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Estimation of genetic parameters of fruit quality traits in mango hybrid population

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ABSTRACT

The study was designed to evaluate the genetic variability for fruit quality in mango progenies. The fruit quality traits of F_1 progenies were evaluated on the basis of morphological and biochemical parameters. The results showed the existence of genetic variability among progenies with differences in the progeny performance for the traits. Value of phenotypic coefficients of variation was higher than genotypic coefficients of variation but minimum difference was noticed between them. Comparatively high degree of genotypic coefficients of variation (GCV) along with phenotypic coefficients of variation was observed in quality traits like, fruit weight, fruit volume, pulp: stone ratio and total carotenoids. High to moderate broad-sense heritability was estimated for different fruit quality traits. High magnitude of broad-sense heritability was recorded in traits like, fruit weight (0.82), fruit volume (0.80), total carotenoids (0.97), ascorbic acids (0.83), stone width (0.71) and fruit length (0.70). Moderate degree of heritability was noted in traits, *viz*., titratable acidity (0.58), fruit width (0.62), stone length (0.68), stone thickness (0.62), peel thickness (0.53) and total soluble solids (0.69). High heritability along with high genetic advance was estimated for fruit weight and fruit volume. Genetic parameters estimated for fruit quality traits of mango may be useful to formulate pre-selection criteria and efficient breeding strategies of mango for development of new hybrids.

Key words: Heritability, genetic advance, GCV, PCV, mango hybrids.

INTRODUCTION

The mango (*Mangifera indica* L.), commonly called as 'King of the fruits' in Indian subcontinent is considered to be a very important delicious tropical fruit in world market for its excellent flavour, delicious taste, attractive colour, and health promoting properties (Rathore *et al*., 15; Shruti *et al*., 16). In mango, fruit quality is determined by pulp characters such as sweetness, acidity, fibreness, firmness and flavour, whereas appearance includes peel colour, size, shape and uniformity. Mangoes with medium size, fibreless, high pulp: stone ratios are preferable. In India, about 30 cultivars are being grown commercially occupying 2.31 million ha area with an annual production 12.75 million tonnes (NHB, 11). These cultivars have been occupied the better position for superior fruit quality traits and most of them are chance seedlings or clonal selections in origin. Efforts are now underway to develop new hybrids having desirable pulp quality and attractive fruit peel colour, so that they can occupy the better position in the domestic and international market.

Knowledge of genetic parameters, such as heritabilities and correlation among characters under selection is very useful for predicting genetic progress in breeding programme and developing efficient breeding strategies (Falconer and Mackay, 4). The genetic parameters of fruit quality traits and taste components have been studied in a number of fruits but most studies included only a few traits (Cheng *et al*., 2). Knowledge of the magnitude of genetic variation among fruit characters and their heritability is very much important in a highly out crossing species like mango (Rajan *et al*., 13). Unfortunately, little information on genetic parameters for fruit quality traits of mango has been reported. In order to enrich the information and acquaint the mango breeder to interpret phenotypic values in terms of potential genetic gain, there is a need to study genetic parameters of traits related to fruit quality. Therefore, the present study was carried out to estimate genetic parameters for important fruit quality traits of horticultural interest to facilitate mango breeding.

MATERIALS AND METHODS

The genetic material used for the study consisted of F_1 progenies of mango derived from crosses of Amrapali and Sensation. Progenies were maintained under uniform cultural conditions at the Division of Fruits and Horticultural Technology, Indian Agricultural Research Institute, New Delhi, India. The number of

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F_1 progenies assessed was 50 during 2008-09. Three fruits were sampled from three different parts of the each hybrid at the mature stage based on the previous year's observation ripening data and as judged from peel colour of the fruits. The samples were taken to the laboratory immediately and kept in boxes for proper ripening

Fourteen fruit quality traits were studied. Fruit quality traits included fruit weight, fruit length, fruit width, stone thickness, stone length, stone weight, pulp and stone ratio, peel thickness, peel colour, pulp colour, total soluble solids, titratable acidity, ascorbic acid and total carotenoids. Fruit weight and stone weight were recorded as mean weight from nine fruits sampled at random from each progeny and expressed in gram. Fruit length, fruit width, stone thickness, stone width and peel thickness were measured for average sized fruits and expressed in cm. °Brix (as measure of sugar content) and acidity were determined more accurately by measuring uniform sample using hand digital refractometer (ATC-1E, Atago, Japan). Titrable acidity was determined by titration method (Ranganna, 1999) and expressed in mg g^1 fresh weight. To estimate the ascorbic acid and total carotenoids contents, 100 g fruit segments were sampled randomly from five fruits and homogenized with blender and determined as per the standard method suggested by Ranganna (15) and expressed in mg 100 g^{-1} fresh weight. The data recorded during 2008 and 2009 for all the traits were pooled and subjected to biometric analysis. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV), heritability (h^2), genetic advance (GA) and correlation among the different fruit quality traits were estimated with help of WINDOSTAT 8.1 software (22).

