“Study of inheritance pattern of major traits in brinjal (Solanum melongena L.)”

THESIS
SUBMITTED TO
Bihar Agricultural University, Sabour, Bhagalpur in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE)
IN
HORTICULTURE (OLERICUTURE)
BY
SUNIL KUMAR
REGISTRATION NO.- M/HORT-V/281/BAC/2015-16

DEPARTMENT OF HORTICULTURE
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2017
JAIP MAA SARASWATI

AFFECTIONATELY

DEDICATED TO MY REVEREND PARENTS
VITA

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Study of inheritance pattern of major traits in brinjal (*Solanum melongena* L.)
By

Sunil Kumar
Reg. No. M/Hort-V/281/BAC/2015

A Thesis Submitted to
The Bihar Agriculture University,
Sabour, Bhagalpur
In Partial Fulfillment of the Requirements
For the Award of Degree
of
Master of Science in Agriculture
(Horticulture)
Department of Vegetable and Floriculture

2017
Brinjal (*Solanum melongena* L.) is one of the most important vegetable crops grown in India and other parts of the world. Due to wider utility of brinjal, good hybrids are in great demand in the Indian market. Hence for a systematic and successful breeding programme, it is essential to identify superior parents for hybridization and crosses to expand the genetic variability for selection of superior genotypes. The nature of gene action acts as a basis for choosing an effective breeding methodology. In order to develop hybrid varieties in brinjal, estimates of these effects are very useful. Further improvement in yield through yield contributing traits depends on the nature and magnitude of heritable variation. The partitioning of heritable variation into additive (fixable) and non-additive (non-fixable) components is useful to provide information on the inheritance of quantitative characters. Keeping these points in view, the present study is undertaken with the following objectives: To estimate the extent of heterosis and to study the gene inheritance pattern of major traits in brinjal. For this study, a random crossing scheme was adopted to develop 8 hybrids in autumn winter season of 2015-16. Selfing was practiced in already existing four hybrids to develop F2 segregating population and the hybrids along with the five parents and two checks and F2 population were evaluated in RBD with three replications to accomplish the objectives. Heterosis studies revealed that though cross Muktakeshi x Rajendra Baigan-2 possessed highest significant heterosis over mid parent
heterosis and better parent towards days to first flowering but Rajendra Baigan-2 × BRBR-01 gave the wider heterotic value for the traits like days for first flowering, days to 50% flowering and days to fruit set. Rajendra Baigan × Swarna Mani possessed highest significant standard heterosis in the desirable direction for average fruit weight, while Rajendra Baigan-2 × BRBR-01 was having high significant standard heterosis for yield per plant, at the same time Rajendra Baigan-2 × BRBL-01 was having high significant standard heterosis for fruit per plant. Study of gene inheritance pattern studies showed that days to first flowering, days to first fruit set and fruit length is controlled by additive gene action, whereas traits like plant height, yield per plant and average fruit weight is controlled by non additive gene action in all four crosses Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBL-01, Rajendra Baigan-2 × Swarnamani, Rajendra Baigan-2 × Muktakeshi. For days to first flowering, days to first fruit set, number of primary branches per plant, fruit length, fruit girth and yield per plant is controlled by over dominance in Rajendra Baigan-2 × BRBR-01 and days to first flowering, number of primary branches per plant, plant height, plant spread and fruit length is controlled by partial dominance in Rajendra Baigan-2 × Muktakeshi. Chi square studies revealed that calyx spininess, fruit pedicel prickles, leaf prickles on upper surface, and leaf pubescence segregate in 3:1 ratio, leaf blade colour and fruit shape trait segregated in 9:3:4 ratio and plant growth habit segregated in 9:6:1 in all the crosses (Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × BRBL 01, Rajendra Baigan-2 × Swarnamani and Rajendra Baigan-2 × BRBR-01).

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Sunil Kumar
Chairman, Advisory Committee
Student
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Place: 
(Sunil Kumar)

Date:
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>°C</td>
<td>Degree Centigrade</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>C.D.</td>
<td>Critical Difference</td>
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<td>cm</td>
<td>Centimeter</td>
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<tr>
<td>df</td>
<td>Degree of freedom</td>
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<td>g</td>
<td>Gram</td>
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<tr>
<td>kg</td>
<td>Kilogram</td>
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<tr>
<td>MT</td>
<td>Metric Tonnes</td>
</tr>
<tr>
<td>ha</td>
<td>Hectare</td>
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<tr>
<td>MSS</td>
<td>Mean Sum of Squares</td>
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<tr>
<td>S. Em (+)</td>
<td>Standard Error of mean</td>
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<tr>
<td>SS</td>
<td>Sum of Squares</td>
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<td>Fig.</td>
<td>Figure</td>
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<td>ht.</td>
<td>Height</td>
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<tr>
<td>wt.</td>
<td>Weight</td>
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<tr>
<td>MPH</td>
<td>Mid parent heterosis</td>
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<tr>
<td>BPH</td>
<td>Better parent heterosis</td>
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<tr>
<td>SH-1</td>
<td>Standard heterosis for Pusa Hybrid-6</td>
</tr>
<tr>
<td>SH-2</td>
<td>Standard heterosis for Arka Anand</td>
</tr>
<tr>
<td>P1 or P2</td>
<td>Parental mean</td>
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<tr>
<td>O</td>
<td>Observed mean</td>
</tr>
<tr>
<td>A</td>
<td>Arithmetic mean</td>
</tr>
<tr>
<td>G</td>
<td>Geometric mean</td>
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<tr>
<td>$\chi^2$</td>
<td>Chi Square analysis</td>
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This is to certify that the thesis entitled “STUDY OF INHERITANCE PATTERN OF MAJOR TRAITS IN BRINJAL (SOLANUM MELONGENA L.)” submitted in partial fulfillment of the requirements for the award of the degree of MASTER OF SCIENCE IN AGRICULTURE in the subject of HORTICULTURE (OLERICULTURE) of the Faculty of Agriculture, Bihar Agricultural University, Sabour, Bhagalpur, Bihar is a genuine record of bona fide research work carried out by MR. SUNIL KUMAR, Reg. No. M/Hort-V/281/BAC/2015 under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that help and information received during the course of this investigation and preparation of the thesis have been duly acknowledged.

Dr. Deepti Singh
Chairman, Advisory Committee
CERTIFICATE-II

We, the undersigned members of the Advisory Committee of MR. SUNIL KUMAR, Reg. No. M/Hort-V/281/BAC/2015-16 a candidate for the degree of MASTER OF SCIENCE (AGRICULTURE) HORTICULTURE majoring in OLERICULTURE have gone through the manuscript of the thesis and agree that the thesis entitled “Study of inheritance pattern of major traits in brinjal (Solanum melongena L.)” may be submitted in partial fulfillment of the requirements for the award of the degree.

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Name and signature of external examiner

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Brinjal (*Solanum melongena* L.), commonly termed as eggplant or aubergine worldwide, is one of the most common and popular vegetable crop grown in India and other parts of the world. It belongs to the family Solanaceae (nightshades), having chromosome number \(2n=2x=24 \ (x=12)\). The family contains 75 genera and over 2000 species, out of which, about 150-200 are tuber bearing and belong to section Tuberarium. The majority of species (about 1800) are non tuber bearing (Gardener, 1963).

The area under brinjal cultivation in India is 711.3 thousand hectare producing 13,557.8 thousand mt with an average national productivity of 19.1 mt/ha. In Bihar the area and production are 57.5 thousand hectare and 1240.5 thousand metric tonne with a productivity of 21.6 mt/ha (NHB Database, 2014). It can be grown in almost all parts of India except higher altitudes. The major brinjal producing states are Bihar, Karnataka, Orissa, West Bengal, Andhra Pradesh, Maharashtra and Uttar Pradesh. West Bengal is the leading brinjal producing state. Bihar ranks third in brinjal production in our country. Unripe brinjal fruit is consumed as cooked vegetable in various ways. Brinjal occupies a prestigious position among diversified group of consumers who frequently keep it in their food menu and ceremonial functions.

The brinjal or eggplant has a lot of vitamins and nutrients. It is a rich source of nutrients, particularly, carbohydrates (4.0%), proteins (1.4g/100g), dietary fiber (1.3g/100g) and vitamins like thiamin (0.04μg/100g), folic acid (34.0μg/100g), niacin and pantothenic acid as well as minerals like calcium (18.0mg/100g), iron (0.38mg/100g), potash (2.0mg/100g), zinc (0.22mg/100g), copper (0.12mg/100g) and manganese (15.0mg/100gm). Eggplant has important
health benefits of lowering the cholesterol levels (reducing the risk of heart disease), reducing the sugar levels of a diabetic person and controlling obesity. Brinjal is known to have Ayurvedic medicinal properties and is good for diabetic patients. It has also been recommended as an excellent remedy for those suffering from liver complaints. The bitterness in brinjal is due to the presence of glycoalkaloids which are of wide occurrence in plants of solanaceae family. The discoloration in brinjal fruit is attributed to high polyphenol oxidase activity. The cultivars which are least susceptible to discoloration are considered suitable for processing purposes.

Brinjal is indigenous to India and wide variability is found in the cultivated species. There are three main botanical varieties under the species *melongena*, the round or egg shaped cultivars that are grouped under var. *esculentum*, the long or slender types that are included under var. *serpentinum* and the dwarf brinjal plants that are put under var. *depressum* (Choudhary, 1976). A large number of cultivars are distributed throughout the country having great diversity in colour, size and shape. Brinjal flowers are large, violet coloured and solitary or in clusters of two or more. In most varieties the perfect flowers are borne singly and opposite to the leaves. In brinjal, heterostyly is a common feature. Four types of flowers have been reported depending on the length of styles, *viz*; (i) long-styled with large ovary, (ii) medium-styled with medium size ovary, (iii) pseudo short-styled with rudimentary ovary and (iv) true short-styled with very rudimentary ovary (Krishnamurthi and Subramaniam, 1954). The long and medium-styled flowers produce fruits whereas pseudo-short and short-styled flowers do not set any fruits.

Brinjal, often a self-pollinated crop, shows some degree of crossing. It has the advantages of easy crossing and production of large number of seeds per cross and has low seed requirement per unit area for exploitation of heterosis. There is a great agro-climatic variation, particularly with respect to uneven rainfall, distribution pattern and variation in temperature which limit the productivity of the crop to a great extent. Hence, thorough evaluation of the
genotypes is required to know the performance of the genotypes in terms of yield and other yield attributing characters.

Based on this, promising suitable strategies to breed varieties with specific requirements, understanding the relationships and genetic systems governing yield and study of gene effects for fruit yield is very important for genotype identification. The yield and its components are controlled by polygenes and are complex in their mode of inheritance. They are highly influenced by the environment. So, partitioning of overall variability into heritable and non-heritable components is necessary. For a systematic breeding programme in any crop, an understanding of the inheritance pattern of botanical characters is essential so that segregation population can be handled effectively. Knowledge of the gene controlling system of the character to be selected and genetic variation are the pre-requisite for viable breeding programme. Therefore, the present study entitled “Study of inheritance pattern of major traits in brinjal (Solanum melongena L.)” is undertaken to understand the nature of gene effects involved in the expression of a character in interacting and non-interacting crosses. An assessment of these genetic parameters shall allow the development of efficient breeding strategies for eggplant cultivar improvement. Keeping the above facts in view, the present investigation is carried on Study of inheritance pattern of major traits in brinjal (Solanum melongena L.) with the following objectives

1. Estimation of extent of heterosis.
2. Gene inheritance pattern of major characters in brinjal.
Eggplant (*Solanum melongena* L.), commonly known as brinjal or aubergine, belongs to angiospermic family: Solanaceae, which is a popular vegetable crop grown in the tropics and subtropics. The success of any crop improvement programme depends on the quantum of genetic variability available for exploitation in the naturally existing types or segregating progenies generated through hybridization. The information on the type of variation in the available genetic material and the part played by the environment on the expression of plant traits is of prime importance for the appraisal of rate and magnitude of possible improvement.

The available literature on heterosis, gene inheritance pattern along with segregation pattern of different traits in brinjal is reviewed in this chapter and presented on the following aspects:


**Estimation of extent of heterosis.**

The term heterosis refers to phenomenon in which the $F_1$ hybrids obtained by crossing two genetically dissimilar gametes or individuals, shows increased or decreased vigour over the parents. Shull (1908) referred this phenomenon as the stimulus of heterozygosis. Generally the term hybrid vigour is used to denote heterosis in the desirable direction. The heterosis over mid parent, better parent and standard check are designated as average heterosis, heterobeltiosis, and standard heterosis respectively. In practical plant breeding, superiority of $F_1$ over mid parent is of little value since it does not offer any
advantage. However the exploitation of hybrid would primarily depend on its performance in comparison to the best existing commercial hybrids/varieties (standard heterosis). Heterosis breeding provides opportunity for improvement in productivity, earliness, uniformity, quality and resistance to diseases and pests.

Baksh (1979) observed heterosis for days to flowering, days to fruit set after first flowering, flowers per inflorescence, plant height and number of branches in a cross of *Solanum incanum × Solanum melongena*. He noted that the hybrids flowered 17 days and 36 days earlier than *Solanum incanum* and *Solanum melongena*, respectively.

Dahiya *et al.* (1985) evaluated crosses made between 10 female lines and 4 male testers in brinjal. They noted that the extent of heterosis over the better parent was 23.02 per cent for fruit length, 6.89 per cent for fruit weight, 15.83 per cent for fruits per plant and 41.23 per cent for yield per plant. The crosses Ludhiana Local × PH-4 and Ludhiana Local Long × Pusa Purple Long exhibited highest significant positive heterosis for total yield. The cross Long Thick × Pusa Purple Long exhibited significant heterosis for fruit number, fruit length and total yield.

Gopinath and Madalagiri (1986) analyzed the data on the parental lines, $F_1$, $F_2$, and the back cross generations of the cross WCGR-112-8 × Pusa Kranti in brinjal and observed significant heterosis over mean parental values for fruit number per plant, yield, fruit length and breadth and plant height.

Verma *et al.* (1986) reported significantly positive heterosis for plant height and negative heterosis for days to flowering by -2.94 per cent in brinjal. Punjab Bahar × Pusa Purple Long showed 13.0 per cent heterosis over the best parental line for yield per plant.

Singh and Kumar (1988) observed heterosis for plant height and number of primary branches in brinjal. They noted that the cross Annamalai × H-4 was significantly taller than its better parent with 26.1 per cent heterosis. Three $F_1$ hybrids had significantly high number of primary branches than their respective parents.
Chadha et al. (1990) determined heterosis derived from data on eleven yield components in seven brinjal genotypes and their F₁ hybrids. Hybrids of Pant Rituraj × PPL, Pant Rituraj × T-3 and Pant Rituraj × PPC were considered to be the best performers.

Singh and Gautam (1991) studied heterosis for five yield components in eight varieties and their F₁ hybrids of brinjal and reported high heterosis in the crosses Pant Samrat × PPL for number of fruits (92.17 per cent), Pant Rituraj × PH-4 for fruit diameter (48.37 percent), Pant Rituraj × Pant Samrat for fruit weight (81.55 per cent) and Arka Kusumakar × White Oblong for yield per plant (62.20 per cent).

Mandal and Dana (1993) reported crosses between eight parents of brinjal. The cross PPC × 17 B showed high heterosis for yield and most of its components. Heterosis over better parent for yield per plant was observed to the extent of 136.82 per cent.

Mandal et al. (1994) reported maximum and significant heterosis in favoured direction for number of fruits per plant, fruit diameter, length of fruits and yield per plant in brinjal.

Ingale and Patil (1996) found significant heterosis over better parent for fruit yield, weight, girth and length of the fruit indicating presence of over dominance in brinjal. The hybrid Gokak Local × Pusa Bhairav showed the highest yield (1.79 Kg per plant), the hybrid Surya × Gokak Local showed improvement for yield (1.71 Kg per plant) and rind thickness (0.82 cm).

Ingale and Patil (1997) reported heterosis in brinjal for the characters *viz*; earliness, fruit yield, plant height, plant spread, primary branches, secondary branches and stem girth by using half diallel set of crosses involving 10 cultivars. The range for mean performance of hybrids was higher than the parents for all characters except plant height. The magnitude of heterosis ranged between -77.9 and -82.7 per cent over mid and better parent values for these characters.
Dubey *et al.* (1998) studied hybrid vigour in 48 F$_1$ hybrid of brinjal and found crosses CO-1 × PPC for days to fifty per cent flowering; BB-13 × Pant Samrat for number of flowers per cluster; Sel-4 × PPC for number of fruits per cluster; FB 18 × KS-33 1 for length of fruit; Sel-5 × KS -331 for diameter of fruit; Sel-4 × Pant Samrat for number of marketable fruits per plant; PB-IS × KS-331 for fruit weight and KS-352 × Pant Samrat for total yield per plant showed maximum heterosis over standard check.

Sathya *et al.* (1998) studied heterosis in brinjal and found that hybrid SM-141 × SM-262 had maximum positive standard heterosis for plant height, plant spread and number of primary branches per plant and hybrid SM6-6 × SM197 for fruit yield per plant; while hybrid SM6-6 SM-l41 was the earliest to flower and to set fruit.

Sousa *et al.* (1998) found that heterosis related to the superior parent ranged from 13.89 to 92.51 per cent for total fruit yield in brinjal. The hybrids displaying highest heterosis related to the superior parent for total yield were Aubergine de Barbentane (AB) × B-14-07 (B1) and Sata Genebra (SG) × Florida market 10 (FM-b).

Babu and Thirumurugan (2000) recorded a negatively significant heterosis value for EP 160 × Pusa Kranti over its better parent value inferred earlier type brinjal. For all other traits *viz*; plant height (14.2), number of branches per plant (25.5), fruit length (12.4), number of fruits (16.3), fruit weight (17.7) and fruit yield (35.6), hybrid EP 39 × Pusa Kranti recorded the highest percentage heterosis values.

Gupta and Singh (2000) estimated the heterosis in crosses between eleven genotypes with two common male parents (Pant Samart and Pant Rituraj). Significant heterosis was observed over better parent and standard parent for all the eight characters in the desired direction. The heterosis ranged from -74.6 to 136.4 %, 80.4 to 136.4 % and - 74.6 to 207.6 % for fruit yield per plant over BP, SP1 and SP2, respectively. The hybrid KS-331×Pant Samrat
gave the highest yield (2.3 kg per plant) among the crosses and was found average in performance for fruit quality components. The same cross also showed maximum heterosis for yield i.e.136.4 per cent, 136.4 per cent and 207.6 per cent over BP, SP1 and SP2, respectively.

Mohanty and Prusti (2000) studied 11 hybrids of brinjal and found that Ravaiya was the highest yielder with a yield potential of 27.98 t/ha and a standard heterosis of 61.55 per cent. The higher yield was to a greater extent, caused by a higher number of fruits per plant and to a lesser extent, caused by larger fruit size.

Prasath et al. (2000) studied heterotic effect on ten characters in thirty hybrids. The study revealed the presence of highly significant and positive heterosis over better parent in majority of crosses for yield and its component characters in brinjal. Significant positive heterosis was exhibited by the crosses H-9 × MDU-1, 193 × MDU-1, 190 × Annamalai for fruit yield per plant, PR × CO-2 for plant height, PR × MDU-1 for branches per plant, 190 × CO-2 for long styled flowers, H-9 × MDU-1 for fruit girth, 202 × CO-2 for fruit length, 180 × Annamalai for fruit weight and 190 × Annamalai for fruit per plant.

Singh and Gopalakrishnan (2000) studied the performance of 5 purple fruited and light green/white fruited aubergine cultivars and their hybrids. In general, the hybrids performed better than the parents with regard to vigour, vegetative growth and fruit yield. Swetha × SM 63 was the earliest hybrid to flower. Arka Keshav × SM 71 produced the longest fruits (21 cm) and exhibited the highest heterosis. Surya × SM 116, exhibited significant heterosis for fruit diameter. SM 141 × TGR obtained the highest yield per plant (2.82 kg); Arka Keshav × SM 71, however, showed the highest heterobeltiliosis and standard heterosis for this trait.

Chadha et al. (2001) conducted a field experiment in Karnataka, to study heterosis in 36 F₁ hybrids of aubergine and their 15 parents. The best parents were P-8 for days to 50 per cent flowering, PBR-6 for branches per
plant, Kt-4 for fruit length, and T-3 for fruit diameter and marketable fruit yield per plant. The heterosis over the better parent ranged from 11.63 per cent (P-8 × Kt-4 and Punjab Barsati × Kt-4) to 37.21 per cent (K-202-9 × Pusa Kranti) for days to 50 per cent flowering, -25 per cent (K-202-9 × t-3) to 8.33 per cent (P-8 × Kt-4, Punjab Barsati × Kt-4, Pbr-7 × T-3, H-7 × Kt-4) for branches per plant, -46.49 (BR-112 × Pusa Kranti) to 10.73per cent (H-7 × Kt-4) for fruit length, -65.31 (H-7 × Kt-4) to 1.02 per cent (K-202-9 × Pusa Kranti) for fruit diameter and -42.30 (KS-314 × Pusa Kranti) to 70.34 per cent (Punjab Barsati × T-3).

Kaur et al. (2001) evaluated a total of 35 F1 aubergine hybrids for fruit yield and its components (number of fruits per plant fruit length, girth and weight). The majority of the crosses showed highly significant heterosis over better parents, indicating the 6 presence of over dominance gene effect for fruit yield. The extent of relative heterosis and heterobeltiosis was -18.1 to 39.97 and -19.40 to 38.40% for fruit yield and -35.29 to 59.25 and -57.80 to 15.55% for fruit weight, respectively. The value of heterosis was - 29.90 to 15.53% over mid parent and -31.96 to 15.5% over better parent. The hybrid S. Ravaiya × DBSR-44 depicted maximum heterobeltiosis and significant positive standard heterosis for fruit yield and for the number of fruits per plant, indicating that the number of fruits was a major component of fruit yield.

Patil et al. (2001) studied the heterosis and performance for 6 fruit characters viz; fruit yield, weight of fruit, length of fruit, girth of fruit, seed per cent and placenta per cent of aubergine. The heterotic effects for 6 fruit characters in 78 hybrids resulted from half diallel set of 13 cultivars revealed heterosis in the range of -80.13 to 121.94per cent over mid-parent and better parent (BP). The heterosis over BP indicated significant values for fruit yield (42 crosses), fruit weight (5 crosses), length of fruit (13 crosses), girth of fruit (7 crosses), seed per cent (22 crosses) and placenta per cent (2 crosses). The hybrid JB-8×IC-025 recorded the highest yield of 3.88 kg/plant. The hybrid JB-18 × IC-025 showed improvement for yield (3.81 kg/plant), seed percentage (9.17 per cent) and placenta percentage (90.83 per cent). Similarly, hybrid JB-8
Kranti showed merits for commercial exploitation due to fruit weight (150.27 g), length of fruit (13.22 cm), seed per cent (9.57 per cent) and placenta per cent (90.43 per cent) along with yield of fruits (3.19 kg/plant).

Thangamani et al. (2004) observed the performance of twenty-five F₁ hybrids of aubergine. Among them COBH-1 performed better than the other hybrids in terms of the important characters including number of fruits per plant, marketable fruit yield.

