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Variability Study in Inter-varietal Crosses of Aubergine (*Solanum melongena* L.)

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ABSTRACT

A field experiment was carried out to assess the genetic variability of yield-attributing traits in 12 aubergine genotypes. The evaluated parameters were number of primary and secondary branches/plant, days to flowering, number of fruits/plant and fruit length, all of which differed significantly in different genotypes. Small differences in genotypic and phenotypic variance and coefficient of variation, high heritability as well as high genetic advance were observed for all traits, indicating additive gene effects. Line-23×Line-24F_2 performed best in terms of number of primary branches/plant (8.5), early flowering (48.18 days after transplanting), and maximum number of fruits/plant (37.29). Line-27 required more days to flowering (58.16) while BARI-2 produced most secondary branches/plant (20.59) and longest fruit (13.70 cm). Hence, a cross between Line-23×Line-24F_2 and BARI-2 is suggested for increased value-added traits.

Keywords: genetic variability, genotypes, heritability

INTRODUCTION

Aubergine (*Solanum melongena* L.) (2n=24) is one of the major Solanaceous crops in Bangladesh and its wide genetic diversity is due to the availability of different landraces and their wild relatives. When considering production and utilization in Bangladesh, 19 major and 20 minor indigenous vegetables (IVs) have been identified and grown in homesteads for family consumption and in the field for commercial purposes. However, landraces and traditional technologies dominate over improved varieties in terms of resistance to pests and disease such as bacterial wilt, shoot and fruit borer (Behera and Singh 2002), environmental stress (drought, high temperature and summer rainfall), short winter, postharvest loss, poor marketing infrastructure and some other constrains of aubergine production. Hence, emphasis should be placed on the development of advance genotypes by breeding and integrated pest management. In Bangladesh, the area under winter aubergine is about 43,000 ha with a production of about 280,000 m tons (BBS 2006). Even though IVs are highly nutritious and defensive foods against various ailments, including cancer (Zeske 2012), little attention has been paid to its improvement and risk of extinction. Therefore, attempts should be made to develop IVs through surveys, collection, evaluation, conservation and network establishment on a regional basis. In addition, information about variability in aubergine germplasm is still insufficient. Therefore, the present study was undertaken to assess the variability in the F_2 population of 12 aubergine genotype and to select suitable lines for breeding programmes.

MATERIALS AND METHODS

Experimental details

The experiment was carried out at the horticultural farm of Sher-E-Bangla Agricultural University, Bangladesh during March to August 2008, at 23° 77' N (lat.) and 90° 33' E (long.), and 8.6 m above sea level. Twelve aubergine genotypes (**Table 1**) from the Department of Genetics and Plant Breeding of the University were used as planting material. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The row-to-row, plant-to-plant and block-to-block distance was 75, 60 and 50 cm, respectively. All aubergines were grown successfully according to standard recommendation (LIBNTS 2008). Data were collected from individual plants of 10 randomly selected hills of each plot. The number of primary and secondary branches/plant was counted during the heading stage. Days to flowering was recorded from the date of soaking seed to date of 100% flowering. The number of fruits/plant was recorded during physiological maturity and fruit length was recorded in cm from the first node of the rachis to the top of the fruit.

Table 1 List of genotypes used in this study.

BARI-1	Line-15	Line-23× Line-24F_1
BARI-2	Line-23	Line-01× Line-25F_2
Line-8	Line-27	Line-14× Line-27F_2
Line-14	Line-01× Line-25F_1	Line-23× Line-24F_2

Estimation of genotypic and phenotypic variances

Genotypic and phenotypic variances were estimated according to Johnson *et al.* (1955).

$$\text{Genotypic variance } (\delta_g^2) = \frac{MSG-MSE}{r}$$

where MSG = mean sum of squares for genotypes, MSE = mean

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sum of squares for error, and r = number of replications.

$$Phenotypic\ variance\ (\delta_p^2) = \delta_g^2 + \delta_e^2$$

where δ^2_g =genotypic variance and δ^2_e = environmental variance = MSE/r

Genotypic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV) were calculated according to Burton (1952).

$$GCV = \frac{\delta_g \times 100}{\bar{x}} \quad \text{and} \quad PCV = \frac{\delta_p \times 100}{\bar{x}}$$

where δ_g = genotypic standard deviation, δ_p = phenotypic standard deviation and denominator = population mean.

