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Character association and path analysis for fruit chromatic, physicochemical and yield attributes in mango (*Mangifera indica*)

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ABSTRACT

The present investigation was conducted during the year of 2014 and 2015 to determine the genotypic and phenotypic correlation along with their direct and indirect effects through path coefficients analysis and to estimate the contribution of most important traits towards fruit quality and yield in mango. The genotypic correlation values were recorded higher than their corresponding phenotypic value in 60 diverse mango genotypes grown at ICAR-IARI, New Delhi. The result suggests that there were strong inherent relationship between the traits. The a* (r^2 = 0.179, 0.178), fruit weight (r^2 = 0.236, 0.234), fruit length (r^2 = 0.371, 0.370), fruit diameter (r^2 = 0.393. 0.391), fruit width (0.366, 0.361), titrable acidity (r^2 = 0.273, 0.272), stone weight (0.329, 0.328), stone length (r^2 = 0.351, 0.347), stone diameter (r^2= 0.249, 0.248), stone width (r^2 = 0.278, 0.272) and peel weight (r^2 = 0.370, 0.365) showed positive association with yield both at genotypic and phenotypic levels, respectively. At genotypic level, the highest positive direct effect was exhibited *via* fruit weight (5.74) followed by b* (1.006), peel % (0.685), stone length (0.292), fruit diameter (0.259), titrable acidity (0.159), pulp: stone (0.143), fruit shape index and ascorbic acid (0.067), stone diameter and stone width (0.053) on yield. The residual effects of genetic and phenotypic path analysis were 0.24 and 0.32 on fruit yield was not much higher side and revealed higher genetic variability, supports lower degree of environmental influence on the selected traits. In combination with correlation coefficient and path analysis, it was found that fruit weight, fruit diameter, stone length, stone diameter and titrable acidity exhibited significant positive correlation coefficients with yield and also induced the high positive direct effect. Thus, results affirmed that fruit weight, fruit diameter, stone length, stone diameter and titrable acidity are the major components of fruit yield and to be considered in mango improvement programme.

Key words: Character association, Chromatic, *Mangifera indica*, Mango, Path coefficients, Yield

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae and comprises 69 species of genus *Mangifera*, which are distributed throughout the world (Kostermans and Bompard 1993). In mango, most of the existing varieties are chance seedling selections made from naturally occurring open-pollinated population (Dinesh *et al*. 2015) except some hybrids, which were results of human interventions. A wide variability in fruit shape, size, peel colour, time of maturity, stone size, pulp content and its quality attributes have been observed in the naturally growing population of seedling mangoes (Singh *et al*. 2012). In spite of sustained research efforts for increasing the production and productivity over the past four decades, the productivity of mango orchards in India is still low as 7.2 tonnes/ha. Further, a large proportion of fruit produced, the fruit quality rarely meets the requirements of consumers as well as export standards (Singh and Kumari 2011). To overcome the problems of poor fruit quality and productivity, adequate knowledge of association between fruit quality, yield and their contributing traits are of importance. The yield is a complex character, which is highly influenced by environment, therefore selection based on yield alone may limit the breeding progress, whereas yield component characters are less complex in inheritance and influenced by the environment to a lesser extent. Thus, effective improvement in yield may be brought through selection of various yield component characters, which show association among themselves and also with yield. In addition, the fruit quality is major determinant of cash value and also colour is a primary component of quality (Francis 1995). The changes in fruit peel and pulp colour during maturation seems useful index of fruit maturity and determinant factor for optimal harvesting time (Malevski *et al*. 1977). Mango fruits ripen unevenly on the tree and fruits are picked by hand

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at an average maturity leads to poor quality upon ripening. Understanding the extent of mango peel colour variability is an important step towards improving fruit quality. Therefore, fruit breeder has to find simple correlation and the extent of direct and indirect effects of different attributes with fruit quality and yield that could be useful to predict superior cross combinations and to identify traits for ideal plant type, thus aid in indirect selection. The correlation in combination with path coefficient analysis quantifies the direct and indirect contributions of one trait upon another (Dewey and Lu 1959), which is a better appreciation of cause and effect relationship between pairs of character. Therefore, the study was undertaken with the objective to determine the genotypic and phenotypic correlations along with their direct and indirect effects through path coefficient analysis in mango to determine the contribution of most important characters towards fruit quality and yield which ultimate helps in selection of superior cross combinations in mango genotypes.

MATERIALS AND METHODS

This study was carried out during the year 2014 and 2015 at experimental farm of mango germplasm block of ICAR-Indian Agricultural Research Institute, New Delhi, India. A total of 60 diverse set of genotypes of average 15-year-old tress were selected under this study (Table 1). These mango genotypes include (recently bred hybrids, cultivars and land races) and were collected from different regions of India and are maintained in field gene banks. The experiment was conducted under randomized block design with three replications and the mean data of study periods were analyzed as per the method suggested by Gomez and Gomez (1984). For determining different physicochemical parameters, 10 uniform sized fruits were collected randomly at maturity stage and then brought to the laboratory. After proper ripening, the 25 different chromatic, physical and biochemical parameters were recorded gradually. The peel colour of each genotype at ripening was been measured using calibrated Hunter Lab UltraScan PRO colorimeter attached with Easy Match QC software and expressed as L* (lightness; 0 = black, 100 = white), a* (−a = greenness, +a = redness), and b* (−b = blueness, +b = yellowness) values. Based on L*, a*, b* data the Hue and chroma value was calculated. Fruit shape was determined by calculating fruit shape index as the ratio of fruit length and diameter, whereas fruit weight was measured using electronic balance (Sartorius) with accuracy of 0.001 g. The digital Vernier calipers were used to measure fruit length and diameter. The measurement of fruit length was made on the polar axis, i.e. between the apex and stylar end. The stone were manually separated from the ripe fruits and skin weight, skin thickness and skin% was calculated. The stone related traits (stone weight, stone length, stone diameter, pulp: stone, pulp% and stone %) were also measured as above. Total soluble solids (TSS), titrable acidity and ascorbic acid were determined by method given in AOAC (1994). The yield per plant has been recorded over the study period and alternate bearing index has been calculated as suggested by (Monselise and Goldschmidt 1982). Estimation of genotypic and phenotypic correlation coefficient was estimated according to Johnson *et al*. (1955). Estimation of path coefficient using genotypic and phenotypic correlation values, path coefficient analysis was done following the procedure of Dewey and Lu (1959).

