PHENOTYPIC STABILITY STUDIES IN BRINJAL
(*Solanum melongena* L.)

By

ANIL BHUSHAN

(J-12-D-161-A)

Thesis submitted to
Faculty of Postgraduate Studies
in partial fulfillment of requirements for the degree of

DOCTORATE OF PHILOSOPHY

IN

VEGETABLE SCIENCE

Division of Vegetable Science and Floriculture
Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu
Main Campus, Chatha, Jammu 180009

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CERTIFICATE-I

This is to certify that thesis entitled **"Phenotypic stability studies in brinjal (*Solanum melongena* L.)"** submitted in partial fulfillment of the requirements for the degree of **Doctorate of Philosophy in Agriculture (Vegetable Science)** to the **Faculty of Post-Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu,** is a record of bonafide research work carried out by **Mr. Anil Bhushan (Registration No. J-12-D-161-A)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. The help and assistance received during the course of these investigations have been duly acknowledged.

Place: Jammu

Date: 09-04-2016

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We, the members of the Advisory Committee of **Mr. Anil Bhushan (Registration No. J-12-D-161-A)**, have gone through the manuscript of the thesis entitled **"Phenotypic stability studies in brinjal (*Solanum melongena* L.)"** and recommend that it may be submitted by the student in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Agriculture.

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Needless to say, errors and omissions are mine.

Dated: 19-08-2016 ***Anil Bhushan***

Place: Chatha, Jammu

ABSTRACT

Title of Thesis	**:**	**Phenotypic stability studies in brinjal (*Solanum melongena* L.)**
Name of the student	**:**	**Anil Bhushan**
Registration No.	**:**	**J-12-D-161-A**
Major Subject	**:**	**Vegetable Science**
Name & Designation of Major advisor	**:**	**Dr. R.K Samnotra (Professor&Head)**
Degree to be awarded	**:**	**Ph.D Vegetable Science**
Name of University	**:**	**Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu**

The present investigation entitled "Phenotypic stability studies in brinjal (*Solanum melongena* L.) was carried out at Vegetable Experimental Farm, Division of Vegetable Science & Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha during 2013-14 and 2014-15 to assess the performance of genotypes across seasons and years for their adaptability under wide range of environments through phenotypic stability studies using Eberhart and Russell regression model. Twenty five brinjal genotypes were evaluated for yield and its components under six environments comprising of six different seasons viz., E_1: Autumn-Winter2013; E_2: Spring-Summer, 2014; E_3: Rainy, 2014; E_4: Autumn-Winter, 2014; E_5: Spring-Summer, 2015 and E_6: Rainy, 2015. Observations were recorded for 14 quantitative traits viz., days to 50 per cent flowering, days to first picking, fruit length (cm), fruit diameter (cm), number of fruits per plant, average fruit weight (g), number of leaves per plant, plant height (cm), number of primary branches per plant, leaf area (cm^2), marketable yield per plant (kg), unmarketable yield per plant (kg), fruit yield per plant (kg) and fruit yield per hectare (q), two qualitative traits viz., ascorbic acid content (mg/100g) and total phenol content (mg/100gm) and five biotic stress traits viz., shoot borer infestation (%), fruit borer infestation (%), spider mite infestation (%), little leaf incidence (%) and phomopsis blight incidence (%). For a given trait, a desirable, widely adapted and stable genotype are defined as one with an individual mean performance greater than the average mean, a regression coefficient (b_i=1), and no deviation from mean squares (S^2d_i=0). Highly significant mean sum of squares for genotypes, environments and genotype × environment interaction were recorded for all the traits except non significant G x E interactions for number of leaves per plant, number of primary branches per plant, ascorbic acid content and little leaf incidence indicating that both linear as well as non linear components were important in building up total G × E interaction. On the basis of stability parameters (μ, b_i and S^2d_i) genotypes PPL-74, Chhaya, PBH-3, Shamli, Pusa Kranti and Pusa Uttam were suitable under favourable environments whereas, genotypes, Rajni, Abhishek and PPL were identified suitable for unfavourable environment and genotypes Pusa Ankur and Navkiran Improved were stable genotypes for days to 50% flowering; genotypes Pusa Uttam, PBH-3 and Shamli were most stable for days to first fruit picking; genotypes Navkiran Improved and MH-80 were identified as widely adapted to all the environments whereas Sandhya, Pusa Ankur and PBH-3 were adapted to unfavourable environments for number of fruits per plant; Genotype PPL-74 found adapted to all type of environments and Sandhya, Chhaya, Abhishek and PPR were found to be specifically adapted to unfavourable environments for average fruit weight. Genotypes Chhaya and PPL were found adapted to all types of environments for marketable yield per plant and PPR was found well adapted for all types of environments for fruit yield per hectare whereas Arka Nidhi and BR-14 were adapted to unfavourable environments for marketable yield per plant and Punjab Sadabahar, Nisha Improved and Arka Keshav were specifically adapted under unfavourable environments. For quality traits, genotype Chhaya was identified as widely adapted to all the environments for ascorbic acid content whereas none of the genotypes was found adapted to all types of environments. For shoot borer infestation, genotypes Rajni and Pusa Kranti were found adapted to all types of environments where as Shamli, PPL-74 and Arka Nidhi were specifically adapted to unfavourable environment. For fruit borer infestation Pusa Kranti and Pusa Ankur were adapted to all type of environments and PPL-74 and Sandhya were adapted to unfavourable environments. For phomopsis blight, genotype Sandhya was adapted to all type of environments whereas Puneri Kateri, PPL-74, Shamli, Chhaya and Abhishek were found adapted to unfavourable environments.

Keywords: Brinjal, phenotypic stability, Eberhart and Russell model

Signature of Major Advisor **Signature of Student**

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CHAPTER-I

INTRODUCTION

Aubergine, commonly known as brinjal or eggplant (*Solanum melongena* L.) is an often cross pollinated crop and belongs to the angiospermic family Solanaceae. It is a popular and principal vegetable crop widely grown in tropics and subtropics (Roychowdhury and Tah, 2011), especially in Asia, Europe, Africa and America (Demir *et al*, 2010). Indian sub-continent and China are its primary centers of diversity (Daunay *et al,* 2001; Kashyap *et al*, 2003; Singh *et al*, 2014). Brinjal has an important nutritional value due to its composition, which includes minerals like potassium, calcium, sodium and iron (Mohamed *et al*, 2003; Raigon *et al*, 2008) as well as dietary fibre (USDA, 2014; Sanchez-Castillo *et al*, 1999). It contains 92.7 per cent water, 4 per cent carbohydrates, 1.4 per cent protein, 1.3 per cent fiber, 0.3 per cent fats, 0.3 per cent minerals and vitamin A in a negligible quantity (Tindall, 1978). Besides this, brinjal fruits are reported to be a rich source of ascorbic acid and phenolics (Vinson *et al.*, 1998; Somawathi *et al*, 2014; Tripathi *et al*, 2014). The oblong-fruited eggplant cultivars are rich in total soluble sugars, whereas the long fruited cultivars contain higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids, dry matter and amide proteins (Somawathi *et al*, 2014). It is ranked amongst the top ten vegetables in terms of antioxidant capacity (Cao *et al*, 1996). The white brinjal is said to be good for diabetic patients (Tripathi *et al*, 2014). There is much variation in the chemical constituents of the fruits of different types and cultivars (Tripathi *et al*, 2014). Brinjal is also valued for its medicinal properties and has got de-cholesterolizing property, primarily due to the presence of 65.1 per cent linoieic and lenolenic poly-unsaturated fatty acids present in flesh and seeds of fruits. Presence of magnesium and potassium salts in fruits also impact de-cholesterolizing action (Bhat, 2011).

In India, it is one of the most common and versatile crops adapted to different agro-climatic regions and can be grown throughout the year right from sea level to snowline for its immature, unripe fruits which are used in a variety of ways as cooked vegetable and in curries (Singh *et al*, 2014). Many brinjal varieties produce fruits with a wide diversity of shapes, sizes and colours (Kashyap *et al*, 2003; Kantharajah and Golegaonkar, 2004). India is the second largest producer of brinjal in the world next to China and produces 13557.8 ‘000 MT from an area of 711.3 ‘000 ha (NHB, 2014). Although, India ranks second after China in worldwide eggplant production, yet its productivity per unit area is relatively low (Jayaramaiah *et al,* 2013). In J&K state, brinjal is grown over an area of 22,00 ha, out of which Jammu region accounts for 1144 ha area with total production of 2,33,661.50 MT (Anonymous, 2014). There are umpteen numbers of commercially grown varieties and hybrids available in the market, released by both public and private sector. However, a genotype possessing considerably high yield potential coupled with stable performance in different environments has great value for its adaptation on large scale and in plant breeding programme (Mehta *et al*, 2011; Bora *et al*, 2011). Moreover, there is an utmost need for development of high yielding stable varieties and hybrids for specific environments and seasons (Vaddoria *et al*, 2009a). Efforts are being made by vegetable breeders to develop new high yielding and pest and disease tolerant genotypes. Genotype and environmental interaction plays a significant role for any such productive gain. Selection of suitable and stable crop varieties has received much attention by the breeders as an advance approach in increasing crop production. A stable variety/hybrid is desirable for obtaining uniform crop yield over a wide range of agro-climatic situations. Stability has been defined as the ability of crop varieties to buffer environmental fluctuations to maintain uniform development of the crop and crop yield with better quality (Mandal and Chaurasia, 2007). Stability in productivity, therefore, is a major and important consideration to identify brinjal genotypes capable of performing well across the environments. Study of stability parameters is useful to measure adaptability and stability of crop cultivars, which can be used to identify genotypes suitable for different environments from season to season. The relative performance of genotypes often changes from one environment to another due to the occurrence of Genotype × Environment interaction. Therefore, it is of utmost importance to understand the nature of G × E interaction for screening and selection of genotypes in an efficient manner. Genotype × Environment interaction is expected to play an important role in the performance of genotypes under diverse environmental conditions, besides their individual effect (Samnotra *et al*, 2011).

However, there is hardly any information available on stability of brinjal genotypes for yield and quality parameters for varied agro-climatic conditions of Jammu region. Since most of the economic characters in brinjal, such as number of fruits per plant and average fruit weight, are quantitative in nature, and are influenced by environmental fluctuations, therefore it becomes imperative to assess the stability of desired genotypes capable of giving higher yields as well as exhibiting tolerance to various biotic stresses like fruit and shoot borer, spider mite, little leaf and phomopsis blight under a wide range of environmental conditions.

Keeping in view the importance of brinjal crop and challenges posed by biotic stresses for its successful production in Jammu region, the present investigation entitled "Phenotypic stability studies in brinjal (*Solanum melongena* L.)" was carried out to study the performance of 25 diverse genotypes under six environments spread over spring-summer, rainy and autumn-winter season for two consecutive years to identify the stable genotypes and their utilization in further breeding programmes for the development of hybrids and desirable genotypes to mitigate the vagaries of climate change with the following objectives:

1. To identify genotypes capable of giving consistent performance over seasons and years,
2. To identify stable quality genotypes rich in ascorbic acid and phenol contents, and
3. To identify stable genotypes tolerant to biotic stresses like fruit and shoot borer, spider mite, little leaf and phomopsis blight.

CHAPTER-II

REVIEW OF LITERATURE

The phenotypic performance of a genotype is not necessarily the same under diverse agro-ecological conditions (Ali *et al*, 2003). Some genotypes may perform well in certain environments, but fail in several others. Genotype-environment (GE) interactions are extremely important in the development and evaluation of plant varieties because they reduce the genotypic stability values under diverse environments (Akcura *et al*, 2005). Stability analysis for growth, yield attributing and quality traits of a genotype is of utmost importance for the sustainable production of brinjal crop under a wide range of climatic conditions. Phenotypic stability is a valuable technique for assessing the response of various genotypes under changing environmental conditions. A genotype does not exhibit the same phenotypic characters including yield and quality in all environments. The failure of a genotype to give the same phenotypic performance when tested under different agro-climatic environments is the reflection of genotype × environment interaction, which is of major importance to the plant breeder in developing stable varieties (Eberhart and Russell, 1966).

Relevant literature pertaining to all the aspects of response of brinjal genotypes to the various environments and phenotypic stability analysis is reviewed under following headings:

1) Response of genotypes to environments for quantitative traits
2) Response of genotypes to environments for qualitative traits
3) Response of genotypes to environments for biotic stresses

1) Response of genotypes to environments for quantitative traits

Yield and yield contributing traits of a crop are highly influenced by environments. Stable genotypes of brinjal are necessary to increase the productivity. A study of G × E interaction is much valuable in the selection of better genotypes (Islam and Newaz, 2001). The magnitude of components of genetic variation and G × E interaction can help to select better genotypes (Haque *et al*, 2003). Phenotypically stable brinjal genotypes are of great importance because the environmental conditions vary from season to season and year after year. Wide adaptation and consistent performance of recommended genotypes is one of the main objectives of any breeding programme (Chaurasia *et al*, 2005). The failure of a genotype to give the same phenotypic performance when tested under different agro-climatic environments is the reflection of genotype × environment interaction which is of major importance and consideration to the plant breeder in developing stable genotypes (Eberhart and Russell, 1966). Relevant literature pertaining to all aspects of quantitative traits of brinjal under the proposed study is reviewed as under:

Singh *et al* (1985) evaluated 12 brinjal genotypes under Hissar conditions for yield and yield contributing characters and found highly significant differences among genotypes and environments and G × E interactions. Among all the genotypes, PBr91-2 and Azad Kranti were stable and produced 51.00 and 47.45 t/ha yield, respectively. However, PH-4, ARU-2C, PBr-129-5 and BR-112 gave good yields under unfavourable conditions, while Vijay was the best under favourable conditions. Similar results have been observed by Khurana *et al.* (1987) for phenotypic stability of brinjal cultivars for fruit yield under Ludhiana conditions.

Sidhu (1989) evaluated 15 varieties of brinjal for four environments (Kharif 1980, 1981, 1982 and 1983) and recorded significant genotype × environment interactions. Amongst all the varieties, S-16 produced the highest average yield (28.69 t/ha) and had the best stability followed by P-8 and Annamalai.

Vadivel and Bapu (1989) evaluated 10 promising accessions of eggplant for fruit yield in bimonthly staggered sowing during 1987-88. They reported significant genotype × environment interactions indicating differential response of genotypes. The genotypes Ep-65 and Annamalai were most stable giving high fruit yields over all environments. Co-2 performed well in favourable environments and Co-1 and Ep-44 in less favourable ones.

Balakrishnan *et al.* (1993) studied the stability of five brinjal hybrids at six sites under Delhi conditions during 1989-91. The results revealed that Pusa Hybrid 6 gave highest mean yield, but proved suitable only for conditions of high soil fertility, whereas Azad and NDBH1 showed under general adaptations.

Chowdhury and Talukdar (1997) tested F_3 generations of 6 brinjal crosses and their 6 parents under three environments (normal sowing and spacing, and late sowing combined with either normal or wider spacing) under Guwahati conditions and evaluated for nine traits *viz.*, days to 50 per cent flowering, days to 75 per cent fruit setting, plant height, primary branches, fruit length, fruit girth, fruit number/plant, average fruit weight and fruit yield/plant. The pooled analysis of variance revealed significant differences among the genotypes. The linear component of genotype environment (G × E) interaction was not significant, but the non-linear component was found to be significant for all traits except days to 50 per cent flowering, days to 75 per cent fruit setting and number of primary branches. Amongst the parents, MHB1, RU2C and Lota gave stable performance for fruit yield/plant and some component traits, whereas most of the crosses showed fairly stable performance for yield/plant and average fruit weight.

Srivastava *et al* (1997) tested 12 brinjal genotypes for stability analysis under Kanpur conditions during *kharif* seasons of 1994-96. They reported significant differences in fruit yield between genotypes and genotype × environment interactions. The genotype KS-351 recorded best fruit yield performance followed by KS-331-5 and these were free from linear as well as non linear component of interaction and as such were regarded as most desirable for cultivation.

Mishra *et al* (1998) evaluated 10 varieties of brinjal during *kharif* seasons of 1991-93 at Regional Research Station, Ghumsar Udaigiri (India). They observed significant differences among varieties under each environment for all characters, indicating real differences among varieties. The genotypes BB 49, BB 7, BB 1, BB 2 and BB 26, in order, showed above average stability and above average yield in all environments, indicating their suitability in all the environments.

Yield and its components were studied by Mohanty and Prusti (2000) for genotype × environment interaction and stability parameters in 15 brinjal genotypes during 1994-96 at Regional Research Station, Bhawanipatna. The results revealed significant linear and non-linear components of genotype-environment interaction for yield and number of fruits/plant, while the predictable portion alone was significant for average fruit weight. Significant positive correlations were also observed between mean performance and regression coefficient for yield and number of fruits/plant, mean performance and deviation from regression for average fruit weight and between regression coefficient and deviation from regression for average fruit weight and number of fruits/plant. Amongst all the genotypes, Pusa Purple Round, BB 6-1, BB 11 and BB 26 were found stable and identified for general adaptability for that region.

Seven round shaped brinjal hybrids *viz*., Neembkar, BH-1, BH-2, ARBH-216, ARBH-242, Pusa Hybrid-6, and Pusa Hybrid-9 were grown for four years during 1994-1998 under Raipur conditions by Rai *et al*. (2000a) for stability analysis of yield and yield contributing characters. The results revealed that the mean squares for environment (linear) as well as hybrid × environment (linear) were highly significant for all the characters under study indicating different response of hybrids. The highest yield was obtained by ARBH-242 (626.84 q/ha) followed by Pusa Hybrid-6 (512.02 q/ha) and Pusa Hybrid-9 (504.93 q/ha). From the yield point of view and its contributing characters, none of the hybrids proved to be stable or adaptive to environmental changes. However, hybrids Neembkar, ARBH-242 and ARBH-216 showed significant response ($b<1$) in two environments.

In an another study under Raipur conditions, Rai *et al*. (2000b) conducted stability analysis on nine long fruited brinjal hybrids for yield and its contributing attributes for four years at Raipur, Chhattisgarh. Mean squares for hybrid × environment (linear) were highly significant for all the characters under study indicating different response of hybrids. The hybrid PBH-6 was found to be stable with regard to yield and its contributing characters. It could be the most stable and useful hybrid for cultivation in Raipur of Chhattisgarh region of Madhya Pradesh.

Genotype × Environment interaction studies in brinjal were undertaken by Sarma *et al.* (2000) by growing 15 genotypes in four environments (2 plant densities, 2 sowing dates) in *rabi* 1995-96 at Jorhat. Significant genotype and G × E interaction effects were observed for yield and seven yield related characters. Stability parameters indicated that JC 2 had average stability for yield/plant, earliness of flowering, tallness, fruit circumference and average fruit weight.

Rai *et al*. (2001a) evaluated 11 genotypes (long fruited) of brinjal *viz*., Punjab Sadabahar, PB-33, PB-30, KS-331, KS-352, NDB26-1, NDB28-2, JB-15, BB-46, BB-13-1 and Pusa Purple Long for stability parameters in respect of yield and its contributing characters over four environments. They observed that pooled deviations from regression for all characters were highly significant. As far as yield was concerned, PB-30 and JB-15 were stable as well as linearly predictable out of which PB-30 was also second highest yielder. Pusa Purple Long was also stable in yield; however, it is good for poor environments only.

Prasad *et al* (2002) evaluated 45 inbred lines in three different environments for a period of three consecutive years i.e. 1993-94, 1994-95 and 1995-96 at Hessarghatta, Bangalore. They recorded significant differences among all the genotypes tested for characters *viz*., yield/plant, yield/plot, fruit weight, fruit length, fruit breadth, fruit firmness, days to flowering, number of branches, plant spread and plant height in all the three environments. The joint regression analysis of variance for different characters indicated that the components genotype × environment interaction was highly significant for all the characters. The insight of stability analysis revealed that the inbred line CH303 (xi=1.71kg, bi=1.60 and s^2di=.01) showed supremacy in yield and was stable for favourable environments followed by CH309, CH267 and CH250.

Mohanty (2002) evaluated the performance of 18 hybrids of brinjal over three years at Regional Research Station, Bhawanipatna during *kharif* 1998 to 2000. He observed wide variation among genotypes, environments and G × E interactions for all traits. Among all the genotypes, only three hybrids (Vardan, Nisha and CHB) were found stable over environments for fruit yield, of which the lone hybrid Nisha showing yield potential of 28.11 t/ha was detected for general adaptability and proposed for commercial cultivation.

Chaurasia *et al.* (2005) tested the performance of 15 varieties/lines for yield and its components for five years from 1993-94 to 1997-98 at experimental farm of IIVR, Varanasi (U.P.). They recorded significant Genotype × Environment interaction for plant height, fruit length, fruit diameter and fruit size, number of fruits/plant and10 fruit weight indicating that linear as well as non-linear components were important. Based on the overall performance, KS-331, KS-224 and H-7 were found promising with high yield and stable performance for number of characters.

Kanwar *et al* (2005) conducted an experiment using six brinjal varieties grown under four environments (winter, spring, summer and rainy seasons of 1999-2000) at Vegetable Research Farm of PAU, Ludhiana to study their stability parameters for the number of fruits/plant, fruit weight, seed weight/fruit and seed yield. The study revealed that Punjab Moti was the best for number of fruits/plant (13.72) and seed yield/hectare (245.64 kg), while Punjab Jamuni Gola was best for fruit weight at harvest (0.21kg) and seed weight/fruit (1.42g).

Suneetha *et al* (2006a) conducted studies on stability analysis of brinjal genotypes which includes 10 homozygous lines, and their 45 hybrids derived from the 10 x 10 diallel mating (excluding reciprocals) of these lines at Vegetable Research Farm, Anand using three seasons viz. summer, rainy and late summer. The study revealed significant mean squares due to seasons, indicating variable expression of the traits in the different seasons. The result on environmental indices revealed rainy season to be congenial for fruit yield/plant, days to first picking, plant height and majority of fruit characters, while summer season was observed to be ideal for fruits/plant, and late summer for primary branches /plant. The parents, PLR1 and JBPR1 were observed to be stable for fruit yield and few yield contributing characters, while the hybrids, PLR1 x JBPR1, Morvi4-2 x JBPR1 and Surati Ravaiya x JBPR1 were identified as high yielding and stable hybrids suitable for cultivation during all the seasons studied.

Kikuchi *et al*, 2008 tested under Kusawa, Japan conditions the stability of fruit set of newly selected parthenocarpic eggplant lines under different seasons with varied temperatures i.e. autumn-winter, early summer and winter cultivation in growth chambers under natural light and observed AE-P03 and AE-P01 to be the best lines under autumn-winter cultivation.

Stability performance over three consecutive seasons for fruit yield and its components in 48 hybrids derived by crossing 16 genetically diverse genotypes was conducted by Vaddoria *et al*, 2009(a) under Junagarh conditions of Gujarat. The partitioning of environments showed that environments (linear) differed significantly and were quite diverse with regards to their effect on the performance of the genotypes for fruit yield and majority of yield components. Seven hybrids viz., JBSR 98-2 x Pant Rituraj, ABL 89-1 x Pant Rituraj, ABL 98-1 x GBL 1, Morvi 4-2 x GBL 1, Sel. 4 x Pant Rituraj, Morvi 4-2 x PLR 1 and Green Round x GBL 1 were found stable with high mean performance, average responsiveness ($b_i \approx 1$) for fruit yield per plant. A perusal of the results on environmental index for various traits under different environments also suggested variable response of the seasons to the different traits studied.

Mehta *et al*, 2011 evaluated seven open pollinated genotypes of long brinjal in the three environments of rainy season under irrigated conditions of Chhattisgarh plains and observed that IBWI-2007-1 was the most stable genotype under irrigated conditions for *kharif* planting as it had high mean, regression coefficient not deviated from unity and non-significant deviation from regression whereas, a local genotype was suitable for fruit yield under low yielding environment.

Bora *et al*, 2011 conducted an experiment on stability studies in 17 brinjal genotypes during 2008-09 (autumn winter, 2008 and spring summer, 2008-09). Each season was splitted into two environments i.e. one with recommended fertilizer dose and another with recommended doses of vermicompost. Pooled analysis revealed the presence of wide genetic variability among the genotypes and among testing environments. Among all the genotypes, PB-67 was the top performing genotype in all the four environments whereas eleven genotypes showed non-significant deviation from regression and therefore, classified as stable. Only five genotypes viz. PB-4, PB-60, PB-67 PB-66 and Punjab Sadabahar expressed regression coefficient approximately to unity, deviation from regression near to zero with above average mean performance.

Panwar *et al*, 2013 evaluated eight brinjal hybrids/varieties namely PPL-74, Chhaya, Surya kiran, Nishant, Pant Samrat, PB-5, PB-67 and Pant Rituraj under Ranichauri conditions. The experiment was conducted during summer-rainy season and data were averaged of two consecutive years, respectively 2011- 2012 and 2012-2013. The results revealed that PPL-74 took minimum days to flowering and first harvest with an average of 45 to 55 days after transplanting, respectively. PPL-74 was found superior over rest of other hybrids with respect to most of desirable characters fruit length (22.05 cm), fruit stalk length (6.98 cm), plant spread (126.16 cm), marketable fruit yield (712.96 t/ha), while minimum values for most of the parameters were observed in PB-67 and Chhaya proved the 2nd best hybrids in respect to the most of characters.

Sanas *et al*, 2014 studied the performance of thirteen local brinjal genotypes under Konkan climatic conditions during the *rabi* season of year 2008-2009.All these thirteen brinjal genotypes showed significant variation in physical fruit characters and yield characters. Physical parameter viz., weight of fruit, length and girth of fruit, shape of fruit and colour of fruit showed notable variation among all the genotypes of brinjal. The genotype SML-5 recorded significantly the highest fruit length (23.01cm). However, the genotype SML-8 showed the maximum fruit breadth (8.03cm). The highest fruit weight was observed in the genotype SML-3 (178.94 g).

Milli *et al*, 2014 tested 36 genotypes of brinjal including local collections and established genotypes under Jorhat climatic conditions during *rabi* season of 2011-12. The overall performance in relation to fruit yield and fruit weight/ plant was the best in the genotype GB 09-05. The other promising genotypes were JB 10-14, GB 09-02-02 and GB 09-10-14.

2) **Response of genotypes to environments for qualitative traits**

Eggplant, grown throughout the year, is a common and popular vegetable crop in the subtropics and tropics, therefore, can play a vital role in achieving the nutritional security (Sarker *et al*, 2006). Being an important source of plant-derived nutrients, the identification of genotypes with higher nutrients and better consumer preference could be beneficial for society, particularly for poor consumers. But the development of cultivars with improved fruit quality and good phytochemical properties, a pressing need for better market value, through breeding has received relatively little attention in vegetables especially in eggplant (Sabolu *et al*, 2014). Phenols and ascorbic acids are important determinants of brinjal fruit flavour (Stommel and Whitaker, 2003). Brinjal fruit is a rich source of ascorbic acid and phenolics, both of which are powerful antioxidents (Vinson *et al*, 1998) and have been reported to successfully suppress the development and growth of tumors, lung cancer (Matsubra *et al*, 2005), inhibit inflammation (Keli *et al*, 1996), and cardiovascular diseases (Knekt *et al*, 1997). Higher ascorbic acid content in brinjal fruit is associated with increased nutritive value of the fruits which would help better retention of colour and flavour (Kumar and Arumugam, 2013). The proximate compositions of fruits estimated in the present investigation *viz.,* moisture, crude protein, total sugar and total phenol contents not only determine fruit quality but also are associated with the tolerance attribute of the genotype against biotic stresses (Karak *et al*, 2012). Although literature is available regarding estimation of ascorbic acid, total phenols and other chemical constituents in various types and varieties of brinjal, a very scanty literature is available regarding the stability analysis of quality traits in brinjal in and outside the country. The available literature concerning the qualitative traits of brinjal is reviewed as under:

Stability analysis for yield and quality was conducted by Suneetha *et al*, 2006(b) at Anand, Gujarat conditions. They reported significant mean squares due to genotypes and seasons as well as genotype x environment interaction for quality and physiological parameters i.e. TSS and total phenols. Among all the hybrids tested, three hybrids viz. Morvi 4-2 x JBPR 1, AB98-10 x JBPR1 and AB98-10 x Morvi 4-2 were found to be stable during all seasons, rainy season and late summer season respectively for total phenol.

Field experiments were conducted by Suneetha *et al* 2006(c) in Gujarat, India, to determine the stability of the yield, yield components and physiological characters of different aubergine genotypes with regard to different cropping seasons (summer, wet and late-summer). The results revealed that the wet season was congenial for fruit yield per plant and yield components, while the summer season was observed to be ideal for quality traits such as total soluble sugars and total phenols and late summer for fruit dry matter and leaf area.

Prohens *et al*, 2007 tested the total phenolics and ascorbic acid contents in a collection of different varietal types and hybrids. The material consisted of 69 varieties of *S. melongena*, two of *S. aethiopicum*, and two of *S. macrocarpon*. Among the *S. melongena* varieties there were materials corresponding to different varietal types: landraces of Spanish (18), African (8), and Caribbean (1) origins; European commercial hybrids (6); commercial non-hybrid varieties (6); materials of south-east Asian origin (6); and experimental hybrids obtained between parents included in the study (24). Large differences in phenolic concentration were found among the materials studied, with a range from 134 mg_kg–1 in *S. aethiopicum* (BBS 157) to 1122 mg_kg–1 in *S. macrocarpon* (BBS 196). When considering only the *S. melongena* materials, the range varied from 280 mg/kg ('Listada de Gand_ıa') to 834 mg_kg–1 (ALM 1). The range of variation within each varietal type is also high, and within each varietal type of *S. melongena* (except for the Caribbean type, which consists of a single variety) there are varieties with relatively high and low phenolic concentrations. Ascorbic acid concentrations are much lower than those of phenolics and range between 10.0 mg_kg–1 for *S. melongena* 'LF3-24' and 22.6 mg_kg–1 for *S. aethiopicum* BBS 159 . A wide range of variation exists within each *S. melongena* varietal type.

Wetwitayaklung and Phaechamud, 2011 tested fourteen *Solanum* cultivars (*S. aculeatissimum, S. melongena, S. torvum, S. trilobatum, S. stramonifolium, S. mammosum* and *S. wrightii*) cultivated in Thailand for their total phenolic contents in term of gallic acid (g) per 100 g of crude extract and per 100 g of dry herb powder. The total phenolic contents of *Solanum* sp. were low, in range of 4.39-1.55 g as gallic acid /100g crude extract and 1.12-0.33 g as gallic acid /100g dried fruit. For *Solanum* crude extracts, the consequence of total phenolics from high to low were *S. melongena* (Long Purple Eggplant), *S. wrightii*, *S. aculeatissimum*, *S. trilobatum, S. mammosum, S. torvum*, and *S. stramonifolium*, respectively. For *Solanum* dried fruits, the consequence of total phenolics from high to low were *S. wrightii*, *S. trilobatum*, *S. melongena*, *S. mammosum*, *S. aculeatissimum*, *S. stramonifolium* and *S. torvum*, respectively.

Boubekri *et al*, 2013 evaluated the effect of temperature on polyphenolic contents and antioxidant capacity of different parts (whole fruit, pulp and peel) of dark purple and white eggplant variety cultivated in different regions of Algeria. They recorded high phenol content for peel of dark purple variety in following order; fresh (548.77 mg GA/g) > frozen (106.11) > dry (93.48). The antioxident capacity, measured as ascorbic acid equivalent anioxident capacity assay, is in the order; peel of fresh dark purple eggplant (324.34 mg AA/g) > whole fruit of frozen dark purple eggplant (182.69 mg/g) > peel of fresh white eggplant (89.52 mg/g).

Kumar and Arumugam, 2013 evaluated 33 indigenous brinjal genotypes collected from in and around Tamilnadu for quantitative and qualitative traits at ACRI, Madhurai and reported ascorbic acid content varying from 7.38 mg/100g (EP 30) to 13.47mg/100g (Keerikai).

Shaheen *et al*, 2013 estimated the total phenol content of five cultivars (BARI-Begun-1, BARI-Begun-5, BARI-Begun-6, BARI-Begun-8 and White Begun) at University of Dhaka and their findings reflect that among the five cultivars studied, BARI-Begun-8 contained the highest (39.3±1.6 and 7.86±0.33mg/GAE/g) and BARI-Begun-5 contained the lowest TPC (16.32±0.22 and 3.16±0.04mg/GAE/g) on dry as well as fresh weight basis, respectively.

San Jose *et al*, 2014 studied proximate composition, carbohydrates, total phenols and vitamin C of eggplant fruits of three Spanish land races, three commercial hybrids and three hybrids between landraces cultivated across two environment conditions (open field and greenhouse for up to four seasons). The results indicated that season (S) had a larger effect than the genotype (G) for composition traits, except for total phenols. G X S interaction was generally of low relative magnitude. Orthogonal decomposition of the season effect showed that differences within OF or GH environments were in many instances greater than those between OF and GH. Spanish landraces presented, on an average lower contents of total carbohydrates and starch and higher contents of total vitamin C, ascorbic acid and total phenolics than commercial hybrids. Hybrids among landraces presented variable levels of heterosis for composition traits. They concluded that cultivation environment has a major role in determining the composition of eggplant traits. Environment and genotypic differences can be exploited to obtain high quality eggplant fruits.

Tripathi *et al*, 2014 conducted biochemical analysis of six long fruited (NB-2, NDBH-2, ND-3, PPL, Pant Samrat and Pusa Kranti) and six round fruited varieties (NB-1, NDBH-1, NDBH-3, Pant Rituraj, Punjab Bahar and PPR) for total phenols and reported PPR (103.42 mg/100g) containing significantly highest total phenol content followed by Pant Rituraj (99.64 mg/100g) where as amongst all the varieties, Punjab Bahar contains lowest total phenol content (79.33 mg/100g).

Somavathi *et al*, 2014 conducted the study to determine the antioxidant activity and total phenol content of five different skin colours/patterns i.e. purple with no lines, light purple with lines, dark purple with lines, pink coloured and purple with green lines. The results revealed significant differences in anti oxidant activity and total phenol content (TPC) in different skin colours with maximum TPC in dark purple with lines (60.94 ± 0.52) and minimum in light purple with lines (48.67 ± 0.26)

Guillermo *et al*, 2014 characterized and compared the ascorbic acid and total soluble phenols in five eggplant types i.e. Chinese, Philippine, American, Hindu and Thai. Of all the types, significantly highest ascorbic acid content (22.0±4.1 mg/100g fresh sample) observed in Hindu type where as significantly highest values for total soluble phenols was recorded in Thai type (2049.8±77.8 mg/100g).

Kandoliya *et al*, 2015 tested six varieties of brinjal viz., JBGR-1, GOB-1, GBL-1, GBL-2, GBL-3 and GBH-2 for antioxidants and nutritional components obtained from Vegetable Research Centre, Junagadh Agricultural University, Junagadh. Higher value for ascorbic acid was obtained from fruits of variety GBL-1 (16.75 mg.100g-1) followed by variety JBGR-1 (15.23 mg.100g-1) where as the lowest value was recorded from the fruits of brinjal variety GBH-2 (9.43

mg.100g-1). The variety GBL-1 having highest phenol content (39.12 mg.100g-1) including higher fraction of chlorogenic as well as cinnamic acid, has comparatively higher antioxidant activity.

Kumaraswamy, 2015 evaluated the total phenolics content and antioxidant activity in extracts from two moderate sized fruit types (purple and green coloured). The results demonstrated that green coloured medium sized fruit exhibit the highest total phenolics content and antioxidant activity of 320µg/500µl of the sample as compared to purple coloured brinjal pulp (210 µg/500 µl).

