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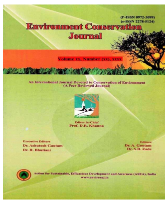

Evaluation of some promising indigenous brinjal genotypes under terai region of West Bengal

Amar Biradar
Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India
Taru Dumi
Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India
Subhamoy Sikder ✉
Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India
Shibnath Basfore
Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India
Ranjit Chatterjee
Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India

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ABSTRACT

Present experiment was implemented under the Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Coochbehar which situated at terai region of West Bengal during the autumn-winter season of 2019-20 and 2020-21 on 28 highly diversified brinjal genotypes on ten highly important yield and yield attributing traits to assess the extent of involvement of different genetic phenomena in manifestation of important yield related traits and to understand the inter relationship among them to design better selection criteria. Result revealed that there was close proximity in the magnitude among the component of coefficient of variation and these component exhibited high estimates coupled with high heritability for almost all the characters excepting days to first flowers and days to fruit maturity indicated less interference of the environmental factors in the manifestation of these traits. High magnitude of heritability coupled with genetic advance of mean for those character suggested possibility for selecting these characters based on phenotypic performance for further improvement at desired direction. Residual effect from path analysis was 0.1367 at genotypic level which suggested that contribution of the traits under study was approximately 86.5% on yield, argued for appropriate selection of traits for success of present experimental study. From character associationship and path coefficient it was found that expected yield was highly correlated in positive direction with average fruits per plant (0.68 and 0.801), average fruit weight (0.48 and 0.565), numbers of primary branches per plant (0.51 and 0.113); hence, these yield attributing traits were significantly positively related with each other which suggested that simultaneous selective breeding strategy considering these characters for improvement of yield could be rewarding due to their probable conditioning by additive gene action.

Introduction

Brinjal (*Solanum melangena* L.), with diploid chromosome numbers (2n=24) belonged to the Solanaceae family, considered as one of the most common and popular vegetable crop in Indian subcontinent. It is also called as *Eggplant, Garden egg, Melangena* and *Aubergine*. The name '*Egg plant*' given due to some of brinjal varieties having round shape with white colour which looks like chicken eggs. In terms of area and production India ranks second after China with approximately 741 thousand hectare of land coverage and 13000 thousand metric tonnes of production (NHB 2019-2020). However, West Bengal is first in both area and production with 162.93 thousand hectares of

Corresponding author E-mail: *subhamoy.sms@gmail.com*
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land coverage and 3 thousand metric tonnes of production, respectively. Brinjal is known as poor man's vegetable as because it comprises of highest production potential quality coupled with ease availability to consumers (Kumar *et al*., 2013). Hence, it is a stable vegetable in our diet since ancient time, considered as reliable source of income for marginal farmers. Brinjal fruits are rich source of vitamins, minerals *viz*., magnesium, calcium, phosphorus and fatty acids. Brinjal has medicinal use like curing asthma, diabetes and liver complaints (Santhosha *et al*., 2017). There is a high demand for brinjal for its nutritional and medicinal values like decholestrolizing property primarily due to presence of linoleic and linoleic fatty acid which are present abundant in flesh and seeds. Because of its low sugar content and high chlorogenic acid content, white brinjal is considered beneficial for diabetic people. (Bajaj *et al*., 1979). These also contributes to brinjal's antioxidant and anti-cancer capabilities (Gonthier *et al*., 2003). It is well-known for treating liver problems and toothaches (Dakone *et al*., 2016) as well as used in improvement of cardiovascular and liver health (Patel *et al*., 2004).

India being a much diversified country with respect to agro-climate, ecology, culture, society and local preferences, provides ample scope for genotypic manipulation and/or modification of brinjal. Hence, throughout the India still there is high demand for improved zone-specific varieties of brinjal. However, again being primary center of origin, India exhibits a greater degree of variability with diverse range of local landraces to many advanced cultivars bring forth greater opportunity for effective selection for desirable kinds.Coupled with the discussed facts, due to global warming and day by day narrow genetic approach towards development of improved brinjal cultivars resulting in loss of variability up to a greater extent. Target specific selective breeding approach always associated with overlooking of useful important traits by mistake that also provide opportunity for further evaluation. Greater extent of variability exist in indigenous germplasm of brinjal with respect to plant morphology, quantitative attributes, yield potential, fruit quality, processing aspects and tolerance to biotic or abiotic stresses (Ullah *et al.,* 2014). For improvement of any desired trait by means of any breeding strategy is comprises with consideration of multiple sub-traits those remain directly and/or indirectly interrelated with principal trait and misjudging may lead negative effect on end product. Specifically, yield components of any crop are complicated being governed by polygenes in their manner of inheritance and also heavily influenced by the environment factors (Kumar *et al*, 2012). For this reason, evaluation of genetic diversified population is paramount important for the assessment of nature of trait and relative breeding potential of the genitors or identifies best combiners. Considering all these information, present experiment was laid out to estimate the magnitude of involvement of different genetic phenomena in manifestation of important yield related traits and to understand the inter relationship among them to design better selection criteria.