Aswani and Khandelwal (2005) studied the exploitation of hybrid vigour in brinjal using a diallel cross, involving 10 parents (excluding reciprocals), namely Pusa Ankur (P1), Arka Nidhi (P2), Arka Keshav (P3), IC-112358 (P4), IC-90984 (P5), Pusa Uttam (P6), Pusa Purple Cluster (P7), Udaipur Local (P8), Pusa Upkar (P9) and Pusa Bhairav (P10), for manifestation of better and mid-parent heterosis for fruit yield per plant and 11 yield attributing traits (days to first flowering, days to 75 per cent flowering, days to first fruit harvest, leaf area, plant height, plant spread, number of fruit clusters per plant, fruit length, fruit width, number of fruits per plant and average fruit weight). All the 45 hybrids showed positive and significant heterosis over better and mid-parents for fruit yield per plant. The better and mid-parent heterosis ranged from 21.06 to 166.03 per cent and from 23.33 to 197.81 per cent, respectively. Significant values of heterosis over better parent and mid-parent were also observed for other attributes, indicating their contribution to the heterosis for fruit yield. The best 5 heterotic hybrids were P7 × P8, P8 × P10, P6 × P10, P6 × P8 and P5.

Baig et al. (2005) evaluated the extent of heterosis for fruit yield and 9 yield-related traits in 10 brinjal (aubergine) parental cultivars and their 45 hybrids. Hybrids ABV 1 × Anuradha, PBR 129-5 × ABV 1 and ABV 1 × Vaishali showed the maximum fruit yield (1.41, 1.33 and 1.27 kg/plant, respectively) with maximum heterosis. Heterosis for fruit yield appeared to be due to the high manifestation of heterosis for fruit number/plant and average fruit weight.
Bavage et al. (2005) observed that the extent of heterosis over commercial control in brinjal (Kalpataru) was 30.47\% for plant height, -10.82\% to 50\% flowering, 50.00\% for percent fruit set, -2.25\% for fruit length : diameter ratio, 87.06\% for number of early fruits per plant and 59.74\% for total yield per plant. The cross Malapur Local × Melavanki Cluster-II, Manjari Gota × Malapur Local and Malapur Local × Melavanki Cluster-I exhibited the highest significant positive heterosis for total yield. Malapur Local × Melavanki Cluster-II also showed the highest positive heterosis for early number of fruits per plant and total yield per plant. Hence, these two parents could be used for crossing programme.

Prabhu et al. (2005) studied heterosis for plant height, branches per plant, number of fruits per plant, mean fruit weight, fruit borer infestation and marketable yield per plant. There by considering these parameters he found that plant height was highest in the hybrid EP 12 × MDU-1 with positive heterosis over better and standard parents these results indicated over dominance. He also found that the number of branches per plant influenced the yield to a significant extent and was higher in the parents EP 65. The hybrid EP 12 × MDU 1 recorded highest number of branches per plant exhibiting significant positive better and standard parent heterosis. Significant values were also recorded by the hybrids EP 65 × Pusa Uttam for mean performance and standard heterosis. The number of fruits per plant was high in the parents EP 65. The cross EP 65 × Pusa Uttam expressed the highest heterobeltiosis of 52.82 percent indicating partial dominance. A high value of mean fruit weight was recorded in parents MDU 1. In terms of mean performance, the parent EP 65 was identified as good performers for lesser fruit borer infestation. Significant low mean performance and negative better parent heterosis was recorded by the crosses EP 65 × Pusa Uttam. The heterosis value was negative, which revealed the possibility of getting fruit borer tolerant hybrids through heterosis breeding. The parents with lesser incidence resulting in a hybrid with least incidence of fruit borer attack might be due to complementation of genes. The hybrid EP 65 × Pusa Uttam performed better for number of fruits per plant with lesser fruit borer
infestation. So there by these hybrids could be recommended for exploitation of heterosis for getting higher marketable yield. × P6, whereas for early flowering and fruiting P1 × P4 showed the best performance.

Shafeeq et al. (2006) reported the maximum heterosis for fruit yield per plant was observed followed by number of fruits/cluster and average fruit weight while significant heterosis only for average fruit weight in brinjal.

Joshi (2007) reported that the crosses NDB 21 × PB 67, PB 64 × PB 67 and PB 66 × PB 67 showed highly significant heterosis over standard parent for most of the economic characters in brinjal.

Singh et al. (2008) studied the extent of standard heterosis for yield contributing characters in 22 F₁ hybrids raised from straight crosses and two standard parents of brinjal. In order to merit F₁ hybrids, DBL-11 × PB-33, Pant Samrat × KS 331, PB 33 × PB 30 and PB 30 × KS 331 showed better performance over standard parent (Pant Samrat) for yield as they recorded significant heterosis of 51.3 per cent, 50.1 per cent, 45.9 per cent and 34.6 per cent respectively.

Das et al. (2009) reported the positive heterosis in brinjal for plant height, primary branches per plant, fruit number per plant and fruit weight and negative heterosis for days to 50% flowering, fruit length and fruit girth.

Polignano et al. (2010) studied genetic divergence in 98 accessions of solanum melongena L. and its allied species S.aethiopicum and S. macrocarpon L. For 16 morpho–agronomic and fruit traits revealed the existence of considerable diversity. The genotypes included in the diverse clusters could be used as promising parents for hybridization in order to obtain a high heterotic response and thus contribute to eggplant breeding.

Chowdhury et al. (2011) studied heterosis in brinjal for earliness, which according to him can be achieved by observing days required for 50% flowering and days to 1st harvest thereby keeping in mind this two traits he got
several crosses with negative significant heterosis over standard check variety like as that in crosses P-20 × P-5 and P-5 × P-19 which was (-27.59%) and (-27.37%) respectively. The degree of heterosis for plant height ranged from 2.12 to 22.36% and -16.96 to 1.91% over better parent and standard check variety, respectively. Also in all the hybrids he evaluated the degree of heterobeltiosis for days to 50% flowering, days to 1st harvest, plant height, and fruit length so from which a wide range of heterosis was observed for fruit length (-34.04 to 32.35% and -7.89 to 93.17%) over better parent and standard check, respectively. He observed that the better parent heterosis for fruit breadth was reduced in all the crosses except in P-1 × P-20 and P-20 × P-14. Same is the trend which he also observed for single fruit weight. A maximum of 105.0% in cross (P-5 × P-19) and 253.65% in cross (P-14 × P-19) heterosis was estimated over better parent and standard check, respectively for fruit breadth, single fruit weight, number fruits/plant and fruit yield.

Kumari (2011) studied heterosis for yield and other component characters of 45 F₁ hybrids of tomato derived from the crosses between 15 lines and 3 testers through line × tester technique was studied. Maximum and significant heterosis was observed for yield, fruit number, plant height and fruits per cluster. Heterosis was appreciable in all hybrids, but was more in four hybrids viz; Sioux × FT-5, S-1001 × Solan Vajr, EC-521041 × FT-5 and S-1001 × EC-15998.

Singh et al. (2012) conducted an experiment with 14 parents and 40 F₁s to study heterosis in brinjal. Crosses showing significant heterosis over the better parent were: HE12 × Aruna for first fruit set; BR-112 × Aruna for fruit length and diameter; Pant Samrat × Punjab Neelam for number of fruits per plant; H-7 × Aruna for fruit weight; H-9 × S-16 for total yield per plant; Negative heterosis were recorded in KT-4 × Aruna for borer and Pant in Rituraj × Punjab Neelam for nematode infestation.

Kumar et al. (2013) evaluated 40 hybrids so to determine the magnitude of heterosis between yield and its attributing traits. In his study the
expression of superiority over the commercial check occurred in 7 crosses, which ranged from 56.36 in (L3 × T4), to 34.07 per cent in (L7 × T2). The hybrid (L7 × T2) had good heterosis values for growth and yield and is recommended as the most promising combination for developing high yielding hybrid eggplant varieties. Most crosses involving T2 as tester parent had significant positive heterosis over the mid-parent and standard variety.

Andrade et al. (20014) reported heterosis in brinjal for yield could be explained by over dominance, but higher yields were only weakly associated with larger frequencies of dominant alleles an indication that yields may be markedly influenced by the action of relatively few loci with over dominant gene action. Heterosis for mean fruit mass was associated with incompletely dominant gene action, and larger fruit mass was associated with larger proportions of dominant alleles. For fruit length/diameter ratio, heterosis was due to incompletely dominant gene action, and dominant alleles were predominantly associated with lower values.

Dubey et al. (2014) got maximum heterosis in brinjal for total yield per plant over better parent in cross KS-314 × IC-90099 (94.72%) followed by KS-314 × PPC (85.10%) concluding that indirect selection for traits such as plant height, long and medium styled flowers per clusters, fruits per plant, fruit length, fruit diameter and primary branches per plant might be done in order to achieve higher yield through heterosis breeding.

Reddy et al. (2014) reported that maximum heterosis for fruit yield per plant was observed in the brinjal followed by the highly significant heterosis for numbers of fruits per cluster while the significant heterosis for average fruit weight. Some of the hybrids showed desirable heterosis for earliness, number of flowers per cluster and phenol content.

Gharge et al. (2016) reported an analysis of hybrid vigour over better parent for fruit yield and yield components and revealed maximum expression of heterosis for yield per plant followed by average fruit weight, plant height,
number of primary branches, pedicel length, length of fruit, number of fruits, fruit girth, fruit breadth and days to 50% flowering in brinjal.

Gene inheritance pattern of major characters in brinjal

The knowledge about the magnitude and behaviour of genetic components for quantitative character being envisaged is very essential for a plant breeder since gene action and effects are the key factors for understanding the inheritance of quantitative traits. Quantitative traits are usually considered to be controlled by multiple genes and are considerably influenced with the interaction of environment.

Gardner (1963) considered ratio of additive to non-additive gene action in order to decide the predominance of the kind of genetic variation for a given character. If the ratio of additive to non-additive gene action is more than unity, it indicates the major role of additive variance in controlling the expression of a character, whereas, less than unity indicates the importance of non-additive variance.

Banerjee and Kalloo (1989) studied the inheritance of earliness and fruit weight in four interspecific crosses of tomato. Two cultivated varieties HS 101 and HS 102 were hybridized with two wild species, *L. birsutum f. glabratum* ‘B 6013’ and *L. pimpinellifolium* ‘A 1921’. Six generations of these crosses were evaluated for these traits and the estimates of gene effects were derived from the generation mean using an epistatic (six parameters) model. There were very wide differences between cultivated and wild species for earliness and fruit weight and in the segregating populations. Plants with delayed maturity and smaller fruit size were recorded with high frequency. It was found that the inheritance pattern was mainly governed by additive gene action. Epistatic effects also contributed towards the inheritance of both traits earliness and fruit weight.

Saha M.C. (1993) studied inheritance for days to flower, plant height, leaf length and leaf breadth in two brinjal varieties *i.e.*, Uttara and
Islampuri. In this study, earliness was observed dominant over lateness but for other characters like plant height, leaf length and leaf breadth partial dominance of higher parental value was observed. Transgressively segregation was observed in all the characters studied except days to flowering suggesting polygenic control of characters. The overall results indicated that there is ample scope for effective selection towards desired direction in developing tall and early varieties of brinjal.

Arshad et al. (2005) studied inheritance of four qualitative characters in four parents (Mash 1, Mash 3, MM 33-40 and MM 45726) of black gram (pubescence, seed coat colour, presence of spots on the seed coat and pod colour). All the four traits revealed monogenic nature of inheritance segregating in mendelian ratio (3:1). The hairiness pattern was observed dominant over non-hairiness; brown seed coat colour dominant over green seed coat colour. Presence of spots on seed coat was dominant to absence of spots and black pods were dominant over brown pods in black gram. Out of three hybrids, two (Mash 1/MM33-40 and 45726/MM33-40) revealed linkage between pod colour vs. presence of spots on seed coat and pod colour vs. seed coat colour that is suggested to be used for preliminary mapping in black gram.

Makani et al. (2007) reported that the single dominant gene was responsible for the inheritance of spiny leaf and two complimentary genes for growth habit and the complimentary genes for fruit bearing habit in brinjal.

Singh et al. (2008) found that additive gene action was responsible for number of fruit/plant, number of locules/fruit and yield/plant in tomato.

Dhameliya and Dobariya. (2009) reported both additive and non-additive gene effects were important for most of the characters in brinjal. The complimentary type of interaction was detected for number of primary branches per plant and in single fruit weight, while duplicate type of epistasis was important for almost all the remaining characters in both the crosses. Simple pedigree selection as well as intermating among the elite segregants in the early
generations followed by delayed selection might be useful in improving the yield levels in brinjal.

Rattan and Chadha (2009) studied gene action in tomato and concluded that for majority of yield attributing traits non-additive gene action were in appreciable magnitude lending credibility to the already well-established practice of exploitation of hybrid vigour in tomato.

Rego (1999) studied a naturally occurring yellow tomato fruit mutant cv. Santa Clara which was reciprocally crossed with the red wild type, after which F₁ plants were self pollinated or backcrossed with both parents. Plants from F₁ generations produced all fruits with a homogeneous deep red color when ripe. F₂ plants showed a 3:1 red : yellow segregation of fruit color, and 100% red when backcrossed with red wild type or 1:1 red:yellow segregation in backcrosses with the yellow mutant; hence, yellow fruit color was determined by a recessive allele. Based on reciprocal crosses, fruit color is unlikely to be determined by maternal genes. Accumulation of lycopene dropped by 99.3% and carotene by 77% in ripe yellow fruits, compared to the red wild type. Leaf and flower chlorophyll and total carotenoid concentrations were not affected by the yellow mutation. However, the mutant fruit had a higher rate of chlorophyll degradation during fruit ripening, while fruit from the F₁ generation showed lower rates of degradation, similar to that observed in red wild type fruits.

Abdelmageed (2010) studied the inheritance of number of pods per plant, number of days to flowering and plant height in two cultivars of okra. Crosses were made between the two parents, and reciprocal F₁’s, F₂’s and all possible backcrosses were derived from the initial crosses. Gene effects, heritability in broad and narrow sense, number of effective factors and genetic advance were determined. No reciprocal differences were found between F₁ and F₂ generation for all the characters studied. Three parameter additive-dominance model utilizing generation means was used to estimate gene effects. The results indicated that most of the genetic variance was accounted by additive and dominance gene effects, with evidence of epistasis. High genetic
variability, high heritability values and genetic gains support the above conclusions regarding the inheritance of characters.

Dharwad et al. (2011) reported that gene action studies showed predominant non-additive gene action for all traits in brinjal. Frequency and magnitude of heterosis was low for number of branches per plant, days to flowering, moderate for number of fruits per plant and high for number of flowers per cluster, number of fruits per cluster and fruit weight (g). High heterosis for yield and yield components viz., number of branches per plant, fruit weight and number of fruits per plant.

Hasanuzzaman M. and Golam F. (2011) studied the genetic component of variation and revealed the importance of non-additive genes which is involved in inheritance of yield and its important components in chilli. The degree of dominance was in range of over dominance range for all the characters and close to complete dominance for plant height. The traits viz. plant height, plant spread, days to first flower, days to 50% flower, number of branches per plant, fruit length and yield showed significant environmental effect. Also for fruit diameter, chlorophyll content, days to 50% flower, number of fruits per plant, fruit weight and fruit length dominant genes was more commonly distributed in the parents.

Hasanuzzaman, M. and Golam, F. (2011) studied gene action for yield and yield contributing traits in Chilli (*Capsicum annuum* L.) in four selected crosses, involving five parents, including their F1's, F2's and first back crosses generations. The significant scaling tests (one or more scales in A, B and C) and joint scaling test indicated the presence of digenic epistasis for all the studied traits. Number of fruits and yield per plant were controlled by additive, dominance and epistatic gene action. Complex genetic behaviour was observed in all traits. Since the segregating generations did not follow a simple Mendelian inheritance, high selection pressure is expected in later generations due to probable successful exploitation of additive and dominance components. From these observations it was suggested that the selection for the improvement
of all traits, particularly yield per plant, should be delayed to the later generations of segregating population in this plant. The modified bulk method of selection is recommended, in which selection is performed after attaining the homozygosity for maximum heterozygous loci. Presence of complementary gene action and prevalence of the high magnitude of non-additive gene effects were found in most of the traits, indicating that heterosis breeding is more effective with high potential in chilli.

Akhtar and Hazra (2013) studied the gene action in tomato and revealed that fruit quality characters were controlled by both additive and non-additive gene, with the non-additive gene effects being more important for improving fruit quality characters.

Lachyan and Dalvi (2013) studied inheritance of four qualitative characters *i.e.* growth habit, flower colour, seed coat colour and seed coat colour pattern) and four quantitative characters *i.e.* pod length (cm), number of pods/plant, number of seeds/pod and seed size (g) in cow pea. The qualitative characters were studied using chi-square test. Out of four qualitative traits, growth habit, flower colour and seed coat colour pattern revealed monogenic nature of inheritance segregating in Mendelian ratio (3:1) and seed coat colour was inherited digenically indicating dominant epistasis (12:3:1). Joint segregation was studied and linkage was revealed only between seed coat colour and seed coat colour pattern. The quantitative characters were studied by comparison of range, mean, standard deviation, and coefficient of variation in parents, **F**<sub>1</sub> and **F**<sub>2</sub> generation. The amount of variability generated in **F**<sub>2</sub> for number of grains/pod was more than both the parents. This result can be used for further selection of plant progenies for crop improvement programme. The **P**1 **P**2 **F**<sub>1</sub> and **F**<sub>2</sub> generations of **H** 7 variety (**P**1) as female parent with four male parents (**P**2) *viz*; **PLR** 1, **GBL** 1, Green round and **GCL** 99-1 were studied for six districts morphological characters *viz*; growth habit, fruit bearing habit, fruit shape, fruit colour, seedling colour and spiny leaf. The single dominant gene was responsible for inheritance of spiny leaf, and possibly two complimentary
genes for growth habit and three complimentary genes for fruit bearing habit were indicated in the present study. The ratio of 162: 94, 45: 19 and 27: 37 for fruit shape; 3: 1, 57: 7 and 54: 10 for fruit colour and 9: 7, 54: 10 and 162: 94 for seedling colour indicated complex nature of inheritance for these characters and the differences in segregation pattern might be due to the presence of variety number of genes among the parental lines used in the study.

Deshmukh et al. (2014) reported that degree of dominance was in range of over dominance for all the characters and close to complete dominance for plant height in brinjal. The traits viz; plant height, plant spread, days to first flowering, days to 50% flowering, number of branches per plant, fruit length and yield exhibited significant environmental effect. For fruit diameter, chlorophyll content, days to 50% flowering, number of fruits per plant, fruit weight and fruit length dominant genes were more frequently distributed in the parents.

Kadams et al. (2015) selected five cultivars of okra qualitative characters. Crosses were made among these cultivars based on some of these characters to generate the F1S and F2 generation was raised. The chi-square test of goodness to fit for F2 data in the result table gave 1:2:1 ratio for colour and fruit hairiness indicating co-dominance gene control for these characters. For fruit structure, it was observed in the F1 that ridge character is control by two dominant genes, the fruits are completely ridged when both the dominant genes are present in homozygous condition and in the presence of both the recessive genes the fruits are round, and the blending of the two genes is indicated by heterozygosity. The F2 generation segregate in the ratio of 15:1, indicating duplicate dominant gene epistasis. This study also revealed a monogenic pattern of inheritance for fruit pigmentation with the pigmented parent dominant over the non-pigmented parent.

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CHAPTER III

MATERIALS AND METHODS
The details of experimental materials and method employed in the present investigation entitled “Study of inheritance pattern of major traits in brinjal (*Solanum melongena* L.)” is as follows:

### 3.1 Experimental site and location

The field experiment was conducted at Vegetable Research Farm, BAU, Sabour, Bhagalpur. The experimental plot had well drained sandy loam soil of good fertility with leveled surface. The pH of soil under study was 7.2. The experimental plot had the facility of tube-well irrigation located in the adjacent of Maize section. All the biochemical analysis was conducted in well-equipped laboratory of Department of Horticulture (Vegetable and floriculture) and Department of Food Science and Technology.

### 3.2 Environmental conditions

BAU is situated in the suburb of Bhagalpur district. It lies on the latitude of 25° 15’ 40” North and longitude of 80° 2’ 42” east with an altitude of 46 meter above mean sea level in the heart of vast Indo-Gangetic plains of north India. The climate of this place is tropical to sub-tropical parts with slightly semi-arid nature and is characterized by very dry summer, moderate rainfall and very cold winter. December and January are usually the coldest month when the mean temperature normally falls as low as 8.5°C whereas May and June are recorded to be the hottest months, having the maximum average temperature of 35.92°C. The rainfall is mostly distributed from middle of June to middle of October. The distribution of rainfall has also been erratic thereby adversely affecting the crops and increasing disease and pest intensity. During growing season the maximum and minimum temperatures were recorded to be around 32.65°C and 8.6°C, respectively. The prevailing weather conditions during crop season were recorded in terms of temperature, relative humidity and rainfall from the meteorological observatory, Agricultural Research Institute, Sabour and have been presented in Table 1.