Stommel *et al*, 2015 evaluated the influence of production environments and stability of diverse genotypes across environments for eggplant fruit phenolic acid content. Ten *Solanum melongena* accessions consisting of five F1 hybrid cultivars, three open pollinated cultivars and two land race accessions, one accession each of *S. macrocarpon* and *S. aethiopicum*, were grown at two locations under greenhouse and open field environments. There were significant differences among accessions for total phenolics acid conjugate content. There were no significant differences detected among the environments for any of the variables. Stability analysis demonstrated widespread instability for phenolic acid content across environments. Stability of the predominant caffeoylquinic acid esters class positively influenced stability of total phenolic acid content for some but not all genotypes.

3) Response of genotypes to environments for biotic stresses

Plants are under constant assault by biotic agents including various pathogens and insect herbivores, with enormous economical and ecological impact (Pimentel, 2002). Cultivated brinjal genotypes often have insufficient levels of resistance to biotic and abiotic stresses (Magioli and Mansur, 2005). Low yields recorded in brinjal in developing countries can be attributed to some limiting factors, prominent among which are climatic factors and occurrence of pest and diseases (Bhatti *et al*, 2013). The crop is extensively damaged by insect pests and diseases apart from other constraints. Several factors are responsible for the low productivity of aubergine mainly due to biotic factors like insect pests and pathogens (Devi *et al*, 2015).

3.1) Response of genotypes to shoot and fruit borer and spider mite

Brinjal is subjected to attack by a number of insect and non-insect pests from nursery stage to harvest. The most extensive pest is brinjal shoot and fruit borer (*Lucinodes orbonalis* Guenee) which reduces the yield and inflicts colossal loss in production (Khan and Singh, 2014). The losses caused by pest vary from season to season because moderate temperature and high humidity favour population build-up of brinjal shoot and fruit borer (Shukla and Khatri, 2010), (Bhushan *et al*, 2011). This pest may reduce the crop yield up to 60-70% (Singh and Nath, 2010) and even up to 90% (Parimi and Zehr, 2009).

Among the non-insect pests, mites are probably the most notorious ones and gaining tremendous importance in the recent years due to their devastating nature. On vegetables alone, spider mites damage accounts from10- 15 per cent yield loss (Anon, 1991). Monica *et al*, 2014 ranked red spider mite as a major pest next to fruit and shoot borer in brinjal. In Jammu region also, prevalence of spider mite has been observed brinjal growing areas, damaging brinjal crop and reducing economic yield. The mite feed on the lower surfaces of leaves, mainly along the adjacent regions of midrib and veins of leaves causing chlorosis of leaves (Singh and Singh, 2014). The work on stability analysis of brinjal against insect pests is meager, however, the related literature is reviewed as under:

Chaudhary and Sharma, 2000 screened nine genotypes of brinjal viz. Arka Keshav, Arka Neelkanth, Hisar Shyamal, PPL, PPC, SM-6-6, SM-6-7, Arka Nidhi and Punjab Barsati against shoot and fruit borer and observed 2.88% (Arka Keshav) to 5.64% (SM-6-6) borer infestation where as PPL followed by PPC recorded maximum borer infestation (28.74% and 19.49%), respectively.

Rai *et al*, 2001(b) conducted the stability analysis against shoot and fruit borer on 15 round and 11 long type genotypes for four years during 1994-98 at Raipur (Chhatisgarh). The results revealed minimum average infestation in long types ranging from 20.61-31.57% whereas round types exhibited maximum infestation ranging from 28.57-40.68% across environments and PPL, PB-33, Punjab Sadabahar and ARBH-201 among long types were found to be most stable genotypes.

Baig and Patil, 2002 evaluated 10 parents and 45 F_1'^{s} for fruit yield and its component characters along with shoot and fruit borer infestation over four environments (locations) during summer/*kharif* 1999. They observed highly significant variation due to genotypes and environments for all the characters studied. The genotypes ABV 1, PBR129-5 and Aruna were found to be good specific combiners for fruit yield and other related traits. The genotype PBR 129-5 had shown highly significant negative *gca* effects for shoot and fruit borer infestation.

Chandrashekhar *et al*, 2008 evaluated 25 brinjal genotypes for field resistance against shoot and fruit borer under Hissar conditions and revealed shoot infestation range between 5.6 to 13.3% whereas fruit infestation indicated that genotype HLB-12 (29.0%) recorded minimum fruit damage followed by NDB-28-2(33.65%) and BB-46(37.5%) fruit damage. The remaining genotypes were found highly susceptible (40.33 to 61.50% fruit damage)

Elanchezhyan *et al*, 2008 screened 25 brinjal varieties under field conditions for major pests and their natural enemies at ACRI, Madurai. The findings revealed that all the entries were prone to attack by shoot and fruit borer and none of them was found to be immune. However, hybrids Ravaiya and Sweta were designated as resistant to shoot and fruit borer, recording damage between 1.0 to 10.0 per cent.

Naqvi *et al*, 2009 screened 13 cultivars of brinjal mainly for their relative susceptibility to shoot and fruit borer infestation during June 2007 and 2008 under Bikaner conditions. They recorded maximum fruit infestation in cultivar Udaipur Local (45.8%) followed by Arka Keshav (41.3%) and Pusa Purple Round (41.0%) where as cultivars Pusa Purple Cluster (14.7%) and Pusa Purple Long (16.5%) recorded minimum fruit infestation.

Vaddaria *et al*, 2009(b) evaluated 48 brinjal hybrids along with their 16 parents and a check variety (GBH1) for fruit borer infestation and fruit yield/plant during three consecutive seasons (environments) viz. *kharif*-2003(E1), *rabi*-summer-2003(E2) and summer-2004(E3) at Junagarh (Gujrat) . The stability analysis indicated that significant G X E interactions for both the attributes revealed that the genotypes had linear response to environmental change, while significant pooled deviation suggested that deviation from linear regression also contributed substantially towards the differences in stability of genotypes. From the point of view of yield and resistance to fruit borer infestation, six hybrids viz. JBSR x Pant Rituraj, ABL98-1 x Pant Rituraj, ABL98-1 x GBL-1, Morvi x GBL1, Morvi4-2 x PLR1 and Green Round x GBL1 were identified as most widely adapted hybrids on the basis of stability parameters.

Sarma, 2010 made investigations on seasonal incidence, screening of brinjal varieties for their reaction against brinjal mite, *Tetranychus* spp., under Dharwad conditions. The results revealed that their incidence was more during summer followed by *rabi* and *kharif* seasons and the natural enemies also followed the same trend reaching their peak with peak infestation of the mites. Among the twelve varieties screened for their reaction against T*etranychus* spp., Arka Nidhi recorded lowest mite population during both the years and also recorded at par yield with the best yielding variety Kalyan. The varieties, Arka Nidhi and Arka Keshav were moderately resistant.

Malik and Rishi Pal, 2013 studied the seasonal incidence of brinjal shoot and fruit borer on 40 germplasm lines of brinjal during 2009-2010 at Vegetable Research Station, Kalyanpur (UP). Minimum fruit infestation (14.18%) was observed on germplasm HMB 10, followed by 18.54, 24.01, 24.07 and 24.29% fruit infestation on SM195, Long Green and S-15-1 genotypes, respectively. Maximum infestation of 53.19% was noticed on H-129.

Khan and Singh, 2014 evaluated response of 192 entries/accessions of brinjal for resistance against shoot and fruit borer at G B Pant University of Agriculture and Technology, Pant Nagar in *kharif* season 2011-12. Minimum mean infestation in fruits was found in genotype EC305163 (0.0%) and IC090132 (0.0%) while maximum mean infestation in fruits was recorded in IC261792 (100%) and IC420406 (100%). Among 192 genotypes of brinjal tested, two of them

EC305163 and IC090132 were found immune to shoot and fruit borer, three genotypes namely IC545256, IC433625 and IC264470 as resistant, 21 fairly resistant, 38 tolerant, 52 susceptible and rest 76 genotypes were found highly susceptible to brinjal shoot and fruit borer.

Nayak, 2014 studied the population dynamics and infestation pattern of brinjal shoot and fruit borer in relation to different environmental factors during winter seasons of 2009-10 and 2010-11 at Keonjhar, Odhisa. The study revealed that temperature exerted a positive influence and relative humidity had a negative effect on the population build up and infestation of the pest.

Nayak *et al*, 2014 studied the variation in larval population of brinjal shoot and fruit borer during rainy, winter and summer seasons of 2009-10 and 2010-11 at Keonjhar district of Odisha under field conditions. During rainy season, the larval infestation initiated in last week of June and increased progressively with two distinct peak levels. In the winter season, the larvae of BSFB appeared for the first time in 4^{th} week of October with two subsequent peak population whereas in summer season, the larvae first appeared on 4^{th} January and later attained two well defined peaks during the crop growth period.

Tripathi *et al*, 2014 conducted the studies on seasonal incidence of mites on okra and brinjal during March to July 2012 at farmer's field under Lucknow conditions. The findings revealed maximum population of *Tetranychus* species in the month of June I^{st} fortnight on okra (352.5) and brinjal (308.6) when average atmospheric temperature was $35.5^{o}C$, relative humidity33% and rainfall nil while minimum population was recorded in Ist fortnight of March when average atmospheric temperature was $21.7^{o}C$, relative humidity 61.7% and rainfall 6.4 mm.

Sivakumar *et al*, 2015 evaluated 34 genotypes including ten parents, twenty one hybrids and three commercial checks for fruit yield per plant and fruit borer infestation at three different environments *viz.*, Horticultural College and Research Institute, Venkataramannagudem (E1), Andhra Pradesh; Horticultural Research Station, Pandirimamidi (E2), East Godavari, Andhra Pradesh and Horticultural Research Station, Aswaraopet (E3), Khammam, Telangana State during summer, 2014. The stability analysis indicated that significant G x E interaction for both the attributes revealed that the genotypes had linear response to environmental change. Further, linear and non-linear components contributed significantly to the differences in stability among the genotypes tested. The three hybrids *viz.*, IC 285140 x Bhagyamathi, Heera x Gulabi and Pusa Shyamala x Gulabi were identified as most widely adapted hybrids for yield and resistance to fruit borer based on stability analysis.

3.2 Response of genotypes to phomopsis blight and little leaf disease

Brinjal crop is susceptible to a wide range of pests and pathogens which cause severe loss in all stages of growth and development. It is known to suffer from 12 diseases and among them phomopsis blight and fruit rot, caused by *Phomopsis vexans*, has been treated as one of the major constraints to eggplant cultivation in the country (Islam and Meah, 2011). Fruit rot and leaf blight disease is a major concern in brinjal production as it reduces yield and marketable value of the crop by nearly 20-30% (Jayaramaiah *et al*, 2013). It has attained serious proportions in Central India (Verma and Bhale, 2003). Sharma *et al*, 2011 made district wise surveys of Jammu region for two consecutive years (2007 and 2008) for phomopsis blight incidence and recorded mean fruit rot incidence and intensity ranging from 07.0 to 14.7 and 03.0 to 08.0 per cent, respectively in 2007, and from 09.1 to 14.1 and 04.9 to 08.0 per cent respectively in 2008.

Patil *et al*, 2002 screened 36 brinjal cultivars for resistance against phomopsis blight at College of Agriculture, Akola and found that there was no variety totally immune to the disease. However, two varieties viz., KS-202-9 and Nurki were resistant, while CHBR-2 and AB-2 were moderately resistant. Varieties like PLR-1, PPC, Pusa Kranti, PBR-129-5, AC-Sel-1 and H-5 were highly susceptible.

Pandey *et al*, 2002 evaluated 41 genotypes including promising varieties, lines, hybrids and local cultivars under natural epiphytotic conditions at IIVR, Varanasi. They found none of the genotype to be resistant and only two varieties viz., Ramnagar Gaint and KS-233 showed moderate resistance whereas most of the other cultivars were moderately susceptible to the fruit rot phase of phomopsis blight.

Pathak *et al*, 2007 evaluated eighteen varieties of brinjal for little leaf incidence under Balrampur, U.P. conditions and recorded minimum and maximum disease incidence in Negumangad Local-3 (0.71%) and Local (35.35%), respectively.

Humauan *et al*, 2015 conducted an experiment at Regional Agricultural Research Station, Ishurdi, Pabna during 2012-2013 to observe the resistance of 15 brinjal varieties against little leaf disease. Among 15 varieties, one variety showed highly resistant (HR) reaction namely local variety Shuktara and eleven varieties showed resistant (R) reaction against little leaf disease. Rest three varieties showed moderately susceptible (MS) reaction to little leaf disease. The highest yield (10.89 t ha-1) was recorded in BARI Begun- 1 and the lowest were obtained from BARI Begun-8.

CHAPTER-III

MATERIALS AND METHODS

The present investigation entitled "Phenotypic stability studies in brinjal (*Solanum melongena* L.) was carried out at Vegetable Experimental Farm, Division of Vegetable Science & Floriculture, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Chatha, Jammu (J&K). The details of experimental site, material used and methodology employed during the course of study are discussed in this chapter.

3.1 EXPERIMENTAL SITE

3.1.1 Location

The experimental field of Division of Vegetable Science and Floriculture, SKUAST, Jammu is situated at 32^o 40'N latitude and 74^o 58' E longitude and has an elevation of 332 m above mean sea level.

3.1.2 Climate

Agro-climatically, the location represents Zone V of Jammu and Kashmir and is characterized by subtropical climate. The place experiences hot dry summer, hot and humid rainy season and cold winter months, the maximum temperature goes up to 45^o C during summer (May to June) and minimum temperature falls to 1^o C during winters. The mean annual rainfall is about 1000-1200 mm. The information on climatic conditions during the crop season was recorded in Division of Agro-meteorology, Chatha. The meteorological data pertaining to the period of crop season in 2013 and 2014 is given in Appendix-III, IV and V.

3.2 EXPERIMENTAL MATERIALS

The experimental material comprised of 25 genotypes of brinjal (10 F_1 hybrids and 15 open pollinated) collected from different parts of the country. The detail of the genotypes along with their source is given below:

List of brinjal genotypes included in the experiment

S. No	Genotypes	Fruit shape	Source
F_1 Genotypes			
1	Rajni	Round	Nunhems Seeds
2	PPL-74	Long	Century Seeds
3	Navkiran Improved	Round	Sungrow Seeds
4	Sandhya	Round	Nunhems Seeds
5	MH-80	Round	Mahycco Seeds
6	Chhaya	Long	Nunhems Seeds
7	PBH-3	Oblong	PAU, Ludhiana
8	Nisha Improved	Oblong	Century Seeds
9	Shamli	Long	Seminis Seeds
10	Abhishek	Round	Nunhems Seeds
Open pollinated genotypes			
11	Punjab Sadabahar	Long	PAU, Ludhiana
12	Arka Shirish	Long	IIHR, Banglore
13	Arka Kusumkar	Oblong	IIHR, Banglore
14	Arka Keshav	Long	IIHR, Banglore
15	Arka Nidhi	Long	IIHR, Banglore
16	Arka Neelkanth	Long	IIHR, Banglore
17	Pusa Shyamla	Oblong	IARI, New Delhi
18	Pusa Kranti	Oblong	IARI, New Delhi
19	Pusa Ankur	Round	IARI, New Delhi
20	Pusa Uttam	Round	IARI, New Delhi
21	PPL	Long	IARI, New Delhi
22	PPR	Round	IARI, New Delhi
23	PPC	Oblong	IARI, New Delhi
24	BR-14	Round	IIVR, Varanasi
25	Puneri Kateri	Oblong	Safal Seeds Co., Jalna

3.3 EXPERIMENTAL DESIGN

The experimental material comprising of 25 genotypes of brinjal were tested under six environments comprised of three seasons of sowing spreading across two years during 2013-2014 and 2014-2015 at the experimental farm of Division of Vegetable Science and Floriculture, SKUAST-Jammu. The individual experiment was conducted in randomized block design with three replications. The uniform, healthy seedlings were planted on ridges maintaining inter and intra row spacing of 90 x 60 cm, respectively. The details of the environments are as under;

Environment	**Season**	**Transplanting time**
E_1:	Autumn-Winter	I^{st} fortnight of September, 2013
E_2:	Spring-Summer	I^{st} fortnight of February, 2014
E_3:	Rainy	I^{st} fortnight of June, 2014
E_4:	Autumn-Winter	I^{st} fortnight of September, 2014
E_5:	Spring-Summer	^{Ist} fortnight of February, 2015
E_6:	Rainy	^{Ist} fortnight of June, 2015

3.3.1 Nursery raising

For preparation of healthy seedlings on soilless media, seeds were sown in pot trays using coco peat, vermiculite and perlite in the ratio of 3:1:1 under protected conditions one month before the transplanting time during each sowing season to create six environments at the experimental farm of the Division of Vegetable Science and Floriculture, SKUAST-Jammu. Proper aftercare operations in respect of irrigation, plant protection were undertaken till seedlings were ready for transplanting.

3.3.2 Cultural practices

Besides the application of farm yard manure (FYM) @ 20 tonnes/ha, the chemical fertilizers were applied as per the recommendations of package of practices of vegetable crops of SKUAST-Jammu (120 kg N, 60 kg P, 60 kg K). Farm yard manure was applied 15 days before transplanting and 1/2 dose of N and full dose of P_2O_5 and MOP was applied at the time of transplanting. Remaining 1/2 dose of N was top dressed 35 days after transplanting followed by earthing up. Other intercultural operations were carried out in accordance with the package of practices of brinjal crop from time to time.

3.3.3 Aftercare

First irrigation was given immediately after transplanting and thereafter the irrigation was given as and when required to maintain the optimum soil moisture in the experimental field. The experimental plots were kept free of weeds by regular hand weeding. To control the pests and diseases, recommended plant protection measures were followed as per the recommended package of practices of vegetable crops.

3.4 EXPERIMENTAL OBSERVATIONS

In each treatment, five plants were randomly selected for recording various observations as detailed below.

3.4.1 Quantitative parameters:

3.4.1.1 Days to 50 per cent flowering

When the flowering was noticed in half of the population of individual treatment, it was considered as 50 per cent flowering and days taken to this stage was considered as days to 50 per cent flowering and was expressed in number.

3.4.1.2 Days to first picking

The number of days taken from date of transplanting to the date at which first marketable fruits were picked.

3.4.1.3 Fruit length (cm)

Fruit length from five randomly selected fruits of each plant was measured from base of the fruit to the tip of fruit with the help of scale.

3.4.1.4 Fruit diameter (cm)

The diameter was measured from the middle portion of the fruit with the help of digital vernier caliper and average diameter was worked out.

3.4.1.5 Number of fruits per plant

Total number of fruits harvested from all the pickings was pooled and average number of fruits per plant was calculated

3.4.1.6 Average fruit weight (g)

Average fruit weight was computed by using formula.

$$\text{Average fruit weight (g)} = \frac{\text{Total fruit weight from all the pickings}}{\text{Total number of fruits from all the pickings}}$$

3.4.1.7 Number of leaves per plant

Five plants were selected randomly from each treatment and total number of leaves was counted after 90 DAT and the mean value was calculated.

3.4.1.8 Plant height (cm)

Five plants were selected randomly from each plot and the plant height was measured with the help of meter scale from the base of plant to the terminal growing point of the main stem after 90 DAT and the mean was calculated.

3.4.1.9 Number of branches per plant

Five plants were selected randomly from each plot and number of primary branches was counted from the main stem after 90 DAT and the mean was calculated.

3.4.1.10 Leaf area (cm^2)

Leaf area of ten leaves obtained from the middle portion of the plants in each plot with the help of leaf area meter after the completion of 50% flowering was noted and average leaf area (cm^2) was calculated.

3.4.1.11 Marketable yield per plant (kg)

The total weight of marketable fruits from five randomly selected plants were obtained from each picking and were pooled by separating the healthy fruits from the infested and the average marketable fruit yield per plant was worked out.

3.4.1.12 Unmarketable yield per plant (kg)

The total weight of unmarketable fruits from five randomly selected plants were obtained from each picking and were pooled by separating the healthy fruits from the diseased and insect infected and distorted and damaged and the average unmarketable fruit yield per plant was worked out.

3.4.1.13 Fruit yield per plant (kg)

The total weight of both marketable and unmarketable fruits from five randomly selected plants was obtained from each picking and was pooled and the average fruit yield per plant was worked out.

3.4.1.14 Fruit yield per hectare (q)

The total weight of fruits from each plot was obtained from each picking and pooled and fruit yield per hectare was calculated on the basis of total plot yield.

3.4.2 Qualitative traits

3.4.2.1 Ascorbic acid content (mg/100g) (Rangana, 1976)

Reagents

1. 3% meta phosphoric acid (HPO_3): Prepare by dissolving the sticks or pellets of HPO_3 in glass distilled water.

2. Ascorbic acid standard: Weigh accurately 100 mg of ascorbic acid and make upto 100 ml with 3% (HPO_3). Dilute 10 ml to 100 ml with 3% (HPO_3).

3. Dye solution: Dissolve 50 mg of the sodium salt of 2, 6 dichloro phenol indophenols in approximately 50 ml of hot distilled water containing 42 mg of sodium bicarbonate. Cool and dilute with glass distilled water to 200 ml.

Procedure

4. Take 5 ml of standard ascorbic acid solution and 5 ml of HPO_3. Fill a microburette with the dye. Titrate with the dye solution to pink colour which should be present for 15 sec. Determine the dye factor i.e. mg of ascorbic acid per ml of the dye.

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Preparation of sample

Fruit juices: Take 10 to 20 mg of sample and make upto 100ml with 3%HPO_3. Filter or centrifuge.

Assay of extract: Take an aliquot (2-10ml) of the HPO_3 extract of the sample and titrate with the standard dye to a pink end point which showed persist for at least 15 sec. the aliquot of sample taken should be such that the titre should not exceed 3-5 ml.

$$\underset{\text{(mg /100g)}}{\text{Mg of ascorbic acid}} = \frac{\text{Titre} \times \text{dye factor} \times \text{volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{weight or volume of sample taken for estimation}}$$

3.4.2.2 Total phenol content (mg/100g) (Thimmaiah, 1999)

Total phenols estimation can be carried out with Folin-Ciocalteu reagent.

Principle: Phenols react with an oxidizing agent phosphomolybdate in Folin –Ciocalteu reagent under alkaline conditions and result in the formation of a blue coloured complex, the molybdenum blue which is measured at 650 nm colorimetrically (Bray and Thorpe,1954)

Reagents

1) 80% Ethanol
2) Folin-Ciocalteu reagent
3) 20% Na_2CO_3
4) Standard (100 mg catechol in 100 ml of water). Dilute 10 times for a working standard.

Method

1) Weigh exactly 0.5 to 1g of the sample and grind it with a pestle and morter in 10-15 time volume of 80% ethanol.
2) Centrifuge the homogenate at 10,000 rpm for 20 minutes. Save the supernatant. Re-extract the residue with five times the volume of 80% ethanol, centrifuge and pool the supernatants.
3) Evaporate the supernatant to dryness.
4) Dissolve the residue in a known volume of distilled water (5 ml).
5) Pipette out different aliquots (0.2 to 2 ml) into test tubes.
6) Make up the volume in each tube to 3 ml with water.
7) Add 0.5 ml of Folin-Ciocalteu reagent.
8) After 3 min., add 2 ml of $Na_2\ CO_3$ solution to each tube.
9) Mix thoroughly. Place the tubes in a boiling water for exactly one minute, cool and measure the absorbance at 650 nm against a reagent blank.
10) Prepare a standard curve using different concentrations of catechol and concentration of phenols in test samples is determined from the standard curve and expressed as mg/100 g material.

3.4.3 Biotic stresses

3.4.3.1 Shoot borer infestation (%)

The number of shoots affected by borer and total number of shoots per plant was recorded from randomly selected five plants and the per cent of shoot borer infestation was worked out.

3.4.3.2 Fruit borer infestation (%)

The number of fruits affected by borer and total number of fruits harvested per plant was recorded from randomly selected five plants and the per cent of fruit borer infestation was worked out.

3.4.3.3 Spider mite infestation (%)

The number of plants affected by spider mite and total number of plants in a treatment was recorded and the per cent of spider mite infestation was worked out.

3.4.3.4 Little leaf incidence (%)

The number of plants affected by little leaf and total number of plants available was recorded and the per cent of little leaf incidence was worked out.

3.4.3.5 Phomopsis blight incidence (%)

The number of fruits affected by phomopsis and total number of fruits harvested per plant was recorded from randomly selected five plants and the per cent of phomopsis blight incidence was worked out.

3.5 STATISTICAL AND BIOMETRICAL ANALYSIS

3.5.1 Analysis of variance for the experiment

Analysis of variance in the individual environments and for the data pooled over environments was carried out as per the procedure suggested by Verma *et al*. (1987). Assuming non-significant differences between replications, the analysis of variance for the experimental design was based on the following model:

$$X_{ij} = \mu + g_i + e_{ij} \quad (i = 1, 2, \ldots\ldots\ldots\ldots\ldots, g)$$

Where,

X_{ij} = phenotype of the ijth observation,

μ = population mean,

g_i = effect of the ith genotype, and

e_{ij} = error term jth observation,

The skeleton of the ANOVA for each individual environment would be:

Source	**d.f.**	**M.S.**	**Expectation of M.S**	**F**
Genotype	(g-1)	MSG	r $\sigma_g + \sigma_e$	MSG/MSE
Error	g(r-1)	MSE	σ^2_e	
Total	(gr-1)			

Where,

r = number of replications

Genotype × Environment interaction:

Usual procedure for detection of G × E interaction was followed by multilocational testing of the genotypes in replicated trials. Following linear mathematical model for observations recorded on the ith genotype in jth environment was used as:

$Y_{ij} = \mu + g_i + E_j + g_{ij} + e_{ij}$

Where,

Y_{ij} = phenotype of the ijth observation,

μ = population mean

g_i = effect of the ith genotype (i = 1, 2, ….., g),

E_j = effect of the jth environment (j = 1, 2, ……, n),

g_{ij} = effect due to G x E interaction, and

e_{ij} = average error associated with ith genotype in jth environment.

Assuming replication component within environments to be non-significant, the skelton of the ANOVA for the experiment would be:

Source of variation	**d.f.**	**M.S.**	**Expected mean squares**
Environments	(e-1)	MSE	
Genotypes	(g-1)	MSG	$\sigma^2_e + \sigma^2_{ge} + e\sigma^2_g$
Genotypes × Environments	(g-1) (e-1)	MSGE	$\sigma^2_e + \sigma^2_{ge}$
Pooled error	m*	Me	σ^2_e

*Degrees of freedom pooled over environments and Me as pooled error mean square

Test of significance

The F-test for testing significance of G × E interaction was:

F = MSGE/Me, for genotype × environment and error degrees of freedom.

In case the G × E interaction was observed to be significant, the appropriate F-test for testing the significant differences among genotypes was:

F = MSG/MSGE, for genotypes and genotype × environment degrees of freedom. However, if G × E interaction was found to be non-significant, mean squares for pooled error and genotype × environment interaction were pooled as:

$$\frac{n_1 s_1 + n_2 s_2}{n_1 + n_2}$$

Where,

n_1, n_2 are the degrees of freedom for G x E interaction and pooled error, respectively, and s_1 and s_2 are corresponding mean squares. The degrees of freedom for the two sources were also pooled. The new mean squares represented the error mean square, which was then used as denominator to test the significance of genotypes.

3.5.2 Stability analysis

3.5.2.1 Analysis of variance for stability

The phenotypic stability of 10 F_1 hybrids and 15 OP varieties were evaluated under six environments comprising of three seasons, Autumn-Winter, Spring-Summer and Rainy season spread over two years during 2013-2014 and 2014-2015 15 i.e. six different environmental conditions was worked out following the linear model proposed by Eberhart and Russel (1966). The parameters are defined by the following model:

$$Y_{ij} = \mu_i + b_i I_j + S_{ij}$$

Where,

Y_{ij} Mean performance of the i^{th} genotype (i=1,2,....g) in the j^{th} environment (j=1,2,.....n),

μ_i overall mean of the i^{th} genotype overall the environments,

b_i regression coefficient which measures the linear response of the i^{th} genotype of varying environments,

I_j environmental index obtained as the mean of all varieties at the j^{th} environment minus the grand mean, and

S_{ij} deviation from linear regression of the i^{th} genotype in the j^{th} environment.

The environmental index I_j for j^{th} environment was calculated as:

$$I_j = \sum Y_{ij}/g) - (\sum_{i=1} \sum_{j=} Y_{ij}/gn)$$

Where,

$$\sum_{j=1}^{n} I_j = 0$$

Based on the above model analysis of variance for phenotypic stability is presented below:

S.No.	Source	Df.	S. S
1.	Genotypes	(g-1)	$(\sum_i Y^2_{i.}/n) - (Y^2../gn)$
2.	Environments	(n-1)	$(\sum_j Y^2_{.j}/g) - (Y^2../gn)$
3.	Environments + (genotypes × environment)	(n-1) + (g-1) (n-1) = g (n-1)	$\sum_i \sum_j Y^2_{ij} - (\sum_i Y^2_{i.}/n)$
4.	Genotypes × Environment	(g-1) (n-1)	$\sum_i \sum_j Y^2_{ij} - (\sum_i Y^2_{i.}/n) - (\sum_j Y^2_{.j}/g) + (Y^2../n)$
5.	Environment (linear)	1	$(1/g)(\sum_j Y_{i.} \sum_j I_j)^2 / \sum_j I^2_j$
6.	Genotypes × Env. (linear)	(g-1)	$\sum_i [(\sum_j Y_{ij} I_j)^2 / \sum_j I^2_j)]$ - Env. (Linear) S.S.
7.	Pooled deviation	G (n-2)	$\sum_i \sum_j S^2_{ij} = \sum_i [\sum_j Y^2_{ij} - (Y^2_{i.}/n)] - [(\sum_j Y_{ij} I_j)^2 / \sum_j I^2_j]$
8.	Pooled error	n(r-1) (g-1)	Pooled replications x genotypes S. S over Environments = Me
9.	Total	(gn-1)	$\sum_i \sum_j Y^2_{ij} - (Y^2../gn)$

Where,

g = number of genotypes,

r = number of replications,

Y_{ij} = basic observation (mean of the ith genotype over replications in jth environment)

Me = (σ^2_e/r)

Estimation of stability parameters

i) Regression coefficient (b_i)= $\sum_j Y_{ij} - (I_j / \sum_j I2_j)$

ii) Mean square deviation (s^2d_i) from linear regression

$= (\sum_j S^2_{ij}/n\text{-}2) - (S^2e/r)$

Where,

$$\sum_J S^2_{ij} = [\sum_J Y^2_{ij} - (Y../n] - (\sum_J Y_{ij}\ I_j/\sum_J I^2_{.j})$$

S^2e = mean square for pooled error

Testing of significance

i) Among the variety means:

$H_0 : g_1 = g_2 = g_3 \ldots = g_n$, the appropriate test is defined as $F \approx MS_1 / MS_3$

ii) Among varieties for their regression on environmental index:

H0 : B1 = B2 = B3 = ……. = Bg

$F \approx MS_2 / MS_3$

iii) The genetic differences among genotypes for their regression on environmental index was tested by 't' test

$$T = [b\text{-}0 / (S.E.\ B)]$$

Where,

S.E (b) = $[\text{MS Pooled deviation} / \sum_J I^2_j]^{0.5}$

iv) The deviation of b_i values from unity was tested as:

t = [b-1/S.E. (b)], for n-2 d.f

v) For the deviation from regression of each genotype

$F = [\sum_J S^2_{ij}/n\text{-}2]$ / M. S. pooled error

A joint consideration of the three parameters, that is

i) The mean performance of the genotype over the environments (Xi)

ii) The regression coefficient (b_i)

iii) The deviation from linear regression (S^2d_i), is used to define stability of genotype.

The estimate of deviations from regressions suggests the degree of reliance that should be put to linear regression in interpretation of the data. If these values are significantly deviating from zero, the expected phenotype cannot be predicted significant. When deviations are not significant, the conclusion may be drawn by the joint consideration of mean yield and regression values given (Eberhart and Russell, 1966).

Regression Co-efficient	**Genotypic mean**	**Deviation from regression**	**Stability**	**Remarks**
b_i= 1	High	S^2d_i low	Average	Well adapted to all environments
b_i =1	Low	S^2d_i low	Average	Poorly adapted to all environments
b_i>1	High	S^2d_i high	Below average	Specifically adapted to favourable environments
b_i <1	High	S^2d_i low	Above average	Specifically adapted to unfavourable environment

CHAPTER-IV

EXPERIMENTAL RESULTS

The experimental results obtained after statistical analysis of data recorded for various parameters in the present investigation entitled "Phenotypic stability studies in brinjal (*Solanum melongena* L.)" carried out during 2013-14 and 2014-15 under six environments for assessing the stability performance of 25 genotypes have seen presented under the following sub heads:

4.1 ANALYSIS OF VARIANCE OVER ENVIRONMENTS

4.1.1 Analysis of variance in individual environments

4.1.2 Environmental indices

4.2 Linear regression vs deviation from linearity

4.3 Phenotypic Stability

4.1 Analysis of variance over environments

Analysis of variance over environments indicates that variances due to brinjal genotypes were highly significant for all the traits under study which revealed the presence of genetic variability among the genotypes for this trait. The mean sum of square due to environments was significant for all the characters which indicated genotypes interacted with environments significantly. The presence of genotypes × environment interaction were also significant for all the traits which provides an opportunity for selecting suitable genotypes with high mean for the trait of interest except non significant mean square values in four traits viz., number of leaves / plant, number of primary branches per plant, ascorbic acid and little leaf incidence which means less variation and least scope of selection for these traits. The presence of both significant and non significant interactions indicated the differential response of genotype to various environment conditions.

4.1.1 Analysis of variance in individual environments

Environment wise analysis of variance revealed that mean sum of square due to genotypes were highly significant for all the traits under study viz., (days to 50% flowering, days to first picking, fruit length, fruit diameter, total number of fruits per plant, average fruit weight, number of leaves per plant, plant height, number of primary branches per plant, leaf area, marketable yield per plant, unmarketable yield per plant, fruit yield per plant, fruit yield per hectare, ascorbic acid, total phenols, shoot borer infestation, fruit borer infestation, spider mite infestation, little leaf incidence and phomopsis blight incidence) in all the six environments indicating existence of genetic differences among the genotypes under study.

Table 4.1: Analysis of variance over environments for various traits in brinjal (*Solanum melongena* L.)

