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Diallel analysis in brinjal (*Solanum melongena* L.) for fruit yield, its attributes and bacterial wilt resistance

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Abstract
A complete diallel cross study was carried out with six parents (Surya, L-3270, L-3263, R-2586, Arka Shirish and R-2583) and their F_1 progeny, to determine heterotic patterns and combining ability for fruit yield, its attributes and bacterial wilt resistance. Considerable magnitude of heterosis was expressed in F_1s for yield per plant character. The four hybrids viz., L-3270 X R-2586 (42.67%), L-3263 X L-3270 (30.91%), Arka Shirish X Surya (27.91%) and R-2583 X Surya (26.41%) qualify to be of commercial value as they manifested significant heterosis over resistant check (Arka Anand) for yield per plant with higher per se resistance to bacterial wilt. Combining ability analysis revealed that the majority of the characters were under the control of non-additive gene action as SCA variances were greater than GCA variances. It was evident from the research that additive variance (Va) was higher than dominance variance (Vd) in number of branches at 90 DAT, days to 50% flowering, fruit length, fruit diameter and number of fruits per plant which indicates preponderance of additivity in these characters, whereas in other thirteen cases dominance variance (Vd) was higher than additive variance (Va). Reciprocal cross differences were observed in most of the crosses with high SCA effects, so that the significance of reciprocal cross difference for all the characters exhibited the presence of a maternal effect.

Keywords: Diallel analysis; Brinjal; Bacterial wilt

1. Introduction
Brinjal (*Solanum melongena* L.) is one of the important vegetable crop belonging to the family Solanaceae. It features in the dishes of virtually every household in India, irrespective of food preferences, income levels or social status. As a part of the most basic or sophisticated Indian meal, brinjal is used in the preparation of a number of sumptuous dishes. Further, in recent years brinjal is being exported in the form of products like baingan bhartha, chatni, pickles etc. to Middle East countries.

The nutritive value of brinjal is comparable well with tomato [1] and fruits are rich source of minerals like Ca, Mg, P and fatty acids. Besides, it is used as fresh vegetable and known to have some medicinal properties in curing diabetics, asthma, cholera, bronchitis, diarrhoea and liver complaints [2]. Its fruits and leaves are reported to lower the blood cholesterol.

Along with tomato and onion, brinjal is the second most important vegetable after potato in India. India is second largest producer of brinjal in the world with an area and production of 7.11 lakh hectares and 135.57 lakh tonnes respectively, contributing to 27.20 per cent of the total world brinjal production. Brinjal share in total vegetable production in India is 8.3 per cent [3].

Successful cultivation of brinjal crop has been hindered due to attack of many insect pests and devastating diseases. Among diseases, bacterial wilt caused by *Ralstonia solanacearum* [4] is a major limiting factor, which has been the most ubiquitous and serious bacterial disease throughout the tropical, sub-tropical and temperate regions of the world [5]. Yield losses in brinjal ranging from 65 to 70 per cent have been reported [6].

Estimation of genetic parameters is needed to understand the genetic architecture of yield and yield contributing components. An information about the mode of gene action and heritability of all the yield contributing components and bacterial wilt resistance are having immense help for a plant breeder to decide about the proper breeding procedure to be adopted and the characters on which the selection has to be made so that selection for yield, yield attributing components and disease resistance are effective.

Most of the quantitative characters, which are of economic value, are highly influenced by environment. As such, highly heritable characters associated with yield are influenced to a lesser degree by environment, which serves as an indicator of high yield in selection programme. The nature and relative magnitude of gene action are also important where progress from selection depends primarily on the additive gene action.

Dominance on the other hand could be effectively utilized in the production of hybrids. If over dominance is exhibited, it would be worth while to use heterosis breeding. The genetic system of brinjal offers several advantages for exploiting heterosis. Exploitation of heterosis has become a potential tool in the improvement of brinjal [7].

Diallel cross designs are frequently used in plant breeding research to obtain information on genetic effects for a fixed set of parental lines or estimates of general combining ability (GCA) and specific combining ability (SCA) variance components from parental lines. The nature of gene action depends primarily upon genetic architecture and the divergence between the parents involved. It is therefore necessary to assess the genetic potentialities of the parents in hybrid combinations through systematic studies, in relation to general and specific combining abilities. In addition, the diallel cross technique was reported to provide early information on the genetic behavior of these attributes in the first (F_1) generation [8].

With keeping this in view the experiment was conducted to determine genetic architecture and to exploit heterosis for yield and its components and bacterial wilt resistance in brinjal (*Solanum melongena* L.)

2. Materials and methods

The field experiment with 30 hybrids, 6 parents and 2 commercial checks (Arka Anand and Pusa Hybrid-6) was carried out at P.G. Centre, UHS campus, Bangalore to estimate heterosis for yield and yield components and the combining ability effects with gene action. The material comprised of 6 parents *viz.*, Surya and L-3270 (resistant to bacterial wilt), L-3263 (moderately resistant), R-2586 (moderately susceptible), Arka Shirish and R-2583 (highly susceptible), besides these parents had good horticultural traits.. These Six parents, were crossed in 6 X 6 diallel crosses to produce the 30 possible F_1 hybrids (Fifteen F_1 plus Fifteen reciprocal F_1). The experiment was laid out in a randomized complete block design with three replications.

Thirty days old seedlings were transplanted in the wilt sick soil. Each entry was represented by single row of 15 plants spaced at 60 cm apart in a row, which were kept apart at 60 cm. Each seedling was artificially inoculated after 25 days after transplanting in the main field. An injury was made at 3rd leaf axil and half ml of inoculum of the concentration 1.0 X 10^8 cfu/ml ($O.D_{600}$ = 0.3) was poured at the injured site. The same set of parents (6), hybrids (30) and commercial checks (2) were raised in bacterial wilt free soil to assess the *per se* performance for various growth, yield and yield attributing characters. Five random plants per replication in each parent and cross were labeled and observation on 18 various characters (plant height and number of branches at 30, 60, 90 DAT, days to 50 per cent flowering, number of flowers per cluster, number of fruits per cluster, per cent fruit set, number of fruits per plant, fruit yield per plant, average fruit weight, fruit yield per hectare, fruit length, fruit diameter, fruit specific gravity and bacterial wilt disease incidence) were recorded.

The breeding value of the plant material was evaluated by analyzing the data on heterosis and combining ability for all the 18 characters at the F_1 generation. The analyses of variance for general (GCA) and specific (SCA) combining abilities and reciprocal effects (RE) were carried out according [9] Method 1 (Full diallel set) and Model 1. Heterosis (MP: mid-parent) and heterobeltiosis (BP: better parent) values were, respectively, calculated by using the formula [MP = (F1- mean of parents/mean of parents X 100]; [BP =(F1 - value of better parent/value of better parent X100] [10]. Statistical analysis of data was carried out by using WINDOWSTAT VERSION 9.1 from Indostat services.

3. Result and Discussion

3.1 Plant growth characters

Plant height is an important growth trait in brinjal which provides seat for number of primary branches. As the number of primary branches gives out secondary and tertiary branches, they determine the ideotype and is related to the crop duration and productivity. Therefore, plant height at 30, 60 and 90 DAT, number of branches at 30, 60 and 90 DAT are the characters related to plant growth and are discussed together.

The significance of variance due to parents and crosses, as revealed by analysis of variance (Table 1), indicated high genetic variability in respect of these 3 traits there by justifying their use in the present investigation.

With respect to heterosis for plant height at 30 days after transplanting, out of 30 crosses, 9 crosses showed positive and significant heterosis over mid parent, while 6 of the crosses showed significant and positive heterobeltiosis indicating the significant presence of over dominance. Positive heterosis over commercial check Arka Anand was also recorded in 20 crosses. Heterosis in these hybrids can be attributed to positive GCA effects of parents Arka Shirish and Surya. The hybrid Arka Shirish X Surya recorded maximum plant height and this may be due to positive GCA effect of Arka Shirish and Surya.

Out of 30 crosses for plant height at 60 days after transplanting, 11 crosses showed positive and significant heterosis over mid parent, while 5 crosses showed significant and positive heterobeltiosis indicating the significant presence of over dominance. Positive heterosis over commercial check Arka Anand was also recorded in 15 crosses. Heterosis in these hybrids can be attributed to positive GCA effects of parents Arka Shirish and R-2586. The hybrid R-2586 X L-3270 recorded maximum plant height with high SCA effect and this may be due to positive GCA effect of R-2586.

For plant height at 90 days after transplanting, out of 30 crosses 12 crosses showed positive and significant heterosis over mid parent, while 4 crosses showed significant and positive heterobeltiosis indicating the significant presence of over dominance (Table 2). Positive heterosis over commercial check Arka Anand and Pusa hybrid-6 was also recorded in 20 and 6 crosses respectively over the checks. Heterosis in these hybrids can be attributed to positive GCA effects of parents, Arka Shirish and R-2586.

