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POLYGENIC VARIATION FOR MORPHOLOGICAL AND BIOCHEMICAL TRAITS OF BRINJAL GENOTYPES (*Solanum melongena* L.) AND ITS WILD RELATIVES

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ABSTRACT

In present investigation, seventeen genotypes of brinjal and its wild relatives assessed for variability for fourteen traits. Significant differences were noticed for all the traits with maximum fruit yield per plant was observed in genotype VR-2 (777.60 g) which may be proved as promising genotype for commercial cultivation in an organic land Sikkim. High PCV and GCV was observed for almost all the traits indicating the wider genetic variability in the germplasm material. High heritability accompanied with high genetic advance as percent of mean respectively, were noticed for almost all traits including polyphenol (99.99%, 148.65%), average fruit weight (98.18 % and 88.20 %). length of fruit (94.55%, 90.62 %), fruit circumference (94. 80%, 59.57 %) and fruit yield per plant (94.44 % and 97.87 %). Fruit yield per plant showed significant positive correlation with average fruit weight (0.91 and 0.93 respectively) both at genotypic and phenotypic level indicate the importance of this character as yield attributing trait for the genetic improvement of yield. Average fruit weight showed highest positive direct effect (0.842 and 0.674) on fruit yield both at phenotypic and genotypic level suggesting that these traits may be improved through direct selection due to predominant additive gene action.

INTRODUCTION

Brinjal (*Solanum melongena* L., 2n = 24) related to the family Solanaceae popularly known as "eggplant" is one of the most popular and principal crop among the cultivated vegetables. Resistance to several pests and diseases of *Solanum macrocarpon* made the crop interesting for further development (Bonsu *et al*., 1998). On the other hand domesticated *Solanum anguivi* are supposed to be good source of essential vitamins and minerals (Denton and Nwangburuka, 2011) and may be recommended as a dietary staple or supplements for nursing mothers, the aged individuals, and patients suffering from anaemia (Elekofehinti *et al*., 2012). Sikkim is blessed with suitable organic conditions for brinjal cultivation, even the average productivity of its neighbouring state West Bengal is much higher because of unavailability of suitable promising cultivar, which can perform efficiently in organic growing conditions. Due to the dependency of any cultivar on genotypic and environmental interactions, it is necessary to assess the genetic variability in available germplasm material to find out the most promising genotypes suitable for commercial cultivation either directly or as a breeding material in future crop improvement programme. Genetic variability refers to the presence of dissimilarity among the individuals of a population. Yield being as a complex character govern by polygenes and largely depends upon the other economic traits, which respond to growing environment actively. The dissimilarity in the available material may be due to the difference either in genetic composition or in the growing environments (Janaki *et al*., 2015). The effectiveness of selection for any trait depends upon the extent of variability to which it will be transmit from one generation to the other, because only heritable portion of variation may be utilized through selection (Maharana *et al*., 2017). The components of estimating genetic variation like coefficient of variation expressed at both genotypic and phenotypic level, heritability and genetic advance are the measures to give an idea about the magnitude and amount of variability present among the germplasm available. While performing the selection procedure for one economic trait the proper knowledge of degree and direction of association to other traits is a key factor as breeders are interested in the improvement of several economic traits together in recent past (Kadwey *et al*., 2015). The degree and direction of association among the traits is of immense importance for planning an effective breeding programme (Panwar *et al*., 2012). Information on nature as well as magnitude of various associations provided by correlation coefficient and path coefficient analysis that act as an effective means to find out direct and indirect sources of associations. By keeping the all above facts in the mind the present study was therefore, initiated with an objective to determine genetic variability in important morphological and biochemical traits of brinjal

genotypes and its wild relatives and to find out the most potent and promising genotype for commercial cultivation at Organic land Sikkim.

