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STUDY OF VARIABILITY, CORRELATION AND PATH ANALYSIS IN BRINJAL (S*OLANUM MELONGENA* L.)

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ABSTRACT
An experiment was conducted on *rabi* 2012-13 for evaluation of 35 genotypes of brinjal for 21 characters revealed that PCV was greater than corresponding GCV for all traits. Maximum PCV (56.26%) and GCV (55.68%) were registered for fruit length: diameter ratio. High estimate of heritability coupled with high genetic advance for most of the yield and its contributing characters which indicating phenotypic selection would be effective for the genetic improvement in these traits. Fruit yield displayed highly significant and positive correlation with number of flowers per cluster (0.49), number of flowers per plant (0.61), number of fruits per cluster (0.41), number of fruits per plant (0.72) and number of branches per plant (0.48) at genotypic level. Path co-efficient study indicated the highest positive direct effect of fruit length : diameter ratio (2.4326) on fruit yield per plant followed by number of fruits per plant (1.2644), fruit diameter (1.2539), dry matter content of fruit (0.9633), moisture content of fruit (0.9238)and number of flowers per cluster (0.9098).

INTRODUCTION

Solanum is a large and important genus of the family *Solanaceae*. The egg plant or brinjal or aubergine (*Solanum melongena* L., 2n = 24) represents the non-tuberous group of *Solanum* species. Brinjal is the most common popular and widely grown, vegetable crop of both tropic and sub-tropics of the world. It is being grown extensively in India, Bangladesh, Pakistan, China, Philippines, France, Italy and USA. Due to its highest production potential and availability of the produce to consumers, it is also termed as poor man's vegetable (Kumar *et al*., 2014). India has accumulated wide range of variability in this crop. Further, the crop exhibits rich genetic diversity and scope for improvement for various horticultural traits.

The success of any crop improvement programme depends upon the nature and magnitude of genetic variability existing in breeding material with which plant breeder is working, choice of parents for hybridization and selection procedure (Meena and Bahadur, 2013). Genetic variability is essentially the first step of plant breeding for crop improvement which is immediately available for germplasm which is considered as the reservoir of variability for different characters (Vavilov, 1951). Phenotypic and genotypic coefficients of variation are useful in detecting amounts of variability present in germplasm. Heritability and genetic advance help in determining the influence of environment in expression of characters and the extent to which improvement is possible after selection (Robinson *et al*., 1949). Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregating generation and needs to be accompanied by a substantial amount of genetic advance (Johanson *et al*., 1955).

Indirect selection in such a situation is more effective and study of correlation among different economic traits are therefore, essential for an effective selection programme because selection for one or more trait results in correlated response for several other traits and sequence of variation will also be influenced. Hence, the knowledge of genotypic and phenotypic correlation between yield and its contributing characters is very essential.

Correlation studies measure only mutual association between two traits and it does not imply the cause and effect of relationship. Path analysis is a standardized partial regression analysis, which further permits the partitioning of correlation coefficient in to components of direct and indirect effects of independent variable on the dependent variable (Wright, 1921).