Source of variation	Df	Days to 50 per cent flowering	Days to first picking	fruit length (cm)	fruit diameter (cm)	Number of fruits per plant	Average fruit weight(g)	Number of leaves per plant	Plant height (cm)	Number of primary branches per plant	Leaf area (cm^2)	Market able yield per plant (kg)
Genotype	24	192.55**	365.61**	86.39**	42.40**	691.85**	15638.65**	408.94**	324.79**	2.93*	867.84**	1531.75**
Environment	5	785.35**	851.29**	17.16**	3.73**	583.24**	876.92**	106.14**	6480.75**	43.23**	161.97**	2162.56**
Replication (within environment)	12	14.27	8.83	0.27	0.08	4.94	8.39	12.34	8.96	0.09	1.48	17.92
Genotype × Environment	120	7.92**	10.35*	0.65**	0.20*	9.91**	17.56**	2.10	20.29**	0.18	4.35**	40.99**
Pooled error	288	3.03	4.22	0.29	0.10	1.86	6.58	1.26	7.77	0.09	1.03	8.20

Source of variation	Df	Unmarket able yield per plant (kg)	Fruit yield per plant (kg)	Fruit yield per hectare (q)	Total phenol Content (mg/100g)	Ascorbic acid content (mg/100g)	Shoot borer infestation (%)	Fruit borer infestation (%)	Spider mite infestation (%)	Little leaf incidence (%)	Phomopsis blight incidence (%)
Genotype	24	72.94**	2093.03**	18583.14**	0.23**	26.58**	135.26**	125.28**	142.38**	49.07**	116.46**
Environment	5	358.56**	4135.84**	31175.31**	0.03**	0.72**	1010.89**	945.80**	681.24**	397.88**	526.45**
Replication (within environment)	12	0.35	23.57	4.67	0.00	0.02	2.00	1.60	21.86**	33.30**	1.74
Genotype × Environment	120	5.36**	55.08**	460.27**	0.01**	0.07	6.25*	4.74*	8.29**	6.84	4.25**
Pooled error	288	0.32	11.23	5.14	0.00	0.01	1.01	1.04	6.44	7.11	1.90

Table 4.1.1: Environment wise analysis of variance for various yield attributing traits in brinjal (*Solanum melongena* L.)

Source of variation	Df	Mean sum of square					
		2012 - 2013			2013 – 2014		
		E_1 Autumn-winter,2013	E_2 Spring-summer,2014	E_3 Rainy season,2014	E_4 Autumn-winter,2014	E_5 Spring-summer,2015	E_6 Rainy season,2015
Day s to 50% flowering							
Genotype	24	87.72*	124.66*	71.89*	95.63*	202.42*	114.098
Error	48	3.09	6.00	11.54	8.53	14.01	11.28
Days to Ist picking							
Genotype	24	99.12*	232.01*	223.56*	130.33*	280.61*	286.42*
Error	48	10.83	15.99	15.21	11.45	13.51	9.05
Fruit length (cm)							
Genotypes	24	33.39*	49.95*	47.80*	32.87*	53.88*	51.03*
Error	48	0.79	0.77	0.62	0.86	1.04	1.19
Fruit diameter (cm)							
Genotype	24	18.75*	22.348*	22.82*	16.63*	27.29*	22.40*
Error	48	0.17	0.23	0.48	0.19	0.32	0.34
Nnumber of fruits per plant							
Genotype	24	300.44*	427.95*	404.54*	111.29*	442.23*	537.74*
Error	48	6.59	5.86	6.45	3.92	6.63	4.94
Average fruit weight (g)							
Genotype	24	6023.80*	8483.69*	8659.49*	6625.72*	8224.85*	8222.53*
Error	48	322.44	10.58	40.10	19.96	15.42	20.54
Number of leaves per plant							
Genotype	24	203.43*	210.83*	215.87*	174.99*	243.25*	209.90*
Error	48	5.31	2.98	3.55	5.71	5.02	4.07
Plant height (cm)							
Genotype	24	183.85*	194.11*	203.96*	165.67*	245.82*	285.25*
Error	48	25.66	33.91	14.03	22.79	17.40	26.02
Number of branches per plant							
Genotype	24	1.25*	2.08*	2.67*	0.72*	3.38*	1.45*
Error	48	0.24	0.34	0.28	0.27	0.30	0.22

Marketable yield per plant (Kg)							
Genotype	24	650.39*	1024.46*	994.99*	223.34*	1031.30*	1285.41*
Error	48	26.61	30.37	32.98	142.34	27.03	190.17
Unmarketable yield per plant (Kg)							
Genotype	24	6.74*	62.79*	89.99*	2.38*	63.56*	68.73*
Error	48	0.28	1.05	10.94	0.15	0.81	0.93
Fruit yield per plant (Kg)							
Genotype	24	737.69*	1423.88*	1475.84*	261.21*	1427.80*	1778.88*
Error	48	36.13	37.62	53.83	22.45	35.46	25.21
Fruit yield per ha (q)							
Genotype	24	5656.35*	12479.57*	13757.78*	4283.76*	12297.32*	14178.71*
Error	48	28.11	19.61	13.21	9.75	9.67	12.13
Ascorbic acid content (mg/100g)							
Genotype	24	12.48*	13.77*	13.23*	13.43*	14.07*	13.75*
Error	48	0.03	0.02	0.03	0.06	0.9	0.03
Total phenol content (mg/100g)							
Genotype	24	0.13*	0.15*	0.14*	0.13*	0.14*	0.12*
Error	48	0.00	0.00	0.00	0.00	0.00	0.00
Shoot bore incidence (%)							
Genotype	24	44.57*	62.78*	99.49*	46.39*	85.65*	160.67*
Error	48	3.12	4.05	4.90	1.30	2.93	1.92
Fruit borer incidence (%)							
Genotype	24	35.66*	75.63*	78.55*	44.47*	92.85*	119.76*
Error	48	2.57	3.30	3.66	1.69	4.50	3.02
Spider mite incidence (%)							
Genotype	24	78.46*	198.22*	95.83*	13.32*	95.18*	70.53*
Error	48	14.86	30.84	20.05	14.63	17.07	22.22
Little leaf incidence (%)							
Genotype	24	12.67*	91.02*	30.47*	19.53*	52.65*	43.49*
Error	48	14.37	37.37	19.60	15.88	27.39	20.25
Phomopsis blight incidence (%)							
Genotype	24	39.48*	69.22*	73.82*	46.27	78.86	104.96*
Error	48	2.99	5.01	3.32	3.22	9.52	10.21

* and ** significant at 5% and 1% probability levels respectively

4.1.2 Environmental indices

The effect of environment in a stability analysis study is quantified through environmental index. The environmental indices obtained in the present study for genotypes are presented in the table 4.1.2 respectively.

The environmental indices varied from-5.93 in E_2 to 6.12 in E_1 (days to 50% flowering), -5.23 in E_5 to 8.21 in E_4 (days to first picking), -1.27 in E_4 to 0.74 in E_5 (fruit length), -0.62 in E_4 to 0.33 in E_5 (fruit diameter), -8.74 in E_4 to 3.22 in E_6 (number of fruits per plant), -8.86 in E_4 to 5.18 in E_3 (average fruit weight), -3.98 in E_4 to 1.45 in E_2 (number of leaves per plant), -22.99 in E_4 to 13.36 in E_3 (plant height), -1.86 in E_4 to 1.07 in E_3 (number of primary branches per plant), -3.50 in E_4 to 2.00 in E_2 (leaf area), -0.54 in E_4 to 0.19 in E_6 (marketable yield per plant), -0.16 in E_4 to 0.11 in E_3 (unmarketable yield per plant), -0.70 in E_4 to 0.27 in E_6 (fruit yield per plant), -56.25 in E_4 to 23.84 in E_6 (fruit yield per hectare), -0.26 in E_4 to 0.22 in E_3 (ascorbic acid content), -0.01 in E_1 to 0.05 in E_3 (total phenol content), -8.14 in E_1 to 7.22 in E_3 (shoot borer infestation), -8.73 in E_1 to 5.57 in E_3 (fruit borer infestation), -8.08 in E_4 to 7.75 in E_2 (spider mite infestation), -4.32 in E_1 to 6.51 in E_2 (little leaf incidence) and -6.34 in E_1 to 5.59 in E_6 (phomopsis blight incidence).

4.2 Linear regression vs deviation from linearity

The results of this model are presented in Table 4.2. The variation due to G × E interaction has been partitioned into two, the predictable component due to linear regression and the unpredictable one due to pooled deviations from regression.

The variances due to genotypes were highly significant revealing that there are sufficient differences in manifestation of variation among genotypes over environments for the traits under investigation.

Similarly, significant mean squares due to environment + (genotype × environment) were observed for all the traits which depicts the existence of genotype × environment interaction.

The linear contribution of the environmental effects on the performance of genotypes was significant for all the traits under study.

The mean squares due to genotype × environment interaction (linear) when tested against combined pooled deviations and pooled error were significant for all the characters except number of leaves per plant. This indicated a considerable interaction by linear components showing existence of significant differences for regression coefficients of genotype means on environmental indices. Significant differences due to G × E (linear) indicated that different genotypes differ

Table 4.1.2: Environmental indices for various traits in brinjal (*Solanum melongena* L.)

Trait	Environmental Index					
	E_1	E_2	E_3	E_4	E_5	E_6
Days to 50% flowering	6.12	-5.93	-2.74	0.43	-4.65	-0.24
Days to first picking	6.15	-5.58	-1.43	8.21	-5.23	-2.11
Fruit length (cm)	-0.79	0.63	0.30	-1.27	0.74	0.40
Fruit diameter (cm)	-0.32	0.28	0.24	-0.62	0.33	0.10
Number of fruits/plant	-2.71	2.65	2.68	-8.74	2.89	3.22
Average fruit weight (g)	-6.13	3.85	5.18	-8.86	2.90	3.05
Number of leaves per plant	0.24	1.45	1.42	-3.98	-0.23	1.09
Plant height (cm)	-17.95	9.65	13.36	-22.99	6.44	11.49
Number of primary branches per plant	-1.51	0.62	1.07	-1.86	0.86	0.81
Leaf area (c m^2)	-3.01	2.00	1.96	-3.50	1.28	1.27
Marketable yield per plant (kg)	-151.19	169.82	158.55	-538.51	166.46	194.86
Unmarketable yield per plant (kg)	-139.95	52.82	113.86	-164.07	65.54	71.80
Fruit yield per plant (kg)	-290.08	228.29	266.14	-703.51	232.74	266.42
Fruit yield per hectare (qtls)	-32.72	21.47	24.78	-56.25	18.89	23.84
Total phenol content (mg/100g)	-0.01	0.02	0.05	-0.06	0.002	-0.008
Ascorbic acid content (mg/100g)	-0.03	0.16	0.21	-0.26	-0.05	-0.03
Shoot borer infestation (%)	-8.14	-0.33	7.22	-6.15	0.67	6.73
Fruit borer infestation (%)	-8.73	2.78	5.57	-6.89	3.35	3.92
Spider mite infestation (%)	-2.67	7.75	1.58	-8.08	0.42	1.00
Little leaf incidence (%)	-4.32	6.51	-1.40	-3.40	2.18	0.43
Phomopsis blight incidence (%)	-6.34	-0.26	2.59	-4.38	2.81	5.59

Table 4.2: Mean Squares due to different source of variation for various traits in brinjal (*Solanum melongena* L.)

Source of variation	Df	Days to 50 per cent flowering	Days to first picking	fruit length (cm)	fruit diameter (cm)	Number of fruits per plant	Average fruit weight(g)	Number of leaves per plant	Plant height (cm)	Number of primary branches per plant	Leaf area (cm^2)	Market able yield per plant (kg)
Genotype	24	192.55**	365.61**	86.39**	42.40**	691.85**	15638.65**	408.94**	324.79**	2.93*	867.84**	1531.75**
Environment + (Genotype × Environment)	125	39.01**	43.99**	1.31**	0.34**	32.84**	51.94**	6.26**	278.70**	1.91**	10.65**	125.85**
Environment (Linear)	1	3926.74**	4256.44**	85.78**	18.67**	2916.21**	4384.60**	530.71**	32403.73**	216.16**	809.87**	10812.81**
Genotype × Environment (Linear)	24	12.66*	23.28**	1.66**	0.42**	37.56**	63.09**	1.86	68.37**	0.33**	11.22**	110.10**
Pooled deviation	100	6.46**	6.83**	0.38	0.14**	2.88**	5.94	2.07**	7.93	0.14**	2.52**	22.76**
Pooled error	288	3.03	4.22	0.29	0.10	1.86	6.58	1.26	7.77	0.09	1.03	8.20

*significant at 5% probability level, ** significant at 1% probability level

Continue table 4.2

Source of variation	**Df**	**Unmarketable yield per plant (kg)**	**Fruit yield per plant (kg)**	**Fruit yield per hectare (qtl)**	**Total phenol Content (mg/100g)**	**Ascorbic acid content (mg/100g)**	**Shoot borer infestation (%)**	**Fruit borer infestation (%)**	**Spider mite infestation (%)**	**Little leaf incidence (%)**	**Phomopsis blight incidence (%)**
Genotype	24	72.94**	2093.03**	18583.14**	0.23**	26.58**	135.26**	125.28**	142.38**	49.07**	116.46**
Environment + (Genotype × Environment)	125	19.49**	218.31**	1688.87**	0.01**	0.09*	46.44**	42.38**	35.21**	22.48**	25.13**
Environment (Linear)	1	1792.78**	20679.20**	155876.56**	0.15**	3.60**	5054.43**	4728.98**	3406.20**	1989.38**	2632.26**
Genotype × Environment (Linear)	24	19.10**	189.25**	1773.94**	0.02**	0.06	14.38**	11.06**	24.79**	12.75**	10.87**
Pooled deviation	100	1.84**	20.68**	126.58**	0.00**	0.06**	4.05**	3.03**	4.00	5.15	2.49*
Pooled error		0.32	11.23	5.14	0.00	0.01	1.01	1.04	6.44	7.11	1.90

*significant at 5% probability level, ** significant at 1% probability level genetically in their response to different environments except for two traits viz., number of leaves per plant and ascorbic acid.

The mean sum of squares due to pooled deviations were first tested against pooled error which showed significant pooled deviation for all the traits except fruit length, average fruit weight, spider mite infestation and little leaf incidence which revealed the importance contribution of non linear component of genotype × environment interaction for these traits. Therefore, genotypes differed considerably with respect to stability for these traits.

4.3 Phenotypic stability

Genotype × environment interaction measures the differences in the response of genotype to changes in the environments. The interaction constitutes an important limiting factor in the estimation of variance components and for the efficiency of selection programme. The magnitude of G × E interaction and stability were estimated as per the procedures described by Eberhart and Russell (1966)

4.3.1 Days to 50% flowering

As evident from table 4.3.1, among all the genotypes, eleven genotypes took less number of days to 50% flowering as compared to average (61.45) over environments. However, only two genotypes viz., Pusa Ankur and Navkiran Improved were found to be stable having lesser mean values (47.89 and 55.78 respectively) with regression coefficient close to unity (b_i= 1.03 and 1.06 respectively) and non significant deviation from regression line (S^2d_i= -1.95 and -0.54 respectively).

Only one genotype PPL showed regression coefficient less than unity (bi=0.67) with non significant deviation from regression line and lower mean value (60.33) than average mean (61.45), was above average in response suitable for unfavourable environment. However, six genotypes viz., PPL-74, Chhaya, PBH-3, Shamli, Punjab Sadabahar, and Pusa Uttam had lower mean values (55.33, 59.28, 56.11, 55.44, 55.22 and 58.72, respectively) and regression coefficient greater than unity (bi= 1.29, 1.23, 1.18, 1.26, 1.13 and 1.36, respectively) with non-significant deviation from regression line ($S^2d_i<0$) which indicates that these genotypes were below average in response and are suitable for favourable environment.

Table 4.3.1: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for days to 50% flowering

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	66.33	55.00	62.00	67.33	56.67	64.33	61.94	0.84	1.35
2	PPL-74	62.33	50.00	53.00	66.67	47.33	52.67	55.33	1.29	1.59
3	Navkiran Improved	62.67	48.67	55.33	63.67	51.00	53.33	55.78	1.06	-0.54
4	Sandhya	72.00	54.33	55.00	73.33	58.00	56.67	61.56	1.46	7.22*
5	MH-80	65.00	53.67	58.67	67.67	55.67	66.00	61.11	0.94	5.14*
6	Chhaya	66.67	53.33	56.67	69.00	52.33	57.67	59.28	1.23	-1.97
7	PBH-3	62.67	48.67	57.33	64.67	47.33	56.00	56.11	1.18	4.38
8	Nisha Improved	65.33	54.67	60.00	67.33	56.67	69.33	62.22	0.84	13.57**
9	Shamli	63.33	49.67	54.67	64.67	46.00	54.33	55.44	1.26	2.43
10	Abhishek	67.67	55.67	61.33	66.00	56.67	61.67	61.50	0.82	-0.9
11	Punjab Sadabahar	60.67	48.33	56.00	63.33	45.33	57.67	55.22	1.13	8.06
12	Arka Shirish	80.67	66.67	65.33	82.33	73.00	68.33	72.72	1.12	13.75
13	Arka Kusumkar	73.33	65.33	66.00	76.00	65.67	65.00	68.56	0.80	0.71
14	Arka Keshav	71.67	62.33	59.33	75.33	63.33	62.33	65.72	1.02	6.42*
15	Arka Nidhi	70.00	58.67	59.67	72.00	62.33	58.67	63.56	0.95	5.64*
16	Arka Neelkanth	73.33	61.00	63.67	76.00	70.67	71.00	69.28	0.84	10.26**
17	Pusa Shyamla	72.33	53.00	60.67	71.00	53.33	63.33	62.28	1.45	1.14
18	Pusa Kranti	67.00	49.33	52.67	66.00	52.00	56.00	57.17	1.33	-1.87
19	Pusa Ankur	55.00	41.67	46.00	54.33	41.67	48.67	47.89	1.03	-1.95
20	Pusa Uttam	67.67	51.00	53.00	69.33	54.67	56.67	58.72	1.36	-0.26
21	PPL	65.00	56.67	58.67	63.33	54.00	64.33	60.33	0.67	4.52
22	PPR	70.67	62.67	64.33	69.33	62.67	68.33	66.33	0.59	-1.47
23	PPC	75.67	63.67	67.00	75.33	68.67	71.67	70.33	0.80	-0.32
24	BR-14	65.67	63.00	61.00	68.67	64.33	63.33	64.33	0.36	-0.15
25	Puneri Kateri	67.33	61.67	61.00	70.00	61.33	63.67	64.17	0.63	-2.09
	Mean	67.60	55.55	58.73	68.91	56.83	61.24	61.45		

*significant at 5% probability level, ** significant at 1% probability level

	S.E (d)	CD5%	CD1%
Genotype	0.72	1.43	1.89
Environment	1.47	2.91	3.85

4.3.2 Days to first picking

Estimation of stability parameters presented in Table 4.3.2 indicates that genotype Pusa Ankur was earliest to first fruit picking which took 68.33 number of days followed by Punjab Sadabahar (73.5), Shamli (74.5), Pusa Kranti (77.89), BR-14 (79.17), PPL-74 (79.78), MH-80 (83.11), PBH-3 (83.39), Chhaya (83.94), Abhishek (83.33), PPL(83.17), Nisha Improved (84.78) and Navkiran Improved (85.22) as compared to average (85.93) over environments. The genotype Arka Shirish was late in maturity (99.44 days) followed by Pusa Shymala (96.72 days), PPR (95.56 days), Arka Keshav (95.50 days), Arka Kusumkar (94.33 days) and Arka Neelkanth (90.94 days).

The genotypes PBH-3 (83.39) and Shamli (74.5) having lower mean values with average mean (85.93) showed regression coefficient close to one (b_i= 0.86 and 1.06) with non significant deviation from regression line, were found to be stable and adapted for all types of environments for this trait. However, genotype Pusa Uttam also recorded regression coefficient close to unity (b_i=0.94) and non-significant deviation from regression line close to zero (S^2d_i=0.65) but slightly higher mean value (87.94) than average mean.

Similarly, seven genotypes viz., PPL-74, MH-80, Abhishek, Punjab Sadabahar, Pusa Kranti, Pusa Ankur and BR-14 with mean values (79.78, 83.11, 83.33, 73.50, 77.89, 68.33 and 79.17, respectively) lower than average mean (85.93) showed regression coefficient greater than unity (b_i= 1.23, 1.13, 1.14, 1.18 and 1.52, respectively) with non significant deviation from regression line which were below average in response whereas, Navkiran Improved, PBH-3 and Chhaya with mean values 85.22, 83.39 and 83.94 days had regression coefficient lesser than one ($b_{i=}$ 0.36, 0.86 and 0.59, respectively) with non significant deviation from regression line were found above average in response and are suitable for unfavourable environments.

4.3.3 Fruit length (cm)

The perusal of stability estimates indicated that among all the genotypes, only four genotypes viz., PPL-74, Punjab Sadabahar, Pusa Kranti and PPL showed significant non linear (S^2d_i) component of G × E interaction.

Based on the three stability parameters, amongst the round fruited genotypes, only two genotypes viz., Pusa Ankur and Sandhya recorded higher mean values of 9.40 cm and 7.42 cm but were found to be stable with regression coefficient close to unity (b_i= 0.85 and 0.93, respectively) with non-significant deviation from regression line (S^2d_i= 0.27 and -0.27, respectively).

Six round fruited genotypes viz., Rajni, MH-80, Chhaya, Nisha Improved, Abhishek and Arka Kusumkar, had significant regression coefficient lesser than unity (b_i= 0.53, 0.51, 0.35, 0.43,

Table 4.3.2: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for days to first picking

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	91.33	81.00	88.33	94.00	81.67	91.67	88.00	0.79	6.78*
2	PPL-74	86.33	73.33	74.00	91.67	75.00	78.33	79.78	1.23	1.75
3	Navkiran Improved	87.00	81.00	84.67	88.33	85.00	85.33	85.22	0.36	-2.25
4	Sandhya	96.67	83.33	85.00	96.67	83.33	81.67	87.78	1.13	1.77
5	MH-80	90.67	79.00	82.00	92.67	76.67	77.67	83.11	1.14	-0.63
6	Chhaya	91.67	82.67	79.33	86.67	81.67	81.67	83.94	0.59	5.89
7	PBH-3	90.00	79.67	82.67	90.00	80.00	78.00	83.39	0.86	-0.07
8	Nisha Improved	90.67	81.67	86.33	93.67	73.33	83.00	84.78	1.10	8.69*
9	Shamli	83.33	70.00	72.33	81.67	68.33	71.33	74.50	1.06	-1.57
10	Abhishek	90.67	76.67	84.00	91.67	73.33	83.67	83.33	1.18	3.09
11	Punjab Sadabahar	85.67	65.67	74.00	86.67	62.33	66.67	73.50	1.75	3.1
12	Arka Shirish	102.67	98.00	99.33	103.33	95.00	98.33	99.44	0.50	-3.01
13	Arka Kusumkar	98.33	89.00	93.67	98.33	93.33	93.33	94.33	0.56	-2.08
14	Arka Keshav	101.00	88.67	93.00	103.33	95.33	91.67	95.50	0.87	2.89
15	Arka Nidhi	94.67	82.33	85.00	95.00	89.33	83.33	88.28	0.81	7.33*
16	Arka Neelkanth	98.67	82.33	84.00	104.00	85.00	91.67	90.94	1.42	6.50*
17	Pusa Shyamla	97.67	91.67	97.67	103.33	90.00	100.00	96.72	0.68	7.86*
18	Pusa Kranti	88.33	70.00	74.00	88.33	71.67	75.00	77.89	1.40	-2.11
19	Pusa Ankur	78.00	59.00	66.33	81.67	61.67	63.33	68.33	1.58	-2.96
20	Pusa Uttam	91.00	83.33	85.67	97.67	81.67	88.33	87.94	0.94	0.65
21	PPL	90.67	75.33	87.33	93.00	71.67	81.00	83.17	1.35	10.51**
22	PPR	97.67	90.00	99.33	100.00	91.00	95.33	95.56	0.58	3.62
23	PPC	96.67	88.33	93.00	103.33	91.67	96.67	94.94	0.78	3.39
24	BR-14	90.00	71.33	76.00	91.67	74.33	71.67	79.17	1.52	3.52
25	Puneri Kateri	92.67	85.33	85.33	96.67	85.00	86.67	88.61	0.81	-2.08
	Mean	92.08	80.35	84.49	94.13	80.69	83.81	85.93		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.74	1.47	1.94
Environment	1.51	2.99	3.96

Table 4.3.3: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for fruit length (cm)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	6.07	6.87	6.50	5.40	6.33	6.40	6.26	0.53	-0.22
2	PPL-74	14.80	17.87	17.53	14.30	15.57	16.10	16.03	1.30	0.85**
3	Navkiran Improved	8.27	8.90	9.40	8.13	9.47	9.73	8.98	0.69	-0.15
4	Sandhya	6.47	7.93	7.63	6.40	8.20	7.87	7.42	0.93	-0.27
5	MH-80	6.50	7.27	7.17	6.20	7.20	6.93	6.88	0.51	-0.28
6	Chhaya	7.83	8.17	7.73	7.20	8.07	7.90	7.82	0.35	-0.25
7	PBH-3	10.27	12.27	11.20	9.00	12.40	11.63	11.13	1.53	-0.20
8	Nisha Improved	5.97	6.53	6.43	5.57	6.30	6.50	6.22	0.43	-0.27
9	Shamli	12.40	13.43	12.13	11.93	13.43	13.17	12.75	0.65	-0.09
10	Abhishek	7.13	7.30	6.57	6.27	7.17	6.33	6.79	0.22	-0.07
11	Punjab Sadabahar	12.60	16.43	16.00	12.37	18.30	18.90	15.77	3.04	1.34**
12	Arka Shirish	16.70	20.13	19.30	16.17	20.70	18.70	18.62	2.14	-0.04
13	Arka Kusumkar	4.70	5.77	4.90	4.30	5.40	5.20	5.04	0.57	-0.23
14	Arka Keshav	11.90	14.83	14.10	11.73	15.17	11.97	13.28	1.50	0.95**
15	Arka Nidhi	12.53	14.13	14.80	14.00	13.73	13.77	13.83	0.35	0.29
16	Arka Neelkanth	5.60	6.13	6.07	5.07	5.23	5.30	5.57	0.22	-0.08
17	Pusa Shyamla	5.53	6.20	5.97	5.87	6.93	6.03	6.09	0.40	-0.15
18	Pusa Kranti	10.43	11.00	10.90	9.20	12.60	13.60	11.29	1.44	1.03**
19	Pusa Ankur	8.73	9.60	9.67	8.27	10.00	10.13	9.40	0.85	0.27
20	Pusa Uttam	9.40	11.13	11.47	8.87	13.27	11.07	10.87	1.72	0.27
21	PPL	14.10	15.63	14.67	11.40	14.80	15.67	14.38	1.67	0.44*
22	PPR	10.10	10.73	10.57	9.73	11.60	10.93	10.61	0.71	-0.19
23	PPC	5.67	7.23	7.07	6.13	7.30	6.67	6.68	0.70	-0.17
24	BR-14	7.73	10.43	10.43	7.50	10.53	10.37	9.50	1.72	-0.17
25	Puneri Kateri	6.30	7.20	6.73	4.63	6.20	6.63	6.28	0.84	0.08
	Mean	9.11	10.52	10.20	8.63	10.64	10.30	9.90		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.17	0.34	0.46
Environment	0.35	0.71	0.93

0.22 and 0.57, respectively) with non significant deviation from regression line which indicated above average response, but all these genotypes had mean values lower than the average mean. The genotypes PBH-3, Arka Shirish and BR-14 with mean values (11.13, 18.62 and 9.50, respectively) showed regression coefficient greater than one (b_i= 1.53, 2.14 and 1.72, respectively) with non significant deviation from regression line and were below average in response and were suitable for favourable environments.

4.3.4 Fruit diameter (cm)

Simultaneous consideration of stability parameters (Table 4.3.4) revealed that three round fruited genotypes viz., Rajni, Pusa Kranti and PPR with high mean values (5.79, 5.65 and 9.94 cm, respectively) and two long fruited genotypes viz., PPL-74 and Arka Shirish, having lower mean values (2.92 and 2.99 cm, respectively) than the average mean (5.03 cm) had regression coefficient close to unity (bi= 1.01, 1.08, 1.09, 1.14 and 1.15) with non significant deviation from regression line ($S^2d_{i=}$ -0.04, 0.08, -0.01, -0.04 and -0.09, respectively) were found to be stable and suitable for all types of environments. Among all genotypes, PPR (9.94 cm) because of its round shape fruits recorded maximum fruit diameter as compared to average fruit diameter (5.03 cm) over environments. This was followed by PBH-3 (9.61 cm), Pusa Uttam (9.36 cm), Pusa Ankur (8.61 cm), Abhishek (7.41 cm), BR-14 (7.39 cm), MH-80 (7.21 cm) and Navkiran Improved (7.14 cm) whereas Arka Nidhi (1.40 cm) followed by Arka Keshav (1.41 cm) and Shamli (2.18 cm) expressed minimum fruit diameter amongst all the long fruited genotypes.

Eleven genotypes viz., Navkiran Improved, Sandhya, Chhaya, Nisha Improved, Shamli, Abhishek, Arka Kusumkar, Pusa Shyamla, PPC, Puneri Kateri and Arka Neelkanth showed significant above average in response (b_i<1) with non significant deviation from regression line (S^2d_i= 0) whereas, two genotypes viz., MH-80 and BR-14 performed below average in response (b_i>1) with non significant deviation from regression line (S^2d_i = 0).

Table 4.3.4: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for fruit diameter (cm)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer,2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	5.53	6.37	6.13	5.10	5.77	5.87	5.79	1.01	-0.04
2	PPL-74	2.87	3.33	3.07	1.97	3.13	3.13	2.92	1.14	-0.04
3	Navkiran Improved	6.70	7.00	7.80	6.63	7.43	7.27	7.14	0.92	-0.01
4	Sandhya	5.53	6.23	5.97	5.87	6.93	6.03	6.09	0.81	0.06
5	MH-80	6.67	7.53	7.73	6.50	7.33	7.50	7.21	1.21	-0.05
6	Chhaya	3.53	3.77	3.77	3.23	3.93	3.93	3.69	0.64	-0.08
7	PBH-3	9.57	11.17	9.03	7.37	10.63	9.90	9.61	2.78	0.69**
8	Nisha Improved	4.17	5.00	4.63	4.07	4.33	4.63	4.47	0.68	-0.03
9	Shamli	2.03	2.23	2.13	1.80	2.57	2.30	2.18	0.57	-0.07
10	Abhishek	7.90	7.30	7.33	6.77	7.57	7.57	7.41	0.35	0.62
11	Punjab Sadabahar	3.07	3.30	3.23	3.00	3.40	3.30	3.22	0.38	-0.09
12	Arka Shirish	2.57	3.27	3.27	2.30	3.37	3.20	2.99	1.15	-0.09
13	Arka Kusumkar	1.93	2.70	2.23	1.80	2.27	2.20	2.19	0.68	-0.06
14	Arka Keshav	1.20	1.63	1.47	1.23	1.53	1.37	1.41	0.39	-0.09
15	Arka Nidhi	1.33	1.57	1.53	1.17	1.37	1.43	1.40	0.32	-0.09
16	Arka Neelkanth	3.60	3.80	4.17	3.40	3.87	3.80	3.77	0.57	-0.07
17	Pusa Shyamla	3.87	4.23	3.53	3.33	3.90	3.67	3.76	0.46	-0.01
18	Pusa Kranti	5.10	6.33	6.33	5.13	5.60	5.40	5.65	1.08	0.08
19	Pusa Ankur	7.03	8.53	8.90	7.47	10.07	9.63	8.61	2.49	0.51**
20	Pusa Uttam	8.47	9.07	10.50	7.70	11.27	9.17	9.36	2.84	0.55**
21	PPL	2.97	3.57	3.50	3.20	3.43	3.43	3.35	0.47	-0.07
22	PPR	9.47	9.93	10.23	9.40	10.73	9.87	9.94	1.09	-0.01
23	PPC	2.44	2.47	3.10	2.33	2.67	2.77	2.63	0.45	-0.04
24	BR-14	6.37	8.33	8.00	6.27	7.63	7.73	7.39	2.08	0.03
25	Puneri Kateri	3.73	4.00	4.07	3.10	3.23	3.23	3.56	0.44	0.09
	Mean	4.71	5.31	5.27	4.41	5.36	5.13	5.03		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.11	0.21	0.28
Environment	0.22	0.43	0.57

4.3.5 Number of fruits per plant

The examination of stability parameters in Table 4.3.5 and Fig.1 revealed that two genotypes viz., Navkiran Improved and Pusa Ankur were stable for this particular trait having high mean values (15.79 and 14.85, respectively) than the average mean (14.68) and regression coefficient close to one (b_i= 0.98 and 0.81, respectively) and non–significant deviation from regression line (S^2d_i= 0.57 and 0.16, respectively).

The highest number of fruits per plant were recorded by the genotypes Shamli (48.50) followed by PPL-74 (45.24), PPC (22.64), Punjab Sadabahar (17.45), Navkiran Improved (15.79), Arka Keshav (15.15), Pusa Ankur (14.85) and Sandhya (14.74) as compared to average (14.68) while lowest value for this trait was recorded for round fruited genotypes like, PPR (5.04) , Puneri Kateri (5.56), Arka Neelkanth (5.69) and BR-14 (5.84).

Five genotypes viz., MH-80, PBH-3, Abhishek, Pusa Shyamla and Rajni with regression coefficient values of 0.96, 0.64, 0.62, 0.83 and 0.69, respectively showed regression coefficient lesser than unity ($b_i<1$) with non significant deviation from regression line which showed above average stability, but all the five genotypes had mean value lesser than the average mean because of round shaped fruits. However, three genotypes viz., Pusa Kranti, Arka Keshav and Nisha Improved with regression coefficient values of 1.21, 1.23 and 1.26, respectively had regression coefficient greater than one ($b_i>1$) with non significant deviation from regression line and displayed below average response and were suitable for favourable environments.