Estimation of heritability

Broad sense heritability was estimated according to Singh and Chaudhary (1985).

$$h_b^2(\%) = \frac{\delta_g^2}{\delta_p^2} \times 100$$

where h^2_b = heritability in a broad sense, δ^2_g = genotypic variance and δ^2_p = phenotypic variance.

Estimation of genetic advance

Genetic advance (GA) of different characters was estimated according to Allard (1960).

$$GA = \frac{\delta_g^2}{\delta_p^2} \times K.\delta p$$

where δ^2_g = genotypic variance, δ^2_p = phenotypic variance, δ_p = phenotypic standard deviation and K = selection differential which is equal to 2.06 at 5% selection intensity.

Genetic advance as percent of mean (GAPM) was estimated by the formula described by Allard (1960).

Statistical analyses

Statistical analyses were performed and analysis of variance (ANOVA) for each parameter was performed by an *F* test and mean values were separated by DMRT (Steel and Torrie 1980). ANOVA was performed according to Goulden (1959). GCV and PCV were estimated according to Burton (1952). Broad sense heritability and GA were calculated as suggested by Allard (1960). Simple correlation coefficients were analyzed following Hayes *et al.* (1955) and Singh and Chowdhury (1985). Correlation coefficients were further partitioned into direct and indirect effects by path coefficient analysis as described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Performance of genotypes

1. Number of primary branches/plant

Significant variability was observed among genotypes with respect to number of primary branches/plant (**Table 2**). Maximum number of primary branches/plant was observed in line-23×Line-24F_2 (8.5), fewest (4.33) in line-01×Line-25F_1. Randhawa *et al.* (1993) studied 24 quantitative characters in 22 aubergine genotypes to derive information on yield correlation, observing variation in the number of primary branches/plant in different genotypes which had a direct effect on yield. Ram *et al.* (2007) and Prabhu *et al.* (2007) also found significant variation in the number of branches/plant in different aubergine genotypes.

2. Number of secondary branches/plant

Significant variability was observed among the tested genotypes with respect to the number of secondary branches/plant (**Table 2**). Highest number of secondary branches/plant (20.59) was observed in BARI-2 which was statistically equal to Line-23×Line-24F_2 (18.83), fewest in Line-14 (8.86). Ram *et al.* (2007) and Prabhu *et al.* (2007) observed that this parameter has a direct significant effect on aubergine yield and that it differs in different genotypes. Mandal and Dana (1992) stated that secondary branches are important traits for the selection of superior genotypes.

3. Days to flowering

Significant variability was observed in flowering time among the 12 genotypes (**Table 2**). Line-23× Line-24F_2 flowered earliest (48.18 days after transplanting (DAT)) while Line-27 needed most time for flowering (58.16 DAT). Ram *et al.* (2007) and Kumar *et al.* (2008) stated that days to flowering has a direct genotype-dependent effect on aubergine yield.

4. Number of fruits/plant

Significant variability was observed among the genotypes with respect to number of fruits/plant (**Table 2**). Maximum number of fruits/plant (37.29) was observed in Line-23×Line-24F_2. Line-27 produced least fruit/plant (10.23). Prabhu *et al.* (2007) also reported variability in this trait for different genotypes. Number of fruits/plant is strongly correlated with yield/plant in aubergine (Srivastava and Sachan 1973). Similarly, path analysis in aubergine showed maximum direct effects of number of fruits/plant on yield in a genotype-dependent manner (Srivastava and Sachan 1973; Vijoy *et al.* 1978; Ram *et al.* 2007).

Table 2 Performance of 12 aubergine genotypes.

