Study on the crossability of three species of *Solanum* in Gangetic plains of West Bengal

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ABSTRACT

The field evaluation for the study of crossability of brinjal was conducted at Central Research Farm, of Bidhan Chandra Krishi Viswavidyalaya Gayeshpur, Nadia, West Bengal with three species of brinjal ; Solanum aethiopicun, Solanum. gilo and two sets (each containing 8 genotypes) of the different cultivers of Solanum melongena. The prime objective was to asses the problems and prospects of both inter and intra- specific hybridization.

Key Words: Brinjal , crossability, heterosis and hybridization.

Brinjal is a native of India, believed to be a crop of Indo-Burma region and perhaps China is the secondary centre of origin of this crop. *Solanum incanum*, a wild species and having wide distribution in atleast 10 habitats in India is the progenitor of the cultivated species, *Solanum melongena*. Being the primary centre of origin, its rich biodiversity exists in different parts of India *viz.*., Eastern Ghats, north-eastern region, central India, eastern India particularly in Orissa and West Bengal. There are more than 100 local cultivars grown in India in different names.

Therefore, brinjal breeding in India is relived heavily upon selection from the indigenous genetic diversity for the development of improved variety. The phenomenon of heterosis has also been explored in developing hybrids in brinjal. In India brinjal hybrids are gaining popularity day by day. Combination breeding approach through selection of parents, hybridization and subsequent selection from the segregates which push aside straight selection approach in the other countries like, Japan, Israel, Philippines, etc is attracting the interest of Indian brinjal breeder also. Transfer of gene from wild source has also been assumed to play a great role in developing variety which are resistant to different biotic and abiotic stress. Information on the extent and nature of gene action for the target characters is essential for framing a sound strategy for combination breeding programme no doubt; however, information on both inter-specific and intra-specific crossability is no less important in developing a sound breeding strategy. But, such information is really meager in Indian perspective.

With this back ground information, the present study has been oriented on studying both inter-specific and intra-specific crossability employing several genotypes of brinjal and two wild *Solanum* species.

MATERIALS AND METHODS

The field experiment was conducted at Central Research Farm, of Bidhan Chandra Krishi Viswavidyalaya Gayeshpur, Nadia, West Bengal on a sandy loam soil during 2005-06 to 2006-07. Inter-specific crossability was studied with one set of genotypes including wild and brinjal genotypes *viz.*, *Solanum aethiopiccum* and *S. gilo* and 8 genotypes of *Solanum melongena viz.*, Tripti, Baramasi, BCB-75, Icebag, Nimpith, P.B.70, Baladi C.U. and Hazari. Intra-specific crossability was studied with two sets of genotyes of brinjal (*Solanum melongena*) *viz.*, Tripti, Baramasi, BCB-75, Icebag, Nimith, P.B.70, Baladi C.U. and Hazari (Set-1) and BCB-38, BCB-75, BCB-1, BCB-18, BCB-23, BCB-42, BCB-43 and BCB-45. (Set-2)

Hybridization was done by emasculation in the afternoon hours and hand pollination in the next day morning on the day of anthesis. Two proximate compositions of the sampled fruits of marketable maturity (total sugar and total phenol contents) were determined to have an understanding on the probable relationship of these two quality parameters with the crossability assuming similar concentration of these two metabolites on the stigma. The mean value of the characters from each genotype in each replication was used for statistical analysis following standard method for randomized block design.

The D^2 statistic was used for assessing the genetic divergence between the inbred lines separately in two years (2003-04 and 2004-05). The grouping of the inbreds was done by using Tocher's method as described by Rao (1952). The criterion used in clustering by this method is any two inbreds belonging to the same cluster should at least, on an average show a smaller D^2 value than those belonging to different clusters

RESULTS AND DISCUSSION

It was evident from the table 1. that *S. aethiopicum* and *S. gilo* were crossable in both ways, although the crossing success was much low, 22.72% in *S. aethiopicum* x *S. gilo* and 26.3% in S. gilo x *S. aethiopicum.* Rao (1979) and Nishio *et al.,* (1984) reported cross compatibility of these two species which agreed well to the present findings. Cytological studies revealed that inter-specific hybrid of *S. aethiopicum* and *S. gilo*, flowered, fruited and seeded normally (Fatokun, 1989). Anaso-Hu (1989) also reported high homology and close relationship of both the species. It is important to note that the crossing success between these two wild species could not be improved much with reciprocal

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changes of the parents indicating some restrictions at both the gametic levels of these two species.

Average crossability of the 8 genotypes of brinjal as both male and female parent have been presented in table 1as expected the cultivar "Tripti" and "Baramasi" recorded the lowest average crossability (21%) when used as female parent crossability of "Tripti" was as low as 10.71% when used as male which necessitates the detailed study on both *in vitro* and *in vivo* pollen germination, pollen tube growth and biochemical composition of pollen to find out the probable difficulties of these variety for the even as male parent. In general, comparatively higher crossability percentage was recorded for four genotypes Baramasi, Hazari, Icebag and BCB-75 when they were used as male parent. In contrast female crossability was comparatively higher in case of other 3 varieties *viz.* Nimpith, P.B. 70 and Baladi CU so, the situation of crossability with respect to average crossing success as well as male or female crossability depends on the specific genotypic condition. BCB 75, Nimpith and Hazari emerged as the most promising parental genotype as far as their crossability as both were concerned.

