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Assessment of genetic variability, its heritable components and character association in yield and yield contributing traits in apricot (*Prunus armeniaca*)

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ABSTRACT

The nature and magnitude of genetic variability and correlation studies was assessed in 20 apricot (*Prunus armeniaca* L.) genotypes for fruit, yield and quality traits. The phenotypic and genotypic coefficients of variation were almost identical in expression for these traits. High heritability and high genetic gain were reported for fruit weight and yield per tree. High heritability with moderate genetic gain was obtained for titratable acidity, pulp/stone ratio, stone width, fruit breadth, firmness, fruit length, total sugars and TSS. Genotypic and phenotypic correlations for important component traits were also significant with each other. Maximum positive direct effect cited towards yield were contributed by fruit weight, followed by phenols, sugar/acid ratio, TSS, stone width, fruit breadth and non reducing sugars. Hence, selection can prove effective for improvement in fruit yield and other traits.

Key words: Apricot, Correlation, Genetic variability, Heritability, Path analysis

The apricot (*Prunus armeniaca* L.) is one of the most important and delicious fruit of temperate regions of the world. The fruits of apricot are attractive, delicious and highly nutritious. They are very rich source of vitamin A and contain more carbohydrates, protein, phosphorous and niacin than majority of other common fruits (Teskey and Shoemaker 1972). In India, it is commercially cultivated in Himachal Pradesh, Jammu and Kashmir, hilly areas of Uttrakhand and to limited extent in the hill regions of north eastern states of the country. Total area under apricot cultivation in Himachal Pradesh is 3661 ha with the production of 5172 MT during 2015-16 (Anonymous, 2015). Solan, Shimla, Kullu, Mandi and Kinnaur are the main districts in Himachal Pradesh where apricot is grown extensively.

Apricots are enjoyed as a fresh fruit but also dried and processed into jam, nectar and squash. The fruits are also distilled into brandy and liquor. The kernels are either sweet or bitter, depending upon the variety. The sweet kernels are used as a substitute for almonds in pastries and confectionery. The bitter kernels are used for oil extraction. The health benefits of apricot include its ability to treat indigestion, constipation, fevers, skin diseases, cancer and anemia. Apricot oil is useful for treating strained muscles and wounds.

In India, apricot cultivation is mostly dependent upon exotic varieties of seedling origin. Though the apricot improvement work started as early as eighties (Seth *et al.* 1984) but it took long time to start with concerted efforts on genetic improvement and still exploration for better cultivar is going on, as most of the present day commercial cultivars lack one or other desirable traits. A wide range of variability present plays an important role in a crop in selecting the best genotypes for desirable characters as well as to select the potential parent for hybridization programmes. Larger the variability in the material, greater is the scope for improvement (Dwivedi *et al.* 2007).

The assessment of variability is the first step in any breeding programme and the progress depends on the extent of genetic variability present in various biometric characters in the gene pool. But few reports are available pertaining to the extent of variability in apricot on various quantitative characters. Since, most of the plant characters of economic importance are polygenic in nature and are highly influenced by environmental fluctuations, therefore, it is difficult to judge whether the observed variability is due to environment or genetics of an individual.

This suggested the imperative need of partitioning the phenotypic variation into its heritable and non-heritable components. For a successful hybridization programme with efficient utilization of the resources, knowledge of association of different characters is the most useful prerequisite. This will help to screen the progeny at early

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stage which is substantially large in case of apricot.

Keeping in view, the existing variability of apricots, it is therefore imperative to study genetic parameters (like heritability, correlations and path coefficient) as important and useful tools for getting the desirable selections as well as selecting genetically superior parents for hybridization programmes to make the fruit crop breeding a successful venture.