RESULTS AND DISCUSSION

For genetic improvement of any fruit crop knowledge of association of important fruit quality and yield attributing traits are prerequisite. Therefore, the genotypic and phenotypic correlation coefficients were analyzed and presented in Table 2 and 3. It appears that in most of the cases, the genotypic correlation values were higher than their corresponding phenotypic values. This opined that there was strong inherent relationship between the traits. This finding was in accordance with that of Bejo and Kamruddin (2014) and Gill and Singh (2015) on mango. Among the studied chromatic traits, b* value, which represents yellowness was found positively and significantly correlated with L* (lightness, 0.615, 0.607) and a* (redness, 0.481, 0.479) at both genotypic and phenotypic levels. This association is important from consumer point of view; mango fruits having red blush on yellow peel are most preferred. Likewise, chroma was found positively and significantly associated with L* (0.575, 0.565), a* (0.608, 0.605), b* (0.986, 0.978) at both the levels. The hue value was found positively and significantly correlated with L* (0.322, 0.306) and b* (0.264, 0.250) value but negatively and significantly correlated with a* value (-0.572, -0.551). Except a*, all the colour value showed negative association with yield. The positive associated value of chromaticity parameter a*, which indicates the high blush colour affecting the cosmetic appearance. Mango fruits having sufficient red blush on peel are preferred in the international trade (Sethi *et al*. 2011). The Hue had a negative linear relationship with TSS, while the other colour components had positive but non-significant linear relationships at both level and this results were in line with the findings of (Bejo and Kamruddin 2014) in mango. In present study, the results revealed that yield was positively and significantly correlated with a*, fruit weight, fruit diameter, fruit width, stone weight, titratable acidity, stone length, stone width, stone diameter, stone width, peel weight and pulp: stone ratio, both at genotypic and phenotypic levels, but it was positive and not significantly correlated in case of traits like pulp weight, peel per cent and pulp stone ratios. Genotypic and phenotypic correlation coefficients revealed that fruit length had significant and positive correlation (0.476, 0.466) with fruit weight. The fruit diameter also revealed positive and significant association with fruit weight (0.630, 0.626) and 4) and fruit width (0.768, 0.761) however negative and significant association with fruit length (-0.327, -0.32) at both genotypic and phenotypic levels respectively. Chadha *et al*. (1993), Nayak *et al.* (2013) and Pareek and Dhaka (2003) also reported similar findings in mango and *ber*, respectively. The fruit shape index showed positive significant correlation with a*,

Table 1 List of mango genotypes studied for correlation and path analysis

Genotype	Origin	Genotype	Origin
Alphan	Saharanpur, Uttar Pradesh	Mallika	IARI, New Delhi
Alphanso	Rantnagiri, Maharashtra	Mombasa	Saharanpur, Uttar Pradesh
Ametista	Brazil	Neelum	Krishnagiri, Tamilnadu
Amnesia Hyderabad	Sangareddy, Telangana	Nissar Pasand	Malihabad, Uttar Pradesh
Amrapali	IARI, New Delhi	Olour	Thrissur, Kerala
Bhadauran	Saharanpur, Uttar Pradesh	Primor-de Amoreira	Brazil
Bombay Green	Kirkee, Maharashtra	Pusa Arunima	IARI, New Delhi
Chausa	Lucknow, Uttar Pradesh	Pusa Lalima	IARI, New Delhi
Dushehari Sabour	Sabour , Bihar	Pusa Peetamber	IARI, New Delhi
Dushehari	Malihabad, Uttar Pradesh	Pusa Pratibha	IARI, New Delhi
Edward	Miami, Florida, USA	Pusa Shresth	IARI, New Delhi
Elard	Miami, Florida, USA	Pusa Surya	Miami, Florida
Extreema	Brazil	Ramkela	Saharanpur, Uttar Pradesh
Ferandin	Panji, Goa	Ratna	Rantnagiri, Maharashtra
Gulab Jamun	Saharanpur, Uttar Pradesh	Rataul	Saharanpur, Uttar Pradesh
Gulab Khas	Sabour, Bihar	Rosari	Brasilia, Brazil
Hardil Aziz	Saharanpur, Uttar Pradesh	S.B.Alibagh	Saharanpur, Uttar Pradesh
Husnara	Sabour, Bihar	Safdar Pasand	Saharanpur, Uttar Pradesh
Hybrid165	Delhi	SaintAlexandrina	Brasilia, Brazil
Irwin	Miami, Florida	Sensation	Miami, Florida, USA
Iturba	Brazil	Smith	Miami, Florida, USA
Janardan Pasand	Kadiam, East Godavari, Andhra Pradesh	Sonatol	Muzaffarnagar, Uttar Pradesh
Kala	Saharanpur, Uttar Pradesh	Tephala	Lucknow , Uttar Pradesh
Kaleped	Sangareddy, Telangana	Tommy Atkins	Miami, Florida, USA
Khasulkhas	Saharanpur, Uttar Pradesh	Totapari Red Small	Krishnagiri, Tamil Nadu
Kurrakan	Thrissur, Kerala	Vanraj	Paria, Gujarat
Langra	Lucknow, Uttar Pradesh	Willard	Miami, Florida, USA
Lucknow Safeda	Lucknow, Uttar Pradesh	Xavier	Panji, Goa
Machlli	Lucknow, Uttar Pradesh	Zardalu	Murshidabad, West Bengal
MahmoodVikarabad	Lucknow, Uttar Pradesh	Zill	Miami, Florida, USA

Hue value, chroma, TSS and fruit length, whereas negative significant with fruit diameter. Negative and insignificant correlation was also observed for fruit shape index with fruit weight and width at both levels. The titrable acidity exhibited non-significant negative or positive relationship with all the traits except fruit weight. In case of sugar: acid ratio, highly positive significant correlation (r^2 = 0.389, 0.385) was observed with TSS, however negative significantly with titrable acidity (-0.216) both the levels, respectively. The ascorbic acid content had positive significant correlation with a* (0.170, 0.166), fruit length (0.298, 0.276), fruit width (0.172. 0.170), fruit shape index (0.189, 0.186), titrable acidity (0.156, 0.152) and sugar: acid ratio (0.211, 0.209) (Table 2). Stone weight, stone diameter, stone length, stone width and skin weight had positive association with a*, fruit weight, fruit diameter, fruit length and fruit width at both levels. Skin thickness showed positive relation with fruit weight, fruit diameter, fruit width in addition to that pulp and pulp: stone ration also showed positives correlation with fruit weight, fruit diameter and fruit width at both genotypic and phenotypic levels. The stone and peel per cent had negatively significant association with fruit weight, and diameter, respectively, however, pulp% showed positive significant correlation at both the levels. The genotypic and