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<td>Max.</td>
<td>Mini.</td>
<td>7.00 am.</td>
<td>2.00 pm.</td>
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Table 3.1: Meteorological data (2016 -17)
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<th>3</th>
<th>4</th>
<th>5</th>
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<td>73.5</td>
<td>4.8</td>
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<td>26.2</td>
<td>88.7</td>
<td>74.1</td>
<td>2.2</td>
<td>6.7</td>
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<td>24.6</td>
<td>91.4</td>
<td>84.4</td>
<td>147.3</td>
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<td>88.8</td>
<td>76.4</td>
<td>10</td>
<td>5.5</td>
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<td>16-22 Sep.</td>
<td>31.6</td>
<td>24.3</td>
<td>90.7</td>
<td>80</td>
<td>42.4</td>
<td>6.9</td>
</tr>
<tr>
<td>23-29 Sep.</td>
<td>30</td>
<td>23.7</td>
<td>89.1</td>
<td>82.7</td>
<td>120.4</td>
<td>5.6</td>
</tr>
<tr>
<td>30-6 Oct.</td>
<td>32.5</td>
<td>25.1</td>
<td>85.8</td>
<td>74.2</td>
<td>23.2</td>
<td>3.2</td>
</tr>
<tr>
<td>7-13 Oct.</td>
<td>30.9</td>
<td>23.9</td>
<td>91.7</td>
<td>76.7</td>
<td>8.6</td>
<td>4.4</td>
</tr>
<tr>
<td>14-20 Oct.</td>
<td>32.2</td>
<td>20.1</td>
<td>86.8</td>
<td>60</td>
<td>0</td>
<td>1.7</td>
</tr>
<tr>
<td>21-27 Oct.</td>
<td>30.9</td>
<td>19.5</td>
<td>89.8</td>
<td>62.1</td>
<td>0</td>
<td>1.9</td>
</tr>
<tr>
<td>28-3 Nov.</td>
<td>30.5</td>
<td>18.8</td>
<td>89.7</td>
<td>64.4</td>
<td>0</td>
<td>2.2</td>
</tr>
<tr>
<td>4-10 Nov.</td>
<td>30.6</td>
<td>16.1</td>
<td>86.8</td>
<td>60.7</td>
<td>0</td>
<td>2.2</td>
</tr>
<tr>
<td>11-17 Nov.</td>
<td>29.2</td>
<td>13.7</td>
<td>92</td>
<td>50.4</td>
<td>0</td>
<td>2.3</td>
</tr>
<tr>
<td>18-24 Nov.</td>
<td>27.8</td>
<td>11.8</td>
<td>92</td>
<td>47.7</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>25-1 Des.</td>
<td>27</td>
<td>12.6</td>
<td>91.5</td>
<td>62.1</td>
<td>0</td>
<td>1.2</td>
</tr>
<tr>
<td>2-8 Des.</td>
<td>24.4</td>
<td>11.6</td>
<td>95.7</td>
<td>72.4</td>
<td>0</td>
<td>3.4</td>
</tr>
<tr>
<td>9-15 Des.</td>
<td>18.7</td>
<td>7.9</td>
<td>97.2</td>
<td>75.4</td>
<td>0</td>
<td>5.5</td>
</tr>
<tr>
<td>16-22 Des.</td>
<td>23.2</td>
<td>8.1</td>
<td>94.7</td>
<td>59.2</td>
<td>0</td>
<td>2.9</td>
</tr>
<tr>
<td>23-29 Des.</td>
<td>23.8</td>
<td>10.7</td>
<td>95.5</td>
<td>70</td>
<td>0</td>
<td>3.2</td>
</tr>
<tr>
<td>1-7 Jan.</td>
<td>21.1</td>
<td>8.6</td>
<td>98.2</td>
<td>76</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8-14 Jan.</td>
<td>21.3</td>
<td>7.9</td>
<td>95.5</td>
<td>60.5</td>
<td>0</td>
<td>2.9</td>
</tr>
<tr>
<td>15-21 Jan.</td>
<td>22.6</td>
<td>6</td>
<td>93.2</td>
<td>48.2</td>
<td>0</td>
<td>3.2</td>
</tr>
<tr>
<td>22-28 Jan.</td>
<td>25.2</td>
<td>8.2</td>
<td>91.4</td>
<td>58.5</td>
<td>12.4</td>
<td>3.4</td>
</tr>
<tr>
<td>29-4 Feb.</td>
<td>22.1</td>
<td>7.8</td>
<td>97.7</td>
<td>63.1</td>
<td>0</td>
<td>4.6</td>
</tr>
<tr>
<td>5-11 Feb.</td>
<td>26</td>
<td>7.6</td>
<td>89.4</td>
<td>50.5</td>
<td>0</td>
<td>3.8</td>
</tr>
<tr>
<td>12-18 Feb.</td>
<td>26.7</td>
<td>9.4</td>
<td>87.5</td>
<td>46</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>19-25 Feb.</td>
<td>28.4</td>
<td>11.4</td>
<td>87</td>
<td>44.2</td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>26-4 Mar.</td>
<td>29.1</td>
<td>13.4</td>
<td>82.8</td>
<td>36</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5-11 Mar.</td>
<td>28.9</td>
<td>12.9</td>
<td>84.5</td>
<td>53.2</td>
<td>3.2</td>
<td>3.6</td>
</tr>
<tr>
<td>12-18 Mar.</td>
<td>28.4</td>
<td>11.9</td>
<td>83</td>
<td>49.5</td>
<td>0.6</td>
<td>4</td>
</tr>
<tr>
<td>19-25 Mar.</td>
<td>30.3</td>
<td>16.4</td>
<td>87.5</td>
<td>56.1</td>
<td>5.9</td>
<td>4.3</td>
</tr>
<tr>
<td>26-1 April.</td>
<td>31.5</td>
<td>21.5</td>
<td>94.2</td>
<td>67.4</td>
<td>0</td>
<td>5.7</td>
</tr>
<tr>
<td>2-8 April</td>
<td>32.9</td>
<td>21.7</td>
<td>92.5</td>
<td>64.2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>9-15 April</td>
<td>36.8</td>
<td>19.8</td>
<td>64</td>
<td>34.4</td>
<td>0</td>
<td>6.1</td>
</tr>
</tbody>
</table>

**Experimental details**

<table>
<thead>
<tr>
<th>Design</th>
<th>RBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of replications</td>
<td>03</td>
</tr>
<tr>
<td>Number of parents</td>
<td>5</td>
</tr>
</tbody>
</table>
Total number of hybrids including reciprocal 8
Planting spacing 75 cm × 60 cm
Check Varieties Arka Anand and Pusa hybrid -6
Plot size 3m x 2.4 m
Number of plant per plot 16
Sowing season Autumn-winter, 2016-17

3.3 Experimental Materials

3.3.1 Hybridization and selfing programme

Each of the five parents were crossed randomly during winter 2016-17 to produce 8 hybrids. The healthy flower buds from new flush, which were about to open next day, were selected for emasculation and pollination. The selected buds were emasculated by hand using forceps in the evening hours between 4.00 pm to 6.00 pm. Emasculated flowers were covered with red coloured butter paper bags to avoid contamination by foreign pollen. Pollination of the emasculated flowers was done next day morning during anthesis time (7.30 am to 10.30 am). Well opened flowers with dehisced anthers were collected from the male parents, the butter paper bag was removed carefully and the stigma was touched with dehisced anthers of male flowers. The female flower was covered with white coloured butter paper bag immediately for easy identification and further avoiding the contamination from other pollen. The pedicel of each pollinated flowers was tied with label, bearing information of female and male parents and date of crossing for identification. Selfing was done in already existing four hybrids to develop F2 segregating population

Table 3.2: List of parental lines, checks and their origin:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Selected lines for crossing</th>
<th>Codes</th>
<th>Source</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rajendra Baigan-2</td>
<td>P1</td>
<td>BAU, Sabour</td>
<td>Plant medium stature, fruits are soft, long, uniform</td>
</tr>
</tbody>
</table>
Plant type is of spreading type, fruits are soft, oblong, uniform dark purple with very few seeds.

Fruits are round, uniform dark blackish purple

Fruits are purple with green stripes towards apex, ovalish round in shape

Fruits are green with white stripes, oblong

3.4 Other materials:

Other materials consisting of field implements and tools, FYM, plant protection chemicals, pan balance, chemical balance, digital Vernier calliper, metre scale and different chemicals were utilised as and when necessary.

3.5 Agronomical practices

3.5.1 Crop husbandry

Farm yard manure was thoroughly mixed in the soil at the time of field preparation. The fertilizer dose NPK is applied in the field in the ratio 100:80:60 kg/ha. The complete dose of phosphatic and potassic fertilizers and one third dose of nitrogenous fertilizers were given at last ploughing. The remaining dose of nitrogenous fertilizer was applied in two split doses as top dressing at one and two months after transplanting. Recommended plant protection measures were followed during the course of experimentation to raise a good crop.

3.5.2 Transplanting of seedlings
Nursery bed was irrigated a day prior to uprooting in order to facilitate easy uprooting of seedlings. Well developed, healthy and uniform seedlings attaining an age of 35 days, of each line were uprooted from the nursery and transplanted in experimental plot in the evening. Transplanting was followed by irrigation with the help of watering can for 5 days in the morning till the plants established properly. Transplanting of seedlings was accomplished on.

3.5.3 Gap filling

The plants were carefully observed from the second day of transplanting. The sign of permanent wilting and the advent of new growth were considered as indications of mortality and survival respectively. Very few gaps filling was done by transplanting uniform, healthy and well developed seedling of same age in each plot with same line and sufficient care was taken for their proper establishment. However, plants transplanted later in the gaps were not included for detailed study.

3.5.4 Tagging of plants for studies

For the sake of recording the data, 5 plants were randomly selected in each plot excluding the border in each replication and they were tagged and numbered. Observations were then recorded at different intervals on the following aspects.

3.6 Observations recorded

Observations were recorded on five randomly selected plants from each genotype in every replication, summed up and divided by five to get mean value. The procedure is described under the respective sub-heads.

3.6.1 Morphological quantitative data.

1. Days to first flowering
Days to first flowering was considered as a number of days from the date of transplanting to the opening of first flower on any of the single plant per plot.

2. Days to 50 % flowering

Days to 50 % flowering was considered as a number of days from the date of transplanting to the opening of first flower on the 50 % plants per plot.

3. Days to first fruit set

Days to first fruit set was considered as number of days taken to attain first fruiting from transplanting.

4. Plant height (cm)

The plant height was measured in centimetre from the base to the top of plant at time of last picking of the fruits by a meter scale.

5. Plant spread (cm$^2$)

The plant spread was measured in centimetre from one end of the plant to the other in both north - south and east - west direction by using a meter tape.

6. Number of primary branches/ plant

The number of branches was counted during peak fruiting stage of the tagged plant and then their average is recorded.

7. Fruit length (cm)

The fruit length was measured with the help of a meter scale when it reached edible maturity.

8. Fruit girth (cm)

The fruit girth was measured with the help of digital Vernier calliper when it reached edible maturity.

9. Fruit weight (g)
At second picking 5 randomly selected fruits were taken from the harvested fruits in each replication and weighed on a pan balance. The total weight was divided by number of fruits and their weight was recorded in gram.

10. **Number of fruits per plant**

The total number of fruits from five randomly selected plants up to last picking was recorded and divided by five to get the number of fruits per plant.

11. **Fruit yield per plant (g)**

The fruits of selected plants were harvested at the edible maturity stage at weekly intervals. Treatment and replication wise weight of fruits were taken with pan balance. The total weight of fruit/plant at all the harvest was recorded and then their average was calculated.

3.6.2 **Morphological qualitative data for documentation of parents and hybrids:**

1. **Leaf blade colour**: Light green/ Green/ Dark green/ Greenish violet/ Violet
2. **Leaf pubescence**: Dense/ Sparse
3. **Number of leaf prickles on upper surface**: None/ Few/ Many
4. **Corolla colour**: White/ Greenish white/ Pale violet/ Light violet/ Bluish violet
5. **Calyx colour**: Green/ Light purple/ Dark purple
6. **Calyx spininess**: Smooth/ Medium thorny/ Highly thorny
7. **Plant growth habit**: Intermediate/ Spreading/ Erect
8. **Fruit pedicel prickles**: None/ Few/ Many
9. **Fruit shape**: Round/ Oblong/ Long/ Oval
10. **Fruit colour**: Dark purple/ Purple/ Light purple/ Light green/ Dark green/ White
11. **Seediness**: Low/ Medium/ High

3.7 **Experimental details**
The investigation was statistically laid out in the Randomized Block Design (RBD) with five parents, eight hybrids replicated thrice planted at a spacing of 75 cm × 60 cm, with 16 plants per replication. 100 plants per F₂ population were planted at 60 cm × 60 cm spacing.

3.8 STATISTICAL ANALYSIS

3.8.1 ANALYSIS OF VARIANCE

The data were subjected to the analysis of variance for randomized block design as suggested by Panse and Sukhatme (1967) partitioning the total variance into that due to replications and treatments for all the characters. The following table represents the expectations of the variance and the appropriate degree of freedom in each case.

Table 3.3: Variance with appropriate degree of freedom

<table>
<thead>
<tr>
<th>SV</th>
<th>DF</th>
<th>SS</th>
<th>MSS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>(r-1)</td>
<td>Sr</td>
<td>Mr</td>
<td>Mr/Me</td>
</tr>
<tr>
<td>Treatment</td>
<td>(t-1)</td>
<td>St</td>
<td>Mt</td>
<td>Mt/Me</td>
</tr>
<tr>
<td>Error</td>
<td>(r-1) (t-1)</td>
<td>Se</td>
<td>Me</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>(rt-1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where,

- r = Number of replications
- t = Number of treatments
- Mr = Mean square of replication
- Mt = Mean square of treatments
- Me = Mean square of errors

Statistical significance was carried out by ‘F’ test. Further, statistical analysis was worked out as per Griffing (1956) and Hayman (1954).

3.8.2 Degrees of dominance using the potency - ratio method (Romero and Frey, 1970)
The degrees of dominance, \( h_1 \) and \( h_2 \) derived for the traits in \( F_1 \) and \( F_2 \) populations respectively were calculated using the potence-ratio method. The magnitude of heterosis was calculated as the difference between the value of \( F_1 \) and that of its better parent and top parent for each character.

\[
h_1 = \frac{(F_1 - MP)}{D}
\]

\[
h_2 = \frac{(F_2 - MP)}{D}
\]

Here, \( D = P_1 - MP \) where \( P_1 \) is larger parent, \( MP \) is mid parent value.

Heterosis over mid parent value (\( H_1 \)) in \( F_1 \) was calculated by

\[
H_1 = \frac{F_1 - MP}{MP} \times 100 \quad \text{where, MP is mid parent value}
\]

Heterosis over mid parent value (\( H_2 \)) in \( F_2 \) was calculated by

\[
H_2 = \frac{F_2 - MP}{MP} \times 100 \quad \text{where, MP is mid parent value.}
\]

The significance of heterosis was ascertained by critical difference (CD) values calculated as follows:

\[
CD = \sqrt{2 \times \frac{\text{MSe}}{r}} \times t \text{ value}
\]

Where,

- \( \text{MSe} \) = Mean sum square for error
- \( r \) = Number of replications
- \( t \) = Table t value at 5% or 1% probability level at error degree of freedom

The significance was tested at 5 percent and 1 percent probability level at the degrees of freedom for error given in the Analysis of Variance.
Table. The heterosis was expressed as percentage increase over better parent and top parent.

3.8.3 Theoretical arithmetic and geometric means of $F_1$ and $F_2$ (Paul, 1978)

The theoretical arithmetic and the geometric means were calculated as:

Theoretical arithmetic mean of $F_1 = \frac{P_1 + P_2}{2}$

Theoretical arithmetic mean of $F_2 = \frac{P_1 + 2F_1 + P_2}{4}$

Theoretical Geometric mean of $F_2 = \text{Antilogarithm of } \left[\frac{\log P_1 + 2 \log F_1 + \log P_2}{4}\right]$  

3.8.4. Chi-square test

The segregation pattern of the qualitative characters, viz., fruit shape, presence of shoulder, pedicel character, stem pigmentation and fruit ribbing will be analyzed by the chi-square test. For each character, we expect the $F_2$ to segregate in a certain ratio which is considered as the null hypothesis. Accordingly, the expected (e) value is calculated. The corresponding observed value being o.

$$\chi^2 = \Sigma [(o-e)^2 / e]$$

The probability (p) at degrees of freedom (n – 1) is recorded from the statistical table, where n is the number of phenotypes obtained in the $F_2$ segregating generation. If the ‘p’ value is greater than 0.05 at the respective degrees of freedom, then the null hypothesis is accepted. If the ‘p’ value is lesser than 0.05 at respective degrees of freedom, then the null hypothesis is rejected.

CHAPTER IV

RESULT
4.4.1 Heterosis

Heterosis is superiority of F₁ hybrid over its parent. Shull (1908) referred this phenomenon as the stimulus of heterozygosis. Generally the term hybrid vigour is used to denote heterosis in the desirable direction. The heterosis over mid parent, better parent and standard check are designated as average heterosis, heterobeltiosis, and standard heterosis respectively. In practical plant breeding, superiority of F₁ over mid parent is of little value since it does not offer any advantage. However the exploitation of hybrid would primarily depend on its performance in comparison to the best existing commercial hybrids/varieties (standard heterosis). Heterosis breeding provides opportunity for improvement in productivity, earliness, uniformity, quality and resistance to diseases and pests.

4.4.1.1 Heterosis for plant growth characters

4.4.1.1.1 Primary branches/plant

The range of relative heterosis and better parent heterosis for primary branches was from -16.85% to 26.25% and from -35.78% to 25.04%, respectively in between Swarnamani × Rajendra Baigan-2 and Rajendra Baigan-2 × Muktakeshi crosses (Table 4.1). Standard heterosis for Pusa Hybrid-6 ranged from -6.89% to 20.68 % and for Arka Anand it ranged from -10% to 16.66% in between Muktakeshi × Rajendra Baigan-2 and Rajendra Baigan-2 × Muktakeshi. Maximum positive heterosis over the mid parent (26.25%) and over the better parent (25.04%) was recorded in the hybrid Rajendra Baigan-2 × Muktakeshi. Standard heterosis for Pusa Hybrid-6 was (20.68 %) and for Arka Anand (16.66%) was recorded in Rajendra Baigan-2 × Muktakeshi. Among the 8 F₁s, 2 crosses showed significantly positive heterosis over the mid parents, 1 showed significant positive heterosis over the better parent, while 4 showed significantly positive heterosis over the standard check Pusa Hybrid-6 and 1 showed significantly positive heterosis over the standard check Arka Anand (Table 4.1).

4.4.1.1.2 Plant height
For plant height, the extent of relative heterosis varied from -4.52% (Muktakeshi × Rajendra Baigan-2) to 19.06% (Rajendra Baigan-2 × Swarnamani). Heterosis over better parent ranged from -11.73% (BRBL-01 × Rajendra Baigan-2) to 12.00% (Rajendra Baigan-2 × Swarnamani), while standard heterosis for Pusa Hybrid-6 ranged between 13.46% to 43.98% and for Arka Anand it ranged from -2.01% to 24.34% in BRBL-01 × Rajendra Baigan-2 and Rajendra Baigan-2 × Swarnamani crosses, respectively. Maximum positive heterosis over the mid parent (19.06%) and over the better parent (12.00%) was recorded in the hybrid Rajendra Baigan-2 × Swarnamani. Maximum positive heterosis was recorded in Rajendra Baigan-2 × Swarnamani (43.98%) for Pusa Hybrid-6 and 24.34% for Arka Anand. Among the 8 F₁ hybrids, 2 showed significantly positive heterosis over the mid parents, no cross showed significant positive heterosis over the better parent while 4 crosses showed significantly positive heterosis over the standard check Pusa Hybrid-6 and 2 cross showed significantly positive heterosis over the standard check Arka Anand (Table 4.1).

4.4.1.1.3 Plant spread

For plant spread the range of heterosis varied from -15.62% (Swarnamani × Rajendra Baigan-2) to 14.74% (BRBL-01 × Rajendra Baigan-2) over the mid parent. The heterobeltiosis for this trait ranged between -33.88% (Swarnamani × Rajendra Baigan-2) to 10.23% (BRBL-01 × Rajendra Baigan-2), while the standard heterosis for Pusa Hybrid-6 varied from 2.14% to 31.05% and for Arka Anand 17.02% to 50.15% in between Rajendra Baigan-2 × BRBL-01 and Rajendra Baigan 2 × Muktakeshi cross. Maximum positive heterosis over the mid parent (14.74%) and over the better parent (10.23%) was recorded in the hybrid BRBL-01 × Rajendra Baigan-2 (Table 4.1). Standard heterosis was recorded in Rajendra Baigan-2 × Muktakeshi (31.05 %) for Pusa Hybrid 6 and 50.15% for Arka Anand. Among the 8 F₁ hybrids, 1 showed negative heterosis in desirable direction over mid parent, 4 showed negative heterosis over the better parent while 2 showed significantly positive heterosis
over the standard variety i.e., Pusa Hybrid-6 and 6 crosses showed significantly positive heterosis over the standard variety i.e. Arka Anand (Table 4.1).

4.4.1.2 Heterosis for fruit characters

4.4.1.2.1 Fruit length

The range of relative heterosis for fruit length was from -36.23% (Muktakeshi × Rajendra Baigan2) to -11.45% (Rajendra Baigan-2 × BRBR-01), and that of heterobeltiosis was from -47.01% (Muktakeshi × Rajendra Baigan-2) to -34.46% (Rajendra Baigan-2 × Muktakeshi) (Table 4.2).

Standard heterosis for Pusa Hybrid-6 it ranged from 20.87% (Muktakeshi × Rajendra Baigan-2) to 49.51 % (Rajendra Baigan-2 × Muktakeshi) and for Arka Anand it ranged from 21.42% (Rajendra Baigan-2 × Muktakeshi) to 36.47% (Muktakeshi × Rajendra Baigan-2). Maximum positive heterosis over the mid parent has been found in Rajendra Baigan 2 × BRBR-01 (-11.45%), whereas, the heterosis over the better parent was recorded in the hybrid Rajendra Baigan-2 × Muktakeshi (-34.46%) and that over the standard check was recorded in 49.51 % (Rajendra Baigan 2 × Muktakeshi) for Pusa Hybrid-6 and 36.47% (Muktakeshi × Rajendra Baigan-2) for Arka Anand. Among the 8 F1 hybrids, 6 crosses showed significantly negative heterosis over the mid parents, all showed significant negative heterosis over the better parent, while 6 crosses showed significantly positive heterosis over the standard parent Pusa Hybrid-6 and no cross showed significantly positive heterosis over the standard parent Arka Anand (Table 4.2).

4.4.1.2.2 Fruit Girth

The range of relative heterosis for fruit girth was from -30.94% (Rajendra Baigan-2 × Swarnamani) to -14.96% (BRBR-01 × Rajendra Baigan-2) and that of heterobeltiosis was from -47.52% (Rajendra Baigan-2 × Swarnamani) to -25.98% (BRBR-01 × Rajendra Baigan-2), whereas for
standard heterosis for Pusa Hybrid-6 it ranged from -42.12% (Rajendra Baigan-2 × BRBL-01) to -24.02% (Swarnamani × Rajendra Baigan-2) and for Arka Anand it ranged from 39.73% (Rajendra Baigan-2 × BRBL-01) to 83.44% (Swarnamani × Rajendra Baigan-2). Maximum negative heterosis over the mid parent (-14.96%) and over the better parent (-25.98%) was recorded in BRBR-01 × Rajendra Baigan-2 and that over the standard check was recorded -24.02% (for Pusa Hybrid-6) and 83.44% (for Arka Anand) in Swarnamani × Rajendra Baigan-2. Among the 8 F₁s, all showed significantly negative heterosis over the mid parents, better parent and standard check Pusa Hybrid-6, whereas all crosses showed significantly positive heterosis over the standard check Arka Anand (Table 4.2).

4.4.1.3 Heterosis for earliness

4.4.1.3.1 First flowering

The range of relative heterosis for first flowering was from -17.88% (Muktakeshi × Rajendra Baigan-2) to 3.20% (Rajendra Baigan 2 × BRBL-01), and that of heterobeltiosis was from -23.92% (Muktakeshi × Rajendra Baigan-2) to -6.13% in five crosses (Rajendra Baigan -2 × Muktakeshi), (Rajendra Baigan 2 × BRBL-01), (BRBL-01 × Rajendra Baigan-2), (Rajendra Baigan-2 × Swarnamani) and (Swarnamani × Rajendra Baigan-2). Standard heterosis for Pusa Hybrid-6 ranged from 0% (Muktakeshi × Rajendra Baigan-2) to 23.38% (Rajendra Baigan -2 × Muktakeshi) and for Arka Anand it ranged from -12.05% (Muktakeshi × Rajendra Baigan-2) to 8.51% (Rajendra Baigan-2 × Muktakeshi). Maximum negative heterosis over the mid parent has been found in Muktakeshi × Rajendra Baigan-2 (-17.88%), whereas, negative heterosis over the better parent (-6.13%) was recorded in five crosses (Rajendra Baigan-2 × Muktakeshi), (Rajendra Baigan-2 × BRBL-01), (BRBL-01 × Rajendra Baigan-2), (Rajendra Baigan-2 × Swarnamani) and (Swarnamani × Rajendra Baigan-2). Standard heterosis was recorded in 23.38% (Pusa Hybrid -6) and 8.51% (Arka Anand) in Rajendra Baigan-2 × Muktakeshi (Table 4.3). Among the 8 F₁ hybrids, 2 crosses showed significantly negative heterosis over the mid parents,
3 showed significant negative heterosis over the better parent, while 2 showed significantly positive heterosis over the standard variety i.e., Pusa Hybrid-6 and no crosses showed significantly positive heterosis over the standard variety i.e., Arka Anand (Table 4.3).

### 4.4.1.3.2 Days taken to 50% flowering

The range of relative heterosis for days taken to 50% flowering was from -18.84% (Rajendra Baigan-2 × BRBR-01) to 2.12% (Rajendra Baigan-2 × BRBL-01), and that of heterobeltiosis was from -22.22% (Rajendra Baigan-2 × BRBR-01) to 0% (Rajendra Baigan-2 × BRBL-01), whereas for standard heterosis for Pusa Hybrid-6 it ranged from 0% (Rajendra Baigan-2 × BRBR-01) to 28.57% (Rajendra Baigan-2 × BRBL-01) and for Arka Anand it ranged from -17.24% (Rajendra Baigan-2 × BRBR-01) to 6.40% (Rajendra Baigan-2 × BRBL-01) (Table 4.3). Maximum positive heterosis over the mid parent was 2.12% and over the better parent was 0% in the hybrid Rajendra Baigan-2 × BRBL-01. Standard heterosis was recorded in 28.57% (Pusa Hybrid-6) and 6.40% (Arka Anand) in the same cross (Rajendra Baigan-2 × BRBL-01). Among the 8 F₁ hybrids, 5 cross showed significantly negative heterosis over the mid parents, 5 showed significant negative heterosis over the better parent, while 3 showed significantly positive heterosis over the standard variety i.e., Pusa Hybrid-6 and 5 showed significantly negative heterosis over the standard variety i.e. Arka Anand (Table 4.3).