MATERIALS AND METHODS

In the present investigation, total seventeen brinjal genotypes including edible wild relatives collected from different sources with few genotypes maintained at department itself evaluated in Randomized Block Design with three replications during the warm season in the year 2017 at Main Experimentation Station of Department of Horticulture, Sikkim University. Seedlings were transplanted at a planting distance of 60 cm × 45 cm. Agronomical practices such as organic fertilization, weeding, organic and eco-friendly plant protections measures were taken up efficiently to raise the successful crop. The observations were recorded on fourteen quantitative traits *viz*., days to 50% flowering (days), plant height (cm), number of branches per plant, length of the leaf (cm), width of the leaf (cm), length of the fruit (cm), circumference of the fruit (cm), number of fruits per plant, average fruit weight (g) and fruit yield per plant (g) including biochemical parameters *viz*., T.S.S. (ºBrix), ascorbic acid (mg/100 g), polyphenol (mg/100 g), total protein (g/100 g) from five randomly selected plants from every genotype under each replication. Morphological parameters were recorded by using standard methodology as suggested by NBPGR descriptors on vegetable crops at their respective growth stage. Biochemical parameters were estimated by the standard protocol suggested by the previous workers viz., T.S.S. (ºBrix) was determined by using a digital refractometer. Ascorbic acid (mg/100 g) was determined by using the method suggested by Rangana, 1976. Polyphenol (mg/100 g) extraction was based on the method by Thimmaiah, 1999, whereas total protein content estimated by the method given by Lowry *et al*., 1951. The recorded data was compiled and statistically analysed using the OPSTAT statistical software for interpretation of the results to draw the valid conclusion. Statistical procedures like genotypic and phenotypic coefficients of variation were calculated as per Burton and Devane (1953). The range of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) were given by Sivasubramanian and Menon (1973). Broad sense heritability is the ratio of genotypic variance to the phenotypic variance was calculated using the formulae of Lush (1949) and genetic advance estimated by the method of Johnson *et al*. (1955). Genetic advance is the improvement over the base population that can potentially be made from selection for a characteristic. The range of heritability and genetic advance (GA) categorized as by Johnson *et al*. (1955). Correlation coefficient is the mutual association between independent variables without implying any cause and effect relationship. It determines the degree of association of characters with yield and among the yield components. Correlation coefficient was calculated by using formula given by Johnson *et al*. (1955) and Al–Jibouri *et al*. (1958) while Path coefficient analysis was estimated by formula suggested by Wright (1921) and elaborated by Dewey and Lu (1959). Path coefficient was calculated separately for all characters considering fruit yield as dependable variable.

RESULTS AND DISCUSSION

Mean performance

It is quite obvious that there was significant difference estimated among all the characters studied for all the genotypes under investigation (table 1). Earliest flowering showed by Pusa Purple Cluster (44 days) followed by Swarna Mani (44.67 days), Arka Shirish, VR-2 (45.33 days), SUB-101 (45.67 days) and Mukta Keshi (46.33 days). The results are in consonance with the finding of Ravali *et al*. (2017) and Patel *et al*. (2017). The difference in the flowering might be due to genetical differences between the available genotypes. The plant height in the wild relatives were recorded high than compared with cultivated genotypes and *Solanum anguivi*-2 (154 cm) was the longest plant found among the landraces followed by *Solanum anguivi*-1 (150.67 cm), *Solanum macrocarpon*-2 (130.33 cm) and *Solanum macrocarpon*-1 (124.33 cm). The minimum plant

Table 1: Mean performances of fourteen traits of brinjal genotypes and its wild relatives

GENOTYPE	Days to 50% flowering	Plant height (cm)	Number of branches/Plant	Leaf length (cm)	Leaf width (cm)	Fruit Length (cm)	Fruit circumference (cm)	No. of fruits/ Plants	Average Fruit weight (g)	Fruit yield/ Plant (g)	Ascorbic acid (mg/ 100 g)	Poly phenol (mg/100g)	T.S.S. (ºBrix)	Protein (g/100 g)
Haritha	48.67	87.67	2.4	22.8	16.47	12.1	9.63	7.33	42.78	308.59	21.34	95.42	4.27	1.16
Rajendra Baigan-2	51.67	95.67	2.83	24.97	21.1	15.33	9.67	7.33	60.12	415.89	16.66	107	4.4	1.07
Arka Shirish	45.33	113	3.07	27.2	22.67	21.1	10.5	7	73.11	507.04	11.78	79.3	4.37	0.74
Swarna Mani	44.67	94.67	2.5	19.7	16.2	8.43	12.93	8.33	49.42	408.19	11.79	255.69	5.67	0.8
Pusa Purple Cluster	44	98.33	2.83	25.07	20.63	11.5	13.53	8.33	57.66	475.04	23.66	325.3	4.33	0.77
IIHR-562	53	90.33	3.07	24.8	18.87	10.67	10.1	8.67	36.31	302.82	26.32	280.2	4.2	0.64
Mukta Keshi	46.33	108.33	3.4	28.43	22.83	13.17	12.4	10	75.91	770.37	16.76	546.83	3.17	1.04
VR-2	45.33	99.33	2.5	23.83	18.23	9.87	17.13	11	71.99	777.6	19.02	66.87	4.53	0.58
IC-89832	49.33	84.33	2.4	22.83	18.53	11.5	16.43	8.67	69.33	600.8	16.63	96.3	3.33	0.83
Punjab Baigan-67	48.67	78.08	2.5	18.7	16.6	13.47	10.6	11.67	40.01	451.99	14.23	96	3.57	0.6
Arkra Kusumakar	54	98.33	2.83	22.43	19.5	9.83	13.93	7.67	44.78	320.78	11.86	83.97	3.3	0.51
IIHR-563	50.33	84	9.67	22.97	15.83	9.87	15.43	8.33	54.48	389.37	23.66	268.3	4.93	0.43
SUB-101	45.67	112	2.83	25.93	19.93	26	5.4	7	30.35	221.56	21.37	133.4	4.8	0.74
S. macrocarpon-1	46	124.33	2.97	37.43	22.43	7.27	14.73	8.67	39.12	313.34	9.61	167.37	5.2	0.36
S. anguivi-1	54	150.67	2.83	21.3	14.97	4.57	7.97	13.67	7.02	84.27	11.8	115.7	3.8	0.65
S. macrocarpon-2	58.67	130.33	2.5	38.3	22.5	10	18.4	8	38.74	289.75	9.5	375.7	4.63	0.36
S. anguivi-2	49	154	3.63	21.53	14.77	4.53	7.533	12	8.48	90.94	11.87	84.17	4.6	0.75
General mean	49.1	106.08	2.82	25.19	18.95	11.72	12.14	9.04	47.04	395.78	16.34	186.91	4.3	0.71
SE(m)	1.56	4.48	0.2	1.36	1.36	0.73	0.49	0.62	1.6	27.1	0.08	0.13	0.62	0.24
C.D AT 5%	4.51	12.91	0.56	3.91	3.91	2.12	1.4	1.78	4.6	78.08	0.37	1.78	0.24	0.07

