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Genetic variability study for yield components and anthocyanin in eggplant (*Solanum melongena*)

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ABSTRACT

The present investigation was carried out during *kharif* 2017 at ICAR-IARI, New Delhi to assess the extent of genetic variability, heritability and genetic advance in eggplant using F_2 population from a cross of Pusa Safed Baingan 1 × Pusa Uttam. A total of 168 F_2 plants were characterized for morphological, and fruit traits and subjected to statistical analysis. Wide ranges of variations were observed for plant height (44.23 cm to 84.36 cm), fruit length (4.17 cm to 13.17 cm), fruit diameter (3.17 cm to 11.53 cm), fruit weight (15.20 g to 248.30 g) and total anthocyanin content (0.01 to 118.12 mg/100 g FW). High PCV and GCV (>20%) were observed for plant height, fruit weight and anthocyanin content. The highest heritability (74.09%) was recorded for fruit diameter indicating wide scope for improvement through selection of this trait. A total of 32 transgressive segregants were observed for fruit weight ranging from 165.30 g to 248.30 g and these can be selected further from F_2. Fruit weight was found to be positively and significantly correlated with plant height (0.09), fruit length (0.53), fruit diameter (0.76) both at genotypic and phenotypic level. The skewness of all the five traits except total anthocyanin was less than 1 which suggests that these traits followed normal distribution, whereas anthocyanin followed discrete distribution. The exploration of genetic variability in the available segregating population may be utilized for effective selection of superior plant type for developing a variety.

Key words: Anthocyanin, Eggplant, Variability, Yield

Solanaceous family consists of many economically important crops like tomato, potato, brinjal, chilli and capsicum. In this group, eggplant or brinjal is native of India and exhibits wide diversity for various morphological and biochemical traits in North Eastern region, Eastern Ghats, Central, and Eastern India. There are more than 100 local cultivars grown by farmers who maintain their own seed year after year (Swarup 2006). It has high nutritive and medical value. The chlorogenic acid (phenolic compound) found in brinjal has anti-diabetic, anti-oxidant, anti-carcinogenic, and anti-obesity effects (Plazas *et al*. 2013). The most common anthocyanin is nasunin which helps in neutralizing free radicals (Chaudhary and Mukhopadhyay, 2012), fight cancer (Salem *et al*. 2013), and also has anti-aging activity (Mai *et al.* 2012). Though, India is the second largest producer in world after China, the productivity (19.1 MT/ha) is low mainly due to cultivation of low yielding hybrids/varieties and susceptibility to various diseases and pests. If the natural variability in a crop species is exhausted, it is necessary to create new variability which is essential for crop improvement. Hybridization is an important source of variability which brings genetic variation for various traits through reshuffling of genes. The magnitude of variability in a population is measured by phenotypic and genotypic coefficient of variation; heritability and genetic advance under selection and helps the plant breeder in selecting elite genotypes from diverse genetic populations. Hence, before venturing into a breeding programme, it is essential to study the variability in yield and yield components, besides, important quality traits. Therefore, the present experiment was conducted to study the extent of genetic variability in segregating F_2 population of eggplant developed from a cross between Pusa Safed Baingan 1 and Pusa Uttam. The segregating population would be utilized for further improvement of eggplant yield through appropriate breeding strategies.

MATERIALS AND METHODS

Two contrasting parents were selected for this study. The female parent Pusa Safed Baingan 1 was developed from an indigenous variable material collected from West Garo Hills, Meghalaya, India. The plants are non-spiny with green leaf vein, fruits are small sized about 40-45 g, white, oval round, cluster bearing habit. The male parent