Thirty days after transplanting, significant and positive heterosis over mid parent was observed in 4 crosses and heterobeltiosis in two crosses and over standard check Arka Anand and Pusa Hybrid-6, 4 and 2 crosses showed positive heterosis for number of branches. However heterobeltiosis may be due to positive GCA effect of Surya and R-2583. Heterosis among these crosses might be due to higher SCA variance than GCA variance indicating the presence of non-additive gene action[11].

Out of 30 crosses for number of branches at 60 days after transplanting, 4 crosses showed positive and significant heterosis over mid parent, while 1 cross showed significant and positive heterobeltiosis. Positive heterosis over commercial check Arka Anand and Pusa Hybrid-6 was also recorded in 7 and 1 cross respectively. Heterosis in these hybrids can be attributed to positive GCA effects of parents

Surya and R-2583. The hybrid R-2583 X Surya recorded maximum number of branches and this may be due to positive GCA effect of R-2583 and Surya[12].

For number of branches at 90 days after transplanting, out of 30 crosses none of the crosses showed significant heterosis over mid parent, better parent and checks (Table 2).

The study revealed that parents, Surya and Arka Shirish are best general combiners for plant height, among the crosses in respect of mean performance at 30 DAT, Surya X Arka Shirish, R-2583 X L-3263 and L-3270 X Arka Shirish showed highly significant positive SCA effect and significant reciprocal cross difference. Presence of high SCA effect in Surya X Arka Shirish may due to significant and positive GCA effect of parent's involved in the cross. At 60 DAT, the highest significant positive SCA effect with significant reciprocal cross difference was observed in the crosses R-2586 X Arka Shirish, R-2586 X Surya, R-2586X L-3263. At 90 DAT, the highest significant positive SCA effect and reciprocal cross differences were observed in the crosses R-2586 X Arka Shirish and R-2583 X L-3270. Both the parents of the best cross combination R-2586 X Arka Shirish were high x high general combiners indicating the role of additive x additive gene interaction. Presence of significant reciprocal cross differences shows the involvement of cytoplasm of female parent/ cytoplasm nuclear interaction in the expression of this trait, whereas absence of maternal effect/ cytoplasm nuclear interaction, involving only nuclear genes shows non-significant reciprocal effect[13].

Among hybrids at 30 DAT, Surya X R-2583, Arka Shirish X Surya showed highest significant SCA effect. Both the parents of this crosses were low general combiners for number of branches. At 60 DAT, crosses R-2586 X L-3270 and R-2586 X L-3263 recorded highest significant positive SCA effects and significant reciprocal cross differences. Both the parents of the R-2586 X L-3270 cross were very low general combiners for this trait. Such behaviour has been attributed to over dominance or epistasis. At 90 DAT, Surya X R-2586 recorded significant positive SCA effects and reciprocal cross difference (Table 4 &5). Presence of highest SCA effect in this hybrid may be due to the positive GCA effects of parents. Hence to utilize these crosses for improvement of number of branches, crossing is need to be done in only one direction without interchanging male and female parents.

These two traits, i.e plant height at 30, 60, 90 DAT and number of branches at 30 and 60 DAT recorded significant SCA variance, there by indicating predominance of non-additive gene action in the expression of these traits[14].

On overall basis, by considering the mean performance and heterosis, Arka Shirish X Surya, R-2586 X L-3270, Arka Shirish X R-2586, R-2583 X Surya crosses and based on significance of GCA and SCA effects, Surya X Arka Shirish, R-2586 X Arka Shirish, Surya X R-2583, R-2586 X L-3270, Surya X R-2586 crosses provide good base for deriving pure lines with enhanced plant ideotype consisting of better plant height and more number of branches with early flowering. However, enough care should be taken to select parents that exhibit low reciprocal effects in crosses during selection for the improvement of these traits.

3.2 Phenological parameters

Early flowering is generally an indication of early yield [15]. In case of days to 50 per cent flowering, 4 crosses showed significant negative heterosis over mid parent and 7 crosses showed significant negative heterosis over better parent. Nine crosses expressed significant negative heterosis over check Arka Anand and 7 crosses expressed significant negative heterosis over Pusa Hybrid-6, which is in desirable direction for this trait (Table 2) [16].

Five crosses showed significant negative SCA variance for days to 50 per cent flowering. Crosses L-3270 X Surya, Arka Shirish X R-2586 and L-3263 X Surya recorded significant and highest SCA effects in desirable direction for earliness with significant reciprocal cross differences (Table 5). Presence of significant SCA effects in L-3270 X Surya and L-3263 X Surya may be due to negative GCA effects of parents (Surya, L-3263 and L-3270) while such behaviour of Arka Shirish X R-2586 has been attributed to over dominance or epistasis, where both the parents of this cross were very low general combiners for this trait[17].

Significance of GCA effects in higher magnitude (Table 3) and high additive variance indicated the presence of additive gene action for days to 50 per cent flowering in the present study. Earlier workers [18] also reported significant GCA variance and additive gene action for days to 50 per cent flowering, thus the present findings are in consonance with previous reports.

On overall basis, by considering the significance of GCA and SCA effects L-3263 X Surya, Arka Shirish X R-2586 and L-3270 X Surya crosses provide good base for deriving pure lines with early flowering type.

3.3 Fruit yield attributes

Seventeen crosses showed significant and positive heterosis over mid parent, 8 crosses showed heterobeltiosis and twenty five and twenty seven crosses showed significant positive heterosis over commercial check Arka Anand (CC-1) and Pusa Hybrid-6 (CC-2) for number of flowers per cluster indicating the presence of over dominance (Table 2). Cross L-3270 X Surya exhibited more number of flowers per cluster. This may be due to the interaction of positive GCA values of L-3270 and negative GCA values of Surya for this trait[19].

Out of 30 crosses, 12, 5, 2 and 13 crosses showed significant positive heterosis over MP, BP, CC-1 and CC-2 respectively. Among hybrids, L-3263 X L-3270 and L-3270 X L-3263 showed more number of fruits per cluster. Presence of more number of fruits per cluster in this hybrids may be due to positive significant GCA effect of both the parents resulting high SCA effect in hybrid [19].

For fruit set per cent, 6, 2, 1 and 2 hybrids showed significant positive heterosis over MP, BP, CC-1 and CC-2 respectively. Presence of higher GCA variance for number of fruits per cluster and for flowers per cluster in the parents L-3270 and L-3263 lead to the hybrid with higher fruit set per cent.

However, 8 out of 15 crosses recorded significant positive SCA effects for number of flowers per cluster, number of fruits per cluster and per cent fruit set (Table 4). Among these, Surya X L-3270, Surya X Arka Shirish (for number of flowers per cluster), L-3263 X L-3270, R-2583 X Arka Shirish (for number of fruits per cluster and fruit set per cent) had highest SCA effects in desirable direction with significant reciprocal cross differences (Table 5). In the cross Surya X L-3270, one of the parent (L-3270) was high general combiner and the other parent was poor general combiner. This indicated the probable event of additive x dominance type of the interaction for the inheritance of number of flowers per cluster. In the cross L-3263 X L-3270, presence of significant positive SCA effects may be due to the significant GCA effects of parents. Both the parents of cross R-2583 X Arka Shirish had very low GCA effects (Table 3). Again this is an

instance of low x low general combiner producing best cross combination [20].

Therefore, crosses viz., Surya X L-3270, Surya X Arka Shirish, L-3263 X L-3270 and R-2583 X Arka Shirish should be concentrated in future breeding programmes for effective improvement of these traits.

Presence of higher dominance variance than additive variance shows the involvement of non-additive gene action for number of flowers/cluster, number of fruits per cluster and fruit set per cent [19].

3.4 Fruit related traits

There was considerable variation among the treatments for these traits as revealed by significant variances in the analysis of variance (Table 1). Many crosses recorded significant heterosis over two checks viz., Arka Anand and Pusa Hybrid-6 in respect of these three traits (Table 2). When the potentiality of crosses with heterosis and mean performance of crosses are taken into consideration, L-3270 X R-2583, Surya X R-2583, L-3270 X L-3263 cross hold promise for deriving lines with improved fruit length, fruit diameter and for fruit specific gravity characters respectively. Parents viz., Arka Shirish, L-3263, L-3270 (for fruit length), Surya, R-2583, R-2586 (for fruit diameter) and R-2583, L-3270, Arka Shirish (for fruit specific gravity) recorded high GCA effects indicating their importance in contributing for the improvement of fruit characters.

