Received : 30 May 2019 | Revised : 27 Feb 2020 | Accepted : 29 Feb 2020

Electronic Journal of Plant Breeding

Research Note

Studies on genetic variability and response to selection for quantitative and qualitative traits over environments in brinjal (*Solanum melongena* L.)

M. Siva[1], B. Balakrishna[2] and T.S.K.K.K. Patro[3]

[1]Ph.D Scholar, Dept. of Vegetable Science
[2]Teaching Associate, Dept. of Genetics and Plant Breeding
[3]Associate Professor, Dept. of Vegetable Science
College of Horticulture, Dr YSR Horticultural University, Andhra Pradesh-534 101, India.
E-Mail: balubreeder@gmail.com

Abstract
The present study was conducted during the Rabi-2017-18 over three environments with 21 hybrids and their seven parents. The characters *viz*., the number of fruits per cluster, fruit width (cm), fruit length to girth ratio, average fruit weight (g) and the total number of fruits per plant recorded high GCV and PCV values and differences between these two parameters also less indicates presence of high genetic variability for these traits among the genotypes. Heritability and genetic advance as per cent mean for aforesaid traits also recorded high values; it means direct selection for these characters may be an effective and further evaluation for knowing the type of gene action actually involved in the phenotypic expression of these traits may be confirmed by estimating GCA and SCA variances by using any mating design.

Keywords
Brinjal, Genetic variability, Quantitative and qualitative characters and Over environments

Brinjal (*Solanum melongena* L.) popularly called as eggplant. It is one of the most important vegetable crops in India. The crop has a lot of variability for many traits as India is the native of this crop. The main constraint in any crop improvement programme is the availability of genetic variability. The success of breeder largely depends upon nature and quantum genetic variability present in the plant material (Prabhu *et al*., 2009). Further, the variability should be portioned into heritable and non-heritable components by calculating GCV and PCV, this gives clear idea about the phenotype of the character to the breeder before selection (Pujer *et al*., 2017). The effectiveness of selection further majorly depends on heritability and genetic advance as per cent mean (Prabakaran. 2010). Hence, before starting any crop improvement programme an enquiry about the genetic nature of variability is utmost important to further utilizing the plant material for crop improvement. The present study was conducted with 21 hybrids and seven parents over three environments to quantify the genetic variability in the plant material.

The study was conducted at three locations *viz*., Venkataramannagudem, Pandirimamidi and Nuzveedu during Rabi-207-18 in Andhra Pradesh, India. Thirty-five days old seedlings of both parents and F_1 were transplanted in the main field by adopting 90 cm × 75 cm spacing in Randomized Block Design with three replications. All crop management practices were adopted to raise a good crop. Data were recorded on five randomly selected plants from each replication of respective treatment for all the characters studied. The mean data was processed by the following methods for drawing conclusions.

Analysis of Variance

The data for different characters were statistically analyzed on the basis of the model given by Cochran and Cox (1950) for Randomized Complete Block Design.

$$Y_{ij} = \mu + b_i + t_j + e_{ij}$$

Where,

Y_{ij} = Performance of the j^{th} genotype in the i^{th} block
µ = General mean
b_i = Effect of i^{th} block
t_j = Effect of j^{th} genotype
e_{ij} = Random error associated with j^{th} genotype and i^{th} block

Estimation of Genetic Parameters

Co-efficient of variation

Phenotypic and Genotypic Coefficients of Variation (PCV and GCV) were computed according to Burton (1952).

$$PCV (\%) = \frac{\text{Phenotypic standard deviation } (ó_p)}{\text{General mean } (\overline{X})} \times 100$$

$$GCV (\%) = \frac{\text{Genotypic standard deviation } (ó_g)}{\text{General mean } ()} \times 100$$

As suggested by Sivasubramaniam and Menon (1973), GCV and PCV were categorized into

Low	=	Less than 10 per cent
Moderate	=	10-20 per cent
High	=	More than 20 per cent

Heritability in a broad sense ($h^2_{(bs)}$)

Heritability in a broad sense was estimated as per Lush (1940) and Allard (1960).

$$h^2_{(bs)} = \frac{\text{Genotypic variance } (ó^2_g)}{\text{Phenotypic variance } (ó^2_p)} \times 100$$