RESULTS AND DISCUSSION

Fruit quality is a complex trait, which depends upon a number of other parameters and their interaction. The analysis of variance (ANOVA) revealed the significant variation among the progenies for all the fruit quality traits. The rich variation, which was recorded in F_1 progenies, could be due to highly heterozygous and diverse genetic background of parents. All the traits studied shows continuous variation and might have polygenic inheritance pattern.

Selection applied to one character can affect other characters because of genetic correlation between traits (Cheng *et al*., 2). Genetic correlations between various fruit quality traits were generally weak. Fruit length was negatively correlated with titrable acidity (-014), suggesting that long fruits would lead to lower titrable acidity content. Wei *et al.* (22) reported negative genetic correlation between berry weight and titrable acidity in table grapes. Stone thickness had positive correlation with titratable acidity (0.20). So, fruit showed high stone thickness might have higher level of titratable acidity. Stone length had negative correlation with titratable acidity (0.21) and positive correlation with peel thickness (0.28) selection for small stone length is likely to lead to a simultaneous increase in titratable acidity content and less peel thickness. Total soluble solids were positively correlated with total carotenoids (0.23) and negatively correlated with titrable acidity. It is sometime more convenient or effective to select for a correlated response than to a select for the desirable characters itself. Knowledge about the correlation studies between various fruit quality traits would certainly provide an idea which could be utilized for selection of desirable traits in future breeding programme. Genetic correlations between traits could be due to pleiotropy. The results obtained from correlation study among various fruit quality traits were in accordance with the results obtained by Karibasappa *et al*. (6), Rai *et al*. (12), and Yadav *et al*. (20) for various mango cultivars.

Among the various physico-chemical characters, high PCV along with high GCV were recorded for fruit weight and fruit volume and ranged from 41.65 to 45.98. Moderate PCV along with GCV were observed for fruit width, peel thickness, and ascorbic acid content while comparatively low GCV along with PCV were found for rest of the characters. Values of PCV were higher than GCV for all the traits but minimal differences existed between them. Genotypic coefficient of variation (GCV) was higher than their respected environmental coefficients of variation for all the characters indicating that phenotypic variability could be the reliable measures of genotypic variability. The values of GCV could be able to help in comparison and measurement of genetic variability among different traits. Rai *et al*. (12) found high range of variations for peel, pulp and stone weight. Karibasappa *et al*. (6) recorded high range of phenotypic and genetic variations for different physico-chemical characters and moderate PCV and GCV were obtained for pulp colour, acidity, peel weight, fruit length and width of mango. The coefficient of variation of traits indicated high magnitude of variability in the above mentioned hybrid progenies. Therefore, selection for these characters may be competent and greater improvement could be expected in the selection of desirable traits. However, GCV alone is not sufficient to determine the extent of heritable variation. Hence, heritability in broad sense was estimated for all the traits.

Heritability is the transmissibility of characters from parents to offspring. Estimation of heritability

Table 1. Genetic correlations between different fruit quality traits in mango.

Trait	Fruit weight	Fruit length	Fruit width	Fruit volume	Stone width	Stone length	Stone thickness	Peel thickness	Ascorbic acid	TSS	Titrable acidity	Total carotenoids	Pulp: stone ratio
Fruit weight	0.00	0.77*	0.38*	0.94*	0.32	0.61*	0.35*	0.39*	0.02	0.01	0.04	0.14*	0.65*
Fruit length			0.27	0.75*	0.28*	0.90*	0.16*	0.39*	0.12*	0.19*	-0.14*	0.05	0.65*
Fruit width				0.34	0.23*	0.27*	-0.16	0.49*	0.18	-0.22*	0.07	-0.10	0.30*
Fruit volume					0.25*	0.62*	0.36*	0.46*	0.08	0.09	0.02	0.08*	0.68*
Stone width						0.16	0.17	0.21	0.07	-0.01	0.01	0.13*	0.20*
Stone length							-0.14	0.28*	0.21*	0.07	-0.27*	-0.02	0.63*
Stone thickness								0.10	0.11*	0.05	0.20*	0.07	-0.22*
Peel thickness									0.17*	-0.03	0.05	0.19*	0.32*
Ascorbic acid										0.18*	-0.12	-0.06	0.25*
TSS											-0.34	0.23*	0.10*
Titrable acidity												0.02	-0.26*
Total carotenoids													-0.10
Pulp: stone ratio													

*Indicates significance at the $p < 0.05$.