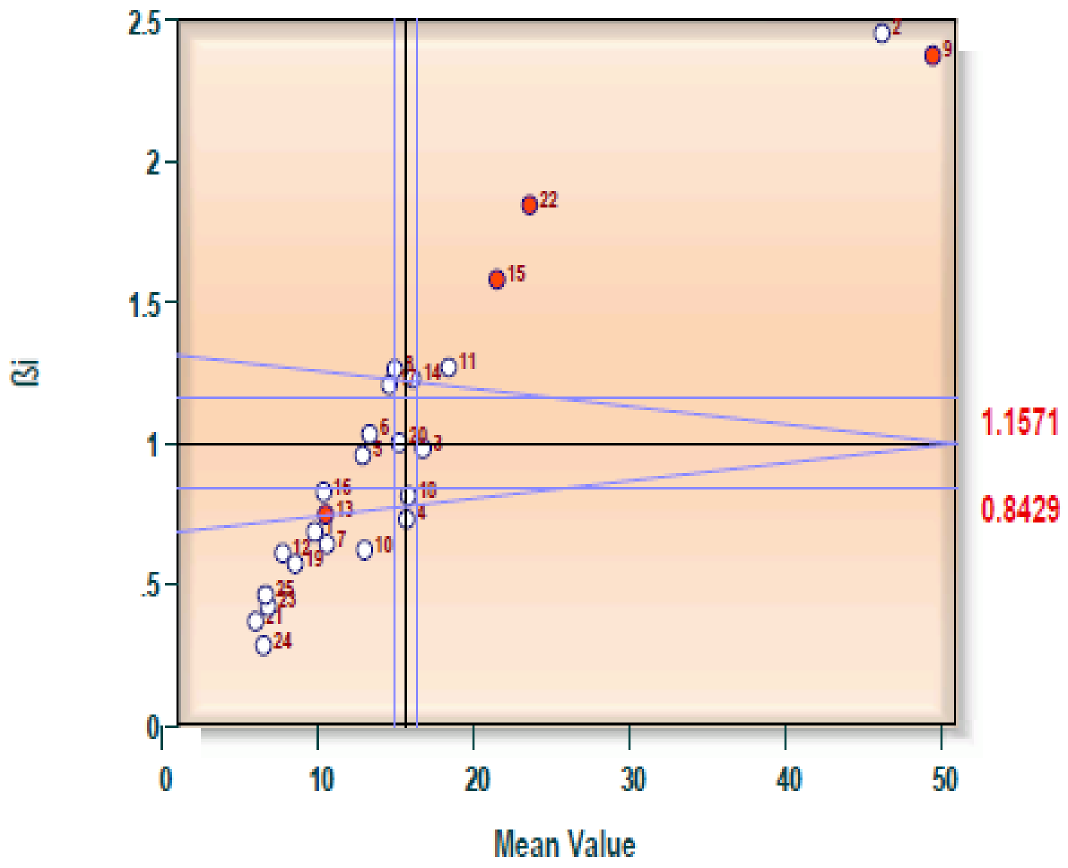
Table 4.3.5: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for number of fruits per plant

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	5.20	9.87	11.97	3.73	9.83	12.47	8.84	0.69	0.33
2	PPL-74	37.33	51.00	52.87	24.43	51.70	54.10	45.24	2.45	-0.73
3	Navkiran Improved	14.77	20.17	16.57	6.40	18.23	18.60	15.79	0.98	0.57
4	Sandhya	14.45	16.07	13.77	7.67	16.87	19.60	14.74	0.73	2.67
5	MH-80	8.00	14.73	13.93	4.20	16.07	14.63	11.93	0.96	-0.84
6	Chhaya	8.73	14.37	16.47	3.73	15.47	15.47	12.37	1.03	-1.18
7	PBH-3	6.40	12.13	13.20	4.61	10.63	10.67	9.61	0.64	0.12
8	Nisha Improved	9.23	17.47	16.30	3.57	20.53	16.80	13.98	1.26	1.33
9	Shamli	46.27	55.70	50.43	25.87	53.87	58.87	48.50	2.37	10.86**
10	Abhishek	11.53	15.10	13.77	5.93	14.40	11.50	12.04	0.62	0.66
11	Punjab Sadabahar	13.82	20.53	21.03	6.47	20.30	22.53	17.45	1.27	-1.52
12	Arka Shirish	4.40	8.83	8.40	1.77	9.03	8.23	6.78	0.61	-1.65
13	Arka Kusumkar	7.40	11.90	15.53	2.90	10.40	9.11	9.54	0.75	4.46*
14	Arka Keshav	11.10	19.47	18.00	4.70	19.97	17.67	15.15	1.23	-0.59
15	Arka Nidhi	14.57	22.47	27.87	7.60	22.20	28.50	20.53	1.58	6.78**
16	Arka Neelkanth	4.00	8.00	7.63	1.80	6.50	6.23	5.69	0.46	-1.22
17	Pusa Shyamla	7.67	11.85	11.23	1.90	12.80	11.00	9.41	0.83	-1.31
18	Pusa Kranti	8.13	15.93	17.30	4.20	16.80	19.37	13.62	1.21	0.70
19	Pusa Ankur	12.30	15.17	16.10	8.00	18.50	19.03	14.85	0.81	0.16
20	Pusa Uttam	6.57	10.90	9.07	2.27	8.83	7.97	7.60	0.57	-0.51
21	PPL	12.80	18.43	16.17	4.83	17.67	15.67	14.26	1.02	0.14
22	PPR	4.00	5.90	6.17	1.83	5.93	6.43	5.04	0.37	-1.96
23	PPC	20.87	23.77	25.33	5.13	30.00	30.73	22.64	1.85	8.09**
24	BR-14	4.30	7.20	7.70	2.30	7.20	6.37	5.84	0.42	-1.61
25	Puneri Kateri	5.50	6.33	7.30	2.70	5.67	5.87	5.56	0.28	-1.36
	Mean	11.97	17.33	17.36	5.94	17.58	17.90	14.68		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.48	0.95	1.26
Environment	0.98	1.94	2.57

Fig.1: Scatter graph of mean values versus regression coefficient for number of fruits / plant



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shyamla	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

4.3.6 Average fruit weight (g)

Simultaneous consideration of stability parameters with respect to average fruit weight Table 4.3.6 and Fig.2 revealed genotype PPL-74 with average fruit weight of 50.44 g is well below the average mean (87.72 g) but highest amongst the long fruited genotypes and regression coefficient approaching one (b_i=0.96) with non significant deviation from regression line was average in response and thus suited for all types of environments. Two round fruited genotypes viz., Abhishek and Sandhya, showed regression coefficient close to unity (b_i=0.83 and 0.80, respectively) with non significant deviation from regression line as well as high values for average fruit weight (117.52 g and 145.73 g, respectively) than average mean (87.72 g) and can be considered as average in response and suitable for all types of environments.

Two genotypes viz., PBH-3 and Pusa Uttam had mean values (147.70 and 173.15 g, respectively) high than average mean with regression coefficient greater than unity (b_i= 1.13 and 1.42, respectively) and non significant deviation from regression line exhibiting below average response and thus suited for favourable environments. Whereas, long fruited genotypes viz., Shamli, Punjab Sadabahar and PPL with lower mean values (30.48, 73.17 and 58.04 g, respectively) showed regression coefficient lesser than unity (b_i= 0.42, 0.70 and 0.70, respectively) and were above average responsive and suited for unfavourable environments.

Estimates of stability parameters further revealed that the genotype BR-14 manifested maximum average fruit weight (180.04 g) as compared to mean (87.72g) across all the environments which was followed by Pusa Uttam (173.15 g), Rajni (156.05 g) , PBH-3 (147.3 g), Sandhya (145.73 g), PPR (131.42 g) and Pusa Kranti (126.99 g) and minimum average fruit weight was recorded in PPC (19.60 g) followed by Shamli (30.48 g) and Arka Kusumkar (33.16 g), Arka Keshav (33.43 g) and Arka Nidhi (33.59 g).

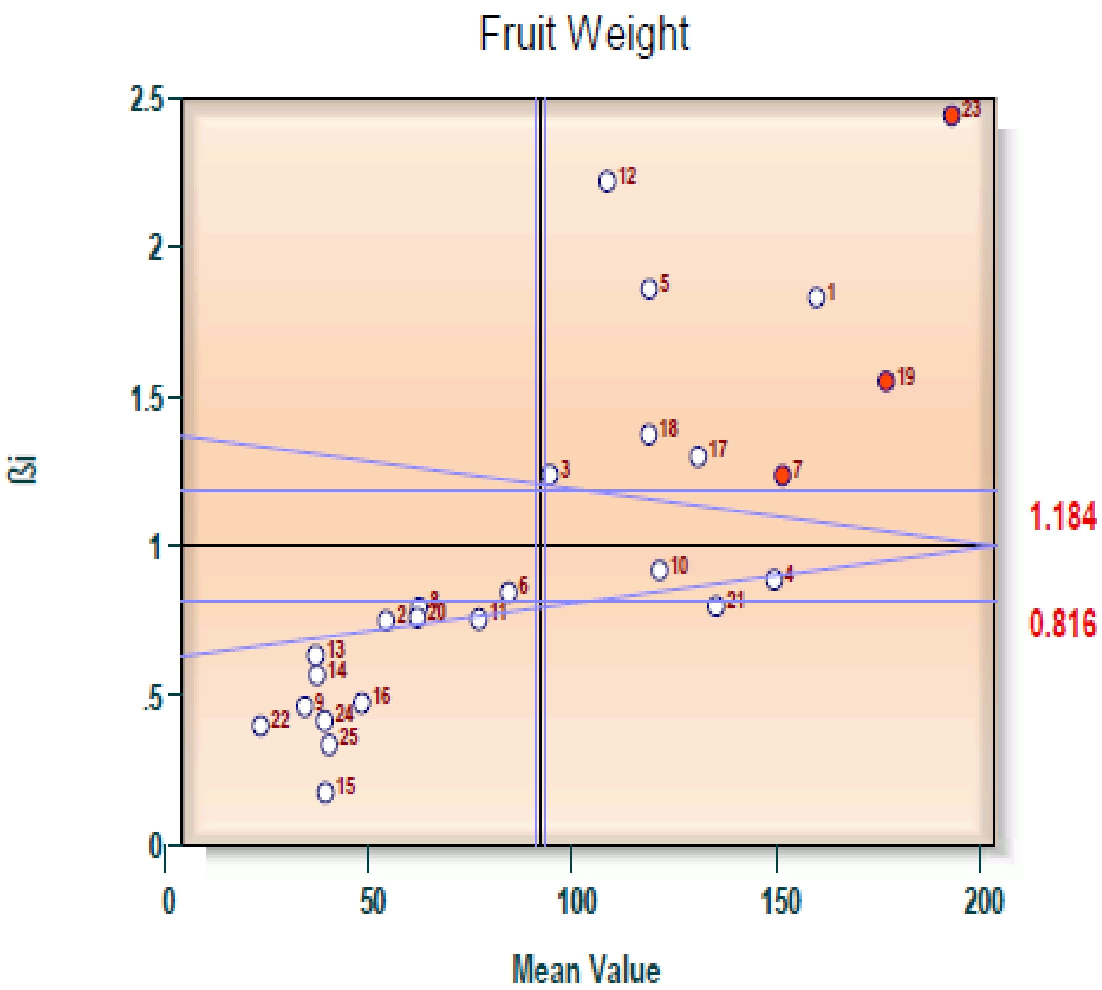
Table 4.3.6: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for average fruit weight (g)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	142.85	162.65	164.88	141.22	161.45	163.25	156.05	1.69	-23.08
2	PPL-74	45.93	53.26	54.83	43.85	50.17	54.61	50.44	0.96	-20.94
3	Navkiran Improved	82.86	98.23	93.82	79.37	97.08	92.31	90.61	1.13	-15.24
4	Sandhya	141.26	148.30	151.94	137.33	151.22	144.33	145.73	0.80	-14.94
5	MH-80	102.03	123.57	124.14	99.83	121.18	119.46	115.04	1.72	-22.53
6	Chhaya	79.84	82.53	84.96	69.50	81.58	84.58	80.50	0.71	-10.00
7	PBH-3	140.39	147.72	157.16	136.84	147.89	156.20	147.70	1.13	-6.07
8	Nisha Improved	53.97	59.93	62.81	51.26	59.75	63.71	58.57	0.72	-20.27
9	Shamli	27.37	32.93	31.90	26.47	31.72	32.47	30.48	0.42	-23.35
10	Abhishek	112.67	121.42	121.58	108.68	121.84	118.95	117.52	0.83	-20.97
11	Punjab Sadabahar	67.88	73.27	77.54	66.89	75.92	77.53	73.17	0.70	-20.65
12	Arka Shirish	90.00	114.70	115.45	85.82	113.38	108.67	104.67	2.04	-18.73
13	Arka Kusumkar	29.84	35.84	36.25	27.07	36.53	33.44	33.16	0.57	-21.76
14	Arka Keshav	30.90	35.98	36.64	27.76	33.93	35.39	33.43	0.51	-22.35
15	Arka Nidhi	34.75	36.48	36.88	33.95	36.35	35.15	35.59	0.16	-23.44
16	Arka Neelkanth	34.12	39.08	40.86	34.35	35.20	35.33	36.49	0.31	-19.04
17	Pusa Shyamla	41.35	46.27	47.23	40.46	44.26	47.09	44.44	0.44	-22.74
18	Pusa Kranti	116.30	132.45	133.91	117.65	133.20	128.45	126.99	1.22	-20.22
19	Pusa Ankur	106.13	118.43	121.28	102.76	117.86	122.87	114.88	1.26	-18.28
20	Pusa Uttam	163.44	185.81	175.86	159.07	180.23	174.50	173.15	1.42	0.28
21	PPL	53.04	59.96	57.50	50.63	66.03	61.10	58.04	0.70	-9.85
22	PPR	127.10	137.91	136.04	124.26	132.20	131.02	131.42	0.72	-17.28
23	PPC	16.13	19.46	21.58	16.73	20.92	22.78	19.60	0.37	-22.09
24	BR-14	120.49	196.11	207.29	167.21	189.80	199.34	180.04	4.36	288.69**
25	Puneri Kateri	32.83	36.39	39.59	31.96	35.06	36.09	35.32	0.38	-21.87
	Mean	79.74	91.95	93.28	79.24	90.99	91.15	87.72		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	1.98	2.38	3.15
Environment	2.44	4.85	6.43

Fig.2: Scatter graph of mean values versus regression coefficient for fruit weight (g)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10.Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16.Pusa Shyamla	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

4.3.7 Number of leaves per plant

Estimation of stability parameters indicated two genotypes viz., Rajni and Nisha Improved with higher mean values (44.03 and 46.16, respectively) than average mean (37.51) and regression coefficient close to one (b_i=0.86 and 1.08, respectively) with non-significant deviation from regression line (S_2d_i= 0.40 and 1.97, respectively) were found stable and thus adapted to all types of environments for this trait.

Three genotypes viz., PPL-74 (1.27), Shamli (1.61) and PPL (1.28) exhibited regression coefficient greater than unity (b_i>1) along with high mean values (57.32, 56.64 and 40.64 respectively) as compared to average mean (37.51) depicting below average response with non significant deviation from regression line and thus suited specifically for favourable environments whereas, genotype Abhishek with mean value (44.98) exhibited regression coefficient lesser than unity ($b_{i=}$0.54) with non significant deviation from regression value reflecting above average response and thus suited for unfavourable environments.

However, in all, seven genotypes recorded highest values for number of leaves/plant as compared to average mean (37.51). The genotype PPL-74 (57.32) recorded maximum number of leaves per plant followed by Shamli (56.64), Pusa Kranti (49.76), Nisha Improved (46.16), Abhishek (44.98), PPL (40.64) and Sandhya (40.05).

4.3.8 Plant height (cm)

From the data presented in stability table 4.3.8 it is evident that five genotypes viz., Shamli, Rajni, Navkiran Improved, Nisha Improved and PPL recorded significant regression coefficient close to one (b_i = 0.96, 1.07, 0.98, 1.09 and 0.97, respectively) with non-significant deviation from regression line showing average response across all the environments and were found stable and thus adapted to all types of environments.

Three genotypes viz., Arka Shirish (90.69 cm), Arka Kusumkar (72.53 cm) and Arka Neelkanth (74.04 cm) had high mean values than average mean (72.15 cm) with regression coefficient greater than unity (b_i= 1.53, 1.14 and 1.17, respectively) with non significant deviation from regression line reflecting below average response and suitable for favourable environments whereas, four genotypes PBH-3 (74.48 cm), Abhishek (75.30 cm), Pusa Kranti (86.68 cm) and Pusa Ankur (74.83 cm) had higher mean values than the average mean coupled with regression coefficient lower than unity (b_i= 0.80, 0.76, 0.88 and 0.91, respectively) and non significant deviation from regression line reflecting above average response and suited specifically for unfavourable environments.

Table 4.3.7: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for number of leaves per plant

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	44.98	46.39	45.49	40.44	44.43	42.47	44.03	0.86	0.40
2	PPL-74	55.69	60.69	58.46	51.78	60.41	56.91	57.32	1.27	3.65
3	Navkiran Improved	35.89	35.53	35.59	29.78	32.03	34.36	33.86	1.06	-0.16*
4	Sandhya	43.06	34.73	45.09	36.03	41.27	40.11	40.05	0.75	15.38**
5	MH-80	34.63	36.45	35.42	31.93	33.32	36.34	34.68	0.78	-1.01
6	Chhaya	34.33	35.00	35.28	32.01	32.61	34.97	34.03	0.60	-1.20
7	PBH-3	36.04	38.18	38.90	34.20	37.05	39.04	37.23	0.82	-0.92
8	Nisha Improved	44.00	46.03	48.93	42.03	46.67	49.29	46.16	1.08	1.97
9	Shamli	59.01	58.03	58.73	49.82	56.39	57.86	56.64	1.61	-0.38
10	Abhishek	45.96	46.49	44.85	42.66	44.91	44.99	44.98	0.54	-1.10
11	Punjab Sadabahar	36.57	39.49	38.93	31.07	37.84	38.36	37.04	1.46	-1.15
12	Arka Shirish	28.79	31.87	32.43	25.51	28.25	30.85	29.62	1.18	-0.61
13	Arka Kusumkar	32.06	33.93	33.20	26.83	32.16	33.16	31.89	1.24	-1.55
14	Arka Keshav	34.87	34.46	33.71	29.37	32.37	34.82	33.27	0.95	-0.83
15	Arka Nidhi	37.87	37.02	36.00	30.36	32.16	35.39	34.80	1.16	1.89
16	Pusa Shyamla	31.63	33.87	33.13	27.19	30.39	32.28	31.42	1.13	-1.34
17	Arka Neelkanth	29.02	29.83	28.00	24.48	27.66	28.33	27.89	0.82	-1.01
18	Pusa Kranti	47.18	51.66	51.29	44.77	51.04	52.61	49.76	1.27	1.56
19	Pusa Ankur	36.72	37.98	37.60	32.40	35.62	39.76	36.68	1.12	-0.51
20	Pusa Uttam	34.66	35.84	34.67	29.69	33.29	35.52	33.94	1.07	-1.38
21	PPL	39.85	42.44	41.74	35.54	40.83	43.45	40.64	1.28	-0.72
22	PPR	36.99	36.27	35.06	31.39	34.03	35.42	34.86	0.82	-0.39
23	PPC	31.47	34.33	33.26	28.11	34.14	32.70	32.33	0.98	-0.09
24	BR-14	26.57	30.80	30.24	25.78	27.51	29.90	28.47	0.84	0.11
25	Puneri Kateri	26.16	26.79	27.40	25.31	25.77	26.21	26.27	0.29	-1.47
	Mean	37.76	38.96	38.94	33.54	37.29	38.60	37,51		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.41	0.81	1.07
Environment	0.83	1.65	2.18

Table 4.3.8: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for plant height (cm)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	56.73	85.53	86.23	47.53	83.07	85.37	74.08	1.07	-3.18
2	PPL-74	54.20	82.77	90.43	48.27	79.30	89.40	74.06	1.13	-3.72
3	Navkiran Improved	54.13	83.60	86.73	53.10	80.47	85.03	73.84	0.98	-5.84
4	Sandhya	53.87	81.93	80.50	46.07	79.27	79.83	70.24	0.98	-0.97
5	MH-80	54	85.23	93.60	50.13	82.63	98.83	77.41	1.25	11.97*
6	Chhaya	50.87	75.67	84.13	51.30	78.93	81.60	70.42	0.93	1.06
7	PBH-3	58.40	84.00	86.73	57.87	78.33	81.57	74.48	0.80	-3.34
8	Nisha Improved	51.13	86.63	84.27	48.60	84.13	82.43	72.87	1.09	5.35
9	Shamli	65.40	87.73	93.60	59.37	85.87	98.10	81.68	0.96	3.46
10	Abhishek	63.60	84.73	84.53	55.60	83.50	79.83	75.30	0.76	2.83
11	Punjab Sadabahar	54.53	82.20	82.70	50.97	78.47	81.67	71.76	0.92	-6.33
12	Arka Shirish	63.13	104.80	109.27	54.80	105.60	106.53	90.69	1.53	0.46
13	Arka Kusumkar	55.80	82.00	91.63	43.80	77.77	84.20	72.53	1.14	3.22
14	Arka Keshav	35.27	75.73	84.10	31.47	74.10	81.93	63.77	1.48`	-4.21
15	Arka Nidhi	44.27	73.73	76.83	39.47	68.20	78.83	63.56	1.07	-4.01
16	Arka Neelkanth	50.67	88.53	87.83	48.33	85.00	83.87	74.04	1.17	3.55
17	Pusa Shyamla	47.77	70.66	74.13	45.07	68.07	72.43	63.02	0.81	-7.54
18	Pusa Kranti	71.20	93.57	99.87	67.23	87.13	101.10	86.68	0.88	4.95
19	Pusa Ankur	57.47	82.40	85.43	54.33	82.67	86.67	74.83	0.91	-5.08
20	Pusa Uttam	49.90	84.37	85.10	45.87	82.37	85.13	72.12	1.17	-3.48
21	PPL	58.23	83.47	88.30	50.53	77.30	85.87	73.95	0.97	-4.06
22	PPR	54	66.33	74.57	50.23	67.03	68.57	63.46	0.56	-2.37
23	PPC	38.07	73.13	75.20	34.83	67.13	66.17	59.09	1.09	4.25
24	BR-14	53.20	73.93	75.90	47.27	67.23	74.70	65.37	0.75	-4.39
25	Puneri Kateri	59.00	72.40	76.07	46.90	61.03	71.33	64.46	0.61	20.41**
	Mean	54.19	81.80	85.51	49.16	78.58	83.64	72.15		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.80	1.58	2.09
Environment	1.63	3.23	4.27

4.4.9 Number of primary branches per plant

Estimation of stability parameters in Table 4.3.9 revealed five genotypes viz., MH-80, Punjab Sadabahar, Pusa Ankur Abhishek, and PPL-74had higher mean values (5.22, 5.36, 5.56, 5.70 and 6.02, respectively) as compared to average mean (5.11) showed regression coefficient close to one (b_i=0.99, 0.94, 0.92, 1.08 and 1.09, respectively) with non significant deviation from regression line (S^2d_i= -0.05, 0.03, 0.09, 0.2 and -0.07, respectively) and thus termed as stable genotypes and adapted to all types of environments.

Six genotypes viz., Rajni (5.41), Navkiran Improved (5.71), Nisha Improved (5.77), Shamli (6.43) Pusa Kranti (6.34) and BR-14 (5.19) had higher mean values than average mean (5.11) and showed regression coefficient greater than one (b_i= 1.23, 1.19, 1.29, 1.14, 1.30 and 1.29, respectively) with non significant deviation from regression line reflecting below average response and specifically adapted to favourable environments. However, none of the genotypes exhibited above average response for this particular trait.

4.4.10 Leaf area (cm^2)

Estimation of stability parameters revealed that only one genotype viz., Nisha Improved showed regression coefficient close to one (b_i=1.10) with non significant deviation from regression line (S^2d_i= 0.01) as well as higher mean value(91.79 cm^2) as compared to average mean (87.64 cm^2) and thus termed as stable genotype and adapted to all types of environments. Whereas genotypes Arka Neelkanth recorded regression coefficient close to one (b_i=1.01) with non-significant deviation from regression line but lower mean value (79.96 cm^2) as compared to average mean.

Two genotypes viz., MH-80 and Arka Shirish showed high mean values (98.54 and 104.36 cm^2 respectively) as compared to average mean (87.64 cm^2) regression coefficient greater than one (b_i= 1.44 and 1.97, respectively) with non significant deviation from regression line close to zero (S^2d_i= 0.85 and 0.78, respectively) reflecting below average response and specifically adapted to favourable environments whereas, three genotypes viz., PBH-3 (95.82 cm^2), Abhishek (93.38 cm^2) and Arka Kusumkar (89.79 cm^2) exhibited higher mean values as compared to average mean with regression coefficient lesser than unity (b_i= 0.70, 0.53 and 0.66, respectively) and non significant deviation from regression line approaching zero (S^2d_i= 0.24, -0.82 and -0.36, respectively) were above average in performance and thus suited for unfavourable environments.

Table 4.3.9: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for number of primary branches per plant

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	3.67	6.20	6.53	3.00	6.40	6.63	5.41	1.23	-0.06
2	PPL-74	4.60	6.67	7.20	3.80	6.97	6.90	6.02	1.09	-0.07
3	Navkiran Improved	4.20	6.80	7.07	3.23	6.53	6.43	5.71	1.19	0.00
4	Sandhya	3.73	5.33	6.73	2.77	5.30	5.83	4.95	1.05	0.16*
5	MH-80	3.67	5.87	6.27	3.43	6.37	5.73	5.22	0.99	-0.05
6	Chhaya	3.00	5.23	6.20	2.90	4.70	5.53	4.59	0.98	0.13*
7	PBH-3	4.40	7.00	6.87	3.43	7.33	6.03	5.84	1.14	0.21*
8	Nisha Improved	3.93	6.40	7.63	3.33	6.83	6.47	5.77	1.29	0.01
9	Shamli	4.87	6.60	7.73	4.23	7.57	7.57	6.43	1.14	0.01
10	Abhishek	4.07	6.60	6.53	3.67	7.07	6.27	5.70	1.08	0.2
11	Punjab Sadabahar	3.67	5.53	6.27	3.87	6.47	6.37	5.36	0.94	0.03
12	Arka Shirish	3.33	5.47	6.20	3.13	6.33	4.97	4.91	1.01	0.15*
13	Arka Kusumkar	3.07	4.87	5.60	2.67	4.67	5.63	4.42	0.93	0.05
14	Arka Keshav	2.60	4.47	4.00	3.63	5.07	4.70	4.08	0.53	0.28**
15	Arka Nidhi	2.93	4.67	4.67	2.90	4.57	4.97	4.12	0.70	-0.05
16	Arka Neelkanth	3.53	5.53	5.37	3.13	5.03	5.37	4.66	0.78	-0.02
17	Pusa Shyamla	3.13	5.40	5.53	2.53	5.13	5.10	4.47	0.97	-0.04
18	Pusa Kranti	4.20	7.53	7.53	4.03	7.93	6.80	6.34	1.30	0.11
19	Pusa Ankur	4.53	5.73	6.40	3.57	6.93	6.20	5.56	0.92	0.09
20	Pusa Uttam	3.07	5.53	6.23	3.17	5.83	5.87	4.95	1.09	-0.06
21	PPL	3.80	5.00	6.23	3.67	5.67	6.13	5.08	0.82	0.06
22	PPR	2.67	4.40	5.20	2.83	4.77	5.73	4.27	0.90	0.14*
23	PPC	2.60	5.40	4.80	2.47	4.27	5.00	4.09	0.89	0.17*
24	BR-14	3.60	6.13	6.40	2.47	6.47	6.10	5.19	1.29	-0.01
25	Puneri Kateri	3.13	4.80	5.33	3.4	4.93	5.57	4.53	0.74	0.01
	Mean	3.60	5.73	6.18	3.25	5.96	5.92	5.11		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.11	0.21	0.28
Environment	0.22	0.43	0.57

Table 4.3.10: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for Leaf area (cm^2)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	77.10	78.51	79.65	75.61	77.31	78.01	77.70	0.45	-0.31
2	PPL-74	72.72	75.71	76.64	71.69	73.07	74.83	74.11	0.63	0.33
3	Navkiran Improved	83.53	91.02	88.85	80.78	87.96	86.93	86.51	1.39	0.77
4	Sandhya	74.91	75.05	74.51	70.60	74.93	74.87	74.14	0.45	1.13
5	MH-80	92.65	101.73	99.86	94.72	100.89	101.38	98.54	1.44	0.85
6	Chhaya	84.31	88.44	86.54	83.22	89.44	88.44	86.73	0.87	0.65
7	PBH-3	95.07	98.06	97.16	92.31	96.85	95.49	95.82	0.70	0.24
8	Nisha Improved	88.45	93.79	95.53	88.15	91.94	92.91	91.79	1.10	0.01
9	Shamli	77.78	81.22	81.95	76.78	81.07	81.46	80.04	0.85	-0.89
10	Abhishek	92.45	94.55	94.59	90.98	94.01	93.69	93.38	0.53	-0.82
11	Punjab Sadabahar	83.88	97.23	95.84	86.60	101.15	99.09	93.96	2.53	9.05**
12	Arka Shirish	98.33	107.46	108.67	97.49	105.35	108.88	104.36	1.97	0.78
13	Arka Kusumkar	87.45	90.99	92.23	87.96	89.61	90.53	89.79	0.66	-0.36
14	Arka Keshav	73.33	75.17	76.36	72.05	73.05	73.94	73.99	0.45	0.35
15	Arka Nidhi	69.81	72.21	72.39	69.77	71.99	71.99	71.36	0.48	-1.04
16	Arka Neelkanth	77.22	80.03	82.23	75.90	82.69	81.71	79.96	1.01	0.58
17	Pusa Shyamla	74.28	82.44	82.17	77.67	82.50	82.58	80.27	1.26	1.32
18	Pusa Kranti	101.33	105.02	105.31	95.29	107.38	101.11	102.57	1.35	7.47**
19	Pusa Ankur	91.46	93.10	92.97	88.12	93.53	95.63	92.47	0.80	1.70*
20	Pusa Uttam	106.90	111.17	110.68	106.42	108.43	106.63	108.37	0.59	1.64*
21	PPL	81.29	95.33	95.96	86.29	95.45	96.15	91.74	2.35	4.72**
22	PPR	95.11	102.66	101.85	96.32	99.93	104.45	100.05	1.30	2.22*
23	PPC	64.42	70.40	69.78	67.08	65.21	68.07	67.49	0.58	3.44**
24	BR-14	103.71	106.63	106.08	103.57	107.49	101.56	104.84	0.40	3.98**
25	Puneri Kateri	68.48	73.10	72.42	68.18	71.92	72.47	71.10	0.85	-0.95
	Mean	84.64	89.64	89.61	84.14	88.93	88.91	87.64		

*significant at 5% probability level, ** significant at 1% probability level

	SE(d)	CD5%	CD1%
Genotype	0.45	0.89	1.18
Environment	0.92	1.82	2.41

4.4.11 Marketable yield per plant (kg)

Estimation of stability parameters presented in the Table 4.3.11 indicated that out of 25 genotypes, two genotypes viz., Shamli and Punjab Sadabahar were found to be stable because of higher marketable yield (1.30 kg and 1.06 kg, respectively) as compared to average mean (0.89 kg) and regression coefficient close to one (b_i=1.12 and 1.05, respectively) with non significant deviation from regression line.

Based on three stability parameters, two genotypes viz., PPL-74 (2.09 kg) and MH-80 (1.06 kg) had regression coefficient greater than one (b_i=2.14 and 1.43, respectively) with non significant deviation from regression line which indicated below average response and thus suitable for favourable environments. None of the genotypes exhibited above average response for this trait.

4.3.12 Unmarketable yield per plant (kg)

Estimation of stability parameters indicated in the Table 4.3.12 that out of 25 genotypes, only genotype Chhaya with lower unmarketable yield per plant (0.20 kg) as compared to average mean (0.22 kg), regression coefficient close to one (b_i=1.03) with non significant deviation from regression line (S^2d_i= -0.50) was found to be stable.

Based on three stability parameters, nine genotypes viz., Shamli, Arka Shirish, Arka Kusumkar, Arka Nidhi, Arka Neelkanth, PPR, Pusa Shymala, PPC and Puneri Kateri with mean values (0.12, 0.15, 0.09, 0.10, 0.05, 0.18, 0.09, 0.08 and 0.04 kg, respectively) lower than the average mean (0.22 kg) had regression coefficient lesser than unity (b_i=0.53, 0.77, 0.44, 0.55, 0.22, 0.77, 0.44, 0.39 and 0.20, respectively) with non significant deviation from regression line showing above average response and thus suitable for unfavourable environments whereas, none of the genotypes under study exhibited below average response and adapted to favourable environments for this particular trait.

4.3.13 Fruit yield per plant (kg)

Stability analysis of data presented in Table 4.3.13 and Fig.3 indicated that only two genotypes viz., Shamli and Punjab Sadabahar recorded high mean value (1.52 kg and 1.36 kg, respectively) as compared to average mean (1.10 kg) with regression coefficient close to one (b_i=1.12 and 1.10, respectively) and were average in response with non significant deviation from regression line and thus can be considered stable for this particular trait. However, Nisha Improved and Chhaya were also having b_i values close to one (0.97 and 1.06) with non-significant deviation from regression line but mean values lower than the average mean.