Table 2 Phenotypic correlation coefficients for 27 fruit chromatic, physicochemical and yield attributes of 60 mango genotypes

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	1																										
2	0.130NS	1																									
3	0.607**	0.479**	1																								
4	0.565**	0.605**	0.978**	1																							
5	0.306**	-0.551**	0.250**	0.078NS	1																						
6	0.148*	0.112NS	0.015NS	0.038NS	-0.127NS	1																					
7	-0.030NS	0.285**	0.003NS	0.061NS	-0.306**	0.466**	1																				
8	0.131NS	0.030NS	-0.103NS	-0.090NS	-0.074NS	0.626**	-0.324**	1																			
9	0.153*	0.275**	0.057NS	0.109NS	-0.266**	0.659**	0.587**	0.761**	1																		
10	-0.084NS	0.284**	0.132NS	0.177*	-0.233**	-0.021NS	0.669**	-0.450**	-0.017NS	1																	
11	0.056NS	0.070NS	0.038NS	0.040NS	-0.006NS	0.067NS	0.067NS	-0.207**	-0.187*	0.246**	1																
12	-0.006NS	0.099NS	0.042NS	0.059NS	-0.074NS	0.182*	0.186*	0.136NS	0.084NS	0.040NS	0.063NS	1															
13	-0.003NS	0.025NS	0.062NS	0.032NS	0.163*	-0.147*	-0.173*	-0.189*	-0.151*	0.024NS	0.385**	-0.216**	1														
14	0.166*	0.035NS	-0.050NS	-0.024NS	-0.146NS	0.087NS	0.276**	0.085NS	0.170*	0.186*	-0.123NS	0.152**	0.209**	1													
15	-0.038NS	0.272**	-0.037NS	0.019NS	-0.309**	0.499**	0.514**	0.312**	0.442**	0.223**	-0.056NS	0.119NS	-0.228**	0.124NS	1												
16	0.072NS	0.297**	0.060NS	0.118NS	-0.314**	0.395**	0.637**	0.279**	0.445**	0.359**	0.022NS	0.160*	-0.231**	0.156*	0.576**	1											
17	0.187*	0.366**	0.141NS	0.196**	-0.268**	0.482**	0.445**	0.442**	0.582**	0.128NS	0.064NS	0.031NS	-0.039NS	0.088NS	0.420**	0.570**	1										
18	-0.065NS	0.204**	-0.007NS	0.027NS	-0.170*	0.161*	0.162**	0.245**	0.161*	-0.144NS	-0.149*	0.160*	-0.201**	0.077NS	0.277**	0.145NS	0.116NS	1									
19	0.104NS	0.446**	0.200**	0.270**	-0.337**	0.562**	0.560**	0.448**	0.600**	0.172*	-0.011NS	0.107NS	-0.256**	0.252**	0.630**	0.604**	0.522**	0.439**	1								
20	0.225**	-0.106NS	0.113NS	0.098NS	0.091NS	0.161*	-0.047NS	0.245**	0.273**	-0.215**	-0.140NS	-0.015NS	-0.117NS	0.116NS	0.086NS	-0.033NS	0.115NS	0.096NS	0.163*	1							
21	0.155*	-0.024NS	-0.021NS	-0.020NS	-0.018NS	0.944**	0.299**	0.525**	0.499**	-0.089NS	0.122NS	0.165*	-0.063NS	-0.004NS	0.265**	0.223**	0.351**	0.049NS	0.306**	0.112NS	1						
22	-0.120NS	0.033NS	-0.154*	-0.143NS	-0.063NS	-0.652**	-0.113NS	-0.339**	-0.314**	0.125NS	-0.075NS	-0.080NS	0.058NS	0.008NS	0.168*	0.001NS	-0.165*	0.077NS	-0.187*	-0.214**	-0.719**	1					
23	0.021NS	0.262**	0.134NS	0.170*	-0.143NS	-0.529**	-0.070NS	-0.197**	-0.123NS	0.051NS	-0.062NS	-0.072NS	-0.034NS	0.083NS	-0.015NS	0.039NS	-0.075NS	0.341**	0.310**	0.063NS	-0.681**	0.576**	1				
24	0.053NS	-0.172*	0.003NS	-0.024NS	0.118NS	0.661**	0.102NS	0.297**	0.239**	-0.096NS	0.076NS	0.085NS	-0.011NS	-0.054NS	-0.081NS	-0.025NS	0.132NS	-0.242**	-0.084NS	0.075NS	0.786**	-0.872**	-0.897**	1			
25	-0.041NS	-0.120NS	-0.062NS	-0.067NS	0.011NS	0.478**	0.001NS	0.428**	0.287**	-0.310**	-0.037NS	-0.120NS	-0.054NS	0.140NS	-0.078NS	0.035NS	0.204**	0.183*	0.163*	0.288**	0.517**	-0.535**	-0.327**	0.478**	1		
26	0.029NS	-0.278**	0.083NS	0.058NS	0.116NS	-0.209**	-0.186*	-0.388**	-0.416**	0.154*	0.154*	-0.108NS	-0.003NS	0.107NS	-0.193**	-0.194**	-0.301**	-0.289**	-0.331**	-0.047NS	-0.105NS	-0.070NS	-0.208**	0.161*	-0.141NS	1	
27	-0.183*	0.178*	-0.220**	-0.158*	-0.318**	0.234**	0.370**	0.391**	0.361**	-0.017NS	-0.106NS	0.272**	-0.259**	0.138NS	0.328**	0.347**	0.248**	0.276**	0.365**	-0.024NS	0.084NS	-0.021NS	0.125NS	-0.063NS	0.160*	-0.366**	1

* Significant at 5% level of probability, ** Significant at 1% level of probability. 1 = L*, 2 = a*, 3 = b*, 4 = chroma, 5 = hue value, 6 = Fruit weight (g), 7 = fruit length (mm), 8 = fruit diameter (mm), 9 = fruit width (mm), 10 = fruit shape index, 11 = TSS (^{O}B), 12 = titrable acidity (%), 13 = TSS: acid, 14 = ascorbic acid (mg/100 g pulp), 15 = stone weight (g), 16 = stone length (mm), 17 = stone diameter (mm), 18 = stone width (mm), 19 = skin weight (g), 20 = skin thickness (mm), 21 = pulp weight (g), 22 = stone %, 23 = skin %, 24 = pulp%, 25 = pulp:stone, 26 = alternate bearing index (ABI), 27 = fruit yield (kg).