Plant materials	Number of primary branches/plant	Number of secondary branches/plant	Days to flowering	Number of fruit/plant	Fruit length
BARI-1	6.18 b	10.83 cde	52.97 bcd	20.94 c	11.70 b
BARI-2	6.46 b	20.59 a	54.69 ab	24.47 b	13.70 a
Line-8	4.60 ef	10.39 cde	49.58 de	13.63 d	12.98 a
Line-14	5.01 de	8.86 e	57.67 a	13.12 d	8.90 d
Line-15	4.65 ef	11.67 bcd	52.27 bcd	12.17 d	11.35 bc
Line-23	4.50 ef	11.59 bcd	50.77 cde	25.83 b	5.16 e
Line-27	5.40 cd	11.55 bcd	58.16 a	10.23 d	11.62 b
Line-01× Line-25F1	4.33 f	12.23 bc	54.63 ab	13.02 d	10.50 c
Line-23× Line-24F1	5.33 d	9.67 de	50.61 cde	26.52 b	4.10 f
Line-01× Line-25F2	6.00 bc	11.67 bcd	50.56 cde	24.23 bc	10.83 bc
Line-14× Line-27F2	6.33 b	13.00 b	53.54 bc	34.93 a	4.61 ef
Line-23× Line-24F2	8.50 a	18.83 a	48.18 e	37.29 a	5.20 e
CV (%)	3.42	5.63	6.39	4.59	5.74
Level of significance	*	*	*	**	*

Within a column treatment means with the same letter(s) are not significantly different according to DMRT at $P \leq 0.05$. ** Significant at $P \leq 0.01$, * Significant at $P \leq 0.05$.

Table 3 Genetic parameters and yield-contributing traits of 12 aubergine genotypes.

Parameters	Number of primary branches/plant	Number of secondary branches/plant	Days to flowering	Number of fruits/plant	Fruit length
Mean sum of square	4.190**	37.495**	28.852**	247.713**	36.854**
Mean	5.608	12.573	52.804	21.366	9.222
Range	4.33-8.5	8.86-20.59	48.18-58.16	10.23-37.29	4.10-13.70
σ^2 g	1.354	12.110	8.288	81.278	12.181
σ^2 e	0.129	1.166	3.989	3.879	0.312
σ^2 p	1.483	13.276	12.277	85.157	12.493
h^2 b	91.299	91.217	67.507	95.445	97.503
GA (5%)	22.901	68.465	48.726	181.439	70.992
GAPM	408.366	544.543	92.277	849.194	769.814
GCV	20.747	27.678	5.452	42.195	37.845
PCV	21.713	28.979	6.635	43.190	38.327
ECV	6.405	8.588	3.782	9.218	6.057

** = Significant at 1% level of probability, σ^2_g = genotypic variance, σ^2_e = environmental variance, σ^2_p = phenotypic variance, h^2b = heritability in broad sense, GA = genetic advance, GAPM = genetic advance in percent mean, GCV = genotypic coefficient of variation, PCV = phenotypic coefficient of variation, ECV = environmental coefficient of variation

5. Fruit length

Significant variability in fruit length was observed among the genotypes (**Table 2**). BARI-2 produced longest fruit (13.70 cm) while Line-23× Line-24F_1 produced shortest fruit (4.1 cm). Ram *et al*. (2007), Prabhu *et al.* (2007) and Sherly and Shanthi (2009) also noted a significant genotype-dependent effect of fruit length on aubergine yield.

Genetic parameters

1. Number of primary branches/plant

There were highly significant differences between the 12 aubergine genotypes for this trait (**Table 3**). The maximum number of primary branches/plant was 8.5, a minimum of 4.33 with a mean of 5.608.σ^2_g (1.354) and σ^2_p (1.483), and GCV (20.747) and PCV (21.713) were close, indicating a low environmental influence by this trait. Higher heritability (91.299) and moderate GA and GAPM were observed for this trait. Prabhu *et al.* (2007) observed higher heritability and genetic advance in this trait for aubergine.

2. Number of secondary branches/plant

There were highly significant differences between the 12 aubergine genotypes for this trait (**Table 3**). The maximum number of secondary branches/plant was 20.59, a minimum of 8.86 and a mean of 12.573. σ^2_g (12.110) and σ^2_p (13.276), and GCV (27.678) and PCV (28.979) were close, indicating a low environmental influence by this trait. Heritability (91.217) for the trait was high accompanied by considerable lower GA and GAPM. Prabhu *et al.* (2007) also observed higher heritability and genetic advance in this trait for aubergine.

