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STUDIES ON HETEROSIS FOR FRUIT YIELD AND ITS COMPONENT TRAITS OVER DIFFERENT ENVIRONMENTAL CONDITION IN BRINJAL (*SOLANUM MELONGENA* L.)

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ABSTRACT

The present investigation was carried out to estimate standard heterosis analysis utilizing eight parents including check and twenty eight hybrids were developed through half diallel mating design. Total thirty six genotypes were evaluated in Randomized Block Design with three replications at three different locations during the year *Rabi* 2021-22. Observations were recorded for fifteen different characters related to yield, quality and pest-disease incidence for this study. The range of standard heterosis for fruit yield per plant was -14.77 to 26.14 % at Navsari (L1), -24.18 % to 23.08 % at Waghai (L2) and -22.73 to 14.77 % at Bardoli (L3). None of the hybrid exhibited positive and significant standard heterosis over all locations. Among total twenty eight hybrids; some top hybrids *viz*., NB-20-7 × GJB 3 and NB-20-4 × GJB 3 at Navsari (L1), NB-20-1 × NB-20-7 and NB-20-3 × GJB 3 at Waghai (L2), NB-20-7 × GJB 3, NB-20-4 × NB-20-9 at Bardoli (L3) exhibited positive and significant standard heterosis for fruit yield per plant with yield contributing traits.
***Keywords* :** Heterosis, Half diallel, Fruit yield, Environment, Brinjal

Introduction

Brinjal (*Solanum melongena* L., 2n = 2x = 24) belongs to family solanaceae; prominent and widely known vegetable crop in India. It is an annual herbaceous plant and it is mainly cultivated in tropical and sub-tropical regions of the globe for its immature fruits as vegetable. It is a versatile crop growing into different agro-climatic regions and can be cultivated throughout the year. It is a native to the Indian subcontinent.

As we know that brinjal continues to be a choice of breeders for exploitation of heterosis due to hardy nature of crop, large size of flowers and large number of seeds per cross. Highly varied consumer acceptance from region to region, low cost of hybrid seed production and low seed requirement per unit area are also demands for development of a large number of high yielding F_1 hybrids. It has been an ideal experimental material for genetic studies due to easy emasculation and pollination. (Pal and Singh, 1949; Mishra, 1961).

Consumers of south Gujarat region prefer purple, round-oval shape, spineless, medium size fruits and long cylindrical large size fruits depending upon its use. The local varieties like “Surati Ravaiya” (round oval) and “Bilimora Bharatha” (long cylindrical) having low yield and susceptibility to diseases and pests. The local genotype and “Bilimora Bharatha” specially used for a food recipe which is popular in South Gujarat region called as “Bharatha”. So, our basic idea is to develop hybrids/ varieties resemble to “Bharatha type” with higher yield as well as quality. To determine the best hybrid combination, heterosis analysis was performed.

Material and Methods

The experimental materials use for present investigation including 28 hybrids developed by 8 × 8 half diallel design, 8 parents (NB-20-1,NB-20-3,NB-20-4,NB-20-5,NB-20-7,NB-20-8,NB-20-9 and GJB-3) including check (GJB-3). Crossing block was developed at Vegetable Research Station, RHRS, Navsari Agricultural University, Navsari. The complete set of 36 genotypes comprising of 28 F_1, 8 parents including check were evaluated in a Randomized Block Design (RBD) with three replications over three different locations during late *Rabi* 2021-22 *viz*., College farm, NMCA, Navsari (L1), Hill Millet Research Station, Waghai (L2) and Wheat Research Station, Bardoli (L3) situated in South Gujarat region. Each entry was sown in a single row having 12 plants keeping row-to-row and plant-to-plant distance of 90 cm and 60 cm, respectively. The recommended package of practices and plant protection measures were followed to raise the healthy crop. Observations *viz*., plant height (cm), branches per plant, days to 50 % flowering, flowers per plant, fruits per plant, fruit length (cm) fruit weight (g), fruit diameter (cm), fruit yield per plant (kg), total phenol content (mg/100 g), total soluble sugar (%) and ascorbic acid (mg/100 g) were recorded on five randomly selected plants from each entry in each replication over the locations. Observations like plant height and fruit length were measured by measure scale, branches per plant, days to 50 % flowering, flowers per plant, fruits per plant by count basis on field, fruit diameter by vernier calliper, fruit yield per plant by weighing balance, total phenol content by adopting the procedure suggested by Malik and Singh (1980), total soluble sugars by adopting the procedure proposed by Dubois *et al.* (1956) and ascorbic acid by 2,6-dichlorophenol indophenol dye method as described by Sadasivam and Manickam (2008) in brinjal.

Results and Discussion

The result for analysis of variances revealed highly significant differences among the genotypes for all of the characters at all three different locations, indicating that there was abundant amount of variability present among all the genotypes in the field. Similar results for genotypes, were also observed by Rani *et al.* (2018), Modh *et al.* (2019), Bagade *et al.* (2020), Kolekar *et al.* (2022) and Naveen *et al.* (2022). With regard to parents, it also showed significant amount of variation for all the traits at all the three locations, indicating that parents possess good amount of genetic variability. Similar results were also observed by Rani *et al.* (2018), Bhatt *et al*. (2019), Chaurasia *et al.* (2019), Modh *et al.* (2019), Bagade *et al.* (2020), Kolekar *et al.* (2022) and Naveen *et al*. (2022). High divergence in the parental lines for most of the characters indicated their suitability for developing divergent hybrids (Mondal *et al*., 2021). Similarly, mean square due to hybrids was found significant for all the characters in all the three locations which specify the diverse response of hybrids.

