GENETIC IMPROVEMENT IN BRINJAL (*Solanum melongena* L.) USING HALF DIALLEL MATING DESIGN

Thesis

by

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CERTIFICATE-I

This is to certify that the thesis titled, "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" submitted in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE (HORTICULTURE) VEGETABLE SCIENCE** in the discipline of **HORTICULTURAL SCIENCES** to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) -173230 is a bonafide research work carried out by **Ms. AAKANKSHA THAKUR (NH-2023-39-M)** daughter of Shri. Jai Chand Thakur under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigation has been fully acknowledged.

Place: Neri, Hamirpur (H.P)
Dated:

Dr. Shiv Pratap Singh
Chairman
Advisory committee

CERTIFICATE-II

This is to certify that the thesis entitled **"Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design"** submitted by **Ms. AAKANKSHA THAKUR (NH-2023-39-M)** daughter of Shri. Jai Chand Thakur to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) - 173230, India in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE) VEGETABLE SCIENCE** in the discipline of **HORTICULTURAL SCIENCES** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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This is to certify that all the mistakes and errors pointed out by external examiner have been incorporated in the thesis entitled "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" submitted by **Ms. Aakanksha Thakur (NH-2023-39-M)** daughter of Shri Jai Chand Thakur to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) –173 230 in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE (HORTICULTURE) VEGETABLE SCIENCE** in the discipline of **HORTICULTURAL SCIENCES.**

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Place: Neri, Hamirpur (H.P) **(Aakanksha Thakur)**

Dated:

CONTENTS

ABBREVIATIONS

%	:	Percent
=	:	Equal to
^{0}C	:	Degree Celsius
ANOVA	:	Analysis of Variance
RCBD	:	Randomized complete block design
SE	:	Standard Error
CD	:	Critical Difference
et al.	:	Co-workers
GCA	:	General Combining Ability
SCA	:	Specific Combining Ability
cm	:	Centimeter
m	:	Meter
mm	:	Millimeter
mg	:	Milligram
g	:	Gram
kg	:	Kilogram
HP	:	Himachal Pradesh
^{0}B	:	Degree Brix
/	:	Per
viz.	:	Videlicet (namely)
i.e.	:	That is
TSS	:	Total Soluble Solids
F_1	:	First Filial generation
F_2	:	Second Filial generation

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INTRODUCTION

Chapter-1

INTRODUCTION

Brinjal, also known as eggplant (*Solanum melongena* L.), sometimes referred to as aubergine or guinea squash globally has diploid chromosome number of 2n=24 and belongs to Solanaceae family. It is mainly a self-pollinated crop which originated in India and has lot of diversity in the country (Vavilov, 1951); while its secondary centre of origin is Southeast Asia. Brinjal genotypes show sufficient variability in terms of different morphological traits as the plants may be herbaceous, branched, semi-erect, erect and about one meter or lower in height. Plants may be spiny or non-spiny, with or without anthocyanin pigmentation. Similarly, the fruits among the various genotypes may vary in size, colour and shape and may be long, oblong, oval, round, obovoid, egg-shaped, cylindrical, elongated, ellipsoid or spherical.

Brinjal is highly nutritive vegetable which is a rich source of various minerals like calcium, magnesium, potassium, iron, zinc and copper. The edible portion of brinjal contains moisture (92.7%), Calcium (18 mg/100 g), Magnesium (15 mg/100 g), Potassium (2 mg/100 g), Phosphorus (47 mg/100 g), Iron (0.38 mg/100 g), Sulphur (44 mg/100 g), Zinc (0.22 mg/100 g), Protein (1.4 g/100 g), Fat (0.3 g/100 g), Carbohydrates (4.0%), Vitamin A (124 I.U./100g), Vitamin C (12 mg/100 g), a small quantity of Vitamin B Complex and Fibre (1.3 g/100 g). In addition to this, it is also a fair source of fatty acids. It possesses antioxidant properties and offers anti-diabetic and cardio-protective benefits (Mibei et al., 2017). The presence of α-glucosidase and α-amylase inhibitors in white brinjal makes it beneficial for individuals with diabetes.

It is widely grown in tropical and subtropical environments as warm season annual and tropical perennial crop respectively. In Asia and the Mediterranean region, it ranks among the top five most important vegetable crops. At world level it is grown in an area of 1.89 million hectare with a production of 59.13 million tonnes per hectare (Anonymous, 2022). However, in India it is grown on an area of 6.78 lakh hectare, with a total production of 12.95 million tonnes per hectare

(Anonymous, 2023). While, in Himachal Pradesh the crop is widely grown in low hills and the total area covered by the crop in state is 1.16 thousand hectare and the total production is 21.35 thousand tonnes (Anonymous, 2024).

Phomopsis blight is an important destructive fungal disease of brinjal prevalent in low hills of Himachal Pradesh which is caused by the pathogen *Phomopsis vexans*. This disease is favoured by warm and humid regions and affects all the above-ground parts of the plant at various stages of the crop growth. This disease results in crop losses ranging from 15-20% (Hossain et al., 2013). The disease can lead to fruit rot which can make them unmarketable. Besides this, the pathogen can also infect seeds, resulting in seedling blight and poor germination. Hence, during the present study efforts were made to screen the parental genotypes and hybrids developed under natural epiphytotic conditions against phomopsis blight of brinjal.

The phenomenon of hybrid vigour in brinjal has been widely used to enhance yield and other yield related traits (Timmareddygari et al., 2021) The local cultivated brinjal genotypes are widely grown by the farmers and they are already adapted to the region; thus, these genotypes can play an important role if, introduced in the hybridisation programme for developing adapted high yielding varieties of brinjal with several desirable traits. The high level of heterosis in desirable direction along with high SCA variance and non-additive type of gene action have been reported in brinjal for several traits including yield (Bavage et al., 2005); thus making the hybrid breeding the first option for breeders for developing improvised varieties of brinjal. Amongst, the various mating designs suggested for developing hybrids and assessing the GCA of parents along with the SCA of the crosses; the half diallel mating design proposed by Griffing (1956) is quite useful and has been used in the present investigation for the development of hybrids. In brinjal many workers have used this design for the estimation of the components of variation and for deriving the combining ability of the parents and crosses (Hazra et al., 2010).

Therefore, for developing high yielding locally adapted hybrids with other improvised quantitative and qualitative horticultural traits and to know the GCA of the parents and the SCA of the different cross combinations the present study

entitled "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" has been undertaken with the following objectives:

i. To estimate the magnitude of heterosis for yield and other important horticultural traits in brinjal.

ii. To evaluate brinjal lines for GCA (General Combining Ability) and SCA (Specific Combining Ability).

iii. To assess the magnitude and nature of gene action.

REVIEW OF LITERATURE

Chapter-2

REVIEW OF LITERATURE

The present investigation entitled "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" was carried out inorder to work out heterosis and to know about combining ability and gene action with respect to yield and its contributing traits. The relevant literature available on the various aspects pertaining to the present study is briefly reviewed under the following sub-heads:

2.1 Heterosis

2.2 Combining ability

2.3 Gene action studies

2.1 Heterosis

Heterosis or hybrid vigour is the phenomenon where hybrid offspring exhibit superior traits or performance compared to their parents. This is determined by the hybrid's efficiency in a specific environment rather than by its absolute worth and appearance. The term "heterosis," as it is currently used, was coined by Shull (1948) and refers to the phenomenon in which the F_1 hybrid obtained by crossing two dissimilar individuals shows the increased or decreased vigour over the better or mid-parental value.

Fonseca and Patterson (1968) used term "heterobeltiosis" to describe the improvement of heterozygotes in relation to better parent. The term "heterobeltosis" most frequently refers to the phenomenon whereby the F_1 population created by mating two genetically different individuals show increased vigour over mid-parental value (relative heterosis) or over better parental value. Standard heterosis or economic heterosis has become more valuable and it manifests as increased or decreased vigour over the standard check variety or hybrid. There are several studies that have reported different estimates of heterosis for brinjal's yield and contributing characteristics. The facts pertaining to these qualities are briefly described as follows:

Mishra (1977) examined the vigour of 12 hybrids of the brinjal and found a wide range of heterobeltiosis in the following characters: fruit length (26.31%) in Pusa Purple Cluster × Type 3, plant height (31.27%) in Banarsi Giant Round × Pusa Purple Long, number of fruits per plant (85.08%) in Type 2 × Banarsi Giant Long and yield per plant (62.08%) in T2 × Banarsi Giant Long over better parents.

30 F_1 hybrids of brinjal along with ten parental lines and three testers were evaluated by Prasath et al. (1998) to assess the magnitude of heterosis. They reported highly significant and positive heterobeltiosis across various traits, including fruit yield (ranging from -0.17% to 101.86%), plant height (-34.19% to 27.26%), number of branches per plant (-16.96% to 63.81%), days to flowering (-10.27% to 16.03%), fruit length (-45.54% to 28.34%), fruit girth (-44.21% to 111.40%), fruit weight (-45.81% to 146.20%), and number of fruits per plant (-39.96% to 120.24%).

The standard heterosis of the top five aubergine hybrids, as determined by Mohanty (2003), were 85.14, 81.50, 75.36, 70.16 and 68.46%, respectively. More number of fruits produced per plant and increased fruit size were the main causes of the higher yield. The bigger fruits of Sufal and the long, thin fruits of Hybrid Green were not favoured; instead, Nisha, Neelgiri and Ravaiya, which produced small to medium-sized fruits per plant, were suggested for commercial production. With the tallest plant (108.68 cm), Navkiran recorded a standard heterosis of 32.33%. The plant with the highest number of branches per plant was Hybrid Green (6.17). Revaiya recorded a standard heterosis of 97.16% and had the most fruits per plant (26.42). Supriya recorded a standard heterosis of 140.00% and produced the biggest fruit, weighing 167.93 g.

Saraswathi (2003) examined six crosses and their F_2 in brinjal viz., SM-6 x Ceylon, SM-6 x Taiwan Naga, SM-6 × Arka Shirish, SM-6 × Erengere, WCGR × Ceylon and WCGR × Taiwan Naga. All F_2 populations showed positive heterosis for the number of branches, except for WCGR × T. Naga (-6.84%). SM-6 × Erengere showed negative heterosis (-2.05%) for leaf area. F_2 populations of SM-6 × A. Shirish (-6.07%) and WCGR × T. Naga (-6.67%) showed negative heterosis for the number of days needed for flowering. SM-6 × Erenger (10.82%) and WCGR × T. naga (41.60%) both showed residual heterosis for number of fruits per plant.

Fruit girth (1.61%) and fruit length (1.32%) showed positive heterosis in the F_2 population of WCGR × Ceylon.

To assess the heterobeltiosis, economic heterosis and standard heterosis for fruit yield per plant, Baig et al. (2005) evaluated 45 hybrids with respective values ranging from -56.76 to 93.32, -18.85 to 190.77 and -39.98 to 118.64%. With the highest levels of heterosis, the hybrids ABV 1 × Anuradha, PBR 129-5 × ABV 1 and ABV 1 × Vaishali produced the maximum number of fruits (1.41, 1.33 and 1.27 kg/plant, respectively). The high manifestation of heterosis for average fruit weight and fruit number/plant seems to be the cause of heterosis for fruit yield per plant and its subsequent increase.

Prabhu et al. (2005) measured heterosis in five hybrids for marketable fruit yield and other components in brinjal. Hybrid EP 65 × Pusa Uttam registered the highest and significant heterosis (52.36%), heterobeltiosis (41.33%) and standard heterosis (51.74%) for yield per plant. This hybrid also possessed significant heterosis for number of fruits per plant and fruit borer infestation in desired direction. Another hybrid EP 12 x MDU 1 also exhibited significant and positive standard heterosis (34.56%) for yield per plant, plant height (57.36%) and branches per plant (82.13%). Standard heterosis for fruit borer infestation was also significant and negative (-44.85%) in the above said hybrid.

Suneetha et al. (2006) discovered that the best parent had the highest expression of heterosis for total soluble sugars and leaf area per plant compared to the control (GBH 1). Heterobeltiosis and standard heterosis over 20% were also noted for fruit pickings per plant, 100-seed weight and days till first picking. The possibility of hybrid production during the off-season was suggested by the high levels of heterosis shown in summertime eggplant hybrids for fruit yield, yield components, quality and physiological characteristics. The hybrid JB 64-1-2 x AB 98-13 was found to be a promising hybrid for both fruit yield and quality for off-season cultivation, while PLR 1 x JBPR 1, a relatively early and dwarf hybrid, was identified as a potential hybrid combination for fruit yield per plant.

The cross AS × GR exhibited the highest heterosis for fruit yield per plant (175.87%), as reported by Shafeeq et al. (2007), followed by AS × KA (50.26%) and BL × GR (41.64%). While the hybrid AS × KA only exhibited significant

heterosis for the average fruit weight of brinjal, the AS × GR hybrid additionally showed highly significant heterosis for both the average fruit weight and the number of fruits per cluster.

Chowdhury et al. (2010) conducted a study involving 15 crosses developed through a half diallel mating design among six inbred lines of brinjal and evaluated them for heterosis over the better parent and standard check across various important agronomic traits. Three replications were employed and the hybrid variety "Tarapuri" served as the standard check. The fruit yield of promising hybrids showed significant positive heterosis, with magnitudes ranging from 9.63% to 74.89% and 8.52% to 72.60% above the standard check and better parent, respectively. Desired heterosis for earliness, higher fruit number and yield was demonstrated by few of the potential hybrids.

12 brinjal crosses generated using a Line × Tester mating design were analyzed by Ramieddy et al. (2011) to study their genetic behaviour. They found that the cross between Arka Shirish and WCGR had the highest positive significant heterosis for fruit yield per plant (84.93% and 60.71%) over the mid parent and better parent, respectively, while the cross between Arka Shirish and IIHR-7 showed (31.02%) maximum hetrosis over the commercial check. For average fruit weight, number of fruits per cluster and number of flowers per cluster, the hybrid Mattugulla x WCGR showed significant heterosis over other hybrids.

According to Nalini et al. (2011), the hybrids IC-112 × IC-909, IC-112 × IC-996 and IC-111 × IC-136 demonstrated significant heterosis for yield components such as fruit weight, number of branches per plant and number of fruits per plant in brinjal.

Singh et al. (2012) evaluated 40 F_1 hybrids and 14 parent lines to study heterosis in brinjal. Significant heterosis over the better parent was observed in several crosses: BR-112 × Aruna for fruit length and diameter; Pant Samrat × Punjab Neelam for fruit number per plant; H-7 × Aruna for fruit weight; and H-9 × S-16 for total yield per plant. The cross HE12 × Aruna showed notable heterosis for the first fruit set. Furthermore, negative heterosis for borer infestation was recorded in the crosses Pant Rituraj × Punjab Neelam and KT-4 × Aruna.

A study on heterosis and other genetic factors in 60 brinjal hybrids, which included four male testers and 15 female lines, was conducted by Ram and Singh (2012), evaluating 10 different traits. Over economic parents, the highest value for positive heterosis 69.23% was observed. Cross combinations KS 223 × T 3, KS 263 × AB 1, ACC 2623 × T 3, ACC8206 × T 3, ACC 8204 × T 3, KS 247 × T 3 and KS 227 × AB 1 for characters days to flowering, days to marketable maturity, plant height (only for KS 223 × T 3), number of branches per plant, number of fruits per plant, width of fruit (only for KS 263 × AB 1), fruit weight (except S 247 × T 3 and KS 227 × AB 1) and plant spread showed maximum heterotic effects.

By utilizing diallel mating fashion for nine parents for developing hybrids Praneetha et al. (2013) developed hybrids in brinjal and studied the impact of heterosis on several trait viz., fruit yield and resistance to fruit borer and shoot borer in brinjal. EP 12 × MDU 1 had the highest heterobeltiosis percentage, followed by EP 65 × Pusa Uttam. For marketable yield per plant, EP 65 × Pusa Uttam had the best parental heterosis. The hybrid EP 5 × APAU Bagmathi showed the highest negative heterobeltiosis for shoot borer infestation. Significant and negative heterosis over better parent was observed in the hybrid EP 65 × MDU 1. The hybrid EP 65 × Pusa Uttam (-18.40%) had the highest significant and negative heterosis over better parent for fruit borer infestation. Only one hybird viz., EP 65 × Pusa Uttam showed significant and positive heterobeltiosis for marketable fruit yield.

Naresh et al. (2013) investigated heterosis in brinjal using line (12) x tester (3) analysis and it was discovered that the cross combinations KS-8507 × KS-7512 (112.64%), KS-5623 × KS-7512 (110.39%) and KS-7846 × KS-8822 (92.47%) recorded a significant increase over mid-parent for yield per plant, while highly significant and positive heterosis over mid-parent was observed for the number of branches per plant (KS-7509-1 × KS-7512, 63.14%), fruit length (KS-5623 × KS-7512, 72.73%), fruit diameter (KS-6103 × KS-8821, 63.27%), fruit weight (KS-7570 × KS-8821, 21.36%) and number of fruits per plant (KS-5623 × KS-7512, 76.72%). Days to 50% flowering and days to maturity in KS-6103 × KS-8821 showed highly significant but negative heterosis over mid parent (-18.18% and -18.75%, respectively). The study concluded that these hybrids may be developed and used in next breeding initiatives to enhance yield components.

Reddy and Patel (2014) evaluated 20 F_1 hybrids formed from five lines × four testers were analysed; the cross AB-8/5 × GJB-2 provided the highest heterosis for fruit yield per plant (103.59%), followed by JBR-6/7 × GJB-2 (35.17%) and AB-8/5 × GBL-1 (41.52%). The hybrid AB-8/5 × GJB-2 showed highly significant heterosis (245.26%) for the number of fruits per cluster, whereas the hybrid JBR-6/7 × GJB-2 showed significant heterosis (17.53%) for the average fruit weight.

At the Regional Horticulture Research Station, Navsari Agricultural University, Navsari, E.E.P. and A.I. (2014) conducted genetic studies on fruit yield per plant and its attributing traits using a line × tester mating design with five lines and four testers. The cross with the highest fruit yield per plant, AB-8/5 × GJB-2 (103.59%), followed by AB-8/5 × GBL-1 (41.52%) and JBR-6/7 × GJB-2 (35.17%), also showed highly significant heterosis (245.26%) for the number of fruits per cluster, while the hybrid JBR-6/7 × GJB-2 displayed significant heterosis (17.53%) for average fruit weight.

Paramappa et al. (2014) examined 15 lines (KB-12-01 to KB-12-15) using three testers (KRCB-1, KRCB-2 and KRCB-3). For plant height, the standard heterosis varied between 8.80 and 13.47%. Similarly, 13.92 to -7.59% for days to first flowering; 20.72 to -7.21% for days to 50% flowering; - 66.67 to 25.00% for per cent fruit set; -32.25 to 49.61% for average fruit weight; -23.85 to 39.55 for fruit length; -12.74 to 52.56% for fruit diameter; -35.70 to 16.70% for number of fruits per plant; -47.81 to 31.77% for yield per plant and -47.76 to 9.57% for yield per hectare. 10 hybrids exhibited both yield-attributing features in a positive direction and standard heterosis for yield per hectare.

Ramani et al. (2015) studied 11 brinjal parents and 28 F_1 hybrids. Fruit borer infestation and fruit yield per plant showed significant heterosis compared to the standard check and the better parent. Two hybrids, JBL-10-04 × GBL-1 and JBL-08-8 × Pant Rituraj, showed the least amount of fruit borer infection and showed negative but desirable heterosis.

The heterobeltiosis for total fruit sugar content (105.10%) was found by Shende et al. (2016) when they used a half diallel mating design to evaluate six parents of brinjal. This was followed by marketable fruit yield per plant (91.77%),

the number of marketable fruits per plant (85.86%) and fruit borer infestation (77.54%).

36 genotypes (12 lines, 2 testers and 24 F_1) were evaluated by conducting an experiment by Bhushan et al. (2016) to estimate heterosis. The results showed that the characteristics examined, including yield and yield-attributing traits, crosses PR × PS and BARI × PS showed the highest economic heterosis. In comparison to the standard cultivar Pant Samrat, the crosses PR × PS, BARI × PS, PB 69 × PS and Punjab Sadabahar × PU showed high significant heterosis.

Hamada et al. (2016) revealed that in brinjal, heterosis between mid-parents and better parents was found in a variety of variables, including total chlorophyll, number of branches per plant (11.92%) and plant height (2.85%). Additionally, early fruit yield per plot (73.67%), early fruit yield per plot and overall fruit yield (35.67%) all showed heterosis over mid-parents along with better parents. Heterosis over mid-parents and better parents was found for chemical traits in brinjal, namely in the amounts of total carotene, anthocyanins, nitrogen, potassium and phosphorus.

Heterosis for 14 useful traits was examined by Kumar et al. (2017) in 28 aubergine hybrids, their 8 parents and two tests. The hybrids PLR-1 × GBL-1, PLR-1 × Doli-5, KS-224 × Doli-5 and PLR-1 × GJB-2 all showed significant heterosis for fruit yield per plant when compared to the local check Surati Ravaiya.

Gururaj et al. (2017) calculated levels of standard heterosis, heterobeltosis and relative heterosis for fruit yield and the eleven brinjal yield-contributing factors. The following F_1 hybrids were found to have significant relative heterosis for fruit yield per plant: CBB-32 × Matti Gulla (154.67%), CBB-25 × BSR-112 (128.03%) and CBB-8 × BSR-112 (126.34%). Similarly, the hybrid CBB-32 × Matti Gulla (128.78%) showed the highest heterobeltiosis (better parent heterosis) for fruit yield per plant, followed by CBB-8 × BSR-112 (122.79%) and CBB-25 × BSR-112 (117.36%). In the case of standard heterosis, hybrid CBB-6 × BSR-112 (69.34%) showed a significant and positive heterosis above standard check EPH-718 (Syngenta) for fruit production per plant, followed by CBB-8 × BSR-112 (66.67%) and CBB-25 × BSR112 (57.50%).

In set of four F_1 in brinjal Chintan et al. (2018) investigated the heterobeltiosis and relative heterosis created by crossing six parents. Fruit yield per

plant, fruit volume and fruit length all showed significantly positive heterobeltiosis in all cross combinations viz. AB-07-02 × GOB 1, Doli 5 × GBL1, Doli 5 × KS 331 and Pusa Uttam × KS 331. This suggests that the hybrid vigour can be used on a large scale for these traits.

