

Studies on variability and character association in Brinjal (*Solanum melongena* L.)

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

**In partial fulfillment of the requirements for
the Degree of**

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In

AGRICULTURE

Horticulture (Vegetable Science)

By

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All the assistance and help received during the course of the investigation has been acknowledged by her.

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Place: Jabalpur

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INTRODUCTION

Brinjal (*Solanum melongena* L. $2n=24$) is an important popular vegetable crop among the Solanaceous group grown throughout the year nationwide except the higher altitude. Being a primary centre of origin India has accumulated wide range of variability in this crop. It is an often cross pollinated crop and possesses considerable diversity for plant stature, fruit yield and yield attributing characters.

India contributes 13443.586 thousand metric tons to the global production of brinjal and ranks second to china (NHB, 2018). Brinjal occupies third position among vegetable crops in India covering 7.8% of total vegetable area i.e.730 thousand hectare with a productivity of 17.5 metric t/ha and production 12801 thousand metric tonnes in India. In Madhya Pradesh the annual production is 1073.63 thousand metric tonnes in an area of 51.35 thousand hectare with a productivity of 25.0 metric t/ha (National Horticulture Board, 2018). Major brinjal producing states are Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra, Uttar Pradesh and Gujarat.

It is used in culinary preparation, pickles and industrially processed foods are also prepared from brinjal. Brinjal has ayurvedic medicinal properties. The fruits of brinjal are excellent remedies for those suffering from liver troubles. White brinjal is good for diabetic patients. It is good source of vit A, B and C. The bitter source of brinjal is due to glycoalkaloids.

The genetic improvement in any crop depends on the available genetic variability for improving quantitative traits and its judicious exploitation through efficient breeding methods. Brinjal exhibits rich genetic diversity and there is scope for improvement for various horticultural traits. Assessment of available genetic variability for important economic traits to develop high yielding varieties is an important function in crop breeding. For any breeding programme, the relative magnitude of genetic variability, nature and extent of character association with yield and its related characters are very important. Hence it is essential to partition the overall variability into its heritable and non heritable components with the help of

genetic parameters like genetic coefficient of variation, heritability and genetic advance. Genetic improvement programme depends on the existence, nature and extent of genetic variation available for manipulation within the species.

Heritability is the heritable portion of phenotypic variance. It is a good index of the transmission of characters from parents to offspring. The estimates of heritability helps the plant breeder in selection of elite genotypes from diverse genetic populations. Heritability coupled with genetic advance are more useful than heritability alone in predicting the resultant effect for selecting the best individual. Genetic advance under selection measures the role of genetic progress as the deviation between the mean genotypic value of the selected families and the mean genotypic value of the base population due to selection. An improvement in yield and quality of brinjal is normally achieved by selecting the genotypes with desirable characters combination existing in nature or by hybridization.

To give a better insight of ancillary character under selection, correlation and path coefficient analysis are the tools, which are being effectively used for determining the rate of various yield components in different crops, leading to the selection of superior genotype. Therefore, towards a rational approach in the improvement of vegetable yield, it is imperative to have information on the association among its component characters and inter-relationship among themselves for simultaneous improvement of yield and its components.

Keeping in view the above facts, the present studies in brinjal entitled with “Studies on variability and character association in Brinjal (*Solanum melongena* L.)” has been carried out with the following objectives:

1. To estimate the parameters of genetic variability in brinjal
2. To find out the inter relationship amongst yield & its attributes at genotypic and phenotypic levels
3. To assess the direct and indirect effect on yield using path coefficient analysis
4. To identify the suitable and better performing genotype for Kymore plateau and Satpura hills of M.P.

REVIEW OF LITERATURE

The success of any plant improvement programme depends on right selection of material and its skilful management. It is only possible when we possess knowledge of previous work done in the field concerned. In brinjal, substantial contribution has been made to the literature regarding its genetics and breeding in the recent years. The literature pertaining to the various aspects of the present study has been reviewed under the following heads:

- 2.1 Coefficient of variation
- 2.2 Heritability and genetic advance
- 2.3 Correlation coefficient analysis
- 2.4 Path coefficient analysis

2.1 Coefficient of variation

For the development of new superior varieties which are far better than the existing ones, we should choose the material that possesses genetic variability having high GCV along with high mean.

Negi *et al.* (2000) studied genetic variability in 40 genotypes of brinjal for 21 characters. Significant differences were found among the genotypes for all the traits indicating wide range of variation. High genotypic coefficients of variation were found for number of fruits per plant, fruit yield per plant and fruit set on normal and total flower basis.

Sharma and Swaroop (2000) revealed that the considerable variation was observed in all the characters. The phenotypic coefficient of variation was higher than genotypic coefficient of variance in all the characters. The genotypic coefficient of variation estimates was high for number of fruits per plant, mean fruit weight and yield per plant in brinjal.

Kumar *et al.* (2000) revealed that highly significant differences were observed for all characters under study. Higher values of phenotypic than genotypic coefficient of variation in all the three environments indicated the role of environmental influence in the expression of various characters.

Mohanty (2001) reported that genotype environment interaction was significant for average fruit weight, numbers of fruits per plant and yield. Phenotypic coefficient of variation was high for number of fruits per plant (42.0%) and average fruit weight (38.9%), whereas it was moderate for number of branches per plant (25.6%).

Mohanty and prusti (2002) evaluated six economic characters .PCV was greater than GCV for all traits. Moderate to high GCV were observed for yield, average fruit weight, number of fruits and branches per plant which could be improved by simple selection in early generation. Plant height and days to first harvest low GCV which required selection for several successive generations for their edification.

Baswana *et al.* (2002) revealed that significant genotypic differences were observed for all the characters studied. Among the genotypes, Arka Sirish recorded the highest number of fruits per plant , whereas CHBR-1 recorded the highest fruit weight. H-17 recorded the lowest number of days before 50% flowering. Fruit yield was highest in AB-1. High genotypic and phenotypic coefficients of variation were observed for number of fruits per plant (86.04%, 89.88%), yield per plant (80.54%, 87.25%) and fruit weight (80.19 gm, 81.51%gm). The magnitude of variation was low for days to 50% flowering (10.17% and 14.17%).

Prasad *et al.* (2004) revealed that highly significant differences were observed among the 52 aubergine genotypes for all characters except fruit yield. Moderate to high estimates of genotypic coefficient of variation (GCV) were observed for average fruit weight, fruit yield, fruit girth, number of fruits per plant and fruit length, indicating the potential of simple selection for the improvement of these characters. The low estimates of GCV were observed for days to first flowering, fruit set and number of primary branches. Moderate estimates of GCV were observed for plant height, days to first flowering and days to first fruit set, indicating the potential for the improvement of these characters through selection in the germplasm.

Kushwah and Bandhyopadhyaya (2005) reported that the highly significant variation among the genotypes was recorded for all traits. High

phenotypic and genetic coefficients of variation were recorded for fruit weight, number of flowers per cluster and fruit diameter.

Singh and Kumar (2005) observed highly significant differences among the 25 divers' brinjal genotypes for different characters. Average fruit weight showed the highest phenotypic and genotypic coefficient of variation closely followed by number of fruits per plant. The lowest values were recorded for days to first fruit set followed by days to first flowering. All the characters exhibited less difference between GCV and PCV values and traits like average fruit weight, days to first fruit harvest, fruit index and yield per plant showed nearly equal GCV and PCV values.

Prabhu and Natarajan (2007) evaluated thirteen diverse genotypes for estimating the range of variability, heritability and genetic advance of growth and yield attributes in brinjal. The high genotypic coefficient of variation expressed by yield contributing traits such as number of fruits per plant, mean fruit weight and fruit borer infestation.

Naliyadhara *et al.* (2007) revealed that PCV was slightly greater than GCV for all traits. Moderate to high GCV was observed for all the characters except fruit yield which could be improved by simple selection methods.

Sherly and Shanthi (2008) indicated that high estimates of phenotypic and genotypic coefficients of variation were observed for fruit length, number of fruits per plant, fruit weight and fruit yield per plant .

Lohakare *et al.* (2008) reported that the highly significant differences were observed among the 23 diverse brinjal genotypes for different characters. The highest genotypic coefficient of variation as well as phenotypic coefficient of variation was observed for number of fruits per cluster.

Mishra *et al.* (2008) reported that the analysis of variance revealed significant differences for all characters except number of primary branches. The estimates of the genetic coefficient of variation (GCV) were higher than the phenotypic coefficient of variation (PCV). The highest estimates of GCV and PCV were recorded for fruit shape index.

Nair and Mehta (2009) reported that the phenotypic coefficient of variation was greater than genotypic coefficient of variation for all the characters. Both phenotypic coefficient of variation as well as genotypic coefficient of variation was high for seed pulp ratio, weight of fruit and number of fruits per plant.

Prabhu *et al.* (2009) studied that genetic parameters of interspecific crosses of brinjal genotypes for high marketable yield and fruit borer resistance. They reported that genotypic coefficient of variation values is lower than that of phenotypic coefficient of variation values for all observed characters. Among the various characters studied, fruit borer infestation showed high genotypic coefficient of variation and phenotypic coefficient of variation.

Dahatonde *et al.* (2010) revealed that the highly significant differences were observed among the 20 diverse brinjal genotypes for fifteen characters. The highest genotypic coefficient of variation was observed for character number of marketable fruits per plant.

Gangopadhyay *et al.* (2010) revealed that the large variability for growth habit, leaf blade lobbing, calyx colour, fruit shape, size and colour and colour distribution. The objective of this study was to develop a core set of brinjal germplasm to facilitate access, conservation and utilization.

Ansari *et al.* (2011) revealed that highly significant differences were observed for most of the traits. Mean performance showed that IBWL recorded highest fruit yield of 1004 g per plant followed by PPC (974 g), GL (931 g), MK (918 g) and PPR (872 g) whereas, in F_1 s PPC x PPR registered a fruit yield of 1347 g per plant followed by WBPF x PPR (1317 g), IBWL x PPR (1293 g), IBWL x PPC, PPL x PPR (1287 g), WBPF x PPC (1282 g), IBWL x WBPF and PPL x PPC (1274 g). The moderate estimates of genotypic coefficient of variation and phenotypic coefficient of variation were observed for number of fruits per cluster, average fruit weight, total number of fruits per plant, fruit length. Maximum genotypic coefficient of variation & phenotypic coefficient of variation were observed for number of flowers per inflorescence, number of fruits per picking and fruit girth, indicating that

selection can be predicted to improve the brinjal genotypes for these characters.

Indiresh and Santhosha (2011) revealed that the analysis of variance showed the prevalence of sufficient genetic variation among the genotypes from all the characters studied except total chlorophyll content. The high phenotypic coefficient of variation and genotypic coefficient of variation were observed for fruit volume, fruit weight, fruit length, leaf area index, number of fruits per plant, fruit borer incidence, fruit diameter and number of fruits per cluster.

Kumar *et al.* (2011a) revealed that the phenotypic coefficient of variation was higher than their corresponding genotypic coefficient of variation for days to 50% flowering, number of flower per cluster, number of long and medium styled flowers per cluster, number of short styled flowers per cluster, days to first fruit set, plant height, number of primary branches per plant, number of fruits per cluster, fruit length, fruit diameter, fruit weight and total yield per plant. The highest GCV and PCV were recorded for total yield per plant and lowest for days to 50% flowering.

Chattopadhyay *et al.* (2011) showed that the brinjal genotypes under study showed highly significant variations among twelve quantitative traits. However, a wide range of variations for days to 50% of flowering (47-79), fruit length (8.70- 23.90cm), fruit girth (2.67-10.30cm), fruit weight (52.33-319.37g), number of marketable fruit per plant (4.33-12.00) and marketable fruit yield per plant (0.39-1.68Kg) among the genotypes was observed.

Kumar *et al.* (2011) showed that the analysis of variance indicated presence of large variability for different characters under study. Genotypes PCPGR No. 7030 and KS-331 for earliness, SMB 115 for maximum number of fruits, BARI for maximum length of fruit, PCPGR No. 7041 and 7028 for maximum number of fruit per plant and Sel-6 for yield were found promising, hence can be utilized for improvement of these traits in brinjal.

Thangavel *et al.* (2011) reported that the magnitude of phenotypic coefficient variation was observed higher than genotypic coefficient of variation, indicating the greater influence of environment. Wider variation

was observed for fruit length and number of fruits per plant, while it was low for days to first flowering and number of branches per plant.

Kumar *et al.* (2012) revealed that highly significant differences were observed for most of the traits. Mean performance showed that EP 27 (1.93Kg) registered highest fruit yield per plant followed by EP 3 (1.83 Kg). High estimates of genotypic coefficient of variation and phenotypic coefficient of variation were observed for number of primary branches per plant, intermodal length, average fruit weight, number of fruits per plant and yield per plant indicating that selection can be predicted to improve the brinjal genotypes of these characters.

Chourasia and Sangeeta (2012) revealed that highest range of variation was reported for fruit weight (g) followed by fruit length (cm), number of fruits per cluster and number of fruits per plant. The highest PCV and GCV were estimated for number of fruits per cluster in all the four seasons indicating its widest range of variability in all the situations under study.

Lokesh *et al.* (2013) revealed that the highest PCV and GCV values were seen for plant height, number of branches per plant, number of fruits per cluster, average of fruit diameter, average of fruit weight, shoot and fruit borer incidence on shoot and fruit and fruit yield per plant indicating high variability in the germplasm.

Chaudhary and Kumar (2014) studied sixteen brinjal genotypes and revealed highly significant difference for almost all agronomic traits indicating a wide range of variability. The GCV values were low in magnitude as compared to PCV values. High amount of phenotypic and genotypic coefficient of variation was observed for fruit yield per plant. Characters like fruit yield per plot, fruit yield per hectare, number of fruit per plant, fruit weight while quantitative traits like number of flowers per plant exhibited moderate PCV and GCV.

2.2 Heritability and genetic advance

It is all known that right selection of the material is one of the important causes for the success of any improvement programme. The proper selection will depend on the knowledge of heritability. Estimate of genetic advance is an important parameter to evaluate effectiveness of selection.

Negi (2000) found that most of the traits in 40 brinjal genotypes showed high estimates of heritability (>70%). High genetic advance coupled with high heritability was exhibited by number of fruits per plant, fruit yield per plant and weight per fruit. Days to 50% flowering and picking had high heritability and low genetic advance.

Sharma and swaroop (2000) reported that heritability estimates were high for length of fruits, number of fruits per plant, mean fruit weight and yield per plant. In spite of high heritability values for most traits, the expected genetic advance as percentage of mean ranged from 11.47 to 95.36%.

Mohanty (2001) reported that the estimates of heritability in the broad sense ranged from 62.9% for plant height to 91.6% for number of fruits per plant. High estimates of genetic gain were obtained for number of fruits per plant (77.26%) and average fruit weight (72.06%), while, it was moderate for number of branches per plant (47.43%).

Das *et al.* (2002) revealed that characters like average fruit weight, fruits per plant, plant height, fruit yield per plant, leaf width, leaves per plant, leaf length and stem girth showed high heritability values. Considering the three genetic parameters namely genotypic coefficient of variability, heritability and genetic advance together, it was evident that phenotypic selection would be more effective for characteristics like average fruit weight, fruit yield per plant, and fruits per plant than other characteristics.

Mohanty and prusti (2002) evaluated for six economic characters. High heritability accompanied by moderate to high GCV and genetic gain were observed for yield, average fruit weight, number of fruits and branches per plant which could be improved by simple selection in early generations. Plant height and days to first harvest manifested high heritability coupled

with low GCV and genetic gain which required selection for several successive generations for their edification. The cultivars Pusa purple Round, Black Beauty, BB 11, BB 4, BB 6-1 and BB 1 were found potential for exploitation.

Baswana *et al.* (2002) revealed that high heritability (broad sense) was observed for fruit weight (96.79%) followed by number of fruits per plant (91.64%) and yield per plant (85.22%). Days to 50% flowering had low heritability (57.16%). The genetic advance as percentage mean was recorded higher for number of fruits per plant (169.50%). High heritability coupled with high genetic advance was observed for number of fruits per plant, fruit weight and yield per plant.

Prasad *et al.* (2004) revealed that moderate to high estimates of heritability and genetic advance were observed for average fruit weight, fruit yield, fruit girth, number of fruits per plant and fruit length, indicating the potential of simple selection for the improvement of these characters. The low estimates of genetic advance were observed for days to first flowering, fruit set and number of primary branches. Moderate estimates of genetic advance and heritability were observed for plant height, days to first flowering and days to first fruit set, indicating the potential for the improvement of these characters through selection in the germplasm.

Kushaw and Bandhyopadhyaya (2005) reported that the high genetic advance was recorded for fruit weight, number of flowers per cluster and fruit diameter. High heritability estimates were recorded for number of days to 50% flowering, number of flower per cluster, number of fruits per cluster, number of days to first picking, number of pickings, fruit length, fruit diameter, fruit weight, number of fruits per plant, plant height and fruit yield per plant suggesting that selection for the remaining characters would be effective.

Singh and Kumar (2005) observed that heritability estimates were high (above 87%) for all the characters in 25 brinjal genotypes. The highest heritability was observed for average fruit weight closely followed by fruit index and yield per plant. The genetic advance as percentage of mean was

high for average fruit weight, number of fruits per plant and yield per plant. High heritability coupled with high genetic advance was observed for number of fruits per plant, average fruit weight and yield per plant.

Golani *et al.* (2007) revealed that the shape and colour of fruits and the genotypes played a major role in the grouping of the genotypes into various clusters. The genotypic coefficient of variation, heritability and genetic advance as percentage of mean were high for fruit length, fruit girth and 10 fruit weight, indicating additive gene action, which contributed to maximum divergence and played a major role in the improvement of brinjal yield.

Dhameliya and Dobariya (2007) reported that the estimates of heritability and genetic advance were high for number of fruits per plant, plant height, days to first picking and fruit yield per plant. The simple selection involving these traits would be effective in genetic improvement of fruit yield in brinjal.

Kaur and Thakur (2007) reported that the fruit weight and plant height exhibited moderate heritability along with high genetic advance, which indicated the importance of additive gene action and factors in the inheritance of above characters.

Mishra *et al.* (2008) reported that the heritability estimates were highest for fruit shape index. High level of genetic advance was registered for fruit shape index and average weight of fruits. Plant height, plant spread, girth of fruit and number of fruits per plant exhibited high levels of genetic advance and heritability, indicating the importance of additive gene effect for these traits. Thus, simple selection will be effective for these traits.

Sherly and Shanthi (2008) revealed that high heritability high genetic advance was registered for fruit length, number of fruits per plant, fruit weight and fruit yield per plant. These characters can be effectively improved through selection.