As suggested by (13), $h^2_{(bs)}$ estimates were categorized into

Low	=	0-30 per cent
Moderate	=	31-60 per cent
High	=	60 per cent and above

Genetic advance (GA)

This was estimated as per the formula proposed by Lush (1940) and Allard (1960).

$$GA = k \times ó_p \times \%\,´^2_{(bs)}$$

Where,

K = Selection differential at 5% selection intensity which accounts to a constant value of 2.06
$\%\,´^2_{(b)}$ = Heritability in broad sense
$ó_p$ = Phenotypic standard deviation

Genetic advance as per cent of mean (GAM)

$$GAM = \frac{\text{Genetic advance}}{\text{Grand mean } ()} \times 100$$

The range of genetic advance as per cent of mean was classified as suggested by Johnson *et al.*, 1955).

Low	=	Less than 10 per cent
Moderate	=	10-20 per cent
High	=	More than 20 per cent

The success of genetic improvement in any crop depends on the availability of genetic variability in that crop. Once the quantum of genetic variability knew then there is a great need to know the proportion of available genetic variability will be inherited to the next generation and quantum of gain in that character after exercising the selection this can be known through the estimation of heritability and genetic advance as per cent of mean.The pooled analysis of variance for 17 characters over three environments indicated that the presence of greater variability among the genotypes for these traits. The data was presented in **Table 1**.

Estimates of GCV and PCV

The values of GCV and PCV were calculated and presented in **Table 2**. Among the 17 traits studied seven characters *viz*., the number of fruits per cluster (27.80) (29.11) (Vidhya and Kumar, 2015), fruit width (cm) (22.52) (23.27) (Vidhya and Kumar, 2015), fruit length to girth ratio (22.65) (24.32), the total number of fruits per plant (33.21) (35.00) (Muniappan *et al.*, 2010 and Pujer *et al.*, 2017) and fruit yield per plant (21.39) (24.08) (Kumar *et al.*, 2013 and Vidhya and Kumar, 2015) exhibited high GCV and PCV values indicates the presence of greater genetic variability among the genotypes studied. However the differences between PCV and GCV values were low for the characters, the number of fruits per cluster, fruit length, fruit width, fruit length to girth ratio and the total number of fruits per plant indicating the influencing of environment on these characters were less and whatever variability present among the genotypes was entirely due to genotype. The traits, Plant height (12.17 & 10.18) (Pujer *et al*., 2017), the number of flowers per cluster (20.52 & 16.91), fruit length (15.87 &14.95), Average fruit weight (20.58 & 19.39), phenols (13.78 & 12.68), Ascorbic acid content (18.47 & 17.98) (Kumar *et al*., 2013) and fruit borer damage percentage recorded PCV and GCV values in the medium range and also low ECV values revealing that the genetic variability for these traits were medium in range among the genotypes but, it was entirely due to genotype and negligible influence of environment on these traits. Kumar *et al*. (2013) reported a similar kind of results while studying with brinjal crop. PCV and GCV values are low for the number of branches per plant, days to first flowering (Kumar *et al*., 2013), days to 50 % flowering, days to first harvest and days to final harvest and ECV values were also low indicating variability due to the genotype was very low in the plant material studied and influence of environment on these characters also negligible.

Table 1.Pooled analysis of variance for quantitative and qualitative traits in brinjal(*Solanum melongena* L.)

Source of Variations	d.f	Plant height (cm)	Branches per plant	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to final harvest	Flowers per cluster	Fruits per cluster	Fruit length (cm)
Replications	2	4.02	1.39	20.54	3.12	6.00	2.24	0.11	0.16	0.20
Environments	2	721.82**	31.89**	236.55**	570.37**	229.32**	295.38**	76.86**	12.14**	17.51**
Interactions	4	3.06	0.92	1.05	1.40	3.26	2.19	0.16	0.03	0.02
Overall Sum	8	182.99**	8.78**	64.79**	144.07**	60.46**	75.50**	19.32**	3.09**	4.44**
Treatments	29	1429.10**	6.31**	64.84**	77.20**	152.56**	756.68	5.10**	6.58**	30.06**
Error	232	64.84	0.64	6.90	8.92	18.26	110.80	0.25	0.07	0.42