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Pusa Uttam was developed by progeny selection of a cross between GR × 91-2 and released for commercial cultivation in 2004. The plants are non-spiny, fruits slightly oval, glossy, dark purple, and medium sized (200-250 g). The present investigation was carried out at the research farm of ICAR-Indian Agricultural Research Institute, New Delhi, during *kharif* 2017. The F_2 population obtained from the selfing of F_1 plants provides very wide variation for important agronomic traits. Twenty plants of each of parents, F_1 and 168 F_2 plants were grown to assess, yield contributing components and anthocyanin content. The experiment was carried out without replication as the variable material was an F_2 segregating population. Recommended package of practices (Singh and Kalda 2003) were followed to raise the crop. The observations were recorded on each plant in F_2 and 20 plants in each of the parents and F_1s for plant height, fruit length, fruit diameter, fruit weight and total anthocyanin content. Anthocyanin content of fresh brinjal fruit peel at edible maturity was estimated by spectrophotometry method given by Giusti *et al.* (2001).The normality of phenotypic traits distribution was verified by the Shapiro-Wilk's test and the phenotypic distribution was explored for all the traits. Phenotypic and genotypic components of variance were estimated by using the formula given by Cochran and Cox (1957).The genotypic and phenotypic coefficient of variation was computed according to Burton (1952). The broad sense heritability (h^2_{bs}) was estimated for all characters as the ratio of genotypic variance to the total of phenotypic variance as suggested by Lush (1949) and Hanson *et al.* (1956). The genetic advance was worked out as per the formula proposed by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The extent of variability with respect to different yield, yield components and anthocyanin in 168 F_2 plants of Pusa Safed Baingan 1 and Pusa Uttam was measured. Variability was measured in terms of mean performance, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance and genetic advance as per cent mean (Table 1). Wide range of variation was observed for plant height (44.23 cm to 84.36 cm) with a mean value of 66.87 cm, fruit length (4.17 cm to 13.17 cm) with a mean value of 9.93 cm, fruit diameter (3.17 cm to 11.53) cm with a mean value of 5.33 cm, average fruit weight (15.20 g to 248.30 g) with a mean value of 114.48 g. In present study large numbers of transgressive segregants were found for all the traits which can be selected further for breeding varieties with higher fruit weight. Out of 168 F_2 plants, total of 32 and 1 transgressive segregants were obtained for fruit weight and anthocyanin content, respectively because of the fact that the value of fruit weight and anthocyanin content in some of the F_2 plants were more than the value of both the parents used in the present study (Fig. 1, 2). Therefore this cross

Table 1 Genetic variability in the F_2 plants from a cross of Pusa Safed Baingan 1 × Pusa Uttam

Characters	Range	Mean	PV	GV	EV	PCV (%)	GCV (%)	h^2 (%)bs	GA (%) mean
Plant height (cm)	44.23-84.36	66.87	22.47	37.29	5.84	36.40	32.89	64.34	43.00
Fruit length (cm)	4.17-13.17	9.93	1.86	1.24	0.62	22.36	20.23	66.88	27.38
Fruit diameter (cm)	3.17-11.53	5.33	0.85	0.63	0.22	23.45	21.76	74.09	23.12
Fruit weight (g)	15.20-248.30	114.48	26.84	26.83	0.01	45.02	23.31	69.96	52.47
Anthocyanin content (mg/100 g FW)	0.01-120.23	24.60	823.00	724.50	98.40	116.50	139.90	71.34	43.20

PV, Phenotypic variance; GV, genotypic variance; EV, Environmental variance; PCV, Phenotypic coefficient of variation; GCV, Genotypic coefficient of variation; h, heritability; GA, Genetic advance