Although the analysis of variance for combining ability showed significant differences due to SCA, GCA and reciprocal variances, the magnitude of GCA (additive) variance were higher for fruit length and diameter and for fruit weight to fruit volume ratio SCA (non-additive) variance was higher (Table 1) [21, 22].

Out of 30 crosses, 11, 8 and 6 crosses recorded highly significant SCA effects (Table 4) in the desirable direction for fruit length, fruit diameter and fruit weight to volume ratio respectively, of which highest SCA effects were observed in the crosses R-2586 X Arka Shirish, R-2583 X L-3270, L-3270 X Arka Shirish (for fruit length), R-2586 X R-2583, L-3270 X R-2583, Arka Shirish X R-2583 (for fruit diameter) and L-3263 X Arka Shirish, L-3270 X R-2583, Surya X Arka Shirish (for fruit specific gravity). These crosses also revealed significant reciprocal differences for fruit related traits (Table 5). Presence of positive and significant general combining ability effects in the parent Arka Shirish might have influenced the fruit length in R-2586 X Arka Shirish. Both the parents of the best cross combination R-2586 X R-2583 were high x high general combiners indicating role of additive x additive gene inter action for fruit diameter [22].The cross, L-3263 X Arka Shirish which recorded significant highest reciprocal effect in desirable direction for fruit specific gravity contains low general combiners for this trait. Such behavior in this cross has been attributed presence of over dominance and epistasis interaction [13].

Thus, the present F_1 material from R-2586 X Arka Shirish, R-2586 X R-2583 and L-3263 X Arka Shirish crosses can prove useful to improve the fruit related characters for brinjal. However, it is essential to know their relationship with fruit yield and its components before making decision on actual selection criteria in breeding programme.

3.5 Yield and yield components

Superior performance of a genotype in terms of fruit yield per plant is the function of number of fruits per plant and average fruit weight, which in turn contribute to higher fruit yield per unit area (per hactare). Therefore, these four yield traits assume special significance in breeding for high yielding varieties or hybrids. The findings of various workers with varying magnitudes of significant heterosis, predominance of additive gene action and GCA variance indicate that fruit yield in brinjal can be improved by simple selection schemes.

Although six, seven and five crosses recorded significant heterosis over both checks in the desirable direction in varying magnitudes for number of fruits per plant, fruit yield per plant and average fruit weight respectively, the cross L-3263 X L-3270 (for number of fruits per plant), L-3270 X R-2586 (for fruit yield per plant), Arka Shirish X R-2583 (for average fruit weight) revealed superior mean performance along with significant positive heterosis for yield attributes [19].

Among the parents, L-3263 and L-3270 were found to be the best general combiner for number of fruits per plant and fruit yield per plant, whereas R-2583 and R-2586 were the best general combiner for average fruit weight. In other words, superiority of L-3263 X L-3270, L-3270 X R-2586 and Arka Shirish X R-2583 cross can be attributed to superior performance of the yield components in the desirable direction from these parents.

Both additive and non-additive gene actions were involved in the expression of fruit yield attributes of this breeding material. The GCA variance is important for number of fruits per plant, while SCA variance is predominant for fruit yield per plant, average fruit weight and fruit yield per hactare. Several workers have reported predominance of GCA variance for number of fruits per plant [21], SCA variance for average fruit weight [23, 24] and predominant SCA variance for fruit yield per plant [14] .

In crosses viz., L-3270 X Surya, L-3270 X L-3263, R-2583 X R-2586 (for number of fruits per plant), R-2586 X L-3270, R-2583 X R-2586, L-3270 X L-3263 (for fruit yield per plant and hactare) and Surya X R-2586, R-2583 X Arka Shirish, R-2586 X Arka Shirish (for average fruit weight), the highly significant and positive SCA effects were observed along with significant reciprocal cross differences (Table 4 & 5).

One of the parent (L-3270) was good general combiner and other parent was a low general combiner in both the crosses like, R-2586 X L-3270 and L-3270 X Surya, suggesting the involvement of additive x dominance type of interaction in the inheritance of number of fruits per plant, fruit yield per plant in these crosses. Presence of high SCA effect in the cross Surya X R-2586 mainly due to significant positive GCA effect of both the parents involved in the cross[13]. In chilli, significant reciprocal effect for green fruit yield [25] and in tomato significant reciprocal effects for mean fruit weight reported [26].

The crosses viz., L-3270 X Surya, L-3270 X L-3263, R-2586 X L-3270 and Surya X R-2586 were promising for future breeding programmes in advanced generations, as they showed highest SCA effects in desirable direction for yield components.

3.6 Bacterial wilt disease reaction

Bacterial wilt caused by *Ralstonia solanacearum* (Smith) [4] is one of the devastating diseases of many solanaceous vegetables in tropical and sub-tropical countries. Effective control of this disease through plant protection measures is an uneconomical and cumbersome method. Therefore, going for resistant cultivars is inevitable. Under such circumstances F_1s with high level of resistance are essential. Therefore, it is important to concentrate on the development of cultivars

which are resistant to this particular disease. Hence, breeding for disease resistance has been one of the most important objective of vegetable breeders.

The analysis of variance (Table 1) indicated significant variation for the selected parents and hybrids, indicating differential reaction of parents and crosses for bacterial wilt disease. As many as ten crosses recorded significant heterosis over resistant check viz., Arka Anand in respect of this trait. When the potentiality of crosses with heterosis and mean performance of crosses are taken into consideration, Surya X R-2586, Surya X L-3270, L-3263 X Surya and L-3270 X L-3263 cross hold promise for deriving lines with improved resistance to bacterial wilt. Earlier many workers also recorded significant heterosis in many F_1's thereby supporting the present findings [27, 28].

Among the crosses, the difference due to GCA variance, SCA variance and reciprocal variance have been highly significant. Three parents, Surya, L-3263 and L-3270, were the best general combiners, and eight crosses recorded significant SCA effect in desirable direction. Parents Surya, L-3263 and L-3270 have imparted good level of resistance to crosses for bacterial wilt disease. Therefore, it is advisable to involve above three parents in the future breeding programmes to develop wilt resistant cultivars.

The magnitude of SCA variance were was higher than GCA variance indicating predominance of non-additive gene action in the expression of this trait (Table 1) [29].

Significant reciprocal differences and highest negative SCA effects were observed in the crosses viz., R-2586 X Surya, L-3270 X Surya, Surya X Arka Shirish and Arka Shirish X R-2586 for bacterial wilt incidence per cent. Presence of highest SCA effect in the cross R-2586 X Surya may be due to the additive x dominance interaction effect where one of the parent showed very low GCA effect (Surya) while other parent (R-2586) showed very high GCA effect (Table 3).Thus, the present F_1 material from R-2586 X Surya, L-3270 X Surya, Surya X Arka Shirish can be useful to improve the bacterial wilt resistance in brinjal.

Reciprocal cross differences were observed in most of the crosses with high SCA effects, so that the significance of reciprocal cross difference for all the characters exhibited the presence of a maternal effect which may be due to the influence of cytoplasmic influence/ cytoplasmic nuclear interactions, which would be ascertained in the later segregating generations. Considering the importance of both additive and non-additive gene actions for yield and its components, genetic improvement could be achieved by a population breeding approach in the form of biparental mating in early generation segregating populations followed by intensive selection in future generations.

Table 1: Analysis of variance (mean sum of squares) for combining ability in respect of 18 characters in brinjal

Sl. No.	Source	MSS				Random effects				
		GCA	*SCA*	Reci.	Error	Vg	Vs	Vreci.	Va	Vd
	d.f	5	15	15	70					
1	Plant height at 30 DAT (cm)	46.217**	28.544**	15.898**	2.778	1.542	14.962	6.561	3.084	14.962
2	Plant height at 60 DAT (cm)	119.771**	113.574**	74.067**	18.926	0.770	54.955	27.569	1.541	54.955
3	Plant height at 90 DAT (cm)	326.904**	196.168**	168.363**	18.389	11.372	103.228	74.989	22.745	103.228
4	No. branches at 30 DAT	0.554	1.595**	1.640**	0.336	-0.083	0.731	0.651	-0.166	0.731
5	No. branches at 60 DAT	1.380	2.710**	1.618**	0.692	-0.105	1.171	0.462	-0.210	1.171
6	No. branches at 90 DAT	29.418	21.858	30.785	28.961	0.610	-4.124	0.911	1.221	-4.124
7	Days to 50% flowering	14.496**	2.695**	4.507**	1.024	0.987	0.970	1.741	1.975	0.970
8	No. flowers/cluster	1.853**	0.775**	0.251**	0.028	0.091	0.433	0.111	0.183	0.433
9	No. fruits/cluster	0.526**	0.132**	0.098**	0.014	0.033	0.068	0.041	0.066	0.068
10	Fruit set%	229.329**	156.719**	56.356**	11.395	6.441	84.381	22.480	12.882	84.381
11	Fruit length (cm)	32.444**	3.563**	5.289**	0.176	2.415	1.967	2.556	4.831	1.966
12	Fruit diameter (cm)	2.360**	0.240**	0.230**	0.009	0.177	0.133	0.110	0.354	0.133
13	Fruit specific gravity (g/ml)	0.004**	0.013**	0.010**	0.001	-0.006	0.007	0.004	-0.001	0.007
14	No. of fruits/plant	203.002**	25.989**	40.144**	1.656	14.816	14.129	19.244	29.632	14.129
15	Fruits yield/plant (g)	21255.54**	68736.42**	22010.62**	3119.48	-3780.3	38100.15	9445.57	-7560.70	38100.15
16	Average fruit weight (g)	968.814**	225.011**	256.852**	7.260	62.568	126.435	124.795	125.137	126.435
17	Fruits yield/ha. (tons)	16.393**	53.041**	16.984**	2.406	-2.917	29.400	7.288	-5.83	29.400
18	Cumulative bacterial wilt incidence at 50 DAI (%)	1189.48**	316.27**	360.21**	8.33	73.59	178.80	175.93	147.19	178.80

