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Genetic Variability in Mango Clones of Langra cv. for Physical-bio Chemical Parameters at Kymore Plateau and Satpura Hills of Madhya Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out to assess the genetic variability, heritability and genetic advance for different characters in 40 clones of mango. The study was conducted at Fruit Research Station (Farm), Imalia for evaluating the variability of Langra clones in Randomized block design. All the characters showed very small difference between genotypic coefficient of variation (GCV) and respective phenotypic coefficient of variation (PCV), indicated that all the characters were least affected by environment. The high phenotypic coefficient of variation and genotypic coefficient of variation were observed for pulp %, peel %, stone %, pulp : stone ratio, pulp : peel ratio, fiber %, density of lenticels, fruit weight kg, acidity %, reducing sugar % in the both years. High heritability coupled with genetic advance were observed for all characters studies indicating these characters are governed by additive gene action and phenotypic selection may be more fruitful. Hence, direct selection may be followed for the improvement of mango for these characters.

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Keywords: Divergence; heritability; genetic advance; langar; mango.

1. INTRODUCTION

“Mango is now widely spread throughout the tropics and sub tropics which comprises of 73 genera and about 830 species and its origin in the north foot hills of India-Myanmar region” [1]. “By virtue of its excellent flavor, delicious taste, attractive colour, delicious fruit quality with richness in vitamins and minerals, accessibility to common man, liking by the masses, mango has been assigned the status of the ‘king of the fruits’ in the tropical world and it is the ‘National Fruit of India’. It occupies relatively the same position in the tropics as is enjoyed by the apple in temperate America or in Europe” [2]. “It is highly heterozygous as performance varies with the climate which resulted in a high level of genetic diversity” [3-6]. “The cross pollination nature and a wide range of prevailing agro climatic conditions have contributed to its wide genetic diversity in India in mango” [7].

“Further, confusion exists in the nomenclature of mango due to different local names of the same variety. Characterization and assessment of diversity is essential to utilize these unique cultivars in crop improvement programme and also for better conservation of genetic resources, it especially benefits a fruit breeder in choosing proper parental materials” [8]. “The evaluation of morphological and agronomic characters can provide relevant information on yield and quality traits, as well as other information of great interest to breeders, such as descriptions of available variation and estimates of trait heritability” [9]. “The progress in breeding programme depends on magnitude of genetic variability present in breeding material. Selection is also effective when there is high degree of genetic variability among the individuals in a population. Therefore, the present investigation was undertaken to estimate the variability, heritability and genetic advance among different traits in mango cultivars. An understanding of the nature and magnitude of variability among the genetic stocks of a crop is of prime importance to breeding. Evaluation of genetic variability is important to know the source of gene for a particular trait within the available germplasm” [8]. “A good knowledge of genetic wealth might also help in identifying desirable cultivars for commercial cultivation. High heritability generally enables to breeder to select plants on the basis of phenotypic expression” (Johnson et al. 1955).

2. MATERIALS AND METHODS

“The experiment was carried out during 2018-2019 and 2019-2020 at Fruit Research Farm, Imalia, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) Which is situated at 22°49' and 20°80' North latitude and 78°21' and 80°58' East longitude at an attitude of 411.78 meter above the mean sea level. The average rainfall ranges from 1350 mm, winter rains are also received usually. The soil of experimental site was clayey in texture 58.4% clay, 22.5% silt and 20.1% sand by using International pipette method having pH 7.2 by pH meter” [10], medium available N 302 kg ha-1 by Alkaline permanganate method [11] high in P 22.6 kg ha-1 by Colorimeteric method , K 430.7 kg ha-1 by Flame photometer method [12] with medium organic carbon (0.70%) by Walkey and Black method [13]. Healthy and vigorous forty superior clones from 50 year old plantation of Langra were selected for the collection of data and the data was analyzed in Randomized Block Design and Opstat software. The distance from plant to plant was 10 m and row to row was 10. Data were recorded on determine the fruit length (cm), fruit width (cm), fruit volume (cc), fruit weight (g), Density of lenticels (cm^2), Diameter of stalk attachment (cm), pulp (%), peel (%), stone (%), pulp : stone ratio, pulp : peel ratio, fiber (%), stone length (cm), stone width (cm), TSS, acidity (%), total sugar (%), reducing sugar (%), non-reducing sugar (%), ascorbic acid (mg/100g) were recorded. Peel and stone of each clone were carefully removed and cleaned with distilled water. TSS was recorded with refracto-meter. Acidity was determined by using standard titration method [14]. Ascorbic acid content of the juice was determined by titrating freshly extracted juice against 2, 6 Dichlorophenol indophenols dye Association of official Analytical Chemists. Total sugars and reducing sugar was estimated as described by Ranganna, [14]. Quantitative measurement of TSS, acidity, ascorbic acid, total sugar, reducing sugar, non-reducing sugar was analyzed when fruit were naturally ripened. Genotypic and phenotypic coefficient of variation was calculated according to Burton [15]. Heritability in broad sense (h^2b) and genetic advance in percent of mean (GA %) were estimated as proposed by Allard 1960 and Johnson et al. (1955).