MATERIALS AND METHODS

A study was carried out in the field gene bank of National Bureau of Plant Genetic Resources, Regional Station Phagli, Shimla, Himachal Pradesh during the year 2014-15 at an elevation of 1924 m amsl. Three replicates of 20 genotypes, viz St. Ambroise, Wenatchee, Nugget, Stirling, Nari, Harogem, Rakovslik, Viva Gold, IC-432145, Erevani, Safed Perchinar, KS-1, AS-1, AS-2, NJ-A96, Jordan Early, Vitillo, Shahib, Kalola and Anglo Arsani consisted the base material for present investigation. To study fruit quality traits, 10 representative fruit samples were taken in three replicates each at optimum maturity.

Fruit and stone length and breadth were measured with the help of a digital Vernier Calliper (Model No. CD-6"CS, Mitutoyo Corp. Japan). The weight of ten fruits under three replicates of each accession was recorded and the average weight per fruit was worked out. Fruit firmness was measured with the help of Effigi penetrometer using 7/16" plunger in kg/cm^2. An average of five fruits was worked out in each of three replications.The total soluble solids content in fruits were determined by Erma hand refractometer (0-32˚Brix). Total sugars, reducing sugars, non reducing sugarwere determined as per the standard procedure given by Ranganna (2009). Total phenols content was determined by Folin-Ciocalteu procedure given by Singleton and Rossi (1965) in which absorbance was measured at 650 nm in spectrophotometer. Pulp to stone ratio was worked out by dividing the weight of the fruit pulp by the weight of the stone. Sugar/acid ratio was worked out by dividing per cent total sugar with per cent titratable acidity.The yield of fruits under each germplasm accession was recorded at the time of harvest by weighing the total fruits on top pan balance. The yield was expressed in kilograms per tree (kg/plant).

To workout various parameters of genetic variability, correlation and path coefficient, the data were subjected to statistical analysis by using SPAR 2.

RESULTS AND DISCUSSION

Analysis of variance presented in Table 1 revealed that mean sum of squares due to genotypes were significant for all the traits studied namely, fruit length, fruit breadth, fruit weight, stone length, stone breadth, stone width, stone weight, pulp to stone ratio, total soluble solids, titratable acidity, total sugars, reducing sugars, non-reducing sugars, sugar-acid ratio, firmness, phenols and yield per tree.

The estimates of range in variation, average mean performance, genotypic and phenotypic coefficient of variation, heritability and genetic gain are presented in Table 2. The range in variation was from 31.79-55.97 g for fruit length; 19.37- 77.59 g for fruit weight; 27.98-54.19 mm for fruit width; 1.11-3.38 g for stone weight; 11.00-29.86 mm for stone length; 10.23-22.32 mm for stone breadth; 7.23-14.40 mm for stone width; 15.57-33.21 for pulp to stone ratio; 10.73-19.56°B for TSS; 0.76-1.86% for titratable acidity; 8.40-16.53% for total sugars; 7.17-10.22% for reducing sugars; 0.62-6.00% for non-reducing sugars; 6.14-18.26 for sugar acid ratio; 70.41-89.57 for phenols and 3.33-7.53 for firmness; 2.73-11.00 kg/tree for fruit yield. Milosevic *et al*. (2014) evaluated Siberian selections and reported the range of fruit length, width, fruit and stone weight 42.38 to 69.28 mm, 43.92 to 52.30 mm, 37.09 to 81.60 g and 2.71 to 4.33, respectively. These differences may be caused by variation in cultivar or origin.

Table 1 Analysis of variance for yield and yield contributing traits in apricot genotypes

Source of variation	Mean sum of square		
	Replication	Genotypes	Error
d.f.	3	19	57
Fruit length	0.34	158.02*	0.28
Fruit breadth	0.11	175.25*	0.09
Fruit weight (g)	0.11	741.72*	0.11
Stone length	0.26	104.15*	0.16
Stone breadth	0.06	66.62*	0.07
Stone width	0.10	17.03*	0.08
Stone weight	0.17	1.00*	0.02
Pulp/stone	0.01	123.98*	0.05
TSS	0.23	19.93*	0.08
Titratable acidity	0.02	0.30*	0.01
Total sugars	0.13	13.76*	0.12
Reducing sugars	0.36	1.90*	0.09
Non-reducing sugars	0.12	7.84*	0.08
Sugar/acid	0.56	47.31*	0.07
Firmness	0.15	3.61*	0.10
Phenol	0.34	99.09*	0.11
Yield (kg/tree)	0.09	17.95*	0.04

*Significant at 5% level of significance.