The outcomes for parent *vs* hybrids were highly significant for plant height (cm), branches per plant, days to 50 % flowering, flowers per plant, fruit weight (g), fruit diameter (cm), fruit yield per plant (kg), total phenol content (mg/100 g), total soluble sugar (%) and ascorbic acid (mg/100 g) for all three locations. These indicates the performance of hybrids as a group was different than that of parents for the given characters which confirms the presence of considerable heterosis due to directional dominance (Bhatt *et al.,* 2019), providing a chance of sorting out some good hybrids for one or more locations. Similar results were also seen by Rani *et al.* (2018) and Naveen *et al.* (2022).

Environments, the results were highly significant for plant height (cm), branches per plant, flowers per plant, fruits per plant, fruit weight (g), fruit diameter (cm), total phenol content (mg/100 g) and ascorbic acid (mg/100 g) in pooled analysis indicating significant influence of environments on the expression of these characters. Pooled analysis had displayed an interesting result showing highly significant outcomes for genotypes, parents, hybrids for all of the characters in pooled over locations suggesting presence of considerable amount of genetic variation in the material for the characters.

In present investigation, heterosis has been calculated over standard check (GJB 3). The objective of the heterosis analysis in this study was to characterise the parents for their potential in upcoming breeding programmes and find an appropriate combination of parents generating a high degree of standard heterosis.

Plant Height (cm)

The ideal plant type is one which is long and acts as source trait to support yield and its component traits (Rani *et al*., 2018). Number of branches for plant can be related with plant height. As taller the plant there may be more chances of higher number of branches and it reflect on fruit yield. That's why an ideal plant should have more height and hence, heterosis in positive direction is desirable for plant height (Santosha *et al*., 2017).

Results revealed that plant height (cm) was significant for 19 hybrids in Navsari (L1); 19 hybrids in Waghai (L2) and 20 hybrids in Bardoli (L3), out of which 7 hybrids exhibits significant and positive standard heterosis for plant height (cm) at Navsari (L1), while 8 hybrids at Waghai (L2) and 10 hybrids at Bardoli (L3). The best performing hybrids for standard heterosis were *viz*., NB-20-1 × NB-20-7 (16.17 %), NB-20-3 × GJB 3 (13.26 %) and NB-20-7 × GJB 3 (12.86 %) at Navsari (L1). The best performing hybrid for standard heterosis at Waghai (L2) were *viz*., NB-20-7 × GJB 3 (24.26 %), NB-20-1 × NB-20-7 (19.71 %) and NB-20-1 × NB-20-3 (19.12 %) while, hybrids *viz*., NB-20-7 × GJB 3 (25.44 %), NB-20-1 × NB-20-7 (24.83 %) and NB-20-3 × GJB 3 (21.87 %) at Bardoli (L3). These findings are in conformity with Rani *et al.* (2018), Chaurasia *et al.* (2019), Modh *et al.* (2019), Bagade *et al.* (2020), Chaudhari *et al.* (2020), Makasare *et al.* (2020), Timmareddygari *et al.* (2020), Kolekar *et al.* (2022) and Susmitha *et al.* (2023).

Branches per plant

As per Rani *et al*. (2018), the number of primary branches per plant is one of the major contributing traits for fruit yield per plant, hence, positive heterosis is desirable for this trait.

For branches per plant, out of 28 hybrids, none of the hybrid at Navsari (L1), one hybrid *viz*., NB-20-4 × NB-20-9 (17.12 %) at Waghai (L2) whereas, two hybrids *viz*., NB-20-1 × GJB 3 (12.17 %) and NB-20-3 × GJB 3 (10.00 %) at Bardoli (L3) possess significant and positive standard heterosis. These results were also obtained by Rani *et al.* (2018), Bhatt *et al.* (2019), Chaurasia *et al.* (2019), Chaudhari *et al*. (2020), Singh *et al*. (2021), Kolekar *et al*. (2022) and Susmitha *et al.* (2023).

Days to 50 % flowering:

The early flowering is positively associated with early yield in brinjal. Earliness also leads to early supply of the produce in the market and enables it to fetch a higher price Rani *et al.* (2018). It also fits well in multiple cropping systems, so negative heterosis was the priority for flowering (Kamalakananan *et al.,* 2007).

The perusal of data revealed that out of 28 hybrids, two hybrids *viz*., NB-20-3 × NB-20-8 (-9.71 %) and NB-20-1 × NB-20-4 (-8.74 %) at Navsari (L1), one hybrid *viz*., NB-20-8 × GJB 3 (-6.72) at Waghai (L2) and three hybrids *viz*., NB-20-1 × NB-20-3 (-7.61 %), NB-20-3 × GJB 3 (-7.61 %) and NB-20-4 × NB-20-8 (-7.61 %) at Bardoli (L3) had significant and negative standard heterosis for this trait. Significant and negative standard heterosis for day to 50 % flowering was also observed by Chaurasia *et al.* (2019), Modh *et al.* (2019), Chaudhari *et al*. (2020), Makasare *et al*. (2020), Timmareddygari *et al*. (2020), Kolekar *et al.* (2022) and Naveen *et al*. (2022).

Flowers per plant

Floral biology has important practical implications, in addition to its scientific relevance, given that flower characteristics and bloom affect fruit characteristics and yield (Rosati *et al.,* 2012).