Table 2 : Mean, Range, Co-efficient of variation, Heritability, Genetic advance and Genetic advance as % of mean

Sl. No.	Characters	General mean	Range	Co-efficient of variation (%)			Heritability% (broad sense)	Genetic advancement	Gen. advance as of % mean
				GCV	PCV	ECV			
1	Days to 50% flowering	49.1	44.00-58.67	7.68	9.45	5.52	65.93%	6.3	12.84
2	Plant Height (cm)	106.08	78.08-154.00	20.70	21.95	7.32	88.89%	42.64	40.2
3	No. of Branches/Plant	2.82	2.40-3.63	10.92	16.22	11.10	45.29%	0.43	15.14
4	Length of the leaf (cm)	25.19	18.70-38.30	20.68	22.68	9.33	83.08%	9.78	38.82
5	Width of the leaf (cm)	18.95	14.77-22.83	12.92	17.92	12.41	52.01%	3.64	19.2
6	Length of the fruit (cm)	11.72	4.53-26.00	45.24	46.53	10.86	94.55%	10.62	90.62
7	Circumference of the fruit (cm)	12.14	5.40-18.40	29.70	30.50	6.95	94.80%	7.23	59.57
8	No. of fruits/Plant	9.04	7.00-13.67	20.47	23.64	11.83	74.96%	3.3	36.5
9	Average fruit weight (g)	47.04	7.02-75.91	43.25	43.65	5.89	98.18%	41.53	88.29
10	Fruit yield/Plant (g)	395.78	84.27-777.60	48.89	50.31	11.86	94.44%	387.35	97.87
11	T.S.S. (ºBrix)	4.3	3.17-5.67	15.93	16.27	3.34	95.78%	1.38	32.12
12	Ascorbic acid (mg/100 g)	16.34	9.50-26.32	32.92	32.94	1.36	99.83%	11.07	67.75
13	Polyphenol (mg/100 g)	186.91	66.87-546.83	1.36	1.72	0.57	99.99%	277.84	148.65
14	Total Protein (g/100 g)	0.71	0.36-1.16	32.86	33.38	5.90	96.88%	0.47	66.62

height showed by Punjab Baigan-67 (78.08). This result was similar with the findings of Kumar *et al*. (2013) and Patel *et al*. (2017). Maximum number of branches showed by IIHR-563 (9.67) followed by *Solanum anguivi*-2 (3.63), Mukta Keshi (3.40), Arka Shirish (3.07), IIHR-562 (3.07). Results obtained by Dubey (2012) and Tundilal (2010) are in close conformity with the present study. Longest leaf was observed in *S. macrocarpon*-2 (38.30 cm) followed by *S. macocarpon*-1 (37.43 cm), this might be due to genetical makeup of the wild species which is morphologically and physiologically differ from cultivated brinjal. Broadest leaf was found in Mukta Keshi (22.83) followed by Arka Shirish (22.67 cm) while narrow leaf was recorded in *Solanum anguivi*-2 (14.77). The result of the present study is not similar to the result published by Rad *et al*. (2015) and Yadav *et al*. (2016). Longest fruit was found in SUB-101 (26.00 cm), followed by Arka Shirish (21.10) whereas the genotype *Solanum anguivi*-2 recorded the shortest fruit length (4.53 cm). Similar results were obtained by Tundilal (2010), Nayak and Nagre (2013) and Ravali *et al*. (2017). Maximum circumference of the fruit found in *Solanum macrocarpon*-2 (18.40 cm) followed by VR-2 (17.13 cm) whereas the genotype SUB-101 produced the minimum circumference of the fruit (5.40 cm). The results are in consonance with Kumar *et al*. (2013) and Vidhya and Kumar (2015). Maximum no. of fruits per plant was recorded in *S. anguivi*-1 (13.67) followed by *Solanum anguivi*-2 (12.00) while minimum no. of fruits per plant was recorded in SUB-101 (7.0). Similar result was obtained by Mohanty (2002) and Chaudhary and Kumar (2014). This might be due to genetic makeup of *Solanum anguivi*-1 and *Solanum anguivi*-2 in which the maximum floral primordia have been developed and more conversion of vegetative to reproductive phase took place ultimately leading to more production of long style and medium style flowers to set the maximum no. of fruits. Highest average fruit weight was recorded in Mukta Keshi (75.91 g) followed by Arka Shirish (73.11 g). Lowest fruit weight average was recorded in *S. anguivi*-1 (7.02 g). The result obtained by Shekar *et al*. (2012) ranged from 44.63 -70.19 g and Ravali *et al*. (2017) ranged from 40-160 g and are not similar with the present finding, since present study incorporates the wild relatives like *Solanum anguivi* which is genetically smaller fruited species. Maximum fruit yield per plant was observed in VR-2 (777.60 g) followed by Mukta Keshi (777.37 g). These genotypes also showed high mean performance for one or other characters besides having higher yield. The high yielding genotypes may be considered in varietal improvement programmes for desired characters (Pandey *et al*., 2016). Minimum fruit yield per plant was found in *S. anguivi*-1 (84.27 g). The results obtained in this study are slightly different with the findings of Lokesh *et al*. (2013) and Yadav *et al*. (2016), since the genotypes were raised organically, and yield may be compromised at some extent.