### 4.4.1.3.3 Days taken to first fruit set

The range of relative heterosis for first fruit set was from -15.44% (Rajendra Baigan-2 × BRBR-01) to 1.78% (Rajendra Baigan-2 × Muktakeshi), and that of heterobeltiosis was from -15.22% (Rajendra Baigan-2 × BRBR-01) to 1.52% (Rajendra Baigan-2 × Muktakeshi), whereas for standard heterosis for Pusa Hybrid-6 it ranged from -17.73% to -1.47% and for Arka Anand it ranged from -18.93% to -4.36% in between Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × BRBL-01 cross. Maximum positive heterosis over the mid parent has been 1.78% and the heterosis over the better parent was recorded
1.52% in cross Rajendra Baigan-2 × Muktakeshi. Heterosis over the standard check was recorded -1.47% (Rajendra Baigan-2 × Muktakeshi) for Pusa Hybrid-6 and -4.36% (BRBL-01 × Rajendra Baigan-2) for Arka Anand. Among the 8 F₁ hybrids, 4 crosses showed significantly negative heterosis over the mid parents, 4 showed significant negative heterosis over the better parent. While 4 showed significantly negative heterosis over the standard variety i.e., Pusa Hybrid-6 and 5 showed significantly negative heterosis over the standard variety i.e. Arka Anand (Table 4.3).

4.4.1.4 Heterosis for yield attributing traits

4.4.1.4.1 Average fruit weight

The range of relative heterosis for average fruit weight was from -19.79% (BRBR-01 × Rajendra Baigan-2) to 9.61% (Rajendra Baigan-2 × Swarnamani) and that of heterobeltiosis was from -38.43% (Rajendra Baigan-2 × Muktakeshi) to -4.81% (BRBL-01 × Rajendra Baigan-2) whereas, for standard heterosis for Pusa Hybrid-6 it ranged from -35.15% (Rajendra-Baigan-2 × BRBL-01) to 17.27% (Rajendra Baigan-2 × Swarnamani) and for Arka Anand it ranged from 13.65% (Rajendra Baigan-2 × BRBL-01) to 105.55% (Rajendra Baigan-2 × Swarnamani). Maximum positive heterosis over the mid parent has been found in Rjendra Baigan-2 × Swarnamani (9.61%), whereas, the maximum positive heterosis over the better parent was absent in all the crosses. Maximum standard heterosis (17.27%) for Pusa Hybrid-6 and 105.55% for Arka Anand was recorded in (Rajendra Baigan-2 × Swarnamani). Among the 8 F₁ hybrids, 3 crosses showed significantly negative heterosis over the mid parents, 7 crosses showed significant negative heterosis over the better parent while 1 cross showed significantly positive heterosis over the standard variety i.e., Pusa Hybrid-6 and 7 crosses showed significantly positive heterosis over the standard variety i.e. Arka Anand(Table 4.4).

4.4.1.4.2 Yield/ plant
The range of relative heterosis for yield / plant was from -15.51\% (Rajendra Baigan-2 × BRBL-01) to 49.33\% (Rajendra Baigan-2 × BRBR-01), and that of heterobeltiosis was from -23.43\% (Rajendra Baigan-2 × BRBL-01) to 25.31\% (Rajendra Baigan-2 × BRBR-01), whereas for standard heterosis for Pusa Hybrid-6 it ranged from 38.79\% (Muktakeshi × Rajendra Baigan-2) to 86.26\% (Rajendra Baigan-2 × BRBR-01) and for Arka Anand it ranged from -4.95\% (Muktakeshi × Rajendra Baigan-2) to 27.55\% (Rajendra Baigan-2 × BRBR-01). Maximum positive heterosis over the mid parent (49.33\%) and over the better parent (25.31\%) was recorded in the hybrid Rajendra Baigan-2 × BRBR-01 and that over the standard checks was recorded in 86.26\% (for Pusa Hybrid 6) and 27.55\% (for Arka Anand) in Rajendra Baigan-2 × BRBR-01. Among the 8 F₁ hybrids, 4 crosses showed significantly positive heterosis over the mid parents, 1 cross showed significant positive heterosis over the better parent. While all showed significantly positive heterosis over the standard variety i.e. Pusa Hybrid-6 and 3 showed significantly positive heterosis over the standard variety i.e. Arka Anand (Table 4.4).

4.4.1.4.3 Fruit /plant

The range of relative heterosis for fruit/plant was from -1.90\% (Muktakeshi × Rajendra Baigan-2) to 53.91\% (BRBR-01 × Rajendra Baigan-2), and that of heterobeltiosis was from -29.05\% (Muktakeshi × Rajendra Baigan-2) to 9.05\% (BRBR-01 × Rajendra Baigan-2), whereas for standard heterosis for Pusa Hybrid-6 it ranged from 26.61\% (Muktakeshi × Rajendra Baigan-2) to 114.01\% (Rajendra Baigan-2 × BRBL-01) and for Arka Anand it ranged from -50.47\% (Muktakeshi × Rajendra Baigan-2) to -16.28\% (Rajendra Baigan-2 × BRBL-01). Maximum positive heterosis over the mid parent has been found in BRBR-01 × Rajendra Baigan-2 (53.91\%) whereas, the heterosis over the better parent was recorded in the same hybrid BRBR-01 × Rajendra Baigan-2 (9.05\%) and that over the standard check was recorded in Rajendra Baigan-2 × BRBL-01 (114.01\%) for Pusa Hybrid-6 and Rajendra Baigan-2 × BRBL-01 (-16.28\%) for Arka Anand. Among the 8 F₁ hybrids, 3 showed significantly positive
heterosis over the mid parents, no cross showed significant positive heterosis over the better parent, while 6 crosses showed significantly positive heterosis over the standard variety \textit{i.e.} Pusa Hybrid-6 and 7 crosses showed significantly negative heterosis over the standard variety \textit{i.e.} Arka Anand (Table 4.4).

4.4.1.4 Yield/hectare

The range of relative heterosis for yield/ha was from -15.51\% to 49.33\% and that of heterobeltiosis was from -23.43\% to 25.31\% in between crosses Rajendra Baigan-2 × BRBL-01 and Rajendra Baigan-2 × BRBR-01, respectively. Standard heterosis for Pusa Hybrid-6 ranged from 38.79\% to 86.26\% and for Arka Anand it ranged from -4.95\% to 27.55\% in Muktakeshi × Rajendra Baigan-2 and Rajendra Baigan-2 × BRBR-01. Maximum positive heterosis over the mid parent (49.33\%) and heterosis over the better parent (25.31\%) was recorded in the hybrid Rajendra Baigan-2 × BRBR-01 and that over the standard check was recorded in 86.26\% (Pusa Hybrid-6) and 27.55\% (Arka Anand) in the same cross Rajendra Baigan-2 × BRBR-01. Among the 8 \( F_1 \) hybrids, 4 crosses showed significantly positive heterosis over the mid parents, 2 showed significant positive heterosis over the better parent. While all showed significantly positive heterosis over the standard variety \textit{i.e.} Pusa Hybrid-6 and 3 showed significantly positive heterosis over the standard variety \textit{i.e.} Arka Anand (Table 4.2).

4.4.2 Gene action

Gene action is a form of allelic interaction in which dominance is absent; the heterozygote is intermediate in phenotype between homozygotes for the alternative alleles. The interaction with in alleles of gene controlling a single character may be dominant, incomplete dominance and co-dominance and are called intra allele interaction. When there is a interaction occurs between different pairs of alleles influencing a character of an individual is said to be interallelic interaction or epistatic. The gene that has masking effect is called epistatic gene, and the gene whose effect is masked is known as
hypostatic gene. Epistasis leads to modification of normal dihybrid or trihybrid segregation ratio in F₂ generation.

4.4.2.1 Gene action for plant growth character

4.4.2.1.1 Number of Primary branches/plant

For the primary branches per plant trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between F₁ mean (3.66) and theoretical arithmetic mean (3.27). Similarly differences were observed in F₂ mean (2.48) and theoretical arithmetic mean (3.46) resulting geometric mean (3.46). Observed F₁ mean (3.66) exceeds the higher parent 3.44 (BRBR-01) while observed F₂ mean (2.48) was lesser than theoretical arithmetic mean (3.47) and geometric mean (3.46) for primary branches per plant (Table 4.5).

For the primary branches per plant trait in cross Rajendra Baigan-2 × Swarnamani differences was observed in between F₁ mean (3.66) and theoretical arithmetic mean (4.41). Similarly differences were observed in F₂ mean (2.65) and theoretical arithmetic mean (4.03) resulting geometric mean (3.93). Observed F₁ mean (3.66) stands in between lower parent (Rajendra Baigan-2) and higher parent 5.71 (Swarnamani), while observed F₂ mean (2.65) was lesser than theoretical arithmetic mean (4.03) and geometric mean (3.93) for primary branches per plant (Table 4.6).

For the primary branches per plant trait in cross Rajendra Baigan-2 × Muktakeshi differences was observed in between F₁ mean (3.88) and theoretical arithmetic mean (3.08). Similarly differences were observed in F₂ mean (2.38) and theoretical arithmetic mean (3.48) resulting geometric mean (3.46). Observed F₁ mean (3.88) exceeds the higher parent 3.11 (Rajendra Baigan-2), while observed F₂ mean (2.38) was lesser than theoretical arithmetic mean (3.48) and geometric mean (3.46) for primary branches per plant (Table 4.7).

For the primary branches trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F₁ mean (3.16) and theoretical
arithmetic mean (3). Similarly differences were observed in $F_2$ mean (2.94) and theoretical arithmetic mean (3.08) resulting geometric mean (3.08). Observed $F_1$ mean (3.16) exceeds the higher parent 3.11 (Rajendra Baigan-2), while observed $F_2$ mean (2.94) was lesser than theoretical arithmetic mean (3.08) and geometric mean (3.08) for primary branches per plant (Table 4.8).

**4.4.2.1.2 Plant height (cm)**

For the plant height trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between $F_1$ mean (74.66) and theoretical arithmetic mean (73.72). Similarly differences were observed in $F_2$ mean (66.85) and theoretical arithmetic mean (74.19) resulting geometric mean (74.07). Observed $F_1$ mean (74.66) stands in between lower parent 67.88 (BRBR-01) and higher parent 79.56 (Rajendra Baigan-2) while observed $F_2$ mean (66.85) was lower than theoretical arithmetic mean (74.19) and geometric mean (74.07) for plant height (Table 4.5).

For the plant height trait in cross Rajendra Baigan-2 × Swarnamani, differences was observed in between $F_1$ mean (89.11) and theoretical arithmetic mean (74.84). Similarly differences were observed in $F_2$ mean (69.76) and theoretical arithmetic mean (81.97) resulting geometric mean (81.58). Observed $F_1$ mean (89.11) exceeds the higher parent 79.56 (Rajendra Baigan-2), while observed $F_2$ mean (69.76) was lesser than theoretical arithmetic mean (81.97) resulting geometric mean (81.58) for plant height (Table 4.6).

For the plant height trait in cross Rajendra Baigan-2 × Muktakeshi differences was observed in between $F_1$ mean (80.55) and theoretical arithmetic mean (83.79). Similarly differences were observed in $F_2$ mean (70.7) and theoretical arithmetic mean (82.17) resulting geometric mean (82.17). Observed $F_1$ mean (80.55) stand in between lower parent 79.56 (Rajendra Baigan-2) and higher parent 88.02 (Muktakeshi), while observed $F_2$ mean (70.7) was lesser than theoretical arithmetic mean (82.17) resulting geometric mean (82.17) for plant height (Table 4.7).
For the plant height trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F₁ mean (71.33) and arithmetic mean (70.67). Similarly differences were observed in F₂ mean (62.81) and theoretical arithmetic mean (71) resulting geometric mean (70.71). Observed F₁ mean 71.33 (Rajendra Baigan-2 × BRBL-01) stood between higher parent 79.56 (Rajendra Baigan-2) and lower parent 61.78 (BRBL-01), while observed F₂ mean (62.81) was lower than both theoretical arithmetic mean (71) and geometric mean 70.71 for plant height (Table 4.8).

4.4.2.1.3 Plant spread (cm)

For plant spread trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between F₁ mean (89.55) and arithmetic mean (82.99). Similarly differences were observed in F₂ mean (75.02) and theoretical arithmetic mean (86.27) resulting geometric mean (86.10). Observed F₁ mean 89.55 (Rajendra Baigan-2 × BRBR-01) exceeds the higher parent 88.88 (BRBR-01) while observed F₂ mean (75.02) was lower than both theoretical arithmetic mean (86.27) and geometric mean (86.10) for plant spread (Table 4.5).

For the plant spread trait in cross Rajendra Baigan-2 × Swarnamani differences was observed in between F₁ mean (101.33) and arithmetic mean (106.53). Similarly differences were observed in F₂ mean (77.51) and arithmetic mean (103.93) resulting geometric mean (101.86). Observed F₁ mean 101.33 stood in between lower parent 77.11 (Rajendra Baigan-2) and higher parent 135.96 (Swarnamani), while observed F₂ mean (77.51) was lower than both theoretical arithmetic mean (103.93) and geometric mean (101.86) for plant spread (Table 4.6).

For the plant spread trait in cross Rajendra Baigan-2 × Muktakeshi differences was observed in between theoretical F₁ mean (108.78) and arithmetic mean (104.65). Similarly differences were observed in F₂ mean (78.97) and arithmetic mean (106.71) resulting geometric mean (104.79). Observed F₁ mean 108.77 exceeded the higher parent 132.19 (Muktakeshi)
while F2 mean 78.97 was found lower than both theoretical arithmetic mean (106.71) and geometric mean (104.79) for plant spread (Table 4.7).

For plant spread trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F1 mean (84.77) and arithmetic mean (74.07). Similarly differences were observed in F2 mean (76.55) and theoretical arithmetic mean (79.42) resulting geometric mean (79.21). Observed F1 mean (84.77) exceeds the higher parent 77.11 (Rajendra Baigan-2) while differences between the observed F2 mean (76.55) was lower than theoretical arithmetic mean (79.42) and theoretical geometric mean (79.21) for plant spread (Table 4.8).

4.4.2.2 Gene action for earliness

4.4.2.2.1 Days to first flowering

For days to first flowering in the cross Rajendra Baigan-2 × BRBR-01 differences was observed in between observed F1 mean (43) and theoretical arithmetic mean of F1 (51.17). Similarly differences were seen in the observed F2 mean (86.53) and the theoretical arithmetic mean (47.08) and theoretical geometric mean (46.80). Observed F1 mean (43) was lesser than the lower parent 46.33 (Rajendra Baigan-2), while the observed F2 mean (86.53) was greater than both theoretical arithmetic mean F2 (47.08) and theoretical geometric mean (46.80) for 1st flowering (Table 4.5).

For days to first flowering in the cross Rajendra Baigan-2 × Swarnamani slight differences was observed in between observed F1 mean (47) and theoretical arithmetic mean of F1 (46.5). Similarly differences were seen in the observed F2 mean (84.85) and the theoretical arithmetic mean (46.75) and theoretical geometric mean (46.74). Observed F1 mean (47) exceeds the higher parent 46.67 (Swarnamani), while the observed F2 mean (84.85) was greater than both theoretical arithmetic mean F2 (46.75) and theoretical geometric mean (46.75) for 1st flowering (Table 4.6).
For days to first flowering in the cross Rajendra Baigan-2 × Muktakeshi slight difference was observed in between observed $F_1$ mean (51) and theoretical arithmetic mean of $F_1$ (50.33). Similarly differences were seen in the observed $F_2$ mean (84.91) and the theoretical arithmetic mean (50.66) and theoretical geometric mean (50.58). Observed $F_1$ mean (51) was in between lower parent 46.33 (Rajendra Baigan-2) and higher parent 54.33 (Muktakeshi), while the observed $F_2$ mean (84.91) was greater than both theoretical arithmetic mean $F_2$ (50.66) and theoretical geometric mean (50.58) for 1st flowering (Table 4.7).

For days to first flowering in the cross Rajendra Baigan-2 × BRBL-01 slight difference was observed in between observed $F_1$ mean (48.33) and theoretical arithmetic mean of $F_1$ (46.83). Similarly differences were seen in the observed $F_2$ mean (88.01) and the theoretical arithmetic mean (47.58) and theoretical geometric mean (47.57). Observed $F_1$ mean (48.33) exceeded the higher parent 47.33 (BRBL-01), while the observed $F_2$ mean (88.01) was greater than both theoretical arithmetic mean $F_2$ (47.58) and theoretical geometric mean (47.57) for 1st flowering (Table 4.8).

4.4.2.2.2 Days taken to first fruit set

For first fruit set trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between $F_1$ mean (55.66) and theoretical arithmetic mean of $F_1$ (65.83). Similarly differences were seen in the observed $F_2$ mean (96.9) and the theoretical arithmetic mean (60.75) and theoretical geometric mean (60.53). Observed $F_1$ mean (55.66) was lesser than the lower parent 65.66 (Rajendra Baigan-2), while the observed $F_2$ mean (96.9) was greater than both theoretical arithmetic mean $F_2$ (60.75) and theoretical geometric mean (60.53) for 1st fruit set (Table 4.5).

For first fruit set trait in cross Rajendra Baigan-2 × Swarnamani differences was observed in between $F_1$ mean (61.33) and arithmetic mean (64). Similarly differences were seen in the observed $F_2$ mean (95.19) and the
theoretical arithmetic mean (62.66) and theoretical geometric mean (62.64). Observed F₁ mean (61.33) was lesser than the lower parent 62.33 (Swarnamani), while the observed F₂ mean (95.19) was greater than both theoretical arithmetic mean F₂ (62.66) and theoretical geometric mean (62.64) for 1st fruit (Table 4.6).

For first fruit set trait in cross Rajendra Baigan-2 × Muktaakeshi differences was observed in between F₁ mean (66.66) and arithmetic mean (65.5). Similarly differences were seen in the observed F₂ mean (95.95) and the theoretical arithmetic mean (66.08) and theoretical geometric mean (66.08). Observed F₁ mean (66.66) exceeded the higher parent 65.66 (Rajendra Baigan-2), while the observed F₂ mean(95.95) was greater than both theoretical arithmetic mean (66.08) and theoretical geometric mean (66.08) for 1st fruit set (Table 4.7).

For first fruit set trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F₁ mean (66.66) and arithmetic mean (67.33). Similarly differences were in F₂ mean (97.01) and the theoretical arithmetic mean (66.5) and theoretical geometric mean (66.48). Observed F₁ mean (66.66) was in between lower parent 65.67 (Rajendra Baigan-2) and higher parent 69 (BRBL-01), while differences between the observed F₂ mean(97.01) was greater than both theoretical arithmetic mean F₂ (66.5) and theoretical geometric mean (66.48) for 1st fruit set (Table 4.8).

4.4.2.3 Gene action for fruit character

4.4.2.3.1 Fruit length (cm)

For fruit length trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between F₁ mean (16.5) and arithmetic mean (18.63). Similarly differences were in F₂ mean (22.26) and theoretical arithmetic mean (17.56) resulting geometric mean (16.78). Observed F₁ mean 16.5 stood in between the higher parent 26.11 (Rajendra Baigan-2) and lower parent 11.16 (BRBR-01), while differences between the observed F₂ mean
was higher than theoretical arithmetic mean (17.56) and geometric mean (16.78) for fruit length (Table 4.5).

For fruit length trait in cross Rajendra Baigan-2 × Swarnamani differences was observed in between F₁ mean (14.55) and arithmetic mean (18.27). Similarly differences were observed in F₂ mean (19.89) and arithmetic mean (16.41) resulting geometric mean (15.50). Observed F₁ mean 14.55 stood between higher parent 26.11 (Rajendra Baigan-2) and lower parent 10.44 (Swarnamani), while differences between the observed F₂ mean (19.89) was higher than both the theoretical arithmetic mean (16.41) and geometric mean (15.50) for fruit length (Table 4.6).

For the fruit length trait in cross Rajendra Baigan-2 × Muktakeshi differences was observed in between F₁ mean (17.11) and arithmetic mean (21.69). Similarly differences were observed in F₂ mean (23.03) and arithmetic mean (19.40) resulting geometric mean (19.06). Observed F₁ mean 17.11 was lesser than lower parent Muktakeshi (17.28), while differences between the observed F₂ mean (23.03) for fruit length was higher than both the theoretical arithmetic mean (19.40) and geometric mean (19.06) for fruit length (Table 4.7).

Rajendra Baigan-2 × BRBL-01 fruit length trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F₁ mean (16.66) and arithmetic mean (21.05). Similarly differences were observed in F₂ mean (20.47) and arithmetic mean (18.86) resulting geometric mean (18.45). Observed F₁ mean 16.66 stood in between lower parent 16 (BRBL-01) and higher parent 26.11 (Rajendra Baigan-2) while the observed F₂ mean (20.47) was higher than theoretical arithmetic mean (18.86) and geometric mean (18.45) for fruit length (Table 4.8).

**4.4.2.3.2 Fruit girth (cm)**

For fruit girth trait in cross Rajendra Baigan-2 × BRBR-01, differences was observed in between F₁ mean (13.11) and theoretical arithmetic mean (15.96). Similarly differences were observed in F₂ mean (18.02) and theoretical arithmetic mean (14.53) resulting geometric mean (14.38). Observed
F1 mean (13.11) was lesser than lower parent 13.59 (Rajendra Baigan-2) while observed F2 mean (18.02) was higher than both theoretical arithmetic mean (14.53) and geometric mean (14.38) for fruit girth (Table 4.5).

For fruit girth trait in cross Rajendra Baigan-2 × Swarnamani, differences was observed in between F1 mean (13.72) and theoretical arithmetic mean (19.87). Similarly differences were seen in F2 mean (19.79) and theoretical arithmetic mean (16.79) resulting geometric mean (16.08). Observed F1 mean 13.72 stood in between lower parent 13.59 (Rajendra Baigan-2) and higher parent 26.15 (Swarnamani) while differences between the observed F2 mean (19.79) was higher than both theoretical arithmetic mean (16.79) and geometric mean (16.08) for fruit girth (Table 4.6).

For fruit girth trait in cross Rajendra Baigan-2 × Muktakeshi, differences were observed in between F1 mean (13) and arithmetic mean (17.92). Similarly differences were observed in F2 mean (17.78) and arithmetic mean (15.46) resulting geometric mean (15.03). F1 mean 13 was found lesser than lower parent 13.59 (Rajendra Baigan-2) while differences between the observed F2 mean (17.78) exceeded the arithmetic mean (15.46) and geometric mean (15.03) for fruit girth trait (Table 4.7).

For fruit girth trait in cross Rajendra Baigan-2 × BRBL-01, differences were observed in between F1 mean (11.72) and arithmetic mean (16.12). Similarly differences were observed in F2 mean (17.65) and arithmetic mean (13.92) resulting geometric mean (13.66). F1 mean 11.72 was found lesser than lower parent 13.59 (Rajendra Baigan-2) while differences between the observed F2 mean (17.65) exceeded the arithmetic mean (13.92) and geometric mean (13.66) for fruit girth (Table 4.8).