Out of 28 hybrids, 14 hybrids at Navsari (L1), 6 hybrids at Waghai (L2) and 5 hybrids at Bardoli (L3) showed significant standard heterosis for these traits. Among those, 10 hybrids, 4 hybrids and 5 hybrids exhibited positive and significant standard heterosis at Navsari (L1), Waghai (L2) and Bardoli (L3), respectively. The best performing hybrids were NB-20-7 × NB-20-9 (28.60 %), NB-20-1 × NB-20-9 (25.44 %) and NB-20-3 × NB-20-8 (24.81 %) at Navsari (L1), NB-20-7 × NB-20-9 (24.31 80 %), NB-20-4 × NB-20-9 (22.28 %) and NB-20-3 × NB-20-8 (17.77 %) at Waghai (L2) while, NB-20-4 × NB-20-9 (24.34 %), NB-20-1 × NB-20-9 (19.55 %) and NB-20-1 × NB-20-5 (17.35 %) at Bardoli (L3). The positive and significant standard heterosis for flowers per plant was also reported by Samlindsujin and Karuppaiah (2018).

Fruits per plant

Number of fruits per plant is economically important character to get higher yield. Standard heterosis for fruit yield per plant is positively associated with heterosis for number of fruits per plant (Rani *et al.* 2018). Hence, emphasis should be given to developing such hybrids which possess more number of fruits per plant.

The promising positive and significant hybrids for this trait were NB-20-7 × NB-20-9 (29.06 %) followed by NB-20-1 × NB-20-9 (26.50 %) and NB-20-3 × NB-20-8 (23.16 %); NB-20-7 × NB-20-9 (30.16 %) followed by NB-20-4 × NB-20-9 (28.42 %) and NB-20-3 × NB-20-8 (23.16 %); NB-20-4 × NB-20-9 (33.00 %) followed by NB-20-7 × NB-20-9 (29.00 %) and NB-20-1 × NB-20-9 (27.00 %) at Navsari (L1), Waghai (L2) and Bardoli (L3), respectively. For this trait, significant and positive standard heterosis was also reported by Rani *et al.* (2018), Bhatt *et al.* (2019), Chaurasia *et al.* (2019), Khobragade *et al.* (2019), Modh *et al*. (2019), Bagade *et al.* (2020), Kolekar *et al*. (2022), Naveen *et al.* (2022) and Susmitha *et al.* (2023).

Fruit length (cm)

Fruit length is an important parameter of fruit deciding consumer preference (Dharwad, 2007).

A total of 10, 9 and 11 hybrids exhibited positive and significant standard heterosis at Navsari (L1), Waghai (L2) and Bardoli (L3), respectively. The outstanding positive and significant hybrids were NB-20-1 × NB20-4 (34.50 %) followed by NB-20-1 × NB-20-3 (33.27 %) and NB-20-1 × NB-20-5 (29.41 %) at Navsari (L1); NB-20-1 × NB-20-4 (28.01 %) followed by NB-20-1 × NB-20-5 (23.31 %) and NB-20-1 × NB-20-3 (22.84 %) at Waghai (L2); NB-20-4 × GJB 3 (23.57 %) followed by NB-20-4 × NB-20-9 (22.74 %) and NB-20-1 × NB-20- 5 (21.53 %) at Bardoli (L3). Positive and significant standard heterosis for fruit length (cm) was also observed by Rani *et al.* (2018), Chaurasia *et al.* (2019), Khobragade *et al.* (2019), Chaudhari *et al.* (2020), Makasare *et al.* (2020), Singh *et al.* (2021) and Susmitha *et al.* (2023).

Fruit Weight (g)

Fruit weight is one of the important component traits having positive correlation with the fruit yield. So positive and significant heterosis is desirable for this trait (Chaurasia *et al.* 2019).

Out of 28 hybrids, 8, 0 and 7 hybrids exhibited significant standard heterosis in positive direction at Navsari (L1), Waghai (L2) and Bardoli (L3) respectively. Hybrids viz., NB-20-1 × NB-20-8 (27.72 %), NB-20-3 × NB-20-9 (26.98 %) and NB-20-5 × NB-20-8 (22.09 %) at Navsari (L1); NB-20-1 × NB-20-7 (7.79 %), NB-20-5 × NB-20-8 (7.08 %) and NB-20-3 × GJB 3 (4.38 %) at Waghai (L2); NB-20-1 × GJB 3 (36.63 %), NB-20-7 × GJB 3 (22.48 %) and NB-20-1 × NB-20-7 (20.18 %) at Bardoli (L3) were the best performing hybrids for fruit weight (g). Positive and significant standard heterosis were also found by Samlindsujin and Karuppaiah (2018), Khobragade *et al.* (2019), Bagade *et al.* (2020), Chaudhari *et al.* (2020), Makasare *et al.* (2020), Naveen *et al.* (2022), Nikhila *et al.* (2022) and Susmitha *et al.* (2023).

Fruit Diameter (cm)

Fruit diameter is also one of the parameters that contributes towards fruit yield of brinjal and also commercially important traits to gain high market value through high productivity (Desai *et al.,* 2016).

Top three performing hybrids were *viz.,* NB-20-4 × NB-20-5 (16.25 %), NB-20-3 × NB-20-4 (13.97 %) and NB-20-3 × NB-20-8 (13.28 %) at Navsari (L1); NB-20-3 × NB-20-4 (13.31 %), NB-20-4 × NB-20-5 (13.31 %) and NB-20-3 × NB-20-9 (12.35 %) at Waghai (L2) while, NB-20-3 × NB-20-9 (15.46 %), NB-20-3 × NB-20-4 (13.09 %) and NB-20-4 × NB-20-5 (12.12 %) at Bardoli (L3).These results were in close conformity with the earlier finding of Khobragade *et al.* (2019), Bagade *et al.* (2020), Chaudhari *et al.* (2020), Makasare *et al.* (2020), Timmareddygari *et al.* (2020), Kolekar *et al.* (2022), Naveen *et al.* (2022) and Nikhila *et al.* (2022).