Hussain et al. (2018) conducted study on 31 cross combinations of brinjal to produce data about the kind and extent of heterosis. In SBPL-27 × A. Kusumakar and GBL-1 × PPL, the range of heterosis (%) over better parent was -84.99 and 226.38, respectively. With respective heterosis (%) of 226.38, 82.03, 69.03, 67.36 and 64.54, the most superior cross combinations for improved parent heterosis were GBL-1 × PPL, PPC × SBW-11, PPC × GBL-1, PPC × GOB-1 and A. Nidhi × P. Kranti.

With the goal of identifying the best heterotic crosses for brinjal (*Solanum melongena* L.) Bhatt et al. (2019) conducted a diallel analysis for analyzing of fruit yield and its components. In terms of fruit yield per plant, the top five heterotic crosses were JBL-10-08-07 × Pant Rituraj, GJB-2 × JBR-15-01, GJB-2 × JBR-15-08, GJLB-4 × JBR-15-08 and JBR-15-08 × JBL-10-08-07.

Quantitative and qualitative data was recorded by Ramesh and Vethamonai (2020) by conducting an experiment with six different genotypes, hybrids and one check variety. The findings indicated that there was high heterosis over check for plant height (22.49%) in Seeptipulam Local × Sevanthampatti Local, number of flowers per plant in Sevanthampatti Local × Spiny Local (34.57%) and number of fruit plants-1 (36.68%) in Spiny Local × Manaparai Local. Sevanthampatti Local × Seeptipulam Local and Seeptipulam Local × Sevanthampatti Local showed the highest levels of negative and significant heterosis above the usual check for earliness and day to first harvesting.

Reddy et al. (2020) examined 24 F_1 created by the Line x Tester fashion, 10 parents (6 females and 4 males) and 2 checks (Kashi Taru and Phule Arjun). For every attribute examined in the desirable direction, there was a significant heterosis over the mid, better and standard parents. Negative heterosis is preferred for traits such as days to 50% flowering and days to first picking. The cross combination DBR-8 × JKGEH-6012 showed the most significant heterosis above the mid parent (-12.10%) and better parent (-17.79%). Characters like fruit weight (DBR-8 × JB-

18), fruit girth (NBJ-19 × DMU-1) and fruit length (DBR-8 × DMU-1) contributed to yield.

Significant heterosis was observed by Deshmukh et al. (2020) in the desired direction for all the characteristics. In terms of fruit yield per plant, the JB-9 × JKGEH-6012 hybrid has the largest positive and significant heterosis compared to Kashi Taru (50.68%) and Phule Arjun (66.49%).

21 single crosses, 10 parents and two standard checks were studied using Line × Tester mating design by Samatha et al. (2021). Research showed that for most of the yield and yield contributing traits, a fair proportion of crosses had a noticeable amount of heterobeltiosis and standard heterosis in a positive direction. The hybrids, RCBG-1 × Bhagyamathi, were found to be superior and to have significant standard heterosis and heterobeltiosis for 11 characteristics: number of branches per plant, number of flower clusters per plant, number of fruits per plant, number of marketable fruits per plant, average fruit weight (g), fruit yield per plant (kg), marketable yield per plant (kg), total yield per hectare, total marketable yield per hectare (tons) and total phenols content; RCBG-4 × Shyamala for the number of flower clusters per plant, days to first flowering, days to 50% flowering, days to first harvest, number of marketable fruits per plant, average fruit weight (g), fruit yield per plant (kg), marketable yield per plant (kg), total yield per hectare, total marketable yield per plant (kg), total yield per hectare, total marketable yield per hectare and total marketable yield per hectare (tons).

Susmitha et. al. (2023) carried out a study in seven genotypes which underwent full diallel hybridization and the 42 resulting hybrids were assessed in RBD alongside their parents. Apart from fruit grith, fruit length, plant height and days to first harvest, the hybrid ICO-345590 × Arka Kusumkar showed strong heterobeltiosis for fruit yield per plant and associated traits. The hybrids ICO-344674 × ICO-383119 for plant height, ICO-344674 × Arka Kusumkar for days to first harvest, Arka Kusumkar × ICO-345590 for fruit length and ICO-345590 × ICO-545862 for fruit girth showed high standard heterosis.

2.2 Combining ability

The study of combining ability provides useful information about the choice of parents based on the performance of their hybrids. The capacity to combine is one of the powerful tools used in the breeding program. It may be used to characterize the kind and degree of gene action, exploit heterosis, assess the performance of lines in hybrid combinations and accumulate fixable genes. It helps the breeder develop an effective breeding plan for the ultimate enhancement of the available materials. Information on combining ability may be used to identify the optimal parent-offspring pairings for offspring with the highest potential productivity and other desirable distinctive features.

The concept is divided into two components: General combining ability (GCA) and Specific combining ability (SCA), as introduced by Sprague and Tatum (1942). Specific combining ability is the deviation of a specific cross from the average of the parents involved, whereas general combining ability is the average performance of a parent over all cross combinations. SCA variance is caused by dominance and epistatic (additive x additive, additive x dominance and dominance x dominance) variance, the GCA variance is caused by additive variance. The specific combining ability was brought on by the presence of non-allelic interactions, whereas general combining capacity was attributed to additive gene action. Griffing (1956) and Carnham et al. (1960) proposed that general combining ability (gca) includes both additive effects and additive × additive interactions. The GCA and SCA variances, in other words, serve as diagnostic tools to identify both additive (linear) and non-additive (non-linear) genetic activity.

The existing literature about the analysis of combining ability in brinjal has been reviewed as follows:

In a 10 × 10 diallel analysis of brinjal, Singh et al. (2002) reported notable differences in the effects of general combining ability and specific combining ability among the parents and their crosses. The parental lines CH-190 and CH-586 were identified as good general combiners for fruit width and number of branches per plant. CH-586, CH-757, CH-190 and Swarna Shree were the good general combiners for the yield-contributing characters. The crosses CH-792 × BL-22, CH-190 × CH-792 and CH-757 × CH-792 were superior in terms of SCA values.

In brinjal, Suneetha et al. (2005) evaluated a 10 × 10 diallel cross (excluding reciprocals) to study traits associated with fruit yield, its components, quality and physiological aspects. Looking at the overall combining ability effects revealed PLR 1 and JBPR 1 to be strong general combiners for fruit yield and quality characters. The hybrid, PLR 1 × JBPR 1, which incorporates effective combiners for fruit production per plant, has achieved the highest fruit yield, along with favourable specific combining ability effects for fruit yield, earliness, dwarfism and 1000-seed weight.

Keskar et al. (2006) conducted a 6 x 6 diallel study of six fruit characters in brinjal. The GCA effects revealed that none of the parents were suitable combiners for the characters under consideration. For the main yield components (fruit length, number of fruits per plant and fruit harvest span), the parents CHES 309, BB 64 and Arka Nilkanth were good general combiners. The hybrids Arka Nilkanth × BB 60C had strong SCA effects for fruit harvest duration, average fruit weight and fruit width in addition to high SCA for yield.

A 10 × 10 diallel analysis (excluding reciprocals) was conducted by Suneetha and Kathiria (2006) to study the combining ability for nine different traits in brinjal. In terms of fruit yield per plant, KS 224, PLR 1, Morvi 4-2 and JBPR 1 seemed to be good general combiners. With both good combiner parents, KS 224 × PLR 1 had the best fruit yield per plant and showed good SCA effects and per se performance for the majority of characteristics.

Using 8 × 8 half diallel design in brinjal, Dharwad (2007) investigated the combining abilities. Given their maximum GCA effects for fruit production and other associated characteristics, the results showed that parents MG, IC 112, IC 111 and IC 136 were good general combiners. IC 112 × IC 997, IC 909 × IC 136 and IC 112 × IC 126 were the hybrids that had the highest SCA effects for fruit yield per plot.

Singh et al. (2007) investigated line × tester analysis in brinjal and it was discovered that among 19 genetically distinct but homozygous genotypes, HAB-573 was a good general combiner for plant dwarfism, early flowering, early fruit harvest and fruit girth, while HAB-792, HAB-885 and HAB-897 were good general combiners for number of fruits plant, fruit length and fruit girth, individually.

Pusa Kranti was a good general combiner for dwarfism and number of branches per plants, whereas Swarna Pratibha was a good general combiner for dwarfism, fruit per plant and fruit length among the testers. Swarna Shree was a good general combiner for all traits except number of fruits per plants, fruit weight, fruit length and fruit yield per plant.

A half-diallel mating scheme involving seven parents and resulting in 21 crosses were used by Ekhlaque et al. (2008) to evaluate combining ability in brinjal. For every character, the mean square resulting from GCA and SCA was significant. The good general combiners were CH-885, CH-889 and Swarna Pratibha. The crosses CH-894 × CH-883 showed high sca effects for fruit yield per plant and fruit girth, CH-885 × Chianki local-2 for fruit harvest, Swarna Pratibha × Chianki local-1 for average fruit weight and CH-889 × Swarna Pratibha for fruit length.

A set of 28 F_1 brinjal hybrids generated through a half diallel mating scheme was evaluated by Dharwad et al. (2011). Parents MG, IC-112, IC-111 and IC-136 were reported to be good general combiners and had good GCA effects for traits including days to flowering, number of fruits per plant, fruit weight and yield per plant.

Ramireddy et al. (2011) carried out an experiment to evaluate combining ability in brinjal. Four crosses—Arka Shirish × IIHR-7, Mattugulla × IIHR-3, Mattugulla × WCGR and Arka Kusumakar × SM6-6 were found to be good specific combiners for fruit yield and other related traits, and they were the most hybrid combinations for commercial exploitation. The genotypes Arka Shirish, Arka Kusumakar, IIHR-7 and SM6-6 were found to be good general combiners.

Using 21 hybrids, Pachiyappan et al. (2012) carried out a study on combining ability to assess characteristics including branches per plant, fruits per plant, individual fruit weight and overall fruit yield per plant. For most of the traits under study, the male KKM-1 and female Annamalai were found to be good general combiners. Co-1 × KKM-1 and Annamalai × KKM-1 were shown to be good specific combiners for fruit yield per plant.

According to Bhushan et al. (2012), the superior general combiners for yield and its contributing traits identified were BSR-11 × PB-64 for fruit length, BSR-11 × U-8-61-3 for fruit girth, PBR-91-1x JBSR-98-2 for average fruit weight and the

cross HABL-1 × JBSR-98-2 for brinjal yield per plant and yield per hectare showed the highest SCA effects.

A 4 × 4 complete diallel mating fashion was used by Hubaity and Teli (2013) to assess combining ability for growth and yield traits in brinjal. For the most desirable horticultural traits, parent Black Beauty was good general combiner. Most of the features showed strong specific combining ability effects in the Early Long Purple × Alton Kubry hybrid combination.

Tiwari et al. (2013) carried out a half-diallel analysis involving 10 brinjal varieties and their 45 F_1 hybrids to examine combining ability. The brinjal variety Azad B-1 showed a favourable and good GCA effect for fruit yield, fruit weight, fruit width, leaf width, leaf length and plant height. Variety Type-3, on the other hand, displayed a favourable GCA effect for four characteristics. The three most promising cross combinations for fruit yield and most of its related features were Type-3 × DVR-8, DVR-8 × S-331 and Azad B-1 × S-331 and were good specific combiners.

A line × tester analysis was used to evaluate the combining ability of 36 eggplant hybrids and their 15 parents (12 lines and 3 testers) as conducted by Naresh et al. (2014). For fruit yield per plant, lines KS-5623 and KS-7840 as well as tester KS7512 were determined to be good general combiners. The T2 × KS-8821 hybrid was determined to have the highest fruit yield based on specific combining ability effects.

Eight brinjal parents and their diallel hybrids were evaluated by Makani et al. (2016) to assess the effects of general and specific combining ability. Based on the effects of general combining ability, the parents GBL-1 and KS-331 were successful general combiners for fruit yield per plant and its associated attributes. Additionally, the parent GBL-1 was good general combiner for both dry matter and total soluble sugars. Based on estimates of specific combining ability effects, the cross combinations Doli-5 × GBL-1, AB-07-08 × GP-180 and AB-07-08 × KS-331 were determined to be the most promising for fruit yield and several of its related traits.

10 parents, 45 F_1 hybrids and a standard check were evaluated, for combining ability analysis by Patel et al. (2017). In terms of fruit yield per plant,

GAOB 2 was a good general combiner, while GBL1, Doli 5, GP-BRJ-215 and GP-BRJ-216 were average general combiners. The hybrids GBL 1 × Doli 5, JBL 10-08-07 × GP-BRJ-216 and GAOB 2 x JBL 10-08-01 showed significant high values of SCA effects in the desired direction for the important yield contributing characters and nutritional quality parameters, according to estimates of specific combining ability effects for fruit yield per plant.

A total of 37 genotypes, including one standard check (Surati Ravaiya), eight parents and twenty-eight hybrids, were evaluated by Desai et al. (2017). For maximum traits, JBGR-1, NSR-1 and JBL-08-8 were the good general combiners among the parents. In addition to performance for fruit yield and its component characters, the crosses AB-09-1 × AB-12-10, AB-09-1 × AB-08-5, AB-08-5 × JBL-08-8 and GJB-3 × AB-12-10 demonstrated maximum SCA effects.

8 × 8 half-diallel mating method was used by Dhirendra et al. (2017) to investigate combining ability in brinjal. In terms of fruit yield, fruit length, fruit weight, total soluble solids and total sugar, GBL-1 was the best general combiner. The SCA effects for fruit yield per plant were shown to be favourable for six hybrids GJB-3 × GOB-1, PLR-1 × GOB-1, KS-224 × GJB-2, KS-224 × GBL-1, Pant Rituraj × Doli-5 and Pant Rituraj × GOB-1.

Bhushan et al. (2018) evaluated specific and general combining abilities in brinjal. In terms of the number of fruits per plant, number of primary branches, number of days to fifty percent flowering and number of days to the first fruit harvest, Punjab Barsati was the good combiner. The maximum SCA effects were shown by the cross JBR-3-16 × PB-64 for days to 50% flowering, PBR-91-1JBSR-98-2 for average fruit weight, BSR-11 × PB-64 for fruit length, BSR-11 × U-8-61-3 for fruit girth and HABL-1 × JBSR-98-2 for yield per plant and per hectare.

Chaurasia et al. (2018) evaluated six lines and three testers of brinjal using Line × Tester design. The estimates of gca for lines and sca for hybrids represented that the lines Sagoli Xingiya, Baromohiya, MLC-1 and the testers SM-6-7 and Longai were good general combiners for most of the traits whereas the hybrids Utsav × Longai, Dari Hariharka × Longai, MLC-3 × SM-6-7, MLC-1 × JC-1, Baromohiya × SM-6-7 and Sagoli Xingiya × JC-1 were the good specific combiners for yield and yield contributing traits. The crosses BM × JC-1, Utsav × Longai,

MLC-1 × JC-1, BM × SM-6-7, MLC-3 × SM-6-7 and MLC-3 × JC-1 had significant (good × poor, poor × good) SCA effect for the traits fruit weight, number of fruits per plant and yield per plant which resulted from one good and one poor general combiner.

A full diallel cross, including reciprocals, among six brinjal lines was performed by Kumar et al. (2019) to analyze the combining ability of key horticultural traits. The parent Sevanthampatti Local and Seetipulam Local were determined to be good general combiners in terms of ascorbic acid concentration, individual fruit weight and earliness (days to first flowering and harvest). In contrast, Karungal Local was considered a good combiner for fruit length, total sugars, number of branches per plant and yield per plant. A cross between Sevanthampatti Local and Seetipulam Local had the best specific combining ability effects that were in the intended direction for plant height, days to first flowering and fruit length.

Kachouli et al. (2019) utilized a randomized block design with two replications to study combining ability analysis using eight parents and 28 F_1s. Variances resulting from GCA and SCA were significant for all traits, according to the combining ability analysis of variance. In terms of fruit yield per plant and the majority of the characteristics, such as average fruit weight, fruit length and seed weight per fruit, parents DRNKVO-2-26 were shown to be good general combiners. For every characteristic at the same time, none of the parents showed the desired GCA effects. Arbha Kranti × Rajendra brinjal, Aruna × DRNKVO-2-26 and DRNKVO-2-26 × JB-15 were all good specific combiners for yield and other yield components.

A study to evaluate the general combining ability of parents and specific combining ability of hybrids in a 7 × 7 half diallel design, involving seven parents and two checks in brinjal, was conducted by Siva et al. (2020). In terms of fruit yield and other yield-contributing traits, such as the number of primary branches per plant, fruits per cluster, fruits per plant, days until final harvest, fruit yield per hectare, fruit yield per plot, ascorbic acid content and fruit borer damage percentage, EC-169084, Pennada, Bhagyamati and EC-169089 were good general combiners among the parents. Four hybrids Bhagyamati × EC-169084, Pennada ×

EC169084, Bhagyamati × EC-169089 and EC-169084 × EC-169089 were shown to be promising based on the SCA effects. In terms of fruit yield, branches per plant, fruits per cluster, fruits per plant, days to final harvest, fruit yield per hectare, fruit yield per plot, ascorbic acid content and fruit borer damage percentage, EC-169084, Pennada, Bhagyamati and EC-169089 were the most promising general combiners among the parents.

Deshmukh et al. (2020) observed that the JB-9 × DMU-1 (7.45) for fruit weight, JB-9 × JKGEH-6012 (2.58) for fruit quantity per plant, DBR-8 × B. Deoria (0.45) for main branch number per plant and JB-9 × JKGEH-6012 (2.51) for fruit yield per plant had the maximum SCA effects.

Singh et. al. (2021) conducted an experiment in which they used eight parents (two testers and six lines) and mated in a line × tester design to assess the combining ability for various yield parameters. In terms of yield and yield-attributing characteristics, PPC was the good general combiner among testers and lines IVBL-116-131, DBR-8 and Jawahar Brinjal.

2.3 Gene action

Expression of polygenic traits is controlled by varying degrees of additive and non-additive gene activity. Many quantitative aspects can be genetically improved with simple progeny selection. Therefore, knowing the kind of gene action involved in the expression of various quantitative characteristics is essential for a plant breeder to start an effective breeding program. Understanding the origin and degree of gene effects influencing the transmission of productivity-related traits will allow breeders to make more informed breeding decisions, quickening genetic advances and breaking down yield obstacles.

The following is a summary of research on the analysis of genetic components and gene action in brinjal.

According to Chezhian et al. (2000), the analysis of variance for general combining ability (GCA) and specific combining ability (SCA) exhibited highly significant differences across all the traits examined in brinjal, highlighting the role of additive and non-additive gene actions. The GCA variance was greater than the SCA variance for most traits, indicating a predominance of additive genetic effects,

except for number of fruits per plant and fruit yield per plant, where non-additive gene action was more prominent.

In a study involving a four-parent diallel cross (JC-1, JC-2, JC-4 and JC-6) of aubergine, Das and Barua (2001) examined the combining ability and extent of heterosis. Both general combining ability (gca) and specific combining ability (sca) mean squares were significant for plant height, fruit length, fruits per plant, fruit weight and yield per plant, demonstrating the impact of both additive and non-additive gene effects.

Eight parental lines of brinjal viz., Arka Nidhi, Pusa Purple Cluster, SM6-6, Arka Keshav, Arka Neelkanth, Hissar Shyamal, Punjab Barsati and SM 6-7 were evaluated in a half diallel fashion by Chaudhary (2001). Analysis of gene action indicated. non-additive effects being more predominant than the additive. All characteristics except fruit weight and fruit diameter had a mean degree of dominance that suggested over-dominance.

Singh et al. (2002) evaluated gene action for different characters in set of a 10 x 10 diallel cross in brinjal. The GCA and SCA variances were highly significant for all the characters indicating the importance of additive and non-additive genetic components in the inheritance of all the characters. Higher magnitude of GCA variances as compared to SCA variances for fruit weight, fruit length, fruit breadth, number of branches and plant height suggested the predominance of additive type of gene action in the expression of these characters.

Gene action in brinjal was studied using a 5 × 5 diallel mating design by Panda et al. (2004). Their study revealed that additive gene effects played a major role in controlling days to first flowering, fruit diameter and total number of fruits per plant. In contrast, non-additive gene effects were more influential for the number of primary branches, marketable fruits per plant and total fruit weight per plant.

10 × 10 diallel cross, excluding reciprocals was conducted by Suneetha et al. (2008) to study fruit yield per plant and related component traits in round brinjal. Their findings indicated that non-additive gene action was predominant for fruit yield and its associated traits.

A line × tester analysis was conducted using 30 brinjal genotypes, consisting of 5 female lines, 4 male lines, their 20 F_1 hybrids, and a standard check (Surti Ravaiya), was conducted by Reddy and Patel (2014) to evaluate 14 traits including seedling height, plant height, number of branches per plant, days to first flowering, days to 50% flowering, number of flowers and fruits per inflorescence, fruit length and diameter, fruit length to fruit diameter ratio, average fruit weight, number of fruits per plant, fruit yield per plant and phenol content. Their combining ability analysis revealed that both additive and non-additive gene actions were involved in controlling all the traits.

Uddin et al. (2015) studied gene action in 18 genotypes for several quantitative traits such as days to first picking, fruit length, fruit breadth, fruit weight, number of fruits per plant and yield per plant. The results showed highly significant variances for both general combining ability (GCA) and specific combining ability (SCA) for all traits, indicating the involvement of both additive and non-additive gene actions. Additive gene effects were predominant for most traits.

Gadhiya et al. (2015) examined ten parental lines, 45 hybrids produced through a half-diallel mating design and included the commercial hybrid AB-1 as a check. The combining ability study showed that non-additive gene action was predominantly responsible for the expression of all traits.

Gharge et al. (2016) studied gene action in brinjal using 8×8 diallel mating design, excluding reciprocals for yield and its component characters in brinjal. Non-additive gene action was noticed to be preponderant for all the characters except days to 50% flowering in which additive gene action was predominant.