4.4.2.4 Gene action for yield attributing traits

4.4.2.4.1 Average fruit weight (g)

For average fruit weight trait in cross Rajendra Baigan-2 × BRBR-01, differences was observed in between F1 mean (109.95) and arithmetic mean (122.26). Similarly differences were observed in F2 mean (77.40) and arithmetic mean (116.10) resulting geometric mean (113.87). Observed F1 mean 109.95
was in between lower parent 90.04 (Rajendra Baigan 2) and higher parent 154.48 (BRBR-01), while $F_2$ mean (77.40) was lower than arithmetic mean (116.10) and geometric mean (113.87) for average fruit trait (Table 4.5).

For average fruit weight trait in cross Rajendra Baigan-2 × Swarnamani, differences was observed in between $F_1$ mean (130.91) and theoretical arithmetic mean (119.42). Similarly differences were in $F_2$ mean (84.32) and theoretical arithmetic mean (125.17) resulting geometric mean (123.10). Observed $F_1$ mean 130.91 exceeded the higher parent 148.81 (Swarnamani), while observed $F_2$ mean (84.32) was lower than both theoretical arithmetic mean (125.17) and geometric mean (123.10) for average fruit trait (Table 4.6).

For average fruit weight trait in cross Rajendra Baigan-2 × Muktakeshi, differences was observed in between $F_1$ mean (107.38) and theoretical arithmetic mean (132.22). Similarly differences were observed in $F_2$ mean (92.11) and theoretical arithmetic mean (119.80) resulting geometric mean (116.00). Observed $F_1$ mean 107.38 was in between lower parent 90.04 (Rajendra Baigan-2) and higher parent 174.41 (Muktakeshi), while differences between the observed $F_2$ mean (92.11) was much lower than both theoretical arithmetic mean (119.80) and geometric mean (116) for average fruit trait (Table 4.7).

For average fruit weight trait in cross Rajendra Baigan-2 × BRBL-01, differences was observed in between $F_1$ mean (72.38) and theoretical arithmetic mean (87.67). Similarly differences were observed in $F_2$ mean (71.34) and theoretical arithmetic mean (80.02) resulting geometric mean (79.64). $F_1$ mean 72.38 was lesser than lower parent 85.30 (BRBL-01), while differences between the observed $F_2$ mean (71.34) was lesser than theoretical arithmetic mean (80.02) and geometric mean (79.64) for average fruit trait (Table 4.8).

4.4.2.4.2 Yield/plant
For yield per plant in cross Rajendra Baigan-2 × BRBR-01, the differences was observed in between F₁ mean (2152.41) and arithmetic mean (1441.35). Similarly differences were observed in F₂ mean (1178.69) and arithmetic mean (1796.88) resulting geometric mean (1744.97). F₁ mean 2152.41 exceeds the higher parent 1717.51 (Rajendra Baigan-2) while differences between the observed F₂ mean (1178.69) stood in between theoretical arithmetic (1796.88) and geometric mean (744.97) for yield/plant (Table 4.5).

For yield per plant trait in cross Rajendra Baigan-2 × Swarnamani, the differences was observed in between F₁ mean (1860.20) and arithmetic mean (1386.96). Similarly differences were observed in F₂ mean (1368.46) and arithmetic mean (1623.58) resulting geometric mean (1582.93). F₁ mean 1860.20 exceeded the higher parent 1717.54 (Rajendra Baigan-2), while differences between the observed mean (138.46) was much lower than both theoretical arithmetic (1623.58 and geometric mean (1582.93) for yield/plant (Table 4.6).

For yield per plant trait in cross Rajendra Baigan-2 × Muktakeshi, the differences was observed in between F₁ mean (1644.17) and theoretical arithmetic mean (1558.97). Similarly differences were observed in F₂ mean (1412.25) and theoretical arithmetic mean (1601.57) resulting geometric mean (1596.85). Observed F₁ mean (1644.17) stood in between higher parent 1717.54 (Rajendra Baigan-2) and lower parent 1400.4 (Muktakeshi), while F₂ observed mean (1412.25) was much lower than both theoretical arithmetic (1601.57) and geometric mean (1596.85) for yield/plant (Table 4.7).

For yield per plant trait in cross Rajendra Baigan-2 × BRBL-01, the differences was observed in between F₁ mean (1618.47) and arithmetic mean (1915.71). Similarly differences were observed in F₂ mean (1425.19) and arithmetic mean (1767.09) resulting geometric mean (1756.1). F₁ mean (1618.47) was found lesser than lower parent 1717.54 (Rajendra Baigan-2) while differences between the observed mean (1425.19) was much lower than both theoretical arithmetic (1767.09) and geometric mean (1756.1) for yield/plant (Table 4.8).

4.4.2.4.3 Fruit /plant
For fruit per plant trait in cross Rajendra Baigan-2 × BRBR-01 differences was observed in between F₁ mean (19.67) and theoretical arithmetic mean (13.31). Similarly differences were observed in F₂ mean (15.35) and theoretical arithmetic mean (16.49) resulting geometric mean (15.35). F₁ mean 19.67 exceeded the higher parent 19.09 (Rajendra Baigan-2) while differences between the observed F₂ mean (15.35) was in close agreement with both theoretical arithmetic (16.49) and theoretical geometric mean (15.35) for fruit/plant (Table-4.5).

For the fruit per plant trait in cross Rajendra Baigan-2 × Swarnamani differences was observed in between F₁ mean (14.20) and theoretical arithmetic mean (13.14). Similarly differences were observed in F₂ mean (16.72) and theoretical arithmetic mean (13.67) resulting geometric mean (12.90). Observed F₁ mean 14.20 stood in between higher parent 19.09 (Rajendra Baigan-2) and lower parent 7.19 (Swarnamani) while differences between the observed F₂ mean (16.72) exceeded both theoretical arithmetic (13.67) and theoretical geometric mean (12.90) for fruit/plant (Table 4.6).

For fruit per plant trait in cross Rajendra Baigan-2 × Muktakeshi differences was observed in between F₁ mean (15.36) and theoretical arithmetic mean (13.58). Similarly differences were observed in F₂ mean (15.58) and theoretical arithmetic mean (14.47) resulting geometric mean (13.81). F₁ mean 15.36 stands between the higher parent 19.09 (Rajendra Baigan-2) and lower parent 8.07 (Muktakeshi), while differences between the observed F₂ mean (15.58) exceeded both theoretical arithmetic mean (14.47) and theoretical geometric mean(13.81) for fruit/plant (Table 4.7).

For fruit per plant trait in cross Rajendra Baigan-2 × BRBL-01 differences was observed in between F₁ mean (22.53) and theoretical arithmetic mean (21.96). Similarly differences were observed in F₂ mean (20.03) and theoretical arithmetic mean (22.24) resulting geometric mean (22.15). F₁ mean 22.53 stands between lower parent 19.09 (Rajendra Baigan-2) and higher parent 24.82 (BRBL-01), while differences between the observed F₂ mean (20.03) was
lower than both theoretical arithmetic mean (22.24) and theoretical geometric mean (22.15) for fruit/plant (Table 4.8).

4.4.3 Chi Square Studies

The chi square test was run to analyse the segregation of spiny and non spiny calyx trait and is mentioned in the following subheads.

\[ \chi^2 = \sum \frac{(o-e)^2}{e} \]

The probability (p) at degrees of freedom (n – 1) is recorded from the statistical table, where n is the number of phenotypes obtained in the F2 segregating generation. If the ‘p’ value is greater than 0.05 at the respective degrees of freedom, then the null hypothesis is accepted. If the ‘p’ value is lesser than 0.05 at respective degrees of freedom, then the null hypothesis is rejected.

4.4.3.1 Calyx spininess:

This trait is characterized by the presence or absence of spines on the calyx.

**Cross 1 : Rajendra Baingan-2 × Muktakeshi**

P₁ (Spine absent) : P₂ (Spine present)

F₁ (Spine present)

F₂ segregation : 68 (Spine present) : 32 (Spine absent)

Null hypothesis: the ratio of segregation of spiny and non-spiny calyx in F₂ is 3:1.

<table>
<thead>
<tr>
<th>Table 4.9.1 Chi square analysis of segregation of spiny and non-spiny calyx trait</th>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D²</th>
<th>D²/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Spine present</td>
<td>68</td>
<td>75</td>
<td>-7</td>
<td>49</td>
<td>0.65</td>
<td>3.82</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>1/4 Spine absent</td>
<td>32</td>
<td>25</td>
<td>7</td>
<td>49</td>
<td>1.96</td>
<td>( \Sigma = \chi^2 = 2.61 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The $\chi^2$ value (2.61) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.11) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 2: Rajendra Baigan-2 × BRBL 01**

$P_1$ (Spine absent) \hspace{1cm} × \hspace{1cm} $P_2$ (Spine present)

\[ \Downarrow \]

$F_1$ (Spine present)

$F_2$ segregation : 69 (Spine present) : 26 (Spine absent)

Null hypothesis: the ratio of segregation of spiny and non-spiny calyx in $F_2$ is 3:1.

**Table 4.9.2 Chi square analysis of segregation of spiny and non-spiny calyx trait**

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>$D^2$</th>
<th>$D^2/E$</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Spine present</td>
<td>69</td>
<td>75</td>
<td>-6</td>
<td>36</td>
<td>0.48</td>
<td>3.82</td>
<td>0.47</td>
</tr>
<tr>
<td>1/4 Spine absent</td>
<td>26</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Sigma = \chi^2 = 0.52$

The $\chi^2$ value (0.52) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.47) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 3: Rajendra Baigan-2 × Swarnamani**

$P_1$ (Spine absent) \hspace{1cm} × \hspace{1cm} $P_2$ (Spine present)

\[ \Downarrow \]

$F_1$ (Spine present)

$F_2$ segregation : 71 (Spine present) : 29 (Spine absent)

Null hypothesis: the ratio of segregation of spiny and non-spiny calyx in $F_2$ is 3:1.
Table 4.9.3 Chi square analysis of segregation of spiny and non-spiny calyx trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Spine present</td>
<td>71</td>
<td>75</td>
<td>-4</td>
<td>16</td>
<td>0.21</td>
<td>3.82</td>
<td>0.0.35</td>
</tr>
<tr>
<td>1/4 Spine absent</td>
<td>29</td>
<td>25</td>
<td>4</td>
<td>16</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 0.85

The χ^2 value (0.85) has been found to be lesser than the critical χ^2 value at df=1. Besides the p at df=1 (0.35) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

Cross 4: Rajendra Baigan-2 × BRBR-01

\[
P_1 (\text{Spine absent}) \times P_2 (\text{Spine present})
\]

\[
\downarrow
\]

\[
F_1 (\text{Spine present})
\]

F_2 segregation: 70 (Spine present) : 30 (Spine absent)

Null hypothesis: the ratio of segregation of spiny and non-spiny calyx in F_2 is 3:1.

Table 4.9.4 Chi square analysis of segregation of spiny and non-spiny calyx trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Spine present</td>
<td>70</td>
<td>75</td>
<td>-5</td>
<td>25</td>
<td>0.33</td>
<td>3.82</td>
<td>0.25</td>
</tr>
<tr>
<td>1/4 Spine absent</td>
<td>30</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 1.33

The χ^2 value (1.33) has been found to be lesser than the critical χ^2 value at df=1. Besides the p at df=1 (0.25) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

4.4.3.2 Plant growth habit:

This trait is characterized by the erect, spreading and intermediate growth habit.
Cross 1: Rajendra Baigan -2 × Muktakeshi

\[ P_1 (\text{Erect}) \times P_2 (\text{Spreading}) \]
\[ \downarrow \]
\[ F_1 (\text{Spreading}) \]

F\(_2\) segregation: 64 (Spreading): 27 (Intermediate): 9 (Erect)


**Table 4.10.1 Chi square analysis of segregation of plant growth habit trait**

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>(D^2)</th>
<th>(D_2/E)</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16</td>
<td>64</td>
<td>56.25</td>
<td>7.75</td>
<td>60.06</td>
<td>1.06</td>
<td>5.99</td>
<td>0.073</td>
</tr>
<tr>
<td>Spreading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/16</td>
<td>27</td>
<td>37.5</td>
<td>-10.5</td>
<td>110.25</td>
<td>2.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16</td>
<td>9</td>
<td>6.25</td>
<td>2.75</td>
<td>7.56</td>
<td>1.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 = 5.22 \]

The \(\chi^2\) value (5.22) has been found to be lesser than the critical \(\chi^2\) value at df=2. Besides the p at df=1 (0.073) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:6:1 is accepted for the trait in the cross.

**Cross 2: Rajendra Baigan-2 × BRBL-01**

\[ P_1 (\text{Erect}) \times P_2 (\text{Erect}) \]
\[ \downarrow \]
\[ F_1 (\text{Erect}) \]

F\(_2\) segregation: 100 (Erect)

Null hypothesis: The ratio of segregation of plant growth habit spreading, intermediate and erect (9:6:1) is absent in F\(_2\) i.e., both the parental lines are homozygous monogenic recessive, hence the F\(_1\) is also homozygous monogenic recessive and there is no segregation in F\(_2\).
Cross 3: Rajendra Baigan-2 × Swarnamani

\[ P_1 \text{ (Erect)} \times P_2 \text{ (Spreading)} \]

\[ \downarrow \]

\[ F_1 \text{ (Spreading)} \]

\( F_2 \) segregation: 65 (Spreading) : 27 (Intermediate) : 8 (Erect)

Null hypothesis: the ratio of segregation of plant growth habit spreading, intermediate and erect in \( F_2 \) is 9:6:1.

Table 4.10.2 Chi square analysis of segregation of plant growth habit trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>( \chi^2 )</th>
<th>( \chi^2 )/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Spreading</td>
<td>65</td>
<td>56.25</td>
<td>8.75</td>
<td>76.56</td>
<td>1.36</td>
<td>5.99</td>
<td>0.091</td>
</tr>
<tr>
<td>6/16 Intermediate</td>
<td>27</td>
<td>37.5</td>
<td>-10.5</td>
<td>110.25</td>
<td>2.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16 Erect</td>
<td>8</td>
<td>6.25</td>
<td>1.75</td>
<td>3.06</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 = 4.79 \]

The \( \chi^2 \) value (4.79) has been found to be lesser than the critical \( \chi^2 \) value at df=2. Besides the p at df=1 (0.091) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:6:1 is accepted for the trait in the cross.

Cross 4: Rajendra Baigan-2 × BRBR-01

\[ P_1 \text{ (Erect)} \times P_2 \text{ (Spreading)} \]

\[ \downarrow \]

\[ F_1 \text{ (Spreading)} \]

\( F_2 \) segregation: 56(Spreading): 36 (Intermediate): 8 (Erect)

Null hypothesis: The ratio of segregation of plant growth habit spreading, intermediate and erect (9:6:1) is absent in \( F_2 \) i.e., both the parental lines are homozygous monogenic recessive, hence the \( F_1 \) is also homozygous monogenic recessive and there is no segregation in \( F_2 \).
Table 4.10.3 Chi square analysis of segregation of plant growth habit trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Spreading</td>
<td>56</td>
<td>56.25</td>
<td>-0.25</td>
<td>0.062</td>
<td>0.001</td>
<td>5.99</td>
<td>0.75</td>
</tr>
<tr>
<td>6/16 Intermediate</td>
<td>36</td>
<td>37.5</td>
<td>-1.5</td>
<td>2.25</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16 Erect</td>
<td>8</td>
<td>6.25</td>
<td>1.75</td>
<td>3.06</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 0.55

The χ^2 value (0.55) has been found to be lesser than the critical χ^2 value at df=2. Besides the p at df=1 (0.75) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:6:1 is accepted for the trait in the cross.

4.4.3.3 Leaf blade colour:

This trait is characterized by the purple, green, pale violet and deep violet leaf blade colour.

Cross 1: Rajendra Baigan -2 × Muktakeshi

P₁ (Green) × P₂ (Purple)

↓

F₁ (Pale violet)

F₂ segregation: 51 (Purple): 20 (Greenish purple): 29 (Green)

Null hypothesis: the ratio of segregation of leaf blade colour in F₂ is 9:3:4.

Table 4.11.1 Chi square analysis of segregation of leaf blade colour trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Purple</td>
<td>51</td>
<td>56.25</td>
<td>-5.25</td>
<td>27.56</td>
<td>0.49</td>
<td>3.82</td>
<td>0.45</td>
</tr>
<tr>
<td>3/16 Greenish purple</td>
<td>20</td>
<td>18.75</td>
<td>1.25</td>
<td>1.56</td>
<td>0.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/16 Green</td>
<td>29</td>
<td>25</td>
<td>4</td>
<td>16</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 1.21

The χ^2 value (1.21) has been found to be lesser than the critical χ^2 value at df=2. Besides the p at df=1 (0.45) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:3:4 is accepted for the trait in the cross.
Cross 2: Rajendra Baigan-2 × BRBL-01

\[ P_1 \text{(Green)} \times P_2 \text{(Green)} \rightarrow F_1 \text{(Green)} \]

F₂ segregation: 100 (Green)

Null hypothesis: The ratio of segregation of leaf blade colour (9:3:4) is absent in F₂ i.e., both the parental lines are homozygous monogenic recessive, hence the F₁ is also homozygous monogenic recessive and there is no segregation in F₂.

Cross 3: Rajendra Baigan-2 × Swarnamani

\[ P_1 \text{(Green)} \times P_2 \text{(Purple)} \rightarrow F_1 \text{(Pale violet)} \]

F₂ segregation: 51 (Purple): 23 (Greenish purple): 23 (Green)

Null hypothesis: the ratio of segregation of leaf blade colour in F₂ is 9:3:4.

Table 4.11.2 Chi square analysis of segregation of leaf blade colour trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected (E)</th>
<th>D=O-E</th>
<th>D²</th>
<th>D²/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Purple</td>
<td>51</td>
<td>56.25</td>
<td>-5.25</td>
<td>27.56</td>
<td>0.49</td>
<td>3.82</td>
<td>0.22</td>
</tr>
<tr>
<td>3/16 Greenish purple</td>
<td>23</td>
<td>18.75</td>
<td>4.25</td>
<td>18.06</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/16 Green</td>
<td>23</td>
<td>25</td>
<td>-2</td>
<td>4</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 = 1.45 \]

The \( \chi^2 \) value (1.45) has been found to be lesser than the critical \( \chi^2 \) value at df=2. Besides the p at df=1 (0.22) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:3:4 is accepted for the trait in the cross.

Cross 4: Rajendra Baigan-2 × BRBR-01
\[ P_1 (\text{Green}) \times P_2 (\text{Purple}) \]

\[ \downarrow \]

\[ F_1 (\text{Deep purple}) \]

\( F_2 \) segregation: 49 (Purple): 23 (Greenish purple): 25 (Green)

Null hypothesis: the ratio of segregation of leaf blade colour in \( F_2 \) is 9:3:4.

### Table 4.11.3 Chi square analysis of segregation of leaf blade colour trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>( D^2 )</th>
<th>( D^2/E )</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Purple</td>
<td>49</td>
<td>56.25</td>
<td>-7.25</td>
<td>52.5625</td>
<td>0.93</td>
<td>3.82</td>
<td>0.16</td>
</tr>
<tr>
<td>3/16 Greenish purple</td>
<td>23</td>
<td>18.75</td>
<td>4.25</td>
<td>18.0625</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/16 Green</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 =1.89 \]

The \( \chi^2 \) value (1.89) has been found to be lesser than the critical \( \chi^2 \) value at df=2. Besides the p at df=1 (0.16) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:3:4 is accepted for the trait in the cross.

#### 4.4.3.4 Leaf pubescence:

This trait is characterized by the dense or sparse for the leaf pubescence

**Cross 1: Rajendra Baigan -2 × Muktakeshi**

\[ P_1 (\text{Sparse}) \times P_2 (\text{Dense}) \]

\[ \downarrow \]

\[ F_1 (\text{Dense}) \]

\( F_2 \) segregation: 67 (Dense): 33 (Sparse)

Null hypothesis: the ratio of segregation of leaf pubescence in \( F_2 \) is 3:1

### Table 4.12.1 Chi square analysis of segregation of leaf pubescence trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>( D^2 )</th>
<th>( D^2/E )</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The $\chi^2$ value (3.41) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.064) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 2: Rajendra Baigan -2 × BRBL-01**

\[
P_1 \text{ (Sparse)} \times P_2 \text{ (Sparse)} \\
\downarrow \\
F_1 \text{ (dense)}
\]

F$_2$ segregation: 78 (Dense): 22 (Sparse)

Null hypothesis: the ratio of segregation of leaf pubescence in F$_2$ is 3:1

**Table 4.12.2 Chi square analysis of segregation of leaf pubescence trait**

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>$D^2$</th>
<th>$D^2/E$</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Dense</td>
<td>78</td>
<td>75</td>
<td>3</td>
<td>9</td>
<td>0.12</td>
<td>3.82</td>
<td>0.064</td>
</tr>
</tbody>
</table>

$\Sigma = \chi^2 = 3.41$

The $\chi^2$ value (0.48) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.49) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 3: Rajendra Baigan -2 × Swana Mani**

\[
P_1 \text{ (Sparse)} x P_2 \text{ (Dense)} \\
\downarrow \\
F_1 \text{ (Dense)}
\]

F$_2$ segregation: 73 (Dense): 27 (Sparse)

Null hypothesis: the ratio of segregation of leaf pubescence in F$_2$ is 3:1

**Table 4.12.3 Chi square analysis of segregation of leaf pubescence trait**

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>$D^2$</th>
<th>$D^2/E$</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 Sparse</td>
<td>22</td>
<td>25</td>
<td>-3</td>
<td>9</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Sigma = \chi^2 = 0.48$
### Table 4.12.4 Chi square analysis of segregation of leaf pubescence trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D²</th>
<th>D²/E</th>
<th>Critical value of χ² at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>74</td>
<td>75</td>
<td>-2</td>
<td>4</td>
<td>0.053333</td>
<td>3.82</td>
<td>0.064</td>
</tr>
<tr>
<td>Dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>27</td>
<td>25</td>
<td>2</td>
<td>4</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sparse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Σ = χ² = 0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The χ² value (0.21) has been found to be lesser than the critical χ² value at df=1. Besides the p at df=1 (0.64) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 4: Rajendra Baigan -2 × BRBR-01**

![Diagram](Diagram.png)

F₂ segregation: 74 (Dense): 26 (Sparse)

Null hypothesis: the ratio of segregation of leaf pubescence in F₂ is 3:1.