Maximum ascorbic acid was recorded in IIHR-562 (26.32 mg/100 g) followed by Pusa Purple Cluster and IIHR-563 (23.66 mg/100 g) and minimum was found in *Solanum macrocarpon*-2 (9.50 mg). The results are in close conformity with the findings of Patel *et al*. (2017). Maximum polyphenol content was recorded in Mukta Keshi (546.83 mg), followed by Pusa Purple Cluster (325.30 mg) while minimum polyphenol content was found in VR-2 (66.87 mg). These results are slightly different with the findings of Ravali *et al*. (2017), due to the genetic makeup of the genotypes and the location of experiment and strong correlation of polyphenol with the environment condition. Maximum T.S.S. was observed in Swarna mani (5.67 ºBrix) followed by *Solanum macrocarpon*-1 (5.20 ºBrix). Minimum value was found in Mukta Keshi (3.17 ºBrix). This view was supported previously by Tundilal (2010), Dubey (2012) and Chaudhary and Kumar (2014). Maximum protein content was recorded in Haritha (1.16 g) and minimum was found in *Solanum macrocarpon*-1 and *Solanum macrocaropn*-2 (0.36 g).

Genetic parameters

From table 2 it was observed that PCV was marginally higher than GCV for all the traits indicating little influence of environment for the expression of the traits. High magnitude

Table 3: Estimates phenotypic and genotypic correlation co-efficient between different characters of Brinjal and its wild relatives

		Days to 50% flowering	Plant Height (cm)	No. of Branches/ Plant	Leaf Length (cm)	Leaf Width (cm)	Fruit length (cm)	Fruit Circumference (cm)	No. of fruits /plant	Average fruit weight (g)	T.S.S. (ºB)	Ascorbic Acid (mg/ 100 g)	Poly phenol (mg/ 100 g)	Protein (g/100 g)	Fruit Yield/ Plant (g)
Days to 50% flowering	P	-	0.18	-0.1	0.16	-0.03	-0.28	0.2	0.09	-0.36	-0.24	-0.17	0.04	-0.26	-0.38
	G	-	0.24	-0.28	0.2	-0.09	-0.34	0.16	0.08	-0.42	-0.29	-0.21	0.05	-0.34	-0.49
Plant Height (cm)	P		-	0.31	0.33	0.03	-0.3	-0.24	0.31	-0.58	0.13	-0.52	-0.01	-0.21	0.51
	G		-	0.57*	0.34	-0.02	-0.32	-0.27	0.49*	-0.62	0.16	-0.56	-0.01	-0.21	0.56*
Number of Branches/ Plant	P			-	0.01	0.12	-0.03	-0.26	0.25	-0.07	-0.14	-0.05	0.13	0.22	-0.01
	G			-	0.17	0.21	-0.02	-0.28	0.25	-0.07	-0.24	-0.73	0.19	0.3	-0.01
Leaf Length (cm)	P				-	0.67*	0.07	0.35	-0.32	0.12	0.21	-0.26	0.38	-0.35	0
	G				-	0.84**	0.06	0.42*	-0.33	0.09	0.24	-0.29	0.42*	-0.39	0.02
Leaf Width (cm)	P					-	0.35	0.23	-0.45	0.41*	-0.07	-0.11	0.33	-0.01	0.29
	G					-	0.54*	0.32	-0.6	0.60**	-0.1	-0.15	0.45*	-0.06	0.47*
Fruit Length (cm)	P						-	-0.31	-0.53	0.37	-0.02	0.27	-0.07	0.27	0.21
	G						-	-0.35	-0.61	0.36	-0.04	0.28	-0.07	0.28	0.22
Fruit Circumference (cm)	P							-	-0.12	0.52*	0.02	-0.03	0.28	-0.44	0.52*
	G							-	-0.16	0.52*	0.03	-0.13	0.29	-0.46	0.53*
No. of fruits/plant	P								-	-0.4	-0.23	-0.21	-0.08	-0.12	-0.05
	G								-	-0.46	-0.28	-0.25	-0.1	-0.15	-0.15
Average Fruit Weight (g)	P									-	-0.17	0.02	0.23	0.24	0.91**
	G									-	-0.17	0.21	0.24	0.26	0.93**
T.S.S. (ºBrix)	P										-	-0.03	-0.02	-0.24	-0.27
	G										-	-0.03	-0.02	-0.26	-0.28
Ascorbic Acid (mg/100 g)	P											-	0.18	0.27	0.19
	G											-	0.18	0.28	0.2
Polyphenol (mg/100 g)	P												-	0.01	0.27
	G												-	0.01	0.27
Protein (g/100 g)	P													-	0.21
	G													-	0.23
Fruit Yield/Plant (g)	P														-
	G														-