Patel et al. (2017) observed that the variance attributed to specific combining ability was greater than that of general combining ability for traits such as plant height, number of fruits per plant, fruit yield per plant, ascorbic acid content and total soluble sugars, indicating a predominant role of non-additive genetic variance in controlling these traits. In contrast, the remaining traits were mainly governed by additive gene action.

Singh et al. (2018) reported the preponderance of additive gene actions for days to 50% flowering, plant height, primary branches per plant, fruit weight, fruit

length, fruits per plant, fruit dry matter percentage, chlorophyll content, leaf area and total phenol. Non-additive gene actions were pre-dominant for secondary branches per plant, fruit yield per plant, photosynthesis rate, stomatal conductance and total soluble solids.

An experiment involving eight diverse cultivars of brinjal (*Solanum melongena* L.) was conducted, during which Rathava et al. (2021) observed a predominance of additive gene action for traits such as days to first picking, number of fruits per plant, fruit length, fruit weight and total soluble sugars.

MATERIALS AND METHODS

Chapter-3

MATERIALS AND METHODS

The present investigation entitled "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" was conducted from the summer season of the year 2024 to the summer season of year 2025 at the Experimental Farm of Department of Vegetable Science, College of Horticulture & Forestry, Neri, Hamirpur HP. The materials and methods used during the present investigation have been described in this chapter as below:

3.1 EXPERIMENTAL SITE

3.1.1. Location

The current study was undertaken at the Experimental Farm of Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, H.P. which is situated in low hill zone of Himachal Pradesh. The site enjoys an elevation of 650 m above mean sea level and lies between 31º41'47.6''North latitude and 72º28'6.3''East longitude, respectively.

3.1.2. Soil

The soil of the experimental block was found to be sandy loam type with good drainage and uniform texture.

3.1.3 Climate and weather conditions

The experimental farm which is situated in Zone-I of Himachal Pradesh; which receives 60–100 cm of rainfall annually. Hot summers and mild winters are typical features of this zone. December and January are the most coldest months of this zone; while May and June are typically the warmest ones. Mostly, the month of July receives the heaviest rainfall. Data related to various parameters such as rainfall, relative humidity and temperature was obtained from the Meteorological Observatory, College of Horticulture and Forestry, Neri, Hamirpur (H.P.); which is presented in Appendix-I.

3.2 EXPERIMENTAL MATERIALS

The details of the experimental material and layout have been given as under:

3.2.1 Technical programme

A) Crossing block

The seeds of parental genotypes were sown in nursery beds during March, 2024 and these were transplanted in the crossing block during April, 2024. Six horticulturally diverse brinjal genotypes viz., Pusa Purple Long, Pusa Purple Cluster, Arka Keshav, Brinjal-LC-71, Brinjal-LC-72 and Brinjal-LC-73; were crossed in half diallel design (excluding reciprocals) given by Griffing (1956) to obtain 15 cross combinations. During the same year the selfed seeds of the parental genotypes were also obtained by selfing of the parents. The detailed description of the parents and check genotypes along with their source is presented in Table 3.2.1 which is as follows:

Table 3.2.1 Sources of parents and check variety used in present study

S. No.	Name of genotype	Source	Distinguishing Features
1.	Pusa Purple Long	IARI, Regional Station, Katrain, Kullu Valley	It is a long-fruited, early maturing genotype. The fruits are light purple in colour and the crop is ready for harvesting from 100–110 days with an average yield potential of 27.5 t/ha. It is suitable for spring and autumn plantings.
2.	Pusa Purple Cluster	IARI, Regional Station, Katrain, Kullu Valley	It is an early maturing and long fruited genotype. Fruits are small, purple in colour and borne in clusters. The crop is ready for picking in 75 days after transplanting. It is resistant to little leaf disease under natural conditions.

3.	Arka Keshav	IIHR, Bangaluru	It is bacterial wilt resistant genotype. Fruits were tender, free from bitter principles with seed maturity. Crop ready for picking in 150 days and has an average yield potential of 45 t/ha.
4.	Brinjal-LC-71	Department of Vegetable Science, COH&F, Neri, Hamirpur	Local genotype adapted to the low hills of Himachal Pradesh.
5.	Brinjal-LC-72	Department of Vegetable Science, COH&F, Neri, Hamirpur	Local genotype adapted to the low hills of Himachal Pradesh.
6.	Brinjal-LC-73	Department of Vegetable Science, COH&F, Neri, Hamirpur	Local genotype adapted to the low hills of Himachal Pradesh.
7	Check (CODE-B02)	Private seed company	Dark coloured fruits long in shape and with solitary bearing habit.

B) Evaluation of F_1 along with parents and check

The 15 F_1's developed along with 6 parental and 1 check genotype were transplanted on 26th February 2025 for their evaluation in randomized complete block design with three replications. During the course of study all the standard cultural practices were followed to raise the healthy crop stand. The details of the layout are as follows:

Parents	06
F_1s	15
Check	01
Design	Randomized Complete Block Design
Replications	3
Spacing	60 cm x 45 cm

Plot size	1.8m x 1.8m
No of plants	12
Location	Experimental Farm, Department of Vegetable Science, COH&F, Hamirpur (H.P.)

Table 3.2.2: List of F_1 hybrid combinations developed during present study

S.No.	Name of F_1 hybrid combination
1.	Pusa Purple Long × Pusa Purple Cluster
2.	Pusa Purple Long × Arka Keshav
3.	Pusa Purple Long × Brinjal-LC-71
4.	Pusa Purple Long × Brinjal-LC-72
5.	Pusa Purple Long × Brinjal-LC-73
6.	Pusa Purple Cluster × Arka Keshav
7.	Pusa Purple Cluster × Brinjal-LC-71
8.	Pusa Purple Cluster × Brinjal-LC-72
9.	Pusa Purple Cluster × Brinjal-LC-73
10.	Arka Keshav × Brinjal-LC-71
11.	Arka Keshav × Brinjal-LC-72
12.	Arka Keshav × Brinjal-LC-73
13.	Brinjal-LC-71 × Brinjal-LC-72
14.	Brinjal-LC-71 × Brinjal-LC-73
15.	Brinjal-LC-72 × Brinjal-LC-73

3.3 Observations recorded

The observations were made on selected plants in each plot for each replication and the mean was calculated for further statistical analysis. Observations were recorded with respect to the following characters:

1. Days to 50 per cent flowering
2. Days to first picking
3. Harvest duration

4. Leaf length (cm)
5. Stem diameter (mm)
6. Plant height (cm)
7. Number of primary branches per plant
8. Pedicel length (cm)
9. Presence of spine
10. Bearing habit
11. Number of fruits per plant
12. Fruit diameter (cm)
13. Fruit length (cm)
14. Fruit colour
15. Average fruit weight (g)
16. Number of seeds per fruit
17. Yield per plant (kg)
18. Ascorbic acid (mg/100g)
19. TSS (ºB)
20. Disease incidence (%) / Severity (%) (if, any)

3.3.1 Days to 50 per cent flowering: The number of days were counted from the day of transplanting seedlings in field to the appearance of first flower in 50 per cent of the plants in a plot.

3.3.2 Days to first picking: The number of days to first picking were recorded from transplanting date of seedlings to the date of first picking of fresh marketable fruits.

3.3.3 Harvest duration: Total numbers of days from first fruit harvest to final fruit harvest were counted and average value was expressed in number of days.

3.3.4 Leaf length (cm): The leaf length was recorded as the distance from petiole to the top of the leaf at harvesting stage and it was expressed in centimetres.

3.3.5 Stem diameter (mm): The diameter of the stem was measured at the base of the stem with the help of the vernier calliper and average was calculated.

3.3.6 Plant height (cm): Plant height was measured in cm from the base to top of the shoot at the end of growing season.

3.3.7 Number of primary branches per plant: Total number of branches emerging from main stem were counted in each plant while measuring the plant height and mean value was calculated.

3.3.8 Pedicel length (cm): Pedicel length of five randomly selected fruits each in 4^{th} to 7^{th} pickings was recorded after taking their average.

3.3.9 Presence of spine: Presence of spines was observed visually and it was classified into two categories viz., Absent or Present; depending upon their absence or presence in a particular genotype.

3.3.10 Bearing habit: On the basis of visual observation the various entries of brinjal genotypes were classified either as "Solitary" or "Cluster" depending upon the number of fruits borne by a genotype at a particular node.

3.3.11 Number of fruits per plant: The number of fruits obtained from each entry, was summed up and was divided by the total number of randomly taken plants to get marketable fruits plant.

3.3.12 Fruit diameter (cm): The diameters of five randomly taken fruits were measured with the help of vernier calliper in cm and average was worked out.

3.3.13 Fruit length(cm): Five fruits from each replication were selected randomly and fruit length was measured in cm with vernier calliper and average was worked out.

3.3.14 Fruit colour: The colour of the fruits at fresh marketable stage was recorded on the basis of visual observation and the fruits were classified as light purple, purple and dark purple in colour respectively.

3.3.15 Average fruit weight (g): The weight of five randomly selected fruits was recorded, and average fruit weight was calculated in gram by dividing the fruit weight by the number of fruits.

3.3.16 Number of seeds per fruit: Number of seeds per fruit were counted in randomly selected five average sized ripe fruits.

3.3.17 Yield per plant (kg): The total weight of fruits was recorded from each selected plant and then was divided by the total number of selected plants to obtain yield per plant.

3.3.18 Ascorbic acid (mg/100g): Ascorbic acid content of fruit was determined by 2,6 dichlorophenolindophenols dye method (Rangana, 1976).

Reagents used:

1. 3% Metaphosphoric acid (HPO3): Prepared by dissolving the sticks or pellets of HPO3 in glass distilled water.

2. Ascorbic acid standard: Weighed accurately 100 mg of ascorbic acid and made upto100ml with 3% (HPO3). Diluted 10 ml to 100 ml with 3% (HPO3).

3. Dye solution: Dissolved 50 mg of the sodium salt of 2, 6 dichlorophenol indophenols in approximately 50 ml of hot distilled water containing 42 mg of sodium bicarbonate. Cooled and diluted with glass distilled water to 200 ml.

Procedure

The crushed fruit samples extracted in 3 per cent metaphosphoric acid solution were titrated with 2,6-dichlorophenol-indophenol dye till a pink end point persisted for 15 seconds. The ascorbic acid content was evaluated by mean of the following formulas:

$$\text{Ascorbic acid content: } \frac{Titre\ x\ Dye\ factor\ x\ Volume\ made\ up}{Volume\ of\ aliquot\ taken\ x\ Weight\ of\ samples\ of\ taken} \text{ x } 100$$

3.3.19 Total soluble solids (^{0}Brix): The fruits used for measuring the trait fruit length were used for the estimation of TSS with the help of hand refractometer. The fruits were cut from middle portion, and the juice extracted from the fruits was sieved through a fine meshed layer of muslin cloth and the extract thus

obtained was dropped over measuring surface of hand refractometer to record TSS values in degree Brix.

3.3.20 Disease incidence (%)/severity (%) (if any)

The severity percentage for Phomopsis blight in brinjal was recorded under natural epiphytotic conditions on ten randomly selected leaves from top to bottom on the four selected plants on which no fungicide spray was given. The following key given by Wheeler (1969) was used for the estimation of severity percentage (Percent Disease Index) for Phomopsis blight in brinjal:

Scale for estimation of Severity (%) (Percent Disease Index) given by Wheeler (1969):

Disease grade	Infected leaf area (%)	Disease reaction
0	No visible infection	Immune (I)
1	1.0-5.0	Resistant (R)
2	5.1-15.0	Moderately resistant (MR)
3	15.1-30.0	Moderately susceptible (MS)
4	31.1-50.0	Susceptible (S)
5	>50.0	Highly susceptible (HS)

The following formula was used for the calculation of percent disease index in brinjal with respect to Phomopsis blight:

$$\textbf{PDI} = \frac{\textbf{Sum of all disease rating}}{\textbf{Total no.of rating} \times \textbf{Maximum disease grade}} \times \textbf{100}$$

3.4 Statistical analysis

The data recorded were subjected to statistical analysis as follows:

1. Analysis of variance for experiment
2. Estimation of heterosis
3. Combining ability analysis
4. Estimation of components of genetic variance and their genetic interpretations

The two software packages which were used for statistical analysis were TNAUSTAT and OPSTAT.

3.4.1 Analysis of variance for experiment

The replicated mean values obtained from 22 genotypes (6 parents, 15 crosses and 1 check) were used for obtaining the analysis of variance for the experiment. The analysis of variance for the experiment was carried out using randomized complete block design whose details are given as follows:

$$Y_{ijk} = m + g_{ij} + b_k + e_{ijk}$$

Where,

Y_{ijk} = phenotypic value of the ij^{th}genotype grown in the K^{th}replication

m = general population mean

g_{ij} = effect of the ij_{th} genotype, where i,j, = 1....g

b_k = effect of the k_{th} replication, where k = 1....r

e_{ijk} = Random error associated with the ijk^{th} observation

Analysis of variance based on the above model led to the following components of variance:

Analysis of variance for experiment

Sources of Variation	d.f.	S.S.	M.S.S	F-value
Replications	r-1	S_r	$M_r = S_r/r-1$	M_r/M_e
Genotypes	g-1	S_g	$M_g = S_g/g-1$	M_t/M_e
Error	(r-1) (g-1)	S_e	$M_e = S_e/(r-1)(g-1)$	M_p/M_e
Total	gr-1	S_t		M_h/M_e

Where,

d.f. = Degree of freedom

S.S = Sum of squares

M.S.S = Mean sum of squares

R = Number of replications

G = Number of genotypes

The standard error of difference between the genotypic means based on r replications was estimated as follows:

$$SD(d)= \pm\sqrt{\frac{2M_e}{r}}$$

Critical Difference (CD) = SE (d) x $t_{(r-1)(g-1)}$ at 5% and 1% level of significance.

3.4.2 Estimation of heterosis

Heterosis over better parent and standard check was calculated as follows:

Per cent heterosis over the better parent = $\frac{\overline{F_1}-\overline{BP}}{\overline{BP}}$ X 100

Per cent heterosis over check = $\frac{\overline{F_1}-\overline{Check}}{\overline{Check}}$ X 100

Where,

$\overline{BP}$= mean performance of the better parent

$\overline{Check}$ = mean performance of check hybrid

3.4.2.1 Test of significance for heterosis over better parent

Test of significance was done for the numerator value for heterosis over better parent, i.e. $\overline{F_1}$ - $\overline{BP}$.

The standard error of difference was computed as under

S.E. of heterosis = $\pm\sqrt{\frac{2M_e}{r}}$

Where,

Me= error mean squares

r = number of replications

The critical difference was calculated by multiplying the S.E of heterosis with table value of t at error d.f. at both 5% and 1% level of significance.

3.4.2.2 Test of significance for heterosis over standard check

Test of significance was done for the numerator value for heterosis over standard check, i.e. $\overline{F_1} - \overline{Check}$.

the standard error of difference was computed as under

S.E. of heterosis = $\pm\sqrt{\frac{2M_e}{r}}$

Where,

Me= error mean squares

r = number of replications

The critical difference was calculated by multiplying the S.E of heterosis with table value of t at error d.f. at both 5% and 1% level of significance.

3.4.3 Combining ability analysis

Combining ability analysis was done using Griffing (1956) Method II (parents and one set of F_1's, were included without reciprocal F1's) and Model I (Fixed effect model). The analysis of variance for combining ability was based on the following mathematical model:

$$X_{ij} = \mu + g_i + g_j + S_{ij} + 1/bc \sum_k \sum_l e_{ijkl}$$

Where,

i, j = 1, ... p, (number of parents)

k = 1, ... b, (number of blocks or replications)

l = 1, ...c, (number of observations taken in each plot)

X_{ij}= Mean performance of i^{th} x j^{th} genotype over k and l

μ =Population mean

g_i (or g_j) = General combining ability of i^{th} (or j^{th}) parent

S_{ij}= Specific combining ability of the crosses between the i^{th} x j^{th} parents such that

Sij= Sji and

e_{ijkl}= the environmental effect corresponding to the ijklth observation

Restrictions imposed on the combining ability analysis are:

i. $\sum g_i = 0$

ii. $\sum S_{ij} + e_{ij} = 0$

Based on the above model, following are the components of variance:

Analysis of variance based on combining ability

Source of variation	Df	Sum of squares	Mean of sum of squares	Expected mean sum of squares
General combining ability	p-1	S_g	M_g= Sg/p-1	$\sigma_e^2 + (p + 2)\ (1/p\text{-}1)\ \sum_i g_i^2$
Specific combining ability	p(p-1)/2	S_s	M_s= Ss/[p(p-1)/2]	$\sigma_e^2 + 2[1/p(p\text{-}1)]\ \sum_i \sum_j S_i^{j2}$
Error	(r-1) (g-1)	S_e	M'$_e$	σ_e^2

Where,

Sg= sum of squares due to gca = $\frac{1}{p+2}(\sum(Xi + Xii)^2 - \left(\frac{4}{p}\right)X^2 \ldots)$

Ss= sum of squares due to sca

p = number of parents

M$'_e$= M_e/ r (where M_e is error mean square from RBD analysis)

X_{ii}= mean value of the ith parent

X_{ij} = the progeny mean value of the i multiply jth hybrid

Estimation of gca and sca effects

General combining ability effect of the ith parent,

$$g_i = \frac{1}{p+2}\left[(X_i + X_{ii}) - \frac{2}{p}X..\right]$$

Specific combining ability effects of the i^{th} and j^{th} cross,

$$S_{ij} = X_{ij} - \frac{1}{p-2}\left[(X_{i.} + X_{ii}) + (X_{.j} + X_{jj}) + \frac{2}{(p+1)(p+2)} X..\right]$$

Where,

p = number of parents

$X_{i.}$= total of the array involving i^{th} parent

$X_{.j}$= total of the array involving j^{th} parent

X_{ii}= mean value of the i^{th} parent

Xjj= mean value of the j^{th} parent

X_{ij}= progeny mean value of i x j^{th} hybrid

X.. = grand total

Σ_e^2= error variance

Standard error (SE) estimation

SE of effects was estimated as follows:

$$\text{SE for gca estimates, SE } (g_i) = \pm\sqrt{\frac{(p-1)}{(p+1)(p+2)}}\sigma^2 e$$

$$\text{E for sca estimates, SE } (S_{ij}) = \pm\sqrt{\frac{(p^2+p+2)}{(p+1)(p+2)}}\sigma^2 e$$

Where,

$\sigma^2 e$= error variance

Critical difference (CD) of the estimates

Critical difference of the effects was calculated by multiplying the corresponding SE (d) values for difference with table value of 't' for error degree of freedom at both 5% and 1% level of significance.

3.4.4 Estimation of genetic components of variation

Genetic components: Keeping in mind the expectations of the mean squares for Griffing Model I (METHOD II) the estimates of components are obtained using below formulas:

- Component due to gca

  $\frac{1}{p-1}\sum_i g_i^2 = (M_{g-} M_e')/(p+2)$

- Component due to sca

  $\frac{2}{p(p-1)}\sum_{i<j}\sum s_{ij}^2$ M_s-M_e'

  Now the ratio of gca variance to sca variance will be

$$\frac{1}{p-1}\sum_i g_i^2 \Big/ \frac{2}{p(p-1)}\sum_{i<j}\sum s_{ij}^2$$

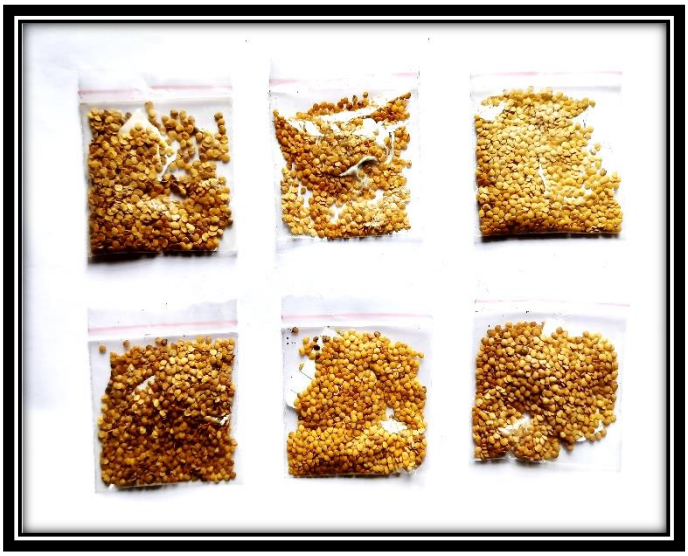
Nursery sowing

Crossing block

Hybridization steps

Plate 1: Nursery sowing for cross block, crossing block and crossing steps in brinjal

Drying of seeds



Seed Storage

Plate 2: Drying of extracted seeds and their storage; general view of experimental trial

RESULT AND DISCUSSION

Chapter-4

RESULT AND DISCUSSION

The present investigation entitled "Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design" was carried out at the Experimental Farm, Department of Vegetable Science, College of Horticulture and Forestry Neri, Hamirpur-177 001 (HP), India. In all 22 genotypes (6 parents and 15 cross combinations and 1 check) were evaluated for their mean performance and estimation of heterosis. Further, combining ability and gene action with respect to various quantitative traits was worked out. The experimental results obtained from the above study are presented and discussed in this chapter as follows:

4.1 ANALYSIS OF VARIANCE FOR EXPERIMENT

The analysis of variance for experiment (Appendix-II) revealed significant mean sum of squares due to genotypes for all the traits studied viz., days to 50 per cent flowering, days to first picking, harvest duration, leaf length (cm), stem diameter (mm), plant height (cm), number of primary branches per plant, pedicel length (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), number of seeds per fruit, yield per plant (kg), ascorbic acid (mg/100g), TSS(ºB), disease severity (%); which indicated that all these genotypes were significantly different with respect to the above quantitative traits and this cleared the way for further analysis. However, mean replication sum of squares were not significant for any of the traits which showed that there was no variation between the different replications with respect to these traits.