This trait is characterized by the presence or absence of fruit pedicel prickles.
Cross 1: Rajendra Baigan -2 × Muktakeshi

\[ P_1 \text{(Absent)} \times P_2 \text{(Present)} \]

F₂ segregation: 68 (Present): 32 (Absent)
Null hypothesis: the ratio of segregation of fruit pedicel prickles in F₂ is 3:1

Table 4.13.1 Chi square analysis of segregation of fruit pedicel prickles trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D²</th>
<th>D²/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Present</td>
<td>68</td>
<td>75</td>
<td>-7</td>
<td>49</td>
<td>0.653333</td>
<td>3.82</td>
<td>0.105</td>
</tr>
<tr>
<td>1/4 Absent</td>
<td>32</td>
<td>25</td>
<td>7</td>
<td>49</td>
<td>1.96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi² = 2.61 \]

The \( \chi² \) value (2.61) has been found to be lesser than the critical \( \chi² \) value at df=1. Besides the p at df=1 (0.105) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

Cross 2: Rajendra Baigan -2 × BRBL-01

\[ P_1 \text{(Absent)} \times P_2 \text{(Present)} \]

F₂ segregation: 72 (Present): 28 (Absent)
Null hypothesis: the ratio of segregation of fruit pedicel prickles in F₂ is 3:1

Table 4.13.2 Chi square analysis of segregation of fruit pedicel prickles trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D²</th>
<th>D²/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Present</td>
<td>72</td>
<td>75</td>
<td>-3</td>
<td>9</td>
<td>0.12</td>
<td>3.82</td>
<td>0.49</td>
</tr>
<tr>
<td>1/4 Absent</td>
<td>28</td>
<td>25</td>
<td>3</td>
<td>9</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi² = 0.48 \]
The $\chi^2$ value (0.48) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.49) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 3: Rajendra Baigan -2 × Swarnamani**

$P_1$ (Absent) $\times$ $P_2$ (Present)

$\Downarrow$

$F_1$ (Present)

$F_2$ segregation: 71 (Present): 29 (Absent)

Null hypothesis: the ratio of segregation of fruit pedicel prickles in $F_2$ is 3:1

**Table 4.13.3 Chi square analysis of segregation of fruit pedicel prickles trait**

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>$D^2$</th>
<th>$D^2/E$</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Present</td>
<td>71</td>
<td>75</td>
<td>-4</td>
<td>16</td>
<td>0.213333</td>
<td>3.82</td>
<td>0.35</td>
</tr>
<tr>
<td>1/4 Absent</td>
<td>29</td>
<td>25</td>
<td>4</td>
<td>16</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Sigma = \chi^2 = 0.85$

The $\chi^2$ value (0.85) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.35) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

**Cross 4: Rajendra Baigan -2 × BRBR-01**

$P_1$ (Absent) $\times$ $P_2$ (Present)

$\Downarrow$

$F_1$ (Present)

$F_2$ segregation: 69 (Present): 31 (Absent)

Null hypothesis: the ratio of segregation of fruit pedicel prickles in $F_2$ is 3:1
Table 4.13.4 Chi square analysis of segregation of fruit pedicel prickles trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 Present</td>
<td>69</td>
<td>75</td>
<td>-6</td>
<td>36</td>
<td>0.48</td>
<td>3.82</td>
<td>0.16</td>
</tr>
<tr>
<td>1/4 Absent</td>
<td>31</td>
<td>25</td>
<td>6</td>
<td>36</td>
<td>1.44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 1.92

The χ^2 value (1.92) has been found to be lesser than the critical χ^2 value at df=1. Besides the p at df=1 (0.16) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.

4.4.3.6 Fruit Shape:

This trait is characterized by the long, oblong and round fruit shape.

Cross 1: Rajendra Baigan -2 × Muktakeshi

\[ \text{P}_1 \text{(Long)} \times \text{P}_2 \text{(Oblong)} \]

\[ \downarrow \]

\[ \text{F}_1 \text{(Long)} \]

F₂ segregation: 45 (Long): 25 (Oblong): 30 (Round)

Null hypothesis: the ratio of segregation of fruit shape in F₂ is 9:3:4

Table 4.14.1 Chi square analysis of segregation of fruit shape trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D^2</th>
<th>D^2/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16 Long</td>
<td>45</td>
<td>56.25</td>
<td>-11.25</td>
<td>126.5625</td>
<td>2.25</td>
<td>3.82</td>
<td>0.069</td>
</tr>
<tr>
<td>3/16 Oblong</td>
<td>25</td>
<td>18.75</td>
<td>6.25</td>
<td>39.0625</td>
<td>2.083333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/16 Round</td>
<td>30</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ = χ^2 = 5.33

The χ^2 value (5.33) has been found to be lesser than the critical χ^2 value at df=1. Besides the p at df=1 (0.069) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:3:4 is accepted for the trait in the cross.
Cross 2: Rajendra Baigan -2 × BRBL-01

\[ P_1 (\text{Long}) \times P_2 (\text{Oblong}) \]
\[ \Downarrow \]
\[ F_1 (\text{Long}) \]

F\textsubscript{2} segregation: 40 (Long): 60 (Oblong)

Null hypothesis: the ratio of segregation of fruit shape in F\textsubscript{2} is 9:7

Table 4.14.2 Chi square analysis of segregation of fruit shape trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D\textsuperscript{2}</th>
<th>D\textsubscript{2}/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td>40</td>
<td>42.18</td>
<td>-2.18</td>
<td>4.78</td>
<td>0.11</td>
<td>3.82</td>
<td>0.65</td>
</tr>
<tr>
<td>Oblong</td>
<td>60</td>
<td>57.81</td>
<td>2.18</td>
<td>4.78</td>
<td>0.082</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 = 1.92 \]

The \( \chi^2 \) value (1.92) has been found to be lesser than the critical \( \chi^2 \) value at df=1. Besides the p at df=1 (0.65) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:7 is accepted for the trait in the cross.

Cross 3: Rajendra Baigan -2 × Swarnamani

\[ P_1 (\text{Long}) \times P_2 (\text{Round}) \]
\[ \Downarrow \]
\[ F_1 (\text{Long}) \]

F\textsubscript{2} segregation: 40 (Long): 34 (Oblong): 21 (Round)

Null hypothesis: the ratio of segregation of fruit shape in F\textsubscript{2} is 9:3:4

Table 4.14.3 Chi square analysis of segregation of fruit shape trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed (O)</th>
<th>Expected E</th>
<th>D=O-E</th>
<th>D\textsuperscript{2}</th>
<th>D\textsubscript{2}/E</th>
<th>Critical value of chi at df=1</th>
<th>p value at df=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td>40</td>
<td>42.18</td>
<td>-2.18</td>
<td>4.78</td>
<td>0.11</td>
<td>5.99</td>
<td>0.19</td>
</tr>
<tr>
<td>Oblong</td>
<td>34</td>
<td>42.18</td>
<td>-8.18</td>
<td>67.035</td>
<td>1.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td>21</td>
<td>15.62</td>
<td>5.37</td>
<td>28.89</td>
<td>1.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Sigma = \chi^2 = 3.55 \]
The $\chi^2$ value (3.55) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.19) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9:3:4 is accepted for the trait in the cross.

**Cross 4 : Rajendra Baigan -2 × BRBR-01**

\[
\begin{array}{c}
P_1 \text{(Long)} \times P_2 \text{(Oblong)} \\
\downarrow \\
F_1 \text{(Long)}
\end{array}
\]

F₂ segregation: 40 (Long): 60 (Oblong)

Null hypothesis: the ratio of segregation of fruit shape in F₂ is 9:7

<table>
<thead>
<tr>
<th>Table 4.14.4 Chi square analysis of segregation of fruit shape trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected ratio</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Long</td>
</tr>
<tr>
<td>Oblong</td>
</tr>
<tr>
<td>$\Sigma = \chi^2 = 0.32$</td>
</tr>
</tbody>
</table>

The $\chi^2$ value (0.32) has been found to be lesser than the critical $\chi^2$ value at df=1. Besides the p at df=1 (0.57) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 9 : 7 is accepted for the trait in the cross.

**4.4.3.7 Leaf prickles:**

This trait is characterized by the presence or absence of the leaf prickels.

**Cross 1 : Rajendra Baingan-2 × Muktakeshi**

\[
\begin{array}{c}
P_1 \text{(None)} \times P_2 \text{(None)} \\
\downarrow \\
F_1 \text{(None)}
\end{array}
\]

F₂ segregation :100 (Absent)

Null hypothesis: The ratio of segregation of leaf prickles (3:1) is absent in F₂. i.e., both the parental lines are homozygous monogenic recessive, hence the F₁ is also homozygous monogenic recessive and there is no segregation in F₂.
Cross 2: Rajendra Baingan-2 × BRBL-01

\[ P_1 \text{(None)} \times P_2 \text{(None)} \]

\[ \downarrow \]

\[ F_1 \text{(None)} \]

F₂ segregation: 100 (Absent)

Null hypothesis: The ratio of segregation of leaf prickles (3:1) is absent in F₂. i.e., both the parental lines are homozygous monogenic recessive, hence the F₁ is also homozygous monogenic recessive and there is no segregation in F₂.

Cross 3: Rajendra Baingan-2 × Swarnamani

\[ P_1 \text{(None)} \times P_2 \text{(Present)} \]

\[ \downarrow \]

\[ F_1 \text{(Few)} \]

F₂ segregation: 73 (Present) : 27 (Absent)

Null hypothesis: the ratio of segregation of leaf prickles present and absent in F₂ is 3:1.

Table 4.15.1 Chi square analysis of segregation of leaf prickles trait

<table>
<thead>
<tr>
<th>Expected ratio</th>
<th>Observed ( O )</th>
<th>Expected ( E )</th>
<th>( D = O - E )</th>
<th>( D^2 )</th>
<th>( D^2/E )</th>
<th>Critical value of ( \chi^2 ) at ( df=1 )</th>
<th>( p ) value at ( df=1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 prickles present</td>
<td>73</td>
<td>75</td>
<td>-2</td>
<td>4</td>
<td>0.05</td>
<td>5.99</td>
<td>0.94</td>
</tr>
<tr>
<td>1/4 prickles absent</td>
<td>27</td>
<td>25</td>
<td>2</td>
<td>4</td>
<td>0.16</td>
<td>[ \Sigma = \chi^2 = 0.21 ]</td>
<td></td>
</tr>
</tbody>
</table>

The \( \chi^2 \) value (0.21) has been found to be lesser than the critical \( \chi^2 \) value at \( df=1 \). Besides the \( p \) at \( df=1 \) (0.64) is greater than 0.05. Hence the null hypothesis, i.e. ratio of 3:1 is accepted for the trait in the cross.
Cross 4 : Rajendra Baingan-2 × BRBR-01

\[ P_1 \text{(None)} \times P_2 \text{(None)} \]

\[ \downarrow \]

\[ F_1 \text{(None)} \]

\[ F_2 \text{ segregation :100 (Absent)} \]

Null hypothesis: The ratio of segregation of leaf prickles (3:1) is absent in \( F_2 \). \textit{i.e.,} both the parental lines are homozygous monogenic recessive, hence the \( F_1 \) is also homozygous monogenic recessive and there is no segregation in \( F_2 \).
### Table 4.3: Estimation of heterosis for earliness

<table>
<thead>
<tr>
<th>Characters</th>
<th>First flowering</th>
<th>Days taken to 50% flowering</th>
<th>Days taken to first fruit set</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPH</td>
<td>BPH</td>
<td>SH-1</td>
</tr>
<tr>
<td>Rajendra Baigan-2 x Muktakeshi</td>
<td>1.32</td>
<td>-6.13</td>
<td>23.38**</td>
</tr>
<tr>
<td>Muktakeshi x Rajendra Baigan-2</td>
<td>-17.88**</td>
<td>-23.92**</td>
<td>0</td>
</tr>
<tr>
<td>BRBL-01x Rajendra Baigan-2</td>
<td>-3.91</td>
<td>-6.13</td>
<td>8.87</td>
</tr>
</tbody>
</table>

**Significance at 5% level of probability**  
**Significance at 1% of probability**  

**Characters:** MPH (Mid parent heterosis), BPH (Better parent heterosis), SH-1 (Standard heterosis for Pusa Hybrid-6) SH-2 (standard heterosis for Arka Anand)
### Table 4.1: Estimation of heterosis for plant growth characters

<table>
<thead>
<tr>
<th>Characters</th>
<th>Primary branches/plant</th>
<th>Plant height (cm)</th>
<th>Plant spread (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPH</td>
<td>BPH</td>
<td>SH-1</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Muktakeshi</td>
<td>26.25**</td>
<td>25.04**</td>
<td>20.68**</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBL-01</td>
<td>5.55</td>
<td>1.81</td>
<td>-1.72</td>
</tr>
<tr>
<td>BRBL-01 × Rajendra Baigan-2</td>
<td>11.11</td>
<td>7.18</td>
<td>3.44</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Swarnamani</td>
<td>-16.85**</td>
<td>-35.78**</td>
<td>13.79*</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBR-01</td>
<td>11.88*</td>
<td>6.46</td>
<td>13.79*</td>
</tr>
<tr>
<td>BRBR-01 × Rajendra Baigan-2</td>
<td>5.10</td>
<td>0.01</td>
<td>6.89</td>
</tr>
</tbody>
</table>

**Significance at 5% level of probability**

**Significance at 1% of probability**

**Characters:** MPH (Mid parent heterosis), BPH (Better parent heterosis), SH-1 (Standard heterosis for Pusa Hybrid-6)SH-2 (Standard heterosis for Arka Anand)
Table 4.2: Estimation of heterosis for fruit characters

<table>
<thead>
<tr>
<th>Characters</th>
<th>Fruit length</th>
<th>Fruit girth</th>
<th>Yield/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPH</td>
<td>BPH</td>
<td>SH-1</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Muktakeshi</td>
<td>-21.12**</td>
<td>-34.46**</td>
<td>49.51**</td>
</tr>
<tr>
<td>Muktakeshi × Rajendra Baigan-2</td>
<td>-36.23**</td>
<td>-47.01**</td>
<td>20.87</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBL-01</td>
<td>-20.84**</td>
<td>-36.16**</td>
<td>45.63**</td>
</tr>
<tr>
<td>BRBL-01 × Rajendra Baigan-2</td>
<td>-27.17**</td>
<td>-41.27**</td>
<td>33.98*</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Swarnamani</td>
<td>-20.35**</td>
<td>-44.25**</td>
<td>27.18*</td>
</tr>
<tr>
<td>Swarnamani × Rajendra Baigan-2</td>
<td>-23.39**</td>
<td>-46.38**</td>
<td>22.33</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBR-01</td>
<td>-11.45</td>
<td>-36.80**</td>
<td>44.17**</td>
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<tr>
<td>BRBR-01 × Rajendra Baigan-2</td>
<td>-15.33*</td>
<td>-39.57**</td>
<td>37.86**</td>
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</table>

*Significance at 5% level of probability  **Significance at 1% of probability

**Characters:** MPH (Mid parent heterosis), BPH (Better parent heterosis), SH-1 (Standard heterosis for Pusa Hybrid-6) SH-2 (Standard heterosis or Arka Anand)
Table 4.4: Estimation of heterosis for fruit yielding attributing traits

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Average fruit weight</th>
<th>Yield/plant</th>
<th>Fruit/plant</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>MPH</td>
<td>BPH</td>
<td>SH-1</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Muktakeshi</td>
<td>-18.79**</td>
<td>-38.43**</td>
<td>-3.80</td>
</tr>
<tr>
<td>Muktakeshi × Rajendra Baigan-2</td>
<td>-8.89</td>
<td>-30.92**</td>
<td>7.91</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBL-01</td>
<td>-17.44*</td>
<td>-19.93*</td>
<td>-35.15**</td>
</tr>
<tr>
<td>BRBL-01 × Rajendra Baigan-2</td>
<td>-1.86</td>
<td>-4.81</td>
<td>-22.91**</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Swarnamani</td>
<td>9.61</td>
<td>-12.03*</td>
<td>17.27*</td>
</tr>
<tr>
<td>Swarnamani × Rajendra Baigan-2</td>
<td>-11.25</td>
<td>-28.78**</td>
<td>-5.05</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × BRBR-01</td>
<td>-10.07</td>
<td>-28.82**</td>
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<td>BRBR-01 × Rajendra Baigan-2</td>
<td>-19.79**</td>
<td>-36.52**</td>
<td>-12.15</td>
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</table>

*Significance at 5% level of probability  **Significance at 1% of probability

**Characters:** MPH (Mid parent heterosis), BPH (Better parent heterosis), SH-1 (Standard heterosis for Pusa Hybrid-6) SH-2 (Standard heterosis or Arka Anand)
Table 4.6: Parental means (P1 and P2), Observed mean (O), theoretical arithmetic mean (A), geometric mean (G) of different characters of F1 hybrid and F2 segregating populations of different crosses (4 crosses with F2)

<table>
<thead>
<tr>
<th>Rajendra Baigan-2 × Swarna Mani</th>
<th>P1</th>
<th>P2</th>
<th>O</th>
<th>F1</th>
<th>A</th>
<th>O</th>
<th>F2</th>
<th>A</th>
<th>G</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days taken to first flowering</td>
<td>46.33</td>
<td>46.66</td>
<td>47</td>
<td>46.5</td>
<td>84.85</td>
<td>46.75</td>
<td>46.74</td>
<td>Over dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days taken to 1st fruit set</td>
<td>65.66</td>
<td>62.33</td>
<td>61.33</td>
<td>64</td>
<td>95.19</td>
<td>62.66</td>
<td>62.64</td>
<td>Over dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary branches/plant</td>
<td>3.11</td>
<td>5.71</td>
<td>3.66</td>
<td>4.41</td>
<td>2.65</td>
<td>4.03</td>
<td>3.93</td>
<td>partial dominance</td>
<td>Both additive and non additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant height</td>
<td>79.56</td>
<td>70.13</td>
<td>89.11</td>
<td>74.84</td>
<td>69.76</td>
<td>81.97</td>
<td>81.58</td>
<td>Over dominance</td>
<td>Non additive gene action</td>
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<td></td>
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<td>Plant spread</td>
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<td>135.96</td>
<td>101.33</td>
<td>106.53</td>
<td>77.51</td>
<td>103.93</td>
<td>101.86</td>
<td>partial dominance</td>
<td>Non additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit length</td>
<td>26.11</td>
<td>10.44</td>
<td>14.55</td>
<td>18.27</td>
<td>19.89</td>
<td>16.41</td>
<td>15.50</td>
<td>partial dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit girth</td>
<td>13.59</td>
<td>26.15</td>
<td>13.72</td>
<td>19.87</td>
<td>19.79</td>
<td>16.79</td>
<td>16.08</td>
<td>partial dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average fruit wt.</td>
<td>90.04</td>
<td>148.81</td>
<td>130.91</td>
<td>119.42</td>
<td>84.32</td>
<td>125.17</td>
<td>123.10</td>
<td>partial dominance</td>
<td>Non additive gene action</td>
<td></td>
<td></td>
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<tr>
<td>Yield/plant</td>
<td>1717.54</td>
<td>1056.37</td>
<td>1860.20</td>
<td>1386.96</td>
<td>1368.46</td>
<td>1623.58</td>
<td>1582.93</td>
<td>Over dominance</td>
<td>Non additive gene action</td>
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Table -4.5: Parental means (P1 and P2), Observed mean (O), Theoretical arithmetic mean (A), Geometric mean (G) of different characters of F₁ hybrid and F₂ cross Rajendra Baigan-2 x BRBR-01

<table>
<thead>
<tr>
<th>Rajendra Baigan-2 × BRBR-01</th>
<th>P1</th>
<th>P2</th>
<th>O</th>
<th>F₁</th>
<th>O</th>
<th>F₂</th>
<th>G</th>
<th>F₁</th>
<th>F₂</th>
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</thead>
<tbody>
<tr>
<td>Days taken to first flowering</td>
<td>46.33</td>
<td>56</td>
<td>43</td>
<td>51.16</td>
<td>86.53</td>
<td>47.08</td>
<td>46.80</td>
<td>Over dominance</td>
<td>Additive gene action</td>
</tr>
<tr>
<td>Days taken to 1st fruit set</td>
<td>65.66</td>
<td>66</td>
<td>55.66</td>
<td>65.83</td>
<td>96.9</td>
<td>60.75</td>
<td>60.53</td>
<td>Over dominance</td>
<td>Additive gene action</td>
</tr>
<tr>
<td>Primary branches / plant</td>
<td>3.11</td>
<td>3.44</td>
<td>3.66</td>
<td>3.277</td>
<td>2.48</td>
<td>3.47</td>
<td>3.46</td>
<td>Over dominance</td>
<td>Both additive and non additive gene action</td>
</tr>
<tr>
<td>Plant height</td>
<td>79.56</td>
<td>67.88</td>
<td>74.66</td>
<td>73.72</td>
<td>66.85</td>
<td>74.19</td>
<td>74.07</td>
<td>Partial dominance</td>
<td>Non additive gene action</td>
</tr>
<tr>
<td>Plant spread</td>
<td>77.11</td>
<td>88.88</td>
<td>89.55</td>
<td>82.99</td>
<td>75.02</td>
<td>86.27</td>
<td>86.10</td>
<td>Over dominance</td>
<td>Non additive gene action</td>
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<td>26.11</td>
<td>11.15</td>
<td>16.5</td>
<td>18.63</td>
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<td>16.78</td>
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<td>Additive gene action</td>
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<td>Fruit girth</td>
<td>13.59</td>
<td>18.34</td>
<td>13.11</td>
<td>15.96</td>
<td>18.02</td>
<td>14.53</td>
<td>14.38</td>
<td>Over dominance</td>
<td>Additive gene action</td>
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<td>109.95</td>
<td>122.26</td>
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<td>113.87</td>
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<td>Non additive gene action</td>
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<td>1796.88</td>
<td>1744.97</td>
<td>Over dominance</td>
<td>Non additive gene action</td>
</tr>
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<td>Fruit /plant</td>
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<td>7.526</td>
<td>19.67</td>
<td>13.31</td>
<td>15.35</td>
<td>16.49</td>
<td>15.35</td>
<td>Over dominance</td>
<td>Both additive and non additive gene action</td>
</tr>
<tr>
<td>Rajendra Baigan-2 × Muktaekshi</td>
<td>P1</td>
<td>P2</td>
<td>O</td>
<td>F₁</td>
<td>O</td>
<td>A</td>
<td>G</td>
<td>F₁</td>
<td>F₂</td>
</tr>
<tr>
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<td>-----</td>
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<tr>
<td>Days taken to first flowering</td>
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<td></td>
<td>46.33</td>
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<td>84.91</td>
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<td>65.33</td>
<td>66.66</td>
<td>95.95</td>
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<td>66.08</td>
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<td>88.02</td>
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<td>83.79</td>
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<td>17.11</td>
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<td>17.92</td>
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<td>Fruit girth</td>
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<td>8.07</td>
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<td>13.58</td>
<td>15.58</td>
<td>14.47</td>
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<td>Partial dominance</td>
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</table>

Table -4.7: Parental means (P1 and P2), Observed mean (O), Theoretical arithmetic mean (A), Geometric mean(G) of different characters of F₁ hybrid and F₂ cross Rajendra Baigan-2 x Muktaekshi
<table>
<thead>
<tr>
<th>Characters</th>
<th>Rajendra Baigan-2 × BRBL-01</th>
<th>P1</th>
<th>P2</th>
<th>F₁</th>
<th>O</th>
<th>A</th>
<th>O</th>
<th>F₂</th>
<th>A</th>
<th>G</th>
<th>F₁</th>
<th>F₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days taken to first flowering</td>
<td>46.33</td>
<td>47.33</td>
<td>48.33</td>
<td>46.83</td>
<td>88.01</td>
<td>47.58</td>
<td>47.57</td>
<td>Over dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days taken to 1st fruit set</td>
<td>65.66</td>
<td>69</td>
<td>65.66</td>
<td>67.33</td>
<td>97.01</td>
<td>66.5</td>
<td>66.48</td>
<td>Partial dominance</td>
<td>Additive gene action</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary branches / plant</td>
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<td>3.166</td>
<td>3</td>
<td>2.94</td>
<td>3.08</td>
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<td>Over dominance</td>
<td>Both additive and non additive gene action</td>
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</tr>
<tr>
<td>Plant height</td>
<td>79.56</td>
<td>61.78</td>
<td>71.33</td>
<td>70.67</td>
<td>62.81</td>
<td>71.00</td>
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<td>Non additive gene action</td>
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<td>74.07</td>
<td>76.55</td>
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<td>Both additive and non additive gene action</td>
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<td>16</td>
<td>16.66</td>
<td>21.05</td>
<td>20.47</td>
<td>18.86</td>
<td>18.45</td>
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<td>Additive gene action</td>
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</tr>
<tr>
<td>Fruit girth</td>
<td>13.59</td>
<td>18.66</td>
<td>11.72</td>
<td>16.12</td>
<td>17.65</td>
<td>13.92</td>
<td>13.66</td>
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<td>Additive gene action</td>
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<tr>
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<td>72.38</td>
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<td>71.34</td>
<td>80.02</td>
<td>79.64</td>
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<td>Non additive gene action</td>
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<td></td>
</tr>
<tr>
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<td>1618.47</td>
<td>1915.71</td>
<td>1425.19</td>
<td>1767.09</td>
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<td>Over dominance</td>
<td>Non additive gene action</td>
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<td></td>
</tr>
<tr>
<td>Fruit /plant</td>
<td>19.09</td>
<td>24.82</td>
<td>22.53</td>
<td>21.96</td>
<td>20.03</td>
<td>22.24</td>
<td>22.15</td>
<td>Partial dominance</td>
<td>Both additive and non additive gene action</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix-1: Qualitative characters of five parents, eight hybrids and two checks