**Highly correlated, * moderately correlated;P-Phenotypic correlation, G-Genotypic correlation

Table 4: Direct and indirect effect of various traits on fruit yield per plant of Brinjal and its wild relatives at phenotypic and genotypic level

		Days to 50% flowering	Plant Height (cm)	No. of Branches / Plant	Leaf Length (cm)	Leaf Width (cm)	Fruit length (cm)	Fruit Circumference (cm)	No. of fruits /plant	Average fruit weight (g)	T.S.S. (ºB)	Ascorbic Acid (mg/ 100 g)	Polyphenol (mg/ 100 g)	Protein (g/100 g)	Fruit Yield/ Plant (g)
Days to 50% flowering	P	-0.084	-0.015	0.008	-0.014	0.003	0.024	-0.008	-0.007	0.03	0.021	0.015	-0.003	0.022	-0.377
	G	-0.346	-0.083	0.097	-0.069	0.032	0.116	-0.056	-0.029	0.146	0.1	0.074	-0.016	0.119	-0.485
Plant Height (cm)	P	-0.012	-0.066	-0.02	-0.022	-0.002	0.02	0.016	-0.024	0.038	-0.009	0.035	0.001	0.014	-0.507
	G	0.016	0.066	0.038	0.022	-0.001	-0.021	-0.018	0.032	-0.041	0.01	-0.037	-0.001	-0.014	-0.557
Number of Branches/ Plant	P	0.003	-0.009	-0.03	-0.001	-0.004	0.001	0.008	-0.007	0.002	0.004	0.002	-0.004	-0.007	-0.008
	G	0.064	-0.13	-0.227	-0.04	-0.048	0.004	0.088	-0.057	0.015	0.054	0.017	-0.044	-0.069	-0.014
Leaf Length (cm)	P	0.002	0.004	0	0.011	0.007	0.001	0.004	-0.004	0.001	0.002	-0.003	0.004	-0.004	0.004
	G	0.016	0.027	0.014	0.08	0.067	0.005	0.033	-0.026	0.007	0.019	-0.023	0.033	-0.031	0.021
Leaf Width (cm)	P	-0.002	0.002	0.007	0.039	0.058	0.02	0.013	-0.026	0.024	-0.004	-0.006	0.019	-0.001	0.29
	G	-0.01	-0.002	0.021	0.086	0.102	0.055	0.033	-0.061	0.062	-0.01	-0.015	0.046	-0.007	0.467
Fruit Length (cm)	P	-0.028	-0.029	-0.003	0.007	0.034	0.098	-0.03	-0.052	0.036	-0.002	0.027	-0.007	0.027	0.213
	G	-0.009	-0.008	-0.001	0.002	0.014	0.026	-0.009	-0.016	0.009	-0.001	0.007	-0.002	0.007	0.22
Fruit Circumference (cm)	P	0.014	-0.036	-0.037	0.051	0.033	-0.045	0.146	-0.017	0.075	0.003	-0.018	0.041	-0.065	0.517
	G	0.033	-0.057	-0.08	0.086	0.067	-0.072	0.207	-0.032	0.108	0.006	-0.027	0.06	-0.096	0.525
No. of fruits/plant	P	0.04	0.161	0.108	-0.142	-0.199	-0.234	-0.051	0.44	-0.178	-0.101	-0.094	-0.037	-0.054	-0.05
	G	0.027	0.159	0.081	-0.106	-0.195	-0.2	-0.051	0.327	-0.15	-0.091	-0.081	-0.032	-0.048	-0.155
Average Fruit Weight (g)	P	-0.302	-0.485	-0.061	0.089	0.346	0.308	0.434	-0.34	0.842	-0.139	0.176	0.196	0.205	0.906
	G	-0.284	-0.419	-0.046	0.062	0.405	0.244	0.353	-0.31	0.674	-0.116	0.142	0.158	0.173	0.928
T.S.S. (ºBrix)	P	0.008	-0.004	0.004	-0.007	0.002	0.001	-0.001	0.007	0.005	0.031	0.001	0.001	0.007	-0.27
	G	0.063	-0.034	0.052	-0.053	0.021	0.008	-0.006	0.061	0.038	-0.218	0.007	0.004	0.056	-0.279
Ascorbic Acid (mg/100 g)	P	-0.006	-0.018	-0.002	-0.009	-0.004	0.01	-0.004	-0.007	0.007	-0.001	0.035	0.006	0.009	0.19
	G	-0.02	-0.052	-0.007	-0.026	-0.014	0.026	-0.012	-0.023	0.019	-0.003	0.092	0.016	0.026	0.195
Polyphenol (mg/100 g)	P	0.002	-0.001	0.006	0.019	0.016	-0.003	0.014	-0.004	0.011	-0.001	0.009	0.049	0.001	0.267
	G	0.002	-0.001	0.01	0.021	0.022	-0.003	0.014	-0.005	0.012	-0.001	0.009	0.05	0.001	0.274
Protein (g/100 g)	P	-0.013	-0.011	0.011	-0.018	-0.001	0.014	-0.022	-0.006	0.012	-0.012	0.014	0.001	0.05	0.206
	G	-0.038	-0.024	0.034	-0.043	-0.007	0.032	-0.051	-0.016	0.028	-0.028	0.031	0.001	0.111	0.228