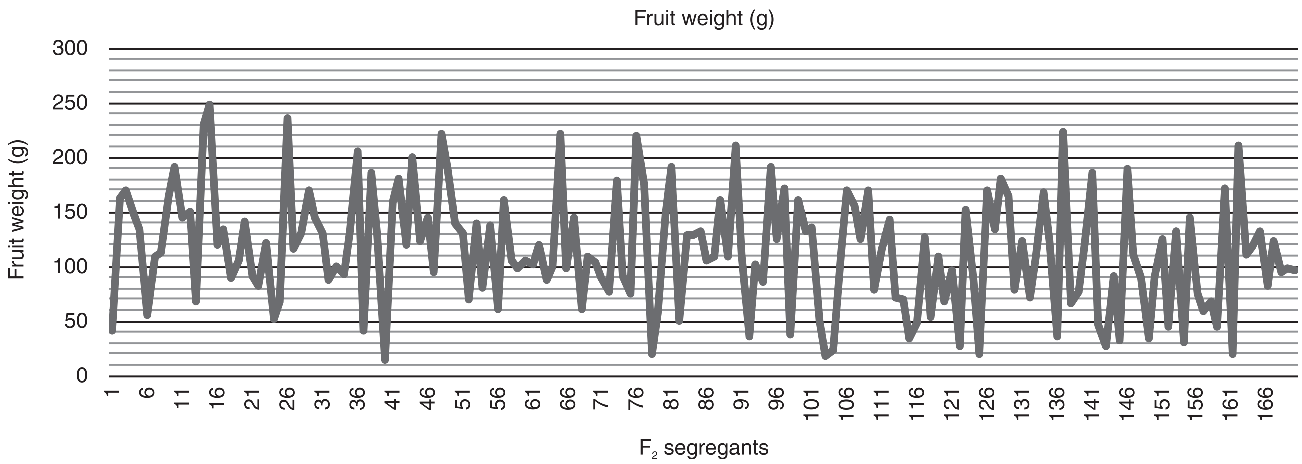

Fig 1. Variability for fruit weight in 168 F_2 plants from a cross of Pusa Safed Baingan 1 × Pusa Uttam

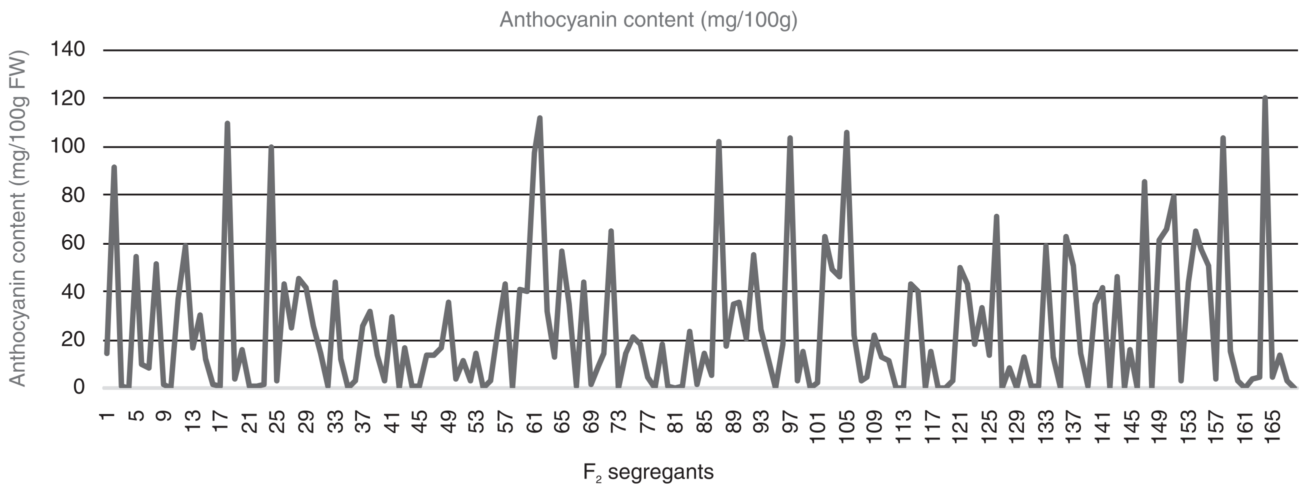

Fig 2. Variability for fruit anthocyanin content in 168 F_2 plants from a cross of Pusa Safed Baingan 1 × Pusa Uttam

combination can be a good source for selection of desirable recombinants from F_2 onward for fruit weight with high anthocyanin as reported by Kumar *et al.* (2013). Singh *et al.* (2013) described that the transgressive segregation is an indicator for broadening of the genetic variance.

The phenotype of crop is influenced by additive gene effect (heritable), dominance (non-heritable) and epistatic (non-allelic interaction). Therefore it is necessary to estimate phenotypic and genotypic coefficients of variation based on genotypic and phenotypic variances respectively. The estimated PCV and GCV are classified as low (0-10%), moderate (11-20%) and high (> 21%) (Sivasubramanian and Menon 1973).The level of PCV and GCV were recorded for the traits like plant height (36.40%, 32.89%), fruit length (22.36%, 20.23%), fruit diameter (23.45%, 21.76%), fruit weight (45.02%, 23.31%) and anthocyanin content (116.50%, 139.98%). The PCV was slightly higher than the corresponding GCV for all the traits which might be due to the interaction of the genotypes with the environment to some degree or environmental factors are majorly influencing the expression of these characters except for anthocyanin content. Similar results were also obtained by Indiresh and Santhosha, 2011, Kumar *et al.* 2012 and Balaji *et al.* 2013.