Table 4.3.11: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for marketable yield per plant (kg)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	0.68	1.33	1.51	0.47	1.30	1.70	1.16	1.51	33.86**
2	PPL-74	1.64	2.40	2.49	1.00	2.34	2.67	2.09	2.14	7.59
3	Navkiran Improved	1.07	1.57	1.17	0.42	1.35	1.37	1.16	1.29	13.3*
4	Sandhya	1.91	2.01	2.00	0.97	2.11	2.35	1.89	1.52	25.1**
5	MH-80	0.69	1.35	1.23	0.35	1.48	1.24	1.06	1.43	10.29
6	Chhaya	0.64	0.95	1.09	0.26	0.98	1.01	0.82	1.05	-4.85
7	PBH-3	0.77	1.41	1.47	0.53	1.22	0.73	1.02	0.97	86.28**
8	Nisha Improved	0.46	0.86	0.76	0.14	0.97	1.48	0.78	1.32	63.16**
9	Shamli	1.22	1.64	1.54	0.66	1.54	1.23	1.30	1.12	21.54
10	Abhishek	1.17	1.39	1.30	0.57	1.29	1.02	1.12	0.86	23.96**
11	Punjab Sadabahar	1.17	1.12	1.21	0.38	1.20	1.30	1.06	1.05	16.98
12	Arka Shirish	0.36	0.65	0.75	0.15	0.80	0.70	0.57	0.85	-2.68
13	Arka Kusumkar	0.19	0.31	0.42	0.06	0.28	0.64	0.32	0.52	10.91
14	Arka Keshav	0.31	0.59	0.53	0.11	0.56	0.51	0.43	0.63	-7.08
15	Arka Nidhi	0.48	0.71	0.82	0.23	0.69	0.86	0.63	0.78	-3.64
16	Arka Neelkanth	0.12	0.24	0.22	0.04	0.19	0.16	0.16	0.22	-7.39
17	Pusa Shyamla	0.28	0.44	0.38	0.06	0.44	0.38	0.33	0.48	-7.47
18	Pusa Kranti	0.88	1.71	1.74	0.44	1.80	1.95	1.42	2.04	16.59
19	Pusa Ankur	1.25	1.48	1.56	0.73	1.80	2.00	1.47	1.40	27.98**
20	Pusa Uttam	0.94	1.41	0.96	0.28	1.11	0.91	0.93	1.07	40.44**
21	PPL	0.62	0.85	0.69	0.21	0.74	0.74	0.64	0.73	-2.29
22	PPR	0.43	0.58	0.57	0.19	0.53	0.60	0.48	0.53	-7.94
23	PPC	0.32	0.38	0.41	0.07	0.51	0.58	0.38	0.57	-2.96
24	BR-14	0.62	0.89	1.05	0.31	0.93	0.70	0.75	0.81	9.97
25	Puneri Kateri	0.17	0.14	0.22	0.07	0.14	0.16	0.15	0.11	-7.18
	Mean	0.74	1.06	1.04	0.35	1.05	1.08	0.89		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.04	0.08	0.11
Environment	0.09	0.17	0.23

Table 4.3.12: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for unmarketable yield per plant (kg)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	0.06	0.28	0.47	0.06	0.29	0.33	0.25	1.30	1.22*
2	PPL-74	0.08	0.31	0.42	0.08	0.25	0.28	0.24	1.07	1.33*
3	Navkiran Improved	0.16	0.41	0.38	0.09	0.41	0.34	0.30	1.09	1.79*
4	Sandhya	0.13	0.37	0.46	0.08	0.44	0.49	0.33	1.42	1.06
5	MH-80	0.13	0.47	0.51	0.07	0.54	0.51	0.37	1.72	1.67*
6	Chhaya	0.05	0.24	0.31	0.03	0.28	0.29	0.20	1.03	-0.50
7	PBH-3	0.14	0.38	0.59	0.10	0.35	0.33	0.32	1.37	4.55**
8	Nisha Improved	0.04	0.19	0.26	0.04	0.24	0.43	0.20	0.99	8.13**
9	Shamli	0.04	0.19	0.18	0.3	0.16	0.14	0.12	0.53	-0.14
10	Abhishek	0.12	0.44	0.37	0.07	0/47	0.34	0.30	1.23	4.89**
11	Punjab Sadabahar	0.13	0.38	0.41	0.05	0.34	0.44	0.29	1.27	1.13*
12	Arka Shirish	0.03	0.21	0.22	0.02	0.22	0.19	0.15	0.77	-0.32
13	Arka Kusumkar	0.03	0.12	0.14	0.01	0.10	0.12	0.09	0.44	-0.69
14	Arka Keshav	0.03	0.11	0.39	0.02	0.11	0.12	0.13	0.82	9.23**
15	Arka Nidhi	0.02	0.11	0.21	0.03	0.12	0.14	0.10	0.55	-0.17
16	Arka Neelkanth	0.02	0.07	0.34	0.02	0.07	0.06	0.05	0.22	-0.76
17	Pusa Shyamla	0.03	0.11	0.14	0.02	0.13	0.13	0.09	0.44	-0.75
18	Pusa Kranti	0.09	0.40	0.58	0.06	0.44	0.53	0.35	1.81	0.73
19	Pusa Ankur	0.06	0.31	0.40	0.09	0.38	0.34	0.26	1.22	0.07
20	Pusa Uttam	0.14	0.61	0.70	0.08	0.49	0.48	0.42	2.00	4.01**
21	PPL	0.06	0.25	0.24	0.03	0.30	0.21	0.18	0.84	1.21*
22	PPR	0.08	0.22	0.26	0.04	0.25	0.24	0.18	0.77	-0.56
23	PPC	0.02	0.08	0.13	0.02	0.12	0.11	0.08	0.39	-0.67
24	BR-14	0.13	0.33	0.07	0.07	0.41	0.46	0.32	1.49	1.12*
25	Puneri Kateri	0.01	0.05	0.08	0.01	0.06	0.05	0.04	0.20	-0.77
	Mean	0.07	0.27	0.34	0.05	0.28	0.29	0.22		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.01	0.03	0.04
Environment	0.03	0.05	0.07

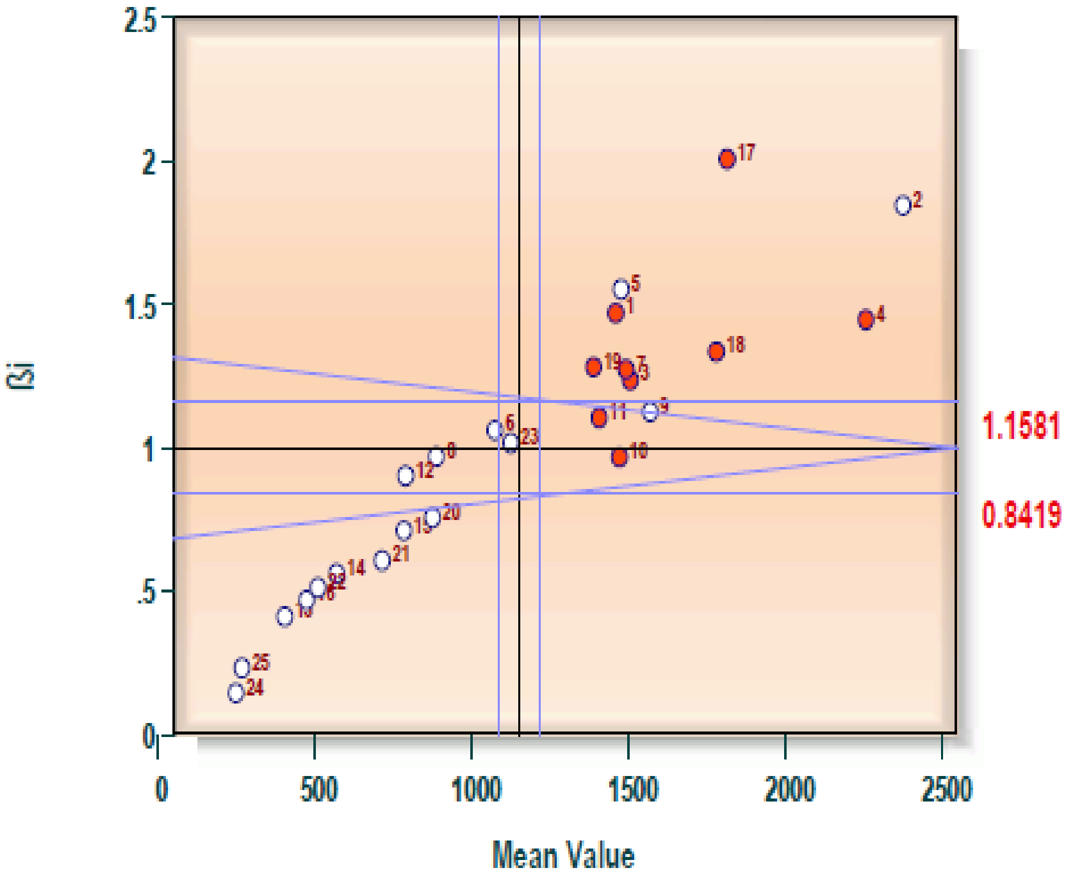
Table 4.3.13: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for fruit yield per plant (kg)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	0.74	1.60	1.97	o.53	1.59	2.03	1.41	1.47	41.42**
2	PPL-74	1.72	2.71	2.91	1.08	1.59	2.95	2.33	1.84	4.14
3	Navkiran Improved	1.22	1.98	1.55	0.50	1.77	1.72	1.46	1.24	23.44*
4	Sandhya	2.04	2.38	2.39	1.05	2.56	2.83	2.21	1.45	39.29**
5	MH-80	0.81	1.82	1.74	0.42	2.02	1.75	1.43	1.55	15.52
6	Chhaya	0.70	1.18	1.40	0.29	1.26	1.31	1.03	1.06	-7.54
7	PBH-3	0.94	1.70	2.07	0.63	1.57	1.66	1.44	1.27	25.99*
8	Nisha Improved	0.51	1.04	1.02	0.18	1.21	1.07	0.84	0.97	-3.77
9	Shamli	1.26	1.83	1.72	0.69	1.71	1.91	1.52	1.12	-3.68
10	Abhishek	1.30	1.80	1.67	0.64	1.75	1.37	1.42	0.97	30.10**
11	Punjab Sadabahar	1.30	1.50	1.62	0.43	1.54	1.74	1.36	1.10	18.07
12	Arka Shirish	0.39	1.01	0.97	0.15	1.02	0.89	0.74	0.90	-4.99
13	Arka Kusumkar	0.22	0.43	0.56	0.08	0.38	0.47	0.36	0.41	-7.70
14	Arka Keshav	0.34	0.70	0.65	0.13	0.67	0.62	0.52	0.56	-10.25
15	Arka Nidhi	0.50	0.82	1.02	0.26	0.81	1.01	0.74	0.71	-3.71
16	Arka Neelkanth	0.14	0.31	0.30	0.06	0.28	0.22	0.22	0.23	-10.25
17	Pusa Shyamla	0.32	0.55	0.53	0.08	0.57	0.52	0.42	0.47	-10.73
18	Pusa Kranti	0.94	2.11	2.32	0.50	2.24	2.49	1.77	2.01	19.66
19	Pusa Ankur	1.30	1.79	1.95	0.82	2.18	2.34	1.73	1.33	29.13**
20	Pusa Uttam	1.09	2.02	1.59	0.36	1.59	1.39	1.34	1.28	54.25**
21	PPL	0.68	1.10	0.93	0.24	1.05	0.95	0.83	0.76	-2.52
22	PPR	0.51	0.80	0.84	0.23	0.78	0.84	0.67	0.61	-11.40
23	PPC	0.34	0.47	0.54	0.09	0.63	0.70	0.46	0.51	-4.49
24	BR-14	0.75	1.21	1.59	0.38	1.35	1.17	1.08	1.02	13.99
25	Puneri Kateri	0.18	0.23	0.29	0.08	0.20	0.21	0.20	0.14	-10.41
	Mean	0.81	1.33	1.37	0.40	1.33	1.37	1.10		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.04	0.08	0.11
Environment	0.08	0.16	0.22

Fig.3: Scatter graph of mean values versus regression coefficient for fruit yield / plant (g)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shymala	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

Three genotypes PPL-74, MH-80 and Pusa Kranti with high mean values (2.33 kg, 1.43 kg and 1.77 kg, respectively) as compared to average mean showed regression coefficient greater than unity (b_i= 1.84, 1.55 and 2.01, respectively) with non significant deviation from regression line exhibiting below average in response and thus suitable for favourable environment. Whereas genotypes Arka Kusumkar, Arka Keshav, Arka Nidhi, Pusa Shymala, PPR, PPC, Puneri Kateri and Arka Neelkanth showed regression coefficient lesser than unity (b_i<1) with non significant deviation from regression line which can be regarded as above average in performance but had lower mean value.

4.3.14 Fruit yield per hectare (q)

Individual regression analysis in Table 4.3.14 and Fig.4 indicated that among 25 genotypes, only one genotype namely PPL-74 recorded high mean value (206.35 q/ha) as compared to average mean (107.00 q/ha) with regression coefficient close to one (b_i= 1.07) and were average in response with non significant deviation from regression line and thus can be considered stable for this particular trait.

Only one genotype viz., Punjab Sadabahar had higher mean (140.14 q/ha) as compared to average mean coupled with regression coefficient lesser than unity ($b_{i=}$ 0.50) performed above average in response with non-significant deviation from regression line and thus suitable for unfavourable environments whereas genotype Shamli with higher mean value (199.55 q/ha) as compared to average mean had regression coefficient greater than unity (b_i= 1.73) with non significant deviation from regression line showed below average response and found suitable for favourable environments.

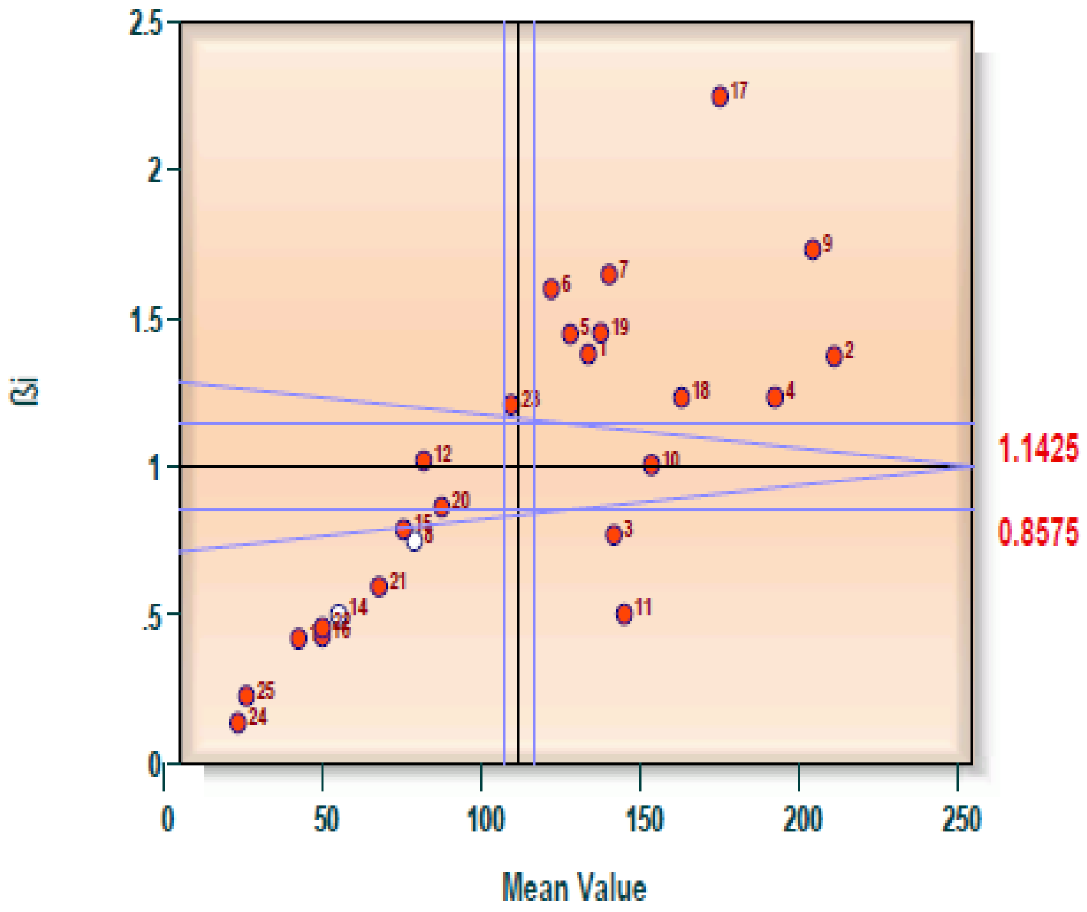
Table 4.3.14: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for fruit yield per hectare (q)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	71.72	139.07	178.84	61.80	136.53	185.32	128.88	1.38	438.63**
2	PPL-74	157.92	233.81	242.42	131.12	244.16	228.66	206.35	1.07	63.42
3	Navkiran Improved	107.00	171.53	137.51	96.14	152.08	157.07	136.89	0.77	170.13**
4	Sandhya	149.97	203.02	222.98	118.15	192.45	239.91	187.75	1.23	249.37**
5	MH-80	76.46	164.77	155.82	40.81	154.86	146.42	123.19	1.45	61.94**
6	Chhaya	58.96	151.08	155.11	31.34	147.69	158.81	117.15	1.60	11.61*
7	PBH-3	69.69	158.52	198.33	52.95	148.40	184.50	135.40	1.65	321.66**
8	Nisha Improved	45.40	92.49	91.75	34.78	89.17	90.97	74.09	0.75	3.24
9	Shamli	127.04	233.95	233.56	112.61	245.30	244.86	199.55	1.73	53.31
10	Abhishek	130.36	175.35	176.50	81.75	168.45	159.99	148.73	1.01	123.74**
11	Punjab Sadabahar	122.25	145.14	153.59	113.00	151.00	155.88	140.14	0.50	8.35
12	Arka Shirish	37.51	106.17	91.22	23.01	108.90	95.62	77.07	1.02	98.87**
13	Arka Kusumkar	22.38	42.56	51.34	15.48	40.08	53.84	37.61	0.42	19.96**
14	Arka Keshav	33.47	62.33	61.04	22.04	63.77	58.79	50.24	0.50	3.02
15	Arka Nidhi	48.56	83.02	92.12	24.25	80.69	95.44	70.68	0.79	20.38**
16	Arka Neelkanth	12.54	31.22	28.57	9.09	25.27	20.60	21.21	0.23	11.80*
17	Pusa Shyamla	28.87	56.64	51.71	21.98	60.58	50.77	45.09	0.43	20.52**
18	Pusa Kranti	90.93	206.68	226.41	48.22	219.40	230.38	170.34	2.24	64.91**
19	Pusa Ankur	127.47	177.98	179.11	82.33	179.35	202.89	158.19	1.23	122.67**
20	Pusa Uttam	105.68	197.56	171.48	36.62	148.84	136.51	132.78	1.45	706.60**
21	PPL	65.20	110.90	94.36	25.63	106.24	93.82	82.69	0.86	124.3
22	PPR	51.77	72.30	76.15	23.56	76.09	77.92	62.97	0.60	25.41**
23	PPC	32.59	46.00	48.77	17.74	58.66	67.37	45.19	0.46	69.95**
24	BR-14	67.73	126.62	149.43	34.78	132.49	116.61	104.61	1.21	133.76**
25	Puneri Kateri	15.83	23.39	26.70	9.97	17.29	18.49	18.61	0.14	8.88*
	Mean	74.29	128.48	131.79	50.77	125.91	130.86	107.00		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	3.18	6.31	8.36
Environment	6.50	12.89	17.06

Fig.4: Scatter graph of mean values versus regression coefficient for fruit yield / hectare (q)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shymala	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

4.3.15 Ascorbic acid content (mg/100g)

Estimation of stability parameters indicated the Table 4.3.15 revealed only two genotypes viz., Sandhya and Chhaya were found to be stable and adapted to all types of environments with higher mean values (11.57 and 13.27 mg/100g, respectively) as compared to average mean (10.84 mg/100g) and regression coefficient close to one ($b_{i=}$ 1.11 and 0.99, respectively) with non significant deviation from regression line close to zero ($S^2d_{i=}$ 0.02 and 0.01, respectively).

Among all the genotypes, two genotypes viz., Navkiran Improved and PBH-3 exhibited below average response with higher mean values (12.71 and 12.42 mg/100g, respectively) as compared to average mean (10.84 mg/100g) and regression coefficient greater than unity (b_i= 1.20 and 1.53, respectively) with non-significant deviation from regression line and thus suitable for favourable environments whereas four genotypes *viz.*, Rajni, PPL-74 Shamli and Punjab Sadabahar had high mean values (12.24, 13.50, 13.60 and 13.06 mg/100g, respectively) and were above average in response (b_i= 0.79, 0.45, 0.32 and 0.78, respectively) with non-significant deviation from regression line and thus suitable specifically for unfavourable environments.

4.3.16 Total phenol content (mg/100g)

A perusal of stability parameters from Table 4.3.16 and Fig.5 indicated that only one genotype PPL-74 with high mean value (1.24 mg/100g) as compared to average mean (0.94 mg/100g), regression coefficient close to unity (b_i=0.88) and non-significant deviation from regression line ($S^2d_{i=}$ 0.00) was found to be stable and thus adapted to all types of environments.

However, among all the genotypes, Arka Keshav recorded maximum total phenol content (1.28 mg/100g) content as compared to the average mean (0.94 mg/100gm). This was followed by Shamli (1.25 mg/100g), PPL-74(1.24 mg/100g) and Arka Nidhi (1.23 mg/100g) while the minimum was noticed in BR-14 and Puneri Kateri (0.71 mg/100g).

The above average in response was recorded in Arka Shirish, BR-14, Pusa Uttam and PPR which was comparable to average mean showed regression coefficient lesser than unity (b_i<1) with non significant deviation from regression line but the mean values were lower than the average mean.

Table 4.3.15: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for ascorbic acid content (100mg/g)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	12.11	12.31	12.37	11.94	12.22	12.48	12.24	0.79	0.01
2	PPL-74	13.52	13.72	13.44	13.33	13.63	13.34	13.50	0.45	0.01
3	Navkiran Improved	12.89	12.82	13.08	12.48	12.45	12.61	12.71	1.20	0.00
4	Sandhya	11.47	11.92	11.73	11.33	11.68	11.28	11.57	1.11	0.02
5	MH-80	10.56	12.10	12.12	10.35	11.34	12.29	11.46	3.75	0.38**
6	Chhaya	13.17	13.29	13.54	12.92	13.48	13.24	13.27	0.99	0.01
7	PBH-3	12.21	12.59	12.83	12.05	12.46	12.35	12.42	1.53	-0.00
8	Nisha Improved	11.44	11.88	12.26	11.42	11.77	12.01	11.80	1.51	0.04**
9	Shamli	13.53	13.65	13.71	13.58	13.49	13.62	13.60	0.32	-0.01
10	Abhishek	12.61	12.87	12.87	12.59	12.31	12.33	12.60	0.89	0.03*
11	Punjab Sadabahar	13.00	13.08	13.25	12.78	13.19	13.06	13.06	0.78	-0.03
12	Arka Shirish	7.84	7.91	8.45	7.72	7.83	7.66	7.90	1.26	0.00*
13	Arka Kusumkar	8.29	8.39	8.61	8.23	8.31	8.39	8.37	0.67	-0.01
14	Arka Keshav	13.50	13.79	13.46	13.20	13.61	13.25	13.47	0.82	0.02*
15	Arka Nidhi	13.26	13.45	13.27	13.25	13.21	13.10	13.26	0.30	-0.00
16	Arka Neelkanth	9.34	9.85	9.85	9.40	9.45	10.14	9.70	1.29	0.08**
17	Pusa Shyamla	10.17	10.45	10.54	9.90	10.28	10.35	10.28	1.28	-0.01
18	Pusa Kranti	9.27	9.57	9.24	8.99	9.39	9.00	9.24	0.77	0.02*
19	Pusa Ankur	8.47	8.74	8.81	8.42	8.28	8.42	8.52	0.98	0.00
20	Pusa Uttam	8.78	8.83	8.71	8.34	8.46	8.46	8.60	0.92	0.01
21	PPL	9.23	9.27	9.27	9.12	9.05	9.09	9.17	0.40	-0.01
22	PPR	9.67	7.99	7.99	7.69	7.87	7.96	8.24	0.63	0.63**
23	PPC	9.73	9.85	9.85	9.54	9.47	9.50	9.65	0.72	0.00
24	BR-14	8.55	8.79	8.89	8.40	8.64	8.57	8.64	1.02	-0.01
25	Puneri Kateri	7.67	7.79	7.89	7.49	7.67	7.61	7.66	0.62	-0.01
	Mean	10.80	10.99	11.05	10.58	10.78	10.81	10.84		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.07	0.14	0.19
Environment	0.14	0.29	0.38

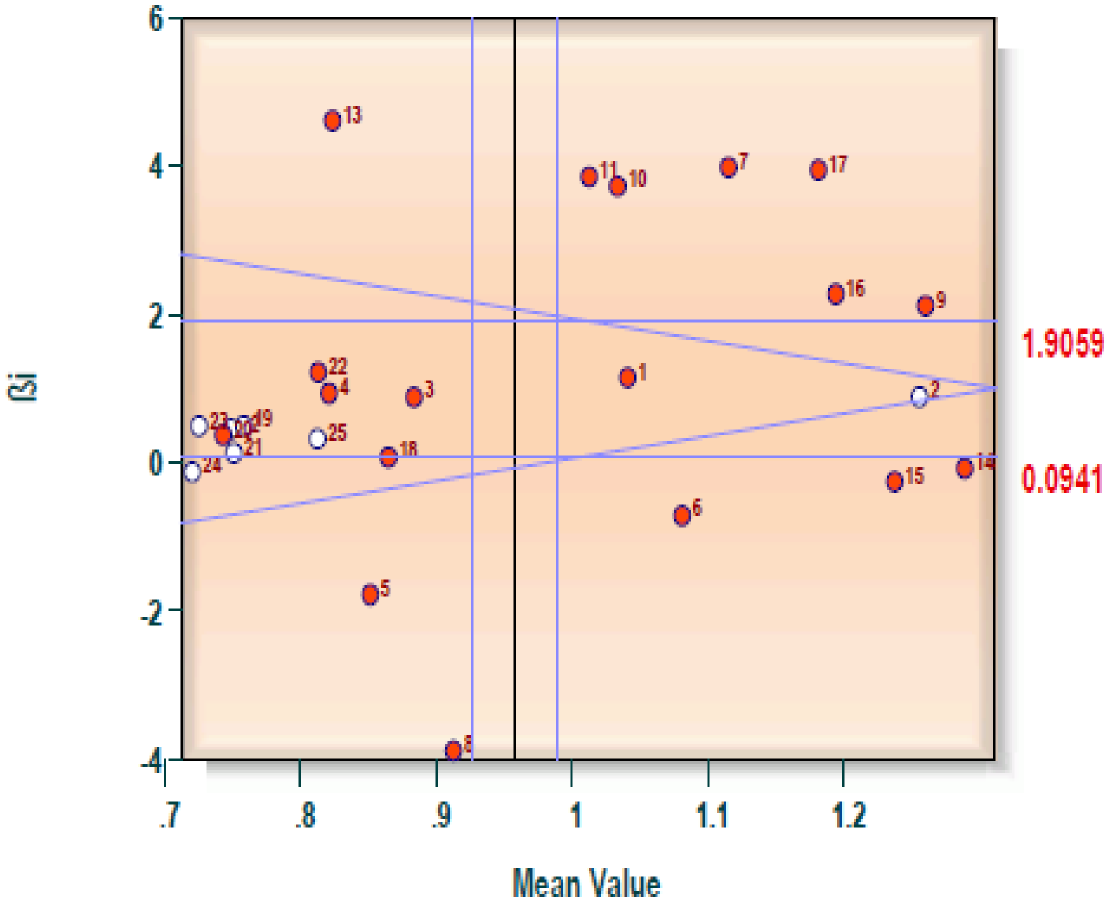
Table 4.3.16: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for total phenol content (100mg/g)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (µ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	0.97	1.11	1.03	0.95	1.07	1.04	1.03	1.14	0.0025**
2	PPL-74	1.24	1.27	1.28	1.19	1.26	1.22	1.24	0.88	0.0000
3	Navkiran Improved	0.86	0.93	0.88	0.81	0.89	0.86	0.87	0.88	0.0005**
4	Sandhya	0.78	0.85	0.84	0.76	0.80	0.83	0.81	0.93	0.0003*
5	MH-80	0.76	0.83	0.82	1.02	0.80	0.81	0.84	-1.78	0.0054**
6	Chhaya	1.03	1.06	1.07	1.15	1.06	1.04	1.07	-0.71	0.0013**
7	PBH-3	1.17	1.15	1.21	0.79	1.13	1.17	1.10	3.98	0.0079**
8	Nisha Improved	0.82	0.82	0.87	1.26	0.80	0.84	0.90	-3.88	0.0166**
9	Shamli	1.32	1.27	1.32	1.08	1.25	1.26	1.25	2.11	0.0026**
10	Abhishek	1.11	1.07	1.11	0.71	1.07	1.07	1.02	3.72	0.0093**
11	Punjab Sadabahar	1.03	1.10	1.07	0.69	1.06	1.05	1.00	3.85	0.0078**
12	Arka Shirish	0.74	0.74	0.77	0.72	0.73	0.72	0.74	0.45	-0.0001
13	Arka Kusumkar	0.74	0.73	1.29	0.71	0.69	0.70	0.81	4.60	0.0380**
14	Arka Keshav	1.32	1.35	1.19	1.24	1.30	1.26	1.28	-0.08	0.0038**
15	Arka Nidhi	1.28	1.30	1.15	1.23	1.25	1.15	1.23	-0.26	0.0046**
16	Arka Neelkanth	0.80	0.83	0.79	0.77	0.81	0.81	0.80	0.32	0.0002
17	Pusa Shyamla	1.16	1.16	1.38	1.11	1.15	1.12	1.18	2.27	0.0050**
18	Pusa Kranti	1.02	1.28	1.32	0.95	1.26	1.18	1.17	3.94	0.0062**
19	Pusa Ankur	0.89	0.88	0.85	0.85	0.83	0.83	0.85	0.07	0.0006**
20	Pusa Uttam	0.75	0.76	0.77	0.72	0.71	0.76	0.75	0.50	0.0002
21	PPL	0.76	0.76	0.73	0.70	0.71	0.72	0.73	0.37	0.0003*
22	PPR	0.73	0.73	0.75	0.74	0.75	0.73	0.74	0.13	0.0000
23	PPC	0.80	0.78	0.84	0.69	0.86	0.84	0.80	1.21	0.0023**
24	BR-14	0.72	0.71	0.73	0.67	0.72	0.73	0.71	0.49	0.0000
25	Puneri Kateri	0.70	0.72	0.70	0.72	0.71	0.71	0.71	-0.13	-0.0001
	Mean	0.94	0.97	0.99	0.89	0.95	0.94	0.94		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.02	0.04	0.05
Environment	0.04	0.08	0.10

Fig.5: Scatter graph of mean values versus regression coefficient for total phenol content (mg/100g)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shymala	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

4.3.17 Shoot borer infestation (%)

The examination of stability parameters in Table 4.3.17 and Fig.6 revealed that only one genotype namely Rajni exhibited lower mean value (15.36%) as compared to average mean (17.58%) had regression coefficient close to unity (b_i=0.94) with non-significant deviation from regression line (S^2d_i=1.75) showed average response and found suitable for all types of environments. However, the incidence of shoot borer was minimum in the genotype Shamli (8.35%) followed by PPL-74 (9.11%), Arka Nidhi (10.79%) and maximum shoot borer infestation was noticed in BR-14 (26.60%) followed by Pusa Uttam (26.09%), PPR (23.99%) and MH-80 (22.26%).

Four genotypes viz., PPL-74, Sandhya, Arka Nidhi and Shamli expressed above average response and found suitable for unfavourable environments with lower mean values (9.11%, 13.74%, 10.79% and 8.35%, respectively) as compared to average mean (17.58%), regression coefficient less than unity (b_i= 0.47, 0.76, 0.83 and 0.53, respectively) and non significant deviation from regression line (S^2d_i= 0.58, -0.89, -0.55 and 0.18, respectively).

Two genotypes viz., Arka Shirish and Pusa Shymala with lower mean values (16.58% and 17.06%, respectively), regression coefficient greater than unity (b_i= 1.12 and 1.23, respectively) and non-significant deviation from regression line were below average in response and suitable for favourable environments.

4.3.18 Fruit borer infestation (%)

The examination of stability parameters presented in the Table 4.3.18 and Fig.7 revealed that only one genotype viz., Pusa Kranti was average in response and recorded lower mean values (16.34%) than average mean (16.82%) with regression coefficient close to unity (b_i=1.01) and non-significant deviation from regression line (S^2d_i=-0.42 and) and thus was considered stable and well adapted for all types of environments.

Minimum fruit borer infestation was recorded in the genotype Shamli (7.47%) as compared to average mean (16.82%). This was followed by PPL-74 (8.65%), Arka Nidhi (10.33%) and Pusa Ankur (12.48%) whereas, Pusa Uttam (25.36%) and BR-14 (25.24%) recorded maximum fruit borer infestation.

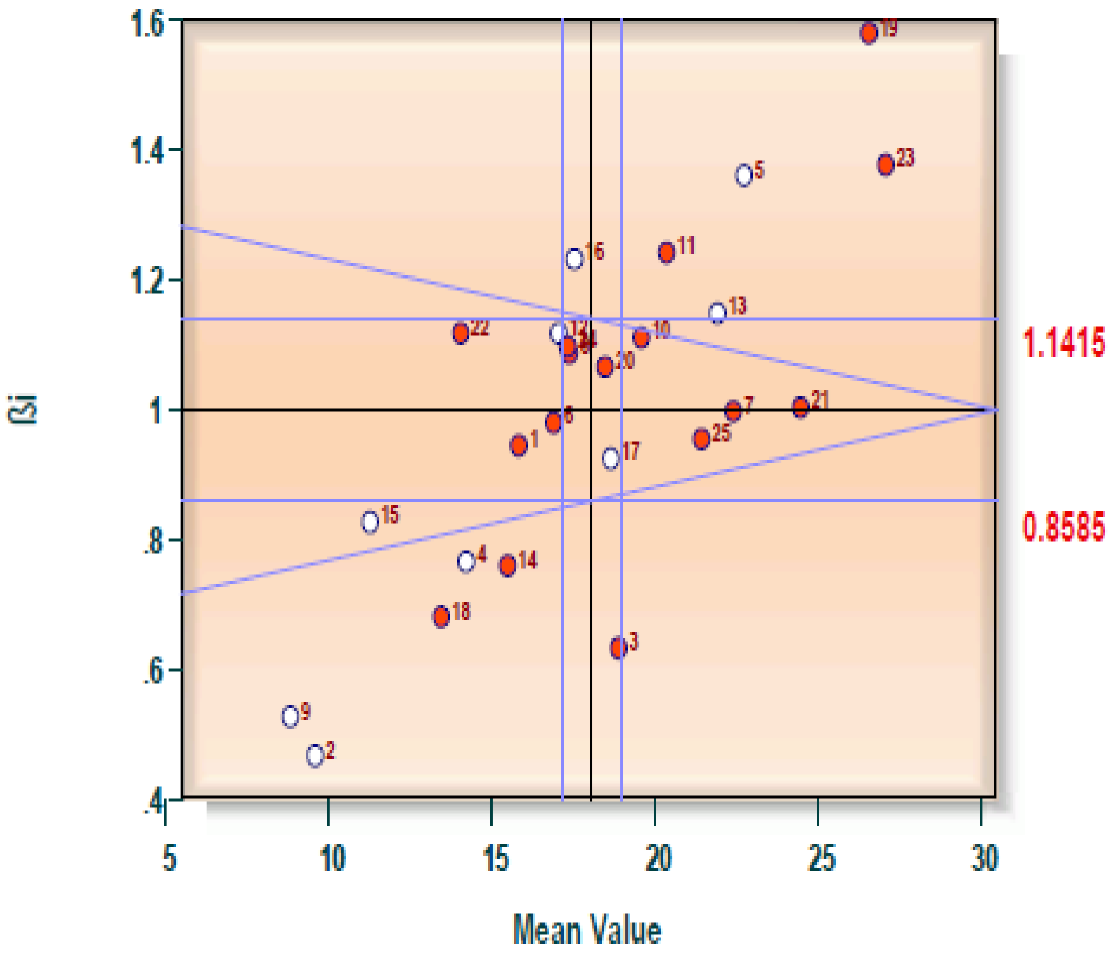
Table 4.3.17: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for shoot borer infestation (%)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	8.40	14.57	24.67	9.30	15.47	19.73	15.36	0.94	1.75
2	PPL-74	5.37	9.07	13.93	7.03	7.57	11.67	9.11	0.47	0.58
3	Navkiran Improved	12.90	17.20	25.07	16.43	16.97	21.87	18.41	0.63	2.26*
4	Sandhya	7.43	13.47	19.07	8.80	14.97	18.73	13.74	0.76	-0.89
5	MH-80	11.20	22.07	30.47	14.10	22.20	33.50	22.26	1.36	0.95
6	Chhaya	7.43	17.13	22.63	9.33	20.53	21.47	16.42	0.98	3.53**
7	PBH-3	15.90	17.13	30.13	17.30	19.57	31.57	21.93	0.99	10.28**
8	Nisha Improved	7.27	16.17	25.83	12.47	15.33	24.37	16.91	1.09	2.01*
9	Shamli	4.30	7.73	13.13	5.93	6.97	12.03	8.35	0.53	0.18
10	Abhishek	9.83	20.70	23.87	10.60	21.40	28.23	19.11	1.11	4.57**
11	Punjab Sadabahar	10.90	21.97	29.13	10.27	19.30	27.77	19.89	1.24	2.37*
12	Arka Shirish	8.20	18.03	25.23	8.50	16.03	23.47	16.58	1.12	0.87
13	Arka Kusumkar	11.73	22.23	29.20	13.50	23.57	28.43	21.44	1.15	0.19
14	Arka Keshav	5.57	13.77	20.03	15.37	13.97	21.37	15.01	0.76	9.21**
15	Arka Nidhi	4.27	10.63	17.03	6.03	10.07	16.73	10.79	0.83	-0.55
16	Arka Neelkanth	14.17	18.30	26.40	16.27	19.23	31.33	20.95	0.95	6.73**
17	Pusa Shyamla	7.87	16.40	25.80	8.27	18.67	25.33	17.06	1.23	-0.33
18	Pusa Kranti	11.80	16.20	26.03	11.70	19.67	23.63	18.17	0.92	0.82
19	Pusa Ankur	5.57	13.20	19.13	10.07	14.90	15.00	12.98	0.68	2.84**
20	Pusa Uttam	14.00	24.47	36.47	17.17	24.73	39.70	26.09	1.58	3.50**
21	PPL	8.33	19.20	24.43	9.33	23.70	23.00	18.00	1.07	8.72**
22	PPR	15.57	23.87	31.03	16.57	27.70	29.23	23.99	1.01	2.26*
23	PPC	3.90	14.77	24.03	5.70	16.20	16.83	13.57	1.12	6.74**
24	BR-14	16.67	24.80	34.90	17.50	27.13	38.60	26.60	1.38	2.49*
25	Puneri Kateri	7.40	18.30	22.50	8.30	20.37	24.23	16.85	1.10	3.88**
	Mean	9.44	17.25	24.81	11.43	18.25	24.31	17.58		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.57	1.13	1.49
Environment	1.16	2.30	3.05