Sao and Mehta (2009) showed that high degree of genetic variability was observed for the characters such as average fruit weight, fruit length, fruit girth, number of flowers per inflorescence, number of fruits per cluster,

total number of fruits per plant and total yield per plant accompanied with high heritability and genetic advance. Some characters like days to first flowering, days to first fruiting, plant height, number of primary branches per plant, total soluble solids and rind thickness showed low to moderate variability coupled with high heritability and low to moderate genetic advance in the present material.

Nair and Mehta (2009) reported that the high heritability accompanied by high genetic advance was observed for weight of fruit. High heritability and moderate genetic advance were observed for plant height, fruiting span and number of fruits per plant suggesting that selection based on phenotypic performance of these traits is possible. Good variation was also observed for the morphological characters investigated. Genotypes PB-64, D-77, PB-67 and JB-15 were found least susceptible to discoloration. It is an important character that should be considered in breeding programmed for developing variety having good consumer preference.

Thangavel *et al.* (2011) reported that the low heritability was observed for fruit girth and yield per plant. High heritability coupled with high genetic advance was observed for days to first flowering and number of branches per plant indicating the involvement of additive gene action in the inheritance of these traits.

Kumar *et al.* (2011a) showed that the high heritability estimates were highest for fruit weight, plant height, days to first fruit set, total yield per plant, fruit length, days to 50% flowering, number of per cluster, long styled flowers per cluster, number of short styled flowers per cluster, number of medium styled flowers per cluster, number of primary branches per plant and number of fruits per cluster. The rest of the characters exhibited moderate to low heritability among the parents. The highest genetic gain was observed for total yield per plant followed by fruit weight, long styled flowers per cluster, medium styled flowers per cluster, number of flower per cluster and fruit length, but it was low for fruit diameter, number of fruits per cluster and plant height.

Ansari *et al.* (2011) revealed that the highest estimates of heritability coupled with genetic advance estimated for the average fruit weight and number of fruits per plant showed effectiveness of simple selection for improvement of these characters.

Indiersh and Santhosha (2011) revealed that the high heritability coupled with high genetic advance were observed for fruit volume, fruit weight, leaf area index, fruit length, fruit diameter and number of fruits per plant, indicating these characters are governed by additive gene action. Hence, direct selection may be followed for the improvement of brinjal for these characters.

Chattopadhyay *et al.* (2011) showed that the three characters namely, fruit weight, plant height and days to 50% flowering exhibited high heritability and genetic advance indicating that such situation may arise due to the action of additive gene controlling the characters.

Kumar *et al.* (2012) revealed that the high estimates of heritability coupled with high genetic advance as percent of mean estimated for the number of primary branches per plant, intermodal length, fruit length, average fruit weight, number of fruits per plant and fruit yield per plant indicated that selection will be effective for improvement of these characters.

Chourasia and Sangeeta (2012) revealed that highest heritability (in broad sense) was found for fruit length (cm) followed by fruit weight, number of fruits per cluster, fruit width (cm) and number of fruits per plant. The characters namely leaf area, number of days to first harvest and number of days to 50% flowering was found to have lower heritability estimates. High heritability with high genetic advance were found in total yield (q/ha), fruit weight (g) and number of leaves per plant.

Lokesh *et al.* (2013) revealed that high heritability accompanied with high genetic advance was noticed for plant height, average fruit weight and shoot and fruit borer incidence on shoot indicating that simple selection may be effective to fix and improve such traits.

Chaudhary and Kumar (2014) revealed that high estimate of heritability in broad sense for all the agronomy traits ranged from 84 to 99 %.

High heritability coupled with high genetic advance was observed for plant height, number of branches per plant, fruit length, fruit diameter, fruit weight, number of fruits per plant and fruit yield per plant while high heritability coupled with low genetic advance was observed for number of flowers per plant and fruit yield per plot.

2.3 Correlation coefficient analysis

Sharma and Swaroop (2000) revealed that the genotypic correlation were higher in magnitude over phenotypic correlation. Most of characters were positively correlated with yield except for days to 50% flowering.

Mohanty (2001) studied 15 brinjal cultivars and reported that genotypic correlation was higher than the corresponding phenotypic correlation. The yield showed positive and significant association with plant height and number of fruits per plant at phenotypic and genotypic levels.

Kumar *et al.* (2002) reported that magnitude of genotypic correlation were higher than phenotypic correlation coefficients. Among the yield contributing characters high correlation values were observed for percent fruit set, number of fruits per plant, fruit weight and fruit width. Number of fruits per plant showed highly significant positive association with yield.

Patel and Sarnaik (2004) estimated the phenotypic and genotypic correlation of different characters on fruit yield per plant of 24 aubergine genotypes. The number of fruits per plant, fruit length and weight per fruit exhibited significant positive correlations with the fruit yield per plant.

Singh and Kumar (2004) reported that the yield per plant showed significant positive correlation with average fruit weight and plant height.

Pathania *et al.* (2005) reported that marketable yield per plant was positively and significantly associated with number of marketable fruits, gross yield and total number of fruits per plant. Days to flowering were significantly associated with days to first picking.

Kushwah and Bandhyopadhyaya (2005) conducted correlation analysis for 13 traits and found that at the genetic level, the number of fruits per plant, fruit diameter and number of pickings showed a significant positive

correlation with yield per plant. At the phenotypic level, fruit yield was positively correlated with the number of pickings, fruit diameter and number of fruits per plant, but was negatively correlated with the number of days to first picking. Fruit weight and diameter were negatively correlated with the number of fruits per plant, fruit length, number of fruits per cluster and number of flowers per cluster.

Kamani and Monpara (2006) reported that the fruits per plant exhibited positive correlation with fruit yield per plant, fruit weight and fruit girth and negative association with fruit length only in one cross, whereas association between fruit weight and fruit yield was significantly positive in both the crosses. Thus, fruit weight seemed to be a major component of fruit yield and due consideration on this characters should be given for improvement in fruit yield.

Naliyadhara *et al.* (2007) revealed that the genotypic correlation coefficients were higher than corresponding phenotypic coefficient for most characters reflecting predominant role of heritable factors. Fruit yield displayed significant and positive genotypic and phenotypic correlations only with fruit weight.

Nair and Mehta (2007) revealed that the correlation coefficient at the phenotypic level of yield per plant was significant and positive with number of fruits per plant and plant height. These traits should be considered highly dependable and reliable during selection to improve the yield. Negative and significant correlation was observed with days to flower initiation, number of branches per plant, days to first picking, number of fruits per cluster and days to last picking.

Prabhu and Natarajan (2007a) reported tht the marketable yield had positive correlation with mean fruit weight.

Lohakare *et al.* (2008) found that in 23 genotypes of green fruits of brinjal, yield per plant was closely associated with number of fruits per cluster, fruit index, average fruit weight and number of fruits per plant.

Prabhu and Natarajan (2008) found that marketable yield per plant recorded positive correlation with plant height (0.736), branches per plant (0.941), fruit length (0.743) and number per plant (0.383).

Prabhu *et al.* (2008) revealed that the marketable yield per plant showed positive significant correlation with plant height, number of branches per plant and mean fruit weight.

Dharwad *et al.* (2009) indicated that strong correlation of number of branches per plant, fruit weight and flowers per inflorescence with fruit yield. However, it exhibited weak association with days to flowering and fruits per cluster.

Jadhao *et al.* (2009) showed that the yield contributing characters viz. plant height, number of branches per plant, days to last picking, fruit weight and number of fruits per plant showed positive significant correlation with fruit yield per plant.

Singh *et al.* (2010) showed that the yield per hectare was positively correlated with number of flowers per plant, number of fruits per plant, fruit length, fruit weight, fruit volume, number of fruit picking, plant height and plant girth, while, days to first fruit harvest and percent of plant wilted showed significant negative association with fruit yield.

Chattopadhyay *et al.* (2011) showed that the genotypic and phenotypic correlation agreed closely with each other. Fruit weight and fruit girth exhibited significantly positive correlations with marketable fruit yield per plant.

Thangamani and Jansirani (2012) revealed that yield per plant showed positive correlation with number of branches per plant, percentage of long styled flowers and number of fruits per plant. A significant negative correlation of yield was observed with days to first flowering.

Rekha and Celine (2013) the correlation studies in the present infestation revealed that the fruit yield per plant recorded positive correlation with fruit length, plant height and fruit per plant. It exhibited negative correlation with fruit infestation by fruit and shoot borer. Shoot infestation by fruit and shoot borer exhibited negative correlation with flowering. Positive

genotypic correlation of yield with fruits per plant was reported that plant height was positively correlated with yield per plant.

Shende *et al.* (2014) revealed that association of fruit yield per plant with number of fruits per cluster and number of fruits per plant were found highly significant of genotypic level.

2.4 Path coefficient analysis

Rajyalakshmi *et al.* (2000) worked out path coefficient analysis in 17 genotypes of brinjal and revealed that leaf area index, number of fruits per plant, fruit weight at phenotypic level, exhibited positive direct effect on yield per plant. Fruits per plant had the highest positive direct effect on yield per plant. Percentage fruit set showed high negative effect on yield but showed positive indirect effect through fruit number.

Sharma and Swaroop (2000) revealed that number of fruits per plant, mean weight of fruits and diameter of fruits had maximum direct effect at genotypic level and hence direct selection could be made for these characters for improving the yield, while maximum direct effect at phenotypic level was showed by number of fruits per cluster, plant height, number of fruits per plant, mean weight of fruits and diameter of fruit. The number of fruits per cluster showed maximum indirect positive effect on yield. Number of flowers per cluster, number of branches per plant, plant height and length of fruit had positive indirect effect towards yield per plant via number of fruits per plant and hence simultaneous selection for these characters can be made for the improvement of yield.

Mohanty (2001) reported that the phenotypic and genotypic path coefficient studies showed that average fruit weight had the highest positive effect on yield followed by the number of fruits per plant.

Singh and Singh (2001) path coefficient analysis in 24 cultivars of brinjal showed that the highest consideration should be given to the traits fruits per plant, average fruit weight and number of branches per plant for improvement of yield in brinjal.

Patel and Sarnaik (2004) estimated the direct and indirect effects on fruit yield per plant of 24 aubergine genotypes. Path coefficient analysis

revealed that the number of fruits per plant, fruit length and weight per fruit had the highest direct effects on fruit yield per plant.

Singh and Kumar (2004) path coefficient analysis revealed that the maximum direct effect on yield was through number of fruits per plant followed by average fruit weight.

Pathania *et al.* (2005) revealed that the purposeful and balanced selection on the basis of horticultural traits viz. fruit diameter, number of fruits (total and marketable), fruit length and days to first picking would be more rewarding for improvement of brinjal.

Naliyadhara *et al.* (2007) revealed that the fruit length, 10 fruits weight and plant spread exerted higher positive direct effect on fruit yield suggesting giving emphasis on such fruits while imposing selection for yield of brinjal.

Nair and Mehta (2007) showed that weight of fruit, number of fruits per plant, days to flower initiation, number of fruits per cluster, days to first picking, length of fruits and number of branches per plant exerted direct positive effect on yield per plant. Hence, emphasis should be given for such traits when imposing selection brinjal yield.

Prabhu and Natarajan (2008) found that positive effect was exerted by branches per plant, mean fruit weight, fruit length and number of fruits per plant on marketable yield. Negative direct effect on marketable yield by plant height, fruit girth, shoot and fruit borer infestation was observed in this study. Path analysis exhibited that the traits like branches per plant, fruit length, number of fruits per plant and mean fruit weight were the most important yield contributing characters owing to their high direct effects and indirect effects via other traits.

Lohakare *et al.* (2008) found that in 23 genotypes of green fruited brinjal revealed positive direct effect on yield per plant through number of fruits per plant, average fruit weight, days to first fruit harvest. Hence, these characters may be given consideration while making selection for the improvement of brinjal.

Jadhao *et al.* (2009) revealed that plant height, number of branches per plant, days to first picking, days to last picking, fruit length and fruit weight showed positive direct effect on fruit yield per plant indicating these characters had direct relation with yield.

Singh *et al.* (2010) showed that the fruit weight and fruit per plant had high direct effect on fruit yield. However, the indirect contribution of fruit diameter was appreciable to affect fruit yield in brinjal.

Chattopadhyay *et al.* (2011) showed that among the eleven yield component traits, fruit weight and number of marketable fruits per plant showed highly positive direct effect on marketable fruit yield per plant. Attention should be paid on selection based on marketable fruit weight and number of marketable fruits per plant for marketable yield improvement of brinjal.

Karek *et al.* (2012) revealed that fruit weight was one of the major contributory factors to yield and fruit girth. Fruit number per plant, fruit weight, fruit girth emerged as the most important fruit yield contributing characters of brinjal and these characters may be used as important selection parameters because of their probable conditioning by additive gene action.

Rekha and celine (2013) revealed that the traits like number of branches per plant, fruit length, number of fruits per plant were the most important yield contributing owing to their high direct and indirect effects and indirect effects via other traits.

Shende *et al.* (2014) revealed that length of fruit, number of fruits per cluster, plant height, days to last picking, average weight of fruit and number of fruits per plant would be selection criteria for yield improvement in brinjal.

MATERIALS AND METHODS

The material and methods pertaining to the thesis entitled “Studies on variability and character association in Brinjal (*Solanum melongena* L.)” are given as below.

3.1 Experimental site

The experiment was carried at Horticulture complex, Department of Horticulture, College of Agriculture, Jabalpur (Madhya Pradesh). The experimental area occupied was quite uniform in respect of topography and fertility.

3.1.1 Soil

The soil of the experimental field was medium black with good drainage, uniform texture and medium NPK status.

3.1.2 Climate and Weather

Jabalpur is situated in “Kymore Plateau and Satpura Hills” agro climatic region of M.P. It falls in 23.9° N latitude and 79.58°E longitudes with an altitude of 411.8 m above the mean sea level. Jabalpur is situated in the semi-arid region having sub-tropical climate with hot dry summer, and cold winter. The average rainfall is about 1375mm, which is mainly distributed from mid June to September. The average maximum and minimum temperature ranges between 46.6°C and 21°C. The mean reaches up to 78% during winter (November- February) with occasional frost.

The data related to weekly maximum and minimum temperature, relative humidity rainfall (mm), sunshine hours and wind velocity (km/hr) recorded at Meteorological Observatory Krishi Nagar, J.N.K.V.V, Jabalpur are presented in the Table3.1. and Fig. 1.

Table 3.1: Weekly meteorological data during the cropping season (2014- 2015) at Jabalpur.

Metro. Weeks.	Temperature (°C)		Sun Shine (hrs.)	Rainfall (mm)	Relative humidity (%)		Rainy days
	Max.	Min.			Mor.	Eve.	
34	30.2	25.1	6.7	84.4	83	58	0
35	31.9	24.2	7.8	3	88	65	2
36	30.8	23.7	2.4	52.2	91	71	7
37	30.7	23.4	3.8	87.4	91	72	6
38	30.8	23.5	8.5	11	89	55	1
39	31.9	21.6	10	0	85	41	0
40	33.4	21	9.4	2.3	86	53	1
41	32.4	20.4	8.4	0	88	55	2
42	32.5	18.8	7.9	0	91	44	0
43	31.6	16.6	8.8	0	89	41	0
44	27.9	14.4	8.6	0	87	29	0
45	28.2	13.9	8.2	0	87	29	0
46	28.6	14.4	6	0	83	26	0
47	27.9	8.9	8.6	0	82	20	0
48	28.4	10.2	8.6	0	85	24	0
49	28.7	8	8.7	0	88	24	0
50	29	11.8	6.2	3.2	89	52	1
51	25.3	5.6	7.6	0	86	32	0
52	23.8	4.8	8.5	0	87	32	0
1	20.5	11.7	6.5	37.7	90	61	3
2	22.1	5.3	8.5	0.0	87	38	0
3	22.2	5.3	8.3	0.0	91	37	0
4	21.0	12.1	3.7	10.2	89	75	2
5	22.5	8.7	9.8	10.8	85	44	2
6	24.2	10.2	7.1	14.4	88	52	1
7	26.8	10.4	9.1	6.2	88	40	1
8	30.6	12.0	9.7	0.0	86	33	0
9	26.7	14.5	6.8	64.8	85	54	3
10	28.0	12.0	9.5	0.0	85	39	0

3.2 Experimental material

Experimental material consists of 16 genotypes and four checks of brinjal obtained from different states of India, during Rabi season 2014. (Table 3.2).

Table 3.2: Details of genotypes and checks used in the study

S.No.	Genotypes	S.No.	Genotypes
1.	2014/BRLVAR-1	11	2013/BRBWRES-1
2	2014/BRLVAR-2	12	2013/BRBWRES-2
3	2014/BRLVAR-3	13	2013BRBWRES-3
4	2014/BRLVAR-4	14	2013BRBWRES-4
5	2013/BRLVAR-1	15	Punjab Sadabahar
6	2013/BRLVAR-2	16	IVBL-9 (Kashi Tarun)
7	2013/BRLVAR-3	17	Arka Kusumkar (C)
8	2013/BRLVAR-4	18	Arka Nidhi (C)
9	2013/BRLVAR-5	19	Pusa purple long (C)
10	2013/BRLVAR-6	20	SM-6-7 (C)

3.3 Experimental details

3.3.1 Design of experiment

The experiment was laid out in Randomized Complete Block Design with three replications and each replication consisted of 20 genotypes. All the genotypes were randomized separately in each replication. The plan of layout is given in Fig.2 and other details are given as below:

1.	Crop	:	Brinjal (<i>Solanum melongena</i> L.)
2.	Design of experiment	:	Randomized Complete Block Design
3.	Number of replication	:	3
4.	Number of genotypes	:	20
5.	Total number of plots	:	60
6.	Plot size	:	3.0m x 3.6m
7.	Spacing	:	60cm x 45cm
8.	Total number of plants per plot	:	40
9.	Distance between replication	:	1.0m
10.	Date of nursery sowing	:	23/8/2014
11.	Date of transplanting	:	14/10/2014

3.4 Agronomical operations

3.4.1 Raising of seedlings

The nursery beds were dug and prepared thoroughly. All the grass, roots, bricks, pieces, residue of previous crop, weeds and other undesirable material if any were removed from the beds. The nursery beds were prepared 1m wide and 3m long and elevated up to 20cm from ground level. Seeds were sown on the nursery beds in rows 5cm apart. After sowing seeds were covered with a thin layer of sieved FYM and paddy straw. Sprinkling of water with water cans was done immediately. This practice was repeated frequently as and when required to make the beds well moisturized till the germination. After germination of seeds, cover of dry paddy straw was removed. Weeding was done manually as and when weeds appeared in the nursery beds without distributing the seedlings.

3.4.2 Land preparation and transplanting

The experimental area was ploughed and harrowed in order to bring the soil in well-pulverized condition. FYM was applied @ 20t/ha. Plots were made according to the layout plan after leveling. Seedlings were uprooted from the nursery bed and transplanted in the plots at a spacing of 60cm row to row and 45cm plant to plant. Transplanting was done in the afternoon hours immediately followed by irrigation for proper establishment of the seedlings. A week after transplanting gap filling was done. All the other recommended package of practices was followed to raise a healthy crop.