Material and Methods

Present experiment was organized at the Instructional Farm under the Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, India during the Autumn-Winter season (September to March) of 2019-20 and 2020-21. The farm is situated at terai agro climatic region of West Bengal (latitude 26 ^{0}19'86" N and longitude 89^{0} 23'53" E) at 43 meter above mean sea level. The soil of the experimental site is characterized by sandy loam in nature, poor in water holding capacity due to course in texture, with low pH (5.2-5.6) and high soil moisture content. Hence, the weather condition is typically sub-tropical humid climate that specified by extreme rainfall coupled with high relative humidity, medium temperature and extended winter season. The experimental material was consisted of twenty eight highly diversified genotypes, out of which twenty seven local genotypes collected from different reputed institutes and agricultural universities of India and national released variety Pusa Purple Long collected from IARI, Pusa, New Delhi, India to be used as check variety in the present experiment. Present investigation was outlined following the randomized complete block design that included three replications for each treatment. Each replication was raised in 3m x 3m plots consisted of 16 plants in each plot maintaining the plant spacing of 75 cm row to row and 75 cm plant to plant; recommended cultivation practice was followed for raising seedling and maintaining germplasm. The observation was recorded on ten important growths and yield related traits *viz.*, average height of height (cm), numbers of primary branches per plant, calyx length (cm), days to first flowering, days to fruit maturity, fruit diameter (cm), fruit length (cm), average weight of fruit (g), number of fruits per plant and yield per hectare of land (t/ha); where metric data were recorded by using vernier calipers (Mitutoyo, 0-150mm) and digital weight machine (Mettler Toledo PBD659). For collection of data, 10 healthy mature plants of almost 60 days old from each plot was selected, average performance under each plot was considered as individual replication. After completion of record keeping process, pooled data over two successive years were statistically analyzed and discussed elaborately. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense and genetic advance for different characters were worked out according to Lush (2010) and the estimates were classified into hierarchical groups as suggested by Nadarajan and Gunasekaran (2008). Phenotypic (r_p) and genotypic (r_g) correlation coefficients of important quantitative traits were estimated as suggested by Saini *et al.* (2018). To know the direct and indirect effects of the important quantitative traits path coefficient analysis was carried out following Rauf *et al.*, (2004).