Residual effect = 0.2053

of genotypic and phenotypic coefficient of variations were recorded for most of the traits, however maximum values were found for fruit yield/plant (50.31 % and 48.89 %) followed by fruit length and average fruit weight respectively for both PCV and GCV, suggests the substantial improvement on brinjal through selection for these traits. The results are in consonance with Lokesh *et al*. (2013), Koundinya *et al*. (2017), Divya and Sharma (2018) and Balas *et al*. (2019). While moderate GCV and PCV were recorded for no. of branches per plant, leaf width, T.S.S. This is in line with the findings of Muniappan *et al*. (2010) and Chaudhary and Kumar (2014).

Most of the characters exhibited high and moderate broad sense heritability indicating that the characters are least influenced by the environmental factors. The data presented in Table 2 showed that the values of heritability ranged from 45.29 % for number of branches per plant to 99.99% for polyphenol. High heritability results for the characters such as plant height (88.89 %), days to 50 % flowering (65.93 %), no. of fruits per plant (74.96 %), fruit circumference (94.80 %), fruit length (94.55 %), average fruit weight (98.18 %), fruit yield per plant (94.44 %), ascorbic acid (99.83 %) and total phenol content (99.99 %) agrees with the findings of Dubey (2012) and Ravali *et al*. (2017), whereas moderate heritability was found in width of the leaf (52.01 %), and no. of branches per plant (45.29 %). High heritability coupled with high genetic advance as per cent of mean was noticed for plant height (88.89% and 40.20 %), fruit yield per plant (94.44 % and 97.87 %), no. of fruits per plant (74.96 % and 36.50 %), average fruit weight (98.18 % and 88.29 %), polyphenol (99.99 % and 148.65 %), ascorbic acid (99.83 % and 67.75 %), T.S.S. (95.78 % and 32.12 %), total protein (96.88 % and 66.62 %), fruit length (94.55 % and 90.62 %), fruit circumference (94.80 % and 59.57 %) and leaf length (83.08 % and 38.82 %). The results are similar with the findings of Koundinya *et al*. (2017), Divya and Sharma (2018) and Balas *et al*. (2019). High estimates of heritability along with high genetic advance provides good scope for further improvement in advance generations (Saxesena *et al*. 2014).

Character association

Correlation coefficient analysis

Table 3 showed phenotypic and genotypic correlation co-efficient between different characters of Brinjal and its wild relatives. Correlation coefficient analysis showed that fruit yield per plant was positive and significantly correlated with average fruit weight (0.93 and 0.91) at both phenotypic and genotypic level respectively, however it is also correlated significantly with fruit circumference (0.53 and 0.52) and plant height (0.56 and 0.51) both at phenotypic and genotypic level. Present investigation are in agreement with the findings of Tundilal (2010). Ascorbic acid and polyphenol were found positively correlated with fruit yield, similar findings were reported by Koundinya *et al*. (2017), Thangamani and Jansirani (2012) regarding the above narrated trait.