3.4.3 Irrigation

The first irrigation was given immediately after transplanting to ensure proper establishment of plant. Subsequent irrigation was given at 15 days interval up to month to January and at an interval of 10 days during the month of February.

3.4.4 Intercultural operations

The experimental plots were kept weed free. Three hand weeding were done.

3.4.5 Fertilizer application

Nitrogen, phosphorous and potassium were applied, as per the treatments through urea, single super phosphate and murate of potash respectively. A uniform dose of 100 Kg N/ha, 60Kg P/ha and 50Kg K/ha. was applied to all the treatments. Full quantity of phosphorus and potassium fertilizer along with one-third of nitrogen was applied before transplanting the seedlings. While, the rest of the nitrogen was applied in two equal splits 25 to 30 and 50 days after transplanting.

3.4.6 Plant protection measures

The crop was sprayed with imidachlorprid 0.2% or thimethoxan 0.025% for control of aphids and jassid, alternate to keep the crop free from pest during crop growth period.

3.5 Sampling

Sampling was done at 30 days up to till harvest for growth analysis. Five plants were randomly selected from each genotype and replication for the study.

3.6 Observation recorded

The data recorded on various parameters were subdivided into four categories during the period of experimentation. The data were recorded as per standard procedure.

(A) Morphological Parameters

3.6.1 Plant height (cm)

The height of the main stem from the ground level to the apical bud (leaf apex) was measured with the meter scale at 30 days interval (i.e 30, 60, 90, 120,150 days after transplanting).

3.6.2 Number of branches per plant

The numbers branches arising from the main stem of each tagged plant was counted at the final picking (i.e.150 DAT) stage.

(B) Phenological parameters

3.6.3 Days to first flowering

Number of days was recorded from the transplanting to the appearance of first flower on the five randomly selected plants in each genotype and replication and average was calculated.

3.6.4 Days to 50% flowering:

Number of days from the date of transplanting to 50 percent of the plants flowered in a plot was recorded.

3.6.5 Days to first picking:

The number of days beginning from transplanting to the day when first picking (fruits attained proper size and colour) was counted for each genotype.

3.6.6 Fruiting span

The number of days beginning from first fruit harvest to till the final picking was counted as the duration of the fruiting or fruiting span.

3.6.7 Number of flowers per cluster

The number of flowers per cluster was counted in five randomly selected flower cluster of each plot and then mean was determined.

(C) Yield parameters

3.6.8 Number of fruits per cluster

The number of fruits per cluster was counted in five randomly marked clusters of each plot and then average was worked out.

3.6.9 Number of fruits per plant

The number of fruits was counted in each picking in five randomly tagged plants from each genotype and it was calculated by dividing the total number of fruits harvested in all the pickings with five.

3.6.10 Fruit length (cm)

The length of fruits from joint of calyx to the apex was measured in centimeter for five randomly selected fruits from each plot, at peak fruiting stage.

3.6.11 Fruit width (cm)

The width of fruit was measured with the help of Vernier caliper and then average was recorded.

3.6.12 Average fruit weight (g)

The weight of five fruits was recorded separately with the help of weighing balance and average was worked out for each genotype.

3.6.13 Fruit yield per plant (kg)

The weight of the fruits of the tagged plants was recorded at each picking and average weight of the fruits per plant was calculated in kg.

3.6.14 Fruit yield per hectare (q/ha)

Total fruit yield (kg) per plot was converted in quintal per hectare by multiplying with factor.

(D) Other parameters

3.6.15 Fruit colour

Colour of ten randomly selected fruits at marketable stage was observed visually as

- Dark purple
- Dull purple
- Purple
- Green
- Black

3.6.16 Fruit shape

Shape of ten randomly selected fruits were observed visually and were categorized as

- Long
- Oblong
- Round
- Small round

3.6.17 Colour of calyx

Colour of calyx of ten randomly selected fruits was observed visually.

- Green
- Purple

3.6.18 Bearing habit

Bearing habits of plant i.e. cluster or single was recorded visually for each genotype.

3.6.19 Presence of spines on plant and fruit:

Presence of spines on plant and fruit observed visually as.

- Present
- Absent

3.6.20 Incidence of Phomopsis blight, Little leaf and Bacterial wilt:

Incidence of diseases like phomopsis blight, little leaf and bacterial wilt was recorded at ten days interval. The incidence of above mentioned diseases was calculated as follows:

3.6.21 Crop duration

Days were recorded from transplanting to harvesting.

3.6 Statistical analysis

The data recorded were subjected to following statistical analysis

3.6.1 Mean

It was calculated by using following formula:

$$\text{Mean } (\bar{X}) = \frac{\sum_{i=1}^n X_i}{n}$$

Where,

$\sum x$ = Sum of all observations

n = Number of observations

3.6.2 Arrangement of data in RCBD:

Treatment	Replications					Total
	I	II	III	-	R	
1	Y_{11}	Y_{12}	Y_{13}	-	Y_{1r}	T_1
2	Y_{21}	Y_{22}	Y_{23}	-	Y_{2r}	T_2
-	-	-	-	-	-	-
t	Y_{t1}	Y_{t2}	Y_{t3}	-	Y_{tr}	T_t
Total	R_1	R_2	R_3	-	R_r	GT

Model $\Rightarrow Y_{ij} = \mu + t_i + r_j + e_{ij}$

Where,

Y_{ij} = Phenotypic performance of i^{th} genotype in j^{th} block

μ = General mean effect

t_i = i^{th} treatment effect

r_j = j^{th} replication effect

e_{ij} = Random error, which is supposed to be identically and independently distributed with mean zero and variance

To work out the standard error for comparison of means, ANOVA table was prepared for Randomized Block Design.

3.6.3 Analysis of Variance

The data was statistically analyzed on the basis of method described by Panse and Sukhatme, (1967) to work out existing variance of observed traits.

Table: 3.2 Analysis of Variance

Source of variation	df	Sum of square	Mean sum of square	F value
Replication	(r-1)	RSS	RMS	RMS/ EMS
Treatment	(t-1)	TSS	TMS	TMS/ EMS
Error	(r-1)(t-1)	ESS	EMS	
Total	(rt-1)			

Where,

- r = number of replications
- ESS = Error sum of square
- t = Number of treatments
- RMS = Replication mean sum of square
- df = degrees of freedom
- TMS = Treatment mean sum of square
- RSS = Replication sum of square
- EMS = Error mean sum of square
- TSS = Treatment sum of square

A significant value of F-test indicates that the test entries differ significantly among themselves, which requires computing the critical difference (CD).

$$\text{Coefficient of variation (CV)} = \frac{\sqrt{\text{EMS}}}{\text{G.M.}} \times 100$$

$$\text{Standard error of difference SE (d)} = \sqrt{\frac{2\text{EMS}}{r}}$$

$$\text{Critical difference (cd)} = t_{(0.01)} \times S_{(d)}$$

Where,

- G.M. = General mean
- $t_{(0.01)}$ = t-value at 1% probability level
- r = number of replication

3.6.4 Genetic variability

Genotypic, environmental and phenotypic variances of the observed traits (expressed in percentage) were calculated by the formula of Burton (1952).

$$\text{Genotypic variance } (\sigma^2_g) = (\text{TMS} - \text{EMS}) / r$$

$$\text{Environmental variance } (\sigma^2_e) = \text{EMS}$$

$$\text{Phenotypic variance } (\sigma^2_p) = \sigma^2_g + \sigma^2_e$$

Where,

- TMS = Treatment mean sum of square
- EMS = Error mean sum of square
- r = Number of replication

3.6.5 Coefficient of variation

The coefficient of variation at genotypic and phenotypic levels was calculated as per the formula proposed by Burton, (1952).

3.6.5.1 Phenotypic coefficient of variation (PCV)

$$\sigma_p^2 = \sigma_g^2 + \sigma_e^2$$

$$PCV = (\sigma_p / \bar{X}) \times 100$$

$$\text{Where, } \sigma_p = \sqrt{\sigma_p^2}$$

3.6.5.2 Genotypic coefficient of variation (GCV)

$$GCV = (\sigma_g / \bar{X}) \times 100$$

Where,

$$\sigma_p^2 = \text{Phenotypic variance}$$

$$\sigma_p = \text{Phenotypic standard deviation}$$

$$\sigma_g^2 = \text{Genotypic variance}$$

$$\sigma_g = \text{Genotypic standard deviation}$$

$$\sigma_e^2 = \text{Environmental variance}$$

$$\bar{X} = \text{General mean}$$

3.6.6 Heritability:

It was calculated in broad sense by the formula proposed by Hanson et al., (1956).

$$\text{Heritability (h}^2\text{)} = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where,

$$h^2 = \text{heritability in broad sense}$$

$$\sigma_g^2 = \text{Genotypic variance}$$

$$\sigma_p^2 = \text{Phenotypic variance}$$

3.6.7 Genetic advance (GA):

Genetic advance is calculated by the formula suggested by Johnson et al., (1955).

$$GA = h \times \sigma_p \times K$$

Where,

$$GA = \text{Genetic advance}$$

$$\sigma_p = \text{Phenotypic standard deviation}$$

$$h = \text{Heritability}$$

$$K = \text{Selection intensity at 5\% level of significance i.e., 2.06}$$

3.6.8 Genetic advance as percent of mean

It was calculated by the following formula:

$$\text{GA as percentage of mean} = \frac{\text{Genetic advance}}{\text{General mean}} \times 100$$

3.6.9 Estimation of correlation coefficients:

All correlation coefficients were calculated at genotypic and phenotypic levels using the formula suggested by Miller et al., (1958).

$$r_{X_i X_j} = \frac{\text{Cov } X_i X_j}{\sqrt{(\text{Var } X_i) \cdot (\text{Var } X_j)}}$$

Where,

$$r_{X_i X_j} = \text{Coefficient of correlation between characters } X_i \text{ and } X_j$$

Cov (X_iX_j) = Covariance between characters X_i and X_j

Var (X_i) = Variance of character X_i

Var (X_j) = Variance of character X_j

Genotypic and phenotypic correlation coefficients were compared by substituting the corresponding variance and covariance for all the observed characteristics.

$$\text{Genotypic } r(X_i Y_i) = \frac{\text{Genotypic cov } X_i Y_i}{\sqrt{\sigma_g^2(X_i) \sigma_g^2(Y_i)}}$$

$$\text{Phenotypic } r(X_j Y_j) = \frac{\text{Genotypic cov } X_j Y_j}{\sqrt{\sigma_p^2(X_j) \sigma_p^2(Y_j)}}$$

Where, $\sigma_g^2(x_i)$ = Genotypic variance of character x_i

of character x_i

$\sigma_g^2(y_i)$ = Genotypic variance of character y_i

$\sigma_p^2(x_i)$ = Phenotypic variance of character x_i

$\sigma_p^2(y_i)$ = Phenotypic variance of character y_i

Testing of correlation coefficient for significance: To test the significance of correlation coefficient, t-value was computed and compared with the tabulated value of 't' at (n-2) degree of freedom at 5% and 1% level of probability.

$$t_c = \frac{r}{\sqrt{1-r^2}} \sqrt{n-2}$$

Where,

t_c = Calculated value of t

r = Estimated value of correlation coefficient

n = Number of paired observations

3.7 Path coefficient analysis:

It is a simple standardized partial coefficient method to detect the direct and indirect effects of the independent variable on dependent variable. It permits separation of correlation into components of direct and indirect effects. The method of path coefficient was developed by Wright (1921) and modified by Dewey and Lu, (1959). The following set of simultaneous equations were formed and used for estimation of direct and indirect effects on seed vigour.

$$R_{1y} = p_{1y} + r_{12}p_{2y} + r_{13}p_{3y} + \dots + r_{1y}p_{1y}$$

$$R_{2y} = r_{2y}p_{1y} + p_{2y} + r_{23}p_{3y} + \dots + r_{21}p_{1y}$$

$$r_{ky} = r_{ki} + r_{ki}p_{2y} + r_{13}p_{3y} + \dots + r_{2iy}p_{iy}$$

$$r_{xky} = r_{xki}p_{iy} + r_{zk2}p_{2y} + r_{xk3}p_{3y} + \dots + p_{ky}$$

where,

R_{xky} = Coefficient of correlation between the independent character

P_{iy} to p_{ky} = Direct effects of character 1 to k on dependent character y

Direct effect: The direct effects were calculated as follows-

$$P_{ky} = \sum_{i=1}^k C_{ki} r_{ky}$$

Indirect effect: Indirect effect of any independent traits on the dependent one *via*. Other independent traits was computed by multiplying the direct effect (P_{ky}) of that independent variable with the corresponding correlation coefficient as follows:

$$K^{\text{th}} \text{ trait via } (n-1) = r_k (n-1) P(n-1) Y$$

Residual effect: Residual effect was obtained as per formula given below:

$$R = \sqrt{1 - E_{di} r_{ji}}$$

Where,

d_i = Direct effect of character

r_{ij} = Correlation coefficient of i^{th} character with j^{th} character

RESULTS

The results obtained from the present investigation “Studies on variability and character association in brinjal (*Solanum melongena* L)” are presented under the following heads:

4.1 Analysis of variance

4.2 Genetic Variability

4.2.1 Range and Mean performance

4.2.2 Coefficient of variation

4.2.3 Heritability

4.2.4 Genetic advance

4.3 Correlation coefficient analysis

4.4 Path coefficient analysis

4.5 Other qualitative parameters

4.1 Analysis of variance

The analysis of variances for all the characters studied has been presented in Table 4.1 Mean square due to genotypes were highly significant for all the characters indicating the presence of genetic diversity in the existing material.

Five characters viz. Fruiting span, number of fruits per plant, average fruit weight, fruit yield per plant, fruit yield per hectare and days to 50 percent flowering exhibited the value of higher magnitude.

Table 4.1: Analysis of variance for various characters in brinjal (mean sum of squares)

Source of variance	df.	Plant height					No. of branches per plant
		30 DAT	60 DAT	90 DAT	120DAT	150DAT	
Replications	2	37.231	36.314	43.472	28.291	40.249	7.335
Genotypes	19	20.906**	78.301**	69.920**	67.709**	57.471**	1.807**
Error	38	0.344	0.270	0.231	0.267	0.278	0.156

Source of variance	df.	Days to 1 st flowering	Days to 50% flowering	Days to 1 st picking	Fruiting span
Replications	2	41.816	30.200	52.816	73.266
Genotypes	19	17.574**	15.143**	44.241**	90.529**
Error	38	2.237	1.164	7.641	8.792

Source of variance	df.	Number of flowers/cluster	Number of fruits/cluster	Number of fruits per plant	Length of fruit (cm)
Replications	2	2.753	1.885	9.215	2.006
Genotypes	19	0.307**	0.494**	122.132**	49.625**
Error	38	0.038	0.029	8.077	1.014

Source of variance	df.	Width of fruit (cm)	Weight of fruit (g)	Crop duration	Fruit yield/ plant (g)
Replications	2	1.178	149.107	0.716	46115.41
Genotypes	19	2.800**	4613.781**	83.869**	87696.05**
Error	38	0.123	108.875	2.295	13309.27

Source of variance	df.	Fruit yield / ha (q)	Incidence of bacterial wilt %	Incidence of phomopsis blight %
Replications	2	3966.272	44.732	24.686
Genotypes	19	35124.425**	145.540**	45.809**
Error	38	2814.976	38.252	22.099

Source of variance	df.	Incidence of little leaf %
Replications	2	5.104
Genotypes	19	32.982**
Error	38	6.419

4.2 Genetic Variability

4.2.1 Range and mean performance of the genotypes

Range and mean performance (maximum and minimum) of the twenty genotypes of brinjal for all the twenty three characters are presented in Table 4.2 a, b, c and d.

4.2.1.1 Plant height (cm)

Plant height varied from 17.89 to 26.36 cm, 30.71 to 49.60 cm, 41.98 to 62.06 cm, 53.80 to 71.80 cm and 65.35 to 79.94 cm with an overall mean performance of 21.02, 37.72, 50.71, 61.16 and 71.90 cm at 30,60,90,120 and 150 DAT respectively. Genotype 2013/BRBWRES-4 recorded the maximum plant height 26.36, 49.60, 62.06, 71.80 and 79.94 cm and genotype 2013/BRLVAR-4 exhibited the minimum 17.89, 30.71, 41.98, 53.80 and 65.35 cm plant height at 30, 60, 90, 120 and 150, respectively.

4.2.1.2 Number of branches per plant

Number of branches per plant ranged between 5.87 to 9.24 with an average performance of 7.37. The maximum branches per plant (9.24) were recorded in genotype SM-6-7, while minimum in 2013/BRBWRES-4 (5.87).

Table 4.2a: Mean performance of morphological characters of brinjal

Genotypes	Plant height (cm)					No. of branches per plant
	30 DAT	60 DAT	90 DAT	120DAT	150DAT	
2014/BRLVAR – 1	23.61	38.88	49.91	60.24	70.78	7.65
2014/BRLVAR – 2	20.97	33.13	48.17	58.42	69.76	6.77
2014/BRLVAR – 3	22.27	33.21	44.26	55.38	65.87	7.44
2014/BRLVAR – 4	24.72	44.73	54.72	63.29	73.78	6.54
Kashi Tarun (C)	25.17	42.80	51.87	60.66	71.29	7.80
Pb. Sadabahar (C)	17.99	32.66	47.77	55.02	67.96	8.29
2013/BRLVAR - 1	19.59	34.29	48.05	58.77	70.46	7.20
2013/BRLVAR - 2	26.36	39.63	53.47	61.96	68.80	6.41
2013/BRLVAR – 3	24.28	36.43	52.94	64.83	75.74	8.10
2013/BRLVAR – 4	19.69	30.71	41.98	53.80	65.35	7.48
2013/BRLVAR – 5	19.65	31.84	50.84	62.55	72.50	7.34
2013/BRLVAR - 6	17.97	31.73	45.58	56.54	68.43	8.06
2013/BRBWRES-1	21.33	41.93	55.30	64.20	73.68	7.48
2013/BRBWRES-2	18.27	38.63	57.01	67.45	79.94	7.03
2013/BRBWRES-3	18.81	36.85	44.62	56.70	66.64	7.58
2013/BRBWRES-4	21.98	49.60	62.06	71.80	78.66	5.87
Arka Kusumakar (Sc)	19.22	38.70	49.22	58.19	71.40	6.23
Arka Nidhi (RC)	21.53	38.99	51.88	61.19	71.10	7.43
PPL (SC)	17.89	44.52	54.59	67.97	79.45	7.65
SM-6-7 (RC)	19.23	35.16	49.99	64.36	76.54	9.24
S.Em±	0.33	0.30	0.27	0.29	0.30	0.22
C.D.5% level	0.97	0.86	0.80	0.86	0.87	0.65

4.2.1.3 Days to first flowering

Days to first flowering varied from 26.33 to 34.00 days with an average being 29.58. Early flowering was observed in Kashi Tarun (C) (26.33 days), while the genotype Pusa purple long (SC) (34.00) days recorded the maximum days to first flowering.