Fruit Yield per Plant (kg)

Improvement in fruit yield in brinjal is one of most important breeding objective of plant breeder. So, the superiority of hybrids over best cultivated hybrid is essential for increasing its commercial value (Bhatt *et al.,* 2019) and yield in any crop is the final product of different yield components. Therefore, positive standard heterosis is highly desirable for this character (Das *et al.,* 2009).

Results revealed that fruit yield per plant (kg) was significant for 2 hybrids at Navsari (L1); 5 hybrids at Waghai (L2) while, 3 hybrids at Bardoli (L3). Among these hybrids *viz.,* NB-20-7 × GJB 3 (26.14 %) and NB-20-4 × GJB 3 (15.34 %) at Navsari (L1), hybrids *viz.,* NB-20-3 × GJB 3 (23.08 %) and NB-20-1 × NB-20-7 (18.13 %) at Waghai (L2) and hybrids *viz.,* NB-20-7 × GJB 3 (14.77 %), NB-20-4 × NB-20-9 (14.77 %) at Bardoli (L3) possess significant and positive standard heterosis for fruit yield per plant (kg). The best performing hybrid for standard heterosis were NB-20-7 × GJB 3 (26.14 %), NB-20-4 × GJB 3 (15.34 %) and NB-20-1 × NB-20-7 (11.93 %) at Navsari (L1). Similar finding in accordance to the above result has also been reported by Rani *et al.* (2018), Samlindsujin and Karuppaiah (2018), Bhatt *et al.* (2019), Chaurasia *et al.* (2019), Khobragade *et al.* (2019), Bagade *et al.* (2020), Chaudhari *et al.* (2020), Deshmukh *et al.* (2020) , Singh *et al.* (2021), Naveen *et al.* (2022), Nikhila *et al.* (2022) and Susmitha *et al.* (2023).

Total Phenol Content (mg/100 g)

Phenol content is also an important character as it helps to reduce the shoot and fruit borer incidence (Kumar *et al*., 2012). But it prone to browning after cutting the brinjal due to excess phenol content, which is less preferred by consumers. So, negative heterosis is desirable in this character (Mishra *et al*., 2012).

The results of standard heterosis for total phenol content (mg/100 g) from various locations revealed that out of 28 different hybrids evaluated at each location, none of the hybrid exhibited negatively significant standard heterosis for total phenol content (mg/100 g) at any of the location. Analogues kind of earlier findings are notice by Rani *et al.* (2018) and Timmareddygari *et al.* (2020).

Total Soluble Sugars (%)

Total soluble sugars (%) value affects the taste of the fruit, because it can indicate the level of sweetness of the fruit. Higher TSS gives the good fruit taste and consumer preference will be more for such fruits. So, the positive standard heterosis is desirable (Hadiwijaya *et al.*, 2020).

Results revealed that total soluble sugars (%) was significant for 11 hybrids in Navsari (L1); 8 hybrids in Waghai (L2) and 5 hybrids in Bardoli (L3), out of which 7 hybrids exhibits significant and positive standard heterosis at Navsari (L1), while 4 hybrids at Waghai (L2) and 3 hybrids at Bardoli (L3) possess significant and positive heterosis. Top hybrids in term of total soluble sugars were *viz.,* NB-20-1 × NB-20-5 (9.86 %), NB-20-9 × GJB 3 (9.07 %), NB-20-3 × NB-20-8 and NB-20-5 × NB-20-9 (7.89 %) at Navsari (L1), hybrids *viz.,* NB-20-3 × NB-20-9 (15.69 %), NB-20-9 × GJB 3 (9.80 %) and NB-20-4 × NB-20-7 (7.84 %) at Waghai (L2) and hybrids *viz.,* NB-20-3 × NB-20-9 (9.80 %), NB-20-3 × NB-20-8 (9.22 %) and NB-20-4 × NB-20-7 (9.22 %) at Bardoli (L3). The derived results were in conformity with Chaudhari *et al*. (2020) and Naveen *et al*. (2022).

Ascorbic Acid Content (mg/100 g)

The higher ascorbic acid content would increase the nutritive value of the fruits, which would help better retention of colour and flavour (Sasikumar, 1999).

Among these, the promising hybrids were *viz.,* NB-20-1 × NB-20-5 (49.89 %), NB-20-5 × GJB 3, NB-20-3 × NB-20-5, NB-20-3 × NB-20-9, NB-20-8 × NB-20-9 (25.05 %) and NB-20-4 × NB-20-9 and NB-20-5 × NB-20-9 (24.84 %) at Navsari (L1), hybrid *viz.,* NB-20-1 × NB-20-5 (51.91 %), NB-20-3 × NB-20-9 (23.52 %) and NB-20-5 × GJB 3 (23.31 %) at Waghai (L2) and hybrid *viz.,* NB-20-1 × NB-20-5 (51.48 %), NB-20-4 × NB-20-9 and NB-20-5 × NB-20-9 (22.78 %), NB-20-3 × NB-20-9 (22.57 %) at Bardoli (L3) exhibited positive and significant standard heterosis for this traits. The positive and significant standard heterosis were also reported by Rani *et al.* (2018), Chaudhari *et al*. (2020) and Timmareddygari *et al.* (2020).

From the above conversion about standard heterosis for various characters in different hybrid combination, none of the hybrid exhibited consistence standard heterosis for all the characters. This finding was also supported by Singh *et al.* (2021), Kolekar *et al.* (2022), Naveen *et al.* (2022), Nikhila *et al.* (2022) and Susmitha *et al.* (2023).