Path coefficient analysis

The statistics relating to the path coefficient analysis representing direct and indirect contribution towards yield have been presented in Table 4. Path co-efficient analysis showed that average fruit weight (0.842 and 0.674) imparted highest positive direct effect on fruit yield followed by no. of fruits per plant, leaf length, fruit length, fruit circumference, ascorbic acid, polyphenol and protein at both phenotypic and genotypic level. Similar result was observed by Kushwah and Bandhyopadhya (2007), Kumar *et al*. (2011) and Lokesh *et al*. (2013) for average fruit weight, and Karak *et al*. (2012) for fruit length, fruit circumference, average fruit weight and no. of fruits per plant. Days to 50% flowering, no. of branches per plant had negative direct effect on fruit yield both at phenotypic and genotypic level. Similar results were revealed by Kumar *et al*. (2013). Average fruit weight expressed high positive indirect effect via leaf width (0.405 and 0.346), while moderate positive indirect effect via fruit circumference and fruit length. The result are in consonance with the findings of Saha (2014). From our investigation, it may be concluded that average fruit weight, number of fruits per plant and fruit circumference emerged as the most important fruit yield and its contributing traits of brinjal wild relatives with predominant additive gene action and these characters might be used for further yield improvement in brinjal and its wild relatives. Genotype VR-2 is proven as promising genotype for commercial cultivation in an organic land Sikkim either directly or can be used as potent parent in further genetic improvement.

REFERENCES

Al-Jibouri, H. A., Miller, P. A. and Robinson, H. F. 1958. Genotypic and environmental variance in an upland cotton cross of interspecific origin. *Agron. J.* **50:** 633-637.

Burton, G. W. and DeVane, E.M. 1953. Estimating heritability in tall fescue (Festuca circunclinaceae) from replicated clonal material. *Agron. J.* **45:** 478-481.

Bonsu, K. O., Owusu, E. O., Nkansah, G. O. and Schippers, R. R. 1998. Preliminary characterization of *Solanum macrocarpon* germ plasm from different ecological zones of Ghana, Workshop for Identification of Vegetable Research Priorities I Brong Ahafo Region of Ghana, Sunyani, Ghana. p- 7.

Balas, A., Jivani, L.L., Valu, M.G., Sakriya, S.G., Gamit, U.C. and Rathod, R.K. 2019. Study of genetic variability and heritability in brinjal (*Solanum melongena* L.). *Pharma. Ino. J.* **8(9):** 44-46.

Chaudhary, P. and Kumar, S. 2014. Variability, Heritability and Genetic Advance studies in Egg-plant (*Solanum melongena* L.). Plant Arch. **14(1):** 483-486.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* **51:** 512-515.

Denton, O. A. and Nwangburuka, C. C. 2011. Genetic variability in eighteen cultivars of *Solanum anguivi* Lam. using principal component analysis (PCA) and single linkage cluster analysis (SLCA). *Ann. Biologic. Res.* **2(4):** 62–67.

Dubey, A. K. 2012. Genetic Variability, Correlation and Path coefficient analysis for fruit yield and its attributing characters in brinjal hybrids. M.Sc. (Ag.) Thesis. Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chattisgarh). p- 66.

Divya, A. and Sharma, A.K. 2018. Genetic variability studies for yield and quality parameters in Brinjal (*Solanum melongena* L.). *J. Pharma. Phyto.* **7(5):** 2494-2496.

Elekofehinti, O. O., Adanlawo, I. G., Saliu, J. A. and Sodehinde, S.

A. 2012. Saponins from *Solanum anguivi* fruits exhibit hypolipidemic potential in *Rattus novergicus*. *Der Pharmacia.* Lett. **4(3):** 811–814.

Johnson, H.W., Robinson, H.F. and Comstock R.E. 1955. Genotypic and phenotypic correlation in soyabeans and their implication in selection. *Agron. J.* **47:** 477-483.

Kushwah, S. and Bandhyopadhya B. B. 2007. Path coefficient analysis of some quantitative traits in Brinjal (*Solanum melongena* L.) under mid hills of Himalayas. *Research on Crops.* **8(1):** 255-257.

Kumar, S., Sharma, J. P. and Chopra, S. 2011. Studies on variability, heritability and genetic advance for morphological and yield traits in Brinjal (*Solanum melongena* L.). *Mysore J. Agri. Sci.* **45(1):** 63-66.

Karak, C., Ray, U., Akhtar, S., Naik, A. and Hazra, P. 2012. Genetic variation and character association in fruit yield components and quality characters in brinjal *Solanum melongena* L. *J. Crop and Weed.* **8(1):** 86-89.

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

Kadwey, S., Dadiga, A., Prajapati, S. and Telugu, R. K. 2015. Correlation and path co-efficient analysis of quantitative and qualitative traits in chilli (*Capsicum annuum* L.) *The Bioscan* (Supplement on Genetics and Plant Breeding). **10(4):** 1909-1914.

Koundinya, A. V. V., Das, A., Layek, S., Chowdhury, R. and Pandit, M. K. 2017. Genetic variability, characters association and path analysis for yield and fruit quality components in Brinjal. *J. App. Nat. Sci.* **9(3):** 1343-1349.