Table 3 Genotypic correlation coefficients for 27 fruit chromatic, physicochemical and yield attributes of 60 mango genotypes

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	1																										
2	0.132NS	1																									
3	0.615**	0.481**	1																								
4	0.575**	0.608**	0.986**	1																							
5	0.322**	-0.572**	0.264**	0.081NS	1																						
6	0.150*	0.112NS	0.015NS	0.038NS	-0.132NS	1																					
7	0.145NS	-0.055NS	-0.080NS	-0.072NS	-0.052NS	0.476*	1																				
8	0.136NS	0.030NS	-0.105NS	-0.091NS	-0.078NS	0.630**	-0.327**	1																			
9	0.158*	0.277**	0.057NS	0.109NS	-0.281**	0.664**	0.231**	0.768**	1																		
10	-0.085NS	0.286**	0.133NS	0.178*	-0.246**	-0.021NS	0.689**	-0.454**	-0.017NS	1																	
11	0.055NS	0.071NS	0.040NS	0.041NS	-0.013NS	0.067NS	-0.152*	-0.208**	-0.189*	0.247**	1																
12	-0.006NS	0.099NS	0.042NS	0.059NS	-0.076NS	0.182*	0.077NS	0.137NS	0.085NS	0.040NS	0.064NS	1															
13	-0.002NS	0.025NS	0.062NS	0.033NS	0.170*	-0.148*	-0.264**	-0.191*	-0.153*	0.023NS	0.389**	-0.216**	1														
14	0.170*	0.035NS	-0.051NS	-0.024NS	-0.150*	0.088NS	0.298**	0.086NS	0.172*	0.189*	-0.123NS	0.156**	0.211**	1													
15	-0.040NS	0.273**	-0.037NS	0.019NS	-0.324**	0.501**	0.181*	0.315**	0.445**	0.226**	-0.055NS	0.120NS	-0.229**	0.125NS	1												
16	0.074NS	0.299**	0.057NS	0.116NS	-0.325**	0.399**	0.295**	0.283**	0.448**	0.362**	0.021NS	0.161*	-0.234**	0.157*	0.581**	1											
17	0.190*	0.368**	0.141NS	0.198**	-0.281**	0.485**	0.244**	0.447**	0.587**	0.129NS	0.068NS	0.031NS	-0.040NS	0.090NS	0.422**	0.577**	1										
18	-0.065NS	0.204**	-0.007NS	0.027NS	-0.175*	0.162*	0.344**	0.246**	0.162*	-0.146NS	-0.150*	0.161*	-0.202**	0.077NS	0.280**	0.145NS	0.117NS	1									
19	0.106NS	0.447**	0.202**	0.272**	-0.352**	0.564**	0.322**	0.451**	0.604**	0.173*	-0.014NS	0.107NS	-0.257**	0.253**	0.633**	0.609**	0.526**	0.442**	1								
20	0.229**	-0.106NS	0.115NS	0.100NS	0.092NS	0.162*	0.127NS	0.248**	0.274**	-0.217**	-0.142NS	-0.014NS	-0.118NS	0.120NS	0.086NS	-0.034NS	0.118NS	0.096NS	0.164*	1							
21	0.158*	-0.024NS	-0.021NS	-0.020NS	-0.017NS	0.946**	0.105NS	0.529**	0.501**	-0.090NS	0.122NS	0.165*	-0.063NS	-0.003NS	0.265**	0.225**	0.353**	0.049NS	0.306**	0.113NS	1						
22	-0.122NS	0.033NS	-0.154*	-0.143NS	-0.065NS	-0.655**	0.007NS	-0.343**	-0.316**	0.125NS	-0.076NS	-0.080NS	0.058NS	0.009NS	0.169*	0.002NS	-0.167*	0.077NS	-0.188*	-0.214**	-0.721**	1					
23	0.021NS	0.262**	0.135NS	0.171*	-0.148*	-0.531**	0.176*	-0.199**	-0.123NS	0.051NS	-0.062NS	-0.072NS	-0.034NS	0.085NS	-0.015NS	0.040NS	-0.075NS	0.343**	0.312**	0.064NS	-0.683**	0.579**	1				
24	0.052NS	-0.173*	0.003NS	-0.025NS	0.122NS	0.664**	-0.108NS	0.301**	0.242**	-0.097NS	0.078NS	0.085NS	-0.010NS	-0.055NS	-0.081NS	-0.024NS	0.134NS	-0.244**	-0.084NS	0.077NS	0.789**	-0.878**	-0.902**	1			
25	-0.043NS	-0.120NS	-0.062NS	-0.068NS	0.010NS	0.479**	0.107NS	0.433**	0.289**	-0.312**	-0.039NS	-0.120NS	-0.053NS	0.140NS	-0.079NS	0.035NS	0.206**	0.185*	0.164*	0.290**	0.518**	-0.536**	-0.329**	0.481**	1		
26	0.028NS	-0.279**	0.082NS	0.058NS	0.120NS	-0.209**	-0.085NS	-0.390**	-0.418**	0.155*	0.156*	-0.108NS	-0.003NS	0.107NS	-0.194**	-0.195**	-0.303**	-0.290**	-0.332**	-0.048NS	-0.105NS	-0.070NS	-0.209**	0.161*	-0.141NS	1	
27	-0.184*	0.179*	-0.220**	-0.159*	-0.331**	0.236**	0.082NS	0.393**	0.368**	-0.017NS	-0.107NS	0.273**	-0.260**	0.139NS	0.329**	0.351**	0.249**	0.278**	0.370**	-0.024NS	0.084NS	-0.021NS	0.126NS	-0.063NS	0.160*	-0.367**	1