4.2.1.4 Days to 50 percent flowering

Early 50 percent flowering was recorded in genotype Kashi Tarun (31.33 days), while the genotype Pusa purple long (SC) (38.33days) for 50 percent flowering. The average days for 50 percent flowering were 34.40 days and it ranged from 31.33 to 38.33 days.

4.2.1.5 Days to first picking

Days to first picking ranged from 50.00 to 64.67 days. Genotype Kashi Tarun was earliest for days to first picking, while Arka Nidhi was latest for the same. The mean was calculated to be 57.48 days.

4.2.1.6 Fruiting span

The mean for fruiting span was 96.56 days and it ranged from 83.67 to 105.00 days. Maximum length of fruiting period was observed in genotype 2013/BRLVAR-2 (105.00 days) and minimum for genotype 2014/BRLVAR-4 (83.67).

4.2.1.7 Numbers of flowers per cluster

The number of flowers per cluster varied from 2.04 to 3.11 with a mean value of 2.58. Genotype 2013/BRLVAR-4 produced considerably more 3.11 flowers per cluster. Whereas, genotype 2014/BRLVAR-2 recorded minimum flowers per cluster (2.04).

4.2.1.8 Numbers of fruits per cluster

Maximum number of fruits per cluster was observed in 2013/BRLVAR-4 (2.88), while, it was least (1.38) in genotype 2014/BRLVAR-2. The average number of fruits per cluster was 2.12 and it ranged between 1.38 to 2.88. fruits per cluster.

Table 4.2b: Mean performance of phenological characters of brinjal

Genotypes	Days to 1st flowering	Days to 50% flowering	Days to 1st picking	Fruiting span	Number of flowers/ cluster	Number of fruits/ cluster
2014/BRLVAR – 1	27.33	31.67	54.67	89.00	2.13	1.67
2014/BRLVAR – 2	27.00	31.67	54.00	90.33	2.04	2.17
2014/BRLVAR – 3	27.00	31.67	50.34	93.33	2.17	1.97
2014/BRLVAR – 4	27.33	32.00	60.33	83.67	2.54	2.67
Kashi Tarun (C)	26.33	31.33	50.00	93.33	2.77	2.37
Pb. Sadabahar (C)	27.00	32.00	50.33	93.67	2.80	2.37
2013/BRLVAR - 1	27.67	33.00	57.00	99.00	2.52	2.11
2013/BRLVAR - 2	29.00	34.33	51.33	105.00	2.47	2.55
2013/BRLVAR – 3	29.33	34.67	61.34	95.33	2.42	1.54
2013/BRLVAR – 4	31.00	35.67	63.00	94.67	3.11	1.58
2013/BRLVAR – 5	31.00	35.33	60.66	96.67	3.09	2.28
2013/BRLVAR - 6	28.67	34.00	61.33	94.67	2.43	1.38
2013/BRBWRES-1	28.33	34.33	56.00	101.33	2.57	2.71
2013/BRBWRES-2	29.67	34.67	63.34	94.33	2.33	2.06
2013/BRBWRES-3	30.67	35.00	55.00	103.00	2.96	1.95
2013/BRBWRES-4	31.00	35.67	55.00	103.67	3.06	2.88
Arka Kusumakar (Sc)	33.00	38.00	59.67	101.33	2.34	2.33
Arka Nidhi (RC)	33.00	37.67	64.67	99.33	2.89	1.83
PPL (SC)	34.00	38.33	58.00	103.33	2.55	2.11
SM-6-7 (RC)	33.33	37.00	63.67	96.33	2.57	2.00
S.Em±	0.86	0.62	1.59	1.71	0.11	0.09
C.D.5% level	2.49	1.79	4.60	4.94	0.32	0.28

4.2.1.9 Number of fruits per plant

The maximum number of fruits per plant was observed in 2013/BRLVAR-5 (27.33), while it was least in genotype 2013/BRBWRES-4 (3.77). The average number of fruits per plant was 11.23 and it ranged from 3.77 to 27.33.

4.2.1.10 Fruit length

The fruit length varied from 11.06 to 25.52 cm with a mean value of 19.09 cm. Genotype 2013/BRBWRES-2 produced considerably long fruit (25.52), while, genotype SM-6-7 (RC) (11.06) produced small fruit.

4.2.1.11 Fruit width (cm)

Fruit width ranged from 3.17 to 6.51 cm and the average was calculated in 4.55 cm. Fruit width was recorded maximum in 2013/BRLVAR-3 (6.51 cm) and least was recorded in genotype 2014BRLVAR-4 (3.17).

4.2.1.12 Average fruit weight (g)

The heaviest fruit were observed in genotype 2013/BRBWES-4 (168.46 g) and were lightest in 2013/BRLVAR-6 (30.87 g). The weight of fruit lied between 30.87 g to 168.46 g, with an average of fruit was 88.10 g.

4.2.1.13 Crop duration

Highest days were observed in genotype Arka Nidhi (RC) (185) and minimum days were observed in genotype 2014/BRLVAR-1 (172.00), 2014/BRLVAR-2 (172.00), 2014/BRLVAR-3 (172.00) and Kashi Tarun (C) (172.00). Crop duration ranged from 172.00 to 185.00 and the average was calculated in 179.88 days.

4.2.1.14 Fruit yield per plant (g)

Maximum fruit yield per plant was recorded in genotype 2013/BRBWRES-1 (1235.00 g) which was closely followed by 2013/BRBWRES-2 (1131.67 g) and 2014/BRLVAR-2 (948.33 g) and which were at par with each other. Genotype Arka Kusumkar (SC) (540.00 g) was poor yielder. The average yield per plant was 790.83 g and it ranged from 540.00 g to 1235.00 g.

Table 4.2c: Mean performance of yield characters of brinjal

Genotypes	Number of fruits per plant	Length of fruit (cm)	Width of fruit (cm)	Weight of fruit (g)	Crop duration
2014/BRLVAR – 1	6.63	21.71	3.78	117.37	172.00
2014/BRLVAR – 2	8.30	23.93	3.47	115.42	172.00
2014/BRLVAR – 3	10.07	22.07	3.87	73.67	172.00
2014/BRLVAR – 4	8.30	22.43	3.17	108.33	172.33
Kashi Tarun (C)	6.63	18.86	4.31	110.67	172.00
Pb. Sadabahar (C)	12.80	23.76	3.28	61.33	172.33
2013/BRLVAR - 1	20.70	18.21	6.20	44.59	182.33
2013/BRLVAR - 2	18.23	15.40	6.00	46.82	182.00
2013/BRLVAR – 3	13.00	15.39	6.51	54.75	182.00
2013/BRLVAR – 4	12.13	16.04	4.66	69.45	183.00
2013/BRLVAR – 5	27.33	17.43	5.56	30.92	182.67
2013/BRLVAR - 6	23.60	16.71	4.38	30.87	183.33
2013/BRBWRES-1	8.00	16.72	4.63	156.81	183.67
2013/BRBWRES-2	8.37	25.52	4.77	138.28	184.00
2013/BRBWRES-3	8.57	14.63	4.13	73.06	182.67
2013/BRBWRES-4	3.77	22.18	3.83	168.46	184.33
Arka Kusumakar (Sc)	5.23	14.00	3.96	103.13	183.33
Arka Nidhi (RC)	8.03	23.44	4.16	84.77	185.00
PPL (SC)	7.33	22.35	4.83	84.82	182.00
SM-6-7 (RC)	7.70	11.06	5.50	88.62	184.67
S.Em±	1.64	0.58	0.20	6.02	0.87
C.D.5% level	4.73	1.67	0.58	17.39	2.52

Table 4.2d: Mean performance of yield characters of brinjal

Genotypes	Fruit yield/ plant (g)	Fruit yield / ha. (q)
2014/BRLVAR – 1	768.33	313.26
2014/BRLVAR – 2	948.33	392.72
2014/BRLVAR – 3	768.33	340.40
2014/BRLVAR – 4	856.67	357.51
Kashi Tarun (C)	716.67	291.37
Pb. Sadabahar (C)	768.33	298.15
2013/BRLVAR - 1	920.00	340.71
2013/BRLVAR - 2	848.33	313.60
2013/BRLVAR – 3	715.00	264.86
2013/BRLVAR – 4	841.67	311.57
2013/BRLVAR – 5	811.67	300.78
2013/BRLVAR - 6	725.00	268.25
2013/BRBWRES-1	1235.00	458.49
2013/BRBWRES-2	1131.67	418.53
2013/BRBWRES-3	626.67	170.50
2013/BRBWRES-4	630.00	168.35
Arka Kusumakar (Sc)	540.00	68.96
Arka Nidhi (RC)	678.33	83.55
PPL (SC)	623.33	169.24
SM-6-7 (RC)	663.33	131.81
S.Em±	66.60	30.63
C.D.5% level	192.34	88.46

4.2.1.16 Fruit yield per hectare (q)

Fruit yield in quintal per hectare varied from 68.96 q/ha to 458.49 q/ha with an average yield of 273.13 q/ha. The maximum fruit yield was recorded in genotype 2013/BRBWRES-1 (458.49 q/ha) followed by 2013/BRBWRES-2 (418.53 q/ha) and 2014/BRLVAR-2 (392.72 q/ha).and which were at par with each other. However, it was found least in genotype Arka Kusumkar (SC) (68.96 q/ha).

4.2.2 Coefficient of variations

Estimations of variation genetic parameters for yield and its attributes exhibited a wide range of variation for the characters studied (Table 4.3). Result indicated that the value of phenotypic coefficient of variations were higher in magnitude than that of genotypic coefficient of variation for all the characters showing that the environment had an important role in influencing the expression of the characters.

4.2.2.1 Phenotypic coefficient of variation

The phenotypic coefficient of ranged from 0.75% for duration of crop to 60.42% for Number of fruits per plant. The phenotypic coefficient of variation was highest for characters viz., number of fruits per plant (60.42%), weight of fruit (g) (45.55%), fruit yield per hectare (q) (42.67%), fruit yield per plant (g) (24.68%), width of fruit (cm) (22.15%) and length of fruit (cm) (21.73%). However, it exhibited low for characters like crop duration (3.02%), followed by days to first picking (5.36%), plant height at 150 DAT (6.12%), fruiting span (6.22%), plant height at 120DAT (7.80%), days to

Table 4.3: Genetic parameters in brinjal

Characters		Grand Mean	Range		Coefficient of variations		Heritability % (BS)	Genetic Advance	GA as % of mean
			Min.	Max.	Phenotypic	Genotypic			
Plant height (cm)	30 DAT	21.02	17.89	26.36	12.76	12.45	95.21	5.26	25.03
	60 DAT	37.72	30.71	49.60	13.59	13.52	98.97	10.45	27.71
	90 DAT	50.71	41.98	62.06	9.55	9.50	99.02	9.88	19.48
	120DAT	61.16	53.80	71.80	7.80	7.75	98.82	9.71	15.88
	150DAT	71.90	65.35	79.94	6.12	6.07	98.56	8.93	12.42
No. of branches / plant		7.37	5.87	9.24	11.39	10.05	77.86	1.35	18.30
Days to 1 st flowering		29.58	26.33	34.00	9.16	7.64	69.55	3.88	13.13
Days to 50% flowering		34.40	31.33	38.33	7.02	6.28	80.00	3.98	11.56
Days to 1 st picking		57.48	50.00	64.67	5.36	4.20	61.49	5.64	6.79
Fruiting span		96.56	83.67	105.00	6.22	5.41	75.60	9.35	9.68
Number of flowers/ cluster		2.58	2.04	3.11	13.82	11.56	69.92	0.52	19.98
Number of fruits/ cluster		2.12	1.38	2.88	20.19	18.53	84.25	0.74	35.14
Number of fruits per plant		11.23	3.77	27.33	60.42	54.87	82.48	11.54	102.72
Length of fruit (cm)		19.09	11.06	25.52	21.73	21.08	94.11	8.04	42.14
Width of fruit (cm)		4.55	3.17	6.51	22.15	20.76	87.82	1.82	40.08
Weight of fruit (g)		88.10	30.87	168.46	45.55	43.98	93.24	77.08	87.49
Crop duration		179.88	172.00	185.00	3.02	2.90	92.21	10.32	5.73
Fruit yield /plant (g)		790.83	540.00	1235.00	24.68	19.91	65.07	261.67	33.09
Fruit yield /ha (q)		273.13	68.96	458.49	42.67	37.99	79.27	190.33	69.68

first flowering (9.16%) and plant height at 90 DAT (9.55%). While numbers of flowers per cluster (13.82%), plant height at 60 DAT (13.59 %), plant height at 30 DAT (12.76%) and number of branches per plant (11.39%) exhibited moderate phenotypic coefficient of variation.

4.2.2.2 Genotypic coefficient of variation

It is revealed from the Table 4.3 that GCV varied from 0.75% for duration of crop to 54.87% for numbers of fruit per plant.

High genotypic coefficient of variation was noted for number of fruits per plant (54.87%) followed by weight of fruit (g) (43.98%), fruit yield per hectare (q) (37.99) and length of fruit (cm) (21.08%). Crop duration (2.90%), days to first picking (4.20%), fruiting span (5.41%), plant height at 120 DAT (6.07%), days to 50% flowering (6.28%), days to first flowering (7.64%), plant height at 120 DAT (7.75%) and plant height at 90 DAT (9.50%) showed lowest GCV. While, it was moderate for width of fruit (cm) (20.76%), fruit yield per plant (g) (19.91%), number of fruits per cluster (18.53%), plant height at 60 DAT (13.52%), plant height at 30 DAT (12.45%), number of flowers per cluster (11.56%) and number of branches per plant (10.05%).

4.2.3. Heritability

The heritability (BS) was computed for each of the characters by the variance components for estimating their relative magnitudes of genotypic and phenotypic variability contributed through environmental factors. The estimates of heritability (BS) for all the characters have been discussed as follow (Table 4.3). It was partitioned as very high (above 90%), high (70 to 90%), moderate (50 to 70%) and low (below 50%).

Result indicated that the heritability estimates were very high for plant height at 90 DAT (99.02%), plant height at 60 DAT (98.97%), plant height at 120 DAT (98.82%), plant height at 150 DAT (98.56%), plant height at 30 DAT (95.21%), length of fruit (cm) (94.11%), weight of fruit (g) (93.24%) and crop duration (92.21%). However, it was recorded high for width of fruit (cm) (87.82%), number of fruits per cluster (84.25%), numbers of fruits per plant (82.48%), days to 50% flowering (80.00%), fruit yield per hectare (q) (79.27%), number of branches per plant (77.86%) and fruiting span (75.60%). Moderate

estimation of heritability was recorded for number of flowers per cluster (69.92%), days to first flowering (69.55%), fruit yield per plant (g) (65.07%) and days to first picking (61.49%).

4.2.4 Genetic advance

Based on the estimate of heritability (BS), expected genetic advance was computed on the hypothetical selection at 5 percent best individual ($K=2.06$). Due to masking influence of environment upon characters concerned, values of genetic advance exhibited high fluctuations. Therefore to attain relative comparison of the characters in relation to environment, genetic advance as percentage of mean was calculated to predict the genetic gain (Table 4.3).

Genetic advance as percentage of mean ranged between 5.73% for crop duration to 102.72% for number of fruits per plant. The highest estimate of genetic advance as percentage of mean was recorded for number of fruits per plant (102.72%), weight of fruit (g) (87.49%), fruit yield per hectare (q) (69.68%), length of fruit (cm) (42.14%), width of fruit (cm) (40.08%), number of fruits per cluster (35.14%), fruit yield per plant (g) (33.09%), plant height at 60 DAT (27.71%) and plant height at 30 DAT (25.03%).

Number of flowers per cluster (19.98%), plant height at 90 DAT (19.48%), number of branches per plant (18.30%) and plant height at 120 DAT (15.88%) showed moderate value of genetic advance as percentage of mean. Whereas, low estimates were observed for days to first flowering (13.13%), plant height at 120 DAT (12.42%), days to 50% flowering (11.56%), fruiting span (9.68%), days to first picking (6.79%) and crop duration (5.73%).

4.3 Correlation coefficient

Correlation coefficients were worked out at phenotypic, genotypic and environmental levels for all possible combination of fourteen characters (Table 4.4). Results indicated that genotypic correlation coefficient in general were of higher magnitude than the corresponding phenotypic correlation coefficient for all the characters.

The results of phenotypic correlation coefficients have been discussed only as the genotypic and environmental correlation were mostly influenced

by the environmental conditions, hence phenotypic correlation will give the correct idea about association between two variables.

4.3.1 Plant height (cm) at 150 DAT

Plant height at 150 DAT showed significant and positive correlation with average weight of fruit (g) (0.473), days to 50% flowering (0.360), days to first flowering (0.342), crop duration (0.324) and number of fruits per cluster (0.277). Highly significant and negative association of this character was observed with number of fruits per plant (-0.287).

4.3.2 Number of branches per plant

Number of branches per plant expressed significant and negative correlation with number of fruits per cluster (-0.485), average fruit weight (-0.324) and length of fruit (cm) (-0.279).

4.3.3 Days to first flowering

Days to first flowering recorded significant and positive association with days to 50% flowering (0.944), crop duration (0.659), fruiting span (0.473), plant height at 150 DAT and number of flowers per cluster (0.297). While, negative association with length of fruit (-0.277).