Fig.6: Scatter graph of mean values versus regression coefficient for shoot borer infestation (%)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shymala	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

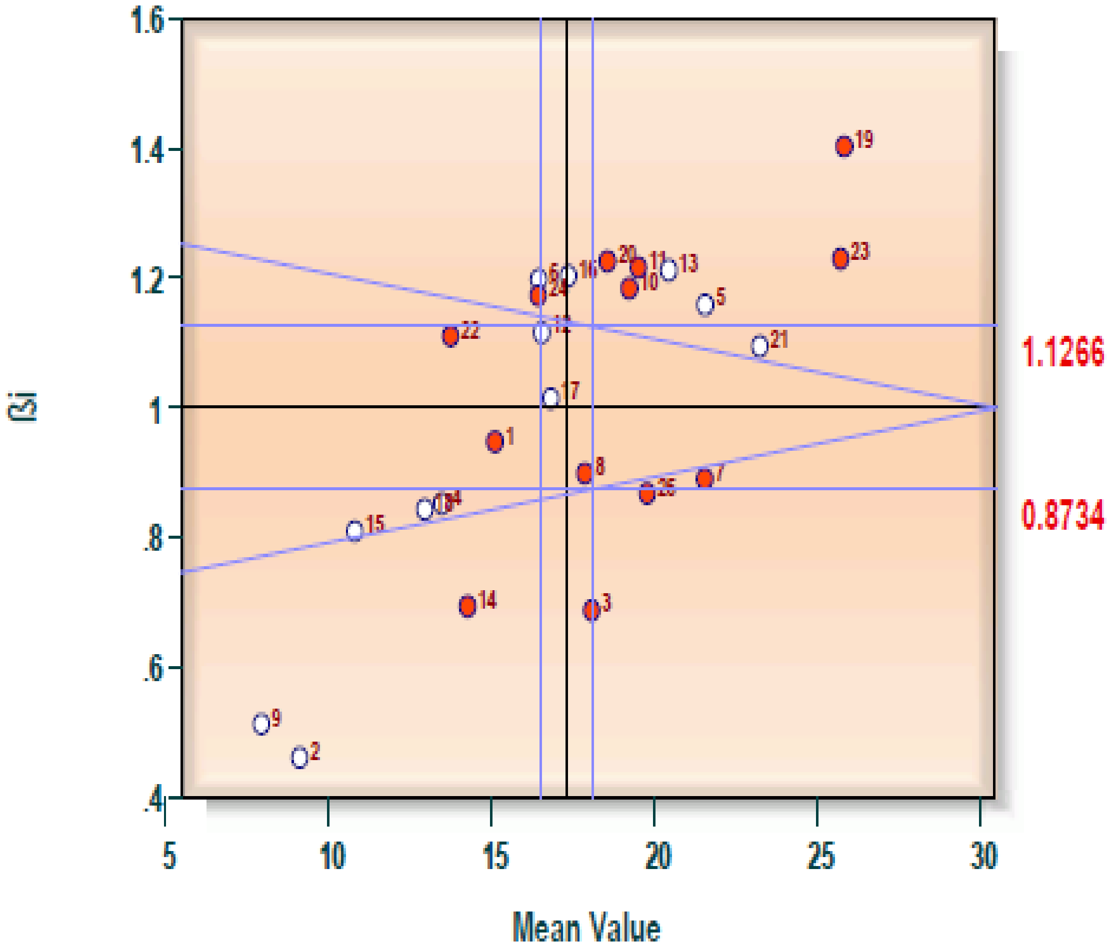
Table 4.3.18: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for fruit borer infestation (%)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	6.87	16.40	23.13	8.13	17.17	16.13	14.64	0.95	3.11**
2	PPL-74	4.33	11.10	12.70	5.97	9.13	8.67	8.65	0.46	0.99
3	Navkiran Improved	10.77	19.73	23.57	14.20	18.70	18.63	17.60	0.69	1.76*
4	Sandhya	5.97	14.83	17.87	6.73	15.83	16.80	13.01	0.85	-0.86
5	MH-80	11.93	25.40	27.20	11.77	26.00	24.23	21.09	1.16	0.70
6	Chhaya	6.03	20.07	21.37	6.80	20.80	20.80	15.98	1.20	-0.05
7	PBH-3	13.67	20.80	27.20	15.07	22.23	27.47	21.07	0.89	4.13**
8	Nisha Improved	7.07	17.40	24.33	14.73	19.07	21.80	17.40	0.90	6.71**
9	Shamli	2.97	9.53	11.07	4.03	8.53	8.67	7.47	0.51	-0.55
10	Abhishek	8.73	22.97	21.87	9.40	26.43	23.13	18.76	1.18	6.04**
11	Punjab Sadabahar	9.83	25.13	24.83	8.67	21.27	24.50	19.04	1.22	3.48**
12	Arka Shirish	7.10	18.63	23.33	7.77	18.57	21.03	16.07	1.11	-0.01
13	Arka Kusumkar	9.67	25.00	26.53	11.10	23.73	23.77	19.97	1.21	-0.02
14	Arka Keshav	5.53	15.10	17.43	11.60	16.50	16.60	13.79	0.69	1.97*
15	Arka Nidhi	3.17	12.27	15.57	5.03	12.53	13.43	10.33	0.81	-0.82
16	Arka Neelkanth	11.20	20.87	22.60	13.87	20.80	26.50	19.31	0.87	3.94**
17	Pusa Shyamla	7.97	18.83	23.57	6.87	21.13	22.93	16.88	1.20	1.25
18	Pusa Kranti	8.00	18.33	22.97	9.03	19.07	20.67	16.34	1.01	-0.42
19	Pusa Ankur	4.30	15.77	17.57	7.57	15.77	13.93	12.48	0.84	0.48
20	Pusa Uttam	11.33	29.20	31.07	17.50	29.23	33.80	25.36	1.40	3.98**
21	PPL	7.03	21.80	22.80	9.47	26.50	20.90	18.08	1.22	5.76**
22	PPR	13.27	25.90	28.23	14.97	27.73	26.47	22.76	1.09	-0.43
23	PPC	4.27	17.03	21.37	5.03	16.90	15.03	13.27	1.11	1.85*
24	BR-14	15.77	26.47	32.10	15.57	28.73	32.83	25.24	1.23	2.91**
25	Puneri Kateri	5.47	21.43	19.67	7.40	21.87	19.93	15.96	1.17	3.32**
	Mean	8.09	19.60	22.40	9.93	20.17	20.75	16.82		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.49	0.98	1.29
Environment	1.01	1.99	2.64

Fig.7: Scatter graph of mean values versus regression coefficient for fruit borer infestation (%)



1. Rajni 2.PPL-74 3.Navkiran Improved
4. Sandhya 5.MH-80 6.Chhaya
7. PBH-3 8.Nisha Improved 9.Shamli
10. Abhishek 11.Punjab Sadabahar 12.Arka Shirish
13. Arka Kusumkar 14.Arka Keshav 15.Arka Nidhi
16. Pusa Shymala 17.Pusa Kranti 18.Pusa Ankur
19. Pusa Uttam 20. PPL 21.PPR
22. PPC 23.BR-14 24.Puneri Kateri
25. Arka Neelkanth

Five genotypes viz., PPL-74, Sandhya, Shamli, Arka Nidhi and Pusa Ankur expressed above average in response with lower mean values (8.65%, 13.01%, 7.47%, 10.33% and 12.48%, respectively) as compared to average mean (16.82%) and regression coefficient less than unity(b_i= 0.46, 0.85, 0.51, 0.81 and 0.84, respectively) with non significant deviation from regression line and thus suitable for unfavourable environments.

Only one genotype namely Arka Shirish had lower mean value (16.07%) than average mean (16.82%), regression coefficient greater than unity (b_i=1.11) and was below average in response with non-significant deviation from regression line (S^2d_i=-0.01)

4.3.19 Spider mite infestation (%)

The examination of stability parameters presented in the Table 4.3.19 revealed only two genotypes Chhaya and BR-14 showed average response with lower values of spider mite infestation (7.29% and 10.07%, respectively), regression coefficient close to unity (b_i=0.93 and 0.91 respectively) and non-significant deviation from regression line (S^2d_i=-6.78 and -6.46, respectively) and thus can be considered as stable genotypes well adapted to all types of environments for this trait.

Minimum spider mite infestation was recorded in the genotype Puneri Kateri (3.47%) as compared to average mean (10.66%). This was followed by Shamli (3.82%), Arka Nidhi (3.82%), PPL-74 (5.21%), Punjab Sadabahar (5.21%) and PPC (5.56%) whereas, maximum spider mite infestation was noticed in Pusa Kranti (19.79%).

Ten genotypes viz., Rajni, PPL-74, Nisha Improved, Shamli, Abhishek, Punjab Sadabahar, Arka Keshav, Arka Nidhi, PPC and Puneri Kateri expressed above average response with lower mean values and regression coefficient less than unity (b_i<1) with non significant deviation from regression line and thus suitable for unfavourable environments whereas, only one genotype namely Sandhya had lower mean value (11.11) than average mean (10.66), regression coefficient greater than unity (b_i= 1.14) and was below average in response with non-significant deviation from regression line (S^2d_i= -2.18).

Table 4.3.19: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for spider mite infestation (%)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	6.25	14.58	10.42	2.08	8.33	8.33	8.33	0.79	-6.69
2	PPL-74	4.17	8.33	6.25	0.00	4.17	8.33	5.21	0.54	-4.48
3	Navkiran Improved	10.42	22.92	16.67	4.17	16.67	16.67	14.58	1.22	-5.65
4	Sandhya	8.33	20.83	10.42	2.08	14.58	10.42	11.11	1.14	-2.18
5	MH-80	8.33	14.58	14.58	6.25	6.25	16.67	11.11	0.61	7.89
6	Chhaya	4.17	14.58	8.33	0.00	8.33	8.33	7.29	0.93	-6.78
7	PBH-3	14.33	22.92	16.67	4.17	16.67	16.67	15.24	1.14	-4.43
8	Nisha Improved	8.33	14.58	8.33	4.17	8.33	8.33	8.68	0.60	-5.51
9	Shamli	2.08	8.33	4.17	2.08	4.17	2.08	3.82	0.39	-4.72
10	Abhishek	10.42	18.75	10.42	4.17	10.42	8.33	10.42	0.83	-2.28
11	Punjab Sadabahar	2.08	10.42	8.33	0.00	4.17	6.25	5.21	0.71	-5.11
12	Arka Shirish	4.17	29.17	20.83	2.08	16.67	16.67	14.93	1.87	4.93
13	Arka Kusumkar	8.33	27.08	16.67	2.08	14.58	14.58	13.89	1.60	-5.96
14	Arka Keshav	2.08	10.42	6.25	0.00	4.17	8.33	5.21	0.70	-4.69
15	Arka Nidhi	2.08	6.25	4.17	0.00	4.17	6.25	3.82	0.42	-5.70
16	Arka Neelkanth	6.25	20.83	14.58	2.08	10.42	12.50	11.11	1.23	-5.27
17	Pusa Shyamla	10.42	20.83	10.42	4.17	16.67	16.67	13.19	1.03	1.76
18	Pusa Kranti	16.67	33.33	20.83	6.25	22.92	18.75	19.79	1.65	-2.57
19	Pusa Ankur	10.42	20.83	16.67	2.08	14.58	14.58	13.19	1.20	-5.00
20	Pusa Uttam	14.58	29.17	16.67	6.25	18.75	16.67	17.01	1.38	-3.40
21	PPL	12.50	31.25	20.83	4.17	16.67	14.58	16.67	1.69	-1.90
22	PPR	20.83	27.08	20.83	4.17	14.58	18.75	17.71	1.31	9.93*
23	PPC	2.08	10.42	6.25	0.00	6.25	8.33	5.56	0.70	-5.17
24	BR-14	8.33	16.67	12.50	2.08	10.42	10.42	10.07	0.91	-6.46
25	Puneri Kateri	2.08	6.25	4.17	0.00	4.17	4.17	3.47	0.41	-6.90
	Mean	7.99	18.42	12.25	2.58	11.08	11.67	10.66		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.56	1.12	1.49
Environment	1.15	2.29	3.03

4.3.20 Little leaf incidence (%)

On perusal of the results presented in the Table 4.3.20, three genotypes viz., Nisha Improved, Arka Kusumkar and PPC recorded lower mean values (5.90, 5.56 and 4.51, respectively), regression coefficient close to one (b_i= 0.94, 0.93 and 0.93, respectively) with non significant deviation from regression line (S^2d_i= -5.30, -4.50 and -7.17, respectively) and were average in response suited for all types of environments.

However, on pooled basis, the genotype PPL-74 (2.43%) and Puneri Kateri (2.43%) recorded minimum little leaf incidence followed by Shamli (2.78%), Rajni (3.47%), Sandhya (4.51%) and PPC (4.51%) whereas maximum little leaf incidence was noticed in BR-14 (12.85%) followed by PPR (12.50%).

Simultaneous consideration of stability parameters further revealed seven genotypes viz., Rajni, PPL-74, Sandhya, Chhaya, Shamli, Punjab Sadabahar, and Puneri Kateri having lower mean values (3.47%, 2.43%, 4.51%, 4.86%, 2.78%, 5.56% and 2.43% respectively) as compared to average mean (6.74%) and regression coefficient values less than unity (b_i= 0.45, 0.53, 0.44, 0.85, 0.25, 0.61 and 0.55, respectively) exhibited above average response with non significant deviation from regression line and thus suitable for unfavourable environments for this particular trait.

4.3.21 Phomopsis blight incidence (%)

Simultaneous consideration of stability parameters presented in the Table 4.3.21 and Fig.8 revealed two genotypes viz., Sandhya and Pusa Kranti exhibited lower mean values (12.17% and 13 77%, respectively) as compared to average mean and regression coefficient close to unity (b_i=1.05 and 1.07, respectively) with non-significant deviation from regression line (S^2d_i= -0.46 and 0.21, respectively) were found to be stable and adapted for all types of environments.

On comparing the mean performance for phomopsis blight among 25 genotypes, PPL-74 (8.81%) had the least damage followed by Shamli (8.92%), Puneri Kateri (9.88%), Sandhya (12.17%) and Rajni (13.18%) whereas, maximum incidence of phomopsis blight was noticed in Arka Shirish (23.85%) followed by Arka Kusumkar (23.59%), BR-14 (22.55%), and PPL (22.10%) as compared to average mean (17.11%) over environments.

Eight genotypes viz., Rajni, PPL-74, Chhaya, Nisha Improved, Shamli, Abhishek, Puneri Kateri and Arka Neelkanth were above average in response with mean values (13.18%, 8.81%, 13.98%, 14.91%, 8.92%, 14.94%, 9.88% and 16.57%, respectively) lower than the average mean (17.11%), regression coefficient less than one (b_i = 0.62, 0.61, 0.69, 0.65, 0.57, 0.56, 0.69 and 0.79, respectively) and non-significant deviation from regression line and suitable for unfavourable environments whereas, none of the genotypes was found below average in response for this particular trait.

Table 4.3.20: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for little leaf incidence (%)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	2.08	6.25	2.08	2.08	6.25	2.08	3.47	0.45	-6.50
2	PPL-74	0.00	4.17	0.00	0.00	6.25	4.17	2.43	0.53	-4.27
3	Navkiran Improved	4.17	8.33	8.33	4.17	10.42	6.25	6.94	0.45	-4.23
4	Sandhya	2.08	6.25	4.17	2.08	6.25	6.25	4.51	0.44	-6.78
5	MH-80	2.08	16.67	6.25	4.17	4.17	4.17	6.25	1.10	2.51
6	Chhaya	0.00	10.42	8.33	0.00	4.17	6.25	4,86	0.85	0.49
7	PBH-3	4.17	16.67	4.17	4.17	4.17	8.33	6.94	1.05	1.91
8	Nisha Improved	0.00	12.50	6.25	4.17	6.25	6.25	5.90	0.94	-5.30
9	Shamli	0.00	4.17	2.08	4.17	4.17	2.08	2.78	0.25	-5.80
10	Abhishek	2.08	14.58	4.17	6.25	10.42	4.17	6.94	1.05	-2.52
11	Punjab Sadabahar	2.08	6.25	2.08	2.08	10.42	10.42	5.56	0.61	5.31
12	Arka Shirish	6.25	16.67	4.17	4.17	16.67	12.50	10.07	1.30	2.64
13	Arka Kusumkar	2.08	10.42	2.08	2.08	10.42	6.25	5.56	0.93	-4.50
14	Arka Keshav	2.08	16.67	6.25	0.00	6.25	4.17	5.90	1.33	-1.47
15	Arka Nidhi	0.00	18.75	2.08	2.08	8.33	2.08	5.56	1.65	-0.02
16	Arka Neelkanth	4.17	16.67	8.33	2.08	8.33	6.25	7.64	1.16	-3.30
17	Pusa Shyamla	4.17	16.67	4.17	8.33	14.58	12.50	10.07	1.18	-0.03
18	Pusa Kranti	2.08	14.58	8.33	4.17	8.33	6.25	7.29	1.02	-5.44
19	Pusa Ankur	6.25	20.83	8.33	2.08	10.42	8.33	9.37	1.46	-1.23
20	Pusa Uttam	2.08	18.75	8.33	4.17	14.58	12.50	10.07	1.56	-6.00
21	PPL	2.08	16.67	6.25	2.08	12.50	8.33	7.99	1.44	-7.25
22	PPR	4.17	20.83	10.42	6.25	16.67	16.67	12.50	1.57	-3.27
23	PPC	0.00	10.42	2.08	2.08	6.25	6.25	4.51	0.93	-7.17
24	BR-14	6.25	20.83	12.50	10.42	14.58	12.50	12.85	1.17	-6.16
25	Puneri Kateri	0.00	6.25	2.08	0.00	2.08	4.17	2.43	0.55	-6.86
	Mean	2.42	13.25	5.33	3.33	8.92	7.17	6.74		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.64	1.27	1.68
Environment	1.31	2.60	3.44

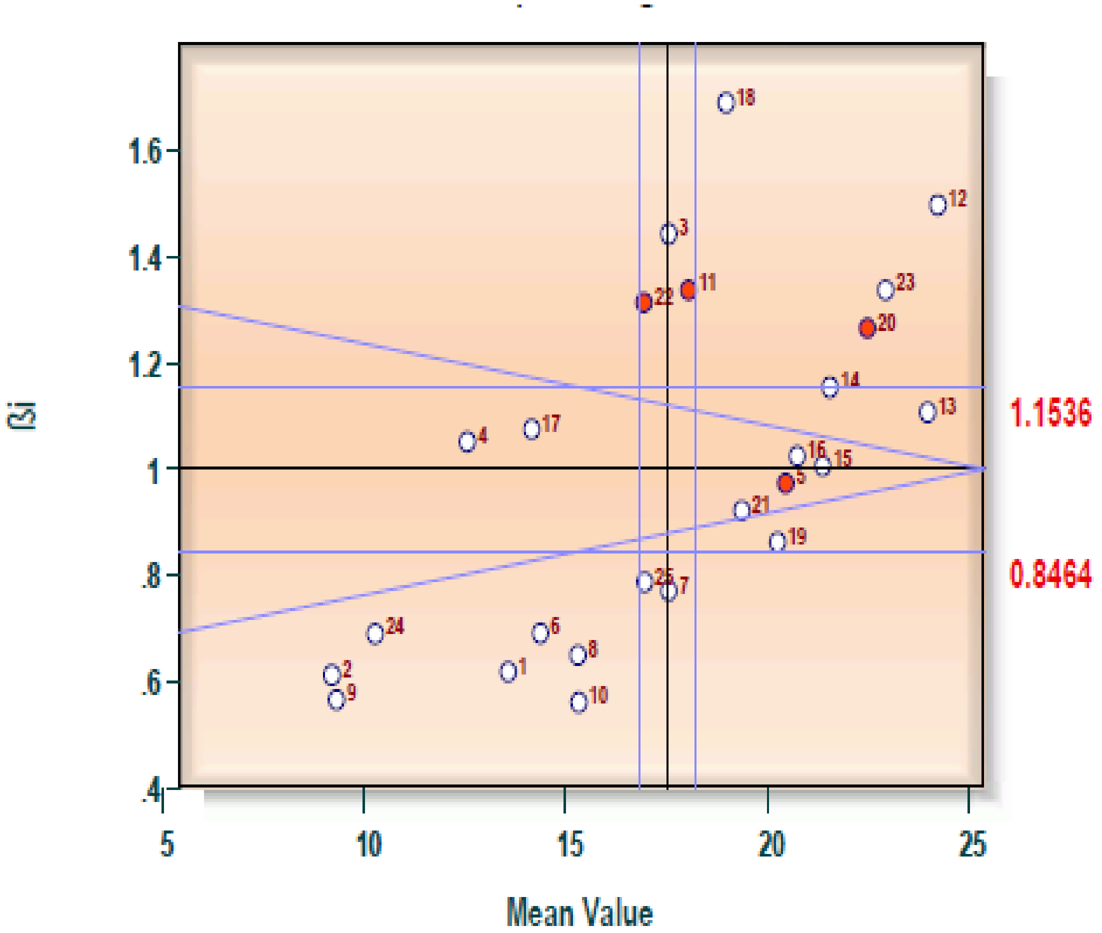
Table 4.3.21: Mean value, regression coefficient (b_i) and variation due to deviation (s^2d_i) for phomopsis blight incidence (%)

S. No.	Genotype	E1 Autumn-winter,2013	E2 Spring-summer, 2014	E3 Rainy season,2014	E4 Autumn-winter,2014	E5 Spring-summer, 2015	E6 Rainy season,2015	Overall mean (μ)	Regression coefficient (b_i)	S^2d_i
1	Rajni	10.47	12.93	15.63	8.86	14.71	16.45	13.18	0.62	-0.68
2	PPL-74	5.02	8.88	12.15	5.69	9.27	11.82	8.81	0.61	-0.62
3	Navkiran Improved	8.31	18.05	21.52	9.94	19.87	25.31	17.17	1.44	-0.71
4	Sandhya	6.06	10.48	14.98	7.20	16.84	17.43	12.17	1.05	-0.46
5	MH-80	11.65	18.4614.25	23.29	18.66	24.40	24.00	20.08	0.97	3.17*
6	Chhaya	7.74	14.61	15.42	12.89	16.39	17.19	13.98	0.69	0.14
7	PBH-3	12.07	15.56	18.24	15.55	19.96	22.60	17.17	0.77	0.91
8	Nisha Improved	10.21	7.81	17.11	12.21	16.44	17.94	14.91	0.65	-1.46
9	Shamli	5.07	14.41	11.32	7.23	9.86	12.24	8.92	0.57	-1.64
10	Abhishek	9.80	19.59	16.68	14.73	15.77	18.25	14.94	0.56	0.19
11	Punjab Sadabahar	7.38	26.52	22.02	11.65	23.88	21.42	17.66	1.34	5.35**
12	Arka Shirish	13.27	23.55	27.91	16.67	28.32	30.42	23.85	1.50	1.68
13	Arka Kusumkar	17.26	21.40	26.20	18.29	25.11	31.13	23.59	1.11	-0.60
14	Arka Keshav	13.76	20.21	24.69	15.87	24.06	27.28	21.18	1.15	-1.68
15	Arka Nidhi	14.16	19.57	23.82	16.79	25.91	25.07	21.00	1.02	-0.07
16	Arka Neelkanth	10.88	16.85	15.58	14.23	20.33	21.68	16.57	0.79	1.58
17	Pusa Shyamla	15.71	13.99	22.60	14.14	23.02	27.11	20.36	1.02	0.09
18	Pusa Kranti	8.00	16.17	16.94	7.96	14.73	20.98	13.77	1.07	0.21
19	Pusa Ankur	8.75	17.17	24.17	11.15	22.60	28.73	18.60	1.69	-0.13
20	Pusa Uttam	15.48	24.63	22.62	16.31	21.45	26.15	19.86	0.86	0.72
21	PPL	15.46	19.63	24.14	14.49	22.46	31.43	22.10	1.26	5.91**
22	PPR	14.01	16.13	21.76	13.97	19.08	25.46	18.99	0.92	0.77
23	PPC	8.36	20.80	17.98	10.23	23.98	22.63	16.55	1.31	3.03*
24	BR-14	14.36	9.73	25.58	17.31	26.24	31.00	22.55	1.34	-1.00
25	Puneri Kateri	5.98	16.72	10.11	6.28	13.45	13.73	9.88	0.69	-0.48
	Mean	10.77	16.85	19.70	12.73	19.27	22.70	17.11		

*significant at 5% probability level, ** significant at 1% probability level

	S.E(d)	CD5%	CD1%
Genotype	0.44	0.88	1.17
Environment	0.91	1.81	2.39

Fig.8: Scatter graph of mean values versus regression coefficient for phomopsis blight incidence (%)



1. Rajni	2.PPL-74	3.Navkiran Improved
4. Sandhya	5.MH-80	6.Chhaya
7. PBH-3	8.Nisha Improved	9.Shamli
10. Abhishek	11.Punjab Sadabahar	12.Arka Shirish
13. Arka Kusumkar	14.Arka Keshav	15.Arka Nidhi
16. Pusa Shymala	17.Pusa Kranti	18.Pusa Ankur
19. Pusa Uttam	20. PPL	21.PPR
22. PPC	23.BR-14	24.Puneri Kateri
25. Arka Neelkanth		

CHAPTER-V

DISCUSSION

`The main aim of plant breeders is to evolve strains which may give maximum mean economic yield over environments and show consistent performance. Productivity of a strain is the function of its adaptability, while the latter is a compromise of fitness (stability) and flexibility. Stability may in fact depends on holding certain morphological and physiological attributes steady and allowing others to vary thereby resulting in predictable G x E interaction for the ultimate trait like yield.

The phenotype of an individual is the reflection of its genotype expressed in a particular environment. The surrounding environment plays a major role and influences the final expression of the genotype into phenotype. In other words, the phenotype (P) of an individual can be expressed as a function of its genotype (G), the environment (E) and their interaction (G x E). Some genotypes when exposed to varying environments comprising regions, seasons, years etc. exhibit a more or less uniform performance. These genotypes with high developmental plasticity usually adjust themselves and remain undisturbed by the change in environment and the G x E interaction is negligible. But most of the genotypes when encounter the changing environmental situations become vulnerable to influence of environment and readily interact with it and consequently their performance depend over varying environments. If a genotype is found to be responding favourable to a particular environment it should be recommended to be grown in that particular environment only. But if wider adaptability is sought then genotype's performance should be evaluated over a number of environments and then suitable genotypes which may perform well in all the environments should be selected. For determining adaptability of different genotypes, they should be subjected to multi-environments, yield testing for number of years or seasons as the case may be. This helps to identify genotypes with low G x E interaction at high level of performance over a wider range of environments.

However, high yield is often associated with decreased yield stability (Padi, 2007). By growing genotypes in different environments, the highest yielding and most stable genotypes can be identified (Luquez *et al*., 2002). Genotypes tested in different locations or years often have significant fluctuation in yield due to the response of genotypes to environmental factors such as soil fertility or the presence of disease pathogens (Kang, 2004). These fluctuations are often referred as genotype × environment interaction.

The aim of the present investigation entitled “Phenotypic stability studies in brinjal (*Solanum melongena* L.)” was to identify high yielding stable genotype for sub tropical regions with better quality and tolerant to biotic stresses. Twenty five brinjal genotypes (15 open pollinated and 10 hybrids) obtained from ICAR, New Delhi, State Agricultural Universities (SAU) and some private vegetable seed companies were tested under six environments comprised of three seasons viz., Spring summer, Rainy and Autumn winter seasons of 2013-14 and 2014-15. The results of the study are discussed below in light of available literature under following headings:

5.1 Analysis of variance

Analysis of variance over environments revealed that mean sum of squares due to genotypes as well as environments were highly significant for all the traits studied which indicated not only the presence of genetic variability among the genotypes but also reflect the extent of diversity in growing conditions during the two years of experimentation. This provides an ample opportunity for selecting suitable genotypes with high mean for all the traits of interest. These results are in accordance to those of Sharma *et al* (2000); Mohanty (2002); Prasad *et al* (2002); Vaddoria *et al* (2009a); Vaddoria *et al* (2009b); Mehta *et al* (2011). Suneetha *et al* (2006) also reported significant mean squares due to genotypes and seasons for fruit yield, yield components, quality and physiological characters except for plant spread.

The presence of genotype × environment interaction were also significant for all the traits studied except two quantitative traits viz., number of leaves / plant and number of primary branches per plant and one quality trait ascorbic acid and one biotic stress little leaf incidence which indicated the differential response of genotype to various environment conditions. The considerable response of genotypes when grown in different environments has also been reported by Mehta *et al* (2011) for fruit yield, plant height, days to first flowering and fruit weight ; Suneetha *et al* (2006) for fruits yield/plant, days to first picking, plant height, primary branches/plant, fruit length, fruit diameter, fruit weight and fruits/plant. Similar results have also been reported for various quantitative and qualitative traits (Mohanty and Prusti, 2000; Rai *et al*, 2001) as well as for biotic stresses in brinjal crop (Vaddoria *et al*, 2009b)

5.1.1 Analysis of variance in individual environments

Environment wise analysis of variance revealed significant genotypic mean sum of squares for all the quantitative and qualitative traits as well as for biotic stress traits which indicate that sufficient genetic variability existed in the genotypes under study.

5.1.2 Environment indices

The environment indices for all the traits under study revealed that none of the trait had positive indices in all the six environments. However, E_3 (Rainy season, 2013) with three negative traits followed by E_2 (Spring-Summer, 2014), E_5 (Spring-Summer, 2015) and E_6 (Rainy season, 2015) environments with four negative traits each. However, E4 (Autumn-Winter, 2014) and E_1 (Autumn-Winter, 2013) recorded maximum number of negative values (19 and 18, respectively). Hence the environment E_3 with least negative indices in their expression was considered to be the most favourable. Similar results regarding variable response of the seasons to the different traits studied have been reported by Kumar *et al* (2000), Prasad *et al* (2002), Rao (2003) and Vaddoria *et al* (2009).

5.2 Linear regression vs deviation from linearity

The pooled analysis of variance for various traits in brinjal over six environments (Table 4.2) revealed that the variation due to G × E interaction has been partitioned into two, the predictable component due to linear regression and the unpredictable one due to pooled deviations from regression. Mean sum of squares due to Environment + (Genotype × Environment) was observed significant for all the fourteen quantitative (days to 50% flowering, days to first picking, fruit length, fruit diameter, number of fruits/ plant, average fruit weight, number of leaves per plant, plant height, number of primary branches per plant, leaf area, marketable yield per plant, unmarketable yield per plant, fruit yield per plant and fruit yield per hectare), two qualitative (total phenol content and ascorbic acid content) and five biotic stress traits (shoot borer infestation, fruit borer infestation, spider mite infestation, little leaf incidence and phomopsis blight incidence) under study which depicted variable genotypic response to environmental fluctuations and independent nature of genetic system governing the stability parameters.

Further partitioning of this component into the Environment (linear) and G x E (linear) revealed significant values against pooled deviation for all the traits. The significant Environment (linear) values substantiated marked variability between the seasons affecting the performance of genotypes whereas, the mean sum of square due to G × E (Linear) indicated significant rate of linear response of the genotypes to environmental changes for all the traits. However, higher magnitude of environment (linear) component as compared to G x E (linear) interaction depicted that major part of the total variation was a linear function of environment which might be responsible for high adaptation in relation to yield and all other related traits under study.

The results of the present study were in conformity with the work reported earlier by various workers viz., Mishra *et al* (1998a) for yield/hectare, fruits/plant, fruit weight, wilt and fruit borer; Mohanty and Prusti (2000) for average fruit weight, fruits/plant and fruit yield/hectare;

Mohanty (2002) for plant height, number of branches/plant, number of fruits/plant, average fruit weight and fruit yield; Kanwar *et al* (2005) for fruit weight at harvest and seed yield; Chaurasia *et al* (2005) for plant height, fruit length, fruit diameter, fruit size, number of fruits/plant and 10 fruit weight; Suneetha *et al* (2006a) for fruit yield/plant, plant spread, 1000 seed weight, TSS and total phenols; Suneetha *et al* (2006b) for fruit yield/plant and primary branches/plant; Mandal and Chaurasia (2007) for fruit set, number of fruits/plant, fruit weight, fruit length, fruit yield and fruit yield; Vaddoria *et al* (2009a) for days to 50% flowering, days to first picking, fruit length, fruit girth, fruit volume, plant height, number of primary branches/plant, plant spread, number of fruits/plant, average fruit weight and fruit yield/plant; Vaddoria *et al* (2009b) for fruit borer infestation and fruit yield/plant; Bora *et al* (2011) for fruit diameter; Sivakumar *et al* (2015) for fruit yield/plant and fruit borer; Stommel *et al* (2015) for total phenolics acids.

Non significant effect of genotype × environment (linear) for number of leaves/plant and ascorbic acid content indicated that the different genotypes did not differ genetically in their response to different environments.

The pooled deviation when tested against pooled error was found significant for all the traits except fruit length, average fruit weight, plant height, spider mite infestation and little leaf incidence which indicated the important contribution of non predictable component. The results are in conformity with the findings of Mohanty (2000) and Chaurasia *et al.* (2005).

5.3 Stability parameters of individual genotypes

Identification of stable genotypes suited to different environmental conditions is the ultimate aim of the estimation of the stability parameters of individual genotype. Many stability models have been developed to identify the stable genotypes. Eberhart and Russell (1966) model is the one which has been used in brinjal and other crops by several workers. In this model, phenotypic stability of the genotypes was measured by three parameters viz., mean performance over environment (μ), linear regression (b_i) and deviation from regression (S^2d_i).The regression coefficient (b_i) measures the responsiveness whereas, deviations from regression (S^2d_i) measure the stability of genotypes.

In the present investigation, the results obtained from the analysis of G × E interaction have been presented in table 4.3.1 to 4.3.21. In this analysis, three parameters of stability were estimated (μ, b_i and S^2d_i). Mean is the performance of genotypes over environments, regression slope as responsiveness and deviation around the regression line considered to be the most stable and vice versa (Jatasara and Paroda, 1981).

Genotypes with significantly positive values (b_i>1) were described as having below average responsiveness where genotypes with significant negative values (b_i<1) were described as exhibiting above average responsiveness and non significant described as average responsiveness. Similarly, genotypes were grouped into above average, below average and average responsiveness in relation to their average mean. Genotypes having significant deviation from regression line (S^2d_i) from zero were described as unstable (unpredictable behavior) with respect to mean performance and responsiveness. Genotypes having deviation from regression line (S^2d_i) non significant described as stable. It has been recognized that the stability should be used to refer to the absence or low magnitude of the unpredictable (non linear) change in response to an environment while predictable (linear) component which represents definite measurable response of a genotype to environmental change could be termed more appropriately a measure of responsiveness of the genotypes (Breese, 1969). A stable genotype is the one whose performance can be predicted easily and precisely. The prediction depends upon the relative magnitude of these two measures i.e. linear and non linear components of genotypes × environment interactions. The prediction will be more reliable when only linear component is significant.

