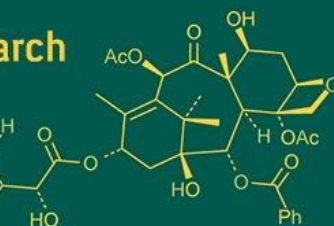
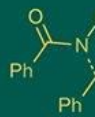


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Combining ability studies for seed quality traits in brinjal (*Solanum melongena* L.)

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Abstract

The present investigation was conducted to evaluate the combining ability for seed quality traits in brinjal (*Solanum melongena* L.) with the objective of identifying superior parents and hybrid combinations for breeding programmes. The experiment was carried out during the Rabi season of 2023-24 at the Seed Unit of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. The experimental material comprised eight parental genotypes and their 15 F₁ hybrids developed through a Line × Tester mating design. The trial was laid out in a Randomized Block Design with three replications. Observations were recorded on important seed quality parameters such as germination percentage, shoot length, root length, seedling vigour indices, 100 seed weight, and dry seedling weight. Statistical analysis was performed to estimate general combining ability (GCA) and special combining ability (SCA) effects.

The results revealed significant variation among parents and hybrids for all traits studied. Among the parents, Bandhtiware (BDHE), Kasral (KL), BB64, Lanja Local (LL), and Singhnath (S) exhibited superior performance for most seed quality traits. High GCA effects were observed in BDHE, KR, KL among lines and KP, SP, LL, and BB64 among testers, indicating the importance of additive gene action. Certain hybrids such as KL × BB64 and KR × BB64 showed outstanding performance for multiple traits.

It was concluded that no single parent possessed all desirable traits; hence, multiple crosses among superior combiners are essential to develop high-quality recombinants. The identified parents and hybrids can be effectively utilized in future brinjal breeding programmes for improving seed quality traits.

Keywords: Brinjal, combining ability, GCA, SCA, seed quality traits, Line × Tester, hybrids

Introduction

The botanical name for brinjal is *Solanum melongena* L. with chromosome number 2n = 24, and it is a member of the Solanaceae family. Brinjal is one of the important vegetable crops globally, with India ranking as the second-largest producer after China. According to FAOSTAT (2022) ^[4], brinjal is cultivated worldwide on approximately 1.85 million hectares, producing around 56.62 million tonnes annually, with an average productivity of 30.64 tonnes per hectare. In India, the crop covers nearly 0.74 million hectares, yielding about 12.77 million tonnes, with a productivity of 17.24 tonnes per hectare. In Maharashtra, brinjal is grown on about 0.02 million hectares, contributing an annual production of 0.34 million tonnes and maintaining an average productivity of 17 tonnes per hectare (NHB, First Advance Estimates 2021-22). Based on general combining ability (GCA) and special combining ability (SCA), breeders can select acceptable genotypes as parents during hybridization for improved cross combinations. Appropriate parent selection based on their combining ability is essential for every breeding effort. Considering all these points present study was carried out to study combining ability for seed germination in brinjal.

Materials and Methods

The study was conducted during the Rabi season of 2023-24 at the Seed Unit of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. The experimental material consisted of eight parental genotypes and their 15 F₁ hybrids developed using an L × T mating design. The trial was arranged in a Randomized Block Design with three replications.

Observations were recorded on key seed quality parameters, including seed germination percentage, seedling shoot length (cm), seedling root length (cm), and seedling dry weight, based on five randomly selected plants from each parent and hybrid in every replication. The collected data were averaged and subjected to appropriate statistical analysis.

Table 1: List of Brinjal genotypes with their sources

Sr. No Lines	Genotypes	Testers	
1	Bandhtiware (BDHE)	1	Konkan Prabha (KP)
2	Kali Ravai (KR)	2	Swarn Pratibha (SP)
3	Kasral (KL)	3	Singnath (S)
		4	Lanja Local (LL)
		5	BB 64 (BB64)

Table 2: Line X Tester Cross combinations

1	BDHE X KP	6	KR X KP	11	KL X KP
2	BDHE X SP	7	KR X SP	12	KL X SP
3	BDHE X S	8	KR X S	13	KL X S
4	BDHE X LL	9	KR X LL	14	KL X LL
5	BDHE X BB64	10	KR X BB64	15	KL X BB64

Results and Discussion

The success of hybridization and selection mostly depends on the correct choice of good parents for desirable traits. According to Gilbert (1958) [5], parents exhibiting higher mean performance are more likely to contribute to the development of superior genotypes. Similarly, Amarnath and Subramanyam (1992) [1] emphasized that parent selection in breeding programs should consider both mean performance and combining ability. Therefore, in the present study, these two criteria were used as the basis for selecting desirable parental lines.

Singh *et al.* (1983) [11] reported that parents exhibiting superior performance are of greater importance and value in crop improvement and breeding programmes. In the present investigation, line Bandhtiware (BDHE) shown superior performance for the characters root length (cm), vigour index II and dry seedling weight while line Kasral shown good performance for remaining all seed quality characters namely germination (%), shoot length (cm), shoot length/root length, vigour Index II and 100 seed weight. Among the testers Konkan Prabha (KP) shown good performance for germination (%), Swarn Pratibha shown superior performance for shoot length/root length, 100 seed weight, Lanja Local shown good performance for four seed quality characters viz., root length (cm), vigour Index I, vigour Index II and dry seedling weight while tester BB64 was found superior for shoot length (cm). Overall, the parental lines Bandhtiware, Kasral, Konkan Prabha, Swarn

Pratibha, Lanja Local, and BB 64 showed favorable performance for most of the evaluated seed quality traits. These genotypes were therefore identified as promising parents and can be effectively utilized in future breeding programmes. (Table 4).