Vg – *GCA* variances Vs – *SCA* variances Vreci – Reciprocal variances Va – Additive variance,
Vd – Dominance variance DAT - Days after transplanting DAI - Days after inoculation

Table 2: Heterosis (%) values over commercial check 1 (CC1) and commercial check 2 (CC2) for 14 different characters in brinjal crosses

Sl. No.	Crosses	Plant height at 90 DAT		No. of branches at 90 DAT		Days to 50% flowering		Number of flowers/cluster		Number of fruits/cluster		Fruit set per cent		Fruit length	
		CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2
1	Surya X A. Shirish	21.04 **	0.88	15.15	5.56	-3.82	-2.33	31.88 **	56.52 **	-18.88 *	32.87 *	-38.08 **	-16.51	-16.67 **	-6.25
2	Surya X R-2583	15.37	-3.84	12.12	2.78	-1.53	0.00	-26.82 **	-13.15	-47.45 **	-13.93	-27.04 **	-1.62	-52.60 **	-46.67 **
3	Surya X R-2586	23.95 **	3.30	18.18	8.33	-4.58	-3.10	15.84 *	37.49 **	-40.82 **	-3.06	-48.62 **	-30.71 **	-45.26 **	-38.42 **
4	Surya X L-3263	13.27	-5.60	18.18	8.33	-13.74 **	-12.40 **	-2.04	16.26	-38.95 **	0.00	-37.26 **	-15.40	-27.95 **	-18.94 **
5	Surya X L-3270	11.61	-6.98	12.12	2.78	-13.74 **	-12.40 **	30.22 **	54.56 **	-7.65	51.25 **	-27.29 **	-1.97	-26.48 **	-17.29 **
6	A. Shirish X Surya	47.37 **	22.83 **	51.52	38.89	-6.87	-5.43	60.06 **	89.97 **	-16.84	36.21 *	-47.74 **	-29.54 *	-15.58 **	-5.03
7	A. Shirish X R-2583	49.96 **	24.98 **	12.12	2.78	4.58	6.20	24.78 **	48.10 **	12.59	84.40 **	-8.90	22.83	-13.85 **	-3.08
8	A. Shirish X R-2586	54.53 **	28.79 **	3.03	-5.56	-6.11	-4.65	27.89 **	51.79 **	-38.78 **	0.28	-51.78 **	-34.99 **	11.83 **	25.81 **
9	A. Shirish X L-3263	21.60 **	1.35	18.18	8.33	-12.98 **	-11.63 **	25.36 **	48.79 **	-23.47 **	25.35	-38.77 **	-17.43	14.00 **	28.25 **
10	A. Shirish X L-3270	18.77 *	-1.01	12.12	2.78	-3.82	-2.33	36.05 **	61.48 **	-2.21	60.17 **	-28.26 **	-3.27	5.70	18.91 **
11	R-2583 X Surya	9.79	-8.50	33.33	22.22	-10.69 **	-9.30 **	16.33 *	38.06 **	-25.51 **	22.01	-35.52 **	-13.06	-47.62 **	-41.07 **
12	R-2583 X A. Shirish	27.67 **	6.41	27.27	16.67	0.00	1.55	12.44	33.45 **	-44.05 **	-8.36	-50.04 **	-32.64 **	-45.02 **	-38.15 **
13	R-2583 X R-2586	27.47 **	6.24	42.42	30.56	2.29	3.88	16.33 *	38.06 **	-45.58 **	-10.86	-52.93 **	-36.53 **	-46.32 **	-39.61 **
14	R-2583 X L-3263	16.02 *	-3.30	3.03	-5.56	-4.58	-3.10	15.45 *	37.02 **	-18.88 *	32.87 *	-29.51 **	-4.95	-19.62 **	-9.58
15	R-2583 X L-3270	19.70 **	-0.24	27.27	16.67	-3.82	-2.33	29.15 **	53.29 **	-32.14 **	11.14	-47.13 **	-28.71 *	-32.35 **	-23.89 **
16	R-2586 X Surya	21.08 **	0.91	39.07	28.90	3.05	4.65	5.83	25.61 **	-47.45 **	-13.93	-49.84 **	-32.37 **	-25.76 **	-16.48 **
17	R-2586 X A. Shirish	-1.29	-17.73 **	-3.03	-11.11	-8.40 *	-6.98	26.14 **	49.71 **	-17.01	35.93 *	-33.89 **	-10.86	-30.09 **	-21.35 **
18	R-2586 X R-2583	19.42 *	-0.47	9.09	0.00	-2.29	-0.78	-5.93	11.65	-35.37 **	5.85	-31.22 **	-7.26	-23.88 **	-14.37 **
19	R-2586 X L-3263	32.69 **	10.59	9.09	0.00	-6.11	-4.65	35.86 **	61.25 **	-29.08 **	16.16	-47.57 **	-29.31 *	-17.53 **	-7.22
20	R-2586 X L-3270	38.83 **	15.71 *	21.21	11.11	-6.11	-4.65	36.73 **	62.28 **	-20.41 *	30.36	-41.49 **	-21.11	-9.19 *	2.16
21	L-3263 X Surya	43.28 **	19.42 **	39.39	27.78	-4.58	-3.10	26.14 **	49.71 **	-28.74 **	16.71	-43.53 **	-23.85	-39.47 **	-31.90 **
22	L-3263 X A. Shirish	12.10	-6.57	3.03	-5.56	-7.63 *	-6.20	16.33 *	38.06 **	-11.90	44.29 **	-21.96 *	5.23	1.59	14.29 **
23	L-3263 X R-2583	-2.95	-19.12 **	15.15	5.56	-11.45 **	-10.08 **	30.03 **	54.33 **	3.40	69.36 **	-20.24 *	7.55	-23.52 **	-13.96 **
24	L-3263 X R-2586	35.11 **	12.61	33.33	22.22	-4.58	-3.10	23.23 **	46.25 **	-13.44	41.78 **	-29.48 **	-4.91	-16.16 **	-5.68
25	L-3263 X L-3270	0.12	-16.55 **	-6.06	-13.89	-9.16 **	-7.75 *	17.40 *	39.33 **	37.59 **	125.35 **	17.72	58.73 **	-13.28 **	-2.44
26	L-3270 X Surya	34.30 **	11.94	21.21	11.11	4.58	6.20	65.89 **	96.89 **	-40.82 **	-3.06	-64.04 **	-51.51 **	-11.90 **	-0.89
27	L-3270 X A. Shirish	4.37	-13.01	15.15	5.56	-1.53	0.00	26.14 **	49.71 **	-25.51 **	22.01	-40.72 **	-20.06	-30.30 **	-21.59 **
28	L-3270 X R-2583	48.02 **	23.36 **	45.45	33.33	-1.53	0.00	28.18 **	52.13 **	-9.86	47.63 **	-29.33 **	-4.71	17.39 **	32.06 **
29	L-3270 X R-2586	26.78 **	5.66	36.36	25.00	-6.11	-4.65	17.49 *	39.45 **	-35.71 **	5.29	-44.58 **	-25.27 *	-27.49 **	-18.43 **
30	L-3270 X L-3263	-0.97	-17.46 **	-6.06	-13.89	-10.69 **	-9.30 **	15.35 *	36.91 **	35.71 **	122.28 **	18.26 *	59.46 **	-12.55 **	-1.62