3. Days to flowering

There were highly significant differences between the 12 aubergine genotypes for this trait (**Table 3**). The maximum days to flowering was 58.16, the minimum was 48.18 while the mean was 52.804. σ^2_g (8.288) and σ^2_p (12.277), and GCV (5.452) and PCV (6.635) were close, indicating a low environmental influence by this trait. Heritability (67.507) of the trait was moderate accompanied by higher GA and GAPM. Ram *et al*. (2007) also observed higher heritability and genetic advance in this trait for aubergine.

4. Number of fruit per plant

There were highly significant differences between the 12 aubergine genotypes for this trait (**Table 3**). The maximum number of fruits/plant was 37.29, the minimum was 10.23 with a mean value of 21.366. σ^2_g (81.278) and σ^2_p (85.157), and GCV (42.195) and PCV (43.190) were close, indicating a low environmental influence by this trait. Higher heritability (95.445) along with moderately higher GA and GAPM of the trait suggest that selection of this character would be effective. Ram *et al.* (2007) also observed higher heritability and genetic advance in this trait for aubergine.

5. Fruit length

There were highly significant differences between the 12 aubergine genotypes for this trait (**Table 3**). Maximum fruit length was 13.70 cm and the minimum was 4.10 cm with a mean of 9.222. σ^2_g (12.181) and σ^2_p (12.493), and GCV (37.845) and PCV (38.327) were close, indicating a low environmental influence by this trait. High heritability (97.503) accompanied by moderate GA and GAPM indicated that selection for this character would be effective. Ram *et al*. (2007), Golani *et al.* (2007), Rai *et al.* (2001), Prabhu *et al.* (2007) and Sherly and Shanthi (2009) also observed higher heritability and genetic advance in this trait for aubergine.

Genotypic and phenotypic correlation coefficient of different yield-attributing traits

1. Number of primary branches/plant

This trait showed a significant positive correlation with number of secondary branches/plant and number of fruit/plant, although the response was genotype-dependent (**Table 4**), which indicates the governance of this trait by a single gene by a pleiotropic effect in which simultaneous improvement would be effective. This trait had an insignificant negative genotypic correlation with fruit length and days to flowering for all genotypes but had a highly significant positive correlation with days to flowering and fruit length, although this was dependent on genotype.

2. Number of secondary branches/plant

Number of secondary branches/plant showed a highly significant positive correlation with number of fruits/plant at the genotypic level and a highly significant positive correlation with days to flowering and fruit length at the phenotypic level (**Table 4**). This trait showed an insignificant positive correlation with fruit length at the genotypic level and with number of fruits/plant at the phenotypic level, and an insignificant negative correlation with days to flowering at the genotypic level.

3. Days to flowering

Days to flowering showed an insignificant positive correlation with fruit length at both genotypic and phenotypic levels and with number of fruits/plant at the phenotypic level (**Table 4**). Days to flowering also showed a highly

Table 4 Genotypic and phenotypic correlation coefficients among outcrossing and yield-contributing traits of intervarietal cross of aubergine.

Parameters		Number of primary branches/plant	Number of secondary branches/plant	Days to flowering	Number of fruits/plant	Fruit length
Number of primary	r_g		0.690**	-0.291	0.741**	-0.240
branches/plant	r_p		0.013	0.358*	0.006	0.453**
Number of secondary	r_g			-0.166	0.507**	0.074
branches/plant	r_p			0.606**	0.092	0.820**
Days to flowering	r_g				-0.548**	0.337
	r_p				0.065	0.284
Number of fruit/plant	r_g					-0.677**
	r_p					0.016
Fruit length	r_g					
	r_p					

* = significant at $P \leq 0.05$, ** indicates significant at $P \leq 0.01$, r_g = genotypic correlation coefficient; r_p = phenotypic correlation coefficient.

significant negative association with number of fruits/plant at the genotypic level. The interrelationships between these traits are governed by the environment.

4. Number of fruit/plant

This trait showed a highly significant negative correlation and insignificant positive correlation with fruit length at the genotypic and phenotypic level, respectively (**Table 4**), indicating that the association between two traits is largely influenced by environmental factors.

5. Fruit length

Fruit length showed no correlation with other considered characteristics at either the genotypic or phenotypic level.

