_	-0.135	0.0320	0.023
FD	-0.286	0.054	0.008	0.149	0.014	0.008	0.046	0.046	_	0.132	0.173
AFW	0.509	0.043	-0.027	-0.562	0.013	-0.061	-0.013	0.061	_0.074	_	-0.111

Residual effect: 0.447

PH = Plant height (cm), DFF = Days to first flowering , DM = Days to maturity , PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average fruit weight (g), FYP = Fruit yield per plant (g).

4.3.2.7 Fruit length (mm)

This character showed positive direct effect (0.102) on yield per plant and positive indirect effect by means of plant height (0.021), days to first flowering (0.001), fruits per plant (0.010), primary branches per plant (0.006) and average fruit weight (0.320) on yield per plant (Table 7). It also showed negative indirect effect of days to maturity (-0.218), secondary branches per plant (-0.078) and fruit diameter (-0.135) on yield per plant. Rekha *et al.* (2012) and Jadhao *et al.* (2009) also reported positive direct effect of fruit length on yield/plant.

4.3.2.8 Fruit diameter (mm)

This character showed negative direct effect (-0.286) on yield per plant and positive indirect effect by means of plant height (0.054), days to first flowering (0.008), days to maturity (0.149), primary branches per plant (0.014), secondary branches per plant (0.008), fruit length (0.046), fruits per plant (0.046) and average fruit weight (0.132). It also showed negative indirect effect of primary branches per plant, secondary branches per plant on yield per plant.

4.3.2.9 Average fruit weight (g)

This character showed positive direct effect (0.509) on yield per plant and positive indirect effect by means of plant height (0.043), primary branches per plant (0.013) fruit length (0.061) on yield per plant. It also showed negative indirect effect of secondary branches per plant (-0.061), days to first flowering (-0.027), days to maturity (-0.562), number of fruits per plant (-0.013), fruit diameter (-0.074) on yield per plant. Shinde *et al.* (2012) reported positive direct effect of average weight on yield/plant.

CHAPTER V

SUMMARY AND CONCLUSION

The present research work was organized at the Sher-e-Bangla Agricultural University farm, Dhaka-1207, Bangladesh. This work was done with 12 genotypes of brinjal lines during October, 2013 to March, 2014. Completely Randomized Design (CRD) containing two replications was utilized for seed sowing which was later transferred to the pots. Data was recorded on a range of yield attributing characters like plant height, days to first flowering, fruit per plant, fruit length (mm), fruit diameter (mm), average fruit weight (g), number of primary branches per plant, number of secondary branches per plant, days to maturity and fruit yield per plant.

The analysis of variance showed significant differences among all the characters present in the study except primary branch per plant. This indicated sufficient amount of variation among the genotypes. Average fruit weight showed highest range of variation (236.37-291.29) with highest mean value (268.57). This provided a great range of variation present in this character. On the other hand, phenotypic variance was higher than the genotypic ones. Characters like average fruit weight, days to first flowering and fruit yield had environmental influence on the expression of this characters. However, characters like plant height, days to maturity and secondary branches per plant had least differences in phenotypic and genotypic variances. This suggested additive gene action for the expression of the characters. All the characters under study offered high heritability except primary branches per plant.

Association between yield and yield attributing characters were studied through correlation of coefficient. Significant positive genotypic and phenotypic correlation was present in secondary branches per plant (0.033, 0.023) respectively. On the other hand, non significant positive genotypic and phenotypic correlation present among days to first flowering (0.033. 0.254), fruit length (0.019, 0.023), fruit diameter (0.182, 0.173)) respectively with fruit yield per plant. Significant negative genotypic and phenotypic correlation present in days to maturity(0.648, 0.608) respectively while non significant negative correlation present among plant height (0.088, 0.087), primary branches per plant (0.115, 0.106), fruit per plant (0.295, 0.228) and average fruit weight (0.110, 0.111).