MATERIALS AND METHODS

The present investigation was carried out at Regional Horticultural Research Station, N.A.U., Navsari, during r*abi* seasons of 2012-13. The experiment was laid out in a randomized block design with three replications. Each genotype consists of three rows with a spacing of 90 x 60 cm and the crop was raised as per package of practices, recommended by of Navsari Agricultural University, Navsari, Gujarat. The crop was maintained properly till last harvest and observation on growth, yield as well as its contributing characters was noted on five randomly selected plants in each plot at different stages of crop growth. The analysis of variance was done as per Pense and Sukhatme (1978) and genotypic and phenotypic coefficient of variation by Weber and Moorthy (1952). Heritability and genetic advance were calculated according to Johnson *et al.* (1955) and Allard (1960), respectively. Path analysis was done as per the procedure outlined by Wright (1921) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed the highly significant differences among the genotypes for all the 21 traits studied indicating there is substantial genetic variability for these traits. The range, general mean, genotypic and phenotypic coefficient of variation, heritability and genetic advance in per cent of mean for all traits are presented in Table 1. The results revealed that phenotypic coefficient of variation (PCV) was higher than its respective genotypic coefficient of variation (GCV) for all the characters studied but minimal differences between them. The GCV helps in comparison and measurement of genetic variability among different characters. High magnitude of GCV was recorded for number of fruits per plant. (Lohakare *et al.*, 2008; Sherly and Santhi, 2008; Naik *et al.*, 2010; Muniappan *et al.*, 2010; Kumar *et al.*, 2011; Sabeena *et al.*, 2011; Dhaka and Soni, 2012 and Kumar *et al.*, 2013) and moderate for fruit yield per plant (Lohakare *et al.*, 2008 and Dhaka and Soni, 2012), for plant height (Sherly and Santhy, 2008 and Tripathi *et al.*, 2009) which indicated that there is considerable scope for improving these characters in desirable direction through a selection programme.

High estimate of heritability coupled with high genetic advance was observed in plant height (Sherly and Santhy, 2008, Tripathi *et al.*, 2009 and Meena and Bahadur, 2014), number of flowers per cluster (Sabeena *et al.*, 2011), number of flowers per plant, number of fruits per cluster (Lohakare *et al.*, 2008 and Naik *et al.*, 2010), number of fruits per plant (Sabeena *et al.*, 2011; Dhaka and Soni, 2012; Kumar *et al.*, 2013 and Meena and Bahadur, 2014), fruit yield per plant (Kumar *et al.*, 2011; Dhaka and Soni, 2012 and Kumar *et al.*, 2013), average fruit weight, number of branches per plant, length of peduncle, fruit length, fruit diameter, fruit length:diameter ratio, fresh weight of fruit and phenol content (Table 1).

Prior to any breeding programme for the improvement in crops, it is imperative to obtain information regarding the inter-relationship of different plant characters with yield and among themselves since it facilitates a quick assessment of high yielding genotypes in selection programme. The real or true association could be known only through genotypic correlation which eliminates the environmental influence.

The estimation of genotypic correlations were higher in magnitude than the corresponding phenotypic values for all characters which indicated that there was a high degree of inter-relationship between two variables at genotypic level (Table 2). Fruit yield showed highly significant and positive association with number of fruits per plant. Similar observation obtained (Nalini *et al.*, 2009; Muniappan *et al.*, 2010; Dahatonde *et al.*, 2010 and Shinde *et al.*, 2012). Fruit yield per plant had also positive and significant correlation with number of branches per plant (Nalini *et al.*, 2009 and Shinde *et al.*, 2012), number of flowers per cluster, number of flowers per plant and number of fruits per cluster which indicating that there was simultaneous selection for these characters might bring an improvement in fruit yield plant. Highly significant at genotypic levels with days to 1st flowering, days to 50 per cent flowering and significant with number of days to first picking. Similar results was reported by Muniappan *et al.* (2010).

The path coefficient analysis permits the separation of direct and indirect effects through related traits by partitioning the genotypic correlation coefficients (Table 3) The path analysis