Average crossability of the 8 genotypes in the second set as both male and female parent is presented in Table 2. No female crossability with very low of 4.6% male crossability was recorded for "BCB 42". Such low male and female crossability was recorded earlier in two other genotypes namely "Tripti" and "Baramasi' of set1. It was established beyond doubt that crossability hindrance in the brinjal genotype was mostly associated with female gametophyte. However, this phenomenon was not uncorrelated with the male gametophyte all together. For this reason, no genotype could register very low female crossability coupled with high male crossability.

No one to one situation could be recorded for separate male and female crossability and for that matter, four genotypes namely BCB 75, BCB 1, BCB 18 and BCB 23 had comparatively higher female than male crossability. On the other hand, BCB 38, BCB 43 and BCB 45 did record comparatively high male crossability. It was conspicuous that male and female crossability were almost equal in some highly crossable genotypes namely, BCB 75 (Female crossability 63.6% and male 63.7%) BCB 43 (Female crossability 59.1%, male crossability 60.9%) and BCB 23 (Female 53.0% and Male 51.2%). These genotypes can be used in any direction as far as crossability is concerned. On the other hand, in another three highly crossable genotypes, male and female crossability varied some what widely in which BCB 38 (Female crossability 58.1% female 64.9%), BCB 45 (Female crossability 58.5% male crossability 64.9%). BCB 1 (Female crossability. 65% male crossability 44.7%) had been included. These genotypes can be used according to the crossability value if the hybrid performance of the respective parental combination is acceptable crossability in relation to genetic divergence.

Crossability in relation to genetic divergence

From the crossability studies employing both inter-specific and intra-specific cross combinations it appeared large effect of genotypes on the success of crosses within and between the *Solanum* species. It was established through crossability success the high homology and close relationship between two wild *Solanum* sp., *S. aethiopicum* and *S. gilo* although; the crossing success was very low. Even if there was no general barriers to crossing between two cultivars of *S. melongena,* the success rates of inter-varietal crossing varied greatly and even zero in quite a few number of cases. For this reason, genetic divergence of all the parental lines was calculated by multivariate analysis of seven characteristics of the genotypes of *S. aethiopicum* and *S. gilo* and each cultivars of *S. melongena* with a view to correlate the crossing success with genetic divergence of the parents (Table 2 and 3). The salient features emerged from this cross is discussed here under.

i) According to the crossability that was registered in genotypes set-1, percentage crossability was significantly and inversely correlated with the genetic divergence of the two parents involved in the crossing programme which was established through the registration of significant negative correlation (r= -0.645) between crossing success and D^2 values between two parents. However, according to the crossability that was registered in genotype Set-2, percentage crossability was found uncorrelated with the genetic divergence of the respective parents (r = 0.231). It is to be mentioned in this respect that genotypes included in Set-1 were comparatively more divergent as depicted by the D^2 values than those of the Set -2. It was apparent that significance of such correlations needs a minimum level of genetic divergence between the parents. This determination may have the relevance with these limitations in view.

ii) Close relationship between *S. aethiopicum* and *S. gilo* as established from the crossability study was supported by the study of genetic divergence as genotype of both the species clustered together revealing lowest genetic divergence (Table 2 and 3).

iii) Successful *S. gilo* x *S. melogena* crosses presented the picture which could not be co-related with the concept of the genetic divergence of the parents and their crossability all together. *S. gilo* crossed with the *S. melongena* cultivars namely 'Tripti', 'Hazari' and 'Icebag' and 'Nimpith' of which *S. gilo* x Icebag cross was successful in both ways. According to Multivariate analysis, the *S. melongena* cultivar 'Uttara' is the nearest to *S. gilo* followed by 'Hazari', 'Baladi CU', 'Tripti' and 'Baramasi'. From this picture, *S. gilo* and Hazari was crossable as expected but the reason of unsuccessful crossing between *S. gilo* x Uttara and *S. gilo* x Baladi CU could not be answered. At the same time, both way crossing success of *S. gilo* x Icebag could not be explained because as per the present analysis biological distance of both these lines are quite far (Table 2).

iv) One cultivar of brinjal," Tripti" emerged as a parent with very low male and female crossability. Its crossing success with 'Baramasi' could well be correlated with lowest genetic divergence between them (Table 3 and 4). Similarly Hazari and Uttara being quite close to Tripti registered crossing success among them. But its unsuccessful crossing with the other much closer cultivar "Nimpith" could not be explained from this multivariate analysis. Such was the case for BCB 42 in second set of inter-varietal crossing (Table 3).