3. RESULTS AND DISCUSSION

3.1 Physical Characters

Result data showed variation for average fruit length, fruit width, fruit weight and fruit volume which ranged between 7.37cm to 9.45cm, 5.16cm to 6.45cm, 112.69 g to 256.35 g and 82.23 cc to 173.18 cc. The variation in fruit size, weight in different mango cultivars was also observed [16-19]. Similarly, Anu et al. [20] was studied and found to be these results in DholiKothi Maldah. The variation in length (6.86-11.50cm) and width (5.37-10.96cm) of fruit in mango was also observed by Kher and Sharma [21]. The similar trend in the variation of fruit weight from 219- 365.33g has also been reported by Majumder et al. [22] while evaluating different mango cultivars. “Thus it is clear that fruit weight is a varietal character which is influenced by environment also. These might be the result of alterations in absorption and translocation pattern of photosynthates, genetic composition and environmental factors. The growth of fruit in the later stage was due to osmotic accumulation of food substances and water” [23].

The variation of fiber content range from 0.98 % to 4.23 % Dendity of lentcels 8.37 to 25.35 per cm^2 area and diameter of stalk attachment 4.22 to 6.06 cm. The fibre content and lenticels density and Diameter of stalk attachment in present study, indicated striking variation. In line with these results, [24] also studied the differences in cultivars for lenticels density on mango fruit surface. “Lenticels are macro-pores on the mango fruit surface which play an important role in gaseous exchange. This indicated the potential of cultivars for table as well as processing purpose if future studied. Cultivars with absent or less fibers are more preferable to the consumers” [25].

The average pulp per cent ranged between 35.87 % to 109.53 %, peel 5.78 % to 17.57 %, and stone 7.36% to 17.67 % indicating string variation found in. Kumar [26] studied 101 mango cultivars at sabour (Bihar) and observed a range of pulp % (56.70% in Safeda Malihabadi to 85.00% in Putu). The difference in pulp % observed from place to place which might be due to environmental and seasonal variation [17]. The pulp % is an important criteria for the evaluation of cultivars in a particular area because this is the part of fruit, which in finally utilized by the people. The present finding related to peel weight are also in accordance with results of Anila and Radha [27] mwho observed the highest peel weight (51.74 g) in Ratna. The present finding related to stone weight are also in accordance with the results of Jilani et al. [28] who observed that stone weight range from (22.99 g to 47.07 g in four varieties and two hybrids viz., Alphonso, Prior, Muvandan, Neelum and hybrid Ratna and H-151. Similarly, variation in stone % among the different mango varieties has also been reported previously [29] Stone size is an important character of mango as it determines the edible portion in fruit. In the results average stone width 2.77cm to 3.42cm and stone length 5.59cm to 7.64 cm. These Significant variation in stone length and width of different mango cultivars was also reported by Abiramiet al. [30]. There was significant variation pulp:peel ratio varied from 2.67 to 8.57 and pulp:stone ratio 2.81 to 7.93. These results were in congruence with the results of Tiwary et al., [31,32]. Thus, it may be attributed that wide variability in the fruit composition noted above arising evidently from the heterozygosity.

3.2 Bio- Chemical

Two essential chemical parameters; TSS and acidity were recorded in support of quality of mango fruits. Average Total soluble solid 16 to 23.96 $brix^0$ and acidity per cent ranged between 0.22 % to 0.52 %. Ghosh et al. [33] recorded more or less similar TSS value (10.4-21.6 ^{0}Brix) in the mango fruit. The values of titerable acidity are in accordance with the results of Kumar [26]. Who reported the range of 0.17 to 0.33 % in different mango cultivars. It was generally considered that greater than 14 °Brix of TSS indicates the good quality of mangoes. Ueda et al. [34] reported that TSS and acidity content are related to the maturity of the fruit. It is dependent on prevailing environmental conditions. The variation in the acidity in different varieties of mango could be due to their varietal characters. Average range of total sugar 15.27% to 22.69%, reducing sugar 3.46% to 6.82% and non-reducing sugar 11.38% to 16.54%.%. Kher and Sharma [21] and Hoda et al. [35] also reported the similar trend of variation i.e. 39.36 to 152.39 in sugar percentage in different mango cultivars.