Source of Variations	d.f	Fruit girth (cm)	Fruit length to girth ratio	Fruit weight (gm)	Fruits per plant	Fruit yield per plant (kg)	Phenols (mg $100g^{-1}$)	Ascorbic acid (mg$100g^{-1}$)	Fruit borer damage (%)
Replicate	2	0.71	0.00	0.01	33.38	0.01	0.00	0.04	6.33
Environments	2	149.93**	0.31**	64.37**	977.31**	6.17**	1.04**	10.27**	586.37**
Interactions	4	0.13	0.00	6.51	22.05	0.11	0.01	0.13	2.18
Overall Sum	8	37.72**	0.08**	19.35	263.70**	1.60**	0.26**	2.64**	149.26**
Treatments	29	86.05**	0.40**	1600.47**	1478.66**	2.30**	3.34**	22.61**	166.69**
Error	232	0.64	0.01	22.17	18.04	0.07	0.07	0.14	6.95

*Significant 5% level of significance **Significant 1% level of significance

Table 2. Estimates of genetic parameters for quantitative and qualitative traits in brinjal (*Solanum melongena* L.)

S. No.	Character	Range		Mean	ECV (%)	PCV (%)	GCV (%)	h^2 (%)	GA as per cent of mean
		Minimum	Maximum						
1	Plant height (cm)	92.17	143.04	10.18	6.66	12.17	10.18	0.70	17.55
2	Number of branches per plant	8.83	12.23	7.71	7.77	10.95	7.71	0.49	11.18
3	Days to first flowering	34.47	45.41	6.36	6.58	9.15	6.36	0.48	9.10
4	Days to 50 per cent flowering	43.11	54.54	5.67	6.14	8.36	5.67	0.46	7.92
5	Days to first harvest	50.04	65.56	6.74	7.45	10.09	6.74	0.45	9.31
6	Days to final harvest	155.04	194.12	4.72	5.86	7.52	4.72	0.39	6.09
7	Number of flowers per cluster	3.18	5.71	16.91	11.62	20.52	16.91	0.68	28.70
8	Number of fruits per cluster	1.58	4.57	27.8	8.55	29.11	27.8	0.91	54.78
9	Fruit length (cm)	7.79	17.38	14.95	5.32	15.87	14.95	0.89	29.03
10	Fruit width (cm)	7.60	20.86	22.52	5.85	23.27	22.52	0.94	44.90
11	Fruit length to girth ratio	0.65	1.76	22.65	8.87	24.32	22.65	0.87	43.43
12	Average fruit weight (g)	40.56	90.24	19.39	6.89	20.58	19.39	0.89	37.63
13	Total number of fruits per plant	15.22	70.21	33.21	11.07	35.00	33.21	0.90	64.90
14	Fruit yield per plant	1.32	3.45	21.39	11.05	24.08	21.39	0.79	39.15
15	Phenols (mg/100g)	3.56	6.12	12.68	5.39	13.78	12.68	0.85	24.03
16	Ascorbic acid content (mg/100g)	5.52	11.76	17.98	4.20	18.47	17.98	0.95	36.08
17	Fruit borer damage percentage (%)	20.80	38.25	13.34	8.34	15.73	13.34	0.72	23.29

The estimates of heritability and genetic advance as per cent mean helpful in deciding, whether a particular character amicable to selection or not. In the present study, the traits *viz*., the number of fruits per cluster (91.00 & 54.78) (4), fruit length (cm) (89.00 & 29.03), fruit width (cm) (94.00 &44.90) (4), fruit length to girth ratio (87.00 & 43.43), average fruit weight (g) (89.00 &37.63), the total number of fruits per plant (90.00 & 64.90), fruit yield per plant (79.00 & 39.15) (Vidhya and Kumar, 2015), phenols (mg/100g) (85.00 & 24.03) (Kumar *et al*., 2013), ascorbic acid content (mg/100g) (95.00 & 36.08) (Kumar *et al*., 2013) and fruit borer damage percentage (72.00 & 23.29)