Fruit yield is complex character which is influenced by many traits like number of fruits per plant, fruit weight (g), fruit length (cm), plant height (cm), branches per plant etc. it cannot be taken as a single entry (Samlindsujin and Karuppaiah, 2018). In this experiment, five hybrids *viz.,* NB-20-7 × GJB 3 at Navsari (L1) and Bardoli (L3), NB-20-4 × GJB 3 at Navsari (L1), NB-20-1 × NB-20-7 and NB-20-3 × GJB 3 at Waghai (L2), NB-20-4 × NB-20-9 at Bardoli (L3) exhibited positive and significant standard heterosis for fruit yield per plant (kg).

In these top yielding crosses, there was no consistency with regard to the relationship between standard heterosis for yield and yield contributing characters. The hybrid NB-20-7 × GJB 3 and NB-20-1 × NB-20-7 had positive and significant standard heterosis for fruit weight (g) and plant height (cm), while the hybrid NB-20-4 × NB-20-9 had positive and significant standard heterosis for fruits per plant and flowers per plant. Hybrid NB-20-4 × GJB 3 had positive and significant standard heterosis fruit weight (g), fruit length (cm) and plant height (cm); while hybrid NB-20-3 × GJB 3 had significant and positive standard heterosis for fruit weight (g), fruits per plant, branches per plant and plant height (cm). This was due to interacting effects of different components in manifestation of standard heterosis for fruit yield (kg). Such reports were in collaboration with Ramani *et al.* (2015), Chaurasia *et al.* (2019), Bagade *et al.* (2020) and Susmitha *et al.* (2023).

On the other hand, for higher standard heterosis, early flowering is responsible and also early hybrids fit well in multiple cropping systems (Kamalakannan *et al*., 2007). For this trait, negative standard heterosis is to be considered as desirable. From the top hybrids, NB-20-3 × GJB 3 and NB-20-7 × GJB 3 had negative and significant and standard heterosis, which is desirable. These findings were in agreement with the findings reported by Chaurasia *et al.* (2019).

It is also interesting to note that some highly heterotic crosses for other important yield component like fruit weight (g), fruit length (cm), fruits per plant, flowers per plant did not exhibit significant and standard heterosis for fruit yield. On the contrary, some of the crosses exhibited significant and negative standard heterosis for these characters. Negative heterosis is due to negative allele coming from the lower scoring parents (Patil *et al*., 2001). Similar findings have been reported by Deshmukh *et al.* (2020) and Kolekar *et al.* (2022).

Conclusion

Utilizing hybrid vigour in brinjal has been acknowledged as a useful strategy for breeders looking to boost yield and other profitable traits. Heterosis measured over standard check is more realistic and has greater practical significance in plant breeding.

Estimation of standard heterosis suggested that maximum heterosis for fruit yield per plant were observed in hybrid, NB-20-7 × GJB 3 at Navsari (L1), NB-20-3 × GJB 3 at Waghai (L2) and NB-20-3 × NB-20-9 and NB-20-7 × GJB 3 at Bardoli (L3). None of the hybrid showed positive and significant standard heterosis for all the traits. These hybrids will be use in further breeding programme for hybridization in brinjal.

Table 1 : Estimation of standard heterosis at individual location for plant height (cm), branches per plant and days to 50 % flowering

Sr. No.	Hybrids	Plant height (cm)			Branches per plant			Days to 50 % flowering		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
		Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli
1.	NB-20-1 × NB-20-3	12.08**	19.12**	14.82**	2.91	-1.97	3.33	0.00	-1.92	-7.61*
2.	NB-20-1 × NB-20-4	1.10	-6.46	6.27*	1.89	-4.09	-13.33**	-8.74*	-3.84	-6.19
3.	NB-20-1 × NB-20-5	-5.21	8.69	1.57	-25.33**	-8.03	-5.50	2.42	-3.36	-2.86
4.	NB-20-1 × NB-20-7	16.17**	19.71**	24.83**	-11.64**	-9.09	-10.00*	-4.86	0.97	-5.24
5.	NB-20-1 × NB-20-8	-6.32	-15.06**	-4.97	-16.59**	-8.03	-10.00*	-6.80	4.33	-3.33
6.	NB-20-1 × NB-20-9	-11.92**	-10.18*	-8.18**	-24.31**	-5.00	-18.83**	0.96	-4.80	0.00
7.	NB-20-1 × GJB 3	7.17*	15.65**	12.47**	0.87	-1.97	12.17*	4.85	2.41	-2.86
8.	NB-20-3 × NB-20-4	-13.58**	-7.70	-9.06**	-28.24**	-30.30**	-16.67**	-5.34	-5.28	-1.43
9.	NB-20-3 × NB-20-5	-15.79**	-5.87	3.32	-7.86	-19.24**	-23.33**	2.91	6.74*	3.33
10.	NB-20-3 × NB-20-7	-4.66	5.55	-5.40	0.87	-8.03	-3.33	-1.95	-3.36	-2.86
11.	NB-20-3 × NB-20-8	-19.02**	16.32**	-7.49*	-17.47**	-28.33**	-28.83**	-9.71*	-1.44	-2.86
12.	NB-20-3 × NB-20-9	-10.89**	-6.37	-9.49**	-9.75	-27.27**	-18.83**	-0.98	8.18*	5.24
13.	NB-20-3 × GJB 3	13.26**	16.23**	21.87**	2.91	6.06	10.00*	-1.95	-4.80	-7.61*
14.	NB-20-4 × NB-20-5	10.45**	-14.32**	13.59**	-10.77	10.15	-7.83	7.76	2.41	2.39
15.	NB-20-4 × NB-20-7	-17.28**	-9.10*	-5.75	-6.84	11.06	-10.00*	-4.86	-2.88	-4.76
16.	NB-20-4 × NB-20-8	-1.42	-7.61	-11.41**	0.87	-1.97	-12.17*	-7.28	-3.84	-7.61*
17.	NB-20-4 × NB-20-9	-16.89**	-11.67*	-11.24**	1.89	17.12*	-15.50**	6.79	6.74*	5.71
18.	NB-20-4 × GJB 3	11.44**	15.82**	13.94**	-1.02	-1.06	-5.50	3.39	4.33	3.33
19.	NB-20-5 × NB-20-7	-15.79**	12.17**	11.16**	-1.02	4.09	6.67	-1.95	-2.88	-3.81
20.	NB-20-5 × NB-20-8	6.55	-11.92**	-5.31	0.00	3.03	-16.67**	8.74	4.33	6.67*
21.	NB-20-5 × NB-20-9	-13.73**	-12.00**	-10.88**	-4.95	0.00	-8.83	-2.91	-5.77	-3.81
22.	NB-20-5 × GJB 3	1.89	3.15	14.56**	-6.84	-1.06	-10.00*	-3.41	-0.48	-3.33
23.	NB-20-7 × NB-20-8	0.31	-12.67**	-1.91	-13.68**	0.00	-13.33**	2.91	6.74*	-3.81
24.	NB-20-7 × NB-20-9	-15.15**	-12.58**	-8.89**	-24.31**	1.97	-12.17*	-1.95	-1.92	0.47
25.	NB-20-7 × GJB 3	12.86**	24.26**	25.44**	0.87	3.03	0.00	-6.32	-3.36	-1.43
26.	NB-20-8 × NB-20-9	-9.47**	-11.34*	-4.97	-11.64*	-1.97	-5.50	0.96	-0.95	3.33
27.	NB-20-8 × GJB 3	3.79	-15.40**	-7.58*	-1.02	1.06	-8.83	-0.98	-6.72*	0.00
28.	NB-20-9 × GJB 3	-11.21**	-7.36	-12.98**	-10.77*	-10.15	-18.83**	8.24	3.38	4.76
	S.Ed ±	2.91	3.51	2.21	0.41	0.44	0.28	2.85	2.28	2.30
	CD @ 5 %	5.80	7.01	4.42	0.82	0.87	0.57	5.68	4.54	4.60
	CD @ 1 %	7.70	9.31	5.86	1.09	1.15	0.75	7.54	6.03	6.10