CONCLUSIONS

In this study, there were minimum differences between GCV and PCV for all the studied traits. High to moderate heritability, high genetic advance and genetic advance as a percent of meant were observed for all traits studied. Thus, selection should made on number of fruits/plant and fruit length to improve the yield of aubergine genotypes. Line-23×Line-24F2 produced most primary branches/plant (8.5), flowered early (48.18 DAT), and had maximum number of fruit/plant (37.29). BARI-2 produced maximum fruit length (13.70 cm). So, crossing Line-23× Line-24F2 with BARI-2 could be beneficial.

REFERENCES

Allard RW (1960) *Principles of Plant Breeding*, John Wiley and sons, Inc., New York, 485 pp

BBS (Bangladesh Bureau of Statistics) (2006) *Tear Book of Agricultural Statistics of Bangladesh Berea of Statistics Division*, Ministry of Planning. Government of the People's Republic of Bangladesh, Dhaka, Bangladesh, 156 pp

Behera TK, Singh N (2002) Interspecific hybridization in eggplant for resistance to shoot and fruit borer. *Capsicum Eggplant News Letter* **21**, 102-105

Burton GW (1952) *Quantitative Inheritance in Grasses*, Proceedings of the 6th International Grassland Conference, Pennsylvania, Pa, USA, August, Vol 1, pp 277-283

Golani IJ, Mehta DR, Naliyadhara MV, Pandya HM, Purohit VL (2007) A study on genetic diversity and genetic variability in brinjal. *Agricultural Science Digest* **27 (1)**, 22-25

Goulden CH (1959) *Methods of Statistical Analysis*, Wiley and Sons, Inc., New York, pp 425-428

Hayes HK, Immer FR, Smith DC (1955) *Methods of Plant Breeding*, McGraw Hill Book Co. Inc., New York, 551 pp

Johanson HW, Robinson HF, Comstock RE (1955) Estimates of genetic and environmental variability in soyabean. *Agronomy Journal* **47**, 314-318

Kumar G, Meena BL, Kar R, Tiwari (2008) Morphological diversity in brinjal (*Solanum melongena* L.) germplasm accessions. *Plant Genetic Resources: Characterization and Utilization* **6 (3)**, 232-236

LIBNTS (2008) Available online: http://libnts.avrdc.org.tw/fulltext_pdf/eam0124.pdf

Mandal N, Dana I (1992) Correlation and path association of some yield contributing characters in aubergine. *Experimental Genetics* **8 (1-2)**, 25-28

Prabhu M, Natarajan S, Pugalendhi L (2007) Variability and heritability in segregating generation of eggplant (*Solanum melongena* L.). *Advances in Plant Sciences* **20 (2)**, 435-437

Rai N, Singh AK, Tirkey T (2001) Stability analysis shaped brinjal varieties for yield and its contributing characters. *Advances in Horticulture and Forestry* **8**, 109-114

Ram K, Singh P, Singh R (2007) Studies on genetic variability and selection parameters for economic characters in egg plant. *International Journal of Plant Science, Muzaffarnagar* **2 (1)**, 99-102

Randhawa S, Kumer JC, Chandha JC (1993) Path analysis for yield and its components in round aubergine. *Punjab Horticultural Journal* **33 (1-4)**, 127-132

Sambandam CN (1960) Some studies on six American varieties/lines of eggplant. MSc thesis, University of Tennessee, Knoxville, USA, 61 pp

Sherly J, Shanthi A (2009) Variability, heritability and genetic advance in brinjal (*Solanum melongena* L.) *Research on Crops* **10 (1)**, 105-108

Singh RK, Chowdhury BD (1985) *Biometrical Methods in Quantitative Genetic Analysis*, Kalyani Publishers, New Delhi, 22 pp

Srivastava LS, Sachan SCP (1973) Studies on flora biology of okra (*Abelmoschus esculentus* L. Moench). *Allahabad Farmer* **47 (1)**, 63-65

Steel RCD, Torrie JH (1980) *Principles and Procedures of Statistics*, McGraw Hill Book Co. Inc., New York, pp 107-109

Vijay OP, Nath P, Jalikop SH (1978) Combining ability in a diallel cross of aubergine. *Indian Journal of Horticulture* **35**, 35-38

Zeske M (2012) Eggpplant health cures. Ehow health. Available online: http://www.ehow.com/ facts_5471232_eggplant-health-cures.html