4.2 MEAN PERFORMANCE AND HETEROSIS

In the present study, mean performance of six parents and the resultant F_1 cross combinations, along with standard check was observed and magnitude of heterosis for different cross combinations over their respective better parents and standard check (CODE-B02) was worked out; with respect to different horticultural characters (Table 4.2.1 to 4.2.20). The mean performance of the parents, hybrid combinations and check along with heterobeltiosis and heterosis over check with respect to different traits have been presented and discussed below

4.2.1. Days to 50 per cent flowering

For days to 50 per cent flowering lesser number of days are desirable as it helps in getting early harvest. The data recorded is presented in Table 4.2.1 with an overall population mean of 46.76 days. Among the parents, minimum days to 50% flowering were recorded by the genotype Pusa Purple Long (42.33 days); while the maximum number of days to 50% flowering were shown by the genotype Brinjal-LC-71 (58.33 days). The range for days to 50% flowering among different cross combinations varied from 31.66 days (Pusa Purple Long × Arka Keshav) to 57.66 days (Pusa Purple Cluster × Brinjal-LC-71). Whereas, the standard check (CODE-B02) took 40.33 days for fifty percent flowering. The outcomes of the current study were in accordance to the findings of Arti and Sharma (2018), Srivastava et al. (2019) and Ravali et al. (2017) in brinjal.

The heterosis for days to 50 per cent flowering over the better parent in different cross combinations ranged from (-10.19 %) Pusa Purple Cluster × Brinjal-LC-72 to (23.37 %) Pusa Purple Cluster × Arka Keshav. Four cross combinations showed negatively significant heterosis over standard check viz., Pusa Purple Long × Brinjal-LC-71 (-12.40 %), Pusa Purple Long × Pusa Purple Cluster (-15.70 %), Pusa Purple Long × Brinjal-LC-72 (-18.18 %) and Pusa Purple Long × Arka Keshav (-21.50 %) indicating their superiority over standard check.

4.2.2 Days to first picking

The number of days to first picking is a crucial economic trait for achieving early crop production and higher market price. Pusa Purple Long showed least number of days to first picking i.e., 59.33 days among the parents. In cross combinations minimum number of days to first picking were recorded by the hybrid Pusa Purple Long × Brinjal-LC-73 (50.66 days) which was statistically at par with Pusa Purple Long × Brinjal-LC-72 (52.33 days) and Pusa Purple Long × Pusa Purple Cluster (52.66 days); which indicated that these genotypes were comparable for the given trait under study. The similar findings have been reported by Patel et al. (2015) and Khan and Singh (2014).

Negatively significant heterobeltiosis is desirable for the trait days to first picking the best cross combination with desirable heterobeltiosis was Pusa Purple Long × Brinjal-LC-73 (-14.61 %) and was followed by Pusa Purple Long × Brinjal-

LC-72 (-11.80 %) and Pusa Purple Long × Pusa Purple Cluster (-11.24 %). Only six cross combinations showed negative significant heterosis over standard check; and the best hybrid combination in terms of economic heterosis was Pusa Purple Long × Brinjal-LC-73 (-19.59 %).

Table 4.2.1-Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait days to 50 percent flowering

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	42.33		
Pusa Purple Cluster	52.33		
Arka Keshav	45.66		
Brinjal-LC-71	58.33		
Brinjal-LC-72	54.33		
Brinjal-LC-73	49.66		
Pusa Purple Long × Pusa Purple Cluster	34.00	-19.68*	-15.70*
Pusa Purple Long × Arka Keshav	31.66	-25.21*	-21.50*
Pusa Purple Long × Brinjal-LC-71	35.33	-16.54*	-12.40*
Pusa Purple Long × Brinjal-LC-72	33.00	-22.04*	-18.18*
Pusa Purple Long × Brinjal-LC-73	36.33	-14.17*	-9.92
Pusa Purple Cluster × Arka Keshav	56.33	23.37*	39.67*
Pusa Purple Cluster × Brinjal-LC-71	57.66	10.19*	42.97*
Pusa Purple Cluster × Brinjal-LC-72	47.00	-10.19*	16.54*
Pusa Purple Cluster × Brinjal-LC-73	51.33	3.36	27.27*
Arka Keshav × Brinjal-LC-71	47.66	4.38	18.18*
Arka Keshav × Brinjal-LC-72	52.66	15.33*	30.57*
Arka Keshav × Brinjal-LC-73	50.00	9.51	23.98*
Brinjal-LC-71 × Brinjal-LC-72	47.00	-13.49*	16.54*
Brinjal-LC-71 × Brinjal-LC-73	55.33	11.42*	37.19*
Brinjal-LC-72 × Brinjal-LC-73	50.66	2.01	25.61*
Check (CODE-B02)	40.33		
Population Mean	46.76		
Range	31.66-58.33		
SE (m) ±	1.71		
$CD_{(0.05)}$	4.89		

*Significant at 5% level of significance

4.2.3 Harvest duration

The analysis of variance (Appendix-I) showed significant variation for harvest duration among parents as well as crosses. The data presented in table 4.2.3 shows variations in harvest duration.

Table 4.2.2-Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait days to first picking

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	59.33		
Pusa Purple Cluster	69.66		
Arka Keshav	63.33		
Brinjal-LC-71	75.66		
Brinjal-LC-72	71.00		
Brinjal-LC-73	64.33		
Pusa Purple Long × Pusa Purple Cluster	52.66	-11.24*	-16.41*
Pusa Purple Long × Arka Keshav	58.00	-2.24	-7.94*
Pusa Purple Long × Brinjal-LC-71	56.00	-5.61	-11.11*
Pusa Purple Long × Brinjal-LC-72	52.33	-11.80*	-16.94*
Pusa Purple Long × Brinjal-LC-73	50.66	-14.61*	-19.59*
Pusa Purple Cluster × Arka Keshav	68.66	8.42*	8.98*
Pusa Purple Cluster × Brinjal-LC-71	62.00	-11.00*	-1.59
Pusa Purple Cluster × Brinjal-LC-72	64.00	-8.13*	1.59
Pusa Purple Cluster × Brinjal-LC-73	58.33	-9.33*	-7.41
Arka Keshav × Brinjal-LC-71	61.33	-3.16	-2.65
Arka Keshav × Brinjal-LC-72	69.00	8.95*	9.52*
Arka Keshav × Brinjal-LC-73	57.00	-10.00*	-9.52*
Brinjal-LC-71 × Brinjal-LC-72	72.33	1.87	14.81*
Brinjal-LC-71 × Brinjal-LC-73	71.33	10.88*	13.22*
Brinjal-LC-72 × Brinjal-LC-73	65.33	1.55	3.70
Check (CODE-B02)	63.00		
Population Mean	62.96		
Range	50.66-75.66		
SE (m)±	1.73		
$CD_{(0.05)}$	4.97		

*Significant at 5% level of significance

Table 4.2.3- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait harvest duration

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	43.66		
Pusa Purple Cluster	56.33		
Arka Keshav	51.00		
Brinjal-LC-71	49.00		
Brinjal-LC-72	65.33		
Brinjal-LC-73	61.00		
Pusa Purple Long × Pusa Purple Cluster	63.33	12.43*	36.69*
Pusa Purple Long × Arka Keshav	47.00	-7.84*	1.45
Pusa Purple Long × Brinjal-LC-71	52.33	6.80*	12.95*
Pusa Purple Long × Brinjal-LC-72	57.33	-12.25*	23.74*
Pusa Purple Long × Brinjal-LC-73	71.33	16.93*	53.96*
Pusa Purple Cluster ×Arka Keshav	57.66	2.36	24.45*
Pusa Purple Cluster × Brinjal-LC-71	62.66	11.24*	35.25*
Pusa Purple Cluster × Brinjal-LC-72	66.33	1.53	43.17*
Pusa Purple Cluster × Brinjal-LC-73	64.00	4.92*	38.14*
Arka Keshav × Brinjal-LC-71	54.66	7.18*	17.98*
Arka Keshav × Brinjal-LC-72	64.33	-1.53	38.85*
Arka Keshav × Brinjal-LC-73	75.00	22.95*	61.88*
Brinjal-LC-71 × Brinjal-LC-72	78.66	20.40*	69.78*
Brinjal-LC-71 × Brinjal-LC-73	50.00	-18.03*	7.92*
Brinjal-LC-72 × Brinjal-LC-73	74.00	13.27*	59.72*
Check (CODE-B02)	46.33		
Population Mean	59.60		
Range	43.66-78.66		
SE (m) ±	1.00		
$CD_{(0.05)}$	2.87		

*Significant at 5% level of significance

The range for harvest duration varied from 43.66-78.66 days. More number of days are desirable for harvest duration; the genotype Brinjal-LC-72 showed maximum harvest duration of 65.33 days and Pusa Purple Long recorded short harvest duration of 43.66 days. None of the F_1's were at par with Brinjal-LC-71 × Brinjal-LC-72 which recorded longest harvest duration of 78.66 days. Similar results have been obtained by Parida et al. (2020) in brinjal.

As many as 9 out of total 15 crosses showed positive heterosis over better parent; which indicated superiority of these cross combinations over their respective better parents. Maximum heterobeltiosis was recorded in Arka Keshav × Brinjal-LC-73 (22.95%) followed by the hybrids Brinjal-LC-71 × Brinjal-LC-72 (20.40%), Pusa Purple Long × Brinjal-LC-73 (16.93%), Brinjal-LC-72 × Brinjal-LC-73 (13.27%), Pusa Purple Long × Pusa Purple Cluster (12.43%), Pusa Purple Cluster × Brinjal-LC-71 (11.24%), Arka Keshav × Brinjal-LC-71 (7.18%), Pusa Purple Long × Brinjal-LC-71 (6.80%), Pusa Purple Cluster × Brinjal-LC-73 (4.92%). Whereas heterosis over standard check was minimum in Brinjal-LC-71 × Brinjal-LC-73 (7.92%) and this made the cross combination a poor cross in terms of harvest duration.

4.2.4 Leaf length (cm)

Maximum leaf length leads to vigorous and healthy plant and it helps in increasing the area of the leaf; which in turn increases photosynthesis for maximum production and higher yields. Table 4.2.4 depicts Pusa Purple Long (16.96 cm) had the maximum leaf length which was statistically at par with the genotypes viz. Arka Keshav (16.33 cm), Pusa Purple Cluster (15.80 cm), Brinjal-LC-72 (15.20 cm); thus suggesting that all these genotypes were equally good as the genotype Pusa Purple Long. However, the Cross Brinjal-LC-71 × Brinjal-LC-72 showed maximum leaf length of 18.00 cm which was statistically at par with Check (CODE-B02) (18.46 cm) and the crosses Arka Keshav × Brinjal-LC-73 (15.96 cm) and Pusa Purple Long × Arka Keshav (15.86 cm) respectively. The results were in accordance with those reported by Singh and Singh (2016), Verma et al. (2021) and Singh et al. (2024) in the heterosis studies performed by them in brinjal.

Heterobeltiosis for leaf length ranged from -0.89% to 18.42% and only one hybrid out of total 15 cross combinations showed significant positive heterobeltiosis and heterosis over standard check. The hybrid combination Brinjal-LC-71 × Brinjal-LC-72 (18.42%), showed its superiority both in terms of heterobeltiosis and economic heterosis.

4.2.5 Stem diameter (mm)

Among the parental lines, the values for the character stem diameter varied from 11.90 mm to 25.30 mm; with an overall mean value of 22.39 mm. The highest stem diameter was observed in the parent Brinjal-LC-72 (25.30 mm).

Table 4.2.4- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait leaf length (cm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	16.96		
Pusa Purple Cluster	15.80		
Arka Keshav	16.33		
Brinjal-LC-71	13.80		
Brinjal-LC-72	15.20		
Brinjal-LC-73	11.33		
Pusa Purple Long × Pusa Purple Cluster	12.10	-28.66*	-34.45*
Pusa Purple Long × Arka Keshav	15.86	-6.49	-14.08*
Pusa Purple Long × Brinjal-LC-71	15.50	-8.61	-16.03*
Pusa Purple Long × Brinjal-LC-72	12.26	-27.71*	-33.59*
Pusa Purple Long × Brinjal-LC-73	14.63	-13.74*	-20.75*
Pusa Purple Cluster × Arka Keshav	14.76	-9.61	-20.04*
Pusa Purple Cluster × Brinjal-LC-71	15.66	-0.89	-15.17*
Pusa Purple Cluster × Brinjal-LC-72	12.86	-18.61*	-30.34*
Pusa Purple Cluster × Brinjal-LC-73	13.36	-15.44*	-27.63*
Arka Keshav × Brinjal-LC-71	12.00	-26.52*	-26.52*
Arka Keshav × Brinjal-LC-72	13.13	-19.6*	-19.60*
Arka Keshav × Brinjal-LC-73	15.96	-2.27	-2.27
Brinjal-LC-71 × Brinjal-LC-72	18.00	18.42*	18.42*
Brinjal-LC-71 × Brinjal-LC-73	15.43	11.81	11.81
Brinjal-LC-72 × Brinjal-LC-73	14.73	-3.09	-3.09
Check (CODE-B02)	18.46		
Population Mean	14.73		
Range	11.33-18.46		
SE (m) ±	0.74		
$CD_{(0.05)}$	2.14		

*Significant at 5% level of significance.

The minimum stem diameter was recorded in Brinjal-LC-71 (11.90 mm); suggesting it as the poor parent for the trait. Among the hybrids, the cross Pusa

Purple Long × Brinjal-LC-71 exhibited the highest stem diameter (29.46 mm); indicating it as the best cross combination with high stem diameter value. While the cross Arka Keshav × Brinjal-LC-71 showed the least value of 18.50 mm. These observations are in agreement to those obtained by Nagraj (2021) in brinjal.

Table 4.2.5 Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait stem diameter (mm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	23.20		
Pusa Purple Cluster	18.43		
Arka Keshav	13.60		
Brinjal-LC-71	11.90		
Brinjal-LC-72	25.30		
Brinjal-LC-73	20.13		
Pusa Purple Long × Pusa Purple Cluster	26.20	12.93*	53.85*
Pusa Purple Long × Arka Keshav	28.03	20.82*	64.59*
Pusa Purple Long × Brinjal-LC-71	29.46	26.98*	72.99*
Pusa Purple Long × Brinjal-LC-72	21.60	-14.62*	26.83*
Pusa Purple Long × Brinjal-LC-73	22.96	-1.03	34.82*
Pusa Purple Cluster × Arka Keshav	19.40	5.26*	13.92*
Pusa Purple Cluster × Brinjal-LC-71	24.86	34.89*	45.98*
Pusa Purple Cluster × Brinjal-LC-72	27.83	10.00*	63.42*
Pusa Purple Cluster × Brinjal-LC-73	20.43	1.49	19.96*
Arka Keshav × Brinjal-LC-71	18.50	36.03*	8.63*
Arka Keshav × Brinjal-LC-72	26.00	2.77*	52.67*
Arka Keshav × Brinjal-LC-73	28.03	39.24*	64.59*
Brinjal-LC-71 × Brinjal-LC-72	26.00	2.77*	52.67*
Brinjal-LC-71 × Brinjal-LC-73	22.60	12.27*	32.71*
Brinjal-LC-72 × Brinjal-LC-73	21.13	-16.48*	24.08*
Check (CODE-B02)	17.03		
Population Mean	22.39		
Range	11.90-29.46		
SE (m) ±	0.16		
$CD_{(0.05)}$	0.45		

*Significant at 5% level of significance

Negative significant heterobeltiosis for this trait was exhibited by two F_1's Brinjal-LC-72 × Brinjal-LC-73 (-16.48%) and Pusa Purple Long × Brinjal-LC-72

(-14.62 %) respectively. Heterobeltiosis ranged from -1.03 % (Pusa Purple Long × Brinjal-LC-73**)** to 39.24 % (Arka Keshav × Brinjal-LC-73). Out of 15 as many as 11 cross combinations showed significant positive heterobeltiosis. Economic heterosis ranged from 8.63 % (Arka Keshav × Brinjal-LC-71) to 64.59 % (Pusa Purple long × Arka Keshav and Arka Keshav × Brinjal-LC-73). None of the crosses however showed negative significant economic heterosis.

Table 4.2.6- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait plant height (cm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	87.10		
Pusa Purple Cluster	79.70		
Arka Keshav	83.46		
Brinjal-LC-71	89.50		
Brinjal-LC-72	76.70		
Brinjal-LC-73	93.03		
Pusa Purple Long × Pusa Purple Cluster	89.33	2.56*	3.44*
Pusa Purple Long × Arka Keshav	83.76	-3.83*	-3.01*
Pusa Purple Long × Brinjal-LC-71	91.66	2.41*	6.14*
Pusa Purple Long × Brinjal-LC-72	88.06	1.10*	1.97*
Pusa Purple Long × Brinjal-LC-73	91.36	-1.80*	5.79*
Pusa Purple Cluster × Arka Keshav	85.66	2.64*	-0.81*
Pusa Purple Cluster × Brinjal-LC-71	81.26	-9.21*	-5.91*
Pusa Purple Cluster × Brinjal-LC-72	81.63	2.42*	-5.48*
Pusa Purple Cluster × Brinjal-LC-73	93.93	0.97*	8.77*
Arka Keshav × Brinjal-LC-71	91.33	2.04*	5.75*
Arka Keshav × Brinjal-LC-72	85.40	2.32*	-1.11*
Arka Keshav × Brinjal-LC-73	92.70	-0.35*	7.34*
Brinjal-LC-71 × Brinjal-LC-72	90.50	1.12*	4.79*
Brinjal-LC-71 × Brinjal-LC-73	88.23	-5.16*	2.17*
Brinjal-LC-72 × Brinjal-LC-73	77.10	-17.12*	-10.72*
Check (CODE-B02)	86.36		
Population Mean	86.71		
Range	76.70-93.93		
SE (m) ±	0.11		
$CD_{(0.05)}$	0.32		

*Significant at 5% level of significance

4.2.6 Plant height (cm)

Plant height is one of the vital growth parameters that reflects the overall vigour of the plant. A critical examination of the mean data presented in Table 4.2.6 revealed that among the parental lines, the maximum plant height was observed in the genotype Brinjal-LC-73 (93.03 cm). The minimum plant height was recorded in Brinjal-LC-72 (76.70 cm). Among the hybrids, the highest plant height was recorded in Pusa Purple Cluster × Brinjal-LC-73 (93.93 cm). The lowest plant height among the cross combinations was observed in Brinjal-LC-72 × Brinjal-LC-73 (77.10 cm); which indicated that this cross combination was a poor combination in terms of plant height; whereas Check (CODE-B02) recorded a plant height of 86.36 cm. The findings were corroborated by the studies conducted by Arti and Sharma (2018), Ansari et al. (2011) and Tabasum et al. (2024) in brinjal.

Nine out of 15 cross combinations were positively significant for heterosis over better parent; which was desirable for the trait plant height. It was maximum in the hybrid combination Pusa Purple Cluster × Arka Keshav (2.64 %) followed by the hybrids Pusa Purple Long × Pusa Purple Cluster (2.56 %), Pusa Purple Cluster × Brinjal-LC-72 (2.42 %) and Pusa Purple Long × Brinjal-LC-71 (2.41 %). Nine crosses surpassed check (CODE-B02) for the trait plant height; However, Pusa Purple Cluster × Brinjal-LC-73 (8.77 %) was found best.

4.2.7 Number of primary branches per plant

Vigour and yield of the plant depend directly upon number of primary branches therefore it is an important trait. The various genotypes (Table 4.2.7) showed the range which varied from 2.33 to 5.33 primary branches per plant for the character under study. Within parents the minimum and maximum value for number of primary branches were recorded in the genotypes Brinjal-LC-71 (4.00) and Brinjal-LC-72 (5.33) respectively. The parental genotypes viz. Pusa Purple Long (4.66), Pusa Purple Cluster (4.33), Arka Keshav (4.33), Brinjal-LC-73 (4.33) were at par with the parent Brinjal-LC-72; indicating that all these genotypes were comparable. Arka Keshav × Brinjal-LC-71 and Brinjal-LC-71 × Brinjal-LC-73 (2.33) revealed minimum number of primary branches for the trait. However, the cross combination Pusa Purple Long × Pusa Purple Cluster (5.33) had maximum number of primary branches and was statistically at par with Pusa Purple Long × Arka Keshav (5.00), Pusa Purple Cluster × Brinjal-LC-72 (4.66), Arka Keshav ×

Brinjal-LC-72 (4.66) and Brinjal-LC-71 × Brinjal-LC-72 (4.33); thus suggesting that all the cross combinations were promising for the trait number of primary branches. These results were in accordance to those obtained by Khan and Singh (2014); Kumar et al. (2023) in hybridization studies conducted in brinjal.

Table 4.2.7- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait number of primary branches

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	4.66		
Pusa Purple Cluster	4.33		
Arka Keshav	4.33		
Brinjal-LC-71	4.00		
Brinjal-LC-72	5.33		
Brinjal-LC-73	4.33		
Pusa Purple Long × Pusa Purple Cluster	5.33	14.38	23.09
Pusa Purple Long × Arka Keshav	5.00	7.30	15.47
Pusa Purple Long × Brinjal-LC-71	2.66	-42.92*	-38.57*
Pusa Purple Long × Brinjal-LC-72	3.66	-31.33*	-15.47
Pusa Purple Long × Brinjal-LC-73	3.00	-35.62*	-30.72*
Pusa Purple Cluster × Arka Keshav	2.66	-38.57*	-38.57*
Pusa Purple Cluster × Brinjal-LC-71	2.66	-38.57*	-38.57*
Pusa Purple Cluster × Brinjal-LC-72	4.66	-12.57	7.62
Pusa Purple Cluster × Brinjal-LC-73	2.66	-38.57*	-38.57*
Arka Keshav × Brinjal-LC-71	2.33	-46.19*	-46.19*
Arka Keshav × Brinjal-LC-72	4.66	-12.57	7.62
Arka Keshav × Brinjal-LC-73	3.33	-23.09	-23.09
Brinjal-LC-71 × Brinjal-LC-72	4.33	-18.76	0.00
Brinjal-LC-71 × Brinjal-LC-73	2.33	-46.19*	-46.19*
Brinjal-LC-72 × Brinjal-LC-73	3.66	-31.33*	-15.47
Check (CODE-B02)	4.33		
Population Mean	3.82		
Range	2.33-5.33		
SE (m) ±	0.46		
$CD_{(0.05)}$	1.31		

*Significant at 5% level of significance

For number of primary branches heterobeltiosis ranged from -12.57 % (Pusa Purple Cluster × Brinjal-LC-72 and Arka Keshav × Brinjal-LC-72) to 14.38% (Pusa Purple Long × Pusa Purple Cluster).