Table 1: Range, mean and components of variance for various traits in brinjal

Sr. No	Character	Range	GCV%	PCV%	Heritability (Broadsense%)	Genetic advance	Geneticadvance % of mean
1.	Days to 1st flowering	44.33-9.67	6.08	8.36	53.00	4.90	9.13
2.	Days to 50 per cent flowering	54.00-68.33	4.55	6.90	43.60	3.92	6.20
3.	Days to first picking	65.00-86.67	7.45	8.72	73.01	9.78	13.11
4.	Days to last picking	139.33-160.67	3.09	4.33	51.19	6.91	4.56
5.	Plant height (cm)	71.74-117.54	12.04	13.08	84.74	22.08	22.84
6.	Number of flowers per cluster	1.00-7.33	37.74	38.32	96.98	3.04	76.56
7.	Number of flowers per plant	26.73-112.13	27.98	28.67	95.27	41.72	56.27
8.	Number of fruits per cluster	1.00-4.00	39.97	40.76	96.17	1.73	80.75
9.	Number of fruits per plant	12.27-44.13	29.19	30.75	90.12	15.88	57.10
10.	Fruit yield per plant(kg/plant)	1.37-3.27	18.46	20.34	82.34	0.82	34.50
11.	Average fruit weight (g)	57.61-179.29	26.63	27.15	96.14	44.84	53.79
12.	Number of branches per plant	6.27-13.27	16.35	19.60	69.61	2.77	28.11
13.	Length of peduncle (cm)	4.53-9.21	21.06	22.23	89.79	2.32	41.11
14.	Fruit length(cm)	7.93-26.23	31.20	31.77	96.43	9.03	63.12
15.	Fruit diamater (cm)	1.94-5.65	31.44	32.02	96.40	2.26	63.59
16.	Fruit length:diameter ratio	1.71-10.18	55.68	56.26	97.95	5.39	113.52
17.	Fresh weigh of fruit(g)	58.52-165.52	24.65	24.67	99.84	40.85	50.74
18.	Moisture content of fruit (%)	90.09-91.22	0.27	0.29	88.23	0.48	0.53
19.	Dry matter content of fruit (%)	8.85-9.99	2.80	2.87	95.64	0.53	5.65
20.	Total phenols (mg/100g)	0.63-1.91	32.72	32.73	99.92	0.87	67.37
21.	Vitamin C (mg/100g)	9.93-16.27	12.56	12.66	98.49	3.17	25.69

Table 2: Genotypic and phenotypic correlation of fruit yield per plant with other characters in various genotypes of brinjal

Characters		1F	50%F	FP	LP	PH	NFC	NFP	FC	FP	AFW
Yield	rg	-0.47**	-0.53**	-0.39*	-0.19	0.09	0.49**	0.61**	0.41**	0.72**	0.09
	rp	-0.29	-0.3	-.0.32	-0.12	0.08	0.44	0.51	0.39	0.61	0.09
1F	rg		1.2	0.78**	0.06	0.27	-0.53**	-0.43**	-0.45**	-0.49**	0.23
	rp		0.63**	0.51**	0.05	0.09	-0.37**	-0.27**	-0.34**	-0.39**	0.16
50%F	rg			0.57**	0.1	0.3	-0.62**	-0.49**	-0.57**	-0.64**	0.27
	rp			0.66**	0.06	0.14	-0.40**	-0.36**	-0.36**	-0.39**	0.16
FP	rg				0	-0.13	-0.35	-0.31	-0.44**	-0.42**	0.09
	rp				0.02	-0.13	-0.30**	-0.28**	-0.37**	-0.34**	0.07
LP	rg					0.18	-0.18	-0.40*	-0.43**	-0.55**	0.41**
	rp					0.12	-0.14	-0.28**	-0.29**	-0.36**	0.26**
PH	rg						-0.26	-0.08	-0.12	-0.1	0.27
	rp						-0.26**	-0.09	-0.08	-0.1	0.25**
NFC	rg							0.79**	0.71**	0.76**	-0.46**
	rp							0.77**	0.68**	0.70**	-0.44**
NFP	rg								0.68**	0.91**	-0.54**
	rp								0.64**	0.83**	-0.51**
FC	rg									0.78**	-0.48**
	rp									0.74**	-0.46**
FP	rg										-0.55**
	rp										-0.53**
AFW	rg										
	rp										
NBP	rg										
	rp										
PL	rg										
	rp										
FL	rg										
	rp										
FD	rg										
	rp										
L:D	rg										
	rp										
FW	rg										
	rp										
MC	rg										
	rp										
DC	rg										
	rp										
TP	rg										
	rp										

Table 2: Cont......