Path coefficient analysis of this present research work showed positive direct effect of secondary branches per plant, fruit length and average fruit weight on yield of fruits both genotypically and phenotypically. On the other hand, indirect positive effect presents in fruit length, fruit diameter, days to first flowering and secondary branches per plant. Indirect negative effect presents in plant height, days to maturity, average fruit weight and primary branches per plant.

From the present study, significant variability present among all the present studied characters. So, it can be concluded that selection procedure can be effective to improve desired characters like plant height, average fruit weight, fruits per plant, fruit length and fruit diameter to get high yielding varieties. Relatively higher and lower values of both genotypic coefficient of variation and phenotypic coefficient of variation for different yield contributing characters like fruit per plant, average fruit weight, fruit length, fruit diameter which were less affected by environments should be selected for future development of higher yielding varieties.

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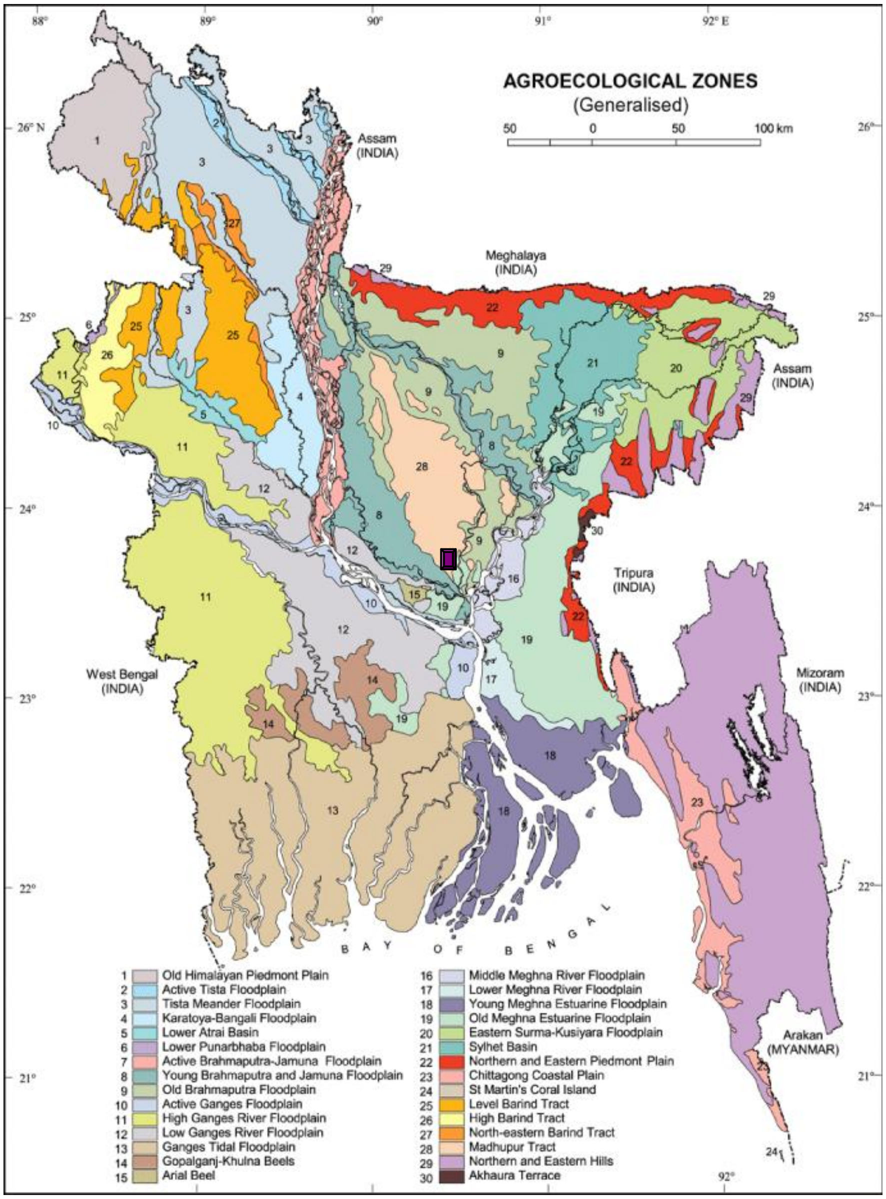
APPENDICES