4.2.8 Pedicel length (cm)

Pedicel length in brinjal is an important trait as it influences fruit orientation and helps in ease of harvesting. An optimal pedicel length can reduce fruit rot by preventing contact with soil and thus improving marketable appearance. Mean pedicel length for the various genotypes varied between 2.30-6.56 cm; with an overall mean of 4.89 cm. In parental genotypes maximum pedicel length was observed in the parental genotype i.e. Brinjal-LC-72 (5.73 cm). Whereas; the parent Brinjal-LC-71 recorded minimum pedicel length of 2.30 cm. Cross combination Pusa Purple Long × Brinjal-LC-73 (6.56 cm) had maximum pedicel length and was at par with the hybrid genotypes Brinjal-LC-72 × Brinjal-LC-73(6.43 cm), Arka Keshav × Brinjal-LC-72 (6.20 cm), Pusa Purple Long × Brinjal-LC-72 (6.16 cm); indicating that all these cross combinations were comparable with the best cross combination Pusa Purple Long × Brinjal-LC-73. However; the Check genotype CODE-BO2 recorded pedicel length value equivalent to 4.30 cm. The similar findings have been reported by Afful et al. (2024) in their studies conducted on brinjal.

Positive heterosis over better parent is desirable for the trait pedicel length and 10 cross combinations showed positive significant heterobeltiosis which ranged between -3.23 to 49.00%. Arka Keshav × Brinjal-LC-71 (49.00%). exhibited highest heterobeltiosis among the cross combinations. Economic heterosis was highest for the cross-combination Pusa Purple Long × Brinjal-LC-73 (52.56%).

4.2.9 Number of fruits per plant

Number of fruits per plant is a crucial trait as it directly contributes to yield in brinjal. Sufficient variation (Table 4.2.9) was observed among different parents and hybrid combinations. Maximum number of fruits were recorded in Brinjal-LC-73 (28.00); which was statistically at par with parents Arka Keshav (26.66) and Brinjal-LC-72 (24.00); suggesting that all these parents were promising for the trait fruits per plant.

Among, the cross combinations Brinjal-LC-72 × Brinjal-LC-73 (37.00) showed maximum number of fruits per plant. Whereas, Pusa Purple Cluster × Brinjal-LC-71 exhibited minimum number of fruits per plant. These findings were

similar to the observations obtained by Ravali et al. (2017), Patel et al. (2015), Devi and Kanaujia (2020) and Reshmika et al. (2015) in brinjal.

Table 4.2.8 Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait pedicel length (cm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	4.50		
Pusa Purple Cluster	4.96		
Arka Keshav	4.00		
Brinjal-LC-71	2.30		
Brinjal-LC-72	5.73		
Brinjal-LC-73	4.50		
Pusa Purple Long × Pusa Purple Cluster	4.80	-3.23	11.63*
Pusa Purple Long × Arka Keshav	5.53	22.89*	28.60*
Pusa Purple Long × Brinjal-LC-71	5.53	22.89*	28.60*
Pusa Purple Long × Brinjal-LC-72	6.16	7.50*	43.26*
Pusa Purple Long × Brinjal-LC-73	6.56	45.78*	52.56*
Pusa Purple Cluster × Arka Keshav	2.80	-43.55*	-34.88*
Pusa Purple Cluster × Brinjal-LC-71	4.06	-18.15*	-5.58
Pusa Purple Cluster × Brinjal-LC-72	3.56	-37.87*	-17.21*
Pusa Purple Cluster × Brinjal-LC-73	5.73	15.52*	33.26*
Arka Keshav × Brinjal-LC-71	5.96	49.00*	38.60*
Arka Keshav × Brinjal-LC-72	6.20	8.20*	44.19*
Arka Keshav × Brinjal-LC-73	6.03	34.00*	40.23*
Brinjal-LC-71 × Brinjal-LC-72	2.53	-55.85*	-41.16*
Brinjal-LC-71 x Brinjal-LC-73	5.50	22.22*	27.91*
Brinjal-LC-72 x Brinjal-LC-73	6.43	12.22*	49.53*
Check (CODE-BO2)	4.30		
Population Mean	4.89		
Range	2.30-6.56		
SE (m) ±	0.14		
$CD_{(0.05)}$	0.41		

*Significant at 5% level of significance

The extent of heterobeltiosis was highest in Pusa Purple Long × Brinjal-LC-71 (46.04%) which was followed by Brinjal-LC-72 × Brinjal-LC-73 (32.14%), Pusa Purple Long × Pusa Purple Cluster (27.13%) and Pusa Purple Long × Arka

Keshav (17.52%). However, economic heterosis was recorded positively significant for only seven cross combinations.

Table 4.2.9- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait number of fruits per plant

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	16.66		
Pusa Purple Cluster	23.33		
Arka Keshav	26.66		
Brinjal-LC-71	12.66		
Brinjal-LC-72	24.00		
Brinjal-LC-73	28.00		
Pusa Purple Long × Pusa Purple Cluster	29.66	27.13*	36.93*
Pusa Purple Long × Arka Keshav	31.33	17.52*	44.64*
Pusa Purple Long × Brinjal-LC-71	24.33	46.04*	12.33
Pusa Purple Long × Brinjal-LC-72	24.00	0.00	10.80
Pusa Purple Long × Brinjal-LC-73	27.33	-2.39	26.18*
Pusa Purple Cluster × Arka Keshav	27.66	3.75	27.70*
Pusa Purple Cluster × Brinjal-LC-71	17.00	-27.13*	-21.51*
Pusa Purple Cluster × Brinjal-LC-72	22.66	-5.58	4.62
Pusa Purple Cluster × Brinjal-LC-73	24.00	-14.29	10.80
Arka Keshav × Brinjal-LC-71	17.33	-35.00*	-19.99*
Arka Keshav × Brinjal-LC-72	25.33	-4.99	16.94
Arka Keshav × Brinjal-LC-73	29.33	4.75	35.41*
Brinjal-LC-71 × Brinjal-LC-72	21.66	-9.75	0.00
Brinjal-LC-71 × Brinjal-LC-73	27.33	-2.39	26.18*
Brinjal-LC-72 × Brinjal-LC-73	37.00	32.14*	70.82*
Check (CODE-B02)	21.66		
Population Mean	24.49		
Range	12.66-37.00		
SE (m) ±	1.46		
$CD_{(0.05)}$	4.20		

*Significant at 5% level of significance

4.2.10 Fruit diameter (cm)

Genotypes showed considerable variation for fruit diameter where Brinjal-LC-71 (7.00 cm) was highest among parents.

Table 4.2.10- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait fruit diameter (cm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	3.66		
Pusa Purple Cluster	3.70		
Arka Keshav	2.73		
Brinjal-LC-71	7.00		
Brinjal-LC-72	4.06		
Brinjal-LC-73	3.93		
Pusa Purple Long × Pusa Purple Cluster	4.30	16.22*	10.26*
Pusa Purple Long × Arka Keshav	4.60	25.68*	17.95*
Pusa Purple Long × Brinjal-LC-71	4.83	-31.00	23.85*
Pusa Purple Long × Brinjal-LC-72	4.30	5.91	10.26*
Pusa Purple Long × Brinjal-LC-73	3.66	-6.87	-6.15
Pusa Purple Cluster × Arka Keshav	4.30	16.22*	10.26*
Pusa Purple Cluster × Brinjal-LC-71	4.26	-39.14*	9.23*
Pusa Purple Cluster × Brinjal-LC-72	4.13	1.72	5.90
Pusa Purple Cluster × Brinjal-LC-73	3.43	-12.72*	-12.05*
Arka Keshav × Brinjal-LC-71	4.06	-42.00*	4.10
Arka Keshav × Brinjal-LC-72	4.33	6.65	11.03*
Arka Keshav × Brinjal-LC-73	3.43	-12.72*	-12.05*
Brinjal-LC-71 × Brinjal-LC-72	4.06	-42.00*	4.10
Brinjal-LC-71 × Brinjal-LC-73	3.86	-44.86*	-1.03
Brinjal-LC-72 × Brinjal-LC-73	4.50	10.84*	15.38*
Check (CODE-B02)	3.90		
Population Mean	4.13		
Range	2.73-7.00		
SE (m) ±	0.12		
$CD_{(0.05)}$	0.35		

*Significant at 5% level of significance

Whereas, Pusa Purple Long × Brinjal-LC-71 (4.83 cm) showed maximum fruit diameter and was statistically at par with Pusa Purple Long × Arka Keshav (4.60 cm) and Brinjal-LC-72 × Brinjal-LC-73 (4.50 cm). Similar results were also obtained by Srivastava et al. (2019), Ravali et al. (2017), Devi and Kanaujia (2020) in brinjal.

Table 4.2.11- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait fruit length (cm)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	14.60		
Pusa Purple Cluster	9.36		
Arka Keshav	12.76		
Brinjal-LC-71	8.40		
Brinjal-LC-72	15.33		
Brinjal-LC-73	12.40		
Pusa Purple Long × Pusa Purple Cluster	14.70	0.68	37.90*
Pusa Purple Long × Arka Keshav	15.20	4.11*	42.59*
Pusa Purple Long × Brinjal-LC-71	15.50	6.16*	45.40*
Pusa Purple Long × Brinjal-LC-72	16.43	7.18*	54.13*
Pusa Purple Long × Brinjal-LC-73	15.06	3.15*	41.28*
Pusa Purple Cluster × Arka Keshav	12.63	-1.02	18.48*
Pusa Purple Cluster × Brinjal-LC-71	9.46	1.07	-11.26*
Pusa Purple Cluster × Brinjal-LC-72	16.30	6.33*	52.91*
Pusa Purple Cluster × Brinjal-LC-73	13.46	8.55*	26.27*
Arka Keshav × Brinjal-LC-71	13.53	6.03*	26.92*
Arka Keshav × Brinjal-LC-72	15.30	-0.20	43.53*
Arka Keshav × Brinjal-LC-73	13.43	5.25*	25.98*
Brinjal-LC-71 × Brinjal-LC-72	10.30	-32.81*	-3.38*
Brinjal-LC-71 × Brinjal-LC-73	14.53	17.18*	36.30*
Brinjal-LC-72 × Brinjal-LC-73	13.36	-12.85*	25.33*
Check (CODE-B02)	10.66		
Population Mean	13.30		
Range	8.40-16.43		
SE (m) ±	0.12		
$CD_{(0.05)}$	0.34		

*Significant at 5% level of significance

Significant and positive heterosis over better parent for fruit diameter ranged between -6.87 % (Pusa Purple Long × Brinjal-LC-73) to 25.68 % (Pusa Purple Long × Arka Keshav). Eight of the crosses out of fifteen showed positive significant heterosis over standard check where Pusa Purple Long × Brinjal-LC-71 (23.85 %) was highest and Pusa Purple Cluster × Brinjal-LC-71 (9.23 %) lowest for the trait.

Table 4.2.12- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait average fruit weight (g)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	47.66		
Pusa Purple Cluster	36.66		
Arka Keshav	34.66		
Brinjal-LC-71	72.66		
Brinjal-LC-72	46.00		
Brinjal-LC-73	72.33		
Pusa Purple Long Pusa Purple Cluster	59.00	23.79*	7.27*
Pusa Purple Long × Arka Keshav	45.33	-4.89	-17.58*
Pusa Purple Long × Brinjal-LC-71	65.33	-10.09*	18.78*
Pusa Purple Long × Brinjal-LC-72	43.66	-8.39*	-20.62*
Pusa Purple Long × Brinjal-LC-73	52.00	-28.11*	-5.45
Pusa Purple Cluster × Arka Keshav	35.66	-2.73	-35.16*
Pusa Purple Cluster × Brinjal-LC-71	71.00	-2.28	29.09*
Pusa Purple Cluster × Brinjal-LC-72	52.66	14.48*	-4.625
Pusa Purple Cluster × Brinjal-LC-73	64.66	-10.6*	17.56*
Arka Keshav × Brinjal-LC-71	45.00	-38.07*	-18.18*
Arka Keshav × Brinjal-LC-72	66.00	43.48*	20.00*
Arka Keshav × Brinjal-LC-73	73.66	1.84	33.93*
Brinjal-LC-71 × Brinjal-LC-72	74.00	1.84	34.55*
Brinjal-LC-71 × Brinjal-LC-73	58.66	-19.27*	6.65*
Brinjal-LC-72 × Brinjal-LC-73	63.33	-12.44*	15.15*
Check (CODE-B02)	55.00		
Population Mean	56.13		
Range	34.66-74.00		
SE (m) ±	1.17		
$CD_{(0.05)}$	3.36		

*Significant at 5% level of significance

4.2.11 Fruit length (cm)

The fruit length varied from 8.40-16.43 cm with a population mean of 13.30 cm indicating presence of significant variability among the genotypes Brinjal-LC-72 15.33 cm gave the maximum fruit length whereas minimum fruit length was observed in parent Brinjal-LC-71 8.40 cm. Cross combination Pusa Purple Long × Brinjal-LC-72 (16.43 cm) obtained maximum fruit length and Pusa Purple Cluster

× Brinjal-LC-72 (16.30 cm) was statistically at par with the best. Pusa Purple Cluster × Brinjal-LC-71 (9.46cm) recorded minimum fruit length. Similar findings for fruit length (cm) were reported by Arti and Sharma (2018), Ansari et al. (2011) and Tabasum et al. (2024) in brinjal.

Heterobeltiosis for cross combination Brinjal-LC-71 × Brinjal-LC-73 (17.18 %) was positively significant and maximum for the trait fruit length followed by Pusa Purple Cluster × Brinjal-LC-73 (8.55 %), Pusa Purple Long × Brinjal-LC-72 (7.18%), Pusa Purple Cluster × Brinjal-LC-72 (6.33 %), Pusa Purple Long × Brinjal-LC-71 (6.16 %), Arka Keshav × Brinjal-LC-71 (6.03 %), Arka Keshav × Brinjal-LC-73 (5.25 %), Pusa Purple Long × Arka Keshav (4.11 %), Pusa Purple Long × Brinjal-LC-73 (3.15 %). Two cross combinations resulted in significant negative heterosis over standard check Pusa Purple Cluster × Brinjal-LC-71 (-11.26 %) and Brinjal-LC-71 × Brinjal-LC-72 (-3.38 %). The values for heterosis over standard check varied from -3.38-54.13 % and thirteen of fifteen cross combinations were better than standard check CODE-B02.

4.2.12 Average fruit weight (g)

Average fruit weight is a key yield-contributing trait, directly influencing total production, though regional consumer preferences may limit its desirability. As per Table 4.2.12, among the parents, Brinjal-LC-71 recorded the highest average fruit weight (72.66 g) which was at par with the parent Brinjal-LC-73 (72.33 g). In the hybrids, the maximum average fruit weight was observed in Brinjal-LC-71 × Brinjal-LC-72(74.00 g), which was statistically at par with Arka Keshav × Brinjal-LC-73 (73.66 g), Pusa Purple Cluster × Brinjal-LC-71 (71.00 g). All these crosses also outperformed the standard check CODE-BO2 (55.00 g) significantly. These results were in accordance to those obtained by Ansari et al. (2011), Madhavi et al. (2015) in brinjal study.

The heterosis over better parent for trait average fruit weight was positively significant for F_1^s Arka Keshav × Brinjal-LC-72 (43.48 %), Pusa Purple Long × Pusa Purple Cluster (23.79 %) and Pusa Purple Cluster × Brinjal-LC-72 (14.48 %). Seven crosses showed negative but significant heterosis over better parent. Among fifteen F_1^s nine recorded positive and significant heterosis over standard check and were better compared to the standard check CODE-B02 for average fruit weight.

4.2.13 Number of seeds per fruit

The number of seeds per fruit is a vital trait in any hybridization program, as it directly influences seed yield and the efficiency of breeding efforts. Brinjal-LC-73 in the parents recorded maximum number of seeds per fruit 577.33 and Pusa Purple cluster recorded least number of seeds per fruit 392.66. Number of seeds ranged between 359.33-669.00 among the crosses whereas the overall population mean was 483.80. Among the crosses Brinjal-LC-71 × Brinjal-LC-72 (669.00) had maximum number of seeds per fruit Brinjal-LC-71 × Brinjal-LC-73 (657.00) was statistically at par. Pusa Purple Cluster × Brinjal-LC-73 (382.66) showed least number of seeds per fruit in crosses. Sailesh et al. (2023) also showed same results in their findings for seeds per fruit.

Heterobeltiosis for number of seeds per fruit should be positive and significant, eight crosses showed positive and significant heterobeltiosis, Arka Keshav × Brinjal-LC-71 showed maximum heterobeltiosis of 38.60 % Economic heterosis was positive and significant for fifteen of the crosses, and ranged between 11.87-86.18 %. Brinjal-LC-71 × Brinjal-LC-72 showed maximum economic heterosis of 86.18 %, while none of the crosses showed negative and significant economic heterosis.

4.2.14 Yield per plant (kg)

Yield serves as a direct measure of a plant's genetic potential and adaptability. In brinjal, consistent high yield is essential for meeting consumer demand and ensuring profitability for growers. The overall mean for the trait was 1.14 and ranged between 0.45-1.63 kg for all the genotypes. Pusa Purple Long (0.91 kg) showed the highest yield per plant and was statistically at par with parent Brinjal-LC-73 (0.83 kg). Cross combinations Pusa Purple Long × Brinjal-LC-72 (1.63 kg) showed maximum yield per plant followed by Pusa Purple Long × Brinjal-LC-73 (1.48 kg), Arka Keshav × Brinjal-LC-71 (1.46 kg) and Pusa Purple Long × Arka Keshav (1.44 kg). These findings were in accordance to the studies of Ravali et al. (2017), Madhavi et al. (2015) and Bisht et al. (2022) for brinjal.

Positive and significant heterosis is desirable for yield per plant, fourteen cross combinations exhibited positive significant heterobeltiosis and was maximum in Arka Keshav × Brinjal-LC-71 (131.75 %).

Table 4.2.13- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait number of seeds per fruit

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	436.00		
Pusa Purple Cluster	392.66		
Arka Keshav	418.00		
Brinjal-LC-71	369.33		
Brinjal-LC-72	522.33		
Brinjal-LC-73	577.33		
Pusa Purple Long × Pusa Purple Cluster	479.33	9.94*	33.40*
Pusa Purple Long × Arka Keshav	477.66	9.56*	32.93*
Pusa Purple Long × Brinjal-LC-71	448.33	2.83	24.77*
Pusa Purple Long × Brinjal-LC-72	412.66	-21.00*	14.84*
Pusa Purple Long × Brinjal-LC-73	402.00	-30.37*	11.87*
Pusa Purple Cluster × Arka Keshav	458.66	9.73*	27.64*
Pusa Purple Cluster × Brinjal-LC-71	468.66	19.36*	30.43*
Pusa Purple Cluster × Brinjal-LC-72	437.66	-16.21*	21.80*
Pusa Purple Cluster × Brinjal-LC-73	477.00	-17.38*	32.75*
Arka Keshav × Brinjal-LC-71	579.33	38.60*	61.23*
Arka Keshav × Brinjal-LC-72	406.33	-22.21*	13.08*
Arka Keshav × Brinjal-LC-73	568.00	-1.62	58.07*
Brinjal-LC-71 × Brinjal-LC-72	669.00	28.08*	86.18*
Brinjal-LC-71 × Brinjal-LC-73	657.00	13.80*	82.84*
Brinjal-LC-72 × Brinjal-LC-73	627.00	8.60*	74.49*
Check (CODE-B02)	359.33		
Population Mean	483.80		
Range	359.33-669.00		
SE (m) ±	5.52		
$CD_{(0.05)}$	15.82		

*Significant at 5% level of significance

followed by Pusa Purple Cluster × Brinjal-LC-71 (105.26 %), Arka Keshav × Brinjal-LC-72 (97.18 %), Pusa Purple Cluster × Brinjal-LC-72 (88.73 %), Brinjal-LC-71 × Brinjal-LC-72 (87.32 %), Pusa Purple Cluster × Arka Keshav (79.37 %), Pusa Purple Long × Brinjal-LC-72 (79.12 %), Arka Keshav × Brinjal-LC-73 (72.29 %), Brinjal-LC-71 × Brinjal-LC-73 (68.67 %), Pusa Purple Long × Brinjal-LC-73 (62.64 %), Pusa Purple Long × Arka Keshav (58.24 %), Brinjal-LC-72 × Brinjal-

LC-73 (48.19 %), Pusa Purple Long × Brinjal-LC-71 (43.96 %) and Pusa Purple Cluster × Brinjal-LC-73 (32.53 %).

Table 4.2.14- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait yield per plant (kg)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	0.91		
Pusa Purple Cluster	0.45		
Arka Keshav	0.63		
Brinjal-LC-71	0.57		
Brinjal-LC-72	0.71		
Brinjal-LC-73	0.83		
Pusa Purple Long × Pusa Purple Cluster	1.09	19.78	-5.22
Pusa Purple Long × Arka Keshav	1.44	58.24*	25.22*
Pusa Purple Long × Brinjal-LC-71	1.31	43.96*	13.91
Pusa Purple Long × Brinjal-LC-72	1.63	79.12*	41.74*
Pusa Purple Long × Brinjal-LC-73	1.48	62.64*	28.70*
Pusa Purple Cluster × Arka Keshav	1.13	79.37*	-1.74
Pusa Purple Cluster × Brinjal-LC-71	1.17	105.26*	1.74
Pusa Purple Cluster × Brinjal-LC-72	1.34	88.73*	16.52*
Pusa Purple Cluster × Brinjal-LC-73	1.10	32.53*	-4.35
Arka Keshav × Brinjal-LC-71	1.46	131.75*	26.96*
Arka Keshav × Brinjal-LC-72	1.40	97.18*	21.74*
Arka Keshav × Brinjal-LC-73	1.43	72.29*	24.35*
Brinjal-LC-71 × Brinjal-LC-72	1.33	87.32*	15.65
Brinjal-LC-71 × Brinjal-LC-73	1.40	68.67*	21.74*
Brinjal-LC-72 × Brinjal-LC-73	1.23	48.19*	6.96
Check (CODE-B02)	1.15		
Population Mean	1.14		
Range	0.45-1.63		
SE (m) ±	0.06		
$CD_{(0.05)}$	0.19		

*Significant at 5% level of significance

Eight of the cross combinations exhibited positive significant economic heterosis and was maximum in Pusa Purple Long × Brinjal-LC-72 (41.74 %) indicating that these combinations performed better for yield per plant than the standard check CODE-B02.