* and ** indicates significance at 5% and 1% levels of probability, respectively

Table 2 : Estimation of standard heterosis at individual location for flowers per plant, fruits per plant and fruit length (cm)

Sr. No.	Hybrids	Flowers per plant			Fruits per plant			Fruit length (cm)		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
		Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli
1.	NB-20-1 × NB-20-3	-11.36	-4.46	-4.59	-11.36*	0.00	-8.00	33.27**	22.84**	20.15**
2.	NB-20-1 × NB-20-4	16.40*	1.65	1.21	16.09**	7.00	7.65	34.50**	28.01**	19.59**
3.	NB-20-1 × NB-20-5	-9.57	12.92	17.35*	-10.08	20.68**	23.35**	29.41**	23.31**	21.53**
4.	NB-20-1 × NB-20-7	7.05	2.81	-6.43	5.40	9.11	-2.35	18.57*	17.11*	17.28**
5.	NB-20-1 × NB-20-8	-24.40**	-19.03**	-9.56	-24.89**	-19.63**	-25.00**	11.97	11.84	14.05*
6.	NB-20-1 × NB-20-9	25.44**	-0.66	19.55**	26.50**	4.58	27.00**	10.37	11.00	13.03*
7.	NB-20-1 × GJB 3	3.68	3.35	-3.92	3.17	8.05	-12.65*	11.31	11.56	14.97*
8.	NB-20-3 × NB-20-4	1.06	-0.12	3.87	0.66	4.89	8.35	-18.57*	1.88	-10.17
9.	NB-20-3 × NB-20-5	-12.62	-8.37	4.50	-12.92*	-9.84**	9.65	12.91	5.17	10.07
10.	NB-20-3 × NB-20-7	18.82**	3.63	15.99*	18.65**	13.32	17.00**	-1.23	-0.75	-0.65
11.	NB-20-3 × NB-20-8	24.81**	17.77*	8.51	24.61**	23.16**	14.65*	-1.70	0.38	1.11
12.	NB-20-3 × NB-20-9	-20.62**	14.08*	3.24	-21.11**	18.95*	4.00	1.98	-3.01	-5.55
13.	NB-20-3 × GJB 3	-1.58	12.49	2.66	-1.89	17.21*	5.65	-1.51	-10.81	-7.58
14.	NB-20-4 × NB-20-5	-22.29**	-12.21	4.55	-22.72**	-9.47**	12.35*	-8.11	15.60*	-6.38
15.	NB-20-4 × NB-20-7	-7.15	10.07	7.84	-7.24	16.47	16.00**	11.12	2.91	6.75
16.	NB-20-4 × NB-20-8	18.30**	-4.29	-3.40	17.98**	1.05	-6.00	16.21*	12.69	12.01*
17.	NB-20-4 × NB-20-9	21.66**	22.28**	24.34**	21.77**	28.42**	33.00**	14.89*	9.21	22.74**
18.	NB-20-4 × GJB 3	10.73	-2.97	2.62	10.41	2.79	4.65	22.71**	17.01*	23.57**
19.	NB-20-5 × NB-20-7	10.30	-5.33	2.82	9.80	0.37	7.65	16.49*	19.17**	11.00
20.	NB-20-5 × NB-20-8	-25.98**	-20.35**	-7.63	-26.17**	-17.53**	-13.65*	15.93*	17.11*	9.33
21.	NB-20-5 × NB-20-9	-4.53	-10.61	6.38	-5.68	-8.79**	7.00	12.44	6.67	4.99
22.	NB-20-5 × GJB 3	15.66*	5.33	13.37	15.14**	11.95	21.00*	18.10*	16.26*	20.52**
23.	NB-20-7 × NB-20-8	2.84	7.10	11.65	2.22	13.68	12.65*	-11.59	-9.40	-9.61
24.	NB-20-7 × NB-20-9	28.60**	24.31**	17.29*	29.06**	30.16**	29.00**	0.57	-3.20	-2.50
25.	NB-20-7 × GJB 3	19.87**	3.25	0.83	19.59**	10.16	5.35	-1.51	3.76	-4.99
26.	NB-20-8 × NB-20-9	-12.82	-9.36	6.58	-12.92*	-3.84	8.00	-2.36	-0.75	-2.68
27.	NB-20-8 × GJB 3	-11.67	-14.03	-8.93	-11.97*	-8.42**	-8.00	-5.75	-1.13	-4.44
28.	NB-20-9 × GJB 3	14.20*	13.37	-2.62	13.58*	22.79**	-1.00	-2.36	-3.38	-5.27
	S.Ed ±	4.32	4.27	4.54	1.19	1.01	1.20	0.79	0.72	0.62
	CD @ 5 %	8.62	8.52	9.06	2.37	2.02	2.39	1.58	1.44	1.23
	CD @ 1 %	11.44	11.31	12.03	3.15	2.7	3.17	2.09	1.91	1.63