Sl. No.	Crosses	Fruit diameter		Fruit specific gravity		Number of fruits/plant		Fruit yield/ plant		Average fruit weight		Fruit yield per hactare		Cumulative bacterial wilt% at 50 DAI	
		CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2
1	Surya X A. Shirish	42.86 **	1.38	0.00	18.85	-29.17 **	-5.56	6.25	10.46	53.35 **	19.74 **	6.24	10.45	0.00	-77.26**
2	Surya X R-2583	85.14 **	31.39 **	-19.31	-4.10	-34.72 **	-12.96	0.83	4.83	57.80 **	23.21 **	0.83	4.82	-6.67	-78.77**
3	Surya X R-2586	62.97 **	15.65 **	-28.97 **	-15.57	-37.50 **	-16.67	-12.90	-9.45	42.63 **	11.37	-12.91	-9.46	-86.89**	-97.02**
4	Surya X L-3263	32.23 **	-6.16	-20.00	-4.92	18.06 *	57.41 **	24.62 **	29.56 **	5.94	-17.28 *	24.62 **	29.56 **	-7.68	-79.00**
5	Surya X L-3270	30.63 **	-7.30 *	-15.86	0.00	16.67 *	55.56 **	19.91 *	24.67 **	3.03	-19.55 **	19.91 *	24.66 **	-80.00**	-95.45**
6	A. Shirish X Surya	45.60 **	3.33	0.00	18.85	-23.61 **	1.85	27.92**	32.99**	68.22 **	31.36**	27.91**	32.97**	-13.33	-80.29**
7	A. Shirish X R-2583	66.51 **	18.17 **	0.00	18.85	-44.44 **	-25.93 *	15.63	20.22 *	115.57 **	68.32 **	15.63	20.21 *	340.11**	0.09
8	A. Shirish X R-2586	19.54 **	-15.17 **	-11.03	5.74	-29.17 **	-5.56	16.26	20.87 *	69.52 **	32.37 **	16.26	20.86 *	259.61**	-18.22**
9	A. Shirish X L-3263	7.54	-23.68 **	8.28	28.69 *	-41.67 **	-22.22 *	-22.21 **	-19.13 *	39.19 **	8.69	-22.23 **	-19.15 *	259.33**	-18.28**
10	A. Shirish X L-3270	18.51 **	-15.90 **	-33.10 **	-20.49	-4.17	27.78 **	0.28	4.25	3.93	-18.84 **	0.27	4.24	0.00	-77.26**
11	R-2583 X Surya	66.17 **	17.92 **	-13.10	3.28	-13.89	14.81	26.43**	31.45**	47.43**	15.13	26.41**	31.42**	-13.33	-80.29**

12	R-2583 X A. Shirish	62.86 **	15.57 **	-17.24	-1.64	-18.06 *	9.26	14.02	18.54 *	38.63 **	8.25	14.03	18.54 *	404.82**	14.80**
13	R-2583 X R-2586	79.89 **	27.66 **	-17.93	-2.46	-33.33 **	-11.11	4.87	9.03	55.91 **	21.74 **	4.88	9.03	380.11**	9.19
14	R-2583 X L-3263	32.23 **	-6.16	-28.97 **	-15.57	-8.33	22.22 *	-1.45	2.45	9.57	-14.45	-1.46	2.44	19.78	-72.76**
15	R-2583 X L-3270	66.29 **	18.00 **	0.69	19.67	-29.17 **	-5.56	-21.86 **	-18.76 *	10.64	-13.61	-21.86 **	-18.76 *	0.00	-77.26**
16	R-2586 X Surya	51.54 **	7.54 *	-0.69	18.03	-63.89 **	-51.85 **	-3.23	0.60	41.27 **	10.32	-3.24	0.59	-60.00**	-90.90**
17	R-2586 X A. Shirish	16.91 **	-17.03 **	-27.59 **	-13.93	1.39	35.19 **	-2.94	0.91	-4.26	-25.24 **	-2.94	0.90	299.89**	-9.06**
18	R-2586 X R-2583	24.80 **	-11.44 **	-23.45 *	-9.02	19.44 *	59.26 **	14.02	18.54**	21.50 *	-5.13	14.01	18.53 **	220.06**	-27.21**
19	R-2586 X L-3263	22.63 **	-12.98 **	-4.83	13.11	-12.50	16.67	9.24	13.57	25.99 **	-1.63	9.23	13.56	60.00**	-63.61**
20	R-2586 X L-3270	36.11 **	-3.41	-7.59	9.84	4.17	38.89 **	20.51 *	25.29 **	16.73	-8.85	20.51 *	25.28 **	-60.00*	-90.90**
21	L-3263 X Surya	69.37 **	20.19 **	-26.90 **	-13.11	-20.83 **	5.56	12.98	17.45 *	41.29 **	10.33	12.97	17.44 *	-80.00**	-95.45**
22	L-3263 X A. Shirish	2.86	-27.01 **	-68.97 **	-63.11 **	12.50	50.00 **	-24.32 **	-21.32 *	-32.73 **	-47.47 **	-24.33 **	-21.33 *	260.11**	-18.10**
23	L-3263 X R-2583	29.83 **	-7.87 *	-34.48 **	-22.13	29.17 **	72.22 **	15.84	20.43 *	-9.31	-29.19 **	15.84	20.43 *	100.00**	-54.52**
24	L-3263 X R-2586	25.49 **	-10.95 **	-23.45 *	-9.02	4.17	38.89 **	18.30 *	22.99 **	15.75	-9.62	18.29 *	22.97 **	60.00*	-63.61**
25	L-3263 X L-3270	13.37 **	-19.55 **	-17.24	-1.64	72.22 **	129.63 **	30.92 **	36.11 **	-23.75 *	-40.46 **	30.91 **	36.10 **	-73.33**	-93.94**
26	L-3270 X Surya	25.71 **	-10.79 **	-22.76 *	-8.20	-43.06 **	-24.07 *	15.91	20.51 *	-4.26	-25.26**	15.91	20.50 *	-73.33**	-93.94**
27	L-3270 X A. Shirish	34.06 **	-4.87	-33.79 **	-21.31	12.50	50.00 **	6.01	10.21	-5.26	-26.02 **	6.00	10.20	-60.00*	-90.90**
28	L-3270 X R-2583	14.17 **	-18.98 **	-58.62 **	-50.82 **	9.72	46.30 **	20.65 *	25.43 **	12.71	-11.99	20.65 *	25.43 **	-20.00	-81.81**
29	L-3270 X R-2586	23.31 **	-12.49 **	-23.45 *	-9.02	20.83 **	61.11 **	42.68 **	48.33 **	19.32	-6.83	42.67 **	48.32 **	-60.06**	-90.92**
30	L-3270 X L-3263	13.14 **	-19.71 **	22.07 *	45.08 **	12.50	50.00 **	-8.09	-4.44	-16.20	-34.56 **	-8.09	-4.45	-80.00**	-95.45**

Table 3: Estimates of general combining ability effects of parents for 18 traits in brinjal

Parents	Plant Height at 30 DAT (cm)	Plant Height at 60 DAT (cm)	Plant Height at 90 DAT (cm)	No. of branches at 30 DAT	No. of branches at 60 DAT	No. of branches at 90 DAT	Days to 50% flowering	No. of flowers/ cluster	No. fruits/ cluster	Fruit set%
Surya	1.34 **	-1.579	-0.637	0.296	0.296	2.556	-0.306	-0.347 **	-0.211 **	0.533
A. Shirish	3.27 **	4.105 **	6.107 **	-0.176	-0.343	-0.889	0.556 *	0.609 **	0.038	-4.043 **
R-2583	-1.69**	-0.306	-2.131	0.241	0.519 *	-0.500	1.361 **	-0.464 **	-0.101 **	1.023
R-2586	-1.64 **	3.471 **	6.638 **	-0.176	-0.120	1.250	0.667 *	-0.014	-0.212 **	-6.141 **
L-3263	-0.20	-3.901 **	-5.243 **	-0.037	-0.287	-1.528	-1.750 **	-0.037	0.251 **	5.525 **
L-3270	-1.07*	-1.790	-4.734 **	-0.148	-0.065	-0.889	-0.528	0.253 **	0.235 **	3.104 **
SE(gi)	0.439	1.146	1.129	0.152	0.219	1.418	0.266	0.044	0.032	0.889
CD(gi) @ 5%	1.128	2.947	2.904	0.393	0.563	3.645	0.685	0.114	0.082	2.286
CD(gi) @ 1%	1.770	4.622	4.556	0.616	0.884	5.718	1.075	0.179	0.129	3.587