* Significant at 5% level of probability, ** Significant at 1% level of probability.1 = L*, 2 = a*, 3 = b*, 4 = chroma, 5 = hue value, 6 = Fruit weight (g), 7 = fruit length (mm), 8 = fruit diameter (mm), 9 = fruit width (mm), 10 = fruit shape index, 11 = TSS (° B), 12 = titrable acidity (%), 13 = TSS: acid, 14 = ascorbic acid (mg/100 g pulp), 15 = stone weight (g), 16 = stone length (mm), 17 = stone diameter (mm), 18 = stone width (mm), 19 = skin weight (g), 20 = skin thickness (mm), 21 = pulp weight (g), 22 = stone %, 23 = skin %, 24 = pulp%, 25 = pulp:stone, 26 = alternate bearing index (ABI), 27 = fruit yield (kg).

phenotypic correlation coefficients revealed that alternate bearing index had highly significant but negative correlation with yield per plant (-0.367, -0.366). This emphasized of the hypothesis the low number of fruit per plant are sign of alternate bearing habit of genotypes. Similar association between traits studied have also been reported by (Islam *et al*. 2010 Saran *et al*. 2007) who reported strong positive correlation between yield per plant and individual fruit weight (r = 0.965), stone weight (r = 0.742), fruit length (r = 0.737), fruit breadth (r = 0.807) and pulp-stone ratio (r = 0.574) in *ber*. Likewise, in guava, the highest significant correlation was noted between fruit length and pulp weight (Kumar 2006), in mango (Attri *et al*. 1999), strawberry (Lal *et al*. 2013) and pomegranate (Lal *et al*. 2013).

Significant genetic or phenotypic correlation coefficient between two traits does not always indicate presence of linkage between them. Two traits having a common physiological or biochemical chain may also show such genetic correlation (Hohenboken 1985). This particularly is true for fruit peel colour, physicochemical properties of fruits and fruit yield in mango, which is determined by some components. Relationship of this character with their components such as chromatic parameters (L*, a*, b*, chroma and Hue), fruit (weight, diameter, length, width and shape), chemical attributes (TSS, titrable acidity, sugar: acid ratio and ascorbic acid), stone related attributes; alternate bearing and yield can be explained as physiological and developmental traits. Besides, the yield being a complex trait and difficult to exploit various yield contributing traits through the knowledge of correlation, therefore, it is important to carry out other analysis including path coefficient that provides a clear indication for selection criterion (McGiffen *et al*. 1994). This allows the partitioning of the correlations among studies traits and their components into direct and indirect effects. The data for all the studied traits were averaged and fruit yield was taken as dependent variable and all the other 26 traits were considered as casual/independent variables (Tables 4 and 5). The data indicated (Table 4) that the highest positive direct effect at genotypic level was exhibited *via* fruit weight (5.74) followed by b* (1.006), peel% (0.685), stone length (0.292), fruit diameter (0.259), titrable acidity (0.159), pulp: stone ratio (0.143), fruit shape index and ascorbic acid (0.067), stone diameter and stone width (0.053), however negative TSS (-0.008), a* (-0.013), alternate bearing index (-0.035), TSS: titrable acidity (-0.107), L* (-0.114), fruit length (-1.53), stone thickness (-0.203), Hue (-0.337), fruit width (-0.356), chroma (-0.536), Hue value (-0.126), fruit length (-.049), fruit diameter (-0.137), fruit width (-0.078), stone weight (-0.413), stone per cent (-0.52), pulp per cent (-0.693), chroma (-1.012), skin weight (-1.92) and pulp weight (-4.11). The maximum positive direct effect at phenotypic level exhibited *via* fruit weight (1.46) followed by skin per cent (0.838), chroma (0.47), stone weight (0.46), fruit diameter (0.28), pulp: stone (0.24), titrable acidity (0.23), stone length (0.20), ascorbic acid (0.12), Hue value (0.08), fruit shape index (0.079), stone diameter (0.062), a* (0.052), stone width (0.037), TSS (0.015) and fruit width (0.011), respectively, whereas highest negative direct effect was showed by L* (-0.006) followed by alternate bearing index (-0.101), TSS: titrable acidity (-0.11), pulp content (-0.179), fruit length (-0.189), skin thickness (-0.271), b* (-0.72), stone % (-0.74), peel weight (-1.12) and pulp weight (-1.25) on total fruit yield/plant (Table 5).

The fruit weight trait had negative genotypic indirect effect on yield *via* a*, b*, chroma, fruit length, fruit width, fruit shape index, TSS, stone weight, peel(%), pulp(%), peel weight, pulp weight and peel thickness. On the other hand, positive indirect effects on yield were observed *via* b*, Hue, fruit diameter, titrable acidity, sugar acid ratio, ascorbic acid, stone length, stone diameter, stone width, stone %, pulp: stone ratio, and alternate bearing index. The character pulp weight had high negative direct effect on yield at genotypic level (-4.11) and at phenotypic level (-1.25) however exerted positive indirect effect *via* a*, chroma, hue value, fruit weight, fruit diameter, titrable acidity, TSS: acid ratio, ascorbic acid, stone length, diameter, stone width, stone per cent, pulp: stone and alternate bearing index. Pulp weight had also negative indirect effect on yield *via* L*, b*, fruit length, fruit width, fruit shape index, TSS, stone weight, peel weight, peel thickness, pulp and peel per cent. Though higher pulp weight is more desirable trait in mango but its contribution directly and indirectly to the productivity is negative, likewise stone weight had also negative contribution towards fruit yield. It is desirable to give due consideration to stone and pulp weight, while selecting mango cultivars for higher productivity. Higher pulp: stone ratio is desirable, while selecting mango cultivars for pickle purposes (Singh *et al*. 2012). Among the quality traits, viz. L*, a*, b*, Hue value, chroma, total soluble solids, titrable acidity and ascorbic acid are the desirable attributes for fruit flavour and taste but these do not affect the production. Mango cultivars having excellent flavour and taste may be selected without compromising total productivity of the crop. The residual effects of genetic and phenotypic path analysis was 0.24 and 0.32, which was not much higher side and revealed higher genetic variability, proved lower per cent of environmental influence on the selected traits and thereby, suggested that no other major yield component is left over.