Characters	NBP	PL	FL	FD	L:D	FW	MC	DC	TP	Vt.C
Yield	0.48**	-0.18	0.02	0.09	0.02	0.12	0.1	-0.12	0.01	-0.21
	0.31	-0.15	0.01	0.09	0.01	0.11	0.08	-0.09	0.01	-0.18
1F	-0.3	-0.03	0.31	-0.09	0.21	0.22	0.12	-0.12	-0.1	-0.21
	-0.20*	-0.02	0.23*	-0.05	0.14	0.16	0.12	-0.08	-0.08	-0.15
50%F	-0.26	-0.17	0.06	0.1	-0.03	0.27	0.15	-0.12	-0.07	-0.16
	-0.20*	-0.09	0.04	0.09	-0.01	0.18	0.12	-0.08	-0.04	-0.09
FP	0.3	0.03	0.25	0.14	0.17	0.12	-0.02	0.03	0.18	-0.28
	-0.24*	0.05	0.20*	-0.1	0.14	0.1	-0.01	0.02	0.15	-0.23
LP	0.09	0.05	-0.12	0.39*	-0.26	0.26	-0.03	-0.01	0.11	-0.02
	0.01	0.05	-0.07	0.29**	-0.19*	0.18	-0.03	0.01	0.08	-0.01
PH	0.22	-0.04	0.04	0.21	-0.05	0.22	-0.11	0.22	0.01	-0.11
	0.16	-0.07	0.01	0.18	-0.06	0.20*	-0.12	0.21*	0.01	-0.09
NFC	0.37*	-0.01	0.19	-0.19	0.18	-0.5	-0.13	0.11	0.06	-0.06
	0.34**	0.01	0.19*	-0.18	0.18	-0.49**	-0.12	0.11	0.06	-0.06
NFP	0.50**	-0.09	0.3	-0.36*	0.38*	-0.52**	-0.07	0.14	-0.13	-0.16
	0.45**	-0.06	0.29**	-0.35**	0.37**	-0.51**	-0.06	0.13	-0.13	-0.16
FC	0.29	-0.05	0.3	-0.51*	0.42*	-0.39*	-0.06	0.09	0.02	0.02
	0.25**	-0.04	0.29**	-0.49**	0.40**	-0.38**	-0.05	0.07	0.02	0.02
FP	0.51**	-0.18	0.2	-0.32	0.31	-0.50**	0.01	0.01	-0.06	-0.09
	0.39**	-0.14	0.20*	-0.30**	0.31**	-0.47**	-0.01	0.01	-0.05	-0.09

Table 2: Cont......

Characters	NBP	PL	FL	FD	L:D	FW	MC	DC	TP	Vt.C
AFW	-0.23	-0.03	-0.15	0.43**	-0.3	0.92**	0.1	-0.09	0.09	-0.15
	-0.16	-0.03	-0.15	0.41**	-0.29**	0.90**	0.1	-0.1	0.08	-0.15
NBP		-0.06	-0.13	0.11	-0.14	-0.22	-0.18	0.28	0.16	0.04
		-0.04	-0.09	0.07	-0.12	-0.18	-0.13	0.19	0.13	0.03
PL			0.24	-0.06	0.21	-0.22	-0.18	0.28	0.16	0.04
			0.23*	-0.05	0.19*	-0.07	-0.13	0.11	0.04	0.11
FL				-0.73**	0.92**	-0.13	-0.01	-0.03	0.01	-0.2
				-0.69**	0.90**	-0.13	0	-0.02	0.01	-0.20*
FD					-0.89**	0.34*	0.13	-0.13	0.05	0.01
					-0.86**	0.34**	0.12	-0.12	0.04	0.01
L:D						-0.24	-0.06	0.02	-0.03	-0.1
						-0.24*	-0.05	0.02	-0.03	-0.1
FW							0.13	-0.15	0.08	-0.21
							0.12	-0.15	0.08	-0.20*
MC								-0.95**	-0.09	-0.28
								-0.89**	-0.08	-0.25**
DC									0.1	0.22
									0.1	0.21*
TP										-0.1
										-0.1