Lush 1949. Genetic variability for quantitative and qualitative characters in Brinjal (*Solanum melongena* L). *Afr. J. Agril. Res*. **8(39):** 4956-4959.

Lowry, O.H., Rosenbraugh, N.J., Farr, A.L. and Randall, R.J. 1951. Protein measurement with the Folin Phenol Reagent. *J. Biol. Chem.* **193:** 265-275.

Lokesh, B., Reddy, S. P., Reddy, R. V. S. K. and Sivaraj, N. 2013. Variability, heritability and genetic advance studies in Brinjal (*Solanum melongena* L.). *Electron. J. Plant Breed*. **4(1):** 1097- 1100.

Mohanty, B. K. 2002. Variability, heritability and genetic advance studies in Brinjal (*Solanum melongena* L). *Indian J. Agric. Res*. **36(4):** 290-292.

Muniappan, S., Saravanan, K. and Ramya, B. 2010. Studies on Genetic Divergence and Variability for Certain Economic Characters in Eggplant (*Solanum melongena* L.). *Electro. J. Pl. Breed.* **1(4):** 462-465.

Maharana, J., Panda, C.M. and Jakhar, P. 2017. Genetic variability among genotypes and character association in kharif potato (*Solanum tuberosum* L.) for different traits. *The Bioscan* (Supplement on Genetics and Plant Breeding). **12(2):** 1195-1202.

Nayak, B. R. and Nagre, P. K. 2013. Genetic variability and correlations studies in Brinjal (*Solanum melongena* L.). *Intern. J. Appl. Bio. Pharma. Tech*. **4(4):** 211-215.

Panwar, S., Singh, K. P., Prasad, K. V., Satyavathi, C. T. and Namita. 2012. Character association and path coefficient analysis in rose (Rosa × Hybrida). *Indian J. Horticulture*. **69(2):** 231-238.

Pandey, V.C., Ram, C.N., Deo, C., Chakravarti, S. K. and Rao, J.K. 2016. Screening of germplasm for quality and yield traits in Tomato (*Solanum lycopersicum* L.). *The Bioscan* (Supplement on Genetics and Plant Breeding). **11(2):** 925-928.

Patel, V. K., Singh, U., Goswami, A., Tiwari, S. K. and Singh, M. 2017. Genetic variability, Interrelationships and path analysis for yield attributes in Eggplant. *Environ. Eco*. **35(2A):** 877-880.

Rangana, S. 1976. Manual of analysis of fruits and vegetable products. Tata McGraw Hill Co. Pvt. Ltd., New Delhi. p-77.

Rad, M. R. N., Poodineh, M., Ghalandarzehi, A. and Abkhoo, J. 2015. Variability, heritability and association analysis in Eggplant (*Solanum melongena* L.). APRN *J. Agril. Bio. Sci*. **10(12):** 464-468.

Ravali, B., Reddy, K. R., Saidaiah, P. and Shivraj, N. 2017. Variability, heritability and genetic advance in Brinjal (*Solanum melongena* L.). *Int. J. Curr. Microbiol. App. Sci*. **6(6):** 42-47.

Sivasubramanian, S. and Menon, P. M. 1973. Variability, heritability and genetic advance for fruit yield, quality and pest and disease incidence in eggplant. *Madras Agril. J.* **60:** 1093-1096.

Shekar, K C., Ashok, P. and Sasikala, K. 2012. Studies on heritability and multivariate analysis in Brinjal (*Solanum melongena* L.). *Veg. Crop. Res. Bull*. **76:** 79-88.

Saha, S. 2014. Variability, correlation and path coefficient analysis in Brinjal (*Solanum melongena* L.). M.Sc. Thesis. Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka. p-65-66.

Saxesena, R. R., Vidyakar, V., Vishwakarma, M. K., Yadav, P. S., Meena, M. and Lal, G. M. 2014. Genetic variability and heritability analysis for some quantitative traits in field pea (*Pisum sativum* L.). *The Bioscan*. **9(2):** 895-898.

Thangamani, C. and Jansirani, P. 2012. Correlation and path coefficient analysis studies on yield and attributing characters in brinjal (*Solanum melongena* L.). *Electr. J. Pl. Breed.* **3(3):** 939-944.

Thimmaiah, S.K. 1999. Standard methods of biochemical analysis. Kalyani Publishers. P. 287-288.

Tundilal, K. V. 2010. Genetic diversity and association studies for fruit yield and its components in brinjal (*Solanum melongena* L.). M. Sc. (Ag.) Thesis. Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhatisgarh. P. 42-65.

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

Wright, S. 1921. Correlation and causation. *J. Agri. Res*. **20:** 257-787.

Yadav, N., Dhankar, S. K., Chandanshive, A. V. and Kumar, V. 2016. Studies on variability, heritability and genetic advance in Brinjal (*Solanum melongena* L.). *The Bioscan*. **11(4):** 3001-3005.