Our research findings showed that fruit weight, fruit diameter, stone length and stone diameter were the major attributes contributing to fruit yield. Hence, selection of large size fruits will lead to good pulp recovery, which suits to processing industry. The present results were also supported by different correlation studies on fruit characteristics of mango (Barholia and Yadav 2003, Vasugi *et al*. 2013). Higher positive direct effects were also observed by (Majumdar *et al*. 2013) for the characters like fruit weight (0.324) and negative direct effects for number of fruits per plant and fruit length towards yield. The critical evaluation of path coefficient analysis indicated that fruit weight had highest direct and positive effect on yield per tree followed by fruit size in *ber* (Saran *et al*. 2007). Significant positive correlation

Table 4 Phenotypic path coefficient analysis for 27 fruit chromatic, physicochemical and yield attributes of 60 mango genotypes

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	-0.006	0.007	-0.437	0.268	0.025	0.217	-0.027	0.037	0.002	-0.007	0.001	-0.001	0.001	0.020	-0.017	0.015	0.012	-0.002	-0.117	-0.061	-0.194	0.089	0.018	-0.009	-0.010	-0.003	-0.183*
2	-0.001	0.052	-0.345	0.287	-0.046	0.165	0.010	0.008	0.003	0.022	0.001	0.022	-0.003	0.004	0.126	0.061	0.023	0.008	-0.503	0.029	0.030	-0.025	0.219	0.031	-0.029	0.028	0.178*
3	-0.004	0.025	-0.720	0.464	0.021	0.022	0.015	-0.029	0.001	0.010	0.001	0.010	-0.007	-0.006	-0.017	0.012	0.009	0.000	-0.226	-0.031	0.026	0.114	0.113	0.000	-0.015	-0.008	-0.220**
4	-0.004	0.031	-0.704	0.475	0.007	0.055	0.013	-0.025	0.001	0.014	0.001	0.013	-0.004	-0.003	0.009	0.024	0.012	0.001	-0.305	-0.026	0.025	0.106	0.142	0.004	-0.016	-0.006	-0.158*
5	-0.002	-0.029	-0.180	0.037	0.083	-0.187	0.009	-0.021	-0.003	-0.018	0.000	-0.017	-0.018	-0.017	-0.143	-0.065	-0.017	-0.006	0.380	-0.025	0.022	0.047	-0.120	-0.021	0.003	-0.012	-0.318**
6	-0.001	0.006	-0.011	0.018	-0.011	1.468	-0.033	0.175	0.008	-0.002	0.001	0.041	0.016	0.010	0.230	0.082	0.030	0.006	-0.634	-0.043	-1.181	0.484	-0.444	-0.118	0.117	0.021	0.236**
7	-0.001	-0.003	0.058	-0.034	-0.004	0.257	-0.189	0.080	0.003	-0.005	-0.002	0.017	0.029	0.035	0.083	0.061	0.015	0.013	-0.362	-0.034	-0.131	-0.005	0.147	0.019	0.026	0.009	0.371**
8	-0.001	0.002	0.074	-0.042	-0.006	0.918	-0.054	0.280	0.009	-0.035	-0.003	0.031	0.021	0.010	0.144	0.058	0.028	0.009	-0.505	-0.066	-0.657	0.251	-0.165	-0.053	0.105	0.039	0.391**
9	-0.001	0.014	-0.041	0.052	-0.022	0.967	-0.044	0.213	0.011	-0.001	-0.003	0.019	0.017	0.020	0.204	0.092	0.036	0.006	-0.676	-0.074	-0.624	0.233	-0.103	-0.043	0.070	0.042	0.366**
10	0.001	0.015	-0.095	0.084	-0.019	-0.030	0.013	-0.126	0.000	0.079	0.004	0.009	-0.003	0.022	0.103	0.074	0.008	-0.005	-0.194	0.058	0.112	-0.093	0.043	0.017	-0.076	-0.016	-0.017NS
11	0.000	0.004	-0.027	0.019	-0.001	0.099	0.028	-0.058	-0.002	0.019	0.015	0.014	-0.043	-0.015	-0.026	0.005	0.004	-0.006	0.013	0.038	-0.152	0.056	-0.052	-0.014	-0.009	-0.016	-0.106NS
12	0.000	0.005	-0.031	0.028	-0.006	0.267	-0.015	0.038	0.001	0.003	0.001	0.225	0.024	-0.006	0.055	0.033	0.002	0.006	-0.121	0.004	-0.207	0.059	-0.060	-0.015	-0.029	0.011	0.272**
13	0.000	0.001	-0.045	0.015	0.014	-0.216	0.050	-0.053	-0.002	0.002	0.006	-0.049	-0.111	-0.025	-0.105	-0.048	-0.002	-0.007	0.289	0.032	0.079	-0.043	-0.028	0.002	-0.013	0.000	-0.259**
14	-0.001	0.002	0.036	-0.011	-0.012	0.128	-0.056	0.024	0.002	0.015	-0.002	-0.012	0.023	0.119	0.057	0.032	0.006	0.003	-0.284	-0.032	0.005	-0.006	0.070	0.010	0.034	-0.011	0.138NS
15	0.000	0.014	0.026	0.009	-0.026	0.732	-0.034	0.087	0.005	0.018	-0.001	0.027	0.025	0.015	0.461	0.119	0.026	0.010	-0.710	-0.023	-0.331	-0.124	-0.013	0.014	-0.019	0.020	0.328**
16	0.000	0.015	-0.043	0.056	-0.026	0.581	-0.055	0.078	0.005	0.028	0.000	0.036	0.026	0.019	0.266	0.207	0.036	0.005	-0.681	0.009	-0.279	-0.001	0.033	0.005	0.008	0.020	0.347**
17	-0.001	0.019	-0.101	0.093	-0.022	0.707	-0.046	0.124	0.007	0.010	0.001	0.007	0.004	0.010	0.194	0.118	0.062	0.004	-0.588	-0.031	-0.439	0.122	-0.063	-0.024	0.050	0.030	0.248**
18	0.000	0.011	0.005	0.013	-0.014	0.236	-0.065	0.069	0.002	-0.011	-0.002	0.036	0.022	0.009	0.128	0.030	0.007	0.037	-0.495	-0.026	-0.061	-0.057	0.286	0.043	0.045	0.029	0.276**
19	-0.001	0.023	-0.144	0.128	-0.028	0.825	-0.061	0.126	0.007	0.014	0.000	0.024	0.029	0.030	0.291	0.125	0.033	0.016	-1.127	-0.044	-0.383	0.139	0.260	0.015	0.040	0.034	0.369**
20	-0.001	-0.005	-0.081	0.046	0.008	0.236	-0.024	0.069	0.003	-0.017	-0.002	-0.003	0.013	0.014	0.040	-0.007	0.007	0.004	-0.183	-0.271	-0.140	0.159	0.053	-0.013	0.070	0.005	-0.024NS
21	-0.001	-0.001	0.015	-0.010	-0.001	1.385	-0.020	0.147	0.006	-0.007	0.002	0.037	0.007	0.000	0.122	0.046	0.022	0.002	-0.345	-0.030	-1.251	0.533	-0.570	-0.140	0.126	0.011	0.084NS
22	0.001	0.002	0.111	-0.068	-0.005	-0.957	-0.001	-0.095	-0.004	0.010	-0.001	-0.018	-0.006	0.001	0.077	0.000	-0.010	0.003	0.211	0.058	0.899	-0.742	0.483	0.156	-0.131	0.007	-0.021NS
23	0.000	0.014	-0.097	0.081	-0.012	-0.777	-0.033	-0.055	-0.001	0.004	-0.001	-0.016	0.004	0.010	-0.007	0.008	-0.005	0.013	-0.350	-0.017	0.852	-0.427	0.838	0.160	-0.080	0.021	0.125NS
24	0.000	-0.009	-0.002	-0.011	0.010	0.971	0.020	0.083	0.003	-0.008	0.001	0.019	0.001	-0.006	-0.037	-0.005	0.008	-0.009	0.095	-0.020	-0.983	0.647	-0.752	-0.179	0.117	-0.016	-0.063NS
25	0.000	-0.006	0.044	-0.032	0.001	0.701	-0.020	0.120	0.003	-0.024	-0.001	-0.027	0.006	0.017	-0.036	0.007	0.013	0.007	-0.184	-0.078	-0.646	0.397	-0.274	-0.085	0.244	0.014	0.160*
26	0.000	-0.014	-0.059	0.027	0.010	-0.306	0.016	-0.109	-0.005	0.012	0.002	-0.024	0.000	0.013	-0.089	-0.040	-0.019	-0.011	0.373	0.013	0.131	0.052	-0.174	-0.029	-0.034	-0.101	-0.366**