Results and Discussion

Genetic variability, Heritability and Genetic advance

In any crop species, variability observed in different important characters among genotypes are generally due to the sole or combined effect of genotype as well as environment, the reason why estimation of the genotypic and phenotypic coefficients of variation were of immense important to determine the magnitude of genotypic and phenotypic variation to have an idea about real value of variation due to genotype. In present experiment, there was higher magnitude of phenotypic coefficients of variation were recorded as compared to the than genotypic coefficients of variation for all the traits studied with negligible difference in most of the cases (Table 1) indicated that there was minimal influence of environmental factors in the manifestation of the traits. The extent of the coefficients of variation for the both due to phenotype and genotype highly varied from character to character from low to high which was evident of prevailing high degree of variation principally due to genetic potentiality among the genotypes under study. High GCV (24.34%) and PCV (24.46%) coupled with heritability (99.09%) and GAM (49.92%) was recorded for plant height. Similar results were found by Shilpa *et al.* (2018) for high GCV and PCV. High estimate for GCV (40.51%), PCV (40.69%), heritability (99.12%) and high GAM (83.07%) was recorded in number of primary branches per plant which were in conformity with the finding of Kumar *et al.* (2012). In case of calyx length, similar high estimated in present investigation which was also reported earlier by Kumar *et al.* (2013). The average fruit diameter was observed 6.28 cm, ranging from 3.16 to 11.88 cm with high estimates for all the genetic parameters and this high GCV and PCV was also reported by the Yadav *et al.* (2016). High GCV (28.64%) and PCV (28.65%) coupled with high heritability (99.91%) and GAM (58.97%) was recorded for fruit length. Kumar *et al.* (2013) and Lokesh *et al.* (2013) in earlier also reported high GCV and PCV for fruit length in brinjal in their experiment. For fruit weight, high GCV (60.25%), PCV (60.25%),heritability (99.98%) and high GAM (124.10%) was observed which were in conformity with the earlier finding of Kumar *et al.* (2012) and Yadav *et al.* (2016). Whereas, high heritability coupled with GAM was reported by Muniappan *et al.* (2010). Numbers of fruit per plant exhibited high estimatesfor all the genetic parameters which were in accordance with the findings of Madhavi *et al.* (2015). Also, high heritability coupled with GAM for fruit numbers per plant was obtained earlier by Lokesh *et al.* (2013) and Yadav *et al.* (2016). The mean varietal performance of fruit yield was 18.48 tonnes per hectare ranged from 5.28 to 42.31 tonnes per hectare. High GCV (64.21%) and PCV (64.22%) couple with high heritability (99.98%), high genetic advance (37.74) and GAM (132.26%). Similar results were also reported by Kumar *et al.* (2013) and Shilpa *et al.* (2018). Estimated components of variation for all these characters were statistically at per as well as towards high heritability which was indicative of presence of

Table 1: Genetic variability parameters for different important traits of brinjal

Characters	Mean	Range		GCV (%)	PCV (%)	Heritability (h^2%)	Genetic Advance (GA)	Genetic Advance (% of Mean)
		Maximum	Minimum					
Plant height (cm)	60.17	92.67	35.17	24.34	24.46	99.09	30.04	49.92
Number of primary branches	4.94	9.03	1.37	40.51	40.69	99.12	4.10	83.07
Calyx length (cm)	3.21	4.97	1.38	28.66	28.68	99.87	1.90	59.00
Days to first flower	55.75	63.38	47.64	6.20	6.35	95.19	6.94	12.46
Days to fruit maturity	36.21	44.39	23.31	14.68	14.97	96.07	10.73	29.63
Fruit diameter (cm)	6.28	11.88	3.16	40.85	40.88	99.82	5.28	84.07
Fruit length (cm)	15.91	25.07	6.41	28.64	28.65	99.91	9.38	58.97
Fruit weight (g)	286.86	709.36	92.15	60.25	60.25	99.98	356.00	124.10
Number of fruits per plant	10.90	39.56	3.21	72.63	72.65	99.95	16.31	149.57
Yield ha^{-1} (t/ha)	18.48	42.31	5.28	64.21	64.22	99.98	37.74	132.26

sufficient variation among the genotype for these character as well as manifestation was more due to genetic potentiality of individual genotypes. Also, high genetic gain suggested improvement of this character could be done by pure line or bulk selection *i.e.*, selection of these characters based on phenotypic performance could be rewarding breeding strategy for further improvement at desired direction. Moderate GCV (14.68%) and PCV (14.97%) for days to fruit maturity and low GCV (6.20%) and PCV (6.35%) for days to first flower indicated negligible genotypic variation for these traits.Kumar *et al.* (2013) and Shilpa *et al.* (2018) in their investigation reported similar finding for these characters. Also, low genetic gain suggested there might be dominance of non-additive genetic factor for the trait that could possibility be improved at desired direction by heterosis or transgressive breeding strategy.