<table>
<thead>
<tr>
<th>Parents and Checks</th>
<th>Plant Growth Habit</th>
<th>Leaf Blade Colour</th>
<th>Leaf Pubesence</th>
<th>Leaf Prickels</th>
<th>Corolla Colour</th>
<th>Calyx Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muktakeshi</td>
<td>Spreading</td>
<td>Purple</td>
<td>Dense</td>
<td>None</td>
<td>Deep violet</td>
<td>Deep purple</td>
</tr>
<tr>
<td>BRBL-01</td>
<td>Erect</td>
<td>Green</td>
<td>Sparse</td>
<td>None</td>
<td>Deep violet</td>
<td>Green</td>
</tr>
<tr>
<td>Swarnamani</td>
<td>Spreading</td>
<td>Purple</td>
<td>Dense</td>
<td>Yes</td>
<td>Deep violet</td>
<td>Deep purple</td>
</tr>
<tr>
<td>BRBR-01</td>
<td>Spreading</td>
<td>Purple</td>
<td>Sparse</td>
<td>None</td>
<td>Violet</td>
<td>Deep purple</td>
</tr>
<tr>
<td>Rajendra Baigan-2</td>
<td>Erect</td>
<td>Green</td>
<td>Sparse</td>
<td>None</td>
<td>White</td>
<td>Green</td>
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<tr>
<td>Pusa Hybrid 6</td>
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<td>Green</td>
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<tr>
<td>Arka Anand</td>
<td>Spreading</td>
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<td>None</td>
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</table>

### Hybrids

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Plant Growth Habit</th>
<th>Leaf Blade Colour</th>
<th>Leaf Pubesence</th>
<th>Leaf Prickels</th>
<th>Corolla Colour</th>
<th>Calyx Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajendra Baigan-2 × Muktakeshi</td>
<td>Spreading</td>
<td>Pale violet</td>
<td>Dense</td>
<td>None</td>
<td>Deep violet</td>
<td>Purple</td>
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<td>Spreading</td>
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<td>Dense</td>
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<td>Pale violet</td>
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<td>Green</td>
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<td>None</td>
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<td>BRBL-01 × Rajendra Baigan-2</td>
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<td>Dense</td>
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<td>Rajendra Baigan-2 × Swarna Mani</td>
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<td>Swarna Mani × Rajendra Baigan-2</td>
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<td>Few</td>
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<td>Light purple</td>
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<tr>
<td>Rajendra Baigan-2 × BRBR-01</td>
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<td>Pale violet</td>
<td>Light purple</td>
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### Appendix-2: Qualitative characters of five parents, eight hybrids and two checks

<table>
<thead>
<tr>
<th>Parents and Checks</th>
<th>Calyx Spininess</th>
<th>Fruit pedicel prickels</th>
<th>Fruit Shape</th>
<th>Fruit Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muktakeshi</td>
<td>Yes</td>
<td>Yes</td>
<td>Oblong</td>
<td>Blackish Purple</td>
</tr>
<tr>
<td>BRBL-01</td>
<td>Yes</td>
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<td>Oblong</td>
<td>Dark Green</td>
</tr>
<tr>
<td>Swarna Mani</td>
<td>Yes</td>
<td>Yes</td>
<td>Round</td>
<td>Blackish Purple</td>
</tr>
<tr>
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<td>Deep Purple</td>
</tr>
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<td>No</td>
<td>Long</td>
<td>Light Purple</td>
</tr>
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<td>Pusa Hybrid-6</td>
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<tr>
<td>Arka Anand</td>
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<td>Hybrids</td>
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<td></td>
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## Appendix-2: Qualitative characters of five parents, eight hybrids and two checks

<table>
<thead>
<tr>
<th>Parents and Checks</th>
<th>Calyx Spininess</th>
<th>Fruit pedicel prickels</th>
<th>Fruit Shape</th>
<th>Fruit Colour</th>
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<tr>
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<td>Blackish Purple</td>
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<td>Oblong</td>
<td>Deep Purple</td>
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<td>Pusa Hybrid-6</td>
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<td>Arka Anand</td>
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<td>Rajendra Baigan-2 x</td>
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<td>Purple</td>
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<td>Purple</td>
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<tr>
<td>Rajendra Baigan-2 x</td>
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<td>Purple</td>
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**Appendix-4: Mean value of parents, hybrids and checks for different characters**

<table>
<thead>
<tr>
<th>Parents, checks and Hybrids</th>
<th>Days to first flowering</th>
<th>Days to 50% flowering</th>
<th>Days to first fruit set</th>
<th>Number of Primary branches per plant</th>
<th>Plant height (cm)</th>
<th>Plant spread (cm)</th>
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<tbody>
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<td>Muktakeshi</td>
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<td>65.00</td>
<td>65.33</td>
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<td>66.67</td>
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<td>66.00</td>
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<td>79.56</td>
<td>82.99</td>
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<td>46.33</td>
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<td>65.67</td>
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<td>79.56</td>
<td>71.11</td>
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<td>Pusa Hybrid-6</td>
<td>41.33</td>
<td>56</td>
<td>67.66</td>
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<td>83</td>
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<tr>
<td>Arka Anand</td>
<td>47</td>
<td>67.66</td>
<td>68.66</td>
<td>3.33</td>
<td>71.66</td>
<td>72.44</td>
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<td>Rajendra Baigan-2 × Muktakeshi</td>
<td>51.00</td>
<td>59.33</td>
<td>66.67</td>
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<td>80.55</td>
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<td>71.33</td>
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<td>59.67</td>
<td>64.33</td>
<td>3.33</td>
<td>70.22</td>
<td>85</td>
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<tr>
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<td>61.33</td>
<td>3.66</td>
<td>89.11</td>
<td>101.33</td>
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<td>Swarnamani × Rajendra Baigan-2</td>
<td>45.67</td>
<td>57.00</td>
<td>57.33</td>
<td>3.66</td>
<td>87.66</td>
<td>89.88</td>
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<td>Rajendra Baigan-2 × BRBR-01</td>
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<td>55.67</td>
<td>3.66</td>
<td>74.66</td>
<td>89.55</td>
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<td>65.67</td>
<td>58.00</td>
<td>3.44</td>
<td>75.33</td>
<td>93.44</td>
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The ultimate aim of any plant breeding programme is to develop superior single cross hybrids. It requires knowledge of genetic makeup of important quantitative characters like yield and its attributing traits. Hence, there has been much renewed interest in the possibility of breeding not only for higher yield but also for better quality crops which can enhance and maintain a healthy human health and diet (Akthar and Hazra, 2013). Selection of parents for hybridization should not be only based on the visual agronomic characters as it may provide a misleading result. The selection of parents based on both visual and genetic parameters is expected to give better results over the selection based on visual parameters alone. The success in breeding programme mainly depends on the combining ability of the parents and choice of superior diverse parents for hybridization. The knowledge of gene action is a useful tool for selection of desirable parents for the development of superior crosses. There are two types of gene action, i.e. additive and non-additive. Panse (1957) suggested that if additive genetic variance is greater the chance of fixing superior genotypes in early segregating generation would be greater whereas if dominant and epistatic interactions are predominant the selection should be postponed to later generation and appropriate breeding techniques should be adopted to obtain useful genotype. The phenomenon of heterosis has attracted the attention of plant breeders due to its conspicuous effects on economic characters, especially fruit yield. Heterosis has been successfully exploited in many solanaceous vegetable crops among which brinjal is one of the major vegetable and the present study is an attempt in realizing the possibility of heterosis with respect to yield and its attributing traits along with quality. Unless and until we have ample information regarding the degree and direction of association for various traits and their direct and indirect influences on
important traits which is influencing the yield and quality parameters, thereby to grip heterosis and gene action studies which are the basic requirements for a thorough understanding of genetic nature of yield and quality components in a more precise manner. The present chapter therefore embodies a brief account of discussion on the entire findings of the investigation entitled “Study of inheritance pattern of major traits in brinjal (Solanum melongena L.)” by studying the genetics of 20 traits in 5 parents, 4 hybrids and 2 checks using random mating design including their 4 reciprocals. In this chapter, an attempt has been made to evaluate and explain important observations/ results recorded during the course of investigation and to discuss the cause(s) and effect(s) in a scientific manner, primarily in the light of available pertinent literature, as under. The salient features of the findings of the present investigation are being discussed here under the following headings:

5.1 Estimation of heterosis for yield its attributing traits and quality in brinjal

Exploitation of heterosis in cultivated plants is one of the most important happenings of the science of genetics in agricultural practices. The exploitation of heterosis requires an intensive evaluation of germplasm to find out diverse donors with high nicking of genes and further identification of heterotic crosses. The results of heterosis attained (Table 4.1 to 4.4) and range of mean values of parents showed the nature and magnitude of heterosis differed for different traits in various hybrid combinations. A close examination of heterotic values of the 4 maturity traits for earliness viz., days to first flowering, days to 50% flowering and days to first fruit set (Table 4.3 ), revealed that only a few F₁ hybrids exhibited significant but very low level of heterosis in desirable direction for all these characters. For maturity traits, negative heterosis is usually desirable, because this will cause the hybrids to produce first fruits earlier as compared to parents, thereby increasing the productivity per day per unit area.

For days to first flowering, the best performing F₁ hybrid regarding earliness for first flowering over the mid parent and better parent heterosis
(-17.88% and -23.92%, respectively) was Muktakeshi × Rajendra Baigan-2 and in same cross, standard heterosis for Pusa hybrid-6 was 0% and for Arka Anand was -12.05%. For 50% flowering, heterosis over mid parent and better parent heterosis was -18.84% and -22.22 %, respectively in Rajendra Baigan-2 × BRBR-01 cross and in the same cross, standard heterosis for Pusa hybrid-6 was 0% and for Arka Anand standard heterosis was -17.24%. For first fruit set, heterosis over mid parent and better parent was -15.44% and -15.22 % in Rajendra Baigan-2 × BRBR-01 and in the same cross standard heterosis for Pusa hybrid-6 was -17.73% and for Arka Anand was -18.93%. The results thus revealed the at par nature of this best performing F₁ hybrid ie. Rajendra Baigan-2 × BRBR-01 with the best standard check i.e. Pusa Hybrid-6 and Arka Anand for earliness characters followed by Muktakeshi × Rajendra Baingan-2. The significant heterobeltiosis estimated for all the maturity traits in desirable direction had also been reported by previous workers (Chowdhury et al, 2011; Reddy and Patel, 2014; Dudhat et al, 2013).

Standard heterosis over rest of the economic traits viz; plant height, plant spread, number of primary branches per plant, fruit length, fruit girth, yield per hectare were found to be having strong significant over the best standard check variety Pusa Hybrid-6 and Arka Anand, thereby depicting superiority of F₁ hybrids over the standard check for all the above mentioned economic traits. Similar kind of high heterosis compared to standard commercial check for these characters have also been reported by Prabhu et al. (2005), Suneetha et al. (2006), Dharwad et al. (2011), Kumar et al. (2013) and Dudhat et al., (2013). Considering the heterosis over standard variety Pusa Hybrid-6 and Arka Anand, the top ranking F₁ hybrids for the above mentioned characters are as follows: for plant height (43.98% and 24.34%) Rajendra Baigan-2 × Swarnamani for number of primary branches per plant (20.68% and 16.66%) Rajendra Baigan-2 × Muktakeshi. For plant spread, Rajendra baigan-2 × Muktakeshi showed 31.05% and 50.15% heterosis and for fruit length, Rajendra Baigan-2 × Muktakeshi showed 49.51% and 36.47% heterosis (over PH-6 and Arka Anand). For fruit girth, Swarnamani × Rajendra Baigan-2 showed -24.02%
and 83.44% heterosis over both the checks and for yield per hectare Rajendra baigan-2 × BRBR-01 depicted 86.26% and 27.55% (Table 4.1 and 4.4).

Fruits per plant is one of the most important components of fruit yield in respect of which hybrids with positive heterosis are desirable. The findings of the present study revealed that 3 crosses i.e. Swarnamani × Rajendra Baigan-2, Rajendra Baigan-2 × BRBR-01, BRBR-01 × Rajendra Baigan-1 expressed high significant heterosis in desirable direction over mid parent (Table 4.2), while 6 crosses showed very strong heterosis for number of fruit per plant over the standard variety Pusa Hybrid-6 from which hybrids were Rajendra Baigan-2 × Mukhtakeshi (45.89%), Rajendra Baigan-2 × BRBL-01 (114.01%), BRBL-01 × Rajendra Baigan-2 (107.75%), Swarnamani × Rajendra Baigan-2 (75.82%), Rajendra Baigan-2 × BRBR-01 (86.89%) and BRBR-01 × Rajendra Baigan-2 (94.63%). In general, the hybrids with significant heterosis for yield also expressed significant heterosis either for fruit weight or for fruits per plant. The work of Prabhu et al. (2005), Chowdhury et al. (2011), Dharwad et al. (2011) and Kumar et al. (2013) are close agreement with these findings.

The above finding indicated that some parental lines have strong heterotic capability compared to other ones during hybridization process. This may be due to diverse parent and favourable cross combination. As the performance of hybrids developed depend upon the heterotic capability of the parents involved, from economic point of view it will be useful to select and utilize the parental lines with strong heterotic capability for important traits associated with yield in order to achieve higher fruit yield in F₁ hybrids through exploitation of heterosis. Since earliness and desirable fruit shape are the important considerations for choice of elite high quality F₁ hybrids, so the decision for final selection of a hybrid for commercial cultivation should also be taken into account. The earlier two factors i.e earliness along with the latter i.e. high fruit quality should be used to exploit an ideal F₁ hybrid in brinjal so that it can suit not only domestic market in general but can also perform well in International market. Out of all the 8 hybrids so generated, three best
performing hybrids in terms of both total fruit yield and quality basis were Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × BRBR-01 and Swarnamani × Rajendra Baigan-2 which matches the present market demand.

5.2 Gene inheritance pattern of major characters in brinjal.

5.2.1 Gene action

The observed F₁ mean was compared with the parental mean and with the theoretical arithmetic mean. Disagreement between observed and theoretical arithmetic F₁ mean suggested the presence of dominance. Partial dominance exists when the observed F₁ mean stands between the theoretical arithmetic mean and the mean of either parent. Over-dominance is encountered when F₁ mean exceeds the higher parent or is lesser than the lower parent. The extent of agreement between observed and theoretical F₂ means indicates the nature of gene action in the inheritance of a particular trait. Arithmetic gene action assumes that the effects of individual gene upon the genotype are additive, whereas, geometric gene action considers that they are multiplicative suggesting non-additive gene action in genotypes. Observed mean for any trait in any cross, if is in close agreement with both theoretical arithmetic and theoretical geometric mean, it indicates importance of both additive and non-additive gene action for the control of this character. Observed F₂ mean if much lower than both theoretical arithmetic and geometric mean with slight inclination towards theoretical geometric mean, clearly suggests the importance of non-additive gene action for the inheritance for the trait. Observed F₁ in between the theoretical arithmetic mean and the parents connotes to partial dominance for the trait. Observed mean for a trait in F₂ of any cross is in close agreement with both the theoretical arithmetic mean and the theoretical geometric mean, indicating the importance of both additive and non-additive gene action for the control of the character. If the observed F₂ mean was much higher than both the theoretical arithmetic and geometric mean with slight inclination towards the arithmetic mean. This denotes the importance of additive gene action for trait inheritance.
Days to first flowering

For first flowering in case of Rajendra Baigan-2 × BRBR-01 cross, observed F₁ mean (43) was lesser than the lower parent 46.33 (Rajendra Baigan-2), indicating the over-dominance. The observed F₂ mean (86.53) was greater than both theoretical arithmetic mean F₂ (47.08) and theoretical geometric mean (46.80) suggesting additive gene action (table 4.5). For the same trait in Rajendra Baigan-2 × Swarnamani observed F₁ mean (47) exceeds the higher parent 46.67 (Swarnamani) indicating the over-dominance, whereas the observed F₂ mean (84.85) was greater than both theoretical arithmetic mean F₂ (46.75) and theoretical geometric mean (46.75) suggesting additive gene action (table 4.6). For first flowering in third cross Rajendra Baigan-2 × Muktakeshi observed F₁ mean (51) was in between lower parent 46.33 (Rajendra Baigan-2) and higher parent 54.33 (Muktakeshi) depicting partial dominance existence, while the observed F₂ mean (84.91) was greater than both theoretical arithmetic mean F₂ (50.67) and theoretical geometric mean (50.58) additive gene action (Table 4.7) In fourth cross, Rajendra Baigan-2 × BRBL-01 observed F₁ mean (48.33) exceeds the higher parent 47.33 (BRBL-01) showing over-dominance, while the observed F₂ mean (88.01) was greater than both theoretical arithmetic mean F₂ (47.58) and theoretical geometric mean (47.58) for first flowering resulting additive gene action (Table 4.8). These results are in line with the work done by Banerjee and Kalloo (1989), Saha M.C. (1993), Abdelmageed (2010).

First fruit set

For 1ˢᵗ fruit set in Rajendra Baigan-2 × BRBR-01 cross, observed F₁ mean (55.67) was lesser than the lower parent 65.67 (Rajendra Baigan-2) showing the over-dominance, while the observed F₂ mean (96.9) was greater than both theoretical arithmetic mean F₂ (60.75) and theoretical geometric mean (60.53). This denotes the importance of additive gene action (Table 4.5). In Rajendra Baigan-2 × Swarnamani observed F₁ mean (61.33) was lesser than the lower parent 62.33 (Swarnamani) indicating the over-dominance, while the observed F₂ mean (95.19) was greater than both theoretical arithmetic mean F₂
(62.67) and theoretical geometric mean (62.64) for 1st fruit set. This denotes the importance of additive gene action (Table 4.6). In Rajendra Baigan-2 × Muktakeshi observed F$_1$ mean (66.67) exceed the higher parent 65.67 (Rajendra Baigan-2), reflecting the over-dominance gene effect, while the observed F$_2$ mean (95.95) was greater than both theoretical arithmetic mean (66.08) and theoretical geometric mean (66.08) for 1st fruit set. This denotes the importance of additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01 observed F$_1$ mean (65.66) was with similar value to lower parent 65.66 (Rajendra Baigan-2) and higher parent 69 (BRBL-01) depicting partial dominance existence, while the observed F$_2$ mean (97.01) was greater than both theoretical arithmetic mean F$_2$ (66.5) and theoretical geometric mean (66.48) for 1st fruit set. This denotes the importance of additive gene action (Table 4.8). The work is in line with the result of the research done by Abdelmageed (2010) and Dharwad (2011).

**Primary branches per plant**

For primary branches per plant, Rajendra Baigan-2 × BRBR-01 cross resulted higher observed F$_1$ mean (3.66) than the higher parent 3.44 (BRBR-01) indicating the over-dominance, while observed F$_2$ mean (2.48) was lesser than theoretical arithmetic mean (3.47) and geometric mean (3.46) for primary branches. It indicated the importance of both additive and non-additive gene action (Table 4.5). In Rajendra Baigan-2 × Swarnamani observed F$_1$ mean (3.67) was in between lower parent (Rajendra Baigan-2) and higher parent 5.71 Swarnamani reflecting partial dominance, while observed F$_2$ mean (2.65) was lesser than theoretical arithmetic mean (4.03) and geometric mean (3.93) for primary branches. It indicated the importance of both additive and non-additive gene action (Table 4.6). In Rajendra Baigan-2 × Muktakeshi, observed F$_1$ mean (3.88) exceeded the higher parent 3.11 (Rajendra Baigan-2) showing the existence of partial dominance, while observed F$_2$ mean (2.38) was lesser than theoretical arithmetic mean (3.48) and geometric mean (3.46) for primary branches. It indicated importance of both additive and non-additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01 observed F$_1$ mean (3.16)
exceeded the higher parent 3.11 (Rajendra Baigan-2), indicating the over-
dominance, while observed $F_2$ mean (2.94) was lesser than theoretical
arithmetic mean (3.08) and geometric mean (3.08) for primary branches again
reflecting the effects of both additive and non-additive gene action (Table 4.8).
The result are in line with the work done by Dhameliya and Dobariya. (2009),
Dharwad (2011).

**Plant height**

For plant height, observed $F_1$ mean of Rajendra Baigan-2 × BRBR-
01 cross (74.67) stood in between lower parent 67.88 (BRBR-01) and higher
parent 79.56 (Rajendra Baigan-2) indicating partial dominance existence, while
observed $F_2$ mean (66.85) was lower than theoretical arithmetic mean (74.19)
and geometric mean (74.07) clearly suggesting the non-additive gene
action(Table 4.5). In Rajendra Baigan-2 × Swarnamani observed $F_1$ mean
(89.11) exceeded the higher parent 79.56 (Rajendra Baigan-2), indicating the
over-dominance, while observed $F_2$ mean (69.76) was lesser than theoretical
arithmetic mean (81.98) resulting geometric mean (81.59) for plant height. This
clearly suggests the importance of non-additive gene action (Table 4.6). In
Rajendra Baigan-2 × Muktakeshi observed $F_1$ mean (80.56) stand in between
lower parent 79.56 (Rajendra Baigan-2) and higher parent 88.02 (Muktakeshi),
indicating partial dominance existence, while observed $F_2$ mean (70.7) was
lesser than theoretical arithmetic mean (82.17) resulting geometric mean (82.1)
for plant height clearly showing non-additive gene action (Table-4.7). In
Rajendra Baigan-2 × BRBL-01 observed $F_1$ mean 71.33 (Rajendra Baigan-2 ×
BRBL-01) stands between higher parent 79.56 (Rajendra Baigan-2) and lower
parent 61.78 (BRBL-01), indicating partial dominance existence, while
observed $F_2$ mean (62.81) lower than both theoretical arithmetic mean (71) and
geometric mean 70.71 for plant height, clearly suggesting the importance of
non-additive gene action (Table 4.8 ). These results are in line of work done by
Plant spread

In Rajendra Baigan-2 × BRBR-01 observed F₁ mean 89.55 (Rajendra Baigan-2 × BRBR-01) exceeds the higher parent 88.88 (BRBR-01) indicating the over-dominance effect, while observed F₂ mean (75.02) was lower than both theoretical arithmetic mean (86.27) and geometric mean (86.10) for plant spread. This clearly suggests the importance of non-additive gene action (Table 4.5). In second cross Rajendra Baigan-2 × Swarnamani observed F₁ mean 101.33 stands in between lower parent 77.11 (Rajendra Baigan-2) and higher parent 135.96 (Swarna Mani), i.e. Partial dominance exists, while observed F₂ mean (77.51) was lower than both theoretical arithmetic mean (103.93) and geometric mean (101.86) for plant spread, clearly suggesting the importance of non-additive gene action (Table 4.6). In third cross, Rajendra Baigan-2 × Muktakeshi observed F₁ mean 108.77 exceeded the higher parent 132.19 (Muktakeshi) i.e, Partial dominance exists, while F₂ mean 78.97 was found lower than both theoretical arithmetic mean (106.71) and geometric mean (104.79) for plant spread, clearly suggesting the importance of non-additive gene (Table 4.7). In fourth cross, Rajendra Baigan-2 × BRBL-01 observed F₁ mean (84.77) exceeded the higher parent 77.11 (Rajendra Baigan-2) indicating the over-dominance, while differences between the observed F₂ mean (76.55) was lower than the theoretical arithmetic mean (79.42) and theoretical geometric mean (79.21) for plant spread indicating the importance of both additive and non-additive gene action (Table 4.8). The results are as per the results obtained by Dharwad (2011), Hasanuzzaman and Golam (2011) and Deshmukh (2014).