Residual effect: 0.24; Bold figures are direct effects. * Significant at 5% level of probability, ** Significant at 1% level of probability. 1 = L*, 2 = a*, 3 = b*, 4 = chroma, 5 = hue value, 6 = Fruit weight (g), 7 = fruit length (mm), 8 = fruit diameter (mm), 9 = fruit width (mm), 10 = fruit shape index, 11 = TSS (^{O}B), 12 = titrable acidity (%), 13 = TSS: acid, 14 = ascorbic acid (mg/100 g pulp), 15 = stone weight (g), 16 = stone length (mm), 17 = stone diameter (mm), 18 = stone width (mm), 19 = skin weight (g), 20 = skin thickness (mm), 21 = pulp weight (g), 22 = stone (%), 23 = skin(%), 24 = pulp(%), 25 = pulp:stone, 26 = alternate bearing index (ABI), 27= phenotypic correlation coefficient with fruit yield (kg).

Table 5 Genotypic path coefficient analysis for 27 fruit chromatic, physicochemical and yield attributes of 60 mango genotypes

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	-0.114	-0.002	0.619	-0.582	-0.108	0.859	-0.022	0.035	-0.056	-0.006	0.000	-0.001	0.000	0.011	0.017	0.022	0.010	-0.003	-0.201	-0.046	-0.648	0.063	0.014	-0.036	-0.006	-0.001	-0.184*
2	-0.015	-0.013	0.484	-0.615	0.193	0.644	0.008	0.008	-0.099	0.019	-0.001	0.016	-0.003	0.002	-0.113	0.087	0.020	0.011	-0.850	0.022	0.098	-0.017	0.179	0.120	-0.017	0.010	0.178*
3	-0.070	-0.006	1.006	-0.997	-0.089	0.089	0.012	-0.027	-0.020	0.009	0.000	0.007	-0.007	-0.003	0.015	0.017	0.008	0.000	-0.384	-0.023	0.086	0.080	0.092	-0.002	-0.009	-0.003	-0.220**
4	-0.066	-0.008	0.992	-1.012	-0.027	0.218	0.011	-0.024	-0.039	0.012	0.000	0.009	-0.003	-0.002	-0.008	0.034	0.011	0.001	-0.518	-0.020	0.083	0.075	0.117	0.017	-0.010	-0.002	-0.159*
5	-0.037	0.007	0.266	-0.082	-0.337	-0.759	0.008	-0.020	0.100	-0.017	0.000	-0.012	-0.018	-0.010	0.134	-0.095	-0.015	-0.009	0.669	-0.019	0.069	0.034	-0.101	-0.085	0.001	-0.004	-0.331**
6	-0.017	-0.001	0.016	-0.038	0.045	5.740	-0.027	0.163	-0.236	-0.001	-0.001	0.029	0.016	0.006	-0.207	0.117	0.026	0.009	-1.073	-0.033	-3.886	0.341	-0.364	-0.460	0.068	0.007	0.236**
7	-0.017	0.001	-0.081	0.072	0.017	1.009	-0.153	0.074	-0.082	-0.005	0.001	0.012	0.028	0.020	-0.075	0.086	0.013	0.018	-0.613	-0.026	-0.430	-0.004	0.121	0.075	0.015	0.003	0.082NS
8	-0.016	0.000	-0.105	0.092	0.026	3.617	-0.044	0.259	-0.273	-0.031	0.002	0.022	0.020	0.006	-0.130	0.083	0.024	0.013	-0.858	-0.050	-2.172	0.179	-0.136	-0.209	0.062	0.014	0.393**
9	-0.018	-0.004	0.057	-0.111	0.095	3.809	-0.035	0.199	-0.356	-0.001	0.002	0.013	0.016	0.012	-0.184	0.131	0.031	0.009	-1.148	-0.056	-2.061	0.164	-0.085	-0.168	0.041	0.015	0.368**
10	0.010	-0.004	0.134	-0.180	0.083	-0.122	0.010	-0.118	0.006	0.067	-0.002	0.006	-0.003	0.013	-0.093	0.106	0.007	-0.008	-0.329	0.044	0.368	-0.065	0.035	0.068	-0.044	-0.005	-0.017NS
11	-0.006	-0.001	0.040	-0.041	0.004	0.384	0.023	-0.054	0.067	0.017	-0.008	0.010	-0.042	-0.008	0.023	0.006	0.004	-0.008	0.026	0.029	-0.503	0.040	-0.043	-0.054	-0.006	-0.006	-0.107NS
12	0.001	-0.001	0.043	-0.060	0.026	1.043	-0.012	0.036	-0.030	0.003	-0.001	0.159	0.023	-0.004	-0.049	0.047	0.002	0.009	-0.204	0.003	-0.679	0.042	-0.049	-0.059	-0.017	0.004	0.273**
13	0.000	0.000	0.062	-0.033	-0.057	-0.851	0.040	-0.050	0.054	0.002	-0.003	-0.034	-0.107	-0.014	0.095	-0.068	-0.002	-0.011	0.488	0.024	0.258	-0.030	-0.023	0.007	-0.008	0.000	-0.260**
14	-0.019	0.000	-0.051	0.024	0.050	0.506	-0.046	0.022	-0.061	0.013	0.001	-0.008	0.022	0.067	-0.052	0.046	0.005	0.004	-0.482	-0.024	0.013	-0.005	0.058	0.038	0.020	-0.004	0.139NS
15	0.005	-0.004	-0.037	-0.019	0.109	2.876	-0.028	0.082	-0.158	0.015	0.000	0.019	0.025	0.008	-0.413	0.170	0.022	0.015	-1.204	-0.018	-1.090	-0.088	-0.010	0.056	-0.011	0.007	0.329**
16	-0.008	-0.004	0.057	-0.118	0.109	2.292	-0.045	0.073	-0.159	0.024	0.000	0.025	0.025	0.011	-0.240	0.292	0.031	0.008	-1.159	0.007	-0.925	-0.001	0.027	0.017	0.005	0.007	0.351**