4.3.4 Days to 50 percent flowering

Days to 50 percent flowering recorded highly significant and positive association with days to first flowering (0.944), crop duration (0.743), fruiting

Table 4.4: Estimates of genotypic and phenotypic correlation coefficients among yield and its contributing traits in brinjal

Characters		No. of branches/ plant	Days to 1 st flowering	Days to 50% flowering	Days to 1 st picking	Fruiting span	Number of flowers/ cluster	Number of fruits/ cluster	No. of fruits /plant	Length of fruit (cm)	Width of fruit (cm)	Av. Weight of fruit (g)	Crop duration	Fruit yield /plant (g)
Plant height (cm) 150 DAT	G	-0.070	0.422	0.416	0.251	0.149	-0.040	0.303	-0.321	0.183	0.219	0.498	0.346	0.072
	P	-0.069	0.342**	0.360**	0.186	0.133	-0.033	0.277*	-0.287*	0.174	0.213	0.473**	0.324*	0.069
No. of branches / plant	G	1	0.035	-0.009	0.225	-0.184	0.047	-0.580	0.161	-0.300	0.259	-0.384	-0.034	-0.118
	P	1	0.053	-0.011	0.181	-0.179	0.010	-0.485**	0.119	-0.279*	0.192	-0.324*	0.005	-0.072
Days to 1 st flowering	G		1	0.965	0.217	0.637	0.410	-0.098	-0.164	-0.348	0.255	-0.016	0.799	-0.553
	P		1	0.944**	0.174	0.473**	0.297*	-0.117	-0.120	-0.277*	0.215	-0.038	0.659**	-0.341**
Days to 50% flowering	G			1	0.202	0.708	0.381	-0.077	-0.116	-0.372	0.321	-0.023	0.867	-0.434
	P			1	0.173	0.563**	0.314*	-0.074	-0.091	-0.301*	0.265*	-0.018	0.743**	-0.305*
Days to 1 st picking	G				1	-0.372	-0.029	-0.518	0.204	-0.038	0.189	-0.095	0.361	-0.336
	P				1	-0.526**	0.059	-0.395**	0.188	-0.056	0.157	-0.101	0.247	-0.284*
Fruiting span	G					1	0.415	0.229	0.042	-0.404	0.447	-0.044	0.750	0.432
	P					1	0.255*	0.196	0.007	-0.299*	0.338**	-0.022	0.637**	0.388**
Number of flowers/ cluster	G						1	0.222	0.138	-0.197	0.042	-0.117	0.440	-0.284
	P						1	0.117	0.157	-0.163	0.112	-0.112	0.331**	-0.162
Number of fruits/ cluster	G							1	-0.254	0.171	-0.214	0.503	-0.111	0.219
	P							1	-0.239	0.147	-0.210	0.489**	-0.088	0.185
No. of fruits /plant	G								1	-0.250	0.537	-0.818	0.207	0.410
	P								1	-0.235	0.469**	-0.770**	0.155	0.364**
Length of fruit (cm)	G									1	-0.546	0.363	-0.476	0.453
	P									1	-0.515**	0.339**	-0.439**	0.374**
Width of fruit (cm)	G										1	-0.471	0.567	0.400
	P										1	-0.440**	0.526**	0.347**
Av. Weight of fruit (g)	G											1	-0.086	0.322
	P											1	-0.078	0.297*
Crop duration	G												1	-0.054
	P												1	-0.044

Significant at 5% level = *

Significant at 1% level = **

span (0.563), plant height at 150 DAT (0.360), number of flowers per cluster (0.314) and width of fruit (cm) (0.265). However, it was exhibited significant and negative with fruit yield per plant (g) (-0.305) and length of fruit (cm) (-0.301).

4.3.5 Days to first picking

Significant and negative association of first picking was observed with fruiting span (-0.526), number of fruits per cluster (-0.395) and fruit yield per plant (-0.284).

4.3.6 Fruiting span

Association of fruiting span was recorded significant and positive with crop duration (0.637), days to 50 percent flowering (0.563), days to first flowering (0.473), fruit yield per plant (0.388), width of fruit (0.338) and number of flowers per cluster (0.255). However, it was exhibited significant and negative with days to first picking (-0.526) and length of fruit (-0.299).

4.3.7 Number of flowers per cluster

Number of flower per cluster showed significant and positive correlation with crop duration (0.331), days to 50 percent flowering (0.314), days to first flowering and fruiting span (0.255).

4.3.8 Number of fruits per cluster

Number of fruits per cluster expressed significant and positive correlation with average fruit weight of fruit (0.489) and plant height at 150 DAT (0.277). While significant and negative association with number of branches per plant (-0.485) and days to first picking (-0.395).

4.3.9 Number of fruits per plant

Number of fruits per plant recorded positive and significant association with width of fruit (0.469) and fruit yield per plant (0.364). However, it exhibited significant and negative association with average weight of fruit (-0.770) and plant height at 150 DAT (-0.287).

4.3.10 Fruit length (cm)

Association of fruit length recorded significant and positive with fruit yield per plant (0.374) and average weight of fruit (0.339). However it exhibited significant and negative association with width of fruit (-0.515), crop duration (-0.439), days to 50 percent flowering (-0.301), fruiting span (-0.299), number of branches per plant (-0.279) and days to first flowering (-0.277).

4.3.11 Fruit width (cm)

Fruit width expressed a significant and positive correlation with crop duration (0.526), number of fruits per plant (0.469), fruit yield per plant (0.347), fruiting span (0.338) and days to 50 percent flowering (0.265). It showed significant and negative correlation with length of fruit (-0.515) and average weight of fruit (-0.440).

4.3.12 Average weight of fruit

Average fruit weight expressed highly significant and positive association with number of fruits per cluster (0.489), plant height at 150 DAT (0.473), length of fruit (0.339) and fruit yield per plant (0.297). It showed significant and negative association with number of fruits per plant (-0.770), width of fruit (-0.440) and number of branches per plant (-0.324).

4.3.13 Crop duration

Crop duration expressed a highly significant and positive correlation with days to 50 percent flowering (0.743), days to first flowering (0.659), fruiting span (0.637), width of fruit (0.526), number of flowers per cluster (0.331) and plant height at 150 DAT (0.324). It showed significant and negative association with length of fruit (-0.439).

4.3.14 Fruit yield per plant (g)

Fruit yield per plant was recorded significant and positive association with fruiting span (0.388), length of fruit (0.374), number of fruits per plant (0.364), width of fruit (0.347) and average weight of fruit (0.297). However, it exhibited significant and negative association with days to first flowering (-0.341), days to 50%flowering (-0.305) and days to first picking (-0.284).

4.4 Path coefficient analysis

To measure the direct as well as indirect association of one variable (cause) through another on the end product (effect), path coefficient were calculated at genotypic and phenotypic levels for all the yield attributing traits. The observed correlation coefficients of fruit yield with its contributing traits were partitioned into direct and indirect effects. In the present investigation, important characters viz., fruit yield per plant is been used as dependable variable. Since the values of genotypic path are more reliable in predicting the correct idea about the direct and indirect effects of the component traits, only this has been discussed below.

The estimates of path coefficient are furnished in the Table 4.5 and 4.6. In general the genotypic direct as well as indirect effects were slightly higher in magnitude as compared to corresponding phenotypic direct and indirect effects. The results obtained from genotypic direct and indirect effects are presented as under.

4.4.1 Direct effect

Path coefficient analysis of different characters towards fruit yield per plant showed that crop duration (4.631) had highest positive direct effect followed by average weight of fruit (2.717), length of fruit (2.005), width of fruit (1.885), number of fruits per plant (1.558), number of branches per plant (1.310), number of fruits per cluster (0.693) and days to first flowering (0.132). Whereas, fruiting span (-0.326) had the highest negative direct effect on days to first picking (-2.798), plant height at 150 DAT (-1.840), days to 50 percent flowering (-0.557) and number of flowers per cluster (-0.400).

Table 4.5: Path coefficients showing direct and indirect effects of different characters on fruit yield per plant (g) in brinjal

Characters		Plant height (cm)	No. of branches / plant	Days to 1 st flowering	Days to 50% flowering	Days to 1 st picking	Fruiting span	Number of flowers/ cluster	Number of fruits/ cluster	No. of fruits /plant	Length of fruit (cm)	Width of fruit (cm)	Av. Weight of fruit (g)	Crop duration	"r" value fruit yield /plant (g)
Plant height (cm)	G	-1.840	-0.092	0.056	-0.232	-0.702	-0.486	0.016	0.210	-0.500	0.367	0.413	1.353	1.602	0.072
	P	-1.061	-0.048	0.397	-0.397	0.338	0.417	0.012	0.012	-0.482	0.144	0.244	1.223	-0.739	0.069
No. of branches / plant	G	0.129	1.310	0.005	0.005	-0.630	0.600	-0.019	-0.402	0.251	-0.602	0.488	-1.043	-0.157	-0.118
	P	0.073	0.691	0.061	0.012	0.329	-0.561	-0.004	-0.021	0.200	-0.230	0.220	-0.837	-0.011	-0.072
Days to 1 st flowering	G	-0.776	0.046	0.132	-0.538	-0.607	-2.077	-0.164	-0.068	-0.256	-0.698	0.481	-0.043	3.700	-0.553
	P	-0.363	0.037	1.160	-1.042	0.316	1.482	-0.107	-0.005	-0.201	-0.229	0.247	-0.098	-1.502	-0.341
Days to 50% flowering	G	-0.765	-0.012	0.127	-0.557	-0.565	-2.309	-0.152	-0.053	-0.181	-0.746	0.605	-0.063	4.015	-0.434
	P	-0.382	-0.008	1.095	-1.104	0.315	1.765	-0.113	-0.003	-0.153	-0.249	0.304	-0.047	-1.694	-0.305
Days to 1 st picking	G	-0.462	0.295	0.029	-0.113	-2.798	1.213	0.012	-0.359	0.318	-0.076	0.356	-0.258	1.672	-0.336
	P	-0.197	0.125	0.202	-0.191	1.819	-1.649	-0.021	-0.017	0.316	-0.046	0.180	-0.261	-0.563	-0.284
Fruiting span	G	-0.274	-0.241	0.084	-0.394	1.041	-3.261	-0.166	0.159	0.065	-0.810	0.843	-0.120	3.473	0.432
	P	-0.141	-0.124	0.549	-0.622	-0.957	3.134	-0.092	0.009	0.012	-0.247	0.388	-0.057	-1.452	0.388
Number of flowers/ cluster	G	0.074	0.062	0.054	-0.212	0.081	-1.353	-0.400	0.154	0.215	-0.395	0.079	-0.318	2.037	-0.284
	P	0.035	0.007	0.345	-0.347	0.107	0.799	-0.361	0.005	0.264	-0.135	0.128	-0.289	-0.755	-0.162
Number of fruits/ cluster	G	-0.557	-0.760	-0.013	0.043	1.449	-0.747	-0.089	0.693	-0.396	0.343	-0.403	1.367	-0.514	0.219
	P	-0.294	-0.335	-0.136	0.082	-0.718	0.614	-0.042	0.044	-0.401	0.121	-0.241	1.264	0.201	0.185
No. of fruits /plant	G	0.591	0.211	-0.022	0.065	-0.571	-0.137	-0.055	-0.176	1.558	-0.501	1.012	-2.223	0.959	0.410
	P	0.305	0.082	-0.139	0.100	0.342	0.022	-0.057	-0.011	1.678	-0.194	0.538	-1.990	-0.353	0.364
Length of fruit (cm)	G	-0.337	-0.393	-0.046	0.207	0.106	1.317	0.079	0.118	-0.390	2.005	-1.029	0.986	-2.204	0.453
	P	-0.185	-0.193	-0.321	0.332	-0.102	-0.937	0.059	0.006	-0.394	0.826	-0.591	0.876	1.001	0.374
Width of fruit (cm)	G	-0.403	0.339	0.034	-0.179	-0.529	-1.458	-0.017	-0.148	0.837	-1.095	1.885	-1.280	2.626	0.400
	P	-0.226	0.133	0.249	-0.293	0.286	1.059	-0.040	-0.009	0.787	-0.425	1.147	-1.137	-1.199	0.347
Av. Weight of fruit (g)	G	-0.916	-0.503	-0.002	0.013	0.266	0.143	0.047	0.349	-1.275	0.728	-0.888	2.717	-0.398	0.322
	P	-0.502	-0.224	-0.044	0.020	-0.184	-0.069	0.040	0.021	-1.292	0.280	-0.505	2.585	0.178	0.297
Crop duration	G	-0.637	-0.045	0.106	-0.483	-1.010	-2.446	-0.176	-0.077	0.323	-0.954	1.069	-0.234	4.631	-0.054
	P	-0.344	0.003	0.765	-0.820	0.449	1.997	-0.119	-0.004	0.260	-0.363	0.603	-0.202	-2.280	-0.044

4.4.2 Indirect effect

4.4.2.1 Plant height

Plant height at 150 DAT imparted highest positive indirect effect on crop duration (1.602), average fruit weight (1.353), width of fruit (0.413), length of fruit (0.367), number of fruits per cluster (0.210), days to first flowering (0.056) and number of flowers per cluster (0.016). However, indirect effect was negative via days to first picking (-0.702), number of fruits per plant (-0.500), fruiting span (-0.486), days to 50 percent flowering (-0.232) and number of branches per plant (-0.092).

4.4.2.2 Number of branches per plant

Number of branches per plant recorded to have positive indirect effect on fruiting span (0.600), width of fruit (0.488), number of fruits per plant (0.251), plant height (0.129), days to first flowering (0.005) and days to 50 percent flowering (0.005). However, negative indirect effect was expressed via average fruit weight (-1.043), days to first picking (-0.630), length of fruit (-0.602), number of fruits per cluster (-0.402), crop duration (-0.157) and number of flowers per cluster (-0.019).

4.4.2.3 Days to first flowering

Days to first flowering revealed high values of positive indirect effect on crop duration (3.700), width of fruit (0.481) and number of branches per plant (0.046). While negative indirect effect was shown through fruiting span (-2.077), plant height (-0.776), length of fruit (-0.698), days to first picking (-0.607), days to 50 percent flowering (-0.538), numbers of fruits per plant (-0.256), number of flowers per cluster (-0.164), number of fruits per cluster (-0.068) and average weight of fruit (-0.043).

4.4.2.4. Days to 50 percent flowering

Days to 50 percent flowering expressed a positive indirect effect on crop duration (4.015), width of fruit (0.605) and days to first flowering (0.127). While, negative indirect effect was shown through fruiting span (-2.309), plant height (-0.765), length of fruit (-0.746), days to first picking (-0.565), number of fruits per plant (-0.181), number of flowers per cluster (-

0.152), average weight of fruit (-0.063), number of fruits per cluster (-0.053) and number of branches per plant (-0.012).

4.4.2.5 Days to first picking

Days to first picking revealed high values of positive indirect effect on crop duration (1.672), fruiting span (1.213), width of fruit (0.356), number of fruits per plant (0.318), number of branches per plant (0.295), days to first flowering (0.029) and number of flowers per cluster (0.012). While, negative indirect effect was shown through plant height (-0.462), number of fruits per cluster (-0.359), average fruit weight (-0.258), days to 50 percent flowering (-0.113) and length of fruit (-0.076).

4.4.2.6 Fruiting span

Fruiting span manifested highest positive indirect effect on crop duration (3.473), days to first picking (1.041), width of fruit (0.843), number of fruits per cluster (0.159), days to first flowering (0.084) and number of fruits per plant (0.065). However, rest of the characters showed negative indirect effect viz., length of fruit (-0.810), days to 50 percent flowering (-0.394), plant height (-0.274), number of branches per plant (-0.241), number of flowers per cluster (-0.166) and average fruit weight (-0.120).

4.4.2.7 Number of flowers per cluster

Number of flowers per cluster expressed a positive indirect effect on crop duration (2.037), length of fruit (0.215), number of flowers per cluster (0.154), days to first picking (0.081), width of fruit (0.079), plant height (0.074), number of branches per plant (0.062) and days to first flowering (0.054). However, high negative indirect effect exhibited via. , fruiting span (-1.353), length of fruit (-0.395), average weight of fruit (-0.318) and days to 50percent flowering (-0.212).

4.4.2.8 Number of fruits per cluster

Number of fruits per cluster exhibited positive indirect effect via, days to first picking (1.449), average weight of fruit (1.367), length of fruit (0.343) and days to 50 percent flowering (0.043). Negative indirect effect was observed through number of branches per plant (-0.760), fruiting span (-

0.747), plant height at 150 DAT (-0.557), crop duration (-0.514), width of fruit (-0.403), number of fruits per plant (-0.396), number of flowers per cluster (-0.089) and days to first flowering (-0.013).

4.4.2.9 Number of fruits per plant

Highest positive indirect effect of number of fruits per plant on fruit yield per plant was recorded through width of fruit (1.012), crop duration (0.959), plant height (0.591), number of branches per plant (0.211) and days to 50 percent flowering (0.065). However, negative indirect effect was exhibited via. ,average weight of fruit (-2.223), days to first picking (-0.571), length of fruit (-0.501), number of fruits per cluster (-0.176), fruiting span (-0.137), number of flowers per cluster (-0.055) and days to first flowering (-0.022).

4.4.2.10 Fruit length

Fruit length revealed positive indirect effect on fruiting span (1.317), average weight of fruit (0.986), days to 50 percent flowering (0.207), number of fruits per cluster (0.118), days to first picking (0.106) and number of flowers per cluster (0.079). The remaining characters showed negative indirect effect via., crop duration (-2.204), width of fruit (-1.029), number of branches per plant (-0.393), number of fruits per plant (-0.390), plant height at 150 DAT (-0.337) and days to first flowering (-0.046).

4.4.2.11 Fruit width

Fruit width exhibited significant positive indirect effect via. , crop duration (2.626), number of fruits per plant (0.837), number of branches per plant (0.339) and days to first flowering (0.034). Negative indirect effect was observed through fruiting span (-1.458), average weight of fruit (-1.280), length of fruit (-1.095), days to first picking (-0.529), plant height at 150 DAT (-0.403), days to 50 per cent flowering (-0.179), numbers of flowers per cluster (-0.040) and number of fruits per cluster (-0.009).

4.4.2.12 Average fruit weight

Average fruit weight manifested positive indirect effect on length of fruit (0.728), number of fruits per cluster (0.349), days to first picking (0.266),

fruiting span(0.143), number of flowers per cluster (0.047) and days to 50 percent flowering (0.013). However, rest of the characters showed negative indirect effect via. , number of fruits per plant (-1.275), plant height at 150 DAT (-0.916), width of fruit (-0.888), number of branches per plant (-0.503), crop duration (-0.398) and days to first flowering (-0.002).

4.4.2.13 Crop duration

Crop duration exhibited significant positive indirect effect on width of fruit (1.069), numbers of fruit per plant (0.323) and days to first flowering (0.106). However, rest of the characters showed negative indirect effect via., fruiting span (-2.446), days to first picking (-1.01), length of fruit (-0.954), plant height at 150 DAT (-0.637), days to 50 percent flowering (-0.483), average weight of fruit (-0.234), numbers of flowers per cluster (-0.176), number of flowers per cluster (-0.119) and number per branches per plant (-0.045).

4.5 Other qualitative parameters

Qualitative characters like fruit colour, fruit shape, colour of calyx, bearing habit, presence of spines on plant and fruit, incidence of shoot and fruit borer, incidence of phomopsis blight, little leaf and bacterial wilt are summarized below.

4.5.1 Fruit colour

Colour of fruits was observed to be dark purple, purple, light purple, green and white. Genotypes 2014/BRLVAR-2, 2014/BRLVAR-3, 2013/BRLVAR-6, Punjab Sadabahar, IVBL-9 (Kashi Tarun), Pusa purple long (SC) and SM-6-7 (RC) exhibited dark purple colour. Whereas, genotypes 2013/BRLVAR-2, 2013/BRLVAR-4, 2013 and 2013/BRBWRES-2 observed purple fruits. Arka nidhi and 2013/BRLVAR-1 were white fruited and 2014/BRLVAR-4, 2013/BRBWRES-3 and 2013/BRBWRES-4 were light purple. Remaining genotypes exhibited green fruit.