Crossability in relation to biochemical composition of fruit

Crossability between the genotypes belonging to both Set-1 and Set-2 have been studied in relation to the biochemical composition of the fruits of marketable maturity. Two proximate compositions of the sampled fruits of marketable maturity (total sugar and total phenol contents) was determined to have an understanding on the probable relationship of these two quality parameters with the crossability assuming similar concentration of these two metabolites on the stigma. It appeared that phenol content might have played some role in crossing success. It is evident from the Table 4 that the less crossable genotypes namely, Tripti, Baramasi and BCB-42 have comparatively low phenol contents, 3.44, 3.93 and 8.45 mg/100 g fresh fruit, respectively and high sugar contents, 3.87, 3.36, 3.27 percen, respectively as compared to the highly crossable genotypes. It is preliminary study which needs further investigation.

From this detailed study it appeared that genetic divergence of the parents played important role for realizing crossing success between them. However, the multivariate analysis needs to be worked out embracing more number of characters for proper biological delineation among the genotypes. However, apart from genetic diversity some other factors, may be cytological barrier or biochemical compositions of the stigmatic fluid might have caused unsuccessful crossing or unilateral incongruity in some crosses.

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Table 1: Average crossability of different genotypes of brinjal as both male and female parents (set 1 and set 2)

Parental line (Set 1)	Average crossability percentage		Parental line (Set 2)	Average crossability percentage	
	As female parent	As female parent		As male parent	As female parent
Tripti	21.48	10.71	BCB 38	58.08	64.91
Baramasi	21.01	29.60	BCB 75	63.63	63.70
Hazari	44.88	48.80	BCB 1	65.00	44.71
Icebag	38.01	45.90	BCB 18	53.44	45.61
BCB 75	48.00	51.26	BCB 23	53.04	51.21
Nimpith	47.05	46.72	BCB 42	0.00	4.62
PB-70	42.30	33.65	BCB 43	59.13	60.97
Baladi CU	39.63	31.96	BCB 45	58.55	64.91

Table 2: Divergence among 10 genotypes (set – 1)

Genotypes	*S. aethiopicum*	*S. gilo*	Tripti	Baramasi	Hazari	Uttara	Icebag	Nimpith	Baladi CU	Pant Brinjal 70
S. aethiopicum	0.00	1857.38	10402.87	9025.66	4131.43	4134.90	24748.03	16496.02	3903.25	38879.68
S. gilo		0.00	9378.28	9681.98	3125.91	2990.90	26647.01	17731.19	3410.19	43748.71
Tripti			0.00	397.20	1964.26	3059.24	5802.68	2273.56	1980.61	15954.06
Baramasi				0.00	2117.74	3278.30	5198.11	1836.25	1915.17	14143.57
Hazari					0.00	1059.94	13364.37	7221.31	474.46	26614.00
Uttara						0.00	14013.27	7298.97	783.92	27075.07
Icebag							0.00	1257.02	12056.49	2720.03
Nimpith								0.00	6256.79	6800.19
Baladi CU									0.00	24641.00
Pant Brinjal 70										0.00

Table 3: Divergence among 10 genotypes (Set 2)

Genotypes	BCB-38	BCB-75	BCB-1	BCB-18	BCB-23	BCB-42	BCB-43	BCB-45	BCB-2	BCB-28
BCB-38	0.00	1857.38	10402.87	9025.66	4131.43	4134.90	24748.03	16496.02	3903.25	38879.68
BCB-75		0.00	9378.28	9681.98	3125.91	2990.90	26647.01	17731.19	3410.19	43748.71
BCB-1			0.00	397.20	1964.26	3059.24	5802.68	2273.56	1980.61	15954.06
BCB-48				0.00	2117.74	3278.30	5198.11	1836.25	1915.17	14143.57
BCB-23					0.00	1059.94	13364.37	7221.31	474.46	26614.00
BCB-42						0.00	14013.27	7298.97	783.92	27075.07
BCB-43							0.00	1257.02	12056.49	2720.03
BCB-45								0.00	6256.79	6800.19
BCB-2									0.00	24641.00
BCB-28										0.00

Table 4 : **Biochemical composition of the fruit in the parental genotypes in Set 1 and Set 2**

Parent	Phenol (mg/100g)	Sugar (%)
S. aethiopicum	18.32	0.98
S.gilo	14.95	1.22
Tripti	3.44	3.87
Baramasi	3.93	3.36
Hazari	9.21	2.65
Icebag	5.28	2.73
BCB-75	10.3	2.75
Nimpith	4.3	3.97
PB-70	4.53	3.14
Baladi CU	11.93	2.20
BCB-38	12.56	2.08
BCB-75	10.18	2.58
BCB-1	4.19	4.18
BCB-18	10.58	2.62
BCB-23	9.87	2.73
BCB-42	8.45	3.27
BCB-43	12.38	2.8
BCB-45	8.75	2.15