Table 4.2.15-Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait ascorbic acid (mg/100g)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	10.63		
Pusa Purple Cluster	9.56		
Arka Keshav	11.43		
Brinjal-LC-71	12.66		
Brinjal-LC-72	12.40		
Brinjal-LC-73	13.36		
Pusa Purple Long × Pusa Purple Cluster	11.23	5.64*	-2.85
Pusa Purple Long × Arka Keshav	13.40	17.24*	15.92*
Pusa Purple Long × Brinjal-LC-71	11.20	-11.53*	-3.11
Pusa Purple Long × Brinjal-LC-72	13.03	5.08*	12.72*
Pusa Purple Long × Brinjal-LC-73	13.56	1.50	17.3*
Pusa Purple Cluster × Arka Keshav	10.30	-9.89*	-10.9*
Pusa Purple Cluster × Brinjal-LC-71	13.30	5.06*	15.05*
Pusa Purple Cluster × Brinjal-LC-72	9.63	-22.34*	-16.70*
Pusa Purple Cluster × Brinjal-LC-73	13.96	4.49*	20.76*
Arka Keshav × Brinjal-LC-71	13.30	5.06*	15.05*
Arka Keshav × Brinjal-LC-72	12.70	2.42	9.86*
Arka Keshav × Brinjal-LC-73	13.43	0.52	16.18*
Brinjal-LC-71 × Brinjal-LC-72	13.50	6.64*	16.78*
Brinjal-LC-71 × Brinjal-LC-73	13.86	3.74*	19.90*
Brinjal-LC-72 × Brinjal-LC-73	14.13	5.76*	22.23*
Check (CODE-B02)	11.56		
Population Mean	12.36		
Range	9.56-14.13		
SE (m) ±	0.13		
$CD_{(0.05)}$	0.39		

*Significant at 5% level of significance

4.2.15 Ascorbic acid (mg/100g)

Considerable variation among parental genotype was seen for ascorbic acid (mg/100g) and Brinjal-LC-73 had maximum ascorbic acid content of 13.36 mg/100g and none of the parents were at par whereas, Pusa Purple Cluster had minimum ascorbic acid recorded 9.56 mg/100g. Cross combinations Pusa Purple Cluster × Brinjal-LC-73 (13.96 mg/100g) and Brinjal-LC-71 × Brinjal-LC-73

(13.86 mg/100g) were at par with Brinjal-LC-72 × Brinjal-LC-73 (14.13 mg/100g) indicating that the cross combinations have high ascorbic acid content whereas standard check CODE-B02 had 11.56 mg/100g of ascorbic acid. Similar findings have been reported by Arti and Sharma (2018) and Sailesh et al. (2023) for brinjal.

Nine of the cross combinations showed positively significant heterosis over better parent and Brinjal-LC-71 × Brinjal-LC-73 (3.74 %) recorded minimum value. Heterosis over standard check was maximum for Brinjal-LC-72 × Brinjal-LC-73 (22.23 %) and other ten crosses were superior for ascorbic acid than the standard check CODE-B02.

4.2.16 TSS (^{0}B)

TSS is one of the most important qualitative traits and enhances the nutritional value. Among the parents Brinjal-LC-71 had maximum TSS of 6.03^{0}B and was at par with Brinjal-LC-73 5.86^{0}B. Hybrids Pusa Purple Long × Brinjal-LC-71 5.70^{0}B and Pusa Purple Cluster × Brinjal-LC-72 5.63^{0}B were also at par with hybrid Arka Keshav × Brinjal-LC-73 5.96^{0}B with highest TSS, as well as standard check with TSS of 5.63^{0}B. These results were in accordance to those obtained by Tabasum et al. (2024) and Kumar et al. (2023).

The extent of Heterobeltiosis for TSS was recorded negatively significant in all the crosses except one i.e., Arka Keshav × Brinjal-LC-72 (10.42 %) which showed positive and significant heterobeltiosis. Whereas, none of the hybrids showed positive and significant economic heterosis indicating standard check was better for the trait TSS as the negative and significant economic heterosis ranged between 0.00-5.86 % for the hybrids.

4.2.17 Disease incidence (%)/ severity (%)

During the course of present investigation, the disease incidence was observed on all the genotypes of brinjal viz. parents, hybrid combinations and the standard check variety. Therefore, disease severity was recorded on the leaves to determine the level of resistance/susceptibility of the various genotypes with respect to Phomopsis blight under natural epiphytotic conditions which is discussed in detail as follows:

Table 4.2.16- Mean performance of parents, crosses and check along with heterosis over better parent and standard check for the trait TSS (ºB)

Parents/Crosses	Mean	Heterosis over better parent (%)	Heterosis over check (%)
Pusa Purple Long	5.53		
Pusa Purple Cluster	5.36		
Arka Keshav	4.63		
Brinjal-LC-71	6.03		
Brinjal-LC-72	4.80		
Brinjal-LC-73	5.86		
Pusa Purple Long × Pusa Purple Cluster	4.90	-11.39*	-12.97*
Pusa Purple Long × Arka Keshav	4.70	-15.01*	-16.52*
Pusa Purple Long × Brinjal-LC-71	5.70	-5.47	1.24
Pusa Purple Long × Brinjal-LC-72	4.80	-13.2*	-14.74*
Pusa Purple Long × Brinjal-LC-73	5.10	-12.97*	-9.41*
Pusa Purple Cluster × Arka Keshav	4.73	-11.75*	-15.99*
Pusa Purple Cluster × Brinjal-LC-71	5.50	-8.79*	-2.31
Pusa Purple Cluster × Brinjal-LC-72	5.63	5.04	0.00
Pusa Purple Cluster × Brinjal-LC-73	5.40	-7.85*	-4.09
Arka Keshav × Brinjal-LC-71	4.86	-19.4*	-13.68*
Arka Keshav × Brinjal-LC-72	5.30	10.42*	-5.86
Arka Keshav × Brinjal-LC-73	5.96	1.71	5.86
Brinjal-LC-71 × Brinjal-LC-72	4.90	-18.74*	-12.97*
Brinjal-LC-71 × Brinjal-LC-73	5.13	-14.93*	-8.88*
Brinjal-LC-72 × Brinjal-LC-73	4.96	-15.36*	-11.9*
Check (CODE-B02)	5.63		
Population Mean	5.24		
Range	4.63-6.03		
SE (m) ±	0.14		
$CD_{(0.05)}$	0.41		

*Significant at 5% level of significance

4.2.17 Phomopsis blight severity (%)

Phomopsis blight is devasting disease of brinjal which cause extensive damage to yield and it is difficult to control. The data pertaining to the Phomopsis blight severity (%) is depicted in table 4.2.17; it revealed that the population mean was 49.97% and the value of disease severity ranged from 33.33-71.33 %.

Table 4.2.17 Phomopsis blight severity (%)

Parents/Crosses	Mean Severity (%) for Phomopsis blight
Pusa Purple Long	66.00 (54.31)
Pusa Purple Cluster	56.66 (48.81)
Arka Keshav	60.66 (51.14)
Brinjal-LC-71	44.00 (41.53)
Brinjal-LC-72	50.66 (45.36)
Brinjal-LC-73	47.66 (43.64)
Pusa Purple Long × Pusa Purple Cluster	71.33 (57.61)
Pusa Purple Long × Arka Keshav	63.00 (52.51)
Pusa Purple Long × Brinjal-LC-71	65.00 (53.71)
Pusa Purple Long × Brinjal-LC-72	69.66 (56.56)
Pusa Purple Long × Brinjal-LC-73	56.00 (48.42)
Pusa Purple Cluster × Arka Keshav	54.00 (47.27)
Pusa Purple Cluster × Brinjal-LC-71	59.00 (50.16)
Pusa Purple Cluster × Brinjal-LC-72	48.33 (44.02)
Pusa Purple Cluster × Brinjal-LC-73	43.00 (40.95)
Arka Keshav × Brinjal-LC-71	38.00 (38.03)
Arka Keshav × Brinjal-LC-72	33.33 (35.24)
Arka Keshav × Brinjal-LC-73	46.66 (43.07)
Brinjal-LC-71 × Brinjal-LC-72	55.33 (48.04)
Brinjal-LC-71 × Brinjal-LC-73	43.33 (41.15)
Brinjal-LC-72 × Brinjal-LC-73	58.00 (49.58)
Check (CODE-B02)	58.66 (49.97)
Population Mean	54.01 (47.32)
Range	33.33-71.33
SE (m) ±	0.64
$CD_{(0.05)}$	1.84

*Significant at 5% level of significance

Among the parents, the genotype Brinjal-LC-71 (44.00) exhibited minimum severity % for phomopsis blight disease making it the most suitable parental genotype in terms of resistance to Phomopsis blight. On the other hand maximum severity of Phomopsis blight was observed in the parent Pusa Purple Long (66.00) making it unsuitable genotype with respect to resistance for the target disease. Among all the cross combinations Arka Keshav × Brinjal-LC-72 showed minimum severity index of (33.33%) and hence this cross combination was

regarded as the best cross combination with reference to resistance against Phomopsis blight.

Table 4.2.18 Characterization of parents, crosses and check with respect to trait presence of spine

Parents/Crosses	Mean
Pusa Purple Long	Absent
Pusa Purple Cluster	Absent
Arka Keshav	Absent
Brinjal-LC-71	Absent
Brinjal-LC-72	Absent
Brinjal-LC-73	Absent
Pusa Purple Long × Pusa Purple Cluster	Absent
Pusa Purple Long × Arka Keshav	Absent
Pusa Purple Long × Brinjal-LC-71	Absent
Pusa Purple Long × Brinjal-LC-72	Absent
Pusa Purple Long × Brinjal-LC-73	Absent
Pusa Purple Cluster × Arka Keshav	Absent
Pusa Purple Cluster × Brinjal-LC-71	Absent
Pusa Purple Cluster × Brinjal-LC-72	Absent
Pusa Purple Cluster × Brinjal-LC-73	Absent
Arka Keshav × Brinjal-LC-71	Absent
Arka Keshav × Brinjal-LC-72	Absent
Arka Keshav × Brinjal-LC-73	Absent
Brinjal-LC-71 × Brinjal-LC-72	Absent
Brinjal-LC-71 × Brinjal-LC-73	Absent
Brinjal-LC-72 × Brinjal-LC-73	Absent
Check (CODE-BO2)	Absent

4.2.18 Presence of spine

The perusal of data presented in (Table 4.2.18) revealed presence of spine on the brinjal plant. All the genotypes were divided into two groups on the basis of visual observation for presence or absence of spines. All the 23 genotypes under study showed absence of spine on the plant and none of the genotypes showed presence of spines during the current study.

4.2.19 Bearing habit

The perusal data presented in Table 4.2.19 revealed bearing habit in brinjal fruits. Parental genotypes showed solitary bearing habit except Pusa Purple Cluster

which exhibited Cluster bearing habit. All the cross combinations had solitary bearing habit and check CODE-B02 also showed solitary bearing habit which concluded that solitary bearing habit was more prevalent than the cluster bearing habit.

Table 4.2.19 Characterization of parents, crosses, check variety with respect to bearing habit

Parents/Crosses	Mean
Pusa Purple Long	Solitary
Pusa Purple Cluster	Cluster
Arka Keshav	Solitary
Brinjal-LC-71	Solitary
Brinjal-LC-72	Solitary
Brinjal-LC-73	Solitary
Pusa Purple Long × Pusa Purple Cluster	Solitary
Pusa Purple Long × Arka Keshav	Solitary
Pusa Purple Long × Brinjal-LC-71	Solitary
Pusa Purple Long × Brinjal-LC-72	Solitary
Pusa Purple Long × Brinjal-LC-73	Solitary
Pusa Purple Cluster × Arka Keshav	Solitary
Pusa Purple Cluster × Brinjal-LC-71	Solitary
Pusa Purple Cluster × Brinjal-LC-72	Solitary
Pusa Purple Cluster × Brinjal-LC-73	Solitary
Arka Keshav × Brinjal-LC-71	Solitary
Arka Keshav × Brinjal-LC-72	Solitary
Arka Keshav × Brinjal-LC-73	Solitary
Brinjal-LC-71 × Brinjal-LC-72	Solitary
Brinjal-LC-71 × Brinjal-LC-73	Solitary
Brinjal-LC-72 × Brinjal-LC-73	Solitary
Check (CODE-BO2)	Solitary

4.2.20 Fruit colour

Variation was observed among the genotypes for the trait fruit colour. Among the parental genotypes Pusa Purple Long, Arka Keshav, Brinjal-LC-71 and Brinjal-LC-73 exhibited dark purple colour, Pusa Purple Cluster light purple colour

and Brinjal-LC-72 purple respectively. Whereas, cross combination Pusa Purple Long × Pusa Purple Cluster, Pusa Purple Long × Arka Keshav, Pusa Purple Long × Brinjal-LC-71, Pusa Purple Long × Brinjal-LC-72, Pusa Purple Long × Brinjal-LC-73, Pusa Purple Cluster × Brinjal-LC-71, Arka Keshav × Brinjal-LC-71, Arka Keshav × Brinjal-LC-72, Arka Keshav × Brinjal-LC-73, Brinjal-LC-71 × Brinjal-LC-73, Brinjal-LC-72 × Brinjal-LC-73 and check (CODE-BO2) showed dark purple colour.

Table 4.2.20 Characterization of parents, crosses, check variety with respect to fruit colour

Parents/Crosses	Mean
Pusa Purple Long	Dark purple
Pusa Purple Cluster	Light purple
Arka Keshav	Dark purple
Brinjal-LC-71	Dark purple
Brinjal-LC-72	Purple
Brinjal-LC-73	Dark purple
Pusa Purple Long × Pusa Purple Cluster	Dark purple
Pusa Purple Long × Arka Keshav	Dark purple
Pusa Purple Long × Brinjal-LC-71	Dark purple
Pusa Purple Long × Brinjal-LC-72	Dark purple
Pusa Purple Long × Brinjal-LC-73	Dark purple
Pusa Purple Cluster × Arka Keshav	Purple
Pusa Purple Cluster × Brinjal-LC-71	Dark purple
Pusa Purple Cluster × Brinjal-LC-72	Purple
Pusa Purple Cluster × Brinjal-LC-73	Purple
Arka Keshav × Brinjal-LC-71	Dark purple
Arka Keshav × Brinjal-LC-72	Dark purple
Arka Keshav × Brinjal-LC-73	Dark purple
Brinjal-LC-71 × Brinjal-LC-72	Purple
Brinjal-LC-71 × Brinjal-LC-73	Dark purple
Brinjal-LC-72 × Brinjal-LC-73	Dark purple
Check (CODE-BO2)	Dark Purple

Only Pusa Purple Cluster was light purple and Brinjal-LC-72 was purple. Four cross combinations showed purple colour viz., Pusa Purple Cluster × Arka Keshav, Pusa Purple Cluster × Brinjal-LC-72, Pusa Purple Cluster × Brinjal-LC-73, Brinjal-LC-71 × Brinjal-LC-72.

4.3. COMBINING ABILITY

Combining ability analysis with respect to different traits viz. days to 50 per cent flowering, days to first picking, harvest duration, leaf length (cm), stem diameter (mm), plant height (cm), number of primary branches per plant, pedicel length (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), number of seeds per fruit, yield per plant (kg), ascorbic acid (mg/100g) and TSS(ºB) was worked out to know the general combining ability of 6 parents and the specific combining ability of the 15 cross combinations. The results pertaining to the general combining ability and specific combining ability with respect to different traits studied during the present investigation are discussed trait wise as follows:

4.3.1 General combining ability

The mean sum of squares for general combining ability (GCA) was found highly significant for all the quantitative traits, (Appendix III). The trait related to disease incidence was however not included in the combining ability analysis. The general combining ability performance of the parental lines for various quantitative horticultural traits is presented and discussed in Table 4.3.1

4.3.1.1 Days to 50 per cent flowering

Earliness is desirable therefore negative general combining ability was also desirable for the trait. Thus, parents with negative significant general combining ability effects were categorized as good general combiners; whereas, those with the non-significant general combining ability effects were average combiners and those with the positive significant general combining effects were poor combiners. The highest significant and negative GCA effect was exhibited by parent Pusa Purple Cluster (-9.11) and hence it was considered as good general combiner. However, four of the parents viz. Brinjal-LC-71 (2.47), Arka Keshav (2.06), Pusa Purple Long (1.93), Brinjal-LC-73 (1.81) were poor general combiners due to significant positive GCA effects shown by them. The remaining one parent i.e. Brinjal-LC-72 (0.85) had non-significant GCA effects and hence was classified as average general combiner. Similarly; Khapte et al. (2013), Pramila et al. (2020), Mishra et al. (2023) and Dudhatra et al. (2024) have also obtained significantly high GCA effects for the character.

4.3.1.2 Days to first picking

General combining ability ranged from -1.06 to 3.94. Pusa Purple Cluster (-6.10) showed negative significant general combining effects and was a good combiner. Whereas, Brinjal-LC-72 (3.94) and Pusa Purple Long (2.74) had positive significant general combining effects and were poor combiners. Three parents showed non-significant general combining ability effects and were average general combiners viz., Arka Keshav (0.28), Brinjal-LC-71 (0.19), Brinjal-LC-73 (-1.06). These results are supported by earlier studies conducted by Anvesh et al. (2024).

4.3.1.3 Harvest duration

Positive significant values are desirable for the trait harvest duration and two of the parents viz., Brinjal-LC-73 (5.96) and Brinjal-LC-72 (4.87) were rated as good general combiners and four with negative and significant GCA effects i.e. Brinjal-LC-71 (-1.12), Pusa Purple Cluster (-1.33), Arka Keshav (-1.92), Pusa Purple Long (-6.46). GCA effects ranged between -1.12 to 5.96.

4.3.1.4 Leaf length (cm)

The estimates for GCA effects rated good general combiner for Pusa Purple Long (0.56) with positive and significant general combining ability effects and all the other five parents were rated as average general combiner. A comparable trend was documented by Mishra et al. (2024), reinforcing these findings.

4.3.1.5 Stem diameter (mm)

Positive values are desirable for stem diameter for general combining ability effects for stem diameter. Brinjal-LC-72 (2.10), Pusa Purple Cluster (1.79) were rated as good general combiners due to positive and significant GCA effects. Whereas, Pusa Purple Long (-2.85), Arka Keshav (-0.62), Brinjal-LC-71 (-0.16), Brinjal-LC-73 (-0.26) rated as poor general combiners which suggested that these parents should not be used for developing hybrids for improving stem diameter. The GCA effects ranged from -0.16 to 2.10.

4.3.1.6 Plant height (cm)

Three parents viz., Arka Keshav (2.01), 2.01 (0.79), Pusa Purple Cluster (0.76) exhibited positive and significant general combining effects and were rated as good general combiners. Negative significant general combining effects were

showed by Pusa Purple Long (-1.32), Arka Keshav (-1.47), Brinjal-LC-72 (-0.77) and were rated as poor general combiners. Comparable outcomes were recorded by Mishra et al. (2024), Khapte et al. (2013), Pramila et al. (2020) and by Anvesh et al. (2024), reinforcing the present study.

4.3.1.7 Number of primary branches per plant

General combining ability effects ranged between -0.25 to 0.62. Pusa Purple Long (0.62), Pusa Purple Cluster (0.33) and Brinjal-LC-72 (0.33) showed positive significant general combining effects and were considered as good general combiners. Arka Keshav (-0.25) having non- significant general combining effects was considered as average general combiner. However, two parents Brinjal-LC-71 (-0.58) and Brinjal-LC-73 (-0.46) were considered poor combiners with negative significant GCA effects. Earlier investigations have also highlighted similar patterns in this regard by Pramila et al. (2020), Mishra et al. (2024) and Khapte et al. (2013) in their study.

4.3.1.8 Pedicel length (cm)

Estimates for general combining ability showed that three parents Pusa Purple Cluster (0.49), Brinjal-LC-71 (0.20), Brinjal-LC-73 (0.84) were rated as good general combiners with positive significant GCA effects. While, the parents Pusa Purple Long (-0.50), Arka Keshav (-0.75), Brinjal-LC-72 (-0.28) were rated as poor general combiners due to negative significant general combining ability. Kumar and Arumugam (2013) also reported comparable findings, supporting the present results.

4.3.1.9 Number of fruits per plant

Analysis for general combining ability showed variation among parents. Two parents exhibited positive significant general combining effects viz., Pusa Purple Cluster (2.15) and Brinjal-LC-73 (4.69) and were categorized as good general combiners. Pusa Purple Long (-3.06), Brinjal-LC-71 (-3.64) showed negative significant general combining effects and were categorized as poor general combiners. Two of the parents showed non-significant general combining ability effects Arka Keshav (0.57), Brinjal-LC-72 (-0.72) and were rated as average general combiners. The current results find support in the work of Khapte et al. (2013), Anvesh et al. (2024) and Kumar et al. (2019).

4.3.1.10 Fruit diameter (cm)

Effects of general combining ability ranged from -0.03 to 0.37 for parents. Due to positive and significant GCA effects Brinjal-LC-71 0.37 rated as good general combiner. Whereas, Arka Keshav (-0.16) and Brinjal-LC-73 (-0.22) exhibited negative significant GCA effects and were rated as poor general combiners. Pusa Purple Long (-0.04), Pusa Purple Cluster (0.08) and Brinjal-LC-72 (-0.03) had non-significant general combining effects and were rated as average combiners. These results are supported by the work of Desai et al. (2017) and Pramila et al. (2020) in their study.