* and ** indicates significance at 5% and 1% levels of probability, respectively.

Table 3 : Estimation of standard heterosis at individual location for fruit weight (g), fruits diameter (cm) and fruit yield per plant (kg)

Sr. No.	Hybrids	Fruit weight (g)			Fruit diameter (cm)			Fruit yield per plant (kg)		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
		Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli
1.	NB-20-1 × NB-20-3	18.69*	0.00	16.26*	0.00	1.92	4.60	-1.70	0.00	-5.11
2.	NB-20-1 × NB-20-4	-0.45	-7.13	4.93	-6.09	-4.94	-9.33*	7.95	-2.75	1.14
3.	NB-20-1 × NB-20-5	8.70	-20.64*	-8.54	-21.99**	-18.38**	-14.48**	-9.09	-3.85	0.57
4.	NB-20-1 × NB-20-7	12.04	7.79	20.18*	-5.53	-5.49	-5.01	11.93	18.13*	4.55
5.	NB-20-1 × NB-20-8	27.72**	-5.93	15.08	-14.25**	-13.17**	-8.36*	-11.36	-24.18**	-22.73**
6.	NB-20-1 × NB-20-9	-8.77	-10.59	-11.38	-13.97**	-8.78	-8.64*	7.95	-6.04	0.00
7.	NB-20-1 × GJB 3	13.59	2.39	36.63**	1.66	-0.14	-3.76	9.66	11.54	9.09
8.	NB-20-3 × NB-20-4	5.12	-8.52	4.14	13.97**	13.31**	13.09**	-1.14	-3.30	0.57
9.	NB-20-3 × NB-20-5	12.81	-4.89	-4.47	-8.44	-4.94	-8.50*	-7.95	-14.84	-6.25
10.	NB-20-3 × NB-20-7	-1.42	-11.69	3.65	1.94	3.29	-2.09	9.66	0.00	7.95
11.	NB-20-3 × NB-20-8	-4.48	-21.13*	-3.64	13.28**	10.15*	8.36*	11.36	-2.20	-1.14
12.	NB-20-3 × NB-20-9	26.98**	-20.41*	6.50	13.14**	12.35*	15.46**	-6.82	-4.95	-1.70
13.	NB-20-3 × GJB 3	21.51*	4.38	15.64*	0.14	-5.08	-2.51	10.80	23.08**	9.66
14.	NB-20-4 × NB-20-5	19.10*	-8.13	-4.72	14.25**	13.31**	12.12**	-13.07	-17.03*	-4.55
15.	NB-20-4 × NB-20-7	18.28*	-9.32	3.73	8.71**	-0.69	-1.25	2.27	5.49	5.68
16.	NB-20-4 × NB-20-8	-8.16	-12.78	11.88	-12.86**	-2.61	-4.60	1.14	-10.99	-6.25
17.	NB-20-4 × NB-20-9	-3.32	-22.23*	-3.30	-4.43	3.84	-3.06	9.66	0.55	14.77*
18.	NB-20-4 × GJB 3	11.80	4.19	16.75*	2.21	4.39	0.70	15.34*	7.69	7.95
19.	NB-20-5 × NB-20-7	1.32	-6.23	6.07	-1.52	4.80	3.76	5.11	-6.59	2.27
20.	NB-20-5 × NB-20-8	22.09*	7.08	13.87	-2.21	0.27	-0.28	-14.77	-12.64	-11.93
21.	NB-20-5 × NB-20-9	4.62	-2.76	-0.01	5.67*	-1.92	1.25	-7.39	-10.44	-4.55
22.	NB-20-5 × GJB 3	3.48	-13.57	-4.98	0.14	0.27	-1.67	11.36	-2.75	2.27
23.	NB-20-7 × NB-20-8	5.51	-15.03	3.64	-0.69	0.55	-0.97	1.14	-2.75	3.98
24.	NB-20-7 × NB-20-9	-10.08	-17.16*	-8.44	7.75**	7.82	3.76	10.80	8.24	5.68
25.	NB-20-7 × GJB 3	12.48	0.54	22.48**	-13.55**	-10.56*	-11.70**	26.14**	10.44	14.77*
26.	NB-20-8 × NB-20-9	14.78	-8.49	-3.22	0.55	1.78	0.00	-5.11	-11.54	-6.25
27.	NB-20-8 × GJB 3	18.40*	-9.91	19.25*	7.61**	8.37	4.46	-1.14	-17.03*	-2.27
28.	NB-20-9 × GJB 3	-0.10	-16.41	12.17	5.81*	5.35	6.41	6.82	3.30	-1.14
	S.Ed ±	6.97	7.33	6.07	0.25	0.36	0.27	0.13	0.15	0.12
	CD @ 5 %	13.89	14.61	12.10	0.49	0.72	0.55	0.27	0.29	0.24
	CD @ 1 %	18.44	19.40	16.06	0.65	0.96	0.73	0.36	0.39	0.31

* and ** indicates significance at 5% and 1% levels of probability, respectively.