Combining ability is a key parameter widely used in plant breeding to assess the genetic potential of breeding materials. Dhillon (1975) [3] emphasized that combining ability provides valuable guidance in selecting parents based on the expected performance of hybrids and their progenies. General combining ability (GCA) reflects the genetic worth of a parent for a particular trait and is mainly associated with additive gene effects, which are heritable and fixable (Simmonds, 1979) [8]. Furthermore, Singh and Nanda (1976) [10] recommended including at least one parent with high GCA effects as an important criterion in parent selection for breeding programmes.

Among the lines significant and positive general combining ability effect was recorded by Bandhtiware (BDHE) for the characters germination (%), root length (cm) and Vigour Index I, Kali Ravai (KR) for all seed quality characters except shoot length/root length and dry seedling weight, Kasral (KL) for shoot length/root length. similar results were recorded by Varshney *et al.* (1999) [12], Singh *et al.* (2002) [9] and Bendale *et al.* (2005) [2] in brinjal.

Among the testers significant general combining ability effect was recorded by Konkan prabha (KP) for the characters germination (%), root length (cm) and 100 seed weight, Swarna Pratibha (SP) for shoot length/root length, Singhnath (S) for all seed quality characters except root length (cm), Lanja Local (LL) for germination (%), Vigour Index II, 100 seed weight and dry seedling weight while tester BB 64 recorded significant general combining ability effect for all seed quality characters. These results are in accordance with the result of Kannanbabu *et al.* (2005) [6] in sorghum.

From the above findings, it can be concluded that no single parent possessed favorable genes for all the traits under study. Hence, multiple crosses among these parents would be beneficial for developing superior recombinants combining desirable characteristics. The relationship between per se performance and GCA effects reflects the breeding potential of individual genotypes. In the present investigation, both these parameters were found to be high in the selected parents, indicating their suitability for use in breeding programmes. When considering all the traits, 5 parents Bandhtiware (BDHE), Kasral (KL), BB64, Lanja Local (LL) and Singhnath (S) were adjudged as best parents (table 5). Therefore, multiple crosses involving these five parents would yield good sergeants with all the seed quality traits in brinjal.

Table 3: Analysis of variance for combining ability in Line X Tester analysis

Source of variation	DF	Ge%	SL (cm)	RL (cm)	SL:RL	V.I.I	V.I.II	100 SW (g)	DSW (g)
Replication	2	3.88*	0.00001	0.005	0.001	571.17*	0.01	0.0001	0.000001
Crosses	14	187.14**	2.21**	2.59**	0.22**	107998.16**	0.32**	0.01**	0.00003**
Lines	2	906.69**	1.25**	11.67**	0.46**	502501.87**	0.18**	0.007**	0.00004**
Testers	4	45.92**	3.77**	1.01**	0.12**	63374.50**	0.32**	0.005**	0.00003**
Line Vs Testers	8	77.86**	1.67**	1.11**	0.21**	31684.07**	0.35**	0.01**	0.00003**
Error	44	1.54	0.004	0.003	0.001	231.26	0.004	0.00007	0.000001

Table 4: Mean performance of lines, testers, crosses for seed quality characters

Sr. No	Genotypes	Ge%	SL (cm)	RL (cm)	SL:RL	V.I.I	V.I.II	100 SW (g)	DSW (g)
Lines									
1	BDHE	75.67	6.21	5.51	1.13	887.11	1.46	0.23	0.0193
2	KR	71.67	4.70	2.64	1.78	525.76	0.88	0.23	0.0123
3	KL	85.67	7.42	3.23	2.30	912.45	1.25	0.32	0.0146
	Mean	77.67	6.11	3.79	1.74	775.10	1.20	0.26	0.02
Tester									
4	KP	95.67	6.27	4.55	1.38	1035.14	1.56	0.38	0.0163
5	SP	73.00	6.67	3.21	2.08	721.26	1.23	0.40	0.0168
6	S	71.00	6.58	5.03	1.31	824.53	1.10	0.30	0.0155
7	LL	91.33	6.23	5.28	1.18	1051.88	2.04	0.30	0.0223
8	BB 64	92.00	6.98	3.87	1.81	997.89	1.58	0.35	0.0171
	Mean	84.60	6.55	4.39	1.55	926.14	1.50	0.35	0.02

Table 5: Top performing hybrids based on mean performance

Sr. No	Characters	Top performing hybrid	Mean
1	Germination%	BDHE X LL	99.67
2	Shoot length	KL X BB64	9.00
3	Root length	KR X BB64	6.57
4	Shoot length/Root length	BDHE X S	1.92
5	Vigour Index I	KR X BB64	1355.52
6	Vigour Index II	KL X BB64	2.49
7	100 Seed weight (g)	KL X BB64	0.475
8	Dry seedling weight (g)	KL X BB64	0.0278

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