5.3.1 Days to 50% flowering

Earliness in brinjal is highly desirable trait as it results in early harvest to fetch remunerative returns. A perusal of stability parameters as per Eberhart and Russel (1966) model for days to 50% flowering exhibited that out of the 25 genotypes, eleven took less number of days to 50% flowering as compared to average (61.45) over environments. Two genotypes viz., Pusa Ankur and Navkiran Improved were found to be stable and adapted for all types of environments whereas, only one genotype PPL was above average in response suitable for unfavourable environment. However, six genotypes viz., PPL-74, Chhaya, PBH-3, Shamli, Punjab Sadabahar, and Pusa Uttam were below average in response and are suitable for favourable environment. The results are in conformity with the earlier work reported by Vaddoria *et al* (2009). In addition, seven genotypes viz., Rajni, Abhishek, Arka Kusumkar, PPR, PPC, BR-14 and Puneri Kateri were found above responsive and two genotypes viz., Arka Shirish and Pusa Shymla were found suitable for favourable environments but all these genotypes had mean values higher than the average mean and thus can be grown in those areas where late harvest is desirable from market point of view. Restof the genotypes were found unstable for this trait.

5.3.2 Days to first picking

The early or late maturity is attributed as genotypic character and is influenced by the environmental factors of particular growing conditions. The genotypes PBH-3 (83.39) and Shamli (74.5) having lower mean values with average mean (85.93) showed regression coefficient close to one with non significant deviation from regression line were found to be stable and adapted for all types of environments for this trait. However, genotype Pusa Uttam also found stable but had slightly higher mean value (87.94) than average mean. Similar results have been reported by Vaddoria *et al* (2009a) in seven identified brinjal hybrids viz., JBSR-98 x Pant Rituraj, ABL98-1 x Pant Rituraj, ABL98-1 x GBL1, Morvi4-2 x PLR1 and Green Round x GBL1in which days to first picking was found stable yield attribute. Similarly seven genotypes viz., PPL-74, MH-80, Abhishek, Punjab Sadabahar, Pusa Kranti, Pusa Ankur and BR-14 were below average in response and suited for favourable environments only whereas, three genotypes viz., Navkiran Improved, PBH-3 and Chhaya showed above average in response and were found suitable for unfavourable environments. Suneetha *et al* (2006a) tested 10 homozygous lines and their 45 hybrids from its 10 x10 diallel mating and reported only three lines/crosses to be below/above average in response and suitable for specific environments for days to first picking.

5.3.3 Fruit length (cm)

Based on three stability parameters for fruit length in diverse genotypes (round, oblong and long fruited), only four genotypes viz., PPL-74, Punjab Sadabahar, Pusa Kranti and PPL showed significant non linear (S^2d_i) component of G × E interaction. Among all the genotypes, only two round fruited genotypes viz., Pusa Ankur and Sandhya recorded mean values of 9.40 cm and 7.42 cm lower than the average mean (9.90 cm) but were found to be stable. Six round fruited genotypes viz., Rajni, MH-80, Chhaya, Nisha Improved, Abhishek and Arka Kusumkar, indicated above average in response but all these genotypes had mean values lower than the average mean. The genotypes PBH-3, Arka Shirish and BR-14 were below average in response and were suitable for favourable environments. Chaurasia *et al* (2005) also tested fifteen divergent genotypes (round, long and small round) for stability analysis and reported three genotypes viz., KS-224, JC-2 and H-7 as stable under Varanasi conditions for fruit length. Similar results have been obtained by Mandal and Chaurasia (2007) who found five highly stable brinjal genotypes viz., BB-71, JNDBL-1, KS-331, PPL and Rajendra Annapurna.

5.3.4 Fruit diameter (cm)

Fruit diameter is directly associated with fruit weight and ultimately yield. Simultaneous consideration of stability parameters revealed that three round and oblong fruited genotypes viz., Rajni, Pusa Kranti and PPR with high mean values (5.79, 5.65 and 9.94 cm, respectively) and two long fruited genotypes viz., PPL-74 and Arka Shirish having lower mean values (2.92 and 2.99 cm, respectively) than the average mean (5.03 cm) had regression coefficient close to unity with non significant deviation from regression line were found to be stable and suitable for all types of environments. Eleven genotypes viz., Navkiran Improved, Sandhya, Chhaya, Nisha Improved, Shamli, Abhishek, Arka Kusumkar, Pusa Shyamla, PPC, Puneri Kateri and Arka Neelkanth showed significant above average response (b_i<1) with non significant deviation from regression line (S^2d_i= 0) whereas, two genotypes viz., MH-80 and BR-14 performed below average in response (b_i>1) with non significant deviation from regression line (S^2d_i = 0). Chaurasia *et al* (2005) also tested fifteen divergent genotypes (round, long and small round) for stability analysis and reported four genotypes viz., KS-331, JC-1 DBSR-91 and H-7 as stable under Varanasi conditions for fruit length. Similar results have also been reported by Prasad *et al* (2002).

5.3.5 Number of fruits per plant

Number of fruits per plant, is an important trait and directly related with the fruit yield. Maximum number of fruits per plant were recorded in long fruited genotypes viz., Shamli (48.50) followed by PPL-74 (45.24), PPC (22.64) and Punjab Sadabahar (17.45), whereas amongst round fruited genotypes, Navkiran Improved (15.79) followed by Pusa Ankur (14.85) and Sandhya (14.74) recorded maximum number of fruits/plant as compared to average (14.68). The examination of stability parameters as per Eberhart and Russell (1966) model revealed that two genotypes viz., Navkiran Improved and Pusa Ankur were stable for this particular trait having high mean values (15.79 and 14.85, respectively) than the average mean (14.68) Five genotypes viz., MH-80, PBH-3, Abhishek, Pusa Shyamla and Rajni showed above average response but all the five genotypes had mean value lesser than the average mean because of round shaped fruits. However, three genotypes viz., Pusa Kranti, Arka Keshav and Nisha Improved displayed below average response and suitable for favourable environments. Similar results were also observed by Vaddoria *et al* (2009a), Mandal and Chaurasia (2007), and Mohanty (2002).

5.3.6 Average fruit weight (g)

Average fruit weight is the most important yield contributing component affecting total fruit yield directly. Simultaneous consideration of stability parameters with respect to average fruit weight revealed that two round fruited genotypes viz., Abhishek and Sandhya were stable having high values for average fruit weight (117.52 g and 145.73 g respectively) than average mean (87.72 g) and can be considered as average in response and suitable for all types of environments whereas one long fruited genotype PPL-74 was also found stable with average response but having lower mean fruit weight(50.44 g) as compared to average mean (87.72 g). Two round fruited genotypes viz., PBH-3 and Pusa Uttam exhibited below average response and thus suited specifically for favourable environments whereas, long fruited genotypes viz., Shamli, Punjab Sadabahar and PPL with lower mean values were above average responsive and suited for unfavourable environments. The results are in conformity with the earlier reported work by Mehta *et al* (2011), Vaddoria *et al* (2009a), Mandal and Chaurasia (2007), Suneetha *et al* (2006b), Kanwar *et al* (2005), Chaurasia *et al* (2005), Mohanty (2002), Prasad *et al* (2002), Rai *et al* (2001a,2001b, 2001c) and Mohanti and Prsuti (2000).

5.3.7 Number of leaves per plant

Number of leaves per plant is positively and significantly associated with fruit yield/plant (Shekar *et al*, 2013). Estimation of stability parameters for number of leaves /plant, as suggested by Eberhart and Russell (1966) model, indicated two genotypes viz., Rajni and Nisha Improved as stable and thus adapted to all types of environments whereas, three genotypes viz., PPL-74 depicted below average response and thus suited specifically for favourable environments. However, only one genotype Abhishek reflected above average response and thus suited for unfavourable environments. Roy chowdhary *et al* (2011) also observed significant differences among 10 genotypes in respect of number of leaves/plant ranging from 34.34 to 85.91.

5.3.8 Plant height (cm)

Plant height is one of the most important components determining the phenotype of a plant which have indirect bearing on yield as plants with greater height are expected to have more number of nodes and thereby, having more number of secondary fruiting branches. Stability analysis for plant height revealed five genotypes viz., Shamli, Rajni, Navkiran Improved, Nisha Improved and PPL as stable showing average response across all the environments and thus adapted to all type of environments. Three genotypes viz., Arka Shirish, Arka Kusumkar and Arka Neelkanth reflecting below average response and suitable for only favourable environments whereas, four genotypes PBH-3, Abhishek, Pusa Kranti and Pusa Ankur had exhibited above average response and suited specifically for unfavourable environments. Similar findings on stability of plant height have been given by Mehta *et al* (2011), Vaddoria *et al* (2009a), Suneetha *et al* (2006a, 2006b); Chaurasia *et al* (2005), Mohanty (2002), Prasad et al (2002) and Rai *et al* (2001b).

5.3.9 Number of primary branches per plant

Number of primary branches per plant had direct bearing on number of fruits per plant and thus resultant yield. Five genotypes viz., MH-80, Punjab Sadabahar, Abhishek, PPL-74 and Pusa Ankur were considered as stable genotypes adapted to all types of environments. However, six genotypes viz., Rajni, Navkiran Improved, Nisha Improved, Shamli, Pusa Kranti and BR-14 were below average responsive and specifically adapted to favourable environments whereas, none of the genotypes exhibited above average response for this particular trait. Similar findings have also been given by Vaddoria *et al* (2009a), Suneetha *et al* (2006b), Prasad *et al* (2002) and Mohanty

(2002) who reported three genotypes (Supriya, Neelgiri and Nisha) as stable ones in respect of number of primary branches/plant.

5.3.10 Leaf area (cm^2)

Larger leaf area of a genotype influences its fruit yield through enhanced photosynthetic activity resulting in improved plant growth. Estimation of stability parameters as per Eberhart and Russell (1966) model in respect of leaf area revealed that only one genotype, viz., Nisha Improved as stable genotype and adapted to all types of environments. Two genotypes viz., MH-80 and Arka Shirish reflecting below average response and specifically adapted to favourable environments whereas, three genotypes viz., PBH-3, Abhishek and Arka Kusumkar exhibited above average respone and thus suited specifically for unfavourable environments. Rest of the genotypes were found unstable for this particular trait. Similar findings were given by Suneetha *et al* (2006a) also who found stable cross AB 98-10 x JBPR 1 in respect of leaf area.

5.3.11 Marketable yield per plant (kg)

High marketable yield is very important from the producer's point of view to fetch remunerative returns in the market. Estimation of stability parameters indicated that out of 25 genotypes, only two genotypes viz., Shamli and Punjab Sadabahar were stable in respect of higher marketable yield (1.30 kg and 1.06 kg, respectively) as compared to average mean (0.89 kg) and regression coefficient close to one with non significant deviation from regression line and thus, suitable for growing under all types of environments. However, two genotypes viz., PPL-74 (2.09 kg) and MH-80 (1.06 kg) had regression coefficient greater than one (b_i=2.14 and 1.43, respectively) with non significant deviation from regression line showed below average response which make them suitable specifically for favourable environments. None of the genotypes exhibited above average response for this trait.

5.3.12 Unmarketable yield per plant (kg)

Unmarketable yield per plant includes all the fruits affected with all types of biotic (disease infected and pest infested) and abiotic stresses (high and low temperature/freezing injury etc.) which render them unsuitable for marketing and general consumptionand it must be as low as possible. According to Eberhart and Russell (1966) model, out of 25 genotypes, only one genotype i.e. Chhaya had lower unmarketable yield / plant (0.20 kg) as compared to average mean (0.22 kg), regression coefficient close to one (b_i=1.03) with non significant deviation from regression line (S^2d_i= -0.50) and was considered stable and suited to all types of environments. Whereas, nine genotypes viz., Shamli, Arka Shirish, Arka Kusumkar, Arka Nidhi, Arka Neelkanth, PPR, Pusa Shyamla, PPC and Puneri Kateri showed above average response which make them suitable for unfavourable environments. However, none of the genotypes under study exhibited below average response..

5.3.13 Fruit yield per plant (kg)

Fruit yield per plant is a complex quantitative trait and stability achieved in this trait can be utilized for all the growing seasons of brinjal to achieve higher and stable yield increments (Vaddoria *et al*, 2009a). Stability analysis indicated that only two genotypes viz., Shamli and Punjab Sadabahar were average in response and thus can be considered stable for this particular trait. However, Nisha Improved and Chhaya also exhibited average response but mean values were lower than the average mean. Three genotypes i.e. PPL-74, MH-80 and Pusa Kranti showed below average responses which make them suitable specifically for favourable environments whereas, genotypes Arka Kusumkar, Arka Keshav, Arka Nidhi, Pusa Shyamla, PPR, PPC, Puneri Kateri and Arka Neelkanth were above average responsive but had lower mean values than average mean. Vaddoria *et al* (2009a) also reported seven hybrids viz., JBSR 98-2 x Pant Rituraj, ABL 89-1 x Pant Rituraj, ABL 98-1 x GBL 1, Morvi 4-2 x GBL 1, Sel. 4 x Pant Rituraj, Morvi 4-2 x PLR 1 and Green Round x GBL 1 as stable. Besides, seven other hybrids were found suitable for favourable environments and four hybrids were found suitable for poor environments for this particular trait. Similar findings were given by Suneetha *et al* (2009b), Vaddoria *et al* (2009b), Mandal and Chaurasia (2007), Kanwar *et al* (2005), Prasad *et al* (2002) and Rai *et al* (2000c)

5.3.14 Fruit yield per hectare (q)

Any genotype possessing considerably high yield potential coupled with stable performance in different environments has great value in plant breeding programme (Mehta *et al*, 2011). The stability of the genotypes for fruit yield of brinjal is a result of its component traits (Vaddoria *et al*, 2009a). Simultaneous regression analysis of stability parameters as suggested by Eberhart and Russell (1966) model indicated that among 25 genotypes, only one genotype namely PPL-74 was average responsive and thus can be considered stable for this particular trait due to the physiological homeostasis to stabilize productivity over a wide range of changing environments due to high degree of individual buffering ability (Mohanty, 2000). Similar findings have been given by Panwar *et at* (2013) who also evaluated eight genotypes during summer-rainy season for two years and reported PPL-74 to be the highest yielder under Ranichouri, Uttrakhand conditions. However, only one genotype viz., Punjab Sadabahar exhibited above average response with and thus suitable specifically for unfavourable environments whereas genotype Shamli, showed below average response and found suitable for favourable environments. The stability of the aforementioned genotypes is directly linked with stability of their component traits viz., average fruit weight, number of fruits per plant, plant height, marketable yield per plant and fruit yield per plant for wide and specific adaptability. Similar reports have been given by various workers in respect of stability of fruit yield/hectare in brinjal viz., Bora *et al* (2011), Mehta *et al* (2011), Mandal and Chaurasia (2007), Chaurasia *et al* (2005), Kanwar *et al* (2005), Prasad *et al* (2002) and Rai *et al* (2000a).

Mean performance of genotypes in individual environments revealed Shamli (E_{1}- 127.04 q/ha, E_{2}- 233.95 q/ha, E_{4}- 112.61 q/ha, E_{5}- 245.30 q/ha and E_{6}- 244.86 q/ha) and PPL-74 (E_{3}- 242.42 q/ha) to be the top performers in all the environments in terms of fruit yield/hectare. Top two performers in terms of fruit yield/ha were Shamli and PPL-74 for spring-summer (239.62 q/ha and 238.95 q/ha, respectively) and rainy season (239.21qtl/ha and 238.95qtl/ha respectively) whereas PPL-74 and Sandhya recorded highest mean yield during autumn-winter season (144.52 q/ha and 134.23 q/ha, respectively). However, amongst the three seasons, rainy season recorded maximum average yields (131.79 q/ha in E_3 and 130.86 q/ha in E_6) followed by spring-summer season (128.48 q/ha in E_2 and 125.91 q/ha in E_5) whereas, lowest yield was recorded in autumn-winter season (74.29 q/ha in E_1 and 50.77 q/ha in E_4). The highest yield in rainy season may be attributed to the favourable climatic conditions during crop growth and especially during harvesting period which results in long fruit picking duration. Suneetha *et al* (2006b) also reported rainy season to be most congenial for high fruit yield/plant.

5.3.15 Ascorbic acid content (mg/100g)

Higher ascorbic acid content in brinjal fruit is associated with increased nutritive value of the fruits which would help better retention of colour and flavour (Sasikumar, 1999) Estimation of stability parameters indicated that among all the genotypes, only two genotypes viz., Sandhya and Chhaya to be stable and adapted to all types of environments. However, two genotypes viz., Navkiran Improved and PBH-3 exhibited below average response and thus suitable for favourable environments whereas, four genotypes *viz.*, Rajni, PPL-74 Shamli and Punjab Sadabahar were above average response and thus suitable specifically for unfavourable environments. Kandoliya *et al* (2015) recorded significant variation among genotypes regarding ascorbic acid content ranging between 9.43 and 16.75 mg/100g while evaluating eight brinjal genotypes. However, the results of the study revealed mean value for ascorbic acid content varying between 7.66 to 13.60 mg/100g among genotypes and 10.80 to 11.05 mg/100g across the environments. Kumar and Arumugam (2013) also recorded ascorbic acid content ranging from 7.38 to 13.47 mg/100g while evaluating 33 indigenous brinjal genotypes.

5.3.16 Total phenol content (mg/100g)

Brinjal fruits are rich source of total phenolics that influence antioxidant content and fruit culinary quality (Stommel *et al*, 2015). A perusal of stability parameters indicated only one genotype PPL-74 as average responsive and thus adapted to all types of environments for this particular trait. The above average response was recorded in Arka Shirish, BR-14, Pusa Uttam and PPR but the mean values were lower than the average mean. However, four genotypes viz., Arka Shirish, Pusa Uttam, PPR and BR-14 showed above average response and suitable for unfavourable situations. None of the genotypes was below average in response. Similar results have been reported by Suneetha *et al* (2006a) who observed two brinjal hybrids viz., Morvi 4-2 x JBPR-1 and AB 98-10 x Morvi 4-2 to be stable under Anand, Gujarat conditions.

Mean value of genotypes for total phenol content varied between 0.71 to 1.28 mg/100g with Arka Keshav recorded maximum total phenol content (1.28 mg/100g) content as compared to the average mean (0.94 mg/100gm) followed by Shamli (1.25 mg/100g), PPL-74(1.24 mg/100g) and Arka Nidhi (1.23 mg/100g). However, significant variation was also observed across environments with total phenol contents ranging from 0.89 to 0.97 mg/100g.

5.3.17 Shoot borer infestation (%)

Brinjal shoot and fruit borer is the most serious insect pest of brinjal crop. It attacks shoots in early plant growth stages and causes death of the shoots in vegetative stage (Sivakumar *et al*, 2015). The examination of stability parameters as per Eberhart and Russell (1966) model revealed that only one genotype namely Rajni showed average response and was found suitable for all types of environments. Four genotypes viz., PPL-74, Sandhya, Arka Nidhi and Shamli expressed above average response suitable for unfavourable environments whereas two genotypes viz., Arka Shirish and Pusa Shyamla were below average in response and suitable specifically for favourable environments. Similar results in respect of shoot and fruit borer infestation were observed by Rai *et al* (2001) who found four genotypes viz., Punjab Sadabahar, PPL, ARBH-201and PB-33 as stable under Raipur conditions.

However, the incidence of shoot borer was minimum in the long fruited genotype Shamli (8.35 %) followed by PPL-74 (9.11%) and maximum shoot borer infestation was noticed in round fruited genotype BR-14 (26.69%) followed by Pusa Uttam (26.09%). Chandrashekhar *et al* (2008) evaluated 25 brinjal genotypes and observed 5.5-13.3 per cent shoot infestation in different genotypes under Hisar conditions. Similar findings were reported by Elanchezhyan *et al* (2008), Chaudhary and Sharma (2000), and Behera *et al* (1999).

5.3.18 Fruit borer infestation (%)

Single most important factor for low productivity of brinjal crop throughout the country can be attributed to incidence of fruit borer rendering them unmarketable (Sivakumar *et al*, 2015). The examination of stability parameters revealed only one genotypes viz., Pusa Kranti as average in response and thus considered stable and well adapted for all types of environments. Five genotypes viz., PPL-74, Sandhya, Shamli, Arka Nidhi and Pusa Ankur expressed above average response with lower mean values as compared to average mean and thus suitable for unfavourable environments whereas, only one genotype namely Arka Shirish had lower mean value than average mean and was below average in response and suited for unfavourable environments. Sivakumar *et al* (2015) identified three hybrids as widely adapted on the basis of fruit yield/plant along with less infestation of fruit borer namely, IC285140 x Bhagyalakshmi, Heera x Gulabi and Pusa Shymala x Gulabi under Andhra Pardesh conditions. Similar findings were given by Vaddoria *et al* (2009) who identified six stable hybrids viz., JBSR 98-2 x Pant Rituraj, ABL 98-1 x Pant Rituraj, ABL 98-1 x GBL 1, Morvi 4-2 x GBL 1, Morvi 4-2 x PLR 1 and Green Round x GBL 1 in respect to yield and resistance to fruit borer infestation under Junagarh conditions.

Amongst the three seasons, minimum average fruit borer infestation was recorded in autumn-winter season (9.01%) followed by spring-summer (19.88%) and rainy season (21.58%). However, minimum fruit borer infestation was recorded in the long fruited genotype Shamli followed by PPL-74 and Arka Nidhi whereas maximum fruit borer infestation was observed in round fruited genotype Pusa Uttam followed by BR-14. Similar findings regarding fruit borer incidence were reported by Khan and Singh (2014), Nayak *et al* (2014), Malik and Rishipal (2013), Naqvi *et al* (2009), Elanchezhyan *et al* (2008), Chandrashekhar *et al* (2008) and Chaudhary and Sharma (2000).

5.3.19 Spider mite infestation (%)

In brinjal, spider mite is a major pest, next to fruit and shoot borer (Monica *et al* 2014). It feeds on the lower surfaces of leaves, mainly along the adjacent regions of midrib and veins of leaves causing chlorosis of leaves. The examination of stability parameters revealed only two genotypes Chhaya and BR-14 as average responsive with lower values of spider mite infestation and thus can be considered as stable genotype well adapted to all types of environments for this trait. However, ten genotypes viz., Rajni, PPL-74, Nisha Improved, Shamli, Abhishek, Punjab Sadabahar, Arka Keshav, Arka Nidhi, PPC and Puneri Kateri expressed above average response with lower mean values and regression coefficient less than unity ($b_i<1$) with non significant deviation from regression line and thus suitable for unfavourable environments whereas, only one genotype namely Sandhya had lower mean value than average mean and was below average in response. Minimum spider mite infestation was recorded in the genotype Puneri Kateri followed by Shamli, Arka Nidhi, PPL-74, Punjab Sadabahar and PPC whereas maximum spider mite infestation was noticed in Pusa Kranti. Sarma and Navdihalli (2010) screened brinjal varieties against spider mite, *Tetranychus* spp.under Dharwad conditions and recorded lowest mite population in Arka Nidhi and on par yield with the best yielded variety Kalyan. The varieties, Arka Nidhi and Arka Keshav were moderately resistant to spider mite. Similar results have been reported by Singh and Singh (2015) and Tripathi *et al* (2014).

5.3.20 Little leaf incidence (%)

Little leaf of brinjal caused by phytoplasma is an important disease in brinjal. It is transmitted through leaf hopper vector, *Cestius phycitis, Hishimonus phycitis* and *Empoasca devastans.* A perusal of the of stability analysis as per Eberhart and Russell (1966) model for little leaf incidence indicated that three genotypes viz., Nisha Improved, Arka Kusumkar and PPC were average in response suited for all types of environments. Furthermore, seven genotypes viz., Rajni, PPL-74, Sandhya, Chhaya, Shamli, Punjab Sadabahar, and Puneri Kateri exhibited above average response which make them suited for unfavourable environments.

However, on pooled basis, the genotype PPL-74 recorded minimum little leaf incidence followed by Puneri Kateri and Shamli whereas maximum little leaf incidence was noticed in BR-14 followed by PPR. Humauan *et al* (2015) evaluated 15 local genotypes of brinjal against little leaf disease and observed one local genotype Shuktara to be highly resistant (HR) and eleven genotypes as resistant (R). Rest three varieties showed moderately susceptible (MS) reaction to little leaf disease.

5.3.21 Phomopsis blight incidence (%)

Phomopsis blight and fruit rot, caused by *Phomopsis vexans,* is one of the major constraints to eggplant cultivation in the country (Islam and Meah, 2011). It reduces yield and marketable value of the crop by nearly 20-30% (Jayaramaiah *et al*, 2013).Simultaneous consideration of three stability parameters given by Eberhart and Russell (1966) model in respect of phomopsis blight incidence revealed two genotypes viz., Sandhya and Pusa Kranti with lower mean values as stable and adapted to all types of environments. In addition, eight genotypes viz., Rajni, PPL-74, Chhaya, Nisha Improved, Shamli, Abhishek, Puneri Kateri and Arka Neelkanth showed above average response with mean values lower than the average mean and suitable for unfavourable environments whereas, none of the genotypes was found below average in response for this particular trait.

Among the three seasons, minimum average disease incidence was recorded in autumn-winter season followed by spring-summer whereas maximum disease incidence was observed in rainy season. On comparing the mean performance for phomopsis blight among 25 genotypes, PPL-74 recorded minimum incidence followed by Shamli and Puneri Kateri whereas, maximum incidence of phomopsis blight was noticed in Arka Shirish followed by Arka Kusumkar and BR-14 as compared to average mean over environments. Sharma *et al* (2011) also reported 7.00 to 14.00 percent disease incidence in district wise survey in Jammu region. Similar findings were given by Pandey *et al* (2002) and Patil *et al* (2002).

CHAPTER-VI

SUMMARY AND CONCLUSION

The present investigation entitled "Phenotypic stability studies in brinjal (*Solanum melongena* L.) was carried out to assess the stability of performance of genotypes of brinjal under subtropical conditions of Jammu region. The experimental material, comprising of 25 genotypes of brinjal (10 F_1 hybrids and 15 OP varieties), were evaluated under six environments comprised of three seasons, Autumn-Winter, Spring-Summer and Rainy season spread over two years during 2013-2014 and 2014-2015 at Experimental Farm of Division of Vegetable Science and Floriculture, Main Campus, Chatha, SKUAST-Jammu. The individual experiment was conducted in randomized block design with three replications. Stability parameters were worked out using the model given by Eberhert and Russell (1966). The methods of investigation and material utilized during the course of investigation and the results obtained on different aspects have been presented in Chapter III and IV, respectively. The results obtained have been discussed in the preceeding chapter in light of the available literature and salient findings of the present investigation are described as under:

- Highly significant differences among genotypes for almost all the traits under study revealed the presence of sufficient genetic variability among the genotypes with respect to quantitative, qualitative and biotic stress traits. The presence of both significant and non significant interactions indicated the differential response of genotypes to various environment conditions.
- Partitioning of G × E interaction into predictable and unpredictable one suggested that both the components were significant for all the traits which were included for stability analysis indicating thereby, high genotype x environment interactions. Similarly, significant mean squares due to environment + (genotype × environment), G × E (linear) and pooled deviation were observed for almost all the traits
- The pooled deviation when tested against pooled error was found significant for all the traits except fruit length, average fruit weight, plant height, spider mite infestation and little leaf incidence which indicated the important contribution of non predictable component.
- Genotype Pusa Ankur has been identified for early maturity whereas, genotype Arka Shirish has been found stable for late maturity and suitable for cultivation under wide range of environments.

- As regard to physiological and biological traits i.e. number of leaves per plant, number of primary branches per plant, leaf area and plant height, genotype Nisha Improved was found stable for almost all the traits.
- For yield and yield contributing traits i.e. fruit length, fruit diameter, number of fruits per plant, average fruit weight, marketable yield per plant, fruit yield per plant and fruit yield per hectare, two genotypes viz., Shamli and Punjab Sadabahar were found stable for fruit and marketable yield per plant whereas, genotype PPL-74 was found stable for average fruit weight and fruit yield per hectare. These three genotypes were found capable of giving consistent performance over seasons and years.
- For ascorbic acid content, only two genotypes viz., Sandhya and Chhaya and for total phenol content only one genotype PPL-74 was found to be stable.
- For biotic stresses like, fruit and shoot borer, spider mite, little leaf and phomopsis blight, minimum shoot and fruit borer infestation was recorded in autumn-winter season followed by spring-summer season whereas maximum infestation was observed in rainy season. For shoot borer infestation, only one round fruited genotype Rajni having lower mean value was found stable whereas, only one oblong genotype Pusa Kranti was found stable for fruit borer infestation. Three long fruited genotypes Shamli, PPL-74 and Arka Nidhi recorded minimum infestation of fruit borer across all the environments. In respect of spider mite infestation, two genotypes viz., Chhaya and BR-14 were found average responsive with lower mean values and thus can be considered as stable genotypes.
- For little leaf incidence, three genotypes viz., Nisha Improved, Arka Kusumkar and PPC having lower mean values were found stable. Two genotypes Sandhya and Pusa Kranti with lower mean values for phomopsis blight incidence were found stable and suitable for growing under wide range of environments.

REFERENCES

Akcura, M., Kaya, Y. and Taner, S. 2005. Genotype-Environment interaction and phenotypic stability analysis for grain yield of durum wheat in the Central Anatolian region. *Turkish Journal of Agriculture and Forestry*. 29: 369-375.

Ali, N., F. Javidfar and Y. Mirza. 2003. Selection of stable rapeseed (*Brassica napus* L.) genotypes through regression analysis. *Pakistan Journal of Botany*. 35: 175-183.

Anonymous, 2014. Annual Area and Production Data. *Directorate of Agriculture*, J&K, Jammu.

Anonymous, 1991. Mites of agricultural importance in India and their management. Technical Bulletin No.1. All India Coordinated Research Project on Agricultural Acrology, UAS, Bangalore, p.18.

Baig, K.S. and Patil, V.D. 2002. Combining ability over environments for shoot and fruit borer resistance and other quantitative traits in *Solenum melongena* L. *Indian Journal of Genetics*. 62(1): 42-45.

Balakrishnan, K.A., Tomar, B.S. and Rakeshwar Verma. 1993. Stability analysis of hybrids of egg plant. Symposium on Heterosis Breeding in Crop Plants- theory and application by Crop Improvement Society of India, Ludhiana.

Behara, T.K., Narendra Singh and Kalda, T.S. and Gupta, S.S. 1999. Screening for shoot and fruit borer incidence in eggplant genotypes under Delhi conditions. *Journal of Entomology*. **61** (4): 372-375.

Bhat, K.L. 2011. Brinjal. Daya Publishing House, New Delhi.

Bhatti, K.H., Kausar Nazia, Rashid Umer, Hussain, K., Nawaz, K. and Siddiqi, E.H. 2013. Effects of biotic stresses on eggplant (*Solanum melongena* L.). *World Applied Sciences Journal*. 26(3): 302-311.

Bhushan, S., Chaurasia, H. K. and Shanker, R. 2011. Efficacy and economics of pest management modules against brinjal shoot and fruit borer (*Leucinodes orbonalis*). *The Bioscan*. 6(4): 639-642.

Bora, Lalit, Singh, Y.V. and Kumar Bharat Bhushan. 2011. Stability for fruit yield and yield contributing traits in brinjal (*Solanum melongena* L.). *Vegetable Science*. 38(2): 194-196.

Boubekri, C., Lanez, T., Djouadi, A. and Rebiai, A. 2013. Effect of drying and freezing on antioxidant capacity and polyphenolic contents of South Algerian eggplants cultivars. *International Journal of Pharmacy and Pharmaceutical Sciences*. 5(3): 244-248.

Bray, H.G. and Thorpe, W.V. 1954. *Meth. Biochem. Anal.* 1, 27-52

Breese, E.L. 1969. The measurement and significance of genotype environment interactions in grasses. *Heridity*. **24**: 27-44

Cao, G., Sofie, E. and Prior, R.L. 1996. Antioxidant capacity of tea and vegetables. *Journal of Agricultural Food and Chemistry*. 44(11): 3426-3431.

Chandrashekhar, H., Malik, V.S., Singh, Ram and Baswana, K.S. 2008. Evaluation of eggplant genotypes for field resistance against *Leucinodes orbonalis* Guenee. *Harayana Journal of Horticultural Science*. 37(1&2): 195-197.

Chaudhary, D.R. and Sharma, S.D. 2000. Screening of some brinjal cultivars against bacterial wilt and fruit borer. *Agricultural Science Digest*. 20(2): 129-130.

Chaurasia, S.N.S., Singh, M. and Mathura Rai 2005. Stability analysis for growth and yield attributes in brinjal. *Vegetable Science*. **32**(2): 120-122.

Chowdhary, D. and Talukdar, P. 1997. Phenotypic stability of brinjal cultivars and few crosses in F_3 generation over environments. *Horticultural Journal*. 10(1): 67-71.

Daunay, M. C, Lester, R. N., Gebhardt, C. H., Hennart, J. W., Jahn, M., Frary, A. and Doganlar, S. 2001. Genetic resources of eggplant (*Solanum melongena* L.) and allied species: A new challenge for molecular geneticists and eggplant breeders. Solanaceae V. Nijmegen University Press, Nijmegen, Netherlands. p. 251-274.

Demir, K., Bakir, M., Sarıkamis, G. and Acunalp, S., 2010. Genetic diversity of eggplant (*Solanum melongena*) germplasm from Turkey assessed by SSR and RAPD markers. *Genetics and Molecular Research*. **9**(3): 1568-1576.

Devi, Payal, Gawde, Preeti and Koshta, V.K. 2015. Screening of some brinjal cultivars for resistance to shoot and fruit borer (*Leucinodes orbonalis* Guenee). *The Bioscan*. 10(1): 247-251.

Eberhart, S.A. and W.A. Russell 1966. S tability parameters for comparing varieties. *Crop Science*. **6**: 36-40.

Elanchezhyan, K., Murli Baskaran, R.K. and Rajavel, D.S. 2008. Field screening of brinjal varieties on major pests and their natural enemies. *Journal of Biopesticides*. 1(2): 113-120.

Guillermo, N.M., Dolores, M.R., Alfonso, G.B., Gustavo, G.A., Basilo, H., Manuel, B.S., Jorge, S.C. and Rosabel, V.d.L.R. 2014. Nutritional and nutraceutical components of commercial eggplant types grown in Sinaloa, Mexico. *Not. Bot. Agrobo*. 42(2): 538-544.

Indian Horticulture Database (2014). Data on area, production and productivity on brinjal in India. National Horticulture Board, New Delhi.

Haque, E., Kabir, G., Mondal, M.A. A. and Alam, A. M. S. 2003. Stability for yield components in wheat (*Triticum aestivum* L.). *Bangladesh Journal of Plant Breeding & Genetics*, **16**(1): 39-44.

Humauan, M.R., Khalequzzaman, K.M. and Akhter, B. 2015. Screening of brinjal varieties against little leaf disease. Detailed Project Report. Division of Plant Pathology, Bangladesh Agricultural Research Institute. Pp.1-2.

Islam, M.R. and Meah, M.B. 2011. Association of *Phomopsis vexans* with eggplant (*Solanum melongena*) seeds, seedlings and its management. *The Agriculturists.* 9(1&2): 8-17.

Islam, A.K.M.A. and Newaz, M.A.2001. Genotype × environment interaction for seed yield and yield contributing characters in dry bean (*Phaseolus vulgaris* L.). *Bangladesh Journal of Plant Breeding & Genetics*.**14** (1):43-48.

Jatasara, D. S. and Paroda, R.S. 1981. Genoype x Environment interaction in segregating generation of wheat. *Indian Journal of Genetics.* **41**: 12-17

Jayaramaiah, K.M, Mahadevakumar, S., Chairth Raj, A.P. and Janardhana, G.R. 2013. PCR based detection of *Phomopsis vexans* (Sacc. and Syd.)- The causative agent of leaf blight and fruit rot disease of brinjal (*Solanum melongena* L.). *International Journal of Life Sciences.* **7**(1): 17-20.