Table 4 : Estimation of standard heterosis at individual location for total phenol content (mg/100 g), total soluble sugar (%) and ascorbic acid (mg/100 g)

Sr. No.	Hybrids	Total phenol content (mg/100 g)			Total soluble sugar (%)			Ascorbic acid (mg/100 g)		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
		Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli	Navsari	Waghai	Bardoli
1.	NB-20-1 × NB-20-3	5.28**	7.72**	8.10**	-1.97	-0.59	2.55	-9.13**	-9.53**	-8.65**
2.	NB-20-1 × NB-20-4	0.70	-1.40	5.28**	-9.86**	-9.80**	-12.35**	21.23**	21.82**	21.52**
3.	NB-20-1 × NB-20-5	3.52	3.16	0.00	9.86**	1.37	4.51	49.89**	51.91**	51.48**
4.	NB-20-1 × NB-20-7	3.52	-1.40	2.46	3.94	1.37	0.59	24.20**	22.88**	21.31**
5.	NB-20-1 × NB-20-8	3.87	-1.40	-1.06	1.18	4.51	3.92	-0.21	-0.21	-0.42
6.	NB-20-1 × NB-20-9	0.35	-0.70	-2.11	1.97	5.88	5.88	-0.21	1.27	-1.05
7.	NB-20-1 × GJB 3	2.82	0.00	-0.35	-7.89*	-4.51	-7.25*	-25.05**	-24.36**	-24.05**
8.	NB-20-3 × NB-20-4	9.86**	11.93**	10.21**	7.10*	4.51	4.51	-25.05**	-24.15**	-23.84**
9.	NB-20-3 × NB-20-5	5.99**	9.12**	8.45**	-9.86**	-10.39**	-4.51	25.05**	22.03**	22.15**
10.	NB-20-3 × NB-20-7	2.46	0.35	-1.41	3.94	4.51	3.92	0.00	0.42	1.69
11.	NB-20-3 × NB-20-8	0.70	-2.46	0.35	7.89*	5.29	9.22**	-25.05**	-24.15**	-24.05**
12.	NB-20-3 × NB-20-9	11.62**	12.63**	6.34**	7.10*	15.69**	9.80**	25.05**	23.52**	22.57**
13.	NB-20-3 × GJB 3	-0.70	-1.75	2.82	-0.79	0.59	3.92	0.00	0.21	0.21
14.	NB-20-4 × NB-20-5	0.00	-1.40	0.00	3.16	0.59	1.96	-25.27**	-23.52**	-23.42**
15.	NB-20-4 × NB-20-7	3.87	-1.05	0.00	-0.79	7.84*	9.22**	0.00	-0.85	-1.48
16.	NB-20-4 × NB-20-8	2.11	-1.40	-1.41	-4.73	-7.25*	-5.29	-46.28**	-45.97**	-45.57**
17.	NB-20-4 × NB-20-9	4.23	6.67**	8.45**	0.59	1.37	-0.59	24.84**	23.09**	22.78**
18.	NB-20-4 × GJB 3	10.21**	10.53**	10.21**	4.54	5.29	0.00	0.00	0.00	0.00
19.	NB-20-5 × NB-20-7	9.15**	12.98**	11.62**	-1.97	-7.84*	-4.51	-0.21	0.64	0.84
20.	NB-20-5 × NB-20-8	3.52	0.00	2.46	-9.27**	-5.88	-3.92	17.41**	18.22**	18.14**
21.	NB-20-5 × NB-20-9	13.38**	7.02**	8.80**	7.89**	7.25*	4.51	24.84**	22.88**	22.78**
22.	NB-20-5 × GJB 3	10.92**	6.67**	7.39**	0.00	-5.29	-2.55	25.05**	23.31**	21.73**
23.	NB-20-7 × NB-20-8	6.34**	6.32*	3.87	7.10*	2.55	3.33	-25.27**	-24.58**	-23.84**
24.	NB-20-7 × NB-20-9	15.85**	8.42**	10.21**	2.56	0.59	2.55	0.00	-1.06	-1.05
25.	NB-20-7 × GJB 3	5.28**	3.16	5.63*	1.18	0.00	-5.88	0.00	-2.33	-0.63
26.	NB-20-8 × NB-20-9	-2.46	-2.46	-0.35	-5.92	-5.29	-2.55	25.05**	21.61**	21.52**
27.	NB-20-8 × GJB 3	-1.06	-1.75	-1.76	-2.76	-3.92	-4.51	0.00	0.00	-0.42
28.	NB-20-9 × GJB 3	9.15	11.23**	11.27**	9.07**	9.80**	5.88	0.00	1.27	-1.05
	S.Ed ±	0.066	0.068	0.069	0.163	0.152	0.157	0.023	0.045	0.042
	CD @ 5 %	0.184	0.191	0.195	0.458	0.427	0.440	0.064	0.127	0.119
	CD @ 1 %	0.245	0.253	0.259	0.608	0.566	0.584	0.084	0.169	0.158

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