Character association analysis

Table 2 revealed that plant height which was significant and positively correlated with primary branches (Gr=0.36) and fruit length (Gr=0.29). Similar findings results were found by Gupta *et al.* (2017) and Mohanty (2003) in which plant height was significantly and positively correlated with number of primary branches. Plant height showed significant and negatively correlated with fruit weight (Gr= -0.23). Number of primary branches showed significant and positive correlation with calyx length (Gr = 0.35), days to first flower (Gr = 0.26), fruit diameter (Gr = 0.42) and yield (Gr = 0.51). Positive association with fruit yield, fruit diameter and fruit weight was also reported by Banerjee *et al.* (2018). Again, number of primary branches showed significant negative relation with days to fruit maturity.Calyx length which was significant and positive correlation with days to first flower (Gr = 0.33), fruit diameter (Gr = 0.61) and fruit weight (Gr = 0.46). This positive relation with fruit weight and fruit diameter was also reported by Kumar *et al.* (2016). However, calyx length showed significant negative relation with days to fruit maturity (Gr = -0.38). Days to first flower found to be significant positive correlated with numbersof fruits per plant (Gr = 0.27) and yield (Gr = 0.29). Dharwad *et al.* (2009) and Mohanty *et al.* (2020) also found positive correlation among days to first flowering and fruit weight. Days to fruit maturity showed significant positive correlation with fruit length (Gr = 0.57) and number of fruits per plant (Gr = 0.31). However, it showed significant negative correlation with fruit diameter (Gr = -0.76), fruit weight (Gr = -0.57) and yield (Gr=-0.25). The negative relationship among days to fruit maturity and yield per hectare was also reported by Mohanty *et al.* (2020). Fruit diameter showed significant positive correlation with fruit weight (Gr = 0.91) and yield (Gr = 0.41). Similar results found by Mohanty *et al.* (2020) and Kumar *et al.* (2016). Whereas, it exhibited significant negative correlation with fruit length (Gr = -0.35) and number of fruits per plant (Gr = -0.31).Fruit length did not exhibited any significant relationship. Fruit weight showed significant positive correlation with yield (Gr = 0.48), but significant negative correlation with number of fruits per plant (Gr = -0.27). Positive association between fruit weight and total yield per hectare was also reported by Dharwad *et al.* (2009). Number of fruits per plant showed significantly positive correlation with yield (Gr = 0.68) and this

Table 2: Genotypic (G) and Phenotypic (P) correlation for important traits of brinjal

Characters		PB	CL	DFF	DFM	FD	FL	FW	FPP	Yield
PH	G	0.36**	-0.01	-0.02	0.04	-0.17	0.29*	-0.23*	0.02	-0.13
	P	0.33**	-0.01	-0.02	0.04	-0.16	0.26*	-0.22*	0.02	-0.13
PB	G		0.35**	0.26*	-0.37**	0.42**	0.00	0.36**	0.21	0.51**
	P		0.33**	0.25*	-0.36**	0.42**	0.00	0.33**	0.21	0.48**
CL	G			0.33**	-0.38**	0.61**	-0.06	0.46**	-0.20	0.17
	P			0.31**	-0.34**	0.60**	-0.05	0.44**	-0.20	0.17
DFF	G				-0.07	0.16	-0.02	0.06	0.27*	0.29**
	P				-0.05	0.15	-0.02	0.05	0.26*	0.26**
DFM	G					-0.76**	0.57**	-0.57**	0.31**	-0.25*
	P					-0.74**	0.54**	-0.56**	0.28**	-0.24*
FD	G						-0.35**	0.91**	-0.31**	0.41**
	P						-0.34**	0.90**	-0.29**	0.40**
FL	G							-0.11	0.05	-0.07
	P							-0.11	0.04	-0.07
FW	G								-0.27*	0.48**
	P								-0.25*	0.46**
FPP	G									0.68**
	P									0.64**

Residual effect= 0.1367 ; * and ** Significant at 5% level and 1% level respectively
N.B: PH- plant height (cm); PB- Number of primary branch; CL- calyx length (cm); DFF- days to first flower; DFM- days to fruit maturity; FD- fruit diameter (cm), FL- fruit length (cm), FW- fruit weight (g), FPP- fruit per plant, Yield- yield in tonnes per hectare of land

finding was in conformity with the earlier investigation of Praneetha *et al.* (2011), Praneetha (2018) and Mohanty *et al*. (2020). Fruit weight and fruit numbers per plant which were positively correlated with yield, but was negatively related with each other suggested limitation in their potentiality to manifest simultaneously and were contrasting traits contributed cumulatively towards the yield. It was clearly evident that yield was highly positively correlated with number of primary branches, first flowering, fruit diameter, fruit length and number of fruit plant. Hence, these yield attributing traits were significantly positively related with each other which suggested that simultaneous selective breeding strategy for improvement of yield considering these characters could be rewarding.