Parents	Fruit length (cm)	Fruit diameter (cm)	Fruit specific gravity (g/ml)	No. of fruits/ plant	Fruits yield/ plant (g)	Average fruit weight (g)	Fruits yield/ ha. (tons)	Cumulative bacterial wilt incidence at 50 DAI (%)
Surya	-1.759 **	0.422 **	-0.034 **	-3.769 **	-40.001 **	7.411 **	-1.111 **	-7.140**
A. Shirish	2.207 *	-0.324 **	0.002	-1.963 **	-41.467 **	1.271	-1.151 **	14.305**
R-2583	-1.780 **	0.559 **	0.029 **	-2.324 **	12.601	9.321 **	0.351	7.447**
R-2586	-0.606 **	0.178 **	-0.003	-2.435 **	-20.928	4.049 **	-0.581	3.217**
L-3263	0.703 **	-0.472 **	-0.003	4.954 **	23.581	-11.622 **	0.654	-6.151**
L-3270	1.235 **	-0.364 **	0.009	5.537 **	66.213 **	-10.430 **	1.839 **	-11.678**
SE(gi)	0.110	0.025	0.008	0.339	14.718	0.710	0.408	0.760
CD(gi) @ 5%	0.284	0.066	0.022	0.871	37.834	1.825	1.050	1.955
CD(gi) @ 1%	0.446	0.104	0.035	1.367	59.347	2.863	1.648	3.067

* - Significant at 5% ** - Significant at 1% DAT – Days after transplantingDAI - Days after inoculation

Table 4: Estimates of specific combining ability (SCA) effects of diallel crosses in F_1 generation for 18 different traits in brinjal

Cross	Plant height at 30 DAT (cm)	Plant height at 60 DAT (cm)	Plant height at 90 DAT (cm)	Number branches at 30 DAT	Number branches at 60 DAT	Number branches at 90 DAT	Days to 50% flowering	Number of flowers/ Cluster	Number of fruits /cluster
F1's									
Surya X A. Shirish	7.106 **	9.662 **	5.356	1.398 **	0.676	-0.750	-0.389	0.632 **	0.279 **
Surya X R-2583	2.043	3.373	-4.221	1.981 **	0.648	-2.306	-1.528 *	-0.052	0.053
Surya X R-2586	-0.121	-8.721 **	-4.807	-0.769 *	-2.046 **	10.111 **	1.500 *	0.049	0.013
Surya X L-3263	0.479	6.768 *	11.823 **	-0.574	-0.046	-0.611	0.250	0.114	-0.248 **
Surya X L-3270	0.023	4.056	6.931 *	-0.463	-1.102 *	-2.583	1.028	1.059 **	-0.043
A. Shirish XR-2583	-2.771 *	3.123	10.651 **	-0.046	0.120	0.806	1.278	-0.190	0.211 *
A. Shirish XR-2586	0.898	-4.021	-8.169 **	-0.130	-0.241	-3.111	-2.194 **	-0.352 **	0.083
A. Shirish X L-3263	-3.335 **	-5.249	-4.338	-0.769 *	0.093	0.833	-1.111	-0.540 **	-0.180 *
A. Shirish X L-3270	-1.507	-2.877	-9.196 **	0.176	0.204	0.528	1.000	-0.479 **	-0.089
R-2583 X R-2586	-2.516 *	-3.477	-2.546	-0.380	0.565	-0.667	0.167	-0.028	-0.025
R-2583 X L-3263	6.218 **	-0.205	-4.599	-0.019	-0.935	0.278	-0.917	0.597 **	0.154
R-2583 X L-3270	1.979	7.434 *	17.409 **	-0.074	0.843	2.639	0.194	0.511 **	-0.090
R-2586 X L-3263	-0.180	9.768 **	9.181 **	0.731	1.537 **	-0.139	0.944	0.380 **	-0.001
R-2586 X L-3270	3.231 *	9.490 **	7.773 **	0.843 *	1.815 **	0.056	-0.611	0.007	-0.118
L-3263 X L-3270	-4.302 **	-5.988 *	-7.730 **	-0.130	0.704	-1.000	0.139	-0.338 **	0.687 **
Reciprocal F_1's									
A. Shirish X Surya	-2.900 *	-1.583	-10.850 **	1.500 **	-1.500 **	-2.000	0.667	-0.483 **	-0.020
R-2583 X Surya	2.333 *	1.850	2.300	-2.500 **	-1.667 **	-1.167	2.000 **	-0.740 **	-0.215 *
R-2586 X Surya	2.367 *	10.467 **	1.183	-1.574 *	0.333	-14.667 **	-1.667 *	0.172	0.065
L-3263 X Surya	2.400 *	-7.183 *	-12.367 **	1.000 *	-1.500 **	-1.167	-2.000 **	-0.483 **	-0.100
L-3270 X Surya	4.667 **	-2.850	-9.350 **	0.167	0.093	-0.500	-4.000 **	-0.612 **	0.325 **
R-2583 XA. Shirish	-1.083	1.617	9.183 **	-0.667	-0.167	-0.833	1.000	0.212	0.555 **
R-2586 XA. Shirish	2.050	12.050 **	23.000 **	0.167	0.500	0.333	0.500	0.030	-0.213 *
L-3263 XA. Shirish	3.017 **	-0.650	3.917	0.333	0.667	0.833	-1.167	0.155	-0.113
L-3270 X A. Shirish	5.467 **	6.533 *	5.933 *	0.500	0.843	-0.167	-0.500	0.170	0.228 **
R-2586 X R-2583	1.867	-0.250	3.317	-0.333	1.167 *	1.833	1.000	0.382 **	-0.100
L-3263 X R-2583	-4.500 **	1.650	7.817 **	-1.167 **	-1.167 *	-0.667	1.500 *	-0.250 *	-0.218 **
L-3270 X R-2583	0.417	-10.933 **	-11.667 **	-0.333	-0.167	-1.000	-0.500	0.017	-0.218 **
L-3263 X R-2586	-0.367	-6.367 *	-1.000	0.167	-1.000	-1.333	-0.333	0.217 *	-0.153
L-3270 X R-2586	-0.600	5.133	4.967	-0.500	-0.500	-0.833	-0.333	0.330 **	0.150
L-3270 X L-3263	1.867	-0.417	0.450	-0.333	-0.167	0.361	0.333	0.035	0.018
SE(Sij)	1.00	2.614	2.57	0.348	0.500	3.233	0.608	0.101	0.073
CD (Sij-Sik)@ 5%	3.262	8.518	8.395	1.136	1.629	10.536	1.981	0.330	0.238
CD(Sij-Sik) @ 1%	4.528	11.822	11.652	1.577	2.261	14.624	2.750	0.459	0.330