(Kumar *et al.*, 2013) were recorded a high heritability along with genetic advance as per cent of mean indicating these characters may be controlled by an additive type of gene action and simple selection may be effective. Days to first flowering (48.00 & 9.10) (Kumar *et al.*, 2013), days to 50 % flowering (46.00 & 7.92), days to first harvest (45.00 & 9.31), days to final harvest (10.94 & 6.09) (Shende *et al.*, 2015) recorded a medium heritability and low genetic advance, it means these traits may be controlled by non-additive type gene action and it can be exploited through heterosis breeding. The character plant height exhibited high heritability (70.00) with medium genetic advance (17.55) revealing that phenotypic expression of this trait may be regulated by the involvement of both additive and non-additive gene actions. Medium heritability (49.00) and genetic advance as per cent of mean (11.18) (Shende *et al.*, 2015) was exhibited by the number of branches per plant it means this character may be controlled by the combination of additive and non-additive type of gene actions. In plant breeding approach, the selection is effective when the character under consideration has more genetic variability and negligible influence of environment on the trait. Heritability and genetic advance as per cent of mean also played a crucial role to decide the type of gene action involved in the phenotypic expression of character. Paul (1978) mentioned that the traits which are having more genetic variability along with high heritability and genetic advance as per cent of the mean may be improved through selection as these may be controlled by additive type gene action and which is fixable. Whereas sometimes heritability may be high and genetic advance as per cent may be low this situation indicates the high heritability may be due to the influence of environment and selection for these traits may not be effective. In the present investigation the traits *viz.*, the number of fruits per cluster, fruit length (cm), fruit width (cm), fruit length to girth ratio and the total number of fruits per plant are more responsive to direct selection. There is further need to confirm the type of gene action involved in the phenotypic expression of these traits by using different mating designs in plant breeding.

REFERENCES

Allard, R.W.(1960). *Principle of Plant Breeding*. John Wiley and Sons Inc., New York. 145-147.

Burton, G.W. (1952). Quantitative inheritance in grasses.*Proceedings of 6th International Grassland Congress.* 277-283.

Cochran, G.W and Cox, M.G. (1950). *Experimental Designs*. John Wiley and Sons Inc., New York. 45-67.[Cross Ref]

Johnson, H.W., Robinson, H.F and Comstock, R.E. (1955).Estimates of genetic and environmental variability in soybean.Agro. J.**47**, 314-318[Cross Ref]

Kumar, S. R., Arumugam, T., Anandakumar, C. R. and Premalakshmi, V. (2013).Genetic variability for quantitative and qualitative characters in Brinjal (*Solanum melongena* L.). *A. J. of Agril. Res.***8** (39), 4956-4959.

Lush, J.L.(1940).Intra-sire correlation on regression of offspring on dams as a method of estimating heritability of characters. *Proceedings of American Society for Animal Production*. **33**. 392-401.

Muniappan, S., Saravanan, K and Ramya, B. (2010). Studies on Genetic Divergence and variability for certain economic characters in eggplant (*Solanum melongena* L.). *Elec.J.Pl.Br.* **1**(4): 462-465.

Paul, N.K. (1978).Genetic architecture of yield and components of yield in mustard (*Brassica juncea* L.).*Theor. Appl. Genet.* **53**. 233-237. [Cross Ref]

Prabakaran S. Evaluation of local types of brinjal (*Solanummelongena*L.). M.Sc., (Hort.) Thesis, Agricultural College and Research Institute, TNAU, Madurai, (2010).

Prabhu M, Natarajan S, Pugalendhi L.(2009).Variability and heritability studies in F5 and F6 progenies of brinjal. *Am.-Eur. J. Sustain. Agric.* **3** (3), 306-309.

Pujer, P., Jagadeesha, R. C and Cholin, S. (2017).Genetic variability, Heritability and Genetic Advance for Yield, Yield Related Components of Brinjal (*Solanummelongena*L.)Genotypes.*Int. J. Pure ApplBiosci.***5** (5), 872-878. [Cross Ref]

Shende, R.A., Desai, S. S and Lachyan, T.S. (2015).Genetic variability and response to selection in brinjal (*Solanummelangena* L.).Int J Curr Res.**7** (10), 21545-21547.

Sivasubramaniam, P and Menon, P.M. (1973).Inheritance of short stature in rice.Madras Agric. J. 60, 1129-1133.

Vidhya, C and Kumar, N. (2015). Genetic variability studies in brinjal (*Solanum melongena* L.) for fruit yield and quality. *Elec.J.Pl.Br.* **6** (3), 668-671.