Fruit length

In Rajendra Baigan-2 × BRBR-01 observed F₁ mean 16.5 stood in between the higher parent 26.11 (Rajendra Baigan-2) and lower parent 11.16 (BRBR-01), i.e partial dominance exists, while differences between the observed F₂ mean (22.27) was higher than theoretical arithmetic mean (17.57) and geometric mean (16.78) for fruit length. This denotes the importance of
additive gene action (Table 4.5). In Rajendra Baigan-2 × Swarnamani observed 
F₁ mean 14.55 stood in between higher parent 26.11 (Rajendra Baigan-2) and 
lower parent 10.44 (Swarnamani), i.e. Partial dominance exists, while 
differences between the observed F₂ mean (19.89) was higher than both the 
theoretical arithmetic mean (16.41) and geometric mean (15.50) for fruit length. 
This denotes the importance of additive gene action (Table 4.6). In Rajendra 
Baigan-2 × Muktakeshi observed F₁ mean 17.11 was lesser than lower parent 
(17.28) indicate the over-dominance. While differences between the observed 
F₂ mean (23.03) for fruit length was higher than both the theoretical arithmetic 
mean (19.40) and geometric mean (19.06) for fruit length (Table 4.7). This 
denotes the importance of additive gene action. In Rajendra Baigan-2 × BRBL-01 
observed F₁ mean (16.67) stands in between lower parent 16 (BRBL-01) and 
higher parent 26.11 (Rajendra Baigan-2) i.e. Partial dominance exists, while the 
observed F₂ mean (20.47) was higher than theoretical arithmetic mean (18.86) and 
geometric mean (18.45) for fruit length (Table 4.8). This denotes the importance of 
additive gene action and is as per the work done by Dharwad (2011).

**Fruit girth**

In Rajendra Baigan-2 × BRBR-01 observed F₁ mean (13.11) was 
lesser than lower parent 13.59 (Rajendra Baigan-2) indicate the over-
dominance, while observed F₂ mean (18.02) higher than both theoretical 
arithmetic mean (14.54) and geometric mean (14.39) for fruit girth. This clearly 
suggests the importance of additive gene action (Table 4.5). In Rajendra 
Baigan-2 × Swarnamani observed F₁ mean 13.72 stands between lower parent 
13.59 (Rajendra Baigan-2) and higher parent 26.15 Swarnamani i.e. partial 
dominance exists, while differences between the observed F₂ mean (19.79) was 
higher than both theoretical arithmetic mean (16.79) and geometric mean 
(16.08) for fruit girth. This clearly suggests the importance of additive gene 
action (Table 4.6). In Rajendra Baigan-2 × Muktakeshi F₁ mean 13 was found 
lesser than lower parent 13.59 (Rajendra Baigan-2) indicated the over-
dominance effect, while differences between the observed F₂ mean (17.78) 
exceeded the arithmetic mean (15.46) and geometric mean (15.03) for fruit girth
trait. It indicated the role of both additive and non-additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01 F\textsubscript{1} mean 11.62 was found lesser than lower parent 13.59 (Rajendra Baigan-2) indicate the Over-dominance. while differences between the observed F\textsubscript{2} mean (17.65) exceeded the arithmetic mean (13.92) and geometric mean (13.66) for fruit girth. It indicated additive gene effects (Table-4.8) and matches the result of Dharwad (2011), Hasanuzzaman and Golam (2011) and Deshmukh (2014).

**Average fruit weight**

In Rajendra Baigan-2 × BRBR-01 observed F\textsubscript{1} mean (109.95) was in between lower parent 90.04 (Rajendra Baigan 2) and higher parent 154.48(BRBR-01), *i.e.* partial dominance exists. While, differences between the F\textsubscript{2} mean (77.40) was lower than arithmetic mean (116.10) and geometric mean (113.87) for average fruit trait. This clearly suggests the importance of non-additive gene action (Table 4.5). In Rajendra Baigan-2 × Swarnamani observed F\textsubscript{1} mean 130.91 exceeded the higher parent 148.81 (Swarnamani) *i.e.* partial dominance exists, while observed F\textsubscript{2} mean (84.32) was lower than both theoretical arithmetic mean (125.17) and geometric mean (123.10) for average fruit trait. This clearly suggests the importance of non-additive gene action (Table 4.6). In Rajendra Baigan-2 × Muktakeshi observed F\textsubscript{1} mean 107.38 was lower than lower parent 90.04 (Rajendra Baigan-2), *i.e.* Partial dominance exists, while differences between the observed F\textsubscript{2} mean (92.11) was much lower than both theoretical arithmetic mean (119.80) and geometric mean (116) for average fruit trait clearly suggesting the effect of non-additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01, F\textsubscript{1} mean 72.38 was lesser than lower parent 85.30 (BRBL-01), indicating the over-dominance, while differences between the observed F\textsubscript{2} mean (71.34) was lesser than theoretical arithmetic mean (80.02) and geometric mean (79.64) for average fruit trait clearly suggesting the importance of non-additive gene action (Table 4.8). These results are in line with the work done by Banerjee and Kalloo (1989), Dhameliya and Dobariya (2009), Dharwad (2011), Hasanuzzaman and Golam (2011) and Deshmukh (2014).
Yield/plant

In Rajendra Baigan-2 × BRBR-01 cross \( F_1 \) mean 2152.41 exceeded the higher parent 1717.51 (Rajendra Baigan-2) indicating the over-dominance, while differences between the observed \( F_2 \) mean (1178.69) stood in between theoretical arithmetic (1796.88) and geometric mean (744.97) for yield/plant (Table 4.5). This clearly suggests the importance of non-additive gene action. In Rajendra Baigan-2 × Swarnamani \( F_1 \) mean 1860.20 exceeded the higher parent 1717.54 (Rajendra Baigan-2), indicating the over-dominance effect, while differences between the observed mean (138.46) was much lower than both theoretical arithmetic (1623.58) and geometric mean (1582.93) for yield/plant. This clearly suggests the importance of non-additive gene action (Table 4.6). In Rajendra Baigan-2 × Muktakeshi observed \( F_1 \) mean 1644.17 stands between higher parent (1717.54) Rajendra Baigan-2 and lower parent (1400.4) Muktakeshi, i.e. partial dominance exists, while differences between the observed mean (1412.25) was much lower than both theoretical arithmetic (1601.57) and geometric mean (1596.85) for yield/plant. This clearly suggests the importance of non-additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01, \( F_1 \) mean 1618.47 was found lesser than lower parent 1717.54 (Rajendra Baigan-2) indicating over-dominance, while differences between the observed mean (1425.19) was much lower than both theoretical arithmetic (1767.09) and geometric mean (1756.1) for yield/plant clearly suggesting the importance of non-additive gene. These results matches the results of work done by Singh (2008), Rattan and Chadha (2009), Dharwad (2011), Hasanuzzaman and Golam (2011) and Deshmukh (2014).

Fruit/plant

In Rajendra Baigan-2 × BRBR-01 \( F_1 \) mean 19.67 exceeded the higher parent 19.09 (Rajendra Baigan-2) indicating the over-dominance, while differences between the observed \( F_2 \) mean (15.35) was in close agreement with both theoretical arithmetic (16.49) and theoretical geometric mean (15.35) for fruit/plant. It indicated importance of both additive and non-additive gene
action (Table 4.5). In Rajendra Baigan-2 × Swarnamani observed $F_1$ mean 14.20 stood in between higher parent 19.09 (Rajendra Baigan-2) and lower parent 7.19 Swarnamani i.e. partial dominance exists, while differences between the observed $F_2$ mean (16.72) exceeded both theoretical arithmetic (13.67) and theoretical geometric mean (12.90) for fruit/plant. It indicated the importance of non-additive gene action (Table 4.6). In Rajendra Baigan-2 × Muktaeshe $F_1$ mean 15.36 stands between the higher parent 19.09 (Rajendra Baigan-2) and lower parent 8.07 (Muktaeshe), i.e. partial dominance exists, while differences between the observed $F_2$ mean (15.58) exceeded both theoretical arithmetic mean (14.47) and theoretical geometric mean(13.81) for fruit/plant. It indicates importance of both additive and non-additive gene action (Table 4.7). In Rajendra Baigan-2 × BRBL-01 $F_1$ mean 22.53 stands between lower parent 19.09 (Rajendra Baigan-2) and higher parent 24.82 (BRBL-01), i.e partial dominance existed, while differences between the observed $F_2$ mean (20.03) was lower than both theoretical arithmetic mean (22.24) and theoretical geometric mean (22.15) for fruit/plant it indicates importance of both additive and non-additive gene (Table 4.8). These results matches the results of work done by Singh (2008), Rattan and Chadha (2009), Dharwad (2011), Hasanuzzaman and Golam (2011) and Deshmukh (2014).

**Chi square test**

**Calyx spininess**

**Null hypothesis** : the ratio of segregation of spiny and non-spiny calyx in $F_2$ is 3:1.

The null hypothesis was accepted in all the crosses, (Rajendra Baigan-2 × Muktaeshe, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBL-01) for the value of ‘p’ in each case was much higher than 0.05. Hence it is proved that ‘calyx spines’ was monogenically dominant over ‘non spininess’ and the single gene responsible is for calyx spininess and for non spininess. For this reason, calyx spines (absent) × calyx spines (present) cross produced all spine present both in $F_1$ and $F_2$. Similar result was suggested by Lachyan and Dalvi (2013), Kadams et al.

**Plant growth habit**

**Null hypothesis**: The ratio of segregation of plant growth habit spreading, intermediate and erect in F$_2$ is 9:6:1.

Null hypothesis for conditioning of the character growth habit in all crosses (Rajendra Baigan-2 × Muktaekshi, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBl-01) by two polygenes has been accepted because ‘p’ was much higher than 0.05. Similar result was found by Brittingham W.M. (1950), Saunders. A.R. (1960), Pethe, U. B. (1990), Lokprakash, (1979), Kumar S.R. et al. (2013) and Ghafoor, A. et al. (2003) and Kehinde, O.B and Adeniji, O.T. (2003).

**Leaf blade colour**

Null hypothesis: the ratio of segregation of leaf blade colour in F$_2$ is 9:3:4.

The null hypothesis was accepted in three crosses (Rajendra Baigan-2 × Muktaekshi, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01) for the value of ‘p’ in each case was much higher than 0.05. Hence it is proved that leaf blade colour is segregate into 9:3:4. Similar result was found by Brittingham W.M. (1950), Saunders. A.R. (1960), Pethe, U. B. (1990), Lokprakash, (1979). Kumar S.R. et al (2013), Ghafoor, A. et al (2003) and Kehinde O.B. and Adeniji, O.T. (2003).

**Leaf pubescence**

F$_2$ segregation: 67 (Dense): 33 (Sparse)

Null hypothesis: the ratio of segregation of leaf pubescence in F$_2$ is 3:1
The null hypothesis was accepted in all the crosses (Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBl-01), for the value of ‘p’ in each case was much higher than 0.05. Hence it is proved that ‘leaf pubescence dense’ was monogenically dominant over ‘sparse’ and the single gene responsible is for dense and for sparse. For this reason, leaf pubescence (absent) × leaf pubescence (present) cross produced all leaf pubescence present both in F₁ and F₂. Similar result was found by Lachyan and Dalvi (2013), Kadam et al. (2015), Brittingham, W.M. (1950), Saunders, A.R. (1960), Pethe, U. B. (1990), Lokprakash, (1979), Kumar S.R. et al. (2013), Ghafoor, A. et al. (2003) and Kehinde, O.B. and Adeniji, O.T. (2003).

**Fruit Pedicel Prickles**

Null hypothesis: the ratio of segregation of fruit pedicel prickles in F₂ is 3:1

The null hypothesis was accepted in all the crosses (Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBl-01) for the value of ‘p’ in each case was much higher than 0.05. Hence it is proved that ‘fruit pedicel prickles was monogenically dominant over ‘absent prickles’ and the single gene responsible is for fruit pedicel prickles present and for absent. For this reason, fruit pedicel prickles (absent) × fruit pedicel prickles (present) cross produced all fruit pedicel prickles present both in F₁ and F₂. Similar result was found by Lachyan and Dalvi (2013), Kadam et. al (2015), Pethe, U. B. (1990), Lokprakash, (1979), Kumar, S.R. et al. (2013), Ghafoor, A. et al. (2003) and Kehinde, O.B. and Adeniji, O.T. (2003).

**Fruit Shape**

The null hypothesis was accepted in the crosses (Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × Swarna Mani), for the value of ‘p’ in each case was much higher than 0.05. Hence, fruit shape is controlled by two and three gene. Similar result was find by Pethe, U. B. (1990), Lokprakash, (1979),

**Leaf prickles**

Null hypothesis: The ratio of segregation of leaf prickles (3:1) is absent in F$_2$. *i.e.* both the parental lines are homozygous monogenic recessive, hence the F$_1$ is also homozygous monogenic recessive and there is no segregation in F$_2$.

The null hypothesis was accepted in all the crosses, (Rajendra Baigan-2 × Muktakashe, Rajendra Baigan-2 × Swarna Mani, Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBl-01) for the value of ‘p’ in each case was much higher than 0.05. Hence it is proved that ‘leaf prickles was monogenically dominant over ‘absent prickles’ and the single gene responsible is for leaf prickles present and for absent. For this reason, leaf prickles (absent) × leaf prickles (present) cross produced all the leaf prickles present both in F$_1$ and F$_2$.

Plate 1: Estimation of heterosis in F₁ cross including reciprocals
Plate 2: Estimation of heterosis in F₁ cross including reciprocals
Plate 3: SEGREGATING POPULATION IN F₂
SUMMARY AND CONCLUSION

The present investigation entitled “Study of inheritance pattern of major traits in brinjal (Solanum melongena L.)” was conducted at vegetable section of Bihar Agricultural University Sabour, Bhagalpur, Bihar. Random crossing was carried out using five parents with a view to study the heterosis and gene inheritance pattern of 4 hybrids, 4 along with their reciprocals and 4 segregating population along with 2 checks that were being evaluated during Kharif 2016-17. The seedling was transplanted on 24\textsuperscript{th} August, 2016 in randomized block design with three replications. The observations were recorded for the characters namely plant height (cm), plant spread (cm\textsuperscript{2}), no of primary branches per plant, days to first flowering, days to 50\% flowering, days to first fruit set, days to first harvest, fruit length (cm), fruit girth (cm), average fruit weight (gm), test weight (gm), no of fruits per plant, fruit yield per plant (gm) and total fruit yield (q/ha). Estimation of heterosis and gene action (gene inheritance pattern) studies was done for above mentioned characters and the results of research works are summarized below:-

1. In the present study of heterosis, for earliness trait cross Muktakeshi × Rajendra Baigan-2 possessed high significant mid parent heterosis, better parent heterosis, standard heterosis for Pusa Hybrid-6 and for Arka Anand towards days to first flowering respectively.

2. Rajendra Baigan-2 × BRBR-01 possessed high mid parent heterosis, better parent heterosis, standard heterosis for Pusa Hybrid -6 and for Arka Anand in the desirable direction for 50\% flowering. The same cross (Rajendra Baigan-2 × BRBR-01) was having high significant mid parent heterosis,
better parent heterosis, standard heterosis for Pusa Hybrid-6 and for Arka Anand the desirable direction for first fruit set also.

3. Cross Muktakeshi × Rajendra Baigan-2 and Rajendra Baigan-2 × BRBL-01 were found earliest to flowering and days to first fruit set.

4. Heterosis studies for plant growth character in Rajendra Baigan-2 × Muktakeshi possessed high significant mid parent heterosis, better parent heterosis, standard heterosis for Pusa Hybrid-6 and for Arka Anand towards primary branches per plant followed by Rajendra Baigan-2 × BRBR-01.

5. Rajendra Baigan-2 × Swarna mani possesed high significant mid parent heterosis, better parent heterosis and standard heterosis for Pusa Hybrid-6 and for Arka Anand towards plant height followed by Swarna mani × Rajendra Baigan-2.

6. For plant spread, Rajendra Baigan-2 × Muktakeshi possessed high significant standard heterosis for Pusa Hybrid-6 and Arka Anand in the desirable direction for plant spread followed by Rajendra Baigan-2 × Swarna mani.

7. Heterosis studies for fruit character revealed that Rajendra Baigan-2 × Muktakeshi possessed high significant standard heterosis for Pusa Hybrid-6 in the desirable direction for fruit length followed by Rajendra Baigan-2 × BRBL-01.

8. For fruit girth trait maximum positive significant heterosis over standard heterosis for Arka Anand was seen in Swarna mani × Rajendra Baigan-2 followed by Rajendra Baigan-2 × Swarna mani.

9. Heterosis studies for yield attributing traits in Rajendra Baigan-2 × BRBR-01 have maximum positive significant heterosis over mid parent heterosis, better parent heterosis and standard heterosis for Pusa Hybrid-6 and Arka Anand towards yield per hectare followed by BRBR-01 × Rajendra Baigan-
2, Swarnamani × Rajendra Baigan-2, BRBL-01 × Rajendra Baigan-2 and Rajendra Baigan-2 × Swarnamani.

10. For average fruit weight Rajendra Baigan-2 × Swarnamani have maximum positive significant heterosis over standard heterosis for Pusa Hybrid-6 and Arka Anand.

11. Rajendra Baigan-2 × BRBR-01 possessed high significant standard heterosis in the desirable direction for yield per plant followed by BRBR-01 × Rajendra Baigan-2, Swarnamani × Rajendra Baigan-2, BRBL-01x Rajendra Baigan-2 and Rajendra Baigan-2 × Swarnamani.

12. Rajendra Baigan-2 × BRBL-01 was having high significant standard heterosis for fruit per plant followed by BRBL-01x Rajendra Baigan-2, BRBR-01 × Rajendra Baigan-2, Rajendra Baigan-2 × BRBR-01 and Swarnamani × Rajendra Baigan-2.

13. In the present study of gene inheritance pattern it was depicted that cross Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × BRBL-01 and Rajendra Baigan-2 × Swarnamani showed over-dominance for days to first flowering, while $F_2$ population for first flowering suggested additive gene action for all the four crosses.

14. Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × Swarnamani, Rajendra Baigan-2 × Muktakeshi indicated over-dominance for first fruit set, while in $F_2$ population for first fruit set suggested additive gene action in all the four crosses.

15. Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × BRBL-01 revealed over-dominance for primary branches per plant. Whereas, in $F_2$ population for same trait both additive and non-additive gene action was observed.
16. Rajendra Baigan-2 × BRBR-01, Rajendra Baigan-2 × Muktakeshi and Rajendra Baigan-2 × BRBL-01 indicated partial dominance for plant height, while in F\textsubscript{2} population for plant height non additive gene action was seen.

17. Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × BRBL-01 indicated over-dominance for plant spread, while in cross Rajendra Baigan-2 × Muktakeshi and Rajendra Baigan-2 × Swarnamani partial dominance was seen. In F\textsubscript{2} population non additive action was observed except Rajendra Baigan-2 × BRBL-01 for plant spread.

18. Rajendra Baigan-2 × Muktakeshi, Rajendra Baigan-2 × Swarnamani and Rajendra Baigan-2 × BRBL-01 indicated the partial dominance fruit length except Rajendra Baigan-2 × BRBR-01. While in F\textsubscript{2} population for fruit length suggested additive gene action was seen in all the four crosses.

19. All the three crosses showed over-dominance for fruit girth except Rajendra Baigan-2 × Swarna Mani. While in F\textsubscript{2} population for fruit girth suggested non additive gene action in Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × Swarna Mani. In cross Rajendra Baigan-2 × Muktakeshi and Rajendra Baigan-2 × BRBL-01 both additive and non additive gene action was observed.

20. All the three crosses showed partial dominance for average fruit weight except Rajendra Baigan-2 × BRBL-01, whereas in F\textsubscript{2} all the four crosses showed non additive gene action.

21. All the three crosses showed over dominance for yield per plant except Rajendra Baigan-2 × Muktakeshi, whereas in F\textsubscript{2} all the four crosses showed non additive gene action.

22. Rajendra Baigan-2 × BRBR-01 indicated the over-dominance fruit per plant, whereas rest three cross showed partial dominance. In F\textsubscript{2} population for fruit per plant suggested both additive and non additive gene action were observed for all the four crosses.
23. In Chi square studies the null hypothesis was accepted for all the crosses (Rajendra Baingan-2 × Muktakeshi, Rajendra Baigan-2 × BRBL 01, Rajendra Baigan-2 × Swarnamani and Rajendra Baigan-2 × BRBR-01), The Chi square value was lesser than the critical Chi square value at df=1. Besides, the value of ‘p’ in each case was much higher than 0.05. Hence it was proved that trait like calyx spininess, fruit pedicel prickles and leaf pubescence, was monogenically controlled by the single gene and were segregated into 3:1 ratio, while similar result was found in one of the cross Rajendra Baigan-2 × Swarnamani for leaf prickles present on upper surface.

24. For leaf prickles present on upper surface, rest three crosses except Rajendra Baigan-2 × Swarnamani showed 100% presence of leaf prickles in F₁ as well as in F₂ generation showing no segregation of trait.

25. The null hypothesis was accepted for all the three crosses Rajendra Baingan-2 × Muktakeshi, Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × Swarnamani for the trait plant growth habit. The Chi square value has been found to be lesser than the critical Chi square value at df=2. Besides, the value of ‘p’ in each case was much higher than 0.05. Hence it was proved that plant growth habit was controlled by two genes that is polymeric gene interaction and plant growth habit segregated into 9:6:1 (Spreading : Intermediate : Erect) ratio and in Rajendra Baigan-2 × BRBL-01 have no gene interaction because both parents are erect in growth habit showing 100% plant with erect growth habit in F₁ as well as in F₂ generation.

26. The null hypothesis was accepted for all the three crosses Rajendra Baingan-2 × Muktakeshi, Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × Swarnamani for leaf blade colour. The Chi square value has been found to be lesser than the critical Chi square value at df=2 Besides the value of ‘p’ in each case was much higher than 0.05. Hence it was proved that leaf blade colour was controlled by two genes that is supplementary gene interaction which gave the segregation ratio of 9:3:4.
(Purple : Greenish purple : Green) ratio. In Rajendra Baigan-2 × BRBL-01 have no gene interaction because both parents have green colour leaf blade in F₁ as well as in F₂ generation showing no segregation.

27. In Rajendra Baingan-2 × Muktakeshi and Rajendra Baigan-2 × Swarnamani the null hypothesis was accepted for fruit shape. The Chi square value has been found to be lesser than the critical Chi square value at df=2. Besides, the value of ‘p’ in each case was much higher than 0.05. Hence it was proved that fruit shape was controlled by two genes that is supplementary gene interaction and fruit shape segregated into 9:3:4 (Long : Oblong : Round) ratio. In Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × BRBL-01 for fruit shape was controlled by three genes with complimentary gene interaction in the ratio of 9:7 (Long : Oblong).

**Future Scope of Research**

On the basis of result and discussion made so far, it may be concluded that plant spread, days to first fruit set, number of fruits per plant and fruit yield per plant can be put to direct selection pressure in order to increase both yield and quality simultaneously in brinjal as these characters exerted direct effect on yield capacity. The hybrids which were identified superior during the research work were Rajendra Baigan-2 × BRBR-01 and Rajendra Baigan-2 × BRBL-01 which can be advanced for improvement of specific traits targeting mainly on yield and earliness traits.


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