* - Significant at 5% ** - Significant at 1%

DAI - Days after inoculation DAT - Days after transplanting

Table 4: continued

Cross	Fruit set percent	Fruit length (cm)	Fruit diameter (cm)	Fruit specific gravity (g/ml)	Number of fruits / plant	Fruit yield / plant (g)	Average fruit weight (g)	Fruit yield/ ha. (tons)	Cumulative Bact. wilt at 50 DAI (%)
F1's									
Surya X A. Shirish	-1.783	0.363	0.069	0.119 **	2.157 *	108.494 **	-1.201	3.014 **	-25.038**
Surya X R-2583	-0.227	-0.360	0.103	0.014	3.019 **	19.510	-11.545 **	0.541	-16.524**
Surya X R-2586	-3.281	0.488	-0.052	0.052 *	-3.204 **	-66.403	17.930 **	-1.846	18.530**
Surya X L-3263	-9.918 **	-0.570 *	0.410 **	0.010	1.241	160.732 **	1.045	4.466 **	-1.412
Surya X L-3270	-10.498 **	0.909 **	-0.359 **	0.018	-2.176 *	109.153 **	11.751 **	3.033 **	31.468**
A. Shirish XR-2583	5.378 *	-1.460 **	0.529 **	0.015	-0.454	133.038 **	8.677 **	3.695 **	6.444**
A. Shirish XR-2586	4.934 *	0.180	-0.445 **	-0.005	3.824 **	84.000 *	-4.703 *	2.333 *	-22.623**
A. Shirish X L-3263	0.369	1.216 **	-0.174 **	-0.059 *	-3.731 **	-263.147 **	-1.365	-7.312 **	22.179**
A. Shirish X L-3270	0.442	-2.101 **	0.332 **	-0.086 **	0.185	-38.701	-4.190 *	-1.076	-8.042**
R-2583 X R-2586	0.301	0.567 *	-0.333 **	-0.038	5.852 **	211.881 **	-10.206 **	5.887 **	9.734**
R-2583 X L-3263	-1.572	1.133 **	-0.304 **	-0.092 **	2.630 **	-9.210	-10.717 **	-0.255	-19.854**
R-2583 X L-3270	-6.754 **	2.554 **	-0.144 *	-0.091 **	-2.787 **	-130.700 **	-7.063 **	-3.630 **	-13.213**
R-2586X L-3263	-2.180	0.613 *	-0.126 *	0.025	-0.759	90.861 *	3.255	2.522 *	-6.606**
R-2586 X L-3270	-2.327	-0.125	-0.069	0.006	2.657 **	228.444 **	0.870	6.346 **	-13.675**
L-3263 X L-3270	20.747 **	-0.682 *	0.101	0.092 **	2.435 **	-20.100	0.603	-0.559	-2.174
Reciprocal F1's									
A. Shirish X Surya	2.750	-0.075	-0.040	0.000	-0.667	-9.587	1.828	-0.268	1.190
R-2583 X Surya	2.415	-0.345	0.277 **	-0.015	-2.500 **	-29.473	5.985 **	-0.818	0.595
R-2586 X Surya	0.350	-1.352 **	0.167 *	-0.068 **	3.167 **	-48.872	-24.578 **	-1.358	-43.887**
L-3263 X Surya	1.783	0.798 **	-0.542 **	0.017	4.667 **	58.865	-7.415 **	1.637	4.668*
L-3270 X Surya	10.458 **	-1.010 **	0.072	0.017	7.167 **	20.235	-20.533 **	0.562	-33.903**
R-2583 X A. Shirish	11.710 **	2.160 **	0.053	0.042	-3.167 **	8.145	16.137 **	0.225	10.715**
R-2586 X A. Shirish	-5.092 *	2.905 **	0.038	0.040	-3.667 **	97.092 *	15.475 **	2.697 *	30.312**
L-3263 X A. Shirish	-4.783 *	0.860 **	0.068	0.187 **	-6.500 **	10.633	15.085 **	0.295	-0.070
L-3270 X A. Shirish	3.545	2.495 **	-0.227 **	0.002	-2.000 *	-28.985	1.928	-0.805	-8.925**
R-2586 X R-2583	-6.178 **	-1.555 **	0.803 **	0.013	-6.333 **	-200.057 **	7.218 **	-5.557 **	28.570**
L-3263 X R-2583	-2.638	0.270	0.035	0.013	-4.500 **	-87.435 *	3.960 *	-2.430 *	8.308**
L-3270 X R-2583	-5.065 *	-3.447 **	0.760 **	0.143 **	-4.667 **	-214.917 **	-0.435	-5.970 **	5.355*
L-3263 X R-2586	-5.150 *	-0.095	-0.042	0.045 *	-2.000 *	-45.817	2.147	-1.272	7.140**
L-3270 X R-2586	0.878	1.268 **	0.187 **	0.038	-2.000 *	-112.052 **	-0.543	-3.113 **	0.003
L-3270 X L-3263	-0.155	-0.050	0.003	-0.095 **	7.167 **	197.227 **	-1.585	5.478 **	0.595
SE(Sij)	2.028	0.252	0.058	0.020	0.773	33.563	1.619	0.932	1.861
CD (Sij-Sik)@ 5%	6.609	0.821	0.192	0.065	2.519	109.353	5.275	3.037	5.652
CD(Sij-Sik) @ 1%	9.173	1.140	0.266	0.090	3.497	151.777	7.322	4.215	7.845

* - Significant at 5% ** - Significant at 1%

DAI - Days after inoculation DAT - Days after transplanting

Table 5: Estimates of reciprocal crosses differences for 18 different traits using SCA effects

Crosses	Plant height at 30 DAT (cm)			Plant height at 60 DAT (cm)			Plant height at 90 DAT (cm)			Number branches at 30 DAT		
	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference
Surya X A. Shirish	7.106 **	-2.900 *	10.006**	9.662 **	-1.583	11.245*	5.356	-10.850 **	16.206**	1.398 **	1.500 **	-0.102
Surya X R-2583	2.043	2.333 *	-0.29	3.373	1.850	1.523	-4.221	2.300	-6.521	1.981 **	-2.500 **	4.481**
Surya X R-2586	-0.121	2.367 *	-2.488	-8.721 **	10.467 **	-19.188**	-4.807	1.183	-5.99	-0.769 *	-1.574 *	0.805
Surya X L-3263	0.479	2.400 *	-1.921	6.768 *	-7.183 *	13.951**	11.823 **	-12.367 **	24.19**	-0.574	1.000 *	-1.574*
Surya X L-3270	0.023	4.667 **	-4.644**	4.056	-2.850	6.906	6.931 *	-9.350 **	16.281**	-0.463	0.167	-0.63
A. Shirish XR-2583	-2.771 *	-1.083	-1.688	3.123	1.617	1.506	10.651 **	9.183 **	1.468	-0.046	-0.667	0.621
A. Shirish XR-2586	0.898	2.050	-1.152	-4.021	12.050 **	-16.071**	-8.169 **	23.000 **	-31.169**	-0.130	0.167	-0.297
A. Shirish X L-3263	-3.335 **	3.017 **	-6.352**	-5.249	-0.650	-4.599	-4.338	3.917	-8.255	-0.769 *	0.333	-1.102
A. Shirish X L-3270	-1.507	5.467 **	-6.974**	-2.877	6.533 *	-9.41*	-9.196 **	5.933 *	-15.129**	0.176	0.500	-0.324
R-2583 X R-2586	-2.516 *	1.867	-4.383*	-3.477	-0.250	-3.227	-2.546	3.317	-5.863	-0.380	-0.333	-0.047
R-2583 X L-3263	6.218 **	-4.500 **	10.718**	-0.205	1.650	-1.855	-4.599	7.817 **	-12.416**	-0.019	-1.167 **	1.148*
R-2583 X L-3270	1.979	0.417	1.562	7.434 *	-10.933 **	18.367**	17.409 **	-11.667 **	29.076**	-0.074	-0.333	0.259
R-2586 X L-3263	-0.180	-0.367	0.187	9.768 **	-6.367 *	16.135**	9.181 **	-1.000	10.181*	0.731	0.167	0.564
R-2586 X L-3270	3.231 *	-0.600	3.831*	9.490 **	5.133	4.357	7.773 **	4.967	2.806	0.843 *	-0.500	1.343*
L-3263 X L-3270	-4.302 **	1.867	-6.169**	-5.988 *	-0.417	-5.571	-7.730 **	0.450	-8.18	-0.130	-0.333	0.203
CD (Sij-Sik)@ 5%	3.262			8.518			8.395			1.136		
CD(Sij-Sik) @ 1%	4.528			11.822			11.652			1.577		

Crosses	Number branches at 60 DAT			Number branches at 90 DAT			Days to 50% flowering			Number of flowers/ cluster		
	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference
Surya X A. Shirish	0.676	-1.500 **	2.176*	-0.750	-2.000	1.25	-0.389	0.667	-1.056	0.632 **	-0.483 **	1.115**
Surya X R-2583	0.648	-1.667 **	2.315**	-2.306	-1.167	-1.139	-1.528 *	2.000 **	-3.528**	-0.052	-0.740 **	0.688**
Surya X R-2586	-2.046 **	0.333	-2.379**	10.111 **	-0.833	10.944*	1.500 *	-1.667 *	3.167**	0.049	0.172	-0.123
Surya X L-3263	-0.046	-1.500 **	1.454	-0.611	-14.667 **	14.056*	0.250	-2.000 **	2.25*	0.114	-0.483 **	0.597**
Surya X L-3270	-1.102 *	0.093	-1.195	-2.583	0.333	-2.916	1.028	-4.000 **	5.028**	1.059 **	-0.612 **	1.671**
A. Shirish XR-2583	0.120	-0.167	0.287	0.806	1.833	-1.027	1.278	1.000	0.278	-0.190	0.212	-0.402*
A. Shirish XR-2586	-0.241	0.500	-0.741	-3.111	-1.167	-1.944	-2.194 **	0.500	-2.694*	-0.352 **	0.030	-0.382*
A. Shirish X L-3263	0.093	0.667	-0.574	0.833	0.833	0	-1.111	-1.167	0.056	-0.540 **	0.155	-0.695**
A. Shirish X L-3270	0.204	0.843	-0.639	0.528	-0.667	1.195	1.000	-0.500	1.5	-0.479 **	0.170	-0.649**
R-2583 X R-2586	0.565	1.167 *	-0.602	-0.667	-1.333	0.666	0.167	1.000	-0.833	-0.028	0.382 **	-0.410*
R-2583 X L-3263	-0.935	-1.167 *	0.232	0.278	-0.500	0.778	-0.917	1.500 *	-2.417*	0.597 **	-0.250 **	0.847**
R-2583 X L-3270	0.843	-0.167	1.01	2.639	-0.167	2.806	0.194	-0.500	0.694	0.511 **	0.017	0.494**
R-2586 X L-3263	1.537 **	-1.000	2.537**	-0.139	-1.000	0.861	0.944	-0.333	1.277	0.380 **	0.217 *	0.163
R-2586 X L-3270	1.815 **	-0.500	2.315**	0.056	-0.833	0.889	-0.611	-0.333	-0.278	0.007	0.330 **	-0.323
L-3263 X L-3270	0.704	-0.167	0.871	-1.000	0.361	-1.361	0.139	0.333	-0.194	-0.338 **	0.035	-0.373*
CD (Sij-Sik)@ 5%	1.629			10.536			1.981			0.330		
CD(Sij-Sik) @ 1%	2.261			14.624			2.750			0.459		