The extent of variability (Table 2) among genotypes was determined in terms of PCV and GCV. The PCV for all the characters was higher than the GCV. The estimates for phenotypic coefficient of variation were high for non reducing sugars (35.12%), yield (32.27%), stone weight (31.65%) and fruit weight (31.50%), whereas, moderate phenotypic coefficient of variation was recorded in sugar/acid ratio (29.52%), stone length (26.01%), titratable acidity (25.33%) , stone breadth (24.56%), pulp/stone ratio (21.53%), stone width (19.24%), firmness (17.79%), fruit breadth (16.45%), fruit length (15.40%) and total sugars (15.27 %).The low phenotypic coefficient of variation was observed for TSS (14.74%), reducing sugars (9.24%) and

Table 2 Variability parameters of yield and yield contributing traits in apricot genotypes

Character	Range		Mean	SE	Heritability (%)	GCV(%)	PCV (%)	GA	Genetic gain (%)
Fruit length	31.79	55.97	40.28	0.26	99.31	15.35	15.40	12.89	31.51
Fruit breadth	27.98	54.19	43.23	0.15	99.80	16.43	16.45	13.62	33.81
Fruit weight (g)	19.37	77.59	40.91	0.17	99.94	31.50	31.50	28.04	64.86
Stone length	11.00	29.86	19.67	0.20	99.39	25.92	26.01	10.47	53.24
Stone breadth	10.23	22.32	6.65	0.13	99.57	24.51	24.56	8.39	50.37
Stone width	7.23	14.40	10.80	0.14	98.22	19.07	19.24	4.20	38.93
Stone weight	1.11	3.38	1.62	0.06	93.89	30.67	31.65	0.99	61.22
Pulp/stone	15.57	33.21	25.87	0.11	99.85	21.52	21.53	11.46	44.29
TSS	10.73	19.56	15.24	0.14	98.35	14.62	14.74	4.55	29.87
Titratable acidity	0.76	1.86	1.14	0.05	88.16	23.78	25.33	0.52	46.01
Total sugars	8.40	16.53	12.30	0.18	96.75	15.02	15.27	3.74	30.44
Reducing sugars	7.17	10.22	7.98	0.15	83.07	8.42	9.24	1.26	15.81
Non-reducing sugars	0.62	6.00	4.05	0.14	95.64	34.34	35.12	2.80	69.19
Sugar/acid	6.14	18.26	11.68	0.13	99.42	29.43	29.52	7.06	60.45
Firmness	3.33	7.53	5.56	0.10	89.63	16.84	17.79	1.83	32.84
Phenol	70.41	89.57	81.59	0.17	99.56	6.10	6.11	10.22	12.53
Yield (kg/tree)	2.73	11.00	6.59	0.16	99.09	32.13	32.27	4.34	65.88

phenols (6.11%).

Similarly, genotypic coefficient of variation was high for non-reducing sugars (34.34%), yield (32.13%), fruit weight (31.50%) and stone weight (30.67%); moderate for sugar/acid ratio (29.43%), stone length (25.92%), stone breadth (24.51%), titratable acidity (23.78%) , pulp/stone ratio (21.52%), stone width (19.07%), firmness (16.84%), fruit breadth (16.43%), fruit length (15.35%) and total sugars (15.02%) and lowest for phenols (6.10%), while other characters also recorded low genotypic coefficient of variation.

Estimation of heritability (broad sense) was also worked out for fruit and stone characteristics. The range of heritability was observed from 83.07 to 99.94%. High heritability was recorded in all the characters under study. Due to this, it is expected to generalize this genetic parameter to late growing stages and reduce the breeding period of apricot (Ismaili *et al*. 2016).