17	-0.022	-0.005	0.142	-0.201	0.094	2.783	-0.037	0.116	-0.209	0.009	-0.001	0.005	0.004	0.006	-0.174	0.169	0.053	0.006	-1.001	-0.024	-1.449	0.087	-0.051	-0.093	0.029	0.011	0.249**
18	0.007	-0.003	-0.007	-0.028	0.059	0.929	-0.053	0.064	-0.058	-0.010	0.001	0.026	0.022	0.005	-0.116	0.042	0.006	0.053	-0.840	-0.020	-0.203	-0.040	0.235	0.169	0.026	0.010	0.278**
19	-0.012	-0.006	0.203	-0.276	0.118	3.238	-0.049	0.117	-0.215	0.012	0.000	0.017	0.027	0.017	-0.262	0.178	0.028	0.023	-1.902	-0.033	-1.259	0.098	0.214	0.059	0.023	0.012	0.370**
20	-0.026	0.001	0.116	-0.101	-0.031	0.933	-0.019	0.064	-0.098	-0.015	0.001	-0.002	0.013	0.008	-0.036	-0.010	0.006	0.005	-0.311	-0.203	-0.464	0.111	0.044	-0.054	0.041	0.002	-0.024NS
21	-0.018	0.001	-0.021	0.020	0.006	5.428	-0.016	0.137	-0.179	-0.006	-0.001	0.026	0.007	0.000	-0.110	0.066	0.019	0.003	-0.583	-0.023	-4.110	0.375	-0.468	-0.547	0.074	0.004	0.084NS
22	0.014	0.000	-0.155	0.145	0.022	-3.760	-0.001	-0.089	0.112	0.008	0.001	-0.013	-0.006	0.001	-0.070	0.001	-0.009	0.004	0.357	0.044	2.963	-0.520	0.396	0.608	-0.077	0.002	-0.021NS
23	-0.002	-0.003	0.135	-0.173	0.050	-3.049	-0.027	-0.052	0.044	0.003	0.001	-0.011	0.004	0.006	0.006	0.012	-0.004	0.018	-0.594	-0.013	2.806	-0.301	0.685	0.625	-0.047	0.007	0.126NS
24	-0.006	0.002	0.003	0.025	-0.041	3.811	0.017	0.078	-0.086	-0.007	-0.001	0.014	0.001	-0.004	0.034	-0.007	0.007	-0.013	0.161	-0.016	-3.243	0.456	-0.618	-0.693	0.069	-0.006	-0.063NS
25	0.005	0.002	-0.062	0.069	-0.003	2.748	-0.016	0.112	-0.103	-0.021	0.000	-0.019	0.006	0.009	0.033	0.010	0.011	0.010	-0.312	-0.059	-2.127	0.279	-0.225	-0.333	0.143	0.005	0.160*
26	-0.003	0.004	0.083	-0.059	-0.041	-1.202	0.013	-0.101	0.149	0.010	-0.001	-0.017	0.000	0.007	0.080	-0.057	-0.016	-0.015	0.632	0.010	0.431	0.036	-0.143	-0.111	-0.020	-0.035	-0.367**

Residual effect: 0.32. Bold figures are direct effects. * Significant at 5% level of probability, ** Significant at 1% level of probability. 1 = L*, 2 = a*, 3 = b*, 4 = chroma, 5 = hue value, 6 = Fruit weight (g), 7 = fruit length (mm), 8 = fruit diameter (mm), 9 = fruit width (mm), 10 = fruit shape index, 11 = TSS (^{O}B), 12 = titrable acidity (%), 13 = TSS: acid, 14 = ascorbic acid (mg/100 g pulp), 15 = stone weight (g), 16 = stone length (mm), 17 = stone diameter (mm), 18 = stone width (mm), 19 = skin weight (g), 20 = skin thickness (mm), 21 = pulp weight (g), 22 = stone %, 23 = skin %, 24 = pulp%, 25 = pulp:stone, 26 = alternate bearing index (ABI), 27= genotypic correlation coefficient with fruit yield (kg).

of fruit weight with pulp content, fruit breadth and fruits/tree and yield in mango also been reported (Bhowmic and Banik 2008, Barhate *et al*. 2012).

In conclusion, correlation coefficient analysis measures the magnitude of relationship between various fruit chromatic, physicochemical and yield associated traits and determines the component traits on which selection can be based for improvement of mango fruit yield. However, path coefficient analysis helped to determine the direct effect of traits and their indirect effects on fruit yield. Therefore, the fruits with higher a*, higher weight and fruit diameter, stone length, and stone diameter should be considered in selection criteria for increasing fruit appearance and yield per tree and more emphasis should be given to selecting genotypes with high a*, high fruit weight and fruit diameter. Even the unexplained variation in phenotypic and genotypic path coefficient was not so high and the variation at phenotypic (0.74) and genotypic (0.68) levels had been determined and further indicated that some of the factors need to be considered in this study, which contributes towards fruit quality and yield per plant. Therefore, some more traits may be considered in future while selecting the genotypes for high fruit yield and quality in mango.

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