Table 2. Environmental coefficients of variation (ECV), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), Broad-sense heritability (h^2_b) and Genetic Advance @ 5% of different fruit quality traits in mango.

Trait	Environmental coefficient of variation (ECV)	Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Broad-sense heritability (h^2b)	Genetic advance @ 5%
Fruit weight	19.48	41.65	45.98	0.82	128.51
Fruit length	9.48	14.40	17.24	0.70	22.84
Fruit width	13.10	16.79	21.29	0.62	15.83
Fruit volume	20.08	40.02	44.77	0.80	120.85
Stone width	8.80	13.92	16.47	0.71	6.84
Stone length	10.07	14.81	17.91	0.68	18.26
Stone thickness	9.90	12.65	16.06	0.62	3.95
Peel thickness	16.12	17.25	23.61	0.53	0.32
Ascorbic acid	10.53	23.03	25.32	0.83	20.04
TSS	7.41	11.02	13.28	0.69	3.77
Titrable acidity	12.20	14.30	18.80	0.58	0.05
Total carotenoids	5.09	33.73	34.11	0.97	56.77
Pulp : stone ratio	21.55	33.89	40.16	0.71	2.61

is useful to fruit breeders as they provide the basis for selection on phenotypic performance. Genetic advance is the improvement over the base population that can be potentially made from the selection for a character, while estimate of heritability is important to find out the heritable portion of variability and genetic gain that can likely to be achieved in the next generation. Therefore, heritability as well as genetic advance was computed in the present study to get a clear idea for the scope of improvement in fruit quality traits of mango.

Heritability estimates varied between traits and ranged from 0.58 to 0.97. High magnitude of broad-sense heritability was recorded in traits like, fruit weight (0.82), fruit volume (0.80), total carotenoids (0.97), ascorbic acid (0.83), stone width (0.71) and fruit length (0.70). The high heritability of above mentioned traits suggest that these traits will be amenable to change through selection as phenotypic expression being less influenced by environmental effects. High degree of broad sense heritability have also reported for fruit quality traits of mango, *viz*. fruit weight, peel weight, stone weight, stone length, fruit length by Rajan *et al*. (14). Conversely, moderate degree of heritability was noted in traits, *viz.*, titratable acidity (0.58), fruit width (0.62), stone length (0.68), stone thickness (0.62), peel thickness (0.53) and TSS (0.69), which confirm the influence of environment on these traits (Rajan *et al*., 13) and suggest that these traits will be more difficult to select or change. Heritability estimates for a trait can vary depending on the genetic variation in the population and size of the experiment (Cheng *et al.*, 2). Nevertheless, soluble solids content and titrable acidity have also been seen shown to be moderately to highly heritable in strawberry (Shaw, 19), and kiwi (Cheng *et al.*, 2).

High genetic advance was found for fruit volume and its weight. Relatively moderate genetic advance showed for ascorbic acid content, stone length and fruit width, while extremely low genetic advance was recorded for titratable acidity. The result pertaining to genetic advance clearly depicted that environmental effects might not be contributing much to the total phenotypic variation for fruit volume and its weight and could have moderate to high influence on stone length, fruit width and ascorbic acid content. Relationship of heritability and genetic advance also give an idea about the type of gene action. According to Johnson *et al.* (5), an estimated heritability associated with genetic advance is more reliable than heritability alone for prognosticating the impact of selection. High heritability accompanied with high genetic advance is mainly referred to the action of additive genes (Panse, 11). A low genetic advance implies that heritability of a particular trait in a specific environment was mainly due to non-additive gene action, whereas, if the heritability was due to additive gene effect, it would be associated with high genetic advance (Shadakshari *et al.*, 17). Bihari and Suryanarayan (1) have also reported the higher magnitude of genetic divergence for fruit weight and moderate estimates of genetic divergence for different guava genotypes. The high heritability along with genetic advance was estimated for fruit weight and fruit volume. These traits had additive gene effect and therefore, have more roles in proficient selection. Comparatively low genetic advance along with high heritability estimates was noted for ascorbic acid content. Comparatively, low genetic advance as percent of mean accompanied with high heritability estimates may be due to non-additive gene action, which associated epistasis and dominance (Rajan *et al*., 13). It was found that fruit weight and total carotenoids had high heritability associated with high GCV, which suggested that these two traits provide greater scope for further selection (Rajan *et al*., 13).

It can be concluded from the present study that estimates the genetic parameters of various fruit quality traits in mango may be useful for quality breeding programme.

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