Genetic gain was low to high for various characters studied which ranged from 12.53% to 69.19%. It was found high (69.19%) for non reducing sugars, yield (65.88%), fruit weight (64.86%), stone weight (61.22%), sugar/acid ratio (60.45%), stone length (53.24%) and stone breadth (50.37%). Whereas, it was found moderate for titratable acidity (46.01%), pulp/stone ratio (44.29%), stone width (38.93%), fruit breadth (33.81%), firmness (32.84%), fruit length (31.51%), total sugars (30.44%) and TSS (29.87%). Genetic gain was found low in reducing sugar (15.81%) and phenols (12.53%).

Johanson *et al.* (1955) indicated that heritability values along with estimates of genetic gain were more useful than heritability value alone in predicting the effect of selection. High heritability with genetic gain were obtained for the character non-reducing sugars, yield, fruit weight, stone weight, sugar/acid ratio, stone length and stone breadth; whereas, high heritability with moderate genetic gain were obtained for the characters viz. titratable acidity, pulp/stone ratio, stone width, fruit breadth, firmness, fruit length, total sugars and TSS. It indicates that most likely the heritability is due to additive gene effects and selection may be effective. High heritability with low genetic gain was found low in reducing sugar (15.81%) and phenols (12.53%). It is an indicative of non-additive gene action. The high heritability exhibited due favorable influence of environment rather than genotype and selection for such traits may not be rewarding. Where heritability is low, selection methods based on families and progeny testing are more effective and efficient (Acquaah 2009)

These results were in conformation with results obtained by Meratinic *et al*. (2007). They observed relatively high value of heritability for fruit and stone weight and dimensions in twenty four apricot cultivars, and ranged from 88 to 93%. Sofi *et al*. (2001) also reported high estimates of heritability (broad sense) along with high genetic advance were observed for fruit weight, stone weight and diameter, fruit diameter, cheek and length. These findings were in consonance with those of Srivastava and Sharma (2006) who found high heritability for all the traits in apricot. Recently, similar studies have also been carried out on different set of apricot accessions collected from Ladakh region of Jammu and Kashmir by Kareem *et al*. (2016).

Correlations studies

The correlation coefficient among different characters

Table 3 Phenotypic and genotypic coefficients of correlation among yield and yield contributing traits in apricot genotypes