Path coefficient analysis

The effects of different independent traits, both individually and in combination with other characters, on the expression of different characters on marketable fruit yield per plant were shown using path coefficient analysis in table 3. Plant height, calyx length, days to first flower, fruit diameter and fruit length showed negligible direct and indirect effect on total yield per hectare through other traits which was inconformity with the investigation outcome of Madhavi *et al*. (2015), Arti *et al.* (2019) and Nikitha *et al*. (2020). Number of primary branches exhibited low positive direct effect (0.113) but negligibleindirect effect through other traits on total yield per hectare which wasin conformity with the finding of Nikitha *et al*. (2020). Days to fruit maturity showed moderate negative direct effect (-0.203) and negligible negative direct effect on total yield per hectare through other traits. Similar finding was earlier also reported by Arti *et al*. (2019). However, fruit weight exhibited high positive direct effect (0.565) on total yield per hectare but moderate negative indirect effect through fruits per plant (-0.206). This finding was in accordance with the observation of Muniappan *et al*. (2010) and Shekhar *et al*. (2014). Whereas, fruits per plant were also showed high and positive direct effect (0.801) on total yield per hectarewith low negative indirect effect through fruit weight (-0.145). Similar kinds of results were found by Muniappan *et al.* (2010) and Sujin *et al.* (2017). From above discussion it was clearly evident that direct contribution of the traits under experiment

Table 3: Phenotypic path coefficient analysis for brinjal considering yield as dependent variable

Character	PH	PB	CL	DFF	DFM	FD	FL	FW	FPP	Yield/ha (Pr)
PH	**-0.078**	0.039	0.000	0.000	-0.009	0.012	0.017	-0.126	0.014	-0.13
PB	-0.027	**0.113**	0.004	0.002	0.074	-0.031	0.000	0.191	0.171	0.51**
CL	0.001	0.038	**0.013**	0.003	0.069	-0.044	-0.004	0.253	-0.157	0.17
DFF	0.001	0.029	0.004	**0.008**	0.012	-0.011	-0.001	0.033	0.208	0.29**
DFM	-0.003	-0.041	-0.005	0.000	**-0.203**	0.055	0.034	-0.319	0.236	-0.25*
FD	0.013	0.048	0.008	0.001	0.152	**-0.073**	-0.022	0.510	-0.234	0.41**
FL	-0.021	0.000	-0.001	0.000	-0.111	0.025	**0.063**	-0.064	0.039	-0.07
FW	0.017	0.038	0.006	0.000	0.114	-0.066	-0.007	**0.565**	-0.206	0.48**
FPP	-0.001	0.024	-0.003	0.002	-0.060	0.021	0.003	-0.145	**0.801**	0.68**

Residual effect= 0.1367 ; * and ** Significant at 5% level and 1% level respectively
N.B: PH- plant height (cm); PB- Number of primary branch; CL- calyx length (cm); DFF- days to first flower; DFM- days to fruit maturity; FD- fruit diameter (cm), FL- fruit length (cm), FW- fruit weight (g), FPP- fruit per plant, Yield- yield in tonnes per hectare of land

on the yield as dependable variable was highest through fruit per plant followed by fruit weight, number of primary branches, fruit length, days to first flowers. Among these, fruit length exhibited negative correlation with yield due to indirect contribution of multiple traits at negative direction and days to first fruiting showed negligible direct effect with the yield. This phenomenon suggested the importance of substantiate the decision for considering the traits in breeding strategy for yield enhancement based on character association, rather trait *via* end product association should be portioned into direct and indirect relation for better understanding the relationship. Residual effect was 0.1367 at genotypic level which suggested that contribution of the traits under study was approximately 86.5% on yield, argued for appropriate selection of traits for success of present experimental study.

Conclusion

From the present investigation it was observed that there was minimal influence of environmental factors in the manifestation of the traits under study. Traits such as, plant height, number of primary branches per plant, calyx length, average fruit diameter, fruit length, fruit weight, numbers of fruit per plant and fruit yield exhibited high components of variation, heritability and genetic gain as percentage of mean was the indication for presence sufficient variation among the genotype for those traits as well as improvement could be done by pure line or bulk selection. Whereas, low estimates for different genetic components suggested there might be dominance of non-additive genetic factor for the trait that could possibility be improved at desired direction by heterosis or transgressive breeding strategy. From character associationship and path analysis, it was clearly evident that number of fruit per plant, individual fruit weight, number of primary branches per plant emerged as the major attributes with their significant contribution towards the total yield of brinjal and can be considered as important selection criteria for the improvement of the yield due to their probable conditioning by additive gene action.

Conflict of interest

The authors declare that they have no conflict of interest.

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