Table 5: continued

Crosses	Number of fruits /cluster			Fruit set per cent			Fruit length (cm)			Fruit diameter (cm)		
	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference
Surya X A. Shirish	0.279 **	-0.020	0.299*	-1.783	2.750	-4.533	0.363	-0.075	0.438	0.069	-0.040	0.109
Surya X R-2583	0.053	-0.215 *	0.268*	-0.227	2.415	-2.642	-0.360	-0.345	-0.015	0.103	0.277 **	-0.174
Surya X R-2586	0.013	0.065	-0.052	-3.281	0.350	-3.631	0.488	-1.352 **	1.840**	-0.052	0.167 *	-0.219*
Surya X L-3263	-0.248 **	-0.100	-0.148	-9.918 **	1.783	-11.701**	-0.570 *	0.798 **	-1.368**	0.410 **	-0.542 **	0.952**
Surya X L-3270	-0.043	0.325 **	-0.368**	-10.498 **	10.458 **	-20.956**	0.909 **	-1.010 **	1.919**	-0.359 **	0.072	-0.431**
A. Shirish XR-2583	0.211 *	0.555 **	-0.344**	5.378 *	11.710 **	-6.332	-1.460 **	2.160 **	-3.62**	0.529 **	0.053	0.476**
A. Shirish XR-2586	0.083	-0.213 *	0.296*	4.934 *	-5.092 *	10.026**	0.180	2.905 **	-2.725**	-0.445 **	0.038	-0.483**
A. Shirish X L-3263	-0.180 *	-0.113	-0.067	0.369	-4.783 *	5.152	1.216 **	0.860 **	0.356	-0.174 **	0.068	-0.242*
A. Shirish X L-3270	-0.089	0.228 **	-0.317*	0.442	3.545	-3.103	-2.101 **	2.495 **	-4.596**	0.332 **	-0.227 **	0.559**
R-2583 X R-2586	-0.025	-0.100	0.075	0.301	-6.178 **	6.479	0.567 *	-1.555 **	2.122**	-0.333 **	0.803 **	-1.136**
R-2583 X L-3263	0.154	-0.218 **	0.372**	-1.572	-2.638	1.066	1.133 **	0.270	0.863*	-0.304 **	0.035	-0.339**
R-2583 X L-3270	-0.090	-0.218 **	0.128	-6.754 **	-5.065 *	-1.689	2.554 **	-3.447 **	6.001**	-0.144 *	0.760 **	-0.904**
R-2586 X L-3263	-0.001	-0.153	0.152	-2.180	-5.150 *	2.97	0.613 *	-0.095	0.708	-0.126 *	-0.042	-0.084
R-2586 X L-3270	-0.118	0.150	-0.268*	-2.327	0.878	-3.205	-0.125	1.268 **	-1.393**	-0.069	0.187 **	-0.256*
L-3263 X L-3270	0.687 **	0.018	0.669**	20.747 **	-0.155	20.902**	-0.682 *	-0.050	-0.632	0.101	0.003	0.098
CD (Sij-Sik)@ 5%	0.238			6.609			0.821			0.192		
CD(Sij-Sik) @ 1%	0.330			9.173			1.140			0.266		

Crosses	Fruit specific gravity (g/ml)			Number of fruits / plant			Fruit yield / plant (g)			Average fruit weight (g)		
	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference
Surya X A. Shirish	0.119 **	0.000	0.119**	2.157 *	-0.667	2.824*	108.494 **	-9.587	118.081*	-1.201	1.828	-3.029
Surya X R-2583	0.014	-0.015	0.029	3.019 **	-2.500 **	5.519**	19.510	-29.473	48.983	-11.545 **	5.985 **	-17.53**
Surya X R-2586	0.052 *	-0.068 **	0.120**	-3.204 **	3.167 **	-6.371**	-66.403	-48.872	-17.531	17.930 **	-24.578 **	42.508**
Surya X L-3263	0.010	0.017	-0.007	1.241	4.667 **	-3.426*	160.732 **	58.865	101.867	1.045	-7.415 **	8.46**
Surya X L-3270	0.018	0.017	0.001	-2.176 *	7.167 **	-9.343**	109.153 **	20.235	88.918	11.751 **	-20.533 **	32.284**
A. Shirish XR-2583	0.015	0.042	-0.027	-0.454	-3.167 **	2.713*	133.038 **	8.145	124.893*	8.677 **	16.137 **	-7.46**
A. Shirish XR-2586	-0.005	0.040	-0.045	3.824 **	-3.667 **	7.491**	84.000 *	97.092 *	-13.092	-4.703 *	15.475 **	-20.178**
A. Shirish X L-3263	-0.059 *	0.187 **	-0.246**	-3.731 **	-6.500 **	2.769*	-263.147 **	10.633	-273.78**	-1.365	15.085 **	-16.45**
A. Shirish X L-3270	-0.086 **	0.002	-0.088*	0.185	-2.000 *	2.185	-38.701	-28.985	-9.716	-4.190 *	1.928	-6.118*
R-2583 X R-2586	-0.038	0.013	-0.051	5.852 **	-6.333 **	12.185**	211.881 **	-200.057 **	411.938**	-10.206 **	7.218 **	-17.424**
R-25813 X L-3263	-0.092 **	0.013	-0.105**	2.630 **	-4.500 **	7.13**	-9.210	-87.435 *	78.225	-10.717 **	3.960 *	-14.677**
R-2583 X L-3270	-0.091 **	0.143 **	-0.234**	-2.787 **	-4.667 **	1.88	-130.700 **	-214.917 **	84.217	-7.063 **	-0.435	-6.628*
R-2586 X L-3263	0.025	0.045 *	-0.02	-0.759	-2.000 *	1.241	90.861 *	-45.817	136.678*	3.255	2.147	1.108
R-258611 X L-3270	0.006	0.038	-0.032	2.657 **	-2.000 *	4.657**	228.444 **	-112.052 **	340.496**	0.870	-0.543	1.413
L-3263 X L-3270	0.092 **	-0.095 **	0.187**	2.435 **	7.167 **	-4.732**	-20.100	197.227 **	-217.327**	0.603	-1.585	2.188
CD (Sij-Sik)@ 5%	0.065			2.519			109.353			5.275		
CD(Sij-Sik) @ 1%	0.090			3.497			151.777			7.322		

Crosses	Fruit yield/ ha. (tons)			Cumulative Bact. wilt at 50 DAI (%)		
	Straight crosses	Reciprocal crosses	Difference	Straight crosses	Reciprocal crosses	Difference
Surya X A. Shirish	3.014 **	-0.268	3.282*	-25.038**	1.190	-26.228**
Surya X R-2583	0.541	-0.818	1.359	-16.524**	0.595	-17.119**
Surya X R-2586	-1.846	-1.358	-0.488	18.530**	-43.887**	62.417**
Surya X L-3263	4.466 **	1.637	2.829	-1.412	4.668*	-6.08*
Surya X L-3270	3.033 **	0.562	2.47	31.468**	-33.903**	65.371**
A. Shirish XR-2583	3.695 **	0.225	3.47*	6.444**	10.715**	-4.271
A. Shirish XR-2586	2.333 *	2.697 *	-0.364	-22.623**	30.312**	-52.935**
A. Shirish X L-3263	-7.312 **	0.295	-7.607**	22.179**	-0.070	22.249**
A. Shirish X L-3270	-1.076	-0.805	-0.271	-8.042**	-8.925**	0.883
R-2583 X R-2586	5.887 **	-5.557 **	11.444**	9.734**	28.570**	-18.84**
R-2583 X L-3263	-0.255	-2.430 *	2.175	-19.854**	8.308**	-28.162**
R-2583 X L-3270	-3.630 **	-5.970 **	2.34	-13.213**	5.355*	-18.568**
R-2586 X L-3263	2.522 *	-1.272	3.794*	-6.606**	7.140**	-13.746**
R-2586 X L-3270	6.346 **	-3.113 **	9.459**	-13.675**	0.003	-13.678**
L-3263 X L-3270	-0.559	5.478 **	-6.037**	-2.174	0.595	-2.769
CD (Sij-Sik)@ 5%	3.037			5.652		
CD(Sij-Sik) @ 1%	4.215			7.845		

*- Significant at 5% ** - Significant at1%

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