Appendix I. Map showing the experimental site under the study



The experimental site under study

Appendix II. Monthly average Temperature, Relative Humidity and Total Rainfall and sunshine of the experimental site during the period from October, 2013 to March, 2014

Month	Air temperature (ºc)		Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum			
October, 2013	34.8	18.0	77	227	5.8
November, 2013	32.3	16.3	69	0	7.9
December, 2013	29.0	13.0	79	0	3.9
January, 2014	28.1	11.1	72	1	5.7
February, 2014	33.9	12.2	55	1	8.7
March, 2014	34.6	16.5	67	45	7.3

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

Appendix III. Physical characteristics and chemical composition of soil of the experimental plot

Soil characteristics	Analytical results
Agrological Zone	Madhupur Tract
P^H	6.00 – 6.63
Organic matter	0.84
Total N (%)	0.46
Available phosphorous	21 ppm
Exchangeable K	0.41 meq / 100 g soil

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

AppendixIV Mean performance of various growth parameter and yield components

Sl No.	Genotypes	PH	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	FYP
1	SM 259	80.20	117.27	171.10	12.65	13.41	13.50	116.04	72.08	242.68	885.14
2	SM 14	72.78	110.44	172.10	10.92	11.62	17.00	117.65	73.48	236.37	877.75
3	SM 257	75.31	123.39	177.93	12.67	15.07	22.67	135.52	72.27	277.50	939.33
4	SM 261	78.38	123.07	179.45	11.65	11.33	17.58	132.77	70.39	287.67	858.01
5	SM 255	70.86	122.53	176.15	11.45	14.28	13.50	120.47	88.43	284.80	853.68
6	SM 225	81.45	126.97	170.95	11.74	14.58	13.67	109.26	67.15	246.52	870.72
7	BARI begun 6	77.22	119.49	174.33	13.20	16.23	22.33	102.40	64.88	248.52	755.81
8	SM 254	71.77	122.58	172.06	11.05	11.87	17.67	144.62	75.42	291.29	980.63
9	SM 260	73.63	119.14	175.96	10.72	13.50	23.50	112.72	70.18	270.48	784.12
10	SM 267	75.88	122.23	181.57	11.75	13.18	17.74	111.23	60.87	282.50	836.88
11	Singnath	77.53	117.80	182.99	12.13	12.24	17.35	146.80	75.19	286.36	418.02
12	Islampuri	74.32	124.62	180.50	11.61	10.95	22.33	108.13	64.42	268.20	460.31
	Mean	75.78	120.80	176.26	11.80	13.19	18.24	121.47	71.23	268.57	793.37
	Min.	70.86	110.44	170.95	10.72	10.95	13.50	102.40	60.87	236.37	418.02
	Max.	81.45	126.97	182.99	13.20	16.23	23.50	146.80	88.43	291.29	980.63

PH = Plant height (cm), DFF = Days to first Flowering , DM = Days to Maturity , PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average Fruit weight (g), FYP = Fruit yield per plant (g).

Appendix IV Analysis of variance of 10 yield and yield related characters of brinjal

Analysis of variance

Source	df	Mean sum of square									
		PH	DFF	DM	PBP	SBP	FPP	FL	FD	AFW	FYP
Replication	2	1.8725	11.9370	2.2356	1.3145	11.2373	38.5213	2.1089	0.4463	91.6809	5562.0002
Treatment	11	32.7067	56.1715	54.0246	1.7066	8.0670	40.9001	659.9580	149.5688	1,182.0710	92977.849
Error	22	0.9224	5.2911	1.1383	0.9314	1.4505	2.5847	3.3669	2.3840	6.8228	1325.1776

PH = Plant height (cm), DFF = Days to first Flowering , DM = Days to Maturity , PBP = Primary branches per plant, SBP = Secondary branches per plant, FPP = Fruit per plant, FL = Fruit length (mm), FD = Fruit diameter (mm), AFW = Average Fruit weight (g), FYP = Fruit yield per plant (g).