Kandoliya, U.K., Bajaniya, V.K., Bhadja, N.K., Bodar, N.P. and Golakiya, B.A. 2015. Antioxidant and nutritional cpmponents of eggplant (*Solanum melongena* L.) fruit grown in Saurastra region. *International Journal of Current Microbiology and Applied Sciences.* **4**(2): 806-813.

Kang, M.S. 2004. Breeding: Genotype-by-environment interaction. p. 218-221. In R.M. Goodman (ed.) *Encyclopedia of Plant and Crop Science*. Marcel-Dekker, New York.

Kantharajah, A.S. and Golengaonkar, P.G. 2004. Somatic embryogenesis in eggplant. *Sci Hortic-Amsterdam.* **99**(2): 107-117.

Kanwar, J.S., Mohanty, S., Jindal, S.K. and Sharma, S.R. 2005. Stability analysis for seed yield and its components in brinjal. *Harayana Journal of Horticulture*. **34**(1-2): 109-110.

Karak, C., Ray, U., Akhter, S., Naik, A. and Hazra, P. 2012. Genetic variation and character association in fruit yield components and quality characters in brinjal (*Solanum melongena* L.). *Journal of Crop and Weed*. **8**(1): 86-89.

Kashyap, V., Kumar, S. V., Collonnier, C., Fusari, F., Haicour, R., Rotino, G. L., Sihachakr, D. and Rajam, M. V. 2003, Biotechnology of eggplant. *Scientia Horticulturae.* **97**: 1-25.

Keli, S.O., Hertog, M.L.G., Feskens, E.J.M. and Kromhout, D. 1996. Dietary flavonoids, antioxidant vitamins and incidence of stroke: the Zutphen study. *Arch. Int. Med.* **156**: 637-642

Khan, R. and Singh, Y.V.2014. Screening for shoot and fruit borer (*Leucinodes orbonalis* Guenee.) resistance in brinjal (*Solanum melongena* L.) genotypes. *The Ecoscan.* **6**(special issue): 41-45.

Khurana, S.C., Singh, G.R., Thakral, K.K., Kalloo. G., Pandita, M.L. and Pandey, U.C. 1987. Phenotypic stability for fruit yield in brinjal (*Solanum melongena* L.). *Haryana Agril. Univ. J. Res.* 17 (2): 189-191.

Kikuchi, K., Honda, I., Matsuo, S., Fukuda, M. and Saito, T. 2008. Stability of fruit set of newly selected parthenocarpic eggplant lines. *Scientia Horticulturae*. **115**: 111-116.

Knekt, P., Jarvinen, R., Seppanen, R., Heliovarra, M., Teppo, L., Pukkala, E. and Aromaa, A. 1997. Dietary flavonoids and the risk of lung cancer and other malignant neoplasms. *American Journal of Epidemology*. **146**: 223-230.

Kumar, A., Dahiya, M.S. and Bhutani, R.D. 2000. Performance of brinjal genotypes in different environments of spring summer season. *Haryana J. Hort. Sci.* **29**: 82-83

Kumar, R.S. and Arumugam, T. 2013. Phenotypic evaluation of indigenous brinjal types suitable for rainfed conditions of South India (Tamilnadu). *African Journal of Biotechnology*. **12**(27): 4338-4342.

Kumaraswamy, L. 2015. Determination of total phenol contents and antioxidant activities in fruits of *Solanum melongena L.* (green) and *Solanum melongena L.* (purple). *International Journal of Advanced Research in Biological Sciences.* **2**(2): 185-189.

Luquez, J.E., Aguirrezabal, L.A.N., Aguero, M.E. and Pereyra, V.R.2002. Stability and adaptability of cultivars in non-balanced yield trials: Comparison of methods for selecting high oleic sunflower hybrids for grain yield and quality. *Crop Science*, **188**:225.

Magioli, C. and Mansur, E. 2005. Eggplant (*Solanum melongena* L.): tissue culture, genetic transformation and use as an alternative model plant. *Acta Bot. Bras.* **19**(1): 139-148.

Malik, Y.P. and Rishi Pal. 2013. Seasonal incidence of brinjal fruit and shoot borer (*Leucinodes orbonalis* Guen.) on different germplasm of brinjal in Central U.P. *Trends in Biosciences.* **6**(4): 389-394.

Mandal, G. and Chaurasia, H.K. 2007. Genotype x environment interaction studies in brinjal (*Solanum melongena* L.). Ph.D Thesis, RAU, Samastipur. *http:/krishikosh.egranth.ac.in/handle/1/15/178.*

Matsubara, K., Kaneyuki, T., Miyake, T. and Mori, M. 2005. Antiangiogenic activity of nasunin, an antioxidant anthocyanin in eggplant peels. *Journal of Agricultural Food and Chemistry.* **53**: 6272-6275.

Mehta, Nandan, Khare, C.P., Dubey, V.K. and Ansari, S.F. 2011. Phenotypic stability for fruit yield and its components in rainy season brinjal (*Solanum melongena* L.) of Chhattisgarh plains. *Electronic Journal of Plant Breeding.* **2**(1):77-79.

Mili, C., Bora, G.C., Das, B. and Paul, S.K. 2014. Studies on variability, heritability and genetic advance in *Solanum melongena* L. (brinjal) genotypes. *Direct Research Journal of Agriculture and Food Science.* **2**(11): 192-194.

Mishra, S.N., Mishra, D. and Mishra, N.C. 1998. Stability analysis in brinjal (*Solanum melongena* L.). *Indian Journal of Horticulture.* **55**(1): 78-80.

Mohamed, A.E., Rashed, M.N. and Mofty, A. 2003. Assessment of essential and toxic elements in some kinds of vegetables. *Ecotox Environ Safe.* 55(3): 251-260.

Mohanty, B.K. 2002. Phenotypic stability of brinjal hybrids. *Progressive Horticulture.* **34**(2): 168-173.

Mohanty, B. K. and Prusti A. M. 2000. Genotype x environment interaction and stability analysis for yield and its components in brinjal *(Solanum melongena* L.). *Journal of Agricultural Science*. **70**: 370-373.

Monica, V.L., Kumar, Anil, Chand, Hari, Paswan, Sudhir and Sanjeev Kumar. 2014. Population dynamics of *Tetranychus urticae* Koch on brinjal crop under North Bihar conditions. *Pest Management in Horticultural Ecosystem*. **20**(1): 47-49.

Naqvi, A.R., Pareek, B.L., Nanda, U.S. and Mitharwal, B.S. 2009. Biophysical characters of brinjal plant governing resistance to shoot and fruit borer, *Leucinodes orbonalis*. *Indian Journal of Plant Protection.* **37**(1&2): 1-6.

Nayak, U.S. 2014. Influence of environmental factors on population dynamics and infestation pattern of *Leucionodes orbonalis* in winter brinjal of Odhisa. *Vegetos*. **27**(3): 244-250.

Nayak, U.S., Baral, K., Mandal, P. and Chatterjee, S. 2014. Seasonal variation in the larval population of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee with respect to different ecological parameters. *International Journal of Bio-resource and Stress Management.* **5**(3): 409-412.

Padi, F.K. 2007. Relationship between stress tolerance and grain yield stability in cowpea. *Journal of Agriculture Science.* Cambridge, **142**: 431-444.

Pandey, K.K., Pandey, P.K., Kalloo, G. and Chaurasia, S.N.S. 2002. Phomopsis blight in brinjal and sources of resistance. *Indian Phytopathology*. **55**(4): 507-509.

Panwar, N.S., Mishra, A.C., Pandey, V., Nautiyal, Mayank and Bahuguna, A. 2013. Evaluation of brinjal (*Solanum melongena* L.) hybrids for growth and yield characters under rainfed mid hill conditions of Uttrakhand. *International Journal of Forestry and Crop Improvement.* **4**(1): 32-35.

Parimi, S. and Zehr, U.B. 2009. Insect resistant crops are integral part of IPM programmes: Bt brinjal. In: Sol 2009: the 6th Solanaceae Genome Workshop,2009 New Delhi, India, book of abstracts, *pp:145*

Pathak, M., Mall, T.P., Ansari, N.A. and Tiwari, J.P. 2007. Screening of brinjal varieties for eco-friendly control against little leaf disease. *International Journal of Plant Science.* **2**(2): 268-269.

Patil, C.U., Asalmol, Prachi and Suri, G.K. 2002. Screening of brinjal cultivars for resistance against phomopsis blight. *Journal of Soils and Crops*. **12**(2): 301-304.

Pimental, D. 2002. Biological Invasions: Economic and environmental costs of alien plant, animal and microbe species. CRCPress, Boca Raton, FL, USA, *pp: 384*

Prasad, V.S.R.K., Singh, D.P., Pal, A.B., Gangopadhyay, K.K. and Pan, R.S. 2002. Assessment of yield stability and ecovalence in egg plant. *Indian Journal of Horticulture.* **59**(4): 386-394.

Prohens, J., Rodriguez, B.A., Raigon, M.D. and Nuez, F. 2007. Total phenolics concentration and browning susceptibility in a collection of different varietal types and hybrids of eggplant: implications for breeding for higher nutritional quality and reduced browning. *Journal of American Society Horticultural Science.* **132**(5): 638-646.

Rai, N., Singh, A.K. and Tirkey, T. 2000(a). Stability in round fruited brinjal hybrids. *Annals of Agricultural Research*. **21**(4): 530-532.

Rai, N., Singh, A.K. and Tirkey, T. 2000(b). Phenotypic stability in long fruited brinjal hybrids. *Vegetable Science*. **27**(2): 133-135.

Rai, N., Singh, A.K. and Tirkey, T. 2001(a). Stability analysis against shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal genotypes. *Annals of Agricultural Research.* **22**(1): 157-159.

Rai, N., Singh, A.K. and Tirkey, T. 2001(b). Stability analysis in long shaped brinjal varieties for yield and its contributing characters. *Advances in Horticulture and Forestry*. **8**: 109-114.

Raigon, M.D., Prohens, J., Munoz-Falcon, J.E. and Nuez, F. 2008. Comparision of eggplant landraces and commercial varieties for fruit content of phenolics, minerals, dry matter and protein. *J Food Compos Anal.* **21**(5): 370-376.

Rangana, S. 1976. Manual of Analysis of Fruits and Vegetables Products, Tata McGraw Hill Co. Pvt. Ltd., New Delhi. P.77.

Rao, Y.S.A. 2003. Diallel analysis over environments and stability parameters in brinjal. Ph.D. thesis submitted to GAU Sardarkrishinagar.

Roychowdhury, R. and Tah, J. 2011. Differential response by different parts of *Solanum melongena* L. for heavy metal accumulation. *Plant Sciences Feed.* **1**(6): 80-83.

Roychowdhary, R., Roy, Souri and Tah, J. 2011. Estimation of heritable components of variation and charcter selection in brinjal (*Solanum melongena* L.) for mutation breeding programme. *Continental Journal of Biological Sciences.* **4** (2): 31-36.

Sabolu, S., Kathiria, K.B., Mistry, C.R. and Kumar, S. 2014. Generation mean analysis of fruit quality traits in eggplant (*Solanum melongena* L.). *Australian Journal of Crop Science*. **8**(2): 243-250.

Samnotra, R.K., Gupta, A., Sharma, N. and Chopra, S. 2011. Stability analysis in chilli (*Capsicum annuum* L.) *Environment and Ecology*. **24**: 570-574.

Sanas, M.P., Sanas, A.P. and Shinde, S.M. 2014. Performance of different types of brinjal for their physical fruit parameters and flowering parameters. *International Journal of Science and Research.* **3** (12): 1995-1997

Sanchez-Castillo, C.P., Englyst, H.N., Hudson, G.J., Lara, J.J., Solano, M.L., Munguia, J.L. and James, W.P. 1999. The non starch polysaccharide content of Mexican foods. *J Food Compos Anal.* **12**(4): 293-314.

San Jose, R., Sanchez-Mata, M.C., Camara, M. and Prohens, J. 2014. Eggplant fruit composition as affected by the cultivation environment and genetic constitution. *J Sci Food Agric.* **94**: 2774-2784.

Sarker, R.H., Yesmin, S. and Hoque, M.I. 2006. Multiple shoot formation in eggplant (*Solanum melongena* L.). *Plant Tissue Culture and Biotechnology*. 16: 53-61.

Sarma, Sitharama and Navdihalli, B.S. 2010. Seasonal incidence and management of brinjal mite, *Tetranychus spp.* Ph.D Thesis. Department of Agricultural Entomology, UAS, Dharwad.

Sarma, S. K., Tallukar P. and Barbara M. 2000. Genotype x environment interacton and phenotypic stability in brinjal. *Annals of Biology*, (Ludhiana). **16**: 59-65.

Sasikumar, A. 1999. Screening of eggplant (*Solanum melongena* L.) genotypes for quality and yield. M.Sc., (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Shaheen, N., Kurshed, A.A.M., Karim, K.M.R., Banu, C.P., Begum, M. and Ishikawa, Y.T. 2013. Total phenol content of different varieties of brinjal (*Solanum melongena* L.) and potato (*Solanum tuberosum* L.) growing in Bangladesh. *Bangladesh Journal of Botany*. **42**(1): 175-177.

Sharma, Muneeshwar, Razdan, V.K. and Gupta, Saurav. 2011. Occurrence of Phomopsis leaf blight and fruit rot of brinjal caused by *Phomopsis vexans* in Jammu. *Annals of Plant Protection*. **19**(2): 396-399.

Shekar, K.C., Ashok, P. and Sasikala, K. 2013. Characterization, character association, and path coefficient analysis in eggplant. *International Journal of Vegetable Science.* **19** (1): 45-57.

Shukla, A. and Khatri, S.N. 2010. Incidence and abundance of brinjal shoot and fruit borer *Leucinoides orbonalis* Guenee. *The Bioscan*. **5**(2): 305-308.

Sidhu, A.S. 1989. Phenotypic stability in brinjal. *Indian Journal of Genetics & Plant Breeding*. **49**(1): 81-83.

Singh, B.K., Singh, S., Singh, B.K. and Yadav, S.M. 2014. Some important plant pathogenic disease of brinjal (*Solenum melongena* L.) and their management. *Plant Pathology Journal*. **13**(3): 208-213.

Singh, G. P., Kalloo, G., Pandey, U. C., Thakral, K. K. and Khurana, S. C. 1985. Phenotypic stability in brinjal. *Harayana Journal of Horticultural Sciences.* **14**(1&2): 118-121.

Singh, S. P. and Nath, P. 2010. Cultural and biophysical management of brinjal shoot and fruit borer (*Leucinodes orbonalis)*. A Biannual New letter of the (CIPS) in cooporation with the (IRAC) and (WRCC-60). **20:** 42- 43.

Singh, P. and Singh, R.N. 2014. Interaction of environmental factors with *Tetranychus neocaledonicus* Andre and its predatory mite in brinjal ecosystem. *Ann. Pl. Protec. Sci.* **23**(1): 23-26.

Sivakumar, V., Uma Jyoti, K., Venket Ramana, C., Paratpara Rao, M.,Rajyalakshmi, R. and Uma Krishna, K. 2015. Genotype x environment interaction of brinjal genotypes against fruit borer. *International Journal of Science and Nature.* **6**(3): 491-494.

Somawathi, K.M., Rizliya, V., Wijesinghe, D.G.N.G., and Madhujith, W.M.T. 2014. Antioxidant activity and total phenolics content of different skin coloured brinjal (*Solanum melongena*). *Tropical Agricultural Research.* **26**(1): 152-161.

Srivastava, B.P., Singh, K.P. and Srivastava, J.P. 1997. Stability for fruit yield in brinjal. *Vegetable Science*. **24**(1): 43-44.

Stommel, J.R, and Whitker, B.D. 2003. Phenolic acid content and composition of eggplant fruit in a germplasm core subset. *Journal of American Society of Horticultural Science*. **128**: 704-710.

Stommel, J.R., Whitaker, B.D., Haynes, K.G. and Prohens Jamie. 2015. Genotype x environment interactions in eggplant for fruit phenolics acid content. *Euphytica*. **205**: 823-836

Suneetha, Y., Patel, J.S., Khatharia, B. Bhanvadia, A. S., Kaharia, P.K., Patel, S.T. 2006(a). Stability analysis for quantitative traits in egg plant (*Solanum melongena* L.). *Crop Research*. **32**(2): 183-187.

Suneetha, Y., Patel, J.S., Khatharia, B. Bhanvadia, A. S., Kaharia, P.K., Patel, S.T. 2006(b). Stability analysis for yield and quality in Brinjal (*Solanum melongena* L.). *Indian Jouranl of Genetics*. **66**(4):351-352.

Suneetha, Y., Kathiria, K.B. and Srinivas, T.2006(c). Genotype x season interaction and phenotypic stability for yield and quality in aubergine. *International Journal of Plant Sciencs*. **1**(2): 177-181.

Thimmaiah, S.K. 1999. Standard Methods of Biochemical Analysis. Kalyani Publishers. p.287-288.

Tindall, H. D. 1978. Commercial Vegetable Growing. University Press, London.

Tripathi, M., Singh, P., Pandey, P., Pandey, V.R., and Singh H. 2014. Antioxidant activities and biochemical changes in different cultivars of brinjal (*Solanum melongena* L.). *American Journal of Plant Physiology*. **9**(1): 24-31.

United States Department of Agriculture (USDA). 2014. USDA national nutrient Database for Standard Reference. *http://www.nal.usda.gov /fnic/foodcomp/search*.

Vadodaria, M.A., Kulkarni, G.H., Madariya,R.B. and Dobariya, K.L. 2009(a). Stability for fruit yield & its component traits in brinjal. *Crop Improvement*. **36**(1):81-87.

Vadodaria, M.A., Dobariya, K.L. , Bhatia, V.J. and Mehta D.R. 2009(b). Stability of brinjal hybrids against fruit borer. *Indian Journal of Agricultural Research*. **43**(2): 88-94.

Vadivel, E. and Bapu, J.R.K. 1989. Genotype x environment interaction for fruit yield in eggplant (*Solanum melongena* L.). *South Indian Horticulture*. **37**(3): 141-143.

Verma, M. M., Gill, K.S. and Vir, D.S. 1987. Genotype – environment interaction, its measurement and significance in plant breeding. Communication Centre, Punjab Agricultural University, Ludhiana, 101.

Verma, R.K. and Bhale, U. 2003. Yield loss relationship in eggplant infected with *Phomopsis vexans* (Sacc. And Syd.) Harter. *JNKVV Research Journal*. **37**(2): 46-48.

Vinson, J.A., Hao, Y., Su, X. and Zubik, L. 1998. Phenol antioxidant quantity and quality in foods: vegetables. *Journal of Agricultural Food and Biochemistry*. **46**: 3630-3634.

Wetwitayaklung, P. and Phaechamud, T. 2011. Antioxidant activities and phenolics content of *Solanum* and *Capsicum* sp. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. **2**(2): 146-154.

Appendix I: Stability Response of brinjal genotypes (*Solanum melongena* L.) to various traits

S. No.	Traits	Stability		
		Adapted to all type of environments	**Specifically adapted to favourable environment**	**Specifically adapted to unfavourable environments**
1	Days to 50% flowering	Pusa Ankur, Navkiran Improved	PPL-74, Chhaya, PBH-3, Shamli, Punjab Sadabahar, Pusa Uttam,	PPL
2	Days to Ist picking	PBH-3, Shamli	PPL-74, MH-80, Abhishek,Pb Sadabahar, Pusa Kranti, Pusa Ankur, BR-14	Navkiran Improved, Chhaya
3	Fruit length (cm)	Sandhya, Pusa Ankur	PBH-3, Arka shrish, BR-14	Rajni, MH-80, Chhaya, Nisha Improved
4	Fruit diameter (cm)	Rajni, Pusa Kranti, PPR	BR-14, MH-80	Navkiran Improved, Chhaya, Nisha Improved
5	Number of fruits/plant	Navkiran Improved, Pusa Ankur	Nisha improved, Arka Keshav, Pusa kranti	Rajni, Abhishek, MH-80, PBH-3, Pusa Shymala
6	Average fruit weight (g)	PPL-74, Abhishek, Sandhya	PBH-3, Pusa Uttam	Shamli, Punjab Sadabahar, PPL
7	Number of leaves/plant	Rajni, Nisha Improved	PPL-74, Shamli, PPL	Abhishek
8	Plant height (cm)	Shamli, Rajni, Navkiran Improved, Nisha Improved, PPL	Arka Kusumkar, Arka Shirish, Arka Neelkanth	PBH-3, Abhishek, Pusa Kranti, Pusa Ankur
9	Number of primary branches/plant	PPL-74, MH-80, Abhishek, Punjab Sadabahar, Pusa Ankur	Rajni, Navkiran Improved, Nisha Improved, Shamli, Pusa Kranti, BR-14	-
10	Leaf area (cm^2)	Nisha Improved	MH-80, Arka Shirish	PBH-3, Abhishek, Arka Kusumkar
11	Marketable yield/plant (kg)	Shamli, Punjab Sadabahar	PPL-74, MH-80	-
12	Unmarketable yield/plant (kg)	Chhaya	-	Shamli,Arka Shirish, Arka Kusumkar, Arka Nidhi, Arka Neelkanth, PPR,Pusa Shymala, PPC Puneri Kateri
13	Fruit yield/plant (kg)	Shamli,Punjab Sadabahar	PPL-74, MH-80, Pusa Kranti	Arka Kusumkar, Arka Nidhi, Arka Keshav, PPR, PPC, Pusa Shymala, Puneri Kateri
14	Fruit yield/hectare(q)	PPL-74	Shamli	Punjab Sadabahar
15	Ascorbic acid content (mg/100g)	Sandhya, Chhaya	Navkiran Improved, PBH-3	Rajni, PPL-74, Shamli, Punjab Sadabahar
16	Total phenol content (mg/100g)	PPL-74	-	Arka Shirish, Pusa Uttam, PPR, BR-14
17	Shoot borer infestation (%)	Rajni	Arka Shirish, Pusa Shymala	Shamli, PPL-74, Arka Nidhi, Sandhya
18	Fruit borer infestation (%)	Pusa Kranti	Arka Shirish	PPL-74, Sandhya, Shamli, Arka Nidhi, Pusa Ankur
19	Spider mite infestation (%)	Chhaya, BR-14	Sandhya	PPL-74, Shamli, Abhishek, Nisha Improved, Punjab Sadabahar
20	Little leaf incidence (%)	Nisha Improved, PPC, Nisha Improved	-	PPL-74, Shamli, Rajni, Sandhya, Punjab Sadabahar, Puneri Kateri
21	Phomopsis blight (%)	Sandhya, Pusa Kranti	-	Rajni, PPL-74, Shamli, Chhaya, Nisha Improved Abhishek, Arka Neelkanth, Puneri Kateri

Appendix II: List of top performing genotypes under individual environments for some important traits

Environment	Temp. (^oC)	Relative Humidity	Rainfall (mm)	Rainy days	Number of fruits per plant	Average fruit weight (g)	Fruit yield per ha (q)	Minimum fruit borer incidence (%)
E1 Sept, 13 Oct, 13 Nov, 13 Dec, 13 Jan, 14	 27.7 24.1 16.6 12.6 11.7	 73.1 70.8 66.6 74.1 74.1	 37.9 13.4 3.1 2.7 15.1	 7 3 1 2 3	Shamli PPL-74 PPC Navkiran Improved Arka Nidhi	Pusa Uttam Rajni Sandhya PBH-3 PPR	PPL-74 Sandhya Abhishek Pusa Ankur Shamli	Shamli ArkaNidhi PPC PPL-74 Pusa Ankur
E2 Feb, 14 Mar, 14 Apr, 14 May, 14 Jun, 14 Jul, 14	 13.3 17.6 22.1 27.6 28.9 30.4	 76.5 72.1 58.9 48.1 43.5 69.5	 5.9 20.9 10.6 3.8 6.4 20.4	 4 8 5 2 2 5	Shamli PPL-74 PPC Arka Nidhi Pb Sadabahar	BR-14 Pusa Uttam Rajni Sandhya PBH-3	PPL-74 Shamli Pusa Kranti Pusa Uttam Pusa Ankur	Shamli Arka Nidhi PPL-74 Arka Keshav Pusa Ankur
E3 Jun, 14 Jul, 14 Aug, 14 Sept, 14 Oct, 14	 28.9 30.4 29.0 25.8 23.6	 43.5 69.5 77.1 74.2 69.6	 6.4 20.4 54.0 125.3 4.6	 2 5 10 9 1	PPL-74 Shamli PPC Arka Keshav Navkiran Improved	BR-14 Pusa Uttam Rajni PBH-3 Sandhya	PPL-74 Shamli Pusa Kranti Sandhya PBH-3	Shamli PPL-74 Arka Nidhi Arka Keshav Pusa Ankur
E4 Sept, 14 Oct, 14 Nov, 14 Dec, 14 Jan, 15	 25.8 23.6 17.9 11.6 10.9	 74.2 69.6 64.9 76.6 80.2	 125.3 4.6 1.6 0.0 4.1	 9 1 1 0 2	Shamli PPL-74 Pusa Ankur Sandhya Arka Nidhi	BR-14 Pusa Uttam Rajni Sandhya PBH-3	PPL-74 Sandhya Pb Sadabahar Shamli Navkiran Improved	Shamli Arka Nidhi PPC PPL-74 Sandhya
E5 Feb, 15 Mar, 15 Apr, 15 May, 15 Jun, 15 Jul, 15	 14.9 17.6 24.0 28.5 30.0 29.9	 73.4 74.0 63.9 49.7 50.5 72.3	 28.7 68.9 35.5 11.2 22.5 101.9	 7 12 8 3 3 11	Shamli PPL-74 PPC Arka Nidhi Nisha Improved	BR-14 Pusa Uttam Rajni PBH-3 Sandhya	Shamli PPL-74 Pusa Kranti Sandhya Pusa Ankur	Shamli PPL-74 Arka Nidhi Pusa Ankur Sandhya
E6 Jun, 15 Jul, 15 Aug,15 Sept, 15 Oct, 15	 30.0 29.9 29.5 27.6 23.3	 50.5 72.3 73.3 69.2 71.9	 22.5 101.9 35.0 34.1 7.3	 3 11 10 3 6	Shamli PPL-74 PPC Arka Nidhi Pb Sadabahar	BR-14 Pusa Uttam Rajni PBH-3 Sandhya	Shamli Sandhya Pusa Kranti PPL-74 Rajni	PPL-74 Shamli Arka Nidhi Pusa Ankur PPC

Besides, Shamli, Chhaya, PPL-74, Sandhya,Pusa Kranti and Punjab Sadabahar were found most tolerant to waterlogged conditions for 72 hours.

Appendix III: Standard Meteorological Week data for the Year 2013

Met. Week	Date & month	Rainfall (mm)	Rainy days	Relative Humidity (%)		Temperature (^{0}C)	
				Morning	Afternoon	Maximum	Minimum
35	27Aug-2 Sep	76.4	3	87	65	33.5	23.8
36	3-9 Sep	76.1	3	84	65	32.2	23.0
37	10-16 Sep	3.2	0	83	58	32.6	23.1
38	17-23 Sep	0.0	0	86	56	33.0	21.6
39	24-30 Sep	31.1	1	84	63	32.4	22.3
40	1-7 Oct	28.2	2	84	65	31.4	21.8
41	8-14 Oct	34.6	1	89	63	30.9	22.1
42	15-21 Oct	0.0	0	89	48	31.2	17.2
43	22-28 Oct	0.0	0	90	50	29.6	16.5
44	29 Oct-4 Nov	4.4	0	93	37	27.7	12.6
45	5-11 Nov	12.2	1	92	49	23.5	11.4
46	12-18 Nov	0.0	0	93	32	25.6	7.5
47	19-25 Nov	0.0	0	94	40	25.1	7.9
48	26 Nov-2 Dec	0.0	0	94	39	25.1	7.1
49	3-9 Dec	0.0	0	94	44	23.7	7.0
50	10-16 Dec	0.0	0	95	45	22.4	6.1
51	17- 23 Dec	7.8	1	97	73	15.6	7.0
52	24-31 Dec	3.0	1	96	49	17.1	2.3

AppendixIV: Standard Meteorological Week data for the Year 2014

Met. Week	Date & month	Rainfall (mm)	Rainy days	Relative Humidity (%)		Temperature (^0C)	
				Morning	Afternoon	Maximum	Minimum
1	1-7 Jan	007.4	1	96	49	18.4	1.6
2	8-14 Jan	001.2	0	85	51	18.0	4.4
3	15-21 Jan	000.0	0	96	66	17.8	6.0
4	22-28 Jan	052.0	2	95	55	20.5	6.9
5	29 Jan -4 Feb	006.0	1	94	73	18.7	8.5
6	5-11 Feb	007.7	1	91	64	18.4	7.7
7	12-18 Feb	005.8	1	92	50	19.1	5.4
8	19-25 Feb	004.0	1	93	55	21.4	7.6
9	26 Feb -4 Mar	002.6	1	92	56	20.3	9.1
10	5-11 Mar	047.4	2	89	58	22.2	10.3
11	12-18 Mar	038.4	2	85	52	25.6	12.3
12	19-25 Mar	013.4	2	86	69	24.3	12.5
13	26 Mar -1 Apr	002.8	1	85	49	27.2	12.9
14	2-8 Apr	019.5	3	84	53	25.6	13.5
15	9-15 Apr	000.0	0	76	39	29.7	12.9
16	16-22 Apr	023.0	2	81	42	28.6	14.1
17	23-29 Apr	000.0	0	70	27	35.8	17.2
18	30 Apr -6 May	011.5	1	64	30	37.3	20.4
19	7-13 May	003.8	1	69	37	33.9	19.8
20	14-20 May	000.0	0	71	38	34.1	18.9
21	21-27 May	000.0	0	50	26	36.7	20.0
22	28 May -3 Jun	000.6	0	50	23	37.4	21.8
23	4-10 Jun	000.0	0	51	16	43.1	21.5
24	11-17 Jun	000.0	0	55	32	40.9	24.2
25	18-24 Jun	000.0	0	57	38	38.4	25.5

26	25 Jun -1 July	026.2	2	68	45	36.9	25.3
27	2-8 July	014.2	1	76	50	36.1	25.1
28	9-15 July	007.4	1	68	45	39.2	27.6
29	16-22 July	026.8	1	82	65	34.3	24.9
30	23-29 July	033.4	2	89	81	30.9	25.7
31	30 July -5 Aug	086.6	4	89	64	35.2	24.7
32	6-12 Aug	044.3	2	87	71	33.9	24.7
33	13-19 Aug	127.8	3	88	66	33.0	23.5
34	20-26 Aug	000.0	0	85	55	34.7	25.3
35	27 Aug -2 Sep	011.2	1	88	78	31.8	24.0
36	3-9 Sep	454.7	5	88	78	26.9	21.7
37	10-16 Sep	033.9	3	84	63	31.0	21.5
38	17-23 Sep	012.6	1	77	63	32.8	17.7
39	24-30 Sep	000.0	0	82	59	32.0	22.8
40	1-7 Oct	000.0	0	91	67	31.7	23.9
41	8-14 Oct	016.9	1	81	54	28.8	16.8
42	15-21 Oct	001.6	0	79	50	28.1	14.6
43	22-28 Oct	000.0	0	83	52	28.4	16.6
44	29 Oct -4 Nov	000.0	0	85	47	27.1	13.0
45	5-11 Nov	008.0	1	88	47	26.8	12.7
46	12-18 Nov	000.0	0	83	39	26.1	8.4
47	19-25 Nov	000.0	0	85	44	24.7	7.3
48	26 Nov -2 Dec	000.0	0	90	41	24.8	8.1
49	3-9 Dec	000.0	0	91	41	24.9	6.0
50	10-16 Dec	000.0	0	92	53	19.8	5.4
51	17- 23 Dec	000.0	0	97	78	12.9	5.1
52	24-31 Dec	000.0	0	94	67	15.8	3.3

AppendixV:Standard Meteorological Week data for the Year 2015

Met. Week	Date & month	Rainfall (mm)	Rainy days	Relative Humidity (%)		Temperature (^{0}C)	
				Morning	Afternoon	Maximum	Minimum
1	1-7 Jan	0	0	90	70	15.9	6.5
2	8-14 Jan	5.4	1	97	78	10.9	6.3
3	15-21 Jan	0	0	92	55	19.2	5
4	22-28 Jan	11.2	1	96	64	17.3	6.4
5	29 Jan -4 Feb	57.8	2	91	54	18.3	5.4
6	5-11 Feb	0	0	86	55	21.4	6.4
7	12-18 Feb	5.8	1	85	60	22.6	10.3
8	19-25 Feb	51.3	4	89	68	22.8	12.4
9	26 Feb -4 Mar	116.6	2	88	64	19.5	9.7
10	5-11 Mar	20.8	3	91	63	20.6	9.7
11	12-18 Mar	107.4	3	89	63	22.6	10.1
12	19-25 Mar	0	0	83	47	29.1	13.5
13	26 Mar -1 Apr	99.6	4	85	67	26.1	15.5
14	2-8 Apr	112.0	5	83	58	25.0	15.1
15	9-15 Apr	0	0	74	46	31.4	16.8
16	16-22 Apr	30	3	77	48	32.1	17.8
17	23-29 Apr	0	0	63	63	35.1	19.2
18	30 Apr -6 May	0.0	0	67	35	34.3	16.8
19	7-13 May	9.1	2	63	44	37.3	21.5
20	14-20 May	8.4	1	76	34	36.4	21.4
21	21-27 May	0.0	0	59	20	39.7	20.8

22	28 May -3 Jun	1.8	0	59	29	37.2	21.5
23	4-10 Jun	0	0	60	34	37.6	21.6
24	11-17 Jun	4.4	1	61	37	37.4	22.7
25	18-24 Jun	16.3	1	65	45	37.7	24.5
26	25 Jun -1 July	89.8	1	67	48	36.7	23.6
27	2-8 July	31.8	1	75	55	36.5	26.0
28	9-15 July	146.9	4	85	64	33.5	24.0
29	16-22 July	102.6	2	83	71	33.5	26.4
30	23-29 July	126.2	4	84	62	34.5	24.9
31	30 July -5 Aug	15.8	2	82	67	33.4	25.5
32	6-12 Aug	101.6	5	91	73	32.5	25.0
33	13-19 Aug	19.0	1	78	63	34.5	25.9
34	20-26 Aug	38.4	2	84	69	34.0	24.7
35	27 Aug -2 Sep	0.0	0	75	55	35.2	24.9
36	3-9 Sep	28.8	1	78	53	34.6	22.6
37	10-16 Sep	0	0	80	53	35.1	23.6
38	17-23 Sep	107.6	2	86	61	32.0	21.2
39	24-30 Sep	0	0	87	56	32.0	19.7
40	1-7 Oct	0	0	84	48	33.0	18.4
41	8-14 Oct	0	0	85	51	31.9	20.6
42	15-21 Oct	19.0	3	85	44	30.2	16.7
43	22-28 Oct	14.4	2	83	68	27.6	14.2
44	29 Oct -4 Nov	3.0	1	90	81	27.0	13.8

Source: Agrometerology observatory, Division of Agronomy, SKUAST-J, Chatha

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CERTIFICATE-IV

Certified that all necessary corrections as suggested by external examiner and the advisory committee have been duly incorporated in the thesis entitled **"Phenotypic stability studies in brinjal (*Solanum melongena* L.)"** submitted by **Mr. Anil Bhushan (Registration No. J-12-D-161-A).**

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