The average ascorbic acid contents between 80.10 to 86.79 mg/100 g. Mitra et al. [36] observed the ascorbic acid content in range of 21.66 mg/100g - 125.40 mg/100g. Such variation in ascorbic acid content could be attributed to the nature and extent of genetic variability present in the experimental material.

Table 1. Estimation of genetic parameter for different physical characters of langra clones of mango

Characters	Range	Mean ±Sem	Coefficient of variation		Heritability (H^2b) (%)	Genetic advance (% over mean)
			Genotypic (%)	Phenotypic (%)		
Fruit length (cm)	7.37-9.45	8.29±0.06	6.13	6.21	97.60	12.49
Fruit width (cm)	5.16-6.45	5.80±0.05	5.09	5.21	95.18	10.29
Fruit volume	82.23-173.18	115.89±0.84	18.25	18.04	99.75	37.08
Fruit weight (g)	112.69-256.35	156.40±0.25	19.90	19.90	99.99	41.06
Density of lenticels (cm^2)	8.37-25.35	13.56±0.10	20.75	20.77	99.79	42.71
Diameter of stalk attachment (cm)	4.22-6.06	5.26±0.06	6.96	7.10	95.92	14.04
Pulp (%)	35.87-109.53	60.69±0.09	25.41	25.42	99.99	52.36
Peel (%)	5.78-17.57	11.04±0.06	25.86	25.87	99.92	53.25
Stone (%)	7.36-17.67	12.39±0.32	24.21	24.41	98.32	49.45
Pulp: stone ratio	2.81-7.93	5.00±0.12	21.30	21.52	98.00	43.45
Pulp: peel ratio	2.67-8.57	5.50±0.10	27.87	27.97	99.32	57.22
Fiber (%)	0.98-4.23	2.64±0.17	33.00	33.95	94.45	66.07
Stone length (cm)	5.59-7.64	6.63±0.08	8.57	8.71	96.67	17.35
Stone width (cm)	2.77-3.42	3.10±0.03	4.69	4.87	92.73	9.13

Table 2. Estimation of genetic parameter for different bio-chemical characters of langra clones of mango

Characters	Range	Mean ±SE	Coefficient of variation		Heritability (h^2) (%)	Genetic advance (% over mean)
			Genotypic (%)	Phenotypic (%)		
Total soluble solids (TSS) $Brix^0$	16-23.96	20.08±0.14	9.76	9.80	99.20	20.03
Acidity (%)	0.22-0.52	0.34±0.02	27.38	28.51	92.17	54.15
Total sugars (%)	15.27-22.69	19.75±0.11	7.21	7.26	98.75	14.77
Reducing sugar (%)	3.46-6.82	5.08±0.12	15.25	15.56	96.05	30.79
Non- reducing sugar (%)	11.38-16.54	14.67±0.19	7.52	7.70	95.34	15.13
Ascorbic acid (mg/100 g)	80.10-86.79	82.82±0.16	2.24	2.26	98.80	4.60