4.3.1.11 Fruit length (cm)

Positive significant general combining ability effects are desirable for fruit length and three parents Pusa Purple Cluster (0.87), Brinjal-LC-72 (0.56) and Brinjal-LC-73 (0.20) were identified as good general combiners due to positive significant general combining effects making them best for considering for selection in making hybrids. However, Pusa Purple Long (-0.82), Arka Keshav (-0.20) and Brinjal-LC-71 (-0.61) showed negative but significant general combining effects and were identified as poor combiners. The results align well with those of Ansari and Singh (2014), Mishra et al. (2024) and Kumar and Arumugam (2013) who observed similar trends.

4.3.1.12 Average fruit weight (g)

Significant variation among the parents were seen for trait average fruit weight and ranged from -4.04 to 6.83. Parents Brinjal-LC-73 (6.83), Brinjal-LC-71 (5.67), Brinjal-LC-72 (2.17) showed positive and significant general combining effects and were rated as good general combiners. Three of the parents were poor general combiners Pusa Purple Cluster (-4.04), Pusa Purple Long (-4.46) and Arka Keshav (-6.17) were rated as poor combiners as they exhibited negative significant general combining effects. The present findings are in line with the observations reported by Mishra et al. (2023), Khapte et al. (2013) and Anvesh et al. (2024).

4.3.1.13 Number of seeds per fruit

Two out of six parents exhibited positive significant general combining ability effects Brinjal-LC-73 (63.40) and Brinjal-LC-72 (43.24) and were identified

as good general combiners. Three with negative significant general combining effects Pusa Purple Cluster (-42.01), Pusa Purple Long (-34.56), Arka Keshav (-28.97) were identified as poor general combiners. One of the parents with non-significant general combining effects Brinjal-LC-71 (-1.10) was identified as average combiner. The observations of Khapte et al. (2013) support the present outcomes.

4.3.1.14 Yield per plant (kg)

General combining ability effects revealed that four parents showed positive GCA effects. Brinjal-LC-72 (0.14), Brinjal-LC-71 (0.10), Brinjal-LC-73 (0.09), Pusa Purple Cluster (0.06) were categorized as good general combiners. While, the genotype Pusa Purple Long (-0.38) categorized as poor general combiner as it showed significant but negative general combining ability effects. Arka Keshav (-0.01) showed non-significant general combining effects and was categorized as average combiner. These results find support in the work of Kumar et al. (2019), Ansari and Singh (2014) and Desai et al. (2017) who reported parallel findings.

4.3.1.15 Ascorbic acid (mg/100g)

Positive and significant general combining is desirable for ascorbic acid. Brinjal-LC-73 (1.20), Brinjal-LC-71 (0.38) and Brinjal-LC-72 (0.22) were good general combiners with significant positive general combining ability effects. Three of the genotypes identified as poor general combiners Pusa Purple Long (-0.77), Arka Keshav (-0.57) and Pusa Purple Cluster (-0.46) due to significant negative general combining ability effects. The data correspond well with the conclusions drawn by Dudhatra et al. (2024), Kumar and Arumugam (2013) reinforcing the study's implications.

4.3.1.16 TSS (^{0}B)

Genotypes showed significant variation for the trait TSS (^{0}B)**,** Brinjal-LC-71 (0.20), Pusa Purple Long (0.14) and Brinjal-LC-73 (0.10) identified positive significant general combining ability and were rated as good general combiners. While, Pusa Purple Cluster (-0.14), Brinjal-LC-72 (-0.14) and Arka Keshav (-0.16) were poor general combiners exhibiting significant negative general combining effects. Dudhatra et al. (2024) and Desai et al. (2017) showed similar results for the trait TSS.

Table 4.3.1 Estimates of general combining ability (GCA) effects of parents for different growth parameters in brinjal

Parents	Traits							
	Days to 50 percent flowering	Days to first picking	Harvest duration	Leaf length (cm)	Stem diameter (mm)	Plant height (cm)	Number of primary branches per plant	Pedicel length (cm)
Pusa Purple Long	1.93 *	2.74*	-6.46*	0.56*	-2.85*	-1.32*	0.62*	-0.50*
Pusa Purple Cluster	-9.11 *	-6.10*	-1.33*	-0.46	1.79*	0.76*	0.33*	0.49*
Arka Keshav	2.06 *	0.28	-1.92*	0.22	-0.62*	-1.47*	-0.25	-0.75*
Brinjal-LC-71	2.47 *	0.19	-1.12*	-0.48	-0.16*	2.01*	-0.58*	0.20*
Brinjal-LC-72	0.85	3.94*	4.87*	0.37	2.10*	-0.77*	0.33*	-0.28*
Brinjal-LC-73	1.81 *	-1.06	5.96*	-0.21	-0.26*	0.79*	-0.46*	0.84*
SE±$_{(gi)}$	0.55	0.56	0.32	0.25	0.05	0.04	0.15	0.04
SE±$_{(gi-gj)}$	0.86	0.87	0.50	0.38	0.08	0.06	0.23	0.07
Good combiner(s)	1	1	2	1	2	3	3	3
Poor combiner(s)	4	2	4	0	4	3	2	3
Average combiner(s)	1	3	0	5	0	0	1	0

*Significant at 5% level of significance

continued…

Parents	Traits							
	Number of fruits per plant	**Fruit diameter (cm)**	**Fruit length (cm)**	**Average fruit weight (g)**	**Number of seeds per fruit**	**Yield per plant (kg)**	**Ascorbic Acid (mg/100g)**	**TSS (ºB)**
Pusa Purple Long	-3.06*	-0.04	-0.82*	-4.46*	-34.56*	-0.38*	-0.77*	0.14*
Pusa Purple Cluster	2.15*	0.08	0.87*	-4.04*	-42.01*	0.06*	-0.46*	-0.14*
Arka Keshav	0.57	-0.16*	-0.20*	-6.17*	-28.97*	-0.01	-0.57*	-0.16*
Brinjal-LC-71	-3.64*	0.37*	-0.61*	5.67*	-1.10	0.10*	0.38*	0.20*
Brinjal-LC-72	-0.72	-0.03	0.56*	2.17*	43.24*	0.14*	0.22*	-0.14*
Brinjal-LC-73	4.69*	-0.22*	0.20*	6.83*	63.40*	0.09*	1.20*	0.10*
SE±$_{(gi)}$	0.49	0.04	0.04	0.36	1.80	0.02	0.04	0.05
SE±$_{(gi-gj)}$	0.75	0.06	0.06	0.57	2.79	0.04	0.07	0.07
Good combiner(s)	2	1	3	3	2	4	3	3
Poor combiner(s)	2	2	3	3	3	1	3	3
Average combiner(s)	2	3	0	0	1	1	0	0

*Significant at 5% level of significance

4.3.1 Specific combining ability

The mean sum of squares due to specific combining ability were highly significant for all the quantitative traits studied (Appendix III). Therefore, the specific combining ability estimates were worked out for all the quantitative traits whose details character wise are presented in the Table 4.3.2 and which are discussed as follows:

4.3.2.1 Days to 50 percent flowering

Significant negative specific combining ability effects were identified for cross combinations Pusa Purple Cluster × Arka Keshav (-8.36), Pusa Purple Cluster × Brinjal-LC-72 (-5.82), Pusa Purple Long × Arka Keshav (-5.40), Pusa Purple Cluster × Brinjal-LC-71 (-5.11) and involved parents with good × poor, good × average, poor × poor and good × poor gca effects. While, five cross combinations with the significant positive specific combining effect and were identified as poor specific combiners, the remaining five were average combiners. The results align well with those of Desai et al. (2017), Anvesh et al. (2024) and Sharma et al. (2016) who observed similar trends for the trait.

4.3.2.2 Days to first picking

Negative and significant specific combining effects are desirable for trait days to first picking for early harvest. Five crosses were good specific combiners viz., Pusa Purple Cluster × Brinjal-LC-72 (-8.48), Pusa Purple Cluster × Brinjal-LC-73 (-5.15), Brinjal-LC-71 × Brinjal-LC-73 (-5.11), Arka Keshav × Brinjal-LC-73 (-3.86), Arka Keshav × Brinjal-LC-72 (-3.19) due to significant negative specific combining ability and involved parents with good × poor, good × average, average × average, average × average, average × poor. Seven of the crosses were average specific combiners. The findings agree with the earlier work of Kumar et al. (2019), who reported similar results.

4.3.2.3 Harvest duration

Six F_1 exhibited significant positive specific combining ability effects Brinjal-LC-71 × Brinjal-LC-73 (9.93), Pusa Purple Long × Brinjal-LC-72 (6.68), Pusa Purple Cluster × Brinjal-LC-73 (6.47), Arka Keshav × Brinjal-LC-71 (5.47), Pusa Purple Long × Pusa Purple Cluster (3.89) and Arka Keshav × Brinjal-LC-72 (3.14) and were categorized as good specific combiners involving parents with poor ×

good, poor × good, poor × good, poor × poor, poor × poor, poor × good gca effects. However, four F_1 exhibited non-significant specific combining ability effects and were average specific combiners.

4.3.2.4 Leaf length (cm)

Analysis for specific combining ability involved Brinjal-LC-71 × Brinjal-LC-73 (2.10), Pusa Purple Cluster × Brinjal-LC-71 (1.88), Pusa Purple Cluster × Arka Keshav (1.55) and Arka Keshav × Brinjal-LC-71 (1.37) with significant positive specific combining ability and involved parents with gca effects of average × average, average × average, average × average × average and average × average. Non-significant values were average specific combiners and were eight for leaf length.

4.3.2.5 Stem diameter (mm)

For the trait stem diameter significant positive specific combining ability was desirable crosses Brinjal-LC-71 × Brinjal-LC-73 (5.81), Pusa Purple Cluster × Brinjal-LC-71 (5.18), Pusa Purple Cluster × Arka Keshav (4.21), Pusa Purple Long × Brinjal-LC-72 (3.40), Arka Keshav × Brinjal-LC-72 (3.17), Arka Keshav × Brinjal-LC-71 (3.00), Brinjal-LC-71 × Brinjal-LC-72 (1.41) and Pusa Purple Long × Brinjal-LC-73 (0.60) showed significant positive specific combining ability and were good specific combiners involving parents with poor × poor, good × poor, good × poor, poor × good, poor × good, poor × poor, poor × good, poor × poor gca effects. There were none average specific combiners but seven crosses were poor specific combiners.

4.3.2.6 Plant height (cm)

Study for specific combining ability involved eight cross combinations with significant positive sca effects viz., Arka Keshav × Brinjal-LC-73 (7.88), Pusa Purple Long × Brinjal-LC-73 (6.83), Brinjal-LC-71 × Brinjal-LC-73 (3.17), Pusa Purple Cluster × Brinjal-LC-73 (3.08), Pusa Purple Cluster × Brinjal-LC-71 (2.16), Pusa Purple Long × Brinjal-LC-71 (2.08), Brinjal-LC-72 × Brinjal-LC-73 (1.47) and Pusa Purple Cluster × Brinjal-LC-72 (1.34) were good specific combiners and involved parents with poor × good, poor × good, good × good, good × good, good × good, poor × good, poor × good, good × poor gca effects. Significant negative specific combining ability values were identified in seven of the cross combinations

and were poor specific combiners. These results corroborate the conclusions drawn by Dudhatra et al. (2024), Kumar et al. (2019) and Sharma et al. (2016).

4.3.2.7 Number of primary branches per plant

Three of the fifteen hybrids showed significant positive specific combining ability Pusa Purple Cluster × Arka Keshav (1.11), Brinjal-LC-71 × Brinjal-LC-72 (1.11) and Arka Keshav × Brinjal-LC-72 (0.77) and were good specific combiner involving parents with good × average, poor × good, average × good gca effects. Nine of the hybrids exhibited non-significant specific combining ability effects and were average specific combiners. Similar findings were reported by Khapte et al. (2013) and Anvesh et al. (2024).

4.3.2.8 Pedicel length (cm)

Specific combining ability effects for seven of the cross combinations were significant positive i.e. Pusa Purple Long × Brinjal-LC-72 (1.59), Brinjal-LC-71 × Brinjal-LC-72 (1.36), Pusa Purple Cluster × Brinjal-LC-72 (1.04), Pusa Purple Cluster × Arka Keshav (0.87), Arka Keshav × Brinjal-LC-73 (0.71), Pusa Purple Long × Arka Keshav (0.32) and Pusa Purple Cluster × Brinjal-LC-73 (0.31) and were rated as good specific combiners involving parents with poor × poor, good × poor, good × poor, good × poor, poor × good, poor × poor, good × good gca effects. Four of the cross combinations were poor specific combiners whereas the remaining four were average specific combiners.

4.3.2.9 Number of fruits per plant

Positive and significant specific combining ability effects were desirable for number of fruits per plant to increase the yield. Brinjal-LC-71 × Brinjal-LC-72 (5.06), Pusa Purple Long × Arka Keshav (4.52), Pusa Purple Cluster × Arka Keshav (3.98), Brinjal-LC-71 × Brinjal-LC-73 (3.64) and Pusa Purple Long × Brinjal-LC-72 (3.14) exhibited significant positive specific combining ability effects and was rated as good specific combiners which involved parents with poor × average, poor × average, good × average, poor × good, poor × average gca effects. Non-significant specific combining effects were exhibited by six crosses and were average specific combiners whereas, four with negative and significant specific combining effects were poor specific combiners. These observations are like those of Dudhatra et al. (2014), Mishra et al. (2024) and Desai et al. (2017).

4.3.2.10 Fruit diameter (cm)

Three of the cross combinations Pusa Purple Long × Brinjal-LC-71 (2.52), Pusa Purple Cluster × Arka Keshav (0.53) and Pusa Purple Cluster × Brinjal-LC-71 (0.24) exhibited significant positive specific combining ability effects and were categorized as good specific combiners and involved parents with average × good, average × poor and average × good gca effects. five of the cross combinations showed significant negative specific combing ability effects and seven showed non-significant sca effects and were rated poor and average specific combiners respectively. These outcomes are in line with Ansari and Singh (2014) and Sharma et al. (2016) findings.

4.3.2.11 Fruit length (cm)

The specific combining ability effects for trait fruit length are significant and positive for 10 of the crosses Arka Keshav × Brinjal-LC-72 (2.50), Pusa Purple Long × Brinjal-LC-72 (2.16), Brinjal-LC-71 × Brinjal-LC-72 (1.92), Pusa Purple Cluster × Brinjal-LC-71 (1.81), Pusa Purple Cluster × Brinjal-LC-72 (1.58), Pusa Purple Cluster × Arka Keshav (1.10), Pusa Purple Cluster × Brinjal-LC-73 (0.57), Brinjal-LC-71 × Brinjal-LC-73 (0.41), Pusa Purple Long × Arka Keshav (0.35) and Brinjal-LC-72 × Brinjal-LC-73 (0.34) and rated as good specific combiners involving parents with poor × good, poor × good, poor × good, good × poor, good × good, good × poor, good × good, poor × good, poor × poor and good × good gca effects. One cross had non-significant specific combining effect and was rated average while four with significant negative specific combining ability were poor specific combiners. Comparable findings were reported by Desai et al. (2017), Khapte et al. (2013), Anvesh et al. (2024) and Mishra et al. (2023) providing further validation.

4.3.2.12 Average fruit weight (g)

Significant positive specific combining ability effects are desirable for average fruit weight Arka Keshav × Brinjal-LC-71 (15.85), Pusa Purple Long × Brinjal-LC-71 (15.27), Pusa Purple Long × Brinjal-LC-73 (13.77), Arka Keshav × Brinjal-LC-73 (8.35), Pusa Purple Cluster × Brinjal-LC-71 (7.52) and Brinjal-LC-71 × Brinjal-LC-73 (4.98) had significant positive specific combining effects and were rated good specific combiners and involved parents with poor × good, poor × good, poor × good, poor × good, poor × good and good × good gca effects. Six of

the crosses were poor specific combiners and three were average specific combiners.

4.3.2.13 Number of seeds per fruit

Specific combining ability effects for five of the cross combination was positive and significant Brinjal-LC-72 × Brinjal-LC-73 (60.63) Pusa Purple Cluster × Arka Keshav (58.92), Pusa Purple Cluster × Brinjal-LC-73 (58.76), Pusa Purple Long × Brinjal-LC-72 (23.92) and Brinjal-LC-71 × Brinjal-LC-73 (15.96) were categorized as good specific combiners and parents involved were with good × good, poor × poor, poor × good, poor × good and average × good gca effects. Specific combining effects for seven crosses were with significant negative sca effects and were rated as poor specific combiners and those with non-significant sca effects were three and rated average specific combiners. Similar results were also observed by Khapte et al. (2013), supporting the current study.

4.3.2.14 Yield per plant (kg)

Significant positive specific combining ability effects are desirable for yield per plant, three cross combinations Pusa Purple Cluster × Brinjal-LC-72 (0.28), Pusa Purple Cluster × Arka Keshav (0.25) and Pusa Purple Cluster × Brinjal-LC-73 (0.19) rated good specific combiners due to significant positive specific combining ability effects and involved parents with good × good, good × average and good × good gca effects. Seven with non-significant and five with significant negative specific combining ability effects were rated as average and poor specific combiners respectively. The observations are in agreement with the findings of Sharma et al. (2016) and Khapte et al. (2013).

4.3.2.15 Ascorbic acid (mg/100g)

Analysis for specific combining ability effects showed that nine of the cross combinations were exhibiting significant positive specific combining ability effects for ascorbic acid viz., Pusa Purple Cluster × Arka Keshav (2.01), Arka Keshav × Brinjal-LC-71 (1.08), Arka Keshav × Brinjal-LC-73 (0.93), Pusa Purple Cluster × Brinjal-LC-72 (0.86), Pusa Purple Long × Brinjal-LC-71 (0.65), Pusa Purple Long × Brinjal-LC-73 (0.53), Pusa Purple Long × Brinjal-LC-72 (0.54), Pusa Purple Cluster × Brinjal-LC-73 (0.41) and Pusa Purple Long × Arka Keshav (0.36) were identified as good specific combiners with parents involved showing poor × poor,

poor × good, poor × good, poor × good, poor × good, poor × good, poor × good, poor × good and poor × poor gca effects. The study's outcomes are consistent with those described by Mishra et al. (2023) and Kumar et al. (2019). With significant negative specific combiners five of the crosses were poor specific combiners while one with non-significant were average specific combiner.

4.3.2.16 TSS (^{0}B)

Five cross combinations Arka Keshav × Brinjal-LC-72 (0.71), Pusa Purple Long × Brinjal-LC-71 (0.46), Brinjal-LC-71 × Brinjal-LC-73 (0.44), Pusa Purple Cluster × Brinjal-LC-71 (0.41) and Pusa Purple Long × Brinjal-LC-73 (0.39) rated good specific combiners due to significant positive specific combining effects and parents involved were with poor × poor, good × good, good × good, poor × good and poor × good gca effects. Eight were average specific combiners whereas two poor due to non-significant specific combining ability effect and significant negative specific combining ability effects respectively. Mishra et al. (2023) confirmed for similar results.