		X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	G	0.96**	0.90**	0.58**	0.57**	0.52**	0.79**	0.33**	-0.08	-0.04	-0.10	0.04	-0.12	-0.02	0.08	-0.08	0.18
	P	0.95**	0.90**	0.57**	0.56**	0.51**	0.76**	0.32**	-0.09	-0.04	-0.09	0.03	-0.13	-0.02	0.07	-0.07	0.18
X2	G		0.86**	0.49**	0.53**	0.49**	0.71**	0.39**	-0.14	0.12	-0.17	0.04	-0.21	-0.16	-0.08	0.04	0.16
	P		0.85**	0.48**	0.53**	0.49**	0.69**	0.39**	-0.14	0.11	-0.16	0.04	-0.21	-0.16	-0.08	0.04	0.16
X3	G			0.34**	0.37**	0.31**	0.80**	0.51**	-0.10	-0.03	-0.13	-0.05	-0.12	-0.01	0.11	-0.09	0.25*
	P			0.33**	0.37**	0.31**	0.78**	0.50**	-0.09	-0.02	-0.12	-0.04	-0.12	-0.01	0.10	-0.08	0.25*
X4	G				0.81**	0.77**	0.54**	-0.29**	-0.03	-0.39**	-0.03	0.08	-0.05	0.33**	0.23*	-0.47**	-0.06
	P				0.80**	0.76**	0.51**	-0.29**	-0.03	-0.36**	-0.031	0.07	-0.05	0.32**	0.21	-0.46**	-0.06
X5	G					0.95**	0.49**	-0.13	-0.40**	-0.27*	-0.43**	-0.23*	-0.40**	0.03	0.10	-0.36**	0.02
	P					0.94**	0.48**	-0.13	-0.39**	-0.26*	-0.42**	-0.21	-0.39**	0.03	0.09	-0.36**	0.02
X6	G						0.46**	-0.19	-0.30**	-0.09	-0.35**	-0.13	-0.34**	-0.06	-0.00	-0.20	0.13
	P						0.44**	-0.18	-0.29**	-0.09	-0.34**	-0.12	-0.33**	-0.05	-0.00	-0.20	0.12
X7	G							-0.10	0.14	-0.25*	0.14	0.04	0.17	0.30**	0.29**	-0.31**	0.35**
	P							-0.10	0.12	-0.23*	0.14	0.05	0.16	0.29**	0.28*	-0.29**	0.33**
X8	G								-0.37**	0.34**	-0.43**	-0.18	-0.46**	-0.46**	-0.27*	0.32**	-0.01
	P								-0.36**	0.32**	-0.42**	-0.16	-0.44**	-0.45**	-0.25*	0.31**	-0.01
X9	G									-0.14	0.99**	0.62**	0.95**	0.58**	0.25*	-0.13	0.25*
	P									-0.13	0.96**	0.56**	0.92**	0.57**	0.24*	-0.12	0.25*
X10	G										-0.18	-0.13	-0.16	-0.85**	-0.56**	0.95**	0.21
	P										-0.17	-0.12	-0.14	-0.80**	-0.50**	0.89**	0.20
X11	G											0.67**	0.94**	0.62**	0.26*	-0.15	0.20
	P											0.59**	0.91**	0.60**	0.25*	-0.15	0.19
X12	G												0.36**	0.53**	-0.04	-0.23*	-0.20
	P												0.31**	0.48**	-0.04	-0.21	-0.18
X13	G													0.53**	0.34**	-0.09	0.34**
	P													0.52**	0.33**	-0.09	0.33**
X14	G														0.50**	-0.86**	-0.12
	P														0.47**	-0.85**	-0.12
X15	G															-0.43**	-0.13
	P															-0.41**	-0.13
X16	G																0.26*
	P																0.26*

X1, fruit length; X2, fruit breadth; X3, fruit weight; X4, stone length; X5, stone breadth; X6, stone width; X7, stone weight; X8, pulp/stone ratio; X9, TSS; X10, titratable acidity; X11, total sugars; X12, reducing sugars; X13, non-reducing sugars; X14, sugar/acid ratio; X15, firmness; X16, phenols; X17, yield/tree; G, Genotypic correlation values; P, Phenotypic correlation values; *Significant at P=0.01, **Significant at P=0.05

Table 4 Estimates of direct and indirect effects of yield and yield contributing trait in apricot genotypes