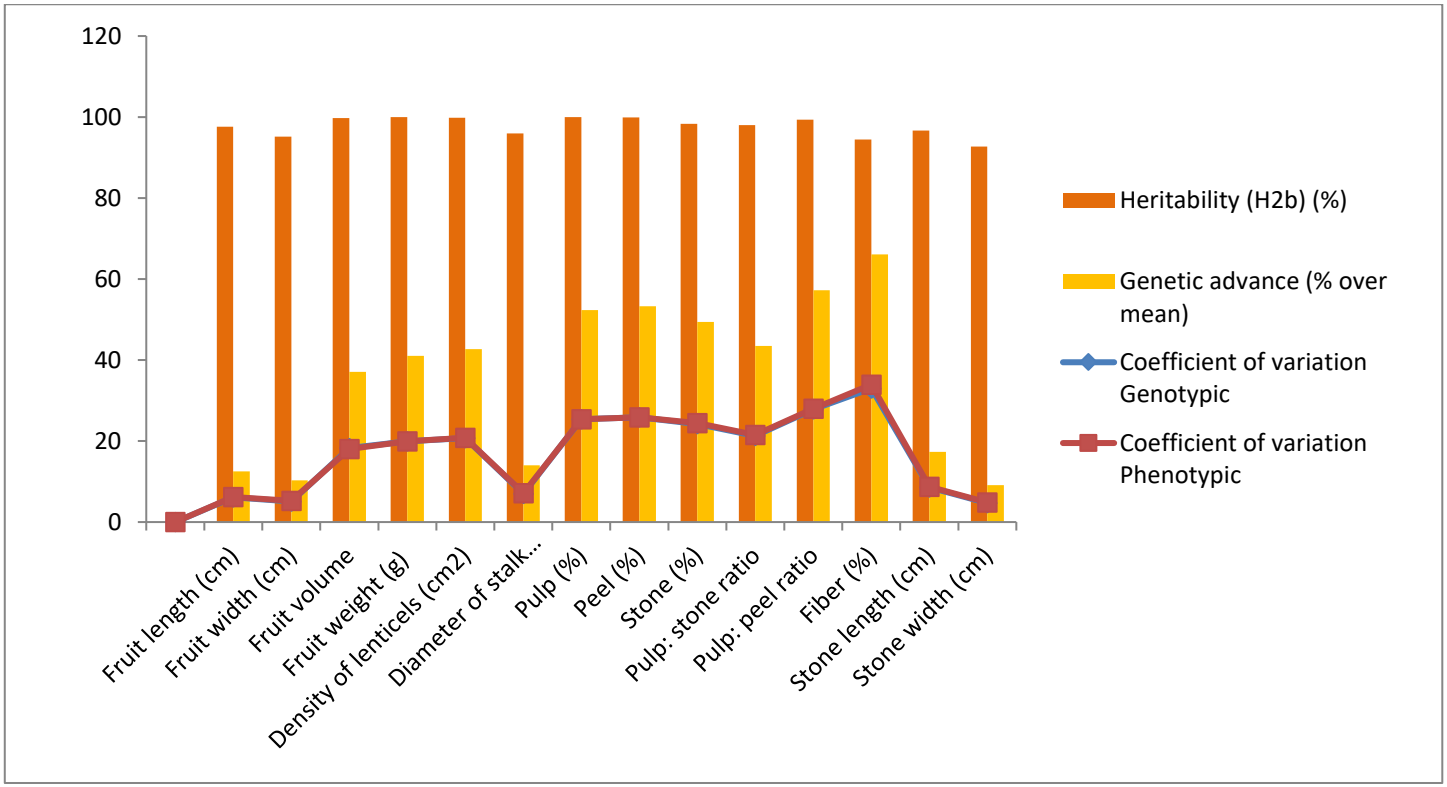

Fig. 1. Eestimates of genetic variability, heritability and expected genetic diversity in clones of langra mango for physiological characters