* Significant at P = 0.05 ** Significant at P = 0.01, (0.05=0.196, 0.01=0.257)

Table 3: Direct and indirecteffect of twenty causal variables on fruit yield per plant in various genotypes of brinjal

Characters	Direct effect on yield	Indirect effect on yield 1F	50%F	FP	LP	PH	NFC	NFP	FC	FP	AFW
1F	0.0964		0.11	0.07	0.006	0.02	-0.05	-0.04	-0.04	-0.04	0.02
50%F	-0.3046	-0.36		-0.17	-0.03	-0.09	0.18	0.15	0.17	0.19	-0.08
FP	-0.0186	-0.01	0.01		0.001	0.002	0.006	0.005	0.008	0.008	-0.001
LP	-0.0992	-0.006	-0.01	0.0009		-0.01	0.01	0.04	0.04	0.05	-0.04
PH	-0.0251	-0.007	-0.0076	0.003	0.004		0.006	0.002	0.003	0.002	-0.006
NFC	0.9098	-0.48	-0.56	-0.32	-0.16	0.23		0.72	0.64	0.69	-0.42
NFP	-1.1919	0.51	0.59	0.37	0.48	0.1	-0.94		-0.81	-1.09	0.65
FC	-0.6108	0.27	0.35	0.27	0.26	0.07	-0.43	-0.41		-0.48	0.29
FP	1.2644	-0.62	-0.82	-0.54	-0.7	-0.13	0.96	1.16	0.99		-0.69
AFW	-0.1538	-0.03	-0.04	-0.01	-0.06	-0.04	0.07	0.08	0.07	0.08	
NBP	0.3375	-0.1	-0.08	-0.1	0.03	0.07	0.12	0.17	0.09	0.17	-0.08
PL	-0.1963	0.006	0.03	-0.07	-0.01	0.008	0.001	0.01	0.01	0.03	0.006
FL	-1.0124	-0.32	-0.06	-0.25	0.12	-0.04	-0.19	-0.3	-0.3	-0.2	0.15
FD	1.2539	-0.11	0.13	-0.18	0.5	0.26	-0.24	-0.45	-0.64	-0.41	0.54
L:D	2.4326	0.52	-0.07	0.42	-0.65	-0.13	0.44	0.94	1.03	0.76	-0.74
FW	0.7106	0.15	0.19	0.08	0.18	0.15	-0.35	-0.37	0.27	-0.35	0.65
MC	0.9238	0.11	0.13	-0.02	-0.02	-0.1	0.12	-0.07	-0.06	0.009	0.01
DC	0.9633	-0.12	-0.12	0.03	-0.005	0.22	0.11	0.13	0.08	0.01	-0.09
TP	-0.1956	0.02	0.01	-0.03	-0.02	-0.0006	-0.01	0.02	-0.004	0.01	-0.017
Vt. C	-0.0412	0.008	0.006	0.01	0.001	0.004	0.002	0.006	-0.001	0.004	0.006

revealed that positive direct effect on yield per plant was recorded for days to 1st flowering, number of flowers per cluster, number of fruits per cluster, number of branches per plant, fruit diameter, fruit length : diameter ratio, fresh weight of fruit, moisture content of fruit and dry matter content of fruit. Similar results were also found for days to 1st flowering (Prabhu *et al*., 2008), flowers per cluster (Nalini *et al*., 2009), for number of fruits per plant Sharma and Swaroopan, 2000; Prabhu *et al*., 2008; Nalini *et al*., 2009; Muniappan *et al*., 2010; Dahatonde *et al*., 2010; Shinde *et al*., 2012 and Thangamani and Jansirani, 2012) number of branches per plant (Prabhu *et al.,* 2008, Kumar *et al*., 2011 and Thangamani and Jansirani, 2012), fruit diameter (Sharma and Swaroopan, 2000 and Thangamani and Jansirani, 2012) and dry matter content of fruit (Thangamani and Jansirani, 2012). This indicated that these characters were directly selected for fruit yield improvement programme.