Table 4.7: Categorization of brinjal genotypes based on fruit colour.

Dark purple	Purple	Light purple	Green	White
2014/BRLVAR-2	2013/BRLVAR-2	2014/BRLVAR-4	2013/BRLVAR-1	Arka Nidhi
2014/BRLVAR-3	2013/BRLVAR-4	2013/BRBWRES-3	2013/BRLVAR-3	
2013/BRLVAR-6	2013/BRBWRES-2	2013/BRBWRES-4	2013/BRLVAR-5	2014/BRLVAR-1
IVBL-9 (Kashi Tarun) Punjab Sadabahar Pusa Purple Long SM-6-7 (RC).			2013/BRBWRES-1 Arka Kusumkar	

4.5.2 Fruit shape

Significant variation was observed among the genotypes for shape of fruits i.e. long, oblong, round and small round (Table 4.8). Shape of fruits was observed to be long in genotypes 2014/BRLVAR-1, 2014/BRLVAR-2, 2014/BRLVAR-4, 2013/BRLVAR-1, 2013/BRLVAR-3, 2013BRLVAR-6, 2013/BRBWRES-4, Arka Kusumkar (SC), Pusa Purple Long (SC), IVBL-9 (Kashi Tarun) and Punjab Sadabahar. Arka Nidhi, SM-6-7 and 2013/BRBWRES-2 were produced round fruit. Whereas, genotypes 2013/BRBWRES-1 and 2013/BRBWRES-3 were produced small round fruit and the remaining genotypes produced oblong fruits.

Table 4.8: Categorization of brinjal genotypes based on fruit shape

Long	Oblong	Round	Small round
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2014/BRLVAR-1	2014/BRLVAR-3	2013/BRBWRES-2	2013/BRBWRE
2014/BRLVAR-2	2013/BRLVAR-2	Arka Nidhi	S-1
2014/BRLVAR-4	2013/BRLVAR-4	SM-6-7	2013/BRBWRE
2014/BRLVAR-1			S-3
2013/BRLVAR-3	2013/BRLVAR-5		
2013/BRLVAR-6			
2013/BRBWRES-4			
Arka Kusumkar			
Pusa Purple Long			
IVBL-9			
Punjab Sadabahar			

4.5.3 Colour of calyx

Genotypes were categorized as dark green, light green, dark purple and light purple for colour of calyx (Table 4.9). Dark green colour of calyx was exhibited in genotypes 2014/BRLVAR-2, 2013/BRLVAR-1, IVBL-9 (Kashi Tarun) and SM-6-7. 2014/BRLVAR-3, 2014/BRLVAR-4 and 2013/BRLVAR-3 recorded dark purple calyx. Genotypes 2013/BRLVAR-4, 2013/BRLVAR-5 and 2013/BRLVAR-6 exhibited light purple and rest of the genotypes light green colour calyx.

Table 4.9 Categorization of brinjal genotypes based on colour of calyx.

Dark green	Light green	Dark purple	Light purple
2014/BRLVAR-2	2014/BRLVAR-1	2014/BRLVAR-3	2013/BRLVAR-4
2013/BRLVAR-1	2013/BRLVAR-2	2014/BRLVAR-4	
	2013/BRBWRES-1		2013/BRLVAR-5
IVBL-9(Kashi Tarun)	2013/BRBWRES-2	2013/BRLVAR-3	
SM-6-7	2013/BRBWRES-3		2013/BRLVAR-6
	2013/BRBWRES-4		
	Arka Kusumkar		
	Arka Nidhi		
	Pusa Purple Long		
	Punjab Sadabahar		

4.5.4 Bearing habit

Bearing habit was observed for single and cluster (Table 4.10). Genotypes 2014/BRLVAR-2, 2014/BRLVAR-4, 2013/BRLVAR-2, 2013/BRLVAR-4, 2013/BRLVAR-6, 2013/BRBWRES-2, IVBL-9 (Kashi Tarun) and Punjab Sadabahar showed single bearing habit, whereas rest of the genotypes were found in cluster.

Table 4.10: Categorization of brinjal genotypes based on bearing habit

Single	Cluster
2014/BRLVAR-2	2014/BRLVAR-1
2014/BRLVAR-4	2014/BRLVAR-3
2013/BRLVAR-2	2013/BRLVAR-1
2013/BRLVAR-4	2013/BRLVAR-3
2013/BRLVAR-6	2013/BRLVAR-5
2013/BRBWRES-2	2013/BRBWRES-1
IVBL (Kashi Tarun)	2013/BRBWRES-3
Punjab Sadabahar	2013/BRBWRES-4
	Arka Kusumkar
	Arka Nidhi
	Pusa PurpleLong
	SM-6-7

4.5.5 Presence of spines on plant

The genotypes have been classified in two groups based on presence of spines i.e. present and absent. These groups identified by the visual observation are given in Table 4.11. Spines were visible in genotype 2013/BRBWRES-1, 2013/BRBWRES-2, 2013/BRBWRES-3, 2013/BRBWRES-4 and 2013/BRLVAR-2. Large number of genotypes was recorded in absent group.

Table 4.11 Categorization of brinjal genotypes based on presence of spines on plant.

Present	Absent
2013/BRBWRES-1	2014/BRLVAR-1, 2013/BRLVAR-2, 2014/BRLVAR-3,
2013/BRBWRES-2	2014/BRLVAR-4, 2013/BRLVAR-1, 2013/BRLVAR-3,
2013/BRBWRES-3	2013/BRLVAR-4, 2013/BRLVAR-5, 2013/BRLVAR-6,
2013/BRBWRES-4	IVBL-9(Kashi Tarun), Punjab Sadabahar, Arka
2013/BRLVAR-2	Kusumkar, Arka Nidhi, Pusa Purple Long, SM-6-7

4.5.6 Presence of spines on fruit

The genotypes have been classified in two groups based on presence of spines i.e. present and absent. These groups identified by the visual observation are given in Table 4.12. Spines are visible in genotype 2013/ BRBWRES-1, 2013/BRBWRES-2, 2013/BRBWRES-3, 2013BRBWRES-4, 2013/BRLVAR-2, 2014/BRLVAR-2 and 2014/BRLVAR-3.and rest of the genotypes were recorded spines on fruit.

Table 4.12 Categorization of brinjal genotypes based on presence of spines on fruit.

Present	Absent
2013/BRBWRES-1	2014/BRLVAR-1, 2014/BRLVAR-4,
2013/BRBWRES-2	2013/BRLVAR-1, 2013/BRLVAR-3,
2013/BRBWRES-3	2013/BRLVAR-4, 2013/BRLVAR-5,
2013/BRBWRES-4	2013/BRLVAR-6, IVBL-9(Kashi Tarun),
2013/BRLVAR-2	Punjab Sadabahar, Arka Kusumkar,
2014/BRLVAR-2	Arka Nidhi, Pusa Purple Long, SM-6-7
2014/BRLVAR-3	

4.5.7 Incidence of phomopsis blight, little leaf and bacterial wilt

The result of incidence of phomopsis blight, little leaf and bacterial wilt is depicted in the table 4.13.

Significant minimum 3.33% incidence of bacterial wilt was recorded in genotypes Arka Kusumkar (SC). 1.67% incidence of phomopsis blight was recorded in genotypes Arka Kusumkar and BRLVAR-1 and 6.67% incidence of little leaf in genotypes Pusa Purple Long.

Table 4.2d : Incidence percentage of diseases of brinjal

Genotypes	Incidence of bacterial wilt %	Incidence of phomopsis blight %	Incidence of little leaf %
2014/BRLVAR-1	14.17	0.00	0.00
2014/BRLVAR-2	15.00	3.39	0.00
2014/BRLVAR-3	18.33	9.17	0.00
2014/BRLVAR-4	10.00	1.71	0.00
Kashi Tarun(C)	4.17	0.00	10.00
Pb. Sadabahar(C)	27.50	0.00	0.00
2013/BRLVAR-1	5.00	1.67	0.00
2013/BRLVAR-2	20.00	0.00	0.00
2013/BRLVAR-3	19.17	0.00	0.00
2013/BRLVAR-4	11.67	2.00	0.00
2013/BRLVAR-5	5.67	0.00	0.00
2013/BRLVAR-6	17.50	13.33	0.00
2013/BRBWRES-1	9.17	3.33	0.00
2013/BRBWRES-2	5.00	0.00	0.00
2013/BRBWRES-3	7.50	4.17	0.00
2013/BRBWRES-4	5.00	0.00	0.00
Arka Kusumkar (SC)	3.33	1.67	0.00
Arka Nidhi (RC)	6.67	0.00	0.00
PPL (SC)	20.00	8.33	6.67
SM-6-7 (RC)	5.83	8.33	10.00
S.Em $\pm$	3.57	2.71	1.46
C.D.5% level	10.31	7.83	4.22

DISCUSSION

The experimental findings of the present investigation “ Studies on variability and character association in Brinjal (*Solanum melongena* L.)” have been discussed in the following heads on the basis of the available literature.

- 5.1 Analysis of variance
- 5.2 Genetic Variability
 - 5.2.1 Range and Mean Performance
 - 5.2.2 Coefficient of variation
 - 5.2.3 Heritability
 - 5.2.4 Genetic advance
- 5.3 Correlation Coefficient analysis
- 5.4 Path Coefficient analysis
- 5.5 Other quality parameters
- 5.6 Identification of better genotypes

5.1 Analysis of variance

The main objective of the present investigation was to study the diversity present in twenty genotypes of brinjal. The estimates of mean sum square due to genotypes were highly significant for all the characters (Table 4.1) indicating the presence of genetic diversity in the existing material. The findings of Negi *et al.* (2000), Sharma and Swaroop (2000), Prasad *et al.* (2004), Singh and Kumar (2005), Lohakare *et al* (2008), Mishra *et al* (2008), Dahatonde *et al* (2010), Ansari *et al* (2011), Inderesh and Santhosha (2011), Chattopadhyay *et al* (2011), Kumar *et al* (2012) and are similar to that of the present findings.

5.2 Genetic variability

5.2.1 Mean performance of the genotypes

The mean performance of the genotypes (Table 4.2a, b and c) revealed a wide range of variability for all the traits. The variation was

highest for fruit yield per plant (540.00 – 1235.00 g) followed by fruit weight (30.87 – 168.46 g), numbers of fruits per plant (3.77 – 27.33), fruiting span (89.00 – 105) and days to first picking (50.00- 64.67). The findings were quite similar to as reported by Kushwah and Bandhyopadhaya (2005), Thangavel *et al.* (2011), Chorasias and Sangeeta (2012).

5.2.2 Coefficient of variation

In the present findings phenotypic coefficient of variation were observed to be higher than the corresponding genotypic coefficient of variation for all the characters studied, however, the difference was narrow which implied their relative resistance to environmental variation. It also described that genetic factors were predominantly responsible for expression of those attributes and selection could be made effective on the basis of phenotypic performance. The findings of Sharma and Swaroop (2000), Atul Kumar *et al.* (2000), Mohanty and Prusti (2002), Naliyadhara *et al.* (2007), Mishra *et al.* (2008), Nair and Mehta (2009), Kumar *et al.* (2011a) and Thangavel *et al.* (2011) were similar to that of the present findings.

5.2.2.1 Phenotypic coefficient of variation

The phenotypic coefficient of variation range from 0.75% for duration of crop to 60.42% for number of fruits per plant. The phenotypic coefficient of variation was highest for characters viz., numbers of fruits per plant (60.42%), weight of fruit (45.55%), fruit yield per hectare (42.67%), fruit yield per plant (24.68%), width of fruit (22.15%), length of fruit (21.73%) and numbers of fruits per cluster (20.19%), indicating that selection of these characters can be predicted to improve the brinjal genotypes. The findings are in close harmony with those of Mohanty (2001), Baswana *et al.* (2002), Singh and Kumar (2005), Sherly and Shanthi (2008), Nair and Mehta (2009), Indresh and Santhosha (2011), Kumar *et al.* (2012), Lokesh *et al.* (2013) and Chaudhary and Kumar (2014) for number of fruits per plant; Mohanty (2001), Baswana *et al.* (2002), Kushwah and Bandhyopadhaya (2005), Singh and Kumar (2005), Sherly and Shanthi (2008), Nair and Mehta (2009), Indresh and Santhosha (2011), Kumar *et al.* (2012) and Chaudhary and Kumar *et al.* (2013) for weight of fruit; Baswana *et al.* (2002), Sherly and Shanthi (2008),

Kumar *et al.* (2011a), Kumar *et al.* (2012) and Chaudhary and Kumar (2014) for fruit yield per plant; and Kushwah and Bandyopadhyaya (2005), Ansari *et al.* (2011) and Indresh and Santhosha (2011) for fruit width, Sherly and Shanthi (2008) and Indresh and Santhosha (2011) for fruit length.

However, it exhibited low for characters like crop duration (3.02%), days to first picking (5.36%), plant height at 150 DAT (6.12%), fruiting span (6.22%), plant height at 120DAT (7.80%), days to first flowering (9.16%) and plant height at 90 DAT (9.55%). While numbers of flowers per cluster (13.82%), plant height at 60 DAT (13.59 %), plant height at 30 DAT (12.76%) and number of branches per plant (11.39%) exhibited moderate phenotypic coefficient of variation. The findings of Mohanty (2001), for number of branches per plant and plant height, Ansari *et al.* (2011) for number of fruits per cluster are similar to the present findings.

5.2.2.2 Genotypic coefficient of variation

It is revealed from the Table 4.3 that GCV varied from 0.75% for duration of crop to 54.87% for numbers of fruit per plant.

High genotypic coefficient of variation was noted for number of fruits per plant (54.87%) followed by weight of fruit (g) (43.98%), fruit yield per hectare (q) (37.99) and length of fruit (cm) (21.08%). The findings are in close harmony with the results of Singh and Shanthi (2008), Nair and Mehta (2009), Dahatonde *et al.* (2010), Indresh and Santhosha (2011) and Chaudhary and Kumar (2014) for number of fruits per plant; Kushwah and Bandyopadhyaya (2005), Singh and Kumar (2005), Praabhu and Natarajan (2007), Sherly and Shanthi (2008) and Nair and Mehta (2009), Indresh and Santhosha (2011), Kumar *et al.* (2012) and Lokesh *et al.* (2013) for average fruit weight. Negi *et al.* (2000), Sharma and Swaroop (2000), Baswana *et al.* (2002), Prasad *et al.* (2004), Sherly and Shanthi (2008), Kumar *et al.* (2012) and Lokesh *et al.* (2013) for fruit yield per plant; Prasad *et al.* (2004), Kushwah and Bandyopadhyaya (2005), Ansari *et al.* (2011), Indresh and Santhosha (2011) and Kumar *et al.* (2011a) for fruit width; Prasad *et al.* (2004), Sherly and Shanthi (2008), Indresh and Santhosha (2011), Kumar *et al.* (2011a) and Lokesh *et al.* (2013) for fruit length. The high values of

GCV suggested greater genotypic variability among the genotypes and responsiveness of the attributes for making further improvement by selection. Crop duration (2.90%), days to first picking (4.20%), fruiting span (5.41%), plant height at 120 DAT (6.07%), days to 50% flowering (6.28%), days to first flowering (7.64%), plant height at 120 DAT (7.75%) and plant height at 90 DAT (9.50%) showed lowest GCV. The findings of Mohanty and Prusti (2002), Lokesh *et al.* (2013) and Prasad *et al.* (2004) and days to first picking were similar to the present finding which indicated that there is limited scope for improvement. While, Width of fruit (cm) (20.76%), fruit yield per plant (g) (19.91%), number of fruits per cluster (18.53%), plant height at 60 DAT (13.52%), plant height at 30 DAT (12.45%), number of flowers per cluster (11.56%) and number of branches per plant (10.05%) recorded moderate GCV. The findings of Mohanty and prusti (2002), Mohanty (2001) and Lokesh *et al* (2013) for number of branches per plant, Ansari *et al.*(2011) and lokesh *et al.* (2013) for number of fruits per cluster was similar to the present findings.

5.2.3 Heritability

Heritability which denotes the proportion of genetically controlled variability expressed by a programme for a particular characters or a set of character is very important biometrical tool for guiding plant breeders for adoption of appropriate breeding procedures. High heritability in broad sense is helpful in identifying appropriate character for selection and enables the breeder to select superior genotypes on the basis of phenotypic expression of quantitative characters. The estimated values of heritability in broad sense were classified as very high (more than 90%), high (70-90%), moderate (50-70%) and low (less than 50%).

Very high estimates of heritability were obtained for the traits viz., Plant height at 90 DAT (99.02%), plant height at 60 DAT (98.97%), plant height at 120 DAT (98.82%), plant height at 150 DAT (98.56%), plant height at 30 DAT (95.21%), length of fruit (cm) (94.11%), weight of fruit (g) (93.24%) and crop duration (92.21%).). However, it was recorded high for width of fruit (cm) (87.82%), number of fruits per cluster (84.25%), numbers of fruits per plant (82.48%), days to 50%flowering (80.00%),fruit yield per

hectare (q) (79.27%), number of branches per plant (77.86%) and fruiting span (75.60%). The results were in close proximate to that Negi (2000), Sharma and Swaroop (2000), Mohanty (2001), Das *et al.* (2002), Mohanty and Prusti (2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Kushwah and Bandhyopadhyaya (2005), Dhameliya and Dobariya (2007), Mishra *et al.* (2008), Sherly and Shanthi (2008), Nair and Mehta (2009), Ansari *et al.* (2011), Indresh and Santhosha (2011), Kumar *et al.*(2012), Chourasia and Sangeeta (2012) and Chaudhary and Kumar (2014) for number of fruits per plant; Das *et al.* (2002), Kushwah and Bandhyopadhyaya (2005), Dhameliya an Dobariya (2007), Kumar *et al.* (2011a), Mishra *et al.* (2008), Nair and Mehta (2009), Chattopadhyay *et al.* (2011) and Chaudhary and Kumar (2014) for plant height; Sharma and Swaroop (2000), Prasad *et al.* (2004), Kushwah and Bandhyopadhyaya (2005), Golani *et al.* (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Kumar *et al.* (2011a), Indresh and Santhosha (2011), Kumar *et al.*(2012), Chourasia and Sangeeta (2012) and Chaudhary and Kumar (2014) for fruit length; Negi (2000), Sharma and Swaroop (2000), Das *et al.* (2002), Mohanty and Prusti (2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Kushwah and Bandhyopadhyaya (2005), Singh and Kumar (2005), Golani *et al.* (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Nair and Mehta (2009), Kumar *et al.* (2011a), Ansari *et al.* (2011), Indresh and Santhosha (2011), Chattopadhyay *et al.* (2011), Kumar *et al.*(2012), Chourasia and Sangeeta (2012), Lokesh *et al.*(2013) and Chaudhary and Kumar (2014) for average fruit weight; Prasad *et al.*(2004), Kushwah and Bandhyopadhyaya (2005), Golani *et al.* (2007), Mishra *et al.* (2008), Sao and Mehta (2009), Indresh and Santhosha (2011), Chourasia and Sangeeta (2012) and Chaudhary and Kumar (2014) for fruit width; Kushwah and Bandhyopadhyaya (2005), Sao and Mehta (2009), Kumar *et al.* (2011a) and Chourasia and Sangeeta (2012) for number of fruits per cluster; Kushwah and Bandhyopadhyaya (2005), Kumar *et al.* (2011a) and Chattopadhyay *et al.* (2011) days to 50 percent flowering; Nair and Mehta (2009) for fruiting span and Kumar *et al* (2011a) and Chaudhary and Kumar (2014) for number of branches. High value of broad sense heritability for the above characters expressed that they were least influenced by environmental modification. It reflected that the phenotypes were the true

representative of their genotypes and selection based on phenotypic performance would be reliable.