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	-0.47	0.70	2.39	-0.27	-0.67	0.67	-1.44	-0.56	-0.15	0.03	0.29	-0.01	-0.09	-0.04	-0.04	-0.16	0.18
X2	-0.45	0.73	2.27	-0.23	-0.63	0.64	-1.30	-0.67	-0.26	-0.10	0.50	-0.02	-0.15	-0.31	0.04	0.08	0.14
X3	-0.42	0.62	2.66	-0.16	-0.44	0.40	-1.46	-0.87	-0.18	0.02	0.38	0.02	-0.09	-0.01	-0.05	-0.17	0.25
X4	-0.27	0.35	0.89	-0.46	-0.95	0.99	-0.98	0.50	-0.06	0.33	0.09	-0.03	-0.04	0.63	-0.11	-0.95	-0.07
X5	-0.27	0.39	0.99	-0.37	-1.18	1.23	-0.90	0.23	-0.73	0.23	1.31	0.09	-0.28	0.05	-0.05	-0.73	0.01
X6	-0.24	0.36	0.83	-0.36	-1.12	1.30	-0.85	0.32	-0.54	0.08	1.06	0.05	-0.24	-0.11	0.00	-0.42	0.12
X7	-0.37	0.52	2.13	-0.25	-0.58	0.60	-1.83	0.18	0.25	0.22	-0.44	-0.02	0.12	0.58	-0.15	-0.62	0.34
X8	-0.15	0.28	1.35	0.14	0.16	-0.24	0.19	-1.71	-0.67	-0.29	1.30	0.07	-0.32	-0.90	0.13	0.65	-0.01
X9	0.04	-0.10	-0.26	0.02	0.47	-0.39	-0.25	0.63	1.82	0.12	-2.98	-0.25	0.66	1.12	-0.12	-0.26	0.27
X10	0.02	0.09	-0.08	0.18	0.32	-0.12	0.46	-0.58	-0.25	-0.86	0.53	0.05	-0.11	-1.65	0.28	1.93	0.21
X11	0.05	-0.12	-0.33	0.01	0.51	-0.45	-0.26	0.74	1.79	0.15	-3.03	-0.27	0.66	1.20	-0.13	-0.31	0.21
X12	-0.02	0.03	-0.13	-0.04	0.27	-0.16	-0.08	0.30	1.13	0.11	-2.02	-0.40	0.25	1.02	0.02	-0.48	-0.2
X13	0.06	-0.15	-0.33	0.02	0.47	-0.44	-0.31	0.78	1.72	0.14	-2.86	-0.14	0.70	1.03	-0.17	-0.18	0.34
X14	0.01	-0.12	-0.01	-0.15	-0.03	-0.07	-0.55	0.79	1.05	0.73	-1.87	-0.21	0.37	1.95	-0.25	-1.75	-0.11
X15	-0.04	-0.06	0.28	-0.10	-0.12	0.00	-0.53	0.45	0.45	0.48	-0.79	0.01	0.23	0.98	-0.50	-0.88	-0.14
X16	0.04	0.03	-0.23	0.22	0.42	-0.26	0.56	-0.54	-0.23	-0.81	0.46	0.09	-0.06	-1.67	0.22	2.04	0.28

X1, fruit length; X2, fruit breadth; X3, fruit weight; X4, stone length; X5, stone breadth; X6, stone width; X7, stone weight; X8, pulp/stone ratio; X9, TSS; X10, titratable acidity; X11, total sugars; X12, reducing sugars; X13, non-reducing sugars; X14, sugar/acid ratio; X15, firmness; X16, Phenols; X17, yield/tree. Residual effect =0.40954. Underline figures are direct effects. ** Significant at P=0.05

was worked out at phenotypic and genotypic levels (Table 3). In general, the genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients.

The phenotypic correlation coefficients among studied characters showed that yield per tree had positive and significant association with stone weight (0.33), non-reducing sugars (0.33), phenol (0.26), and fruit weight (0.25) and TSS (0.25).

Similarly, fruit length was significantly and positively correlated with fruit weight, (0.90) fruit breadth (0.95), stone weight (0.76), stone breadth (0.66), stone length (0.57), stone width (0.51), pulp/stone (0.32). Fruit breadth showed positive and significant correlation with fruit weight (0.85), stone weight (0.69), stone breadth (0.53), stone width (0.49), stone length (0.48), pulp/stone ratio (0.39). Similar findings were presented by Milosevic *et al.* (2014). They showed that fruit length was highly correlated with the other fruit dimension, whereas both dimensions significantly correlated with fruit weight; this result showed that the fruit weight of apricot related to length and width. However, fruit weight showed positive and significant correlation with stone weight (0.78), pulp/stone ratio (0.50), stone breadth (0.37), stone length (0.33), and stone width (0.31). No correlations between fruit weight and TSS, or TSS/Acidity were observed. The results were in agreement with previous studies on apricot (Ruiz and Egea 2008).