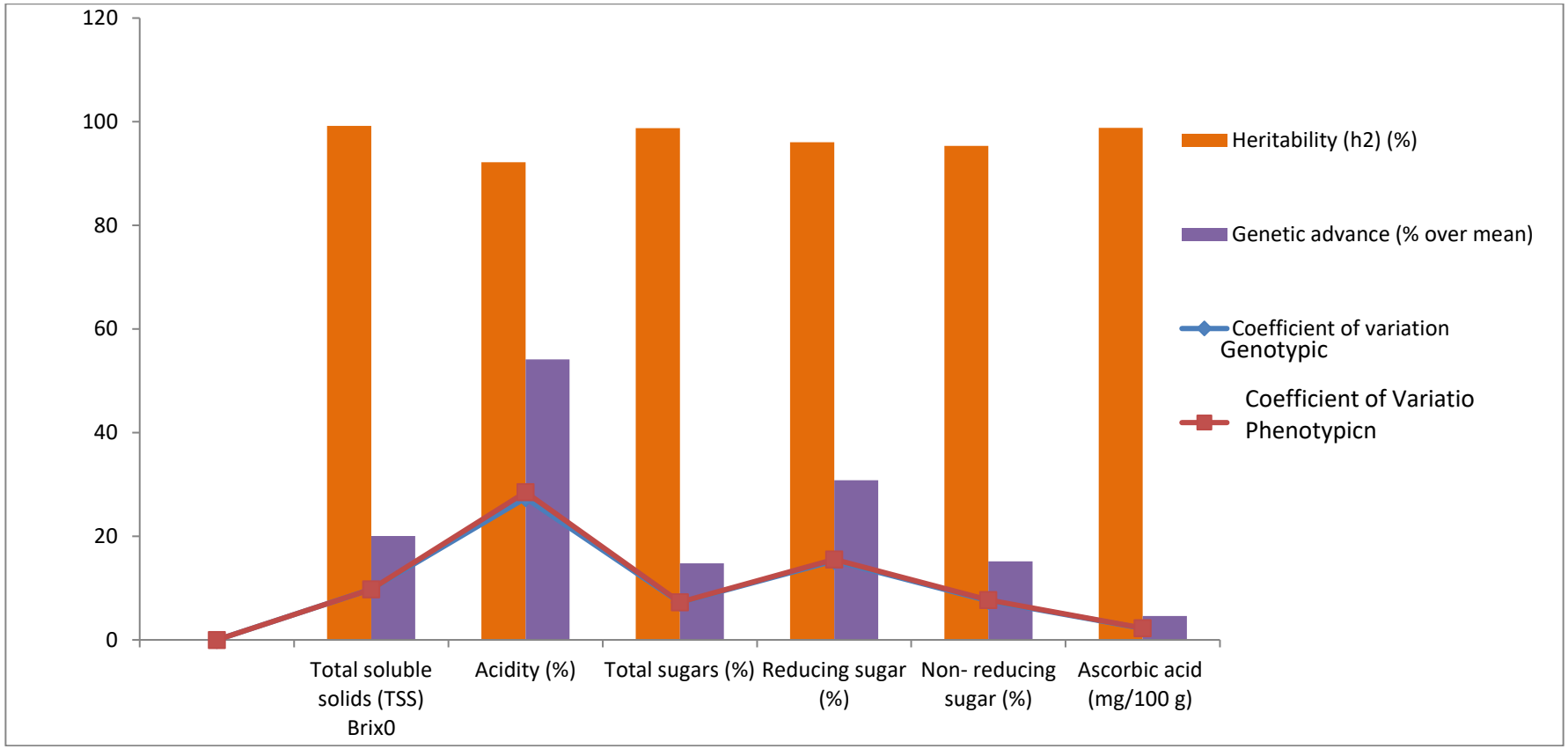

Fig. 2. Estimation of genetic variability, heritability and expected genetic advance in clones of langra mango for bio-chemical characters

3.3 Genetic Variability

High genotypic and phenotypic coefficient of variation was recorded for pulp %, peel %, stone %, pulp:stone ratio, pulp:peel ratio, fiber %, density of lenticels, fruit weight, acidity %, reducing sugar. High genotypic and phenotypic coefficient of variation for fruit weight, pulp weight, peel weight, stone weight, stone %, pulp stone ratio, total soluble solids, acidity %, reducing sugar and non-reducing sugar observed in mango by Patel et al. [37]. Similarly, Himabindu et al. [38] and Rajan et al. [39] observed High genotypic and phenotypic coefficient of variation for fruit length, fruit width, fruit weight, peel %, pulp:stone ratio, pulp:peel ratio, stone percent, stone length and stone width.similar observation were recorded by Sridhar et al. [40] for fruit length, fruit width, fruit weight, pulp % and fruit yield. Phenotypic coefficient of variation (PCV) was greater than the corresponding genotypic coefficient of variation (GCV) for all the characters indicated the importance of environment in expression of characters.

3.4 Heritability

In the results High heritability was estimated for all the characters studied which ranged from 89.65% to 99.98%. Further, similar results obtained by Simi [41], Rajan et al. [39] Rathod [42], Patel et al. [37] Himabindu et al. [38], Galal et al. [43] Sridhar et al. [40] Majumder et al. [44] except fruit drop percent. Ranpise and Desai [45] observed high values of heritability for fruits per plant, average fruit weight, juice per cent, TSS and acidity. “This indicates that either these were simply inherited characters governed by a few major genes or additive gene effects even if, they were under polygenic control and therefore, selection of these characters would be more effective for improvement” [46,47]. Moderate to low estimate the broad sense heritability indicating that improvement through selection would be limited.

3.5 Heritability and Genetic Advance

According to Johnson et al. [46] an “estimated heritability associated with genetic advance is more reliable than heritability alone for prognosticating the impact of selection”. In present investigation, high genetic advance as percent of mean were observed for fruit weight, density of lenticels, pulp %, Peel %, Stone %, pulp: stone ratio, pulp:peel ratio and fiber % among the characters, TSS, acidity and Reducing sugar characters were recorded highest comparing to all characters. It also revealed high degree of variation among the cultivars. Patel et al. [37] also observed for fruit yield, fruit length, fruit width, fruit volume, fruit weight, stone %, pulp stone ratio, TSS, acidity, reducing sugar, non-reducing sugar. High heritability coupled with high genetic advance was observed for fruit weight and fruit volume with finding of Nayak et al. [48-49].

4. CONCLUSION

The present study, it can be concluded that the significant variation exist within the genotypes based on physico-chemical characters. All of the characters showed high heritability estimates and high genetic progress, which suggested additive gene action and suggested that selection based on these characters would be more trustworthy. Characters with high genetic advancement and high heritability suggested that selection might have occurred in previous generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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