Moderate estimation of heritability was recorded for number of flowers per cluster (69.92%), days to first flowering (69.55%), fruit yield per plant (g) (65.07%) and days to first picking (61.49%). Low was recorded for duration of crop (25.86%) which indicated that selection based on phenotypic performance would be rewarding. The results were in close agreement with that of Prasad *et al.* (2004) and Kaur and Thakur (2007) for days to first picking; Sao and Mehta (2009) for days to first flowering.

5.2.4 Genetic advance

Heritability indicates only the effectiveness with which selection of a genotype can be based on phenotypic performance, but fails to indicate the genetic progress. Heritability estimates along with genetic gains are more effective and reliable in predicting the improvement through selection (Johnson *et al.* 1955). Estimates of genetic advance helps to predict the extent of improvement that can be achieved for improving the different characters. The estimated values of genetic advance as percent of mean were classified as high (more than 25%), moderate (15-25%) and low (less than 15%).

Genetic advance as percentage of mean ranged between 0.40% for duration of crop to 102.72% for number of fruits per plant. The highest estimate of genetic advance as percentage of mean was recorded for number of fruits per plant (102.72%), weight of fruit (g) (87.49%), fruit yield per hectare (q) (69.68%), length of fruit (cm) (42.14%), width of fruit (cm) (40.08%), number of fruits per cluster (35.14%), fruit yield per plant (g) (33.09%), plant height at 60 DAT (27.71%) and plant height at 30 DAT (25.03%). The results were in consonance with Negi (2000), Mohanty (2001), Mohanty and Prusti (2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Singh and Kumar (2005), Dhameliya and Dobariya (2007), Mishra *et al.* (2008), Sherly and Shanthi (2008), Sao and Mehta (2009), Ansari *et al.* (2011), Indires and Santhosha (2011) and Kumar *et al.* (2012) for number of fruits per plant, Negi (2000), Baswana *et al.* (2002), Prasad *et al.* (2004),

Singh and Kumar (2005), Dhameliya and Dobariya (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Kumar *et al.* (2011a) and Kumar *et al.* (2012) for fruit yield per plant, Negi (2000), Mohanty (2001), Mohanty and Prusti (2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Kushwah and Bandhyopadhyaya (2005), Singh and Kumar (2005), Golani *et al.* (2007), Kaur and Thakur (2007), Mishra *et al.* (2008), Sherly and Shanthi (2008), Sao and Mehta (2009), Nair and Mehta (2009), Kumar *et al.* (2011a), Kumar *et al.* (2012), and Chourasia and Sangeeta (2012), for average fruit weight, Prasad *et al.* (2004), Kushwah and Bandhyopadhyaya (2005), Golani *et al.* (2007), Mishra *et al.* (2008), Sao and Mehta (2009), and Indires and Santhosha (2011), for fruit width, Prasad *et al.* (2004), Golani *et al.* (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Kumar *et al.* (2011a), Indires and Santhosha (2011), and Kumar *et al.* (2012) for fruit length, Kushwah and Bandhyopadhyaya (2005), and Kumar *et al.* (2011a) for number of flowers per cluster.

Plant height at 90 DAT (19.48%), at 120 DAT (15.88%), Number of branches per plant and Number of flowers per cluster (19.98%) showed moderate value of genetic advance as percentage of mean. The findings were in agreement to the findings of Kumar *et al.* (2011a) for plant height, Kushwah and Bandhyopadhyaya (2005), and Kumar *et al.* (2011a) for number of flowers per cluster, and Mohanty (2001) for number of branches per plant.

Low estimates were observed for plant height at 150 DAT (12.42%), Days to first flowering (13.13%), Days to 50% flowering (11.56 %), Days to first picking (6.79 %), Fruiting span (9.68%), Crop duration (5.73%) and Duration of crop (0.40%). The findings were in agreement to Mohanty and Prusti (2002) and Kumar *et al.* (2011a) for plant height. Prasad *et al.* (2004) for days to first flowering. Mohanty and Prusti (2002) for days to first picking.

High heritability coupled with high genetic advance for traits like numbers of fruits per plant (11.54), weight of fruit (g) (77.08), fruit yield per hectare (q) (190.33), length of fruit (cm) (8.04), width of fruit (cm) (1.82), number of fruits per cluster (35.14%), fruit yield per plant (g) (33.09%), plant height at 60 DAT (27.71%) and plant height at 30 DAT (25.03%). The results were in consonance with Negi (2000), Mohanty (2001), Mohanty and Prusti

(2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Singh and Kumar (2005), Dhameliya and Dobariya (2007), Mishra *et al.* (2008), Sherly and Shanthi (2008), Sao and Mehta (2009), Ansari *et al.* (2011), Indires and Santhosha (2011) and Kumar *et al.* (2012) for number of fruits per plant, Negi (2000), Baswana *et al.* (2002), Prasad *et al.* (2004), Singh and Kumar (2005), Dhameliya and Dobariya (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Kumar *et al.* (2011a) and Kumar *et al.* (2012) for fruit yield per plant, Negi (2000), Mohanty (2001), Mohanty and Prusti (2002), Baswana *et al.* (2002), Prasad *et al.* (2004), Kushwah and Bandhyopadhy (2005), Singh and Kumar (2005), Golani *et al.* (2007), Kaur and Thakur (2007), Mishra *et al.* (2008), Sherly and Shanthi (2008), Sao and Mehta (2009), Nair and Mehta (2009), Kumar *et al.* (2011a), Kumar *et al.* (2012), and Chourasia and Sangeeta (2012), for average fruit weight, Prasad *et al.* (2004), Kushwah and Bandhyopadhy (2005), Golani *et al.* (2007), Mishra *et al.* (2008), Sao and Mehta (2009), and Indires and Santhosha (2011), for fruit width, Prasad *et al.* (2004), Golani *et al.* (2007), Sherly and Shanthi (2008), Sao and Mehta (2009), Kumar *et al.* (2011a), Indires and Santhosha (2011), and Kumar *et al.* (2012) for fruit length, Kushwah and Bandhyopadhy (2005), and Kumar *et al.* (2011a) for number of flowers per cluster.

Plant height at 90 DAT (19.48%), at 120 DAT (15.88%), Number of branches per plant and Number of flowers per cluster (19.98%) showed moderate value of genetic advance as percentage of mean. The findings were in agreement to the findings of Kumar *et al.* (2011a) for plant height, Kushwah and Bandhyopadhy (2005), and Kumar *et al.* (2011a) for number of flowers per cluster, and Mohanty (2001) for number of branches per plant.

Low estimates were observed for plant height at 150 DAT (12.42%), Days to first flowering (13.13%), Days to 50% flowering (11.56 %), Days to first picking (6.79 %), Fruiting span (9.68%) and crop duration (5.73%) . The findings were in agreement to Mohanty and Prusti (2002) and Kumar *et al.* (2011a) for plant height. Prasad *et al.* (2004) for days to first flowering. Mohanty and Prusti (2002) for days to first picking.

5.3. Correlation coefficient analysis

A wide range of variation in quantitative characters provides the basis for selection in plant breeding programme. The knowledge of association among the characters is useful to the breeder for improving the efficiency of selection. Correlation coefficient analysis measures the mutual relationship between plant characters and determines the component character on which selection can be made for genetic improvement of yield. Investigation regarding the presence of component and nature of association among themselves is essential and pre-requisite for improvement in yield. Correlation coefficient provides a clear picture of the extent of association between a pair of traits and indicates whether simultaneous improvement of the correlated traits may be possible or not. The knowledge of genetic association between yield and its component characters help in improving the efficiency of selection for yield by making proper choice and balancing one component with another. Correlation for all the traits that indicated inherent association between various characters. The findings were in agreement to Sharma and Swaroop (2000), Mohanty (2001), Kumar *et al.* (2002) and Naliyadhara *et al.* (2007).

5.3.1 Fruit yield per plant (g)

In the present findings significant and positive phenotypic correlation of fruit yield per plant was observed with fruiting span, number of fruits per plant, length of fruit, width of fruit, average weight of fruit. However, it exhibited significant and negative association with days to first picking, days to 50% picking and days to first flowering. The highest positive and significant correlation coefficient of fruiting span, number of fruits per plant, length of fruit, width of fruit, average weight of fruit indicating that these characters are the primary yield determinants in brinjal. These findings corroborated the earlier findings of Mohanty (2001), Singh and Kumar (2004), Prabhu *et al.* (2008), for number of fruits per plant, Patel and Sarnik (2004) and Prabhu and Natarajan (2008) for fruit length, Kumar *et al.* (2002), Kushwah and Bandhyopadhyaya (2005) and Chattopadhyay *et al.* (2011) for fruit width; Kamani and Manpara (2006), Naliyadhara *et al.* (2007), Lohakare

et al. (2008), Prabhu and Natarajan (2008), Prabhu *et al.* (2008) and Chattopadhyay *et al.* (2011) for average fruit weight.

5.3.2 Plant height (cm)

Plant height at 150 DAT showed significant and positive correlation with average weight of fruit (g) , days to 50% flowering , days to first flowering , crop duration and number of fruits per cluster . Highly significant and negative association of this character was observed with number of fruits per plant. These results are in close harmony with the findings of Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Prabhu *et al.* (2008) and Chattopadhyay *et al.* (2011) for average fruit weight. Nair and Mehta (2007), Dharwad *et al.* (2009) and Thangamani and Jansirani (2012) for days to first flowering.

5.3.3 Number of branches per plant

Number of branches per plant expressed significant and negative correlation with number of fruits per cluster, length of fruit (cm) and average weight of fruit (g). These results are in close ceremony with the findings of Patel and Sarnik (2004) and Prabhu and Natarajan (2008) for fruit length, Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Prabhu *et al.* (2008) and Chattopadhyay *et al.* (2011) for average fruit weight.

5.3.4 Days to first flowering

Association of days to first flowering was recorded significant and positive with days to 50 percent flowering, fruiting span, number of flowers per cluster, crop duration and duration of crop and negative with length of fruit (cm). These findings corroborated the earlier findings of Patel and Sarnik (2004) and Prabhu and Natarajan (2008) for negative association with length of fruit (cm).

5.3.5 Days to 50 percent flowering

Days to 50 percent flowering recorded highly significant and positive correlation with fruiting span, number of flowers per cluster, width of fruit (cm), crop duration. These findings corroborated the earlier findings of Kushwah and Bandhyopadhyaya (2005) for width of fruit and for negative

association with length of fruit (cm) and fruit yield per plant. Patel and Sarnik (2004) and Prabhu and Natarajan (2008) for fruit length for negative association with length of fruit (cm).

5.3.6 Days to first picking

Significant and negative association of days to first picking was observed with fruiting span, number of fruits per cluster and fruit yield per plant. These findings corroborated the earlier findings of Kushwah and bandhyopadhyaya (2005), Nair and Mehta (2007) and Singh *et al.* (2010) for negative association with fruit yield per plant and Kushwah and Bandhyopadhyaya (2005) and Chattopadhyay *et al.* (2011) for fruit width.

5.3.7 Fruiting span

Association with fruiting span was recorded significant and positive with number of flowers per cluster, width of fruit (cm), crop duration and fruit yield per plant. These findings corroborated the earlier findings of Kushwah and bandhyopadhyaya (2005), Nair and Mehta (2007) and Singh *et al.* (2010) for positive association with fruit yield per plant. and Patel and Sarnik (2004) and Prabhu and Natarajan (2008) for fruit length for negative association with length of fruit (cm).

5.3.8 Number of flowers per cluster

Number of flowers per cluster showed significant and positive association with crop duration and negative association with duration of crop.

5.3.9 Number of fruits per cluster

Number of fruits per cluster showed significant and positive association with average weight of fruit.

5.3.10 Number of fruits per plant

Number of fruits per plant recorded positive and significant correlation with width of fruit (cm) and negative correlation with average weight of fruit (g) and duration of crop. These findings corroborated the earlier finding of Kushwah and Bandhyopadhyaya (2005) for average fruit weight.

5.3.11 Length of fruit (cm)

Association of fruit length was recorded significant and positive with average weight of fruit (g). These findings corroborated the earlier finding of Kushwah and Bandhyopadhyaya (2005) and Kumar *et al.* (2002) for average fruit weight. and negative association with width of fruit (cm) and crop duration.

5.3.12 Width of fruit (cm)

Fruit width expressed a highly significant and positive correlation with crop duration and negative association with average weight of fruit (g).

5.3.13 Average fruit weight (g)

Average fruit weight expressed highly significant and positively association with fruit yield per plant.

5.4 Path coefficient analysis

Correlation coefficients are the indication of simple association between variables. In a biological system, however the relationship may exist in a very complex form. It is therefore, essential to the study the relationship among variable in a comprehensive way. Path coefficient analysis is a power full tool, which enable portioning of the given relationships in its further components. In other words, it takes into account not only the relationship of component characters with the dependent character, but simultaneously takes care of its relationship with other component also. Thus, it helps in understanding the causal system in a better way because it enables portioning the total correlations coefficient into direct and indirect effects of various characters.

In the present investigation path coefficient analysis was carried out for characters under study using genotypic and phenotypic correlation coefficient and taking fruit yield per plant as dependable variable, in order to see the causal factor and so as to identify the components which are responsible for producing fruit yield per plant. In general, the genotypic direct as well as indirect effects were slightly higher in magnitude as compare to

corresponding phenotypic direct and indirect effects indicating that the masking effect of the environment.

Path coefficient analysis of different characters contributing towards fruit yield per plant showed that crop duration had highest positive direct effect followed by average weight of fruit , length of fruit , width of fruit , number of fruits per plant, number of branches per plant , number of fruits per cluster, and days to first flowering. The results are in propinquity with Rajyalakshmi *et al.* (2000), Sharma and Swaroop (2000), Mohanty (2001), Singh and Singh (2001), Patel and Sarniak (2004), Singh and Kumar (2004), Naliyadhara *et al.* (2007), Nair and Mehta (2007), Prabhu and Natrajan (2008), Prabhu *et. al.* (2008), Lohakare *et al.* (2008) , Dharwar *et al.* (2009), Jadhao *et al.* (2009), Singh *et al.* (2010), Chattopadhyaya *et al.* (2011) and Thangamani and Jhansi Rani (2012) for average fruit weight, (2011) and Thangamani and Jhansi Rani (2012) for average fruit weight, Patel and Sarniak (2004), Naliyadhara *et al.* (2007), Nair and Mehta (2007), Prabhu and Natrajan (2008), Prabhu *et. al.* (2008), Singh *et al.* (2011) and Thangamani and Jhansi Rani (2012) for fruit length, Sharma and Swaroop (2000), Pathaniya *et al.* (2005), Singh *et al.* (2011) and Thangamani and Jhansi Rani (2012) for fruit width, Rajyalakshmi *et al.* (2000), Sharma and Swaroop (2000), Mohanty (2001), Singh and Singh (2001), Patel and Sarniak (2004), Singh and Kumar (2004), Nair and Mehta (2007), Prabhu and Natrajan (2008), Prabhu *et. al.* (2008), Lohakare *et al.* (2008) , Dharwar *et al.* (2009), Singh *et al.* (2010), Chattopadhyaya *et al.* (2011) and Thangamani and Jhansi Rani (2012) number of fruits per plant, Sharma and Swaroop (2000), Dharwad *et al.* (2009) for number of fruits per cluster, Nair and Mehta (2007), Jadhao *et al.*(2009) for days to first flowering. The characters crop duration had highest positive direct effect followed by average weight of fruit , length of fruit , width of fruit , number of fruits per plant, number of branches per plant , number of fruits per cluster and days to first flowering. This indicates true relationships with fruit yield per plant and direct selection for these traits would result in higher breeding efficiency for improving yield. Thus, these traits might be reckoned as the most important components traits for fruit yield per plant.

Whereas, fruiting span had the highest negative direct effect on days to first picking , plant height at 150 DAT, days to 50 percent flowering and number of flowers per cluster. The results are in propinquity with Prabhu and Natarajan (2008), and Dharwad *et al.* (2009).for days to flowering . this indicated that th indirect effect was the cause of correlation and the indirect effect causal factors are to be considered simultaneously for selection. Fruiting span and days to first picking imparted a negative direct effect on fruit yield per plant, as well as they were negatively correlated to it. Under such circumstance direct selection for this character should be avoided, instead indirect selection should be followed.

Path coefficient analysis revealed that average weight of fruit, length of fruit, width of fruit and number of fruits per plant are the most important character contributing towards fruit yield and hence purposeful balanced selection based on these characters would be rewarding for improvement in brinjal. Direct selection of days of first picking , plant height at 150 DAT, days to 50 percent flowering and number of flowers per cluster should be avoided instead of indirect selection.

5.5 Other Quality parameters

Qualitative characters like fruit colour, fruit shape, colour of calyx, bearing habit, presence of spines on plant and fruit, incidence of shoot and fruit borer, incidence of phomopsis blight, little leaf and bacterial wilt are summarized below.

4.5.1 Fruit colour

Colour of fruits was observed to be dark purple, purple, light purple, green and white. Genotypes 2014/BRLVAR-2, 2014/BRLVAR-3, 2013/BRLVAR-6, Punjab Sadabahar, IVBL-9 (Kashi Tarun), Pusa purple long (SC) and SM-6-7 (RC) exhibited dark purple colour. Whereas, genotypes 2013/BRLVAR-2, 2013/BRLVAR-4, 2013 and 2013/BRBWRES-2 observed purple fruits. Arka nidhi and 2013/BRLVAR-1 were white fruited and 2014/BRLVAR-4, 2013/BRBWRES-3 and 2013/BRBWRES-4 were light purple. Remaining genotypes exhibited green fruit. The findings are in

agreement with the findings of Gangopadhyay *et al.* (2010) and Nair and Mehta (2009).