4.3.2 Estimates of specific combining ability (SCA) effects of cross combination for different growth parameters in brinjal

Hybrids	Traits							
	DFF	DFP	HD	LL (cm)	SD (mm)	PH (cm)	NPBPP	PL (cm)
Pusa Purple Long × Pusa Purple Cluster	12.43*	10.06*	3.89*	1.14	-3.16*	-6.48*	-0.43	0.05
Pusa Purple Long × Arka Keshav	-5.40*	-2.65	-0.86	1.00	-5.58*	-0.48*	0.15	0.32*
Pusa Purple Long × Brinjal-LC-71	6.85*	9.77*	-3.65*	-0.84	-7.74*	2.08*	0.15	-2.33*
Pusa Purple Long × Brinjal-LC-72	4.48*	1.35	6.68*	-0.29	3.40*	-7.95*	0.57	1.59*
Pusa Purple Long × Brinjal-LC-73	-1.15	-0.32	1.26	-3.57*	0.60*	6.83*	0.36	-0.77*
Pusa Purple Cluster × Arka Keshav	-8.36*	0.85	-9.99*	1.55*	4.21*	-2.26*	1.11*	0.87*
Pusa Purple Cluster × Brinjal-LC-71	-5.11*	-1.07	-5.45*	1.88*	5.18*	2.16*	-0.89*	-0.08
Pusa Purple Cluster × Brinjal-LC-72	-5.82*	-8.48*	-6.45*	-2.21*	-4.94*	1.34*	-0.81*	1.04*
Pusa Purple Cluster × Brinjal-LC-73	-3.44*	-5.15*	6.47*	0.74	-1.12*	3.08*	-0.68	0.31*
Arka Keshav × Brinjal-LC-71	6.06*	-1.44	5.47*	1.37*	3.00*	-6.01*	-0.31	-0.31*
Arka Keshav × Brinjal-LC-72	-2.98	-3.19*	3.14*	-2.28*	3.17*	-2.87*	0.77	-0.33*
Arka Keshav × Brinjal-LC-73	0.39	-3.86*	-0.28	-1.19	-1.33*	7.88*	-0.43	0.71*
Brinjal-LC-71 × Brinjal-LC-72	2.27	1.86	0.35	-1.32	1.41*	-2.58*	1.11*	1.36*
Brinjal-LC-71 × Brinjal-LC-73	-1.36	-5.11*	9.93*	2.10*	5.81*	3.17*	0.57	0.07
Brinjal-LC-72 × Brinjal-LC-73	5.60*	5.48*	-21.0*	0.71	-1.88*	1.47*	-1.35*	0.01
$SE_{(Sij)}$	1.52	1.55	0.89	0.68	0.14	0.10	0.40	0.12
$SE_{(Sij-Sik)}$	2.27	2.31	1.33	1.01	0.21	0.14	0.60	0.18
$SE_{(Sij-Skl)}$	2.1	2.14	1.23	0.94	0.19	0.12	0.56	0.17
Good combination	5	5	6	4	8	8	2	7
Poor combination	5	3	5	3	7	7	3	4
Average combination	5	7	4	8	0	0	10	4

*Significant at 5% level of significance

DFF: Days to 50 per cent flowering; **DFP:** Days to first picking; **HD:** Harvest duration; **LL:** Leaf length (cm); **SD:** Stem diameter (cm); **PH:** Plant height (cm); **NPBPP:** Number of primary branches per plant; **PL:** Pedicel length (cm)

continued…

Hybrids	Traits							
	NFPP	**FD (cm)**	**FL (cm)**	**AFW (g)**	**NSPF**	**YPP (kg)**	**AA (mg/100g)**	**TSS (^{0}B)**
Pusa Purple Long × Pusa Purple Cluster	-0.40	-0.49*	-4.11*	-11.02*	-20.49*	-0.38*	-1.62*	0.14
Pusa Purple Long × Arka Keshav	4.52*	-1.22*	0.35*	-10.36*	-8.20	-0.13*	0.36*	-0.58*
Pusa Purple Long × Brinjal-LC-71	-5.27*	2.52*	-3.60*	15.27*	-84.74*	-0.30*	0.65*	0.46*
Pusa Purple Long × Brinjal-LC-72	3.14*	-0.02	2.16*	-8.44*	23.92*	-0.20*	0.54*	-0.43*
Pusa Purple Long × Brinjal-LC-73	1.73	0.04	-0.41*	13.77*	58.76*	-0.02	0.53*	0.39*
Pusa Purple Cluster × Arka Keshav	3.98*	0.53*	1.10*	-0.11	58.92*	0.25*	2.01*	-0.23
Pusa Purple Cluster × Brinjal-LC-71	1.18	0.24*	1.81*	7.52*	1.71	0.01	-1.13*	0.41*
Pusa Purple Cluster × Brinjal-LC-72	-2.07	0.10	1.58*	-11.19*	-78.29*	0.28*	0.86*	-0.14
Pusa Purple Cluster × Brinjal-LC-73	-4.15*	-0.35*	0.57*	-6.98*	-109.12*	0.19*	0.41*	-0.09
Arka Keshav × Brinjal-LC-71	-4.57*	-0.09	-3.16*	15.85*	9.01	-0.07	1.08*	0.23
Arka Keshav × Brinjal-LC-72	-1.82	0.17	2.50*	0.48	-66.33*	0.06	-2.43*	0.71*
Arka Keshav × Brinjal-LC-73	-5.90*	-0.34*	0.03	8.35*	-47.16*	-0.12*	0.93*	0.23
Brinjal-LC-71 × Brinjal-LC-72	5.06*	-0.16	1.92*	1.43	-125.54*	0.01	-0.31*	0.01
Brinjal-LC-71 × Brinjal-LC-73	3.64*	-0.87*	0.41*	4.98*	15.96*	0.10	-0.55*	0.44*
Brinjal-LC-72 × Brinjal-LC-73	-1.24	-0.04	0.34*	-7.07*	60.63*	0.03	0.04	-0.05
$SE_{(Sij)}$	1.33	0.11	0.11	1.00	4.94	0.06	0.12	0.13
$SE_{(Sij-Sik)}$	1.99	0.16	0.15	1.50	7.37	0.09	0.18	0.19
$SE_{(Sij-Skl)}$	1.84	0.15	0.12	1.38	6.83	0.09	0.17	0.18
Good combination	5	3	10	6	5	3	9	5
Poor combination	4	5	4	6	7	5	5	2
Average combination	6	7	1	3	3	7	1	8

*Significant at 5% level of significance

NFPP: Number of fruits per plant; **FD:** Fruit diameter (cm); **FL:** Fruit length (cm); **AFW:** Average fruit weight (g); **NSPF:** Number of seeds per fruit; **YPP:** Yield per plant (kg); **AA:** Ascorbic acid (mg/100g); **TSS:** Total Soluble Solid (^{0}B)

4.4 Gene Action

By applying Griffing's Method 2 (Model-I) to the brinjal population under study the following results (Table 4.4.1.) regarding gene action were obtained with respect to different horticultural traits studied.

4.4.1 Estimates of genetic components of variance for different horticultural traits

Sr. No	TRAITS	σ^2_{GCA}	σ^2_{SCA}	$\sigma^2_{GCA}/\sigma^2_{SCA}$
1.	Days to 50 percent Flowering	19.84	38.83	0.51
2.	Days to first picking	11.90	32.42	0.36
3.	Harvest duration	21.41	66.24	0.32
4.	Leaf length (cm)	0.12	3.19	0.03
5.	Stem diameter (mm)	3.23	20.41	0.15
6.	Plant height (cm)	1.93	31.34	0.06
7.	Number of primary branches per plant	0.21	0.46	0.46
8.	Pedicel Length (cm)	0.37	1.23	0.29
9.	Number of fruits per plant	9.73	12.27	0.79
10.	Fruit diameter (cm)	0.04	0.72	0.05
11.	Fruit length (cm)	0.43	6.02	0.07
12.	Average fruit weight (g)	33.31	146.98	0.22
13.	Number of seeds per fruit	1933.94	5510.72	0.35
14.	Yield per plant (kg)	0.03	0.05	0.71
15.	Ascorbic acid (mg/100g)	0.54	1.33	0.41
16.	TSS (^oB)	0.02	0.16	0.15

The examination of the data presented in Table 4.4.1 indicated that non-additive genetic effects played a major role in the expression of most of the traits studied. This inference was based on the fact that, for all 16 traits evaluated, the ratios of σ^2gca to σ^2sca were less than 1, highlighting the greater influence of non-additive gene action. The values pertaining to ratios which were extremely low (≤0.03) with respect to traits like leaf length (cm), plant height (cm), fruit diameter (cm) and fruit length (cm) indicate the significant impact of non-additive gene action on the expression of these traits. However, number of fruits per plant (0.79) recorded highest ratio for variance and hence suggested near and equal contribution of additive and non-additive effects.

Although still predominantly governed by non-additive genetic effects, traits number of seeds per fruit, days to 50 percent flowering, number of primary branches per plant and ascorbic acid, exhibited relatively higher σ^2gca/σ^2sca ratios (0.71, 0.51, 0.46 and 0.41 respectively); suggesting a more balanced contribution of additive and non-additive gene actions in the inheritance of these traits.

Notably, the investigation did not identify any traits predominantly controlled by additive genetic effects. The outcomes suggest that breeding methods targeting non-additive genetic variation, such as hybrid breeding, may offer greater potential for improving the traits studied in the given brinjal population. In situations where σ^2sca was greater than σ^2gca, it was evident that dominant genetic effects outweighed additive ones, underscoring the importance of non-additive gene action in the inheritance of these traits.

Pusa Purple Long

Pusa Purple Cluster

Arka Keshav

Brinjal-LC-71

Brinjal-LC-72

Brinjal-LC-73

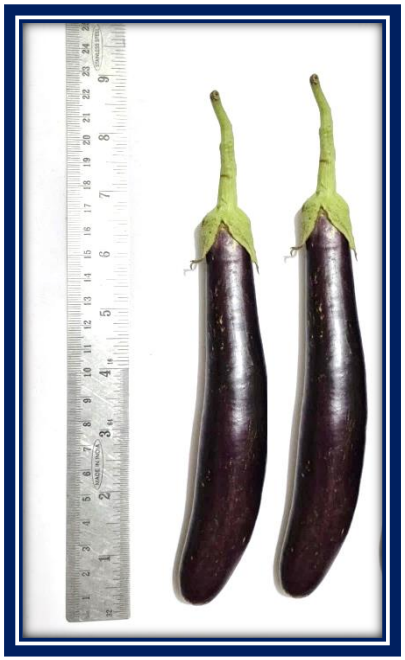
Check (CODE-B02)

Parents and Check Variety

Plate 3: Various parental genotypes used in hybridization

Pusa Purple Long x Pusa Purple Cluster

Pusa Purple Long x Arka Keshav



Pusa Purple Long x Brinjal-LC-71

Pusa Purple Long x Brinjal-LC-72

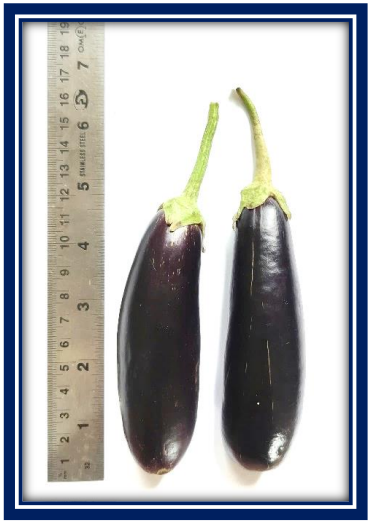
Pusa Purple Long x Brinjal-LC-73

Pusa Purple Cluster x Arka Keshav

Pusa Purple Cluster x Brinjal-LC-71

Pusa Purple Cluster x Brinjal-LC-72

Pusa Purple Cluster x Brinjal-LC-73



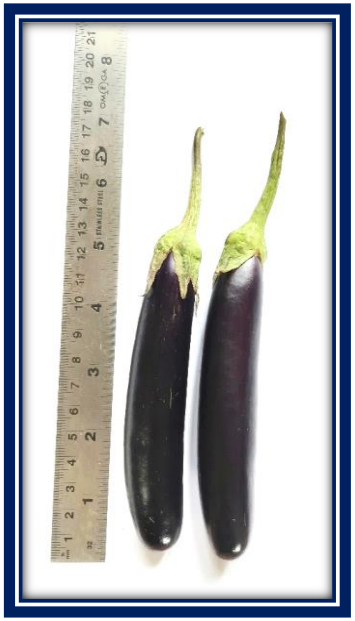
Arka Keshav x Brinjal-LC-71

Arka Keshav x Brinjal-LC-72

Arka Keshav x Brinjal-LC-73

Brinjal-LC-71 x Brinjal-LC-72

Brinjal-LC-71 x Brinjal-LC-73



Brinjal-LC-72 x Brinjal-LC-73

Plate 4: Various cross combinations obtained by hybridization

SUMMARY AND CONCLUSIONS

Chapter-5

SUMMARY AND CONCLUSIONS

The present investigation entitled "**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**" was conducted at the Experimental Research Farm of the Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, HP, India, during year 2024 and 2025. The major objectives of the study were to estimate the extent of heterosis, combining ability and gene action for different horticultural traits.

The study utilized six inbred lines, developed by selfing of the following parental genotypes: Pusa Purple Long, Pusa Purple Cluster, Arka Keshav, Brinjal-LC-71, Brinjal-LC-72, and Brinjal-LC-73. To assess standard heterosis, a widely adopted commercial hybrid from the private sector, CODE-B02, was used as a standard check. A half diallel mating design (excluding reciprocals) was employed to generate fifteen F_1 hybrids from these parents. The experimental material—comprising the six parents, fifteen hybrids, and the check—was laid out in a randomized complete block design (RCBD) with three replications for evaluation.

Observations were recorded for seventeen quantitative traits viz., days to 50 per cent flowering, days to first picking, harvest duration, leaf length (cm), stem diameter (mm), plant height (cm), number of primary branches per plant, pedicel length (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), number of seeds per fruit, yield per plant (kg), ascorbic acid (mg/100g), TSS(^{0}B), disease incidence (%)/severity (%) and three qualitative traits viz. presence of spine, bearing habit and fruit colour.

5.1 ANALYSIS OF VARIANCE

The analysis of variance for different traits showed that the mean sum of squares due to genotypes were significant across all the traits studied, suggesting the presence of substantial genetic variability among the genotypes evaluated. This justified proceeding further for detailed analysis.

5.2 MEAN PERFORMANCE STUDIES

The individual performance of the parents and hybrids was evaluated for all the horticultural traits, and the key findings derived from the current investigation are summarized below.

For the important horticultural trait yield per plant, Pusa Purple Long (0.91) was best, followed by Brinjal-LC-73 (0.83) and Brinjal-LC-72 (0.71). These parental genotypes were also best for traits viz. days to 50 per cent flowering, days to first picking, harvest duration, leaf length, stem diameter, plant height, number of primary branches per plant, pedicel length, number of fruits per plant, fruit length, number of seeds per fruit and ascorbic acid.

Among the cross combinations Pusa Purple Long × Brinjal-LC-72 (1.63) outperformed other crosses for yield per plant and was followed by Pusa Purple Long x Brinjal-LC-73 (1.48) and Arka Keshav x Brinjal-LC-71 (1.46). These cross combinations also exhibited highest values for other traits i.e. days to first picking, pedicel length and fruit length.

5.3 Heterosis studies

Highest heterosis over better parent was exhibited by cross combination Arka Keshav x Brinjal-LC-71 (131.75%) followed by Pusa Purple Cluster × Brinjal-LC-71 (105.26%) and Arka Keshav x Brinjal-LC-72 (7.18%). These cross combinations also showed maximum values for the traits: pedicel length, number of seeds per fruit and TSS.

Pusa Purple Long × Brinjal-LC-72 (41.74%) exhibited maximum heterosis over standard check for yield per plant followed by Pusa Purple Long × Brinjal-LC-73 (28.70%) and Arka Keshav × Brinjal-LC-71 (26.96%). These hybrid combinations were also best for other traits like pedicel length and fruit length.

5.4 Combining ability

For yield per plant highest significant desirable GCA effects were shown by genotypes viz. Brinjal-LC-72 (0.14), Brinjal-LC-71 (0.10) and Brinjal-LC-73 (0.09) indicating that they were good general combiners. These parental genotypes were also good general combiners for other traits like days to first picking, harvest duration, stem diameter, plant height, number of primary branches per plant, pedicel

length, number of fruits per plant, fruit diameter, fruit length, average fruit weight, number of seeds per fruit, ascorbic acid and TSS.

Within the cross combinations Pusa Purple Cluster × Brinjal-LC-72 (0.28) showed maximum positive significant SCA effects for yield per plant followed by Pusa Purple Cluster × Arka Keshav (0.25) and Pusa Purple Cluster × Brinjal-LC-73 (0.19). These cross combinations also showed significant SCA effects for days to 50 percent flowering, days to first picking, harvest duration, leaf length, stem diameter, plant height, number of primary branches per plant, pedicel length, fruit diameter, fruit length, number of seeds per fruit and ascorbic acid.

5.5 Gene action

This study explored the genetic control of traits through variance component analysis, utilizing estimates of σ^2sca and σ^2gca. The results consistently revealed that σ^2sca values were greater than σ^2gca across all traits examined, indicating the dominance of non-additive gene action. This conclusion was further reinforced by the σ^2gca/σ^2sca ratio, which remained below one for all traits, confirming the significant role of non-additive effects. These outcomes underscored the notable influence of non-additive genetic factors in enhancing various traits through specific cross combinations. Consequently, the findings suggested that hybrid breeding would be a more effective strategy for improving the traits studied, as compared to conventional selection methods during the present investigation.

Conclusion

- Pusa Purple Long recorded maximum mean value for yield per plant and this was also superior for the characters days to 50 percent flowering, days to first picking and leaf length.
- The cross-combination Pusa Purple Long × Brinjal-LC-72 excelled over the other hybrids in terms of yield per plant and also showed superior performance for the trait fruit length.
- Arka Keshav × Brinjal-LC-71 exhibited the highest heterobeltiosis for yield per plant and this was also superior for the characters pedicel length and number of seeds per fruit.
- The parent Brinjal-LC-72 showed maximum significant positive GCA effects and was most desirable for yield per plant.

- Among the different hybrid combinations, Pusa Purple Cluster x Brinjal-LC-72 demonstrated the highest significant and positive specific combining ability (SCA) effect for fruit yield per plant.
- In the present study, the σ^2gca/σ^2sca ratio was found to be less than one for all the traits evaluated including yield per plant, indicating that hybridization could be an effective and better approach for improving all the traits studied.

Pusa Purple Long x Brinjal-LC-72

Pusa Purple Long x Brinjal-LC-73

Arka Keshav x Brinjal-LC-71

Plate 5: Top three cross combinations on the basis of their mean performance

Table 5.5.1 Top three cross combinations on the basis of yield per plant (kg) in terms of heterobeltiosis, Standard heterosis and SCA values.

S.No.	Parameter	Crosses
1.	**Heterobeltiosis**	Arka Keshav × Brinjal-LC-71 Pusa Purple Cluster × Brinjal-LC-71 Arka Keshav × Brinjal-LC-72
2.	**Standard heterosis**	Pusa Purple Long × Brinjal-LC-72 Pusa Purple Long × Brinjal-LC-73 Arka Keshav × Brinjal-LC-71
3.	**SCA**	Pusa Purple Cluster × Brinjal-LC-72 Pusa Purple Cluster × Arka Keshav Pusa Purple Cluster × Brinjal-LC-71

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APPENDICES

APPENDIX-I

Mean monthly meteorological data during the cropping period (January to June, 2025) at College of Horticulture and Forestry Neri, Hamirpur

Month	Average monthly temperature (°C)		Average relative humidity (%)	Rainfall (mm)
	Minimum	Maximum		
February	11.24	22.88	46.13	4.04
March	14.47	28.35	44.22	0.85
April	21.64	36.32	33.36	1.03
May	25.46	37.63	40.08	1.91
June	27.08	37.79	46.21	7.47

Source: Meteorological Observatory, Department of Soil Science and Water Management, College of Horticulture and Forestry, Neri, Hamirpur H.P. 177001

APPENDIX-II

Analysis of variance for various traits in brinjal genotypes

Source	Mean sum of squares			
Character	**Replications**	**Genotypes**	**ERROR**	**TOTAL**
Df	2	21	42	65
Days to 50 percent Flowering	0.54	211.25*	8.76	220.55
Days to first picking	0.78	146.21*	9.04	156.03
Harvest duration	3.28	293.54*	3.01	299.83
Leaf length (cm)	0.47	11.30*	1.67	13.44
Stem diameter (mm)	0.01	66.63*	0.07	66.71
Plant height (cm)	0.07	78.32*	0.03	78.42
Number of primary branches per plant	1.01	2.88*	0.63	4.52
Pedicel Length (cm)	0.02	4.87*	0.06	4.95
Number of fruits per plant	3.45	89.61*	6.47	99.53
Fruit diameter (cm)	0.05	1.84*	0.04	1.93
Fruit length (cm)	0.02	16.49*	0.04	16.55
Average fruit weight (g)	5.77	509.16*	4.13	519.06
Number of seeds per fruit	36.42	25,267.19*	91.58	25395
Yield per plant (kg)	0.004	0.32*	0.01	0.33
Ascorbic acid (mg/100g)	0.16	6.14*	0.05	6.35
TSS (ºB)	0.05	0.57*	0.06	0.68
Phomopsis blight severity (%)	2.24	309.57*	3.60	315.41

APPENDIX-III

Analysis of variance for combining ability of various traits in brinjal genotypes

Source	Mean sum of squares			
Character	**GCA**	**SCA**	**ERROR**	**TOTAL**
Df	5	15	40	60
Days to 50 percent Flowering	161.68*	41.79*	2.95	206.42
Days to first picking	98.31*	35.46*	3.04	136.81
Harvest duration	172.31*	67.24*	1.00	240.55
Leaf length (cm)	1.57*	3.77*	0.58	5.92
Stem diameter (mm)	25.94*	20.44*	0.02	46.40
Plant height (cm)	15.53*	31.36*	0.01	46.90
Number of primary branches per plant	1.96*	0.67*	0.20	2.83
Pedicel Length (cm)	2.98*	1.25*	0.01	4.24
Number of fruits per plant	80.15*	14.54*	2.26	96.95
Fruit diameter (cm)	0.34*	0.74*	0.01	1.09
Fruit length (cm)	3.49*	6.04*	0.01	9.54
Average fruit weight (g)	267.76*	148.26*	1.27	417.29
Number of seeds per fruit	15502.64*	5541.79*	31.06	21075.49
Yield per plant (kg)	0.29*	0.05*	0.004	0.34
Ascorbic acid (mg/100g)	4.40*	1.35*	0.01	5.76
TSS (ºB)	0.22*	0.18*	0.02	0.42

ABSTRACT

Department of Vegetable Science

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Title of thesis	:	**Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design**
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Admission Number	:	NH-2023-39-M
Major Discipline	:	Vegetable Science
Minor Discipline(s)	:	1. Genetics and Plant Breeding 2. Plant Pathology
Date of thesis submission	:	
Total pages of the thesis	:	104+iii
Number of words in abstract	:	346
Major Advisor	:	Dr. Shiv Pratap Singh

ABSTRACT

The present investigation entitled **"Genetic improvement in brinjal (*Solanum melongena* L.) using half diallel mating design"** was undertaken during 2024-2025 at the Experimental Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur (HP). The study aimed to evaluate heterosis, general combining ability (GCA), specific combining ability (SCA), and the nature of gene action for important horticultural traits in brinjal. The experimental material consisted of six diverse inbred lines, 15 F_1 hybrids developed through a half diallel mating design, and a standard check variety 'CODE-B02'. The genotypes were evaluated in a Randomized Complete Block Design (RCBD) with three replications. Significant differences were observed among the genotypes for all the traits studied, which included days to 50% flowering, days to first picking, harvest duration, plant height (cm), stem diameter (mm), leaf length (cm), number of primary branches per plant, pedicel length (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), number of seeds per fruit, yield per plant (kg), ascorbic acid (mg/100g), TSS (^{0}B) and severity (%) for Phomopsis blight. Among the parental lines, Pusa Purple Long (0.91 kg) and Brinjal-LC-73 (0.83 kg) were found superior performers based on mean yield per plant and traits such as early flowering, early picking, number of fruits per plant and number of primary branches. Brinjal-LC-72 (0.14) exhibited the most desirable GCA effect for yield per plant. On the basis of yield per plant cross combinations Pusa Purple Long × Brinjal-LC-72 (1.63 kg), Pusa Purple Long × Brinjal-LC-73 (1.48 kg) and Arka Keshav × Brinjal-LC-71 (1.46 kg) were found superior. The cross Pusa Purple Cluster × Brinjal-LC-72 (0.28) recorded the highest SCA effect for yield per plant. High levels of heterobeltiosis and standard heterosis were also observed in crosses like Arka Keshav × Brinjal-LC-71(131.75%) and Pusa Purple Long × Brinjal-LC-73 (28.70%) for yield per plant. Gene action studies indicated a predominance of non-additive gene effects for all traits including yield per plant; suggesting that hybrid breeding would be a better choice to enhance yield and related traits studied during present investigation.

Signature of the student
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BRIEF BIO-DATA

BRIEF BIO-DATA

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