The coefficient of variation indicates only the extent of variability existing for various traits, but does not give any information about its heritable portion. Therefore, heritability accompanied by estimates of genetic advance as per cent of mean was estimated. High heritability was observed for all the traits under the study, viz. plant height (64.34%), fruit length (66.88%), fruit diameter (74.09%), fruit weight (69.96%) and anthocyanin content (71.34%). Heritability enables the plant breeder to decide the extent of selection pressure to be applied under a particular environment. The heritability worked out in broad sense, would suggest the amount or percent of variation is heritable and selection is effective. The heritability was classified by Robinson *et al.* (1951) as low (0-30%), moderate (31-60%) and high (> 61%). High heritability indicates that genetic variance is contributing in larger portion for the phenotypic variance of the characters under study and predominance of additive gene component. Thus, there is ample scope for improving these characters with direct selection. Similar findings were also reported by Muniappan *et al.* 2010, Kumar *et al.* 2012 and Arunkumar *et al.* 2013. High heritability estimates coupled with high genetic advance in percentage of mean for number of plant height, fruit weight and anthocyanin were obtained. Hence, pure lines can be developed by selfing those selected F_2 plants generation after generation. These lines with desirable characters in combination with high yield potential can be used as high yielding variety as well as the parents for hybrid development which suggest a wide scope for improvement through selection of these traits.

The correlations between the 5 traits are listed in Table 2. All the correlations between traits were positive. There was high correlation (r = 0.76) between fruit diameter and fruit weight. Fruit diameter was positively correlated with all traits. Fruit weight was positively correlated with fruit length, fruit diameter, and plant height and fruit anthocyanin content with highest correlation value of 0.76 with fruit

Table 2 Correlation analysis between different quantitative traits in 168 F_2 plants from a cross of Pusa Safed Baingan 1 × Pusa Uttam

Traits	Plant height	Fruit length	Fruit diameter	Fruit weight	Anthocyanin content
Plant height	1	0.19^{*}	0.19^{*}	0.09	0.05
Fruit length		1	0.64^{**}	0.53^{**}	0.05
Fruit diameter			1	0.76^{**}	0.01
Fruit weight				1	0.01
Anthocyanin content					1

Table 3 Statistics of quantitative traits of F_2 plants from a cross of Pusa Safed Baingan 1 × Pusa Uttam

Traits	Minimum	Maximum	Mean	Std Deviation	Variance	CV (%)	Skewness	Kurtosis
Plant height (cm)	44.23	84.36	66.87	10.05	101.03	15.03	0.28	-0.07
Fruit Length (cm)	4.17	13.17	9.93	1.17	1.37	11.79	0.32	-0.28
Fruit diameter (cm)	3.17	11.53	5.33	0.82	0.06	15.45	0.16	-0.46
Fruit weight (g)	15.20	248.30	114.48	51.60	2662.59	45.07	0.23	-0.37
Anthocyanin (mg/100 g FW)	0.01	120.23	20.60	25.33	641.72	124.10	1.70	2.22

diameter. The plant height was positively correlated with fruit length, fruit diameter, fruit weight and fruit anthocyanin content with highest value of 0.19 with fruit length. Fruit anthocyanin content was positively correlated with fruit weight (0.01), plant height (0.05) and fruit diameter 0.01. Thus direct selection for growth and yield components could be made for improving the yield. Similar findings were reported by Ahmed *et al.* 2013, Arunkumar *et al.* 2013, Dhaka and Soni 2014. Based on the results, it is possible to breed desirable eggplant varieties combining high fruit weight and anthocyanin content.

The mean phenotypic values, standard errors, variance and skewness, kurtosis of all quantitative traits are presented in Table 3 according to Shapiro–Wilk test. The skewness of all the 5 traits except fruit anthocyanin was less than 1 in absolute value in each case. This suggested that the trait followed normal distribution which is true in our case. Therefore the population developed in the present study is very much suitable for selecting desirable segregates for yield and anthocyanin content from F_2 plants which can serve as basic materials for developing superior cultivars with higher productivity and anthocyanin content.

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