4.5.2 Fruit shape

Significant variation was observed among the genotypes for shape of fruits i.e. long, oblong, round and small round. Shape of fruits was observed to be long in genotypes 2014/BRLVAR-1, 2014/BRLVAR-2, 2014/BRLVAR-4, 2013/BRLVAR-1, 2013/BRLVAR-3, 2013/BRLVAR-6, 2013/BRBWRES-4, Arka Kusumkar (SC), Pusa purple long (SC), IVBL-9 (Kashi Tarun) and Punjab Sadabahar. Arka Nidhi, SM-6-7 and 2013/BRBWRES-2 were produced round fruit. Whereas, genotypes 2013/BRBWRES-1 and 2013/BRBWRES-3 were produced small round fruit and the remaining genotypes produced oblong fruits. The findings are in agreement with the findings of Gangopadhyay *et al.* (2010).

4.5.3 Colour of calyx

Genotypes were categorized as dark green, light green, dark purple and light purple for colour of calyx. Dark green colour of calyx was exhibited in genotypes 2014/BRLVAR-2, 2013/BRLVAR-1, IVBL-9 (Kashi Tarun) and SM-6-7. 2014/BRLVAR-3, 2014/BRLVAR-4 and 2013/BRLVAR-3 recorded dark purple calyx. Genotypes 2013/BRLVAR-4, 2013/BRLVAR-5 and 2013/BRLVAR-6 exhibited light purple and rest of the genotypes light green colour calyx. The findings are in agreement with the findings of Gangopadhyay *et al.* (2010).

4.5.4 Bearing habit

Bearing habit was observed for single and cluster. Genotypes 2014/BRLVAR-2, 2014/BRLVAR-4, 2013/BRLVAR-2, 2013/BRLVAR-4, 2013/BRLVAR-6, 2013/BRBWRES-2, IVBL-9 (Kashi Tarun) and Punjab sadabahar showed single bearing habit, whereas rest of the genotypes were found in cluster.

4.5.5 Presence of spines on plant

The genotypes have been classified in two groups based on presence of spines i.e. present and absent. Spines were visible in genotype

2013/BRBWRES-1,2013/BRBWRES-2,2013/BRBWRES-3,2013/BRBWRES-4 and 2013/BRLVAR-2. Large number of genotypes was recorded in absent group.

4.5.6 Presence of spines on fruit

The genotypes have been classified in two groups based on presence of spines i.e. present and absent. Spines are visible in genotype 2013/BRBWRES-1,2013/BRBWRES-2,2013/BRBWRES-3,2013BRBWRES-4, 2013/BRLVAR-2, 2014/BRLVAR-2 and 2014/BRLVAR-3.and rest of the genotypes were recorded spines on fruit.

4.5.7 Incidence of phomopsis blight, little leaf and bacterial wilt

The result of incidence of phomopsis blight, little leaf and bacterial wilt is depicted. Significant minimum 3.33% incidence of bacterial wilt was recorded in genotypes Arka kusumkar (SC). 1.67% incidence of phomopsis blight was recorded in genotypes Arka kusumkar and BRLVAR-1 and 6.67% incidence of little leaf in genotypes Pusa purple long.

5.6 Identification of better genotypes

An overall observation of quantitative and qualitative characters genotype 2013/BRBWRES-1 was recorded best with highest yield of 458.49 q/ha followed by 2013/BRBWRES-2 (418.53 q/ha) and these were identified as best genotypes for cultivation in Kymore Plateau and Satpura hills agro climatic region of M.P.

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary

The present investigation entitled “Studies on variability and character association in Brinjal (*solanum melongena* L).” was carried out during rabi season of 2014- 2015 at the horticulture complex, Department of Horticulture, College of Agriculture , J.N.K.V.V., Jabalpur (M.P). The experimental material for the present investigation was comprised of 40 genotypes of Brinjal. These genotypes were sown in Randomized Complete Block Design with three replications, to observed morphological, phonological yield and other quality parameters and to estimate the genetic variability and association analysis. Observations were recorded on the basis of five random competitive plants selected from each genotype separately for morphological, phenological yield and other quality parameters were evaluated as per standard procedure. On the basis of results, the present investigation is summarized follows:

The estimates of mean sum of square due to genotypes were highly significant for all the characters indicating the presence of genetic diversity in the existing material.

The mean performance of the genotypes revealed a wide range variability for all the traits. The variation was highest for fruit yield per plant followed by days to first picking, fruiting span, weight of fruit (g) and crop duration.

The present study revealed that the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the traits which might be due to interaction of the genotypes with the environment to some degree or other explaining environmental factors influencing the expression of these characters. High Phenotypic and Genotypic coefficient of variation was observed numbers of fruits per cluster, number of fruits per plant, length of fruit (cm), width of fruit (cm), weight of fruit (g) and fruit yield per hectare which suggests greater phenotypic and genotypic variability among the genotypes and responsiveness of the attributes for making further

improvement by selection. However, days of first flowering, days of 50 per cent flowering, days to first picking, fruiting span and crop duration, plant height at 90 DAT, 120DAT and 150 DAT, showed low estimates of genotypic and phenotypic coefficient of variation indicating their limited scope for improvement.

High heritability coupled with high genetic advance for traits like number of branches of plant, days to 50 percent flowering, fruiting span, number of fruit per cluster, number of fruit per plant, width of fruit (cm) and fruit yield per hectre. Suggested that the preponderance of additive genes. It also indicated higher response for selection as these characters are governed by additive gene action.

High heritability coupled with moderate genetic advance as percentage of mean were manifested by number of branches per plant, days to first picking, number of flowers per cluster fruit yield per plant, , which might be attributed to additive gene action conditioning their expression and phenotypic selection for their amenability can be brought about.

High heritability coupled with low genetic advance as percentage of mean was not observed. This revealed the predominance of non additive gene action in the expression of these characters.

The genotypic correlation coefficient were higher and magnitude that their corresponding phenotypic one, indicating there by strong inherent association between different traits studied. The phenotypic expression of correlation was lessened possibly due to multiple influences of environmental components. In view of their correspondence, selection on phenotypic basis would be effective.

The highest positive and significant correlation coefficient of fruit yield per plant was noted with fruiting span, number of fruits per plant, length of fruit, width of fruit and average weight of fruit (g), which indicated that effective improvement in brinjal yield through this components could be achieved. The yield attributing characters exhibited varying trend amongst them. Plant height at 150 DAT showed significant and positive correlation with test to first flowering, days to 50% flowering, number of fruits per cluster, average weight

of fruit and crop duration. Days to first flowering expressed significant and positive correlation with days to 50% flowering, fruiting span, number of flowers per cluster and crop duration. Association of days to 50% flowering was recorded significant and positive with fruiting span, number of flowers per cluster, width of fruit and crop duration. Fruiting span was recorded significant and positive with number of flowers per cluster, width of fruit, crop duration and fruit yield per plant. Association of number of flowers per cluster was recorded significant and positive with crop duration. Association of number of fruits per cluster was recorded significant and positive with average weight of fruit. Number of fruits per plant expressed significant and positive correlation with width of fruit. Length of fruit expressed with significant and positively association with average weight of fruit. Fruit width expressed significant and positive correlation coefficient with crop duration.

However, fruit yield per plant exhibited significant and negative association with days to first flowering, days to 50% flowering and days to first picking. Highly significant and negative association of plant height 150 DAT was observed with number of fruit per plant. Number of branches per plant were found significant and negative with number of fruit per cluster, length of fruit and average weight of fruit. Days to first flowering were found significant and negative with length of fruit. Days to 50% flowering was showed significant and negative with length of fruit. Days to first picking was showed significant and negative with fruiting span and number of fruits per cluster. Fruiting span was showed significant and negative with length of fruit. Number of flowers per cluster were showed significant and negative with nothing. Number of fruits per plant exhibited significant and negative with nothing. Fruit length exhibited significant and negative association with width of fruit and crop duration. Width of fruit exhibited significant and negative association with average weight of fruit.

Path coefficient analysis revealed that number of fruits per plant, number of flowers per cluster, length of fruit, width of fruit, average weight of fruit and crop duration are the most important characters contributing towards fruit yield and hence purposeful and balanced selection based on these characters would be made rewarding for improvement of brinjal.

Expression of eight distinguishing morphological traits were observed visually at plant and fruit levels to categorize the genotypes as per national test guidelines developed by ICAR.

At plant and fruit level, the expression of eight morphological characters at different stages of plant and fruit was observed to categorize the genotypes. Fruit colour, fruit shape, colour of calyx, bearing habit, presence of spines on plant and fruit and uniform distinguishing characters for verification of brinjal genotypes at field level.

An overall observation of quantitative and qualitative characters genotype 2013/BRBWRES-1 was recorded with highest yield of 458.49 q/ha followed by 2013/BRBWRES-2 (418.53 q/ha) and these were identified as best genotypes for cultivation in Kymore Plateau and Satpura hills agro climatic region of M.P.

6.2 Conclusion

Analysis of variance revealed highly significant variance for all the traits depicting greater variability in the existing material.

The mean performance of the genotypes revealed a wide range of variability for all the traits. The variation was highest for crop duration, weight of fruit, fruiting span and days to first picking.

The PCV was higher than the GCV for all the characters. High PCV and GCV was observed for length of fruit, width of fruit, weight of fruit and number of fruits per plant, indicating greater diversity for these traits and their improvement through selection.

High heritability coupled with high genetic advance for traits like number of fruits per cluster, number of fruits per plant, length of fruit, width of fruit and weight of fruit, fruit yield per plant and fruit yield per hectare. Suggested that the preponderance of additive genes. It also indicated higher response for selection of high yielding genotypes as these characters are governed by additive gene actions.

The association studies indicated that the advantages of upgrading brinjal genotypes through simultaneous selection for fruit width, fruit length, average fruit weight.

Path coefficient analysis revealed that number of fruits per plant, number of flowers per cluster, length of fruit, width of fruit, average weight of fruit and crop duration are the most important characters contributing towards fruit yield and hence purposeful and balanced selection based on these characters would be made rewarding for improvement of brinjal.

The finding will help to a great extent in maintenance breeding, quality seeds production, seed certification and seed testing programme. It also used for screening of genotypes for quality and high yield. Brinjal genotypes in active seed multiplication chain at national level may be verified with the help of observed distinguishing, stable and uniform morphological traits at plant and fruit level viz., fruit colour, fruit shape, colour of calyx, bearing habit and presence of spines on plant and fruit.

An overall observation of quantitative and qualitative characters genotype 2013/BRBWRES-1 was recorded with having highest yield of 458.49 q/ha followed by 2013/BRBWRES-2 (418.53 q/ha) and these were identified as best genotypes for cultivation in Kymore Plateau and Satpura hills agro climatic region of M.P.

6.3 Suggestions for further work

1. Stability of distinct traits of brinjal should be established over the years.
2. Traits identified for high heritability coupled with high and moderate genetic gain may be considered in selection for the improvement of crop.
3. Characters having desirable association and direct effects with fruit yield should be given due considered for genetic improvement in brinjal.
4. The genotypes showing greater yield potential with other desirable qualities may be tested under different agro climatic conditions and those found suitable could be recommended for general cultivation.

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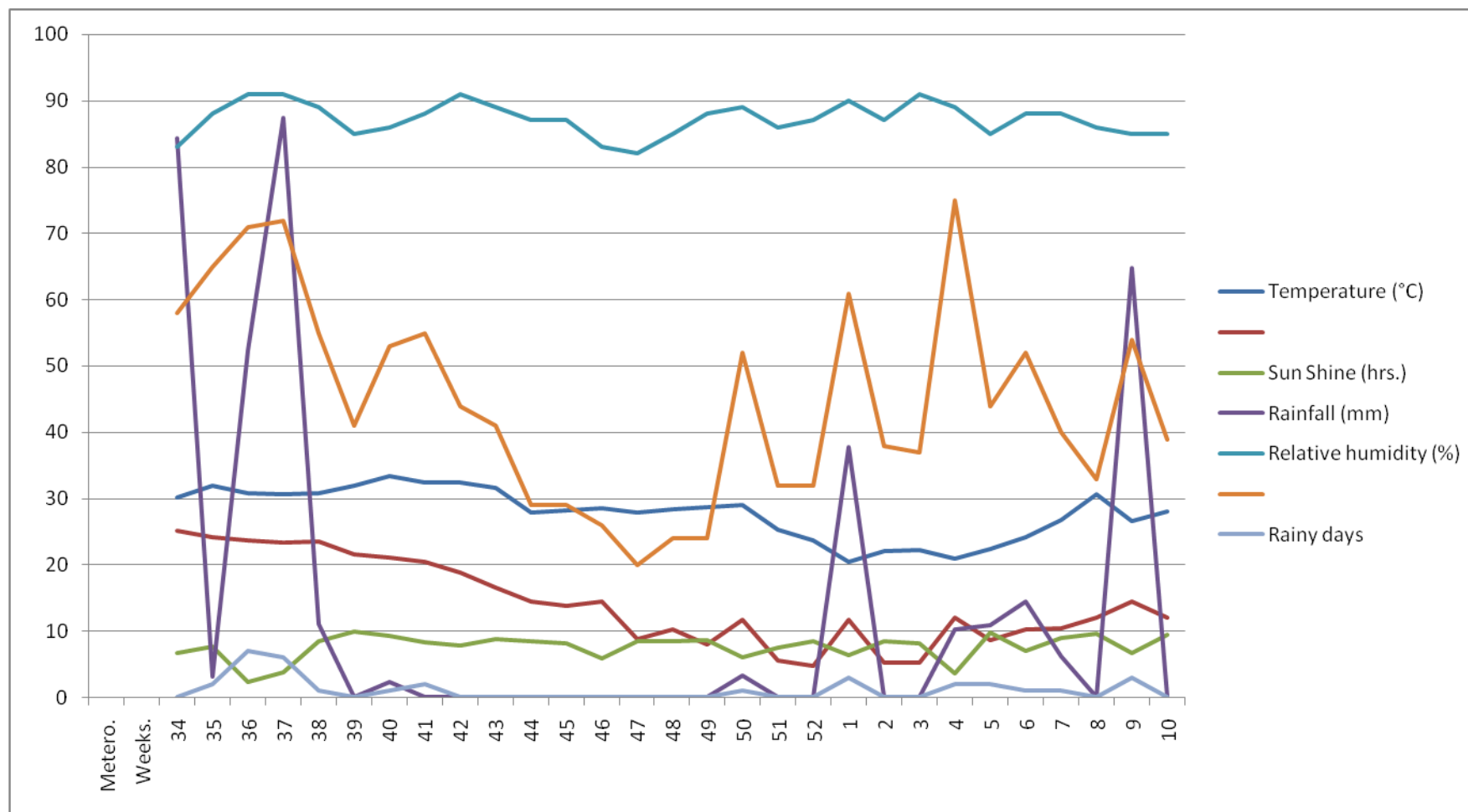


Fig.No. 31 : Weekly Meteorological data during the cropping season (2013-14)

PLAN OF LAYOUT

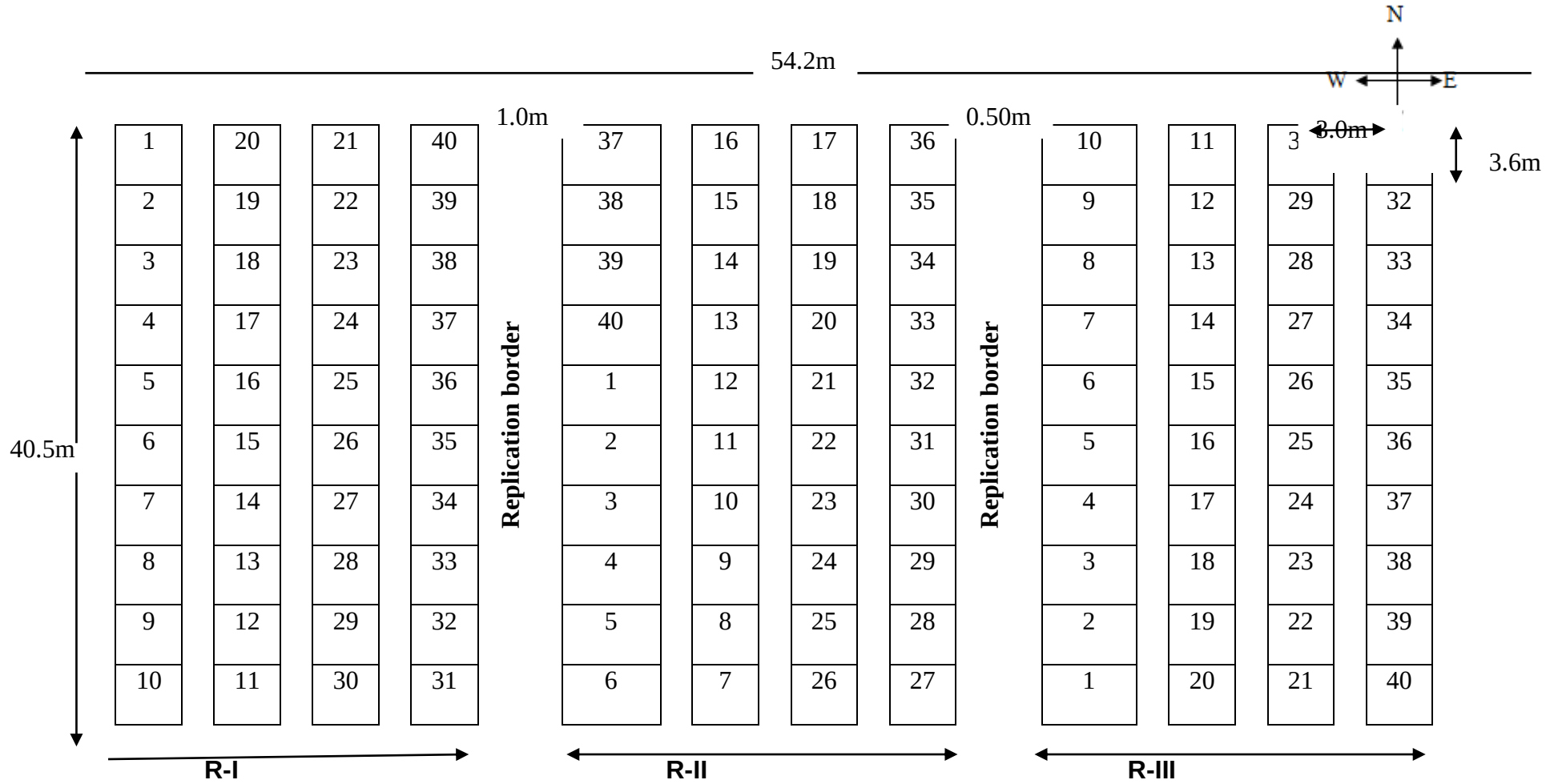


Fig.2: Layout plan of the experimental field

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Scientific interests

- Plant Breeding
- Environmental Science
- Research and Development

Awards

For the partial fulfilment of the Master's degree programme she was allotted a research problem on "**Studies on variability and character association in Brinjal**" which was successfully conducted by her and being submitted in the form of the thesis.