Direct negative effect on fruit yield per plant was found with days to 50 per cent flowering, days to first picking, days to last picking, plant height, number of flowers per plant, number of fruits per cluster, average fruit weight, length of peduncle, fruit length, total phenols and vitamin C. Similar results were also noted by (Sharma and Swaroopan, 2000 and Shinde *et al*., 2012) for 50 per cent flowering (Praneetha, 2006; Naliyadhara *et al*., 2007; Prabhu *et al*., 2008; Kumar *et al*., 2011; Dahatonde *et al*., 2010; Muniappan *et al*., 2010 and Thangamani and Jansirani, 2012), for plant height (Sharma and Swaroopan, 2000 and Kumar *et al*., 2011), for fruit length (Thangamani and Jansirani, 2012) for total phenol content and for vitamin C (Praneetha, 2006). Therefore, indirect selection practiced on

Table 3: Cont......

Characters	NBP	PL	FL	FD	L:D	FW	MC	DC	TP	Vt. C	Correlation Coefficient
1F	-0.02	-0.003	0.03	-0.009	0.02	0.02	0.01	-0.01	-0.01	-0.02	-0.47**
50%F	0.05	-0.02	-0.03	0.009	0.02	-0.08	-0.04	0.03	0.02	0.05	-0.53**
FP	0.005	-0.01	-0.004	0.002	-0.003	-0.002	0.01	-0.0007	-0.003	0.005	-0.39*
LP	-0.009	-0.005	0.01	-0.03	0.02	-0.02	0.003	0.0006	-0.01	0.002	-0.19
PH	-0.005	0.001	-0.001	0.005	0.001	-0.005	0.002	-0.005	-0.0001	0.003	0.09
NFC	0.34	-0.007	0.17	-0.176	0.16	-0.45	-0.12	0.1	0.05	-0.059	0.49**
NFP	-0.6	0.1	-0.36	0.43	-0.46	0.63	0.09	-0.17	0.16	0.19	0.61**
FC	-0.17	0.03	-0.18	0.31	-0.26	0.24	0.04	-0.05	-0.01	-0.01	0.41**
FP	0.65	-0.23	0.26	-0.41	0.39	-0.63	0.01	0.02	-0.07	-0.12	0.72**
AFW	0.03	0.004	0.02	-0.06	0.04	-0.14	-0.01	0.01	-0.01	0.02	0.09
NBP		-0.02	-0.04	0.03	-0.04	-0.07	-0.06	0.09	0.05	0.01	0.48**
PL	0.01		-0.04	0.01	-0.04	0.01	0.02	-0.02	-0.009	-0.02	-0.18
FL	0.13	-0.24		0.73	-0.93	0.13	0.01	0.03	-0.008	0.2	0.02
FD	0.14	-0.07	-0.91		-1.12	0.43	0.16	-0.16	0.06	0.004	0.09
L:D	-0.34	0.51	2.25	-2.17		-0.59	-0.15	0.05	-0.09	-0.25	0.02
FW	-0.16	-0.05	-0.09	0.24	-0.17		0.09	-0.11	0.06	-0.15	0.12
MC	-0.17	-0.13	-0.01	0.12	-0.05	0.12		-0.88	-0.08	-0.26	0.1
DC	0.27	0.09	-0.03	-0.12	0.02	-0.15	-0.92		0.1	0.21	-0.12
TP	-0.03	-0.009	-0.001	-0.009	0.007	-0.01	0.017	0.02		0.02	0.01
Vt. C	-0.002	-0.005	0.008	-0.0002	0.004	0.008	0.01	-0.009	0.004		-0.21

Residual effect = 0.9447

these characters will result in the improvement of respective characters and ultimately fruit yield.

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