Pulp to stone ratio showed significant correlation with titratable acidity (0.32) and phenols (0.31). Total soluble solids had positive and significant correlation with total sugars (0.96), non-reducing sugars (0.92), sugar/acid (0.57), reducing sugars (0.56), and firmness (0.24). At genotypic level in general, the nature of correlation coefficients were almost similar to those observed at phenotypic level for most of the traits, but the values were higher than the corresponding phenotypic ones.

Correlation studies revealed that yield had positive association with stone weight (0.33), non-reducing sugars (0.33), phenol (0.26), and fruit weight (0.25) and TSS (0.25). Fruit weight had positive indirect effect with stone weight (0.78). Similar results were reported by Mratinic *et al*. (2011) and Milosevic and Milosevic (2010). Saran (2007) reported that yield of peach genotype had significant positive correlation with fruit weight and stone weight.

Path analysis

In order to understand the casual factors of the correlation among traits studied, the estimates of direct and indirect effects were computed through path analysis and are presented in Table 4.

The direct positive effects can be arranged in the following descending order: fruit weight (2.66), phenols (2.04), sugar/acid ratio (1.95), TSS (1.82), stone width (1.30), fruit breadth (0.73) and non reducing sugars (0.70).

However, fruit length showed positive indirect effect via fruit weight (2.39), fruit breadth (0.70), stone width (0.67) and total sugars (0.29). Fruit breadth depicted positive indirect effect via fruit weight (2.27), stone width (0.64) and total sugars (0.50). Fruit weight showed positive indirect effect via fruit breadth (0.62), stone width (0.40) and total sugars (0.38).

Stone weight depicts positive indirect effect via fruit breadth (0.52), fruit weight (2.13), stone width (0.60), total soluble solids (0.25), titratable acidity (0.22) and sugar/acid ratio (0.58).

Whereas, pulp to stone ratio depict positive indirect effect via fruit breadth (0.28), fruit weight (1.35), total sugars (1.30) and phenols (0.65).

Total soluble solids showed positive indirect effect via stone breadth (0.47), pulp/stone ratio (0.63), non-reducing sugars (0.66) and sugar/acid ratio (1.12). Titratable acidity had positive indirect effect via stone length (0.18), stone breadth (0.32), stone weight (0.46), total sugars (0.53), firmness (0.28) and phenols (1.93). Whereas, total sugars depicted positive indirect effect via stone breadth (0.51), pulp/stone ratio (0.74), total soluble solids (1.79), non-reducing sugars (0.66) and sugar/acid ratio (1.20).

Path coefficient analysis is a potent and efficient technique in selection, because correlation coefficient alone when considered as the criteria for selection of high yield, may provide misleading information, as such a character may not be directly correlated with yield so that the character could be considered as a criterion for selection. Path analysis also helps in partitioning correlation coefficients into direct and indirect effects of component characters in yield.

Maximum positive direct effect towards yield was contributed by fruit weight (2.66), phenols (2.04), sugar/acid ratio (1.95), TSS (1.82), stone width (1.30), fruit breadth (0.73) and non reducing sugars (0.70). Saran (2007) reported that fruit weight had highest direct and positive effect followed by number of flower per shoot on yield per tree.

Low magnitude of residual effect at genotypic level indicated that the traits included in the present investigation accounted for most of the variation present in the dependent variable that is fruit yield per tree. The studies on path coefficient analysis suggested that selection for fruit weight (2.66), phenols (2.04), sugar/acid ratio (1.95), TSS (1.82), stone width (1.30), fruit breadth (0.73) and non reducing sugars (0.70) would be effective for improving yield in apricot genotypes. The present findings were in agreement with those of Lal *et al*. (2016), who reported positive correlation of fruit weight, fruit diameter on fruit yield in peach.

The present investigation suggested that traits like fruit weight, stone weight, phenols, sugar/acid ratio, TSS, stone width, fruit breadth and non reducing sugars should be given more emphasis in the selection programme aimed at improving yield/tree in apricot.

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