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Correlation and Path Coefficient Analysis of Fruits Yield and Yield Attributes in Okra [*Abelmoschus esculentus* (L.) Moench]

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A B S T R A C T

Twenty germplasm lines of okra (*Abelmoschus esculentus* (L.) Moench) were evaluated in a randomized block design with two replications at Vegetable Research Farm, The field experiment was carried out at Horticulture Research Scheme (Vegetable) and Department of Horticulture, College of Agriculture, VNMKV, Parbhani, during the *Kharif* season, 2016-17.Twenty okra genotypes were studied for evaluation of correlation and path co-efficient analysis of fruits yield and yield attributes in okra (*Abelmoschus esculentus* L.). Plant height, number of branches, number of fruits per plant, inter nodal length, last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of picking and iodine content, were found to possess significant and positive correlation with fruit yield per plant. It was observed that with increase in plant height and less intermodal length, there was corresponding increases of fruit yield per hectare. Path coefficient analysis of different yield and yield contributing traits on fruit yield per plant revealed with plant height, number of branches per plant inter nodal length, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, fruit length, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and crude fiber content, iron content showed positive direct effect on fruit yield these characters play a major role in recombination breeding and suggested that direct selection based on these traits will be rewarded for crop improvement of okra.

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is popularly known as lady's finger or bhendi. Okra is one of the important members of Malvaceae family having higher chromosome number of 2n=130 and polyploidy in nature.The family Malvaceae consists of about 34 *Abelmoschus species*, including 30 species in the Old World and four in the New World (*Joshi et al.*, 1974). The species *A. tuberculatus*, a wild type is native to India. The cultivated species *A. esculentus*is *believed* to be originated in the Hindustani centre, *i.e.*, India according to the taxonomic classification of Zeven and Zhukovsky

(1975). It is the only vegetable crop of significance in the Malvaceae family. It is extensively grown in temperate, subtropical and tropical regions of the world (Kochhar, 1986). It is a specialty pod vegetable, which is very popular in India. Its fruits have high nutritive, medicinal and industrial value and export potential. Its fruits are rich in vitamins, calcium, potassium and other mineral matters (Effing *et al.,* 2009) (Guddadamath *et al.*, 2011).Okra seed oil is rich in unsaturated fatty acids such as linoleic acid (Savello *et al.*, 1980), It is reported to have alkaline pH which contributes to its relieving effect in gastrointestinal ulcer by neutralizing digestive acid (Wamanda, 2007), which is essential for human nutrition. Unlike many other members of pod vegetable group, it is not strictly season-bound and hence can be gown twice a year. Being a warm season crop, it can be grown as spring-summer as well as rainy season crop in major agro-ecological zones of India. It fits well in sequential cropping systems due to its quick growing habit, medium duration and tolerance to drought, heat and wide variation in rainfall. Optimizing pod yield is one of the most important goals for most okra growers and, consequently, most okra breeding programs. For improving this crop through conventional breeding and selection, adequate knowledge of association that exists between yield and yield related characters is essential for the identification of selection procedure. In okra, all growth, earliness and yield associated traits are quantitative in nature. Such characters are controlled by polygene and are much influenced by environmental fluctuations. Pod yield of okra is a complex quantitative trait, which is conditioned by the interaction of various growth and physiological processes throughout the life cycle (Adeniji and Peter, 2005). In general, plant breeders commonly select for yield components which indirectly increase yield since direct selection for yield *per se* may not be the most efficient method for its improvement. Indirect selection for other yield - related characters, which are closely associated with yield, will be more effective. The appropriate knowledge of such interrelationships between pod yield and its contributing components can significantly. In any selection program me, it may not always be reliable to select on the basis of yield alone for evolving high yielding genotypes, because yield is a complex character under polygenic control and also collectively influenced by many component characters. The interrelationships between yield and yield contributing characters estimated by correlation coefficient analysis provide information on nature, extent and direction of selection. The method of path coefficient analysis developed by Wright (1921) is helpful in partitioning correlation coefficients into direct and indirect effects and in assessment of relative contributions of each component to the yield.

Improve the efficiency of a breeding program through the use of appropriate selection indices. Correlation and path coefficient analyses are prerequisites for improvement of any crop including okra for selection of superior genotypes and improvement of any trait. In plant breeding, correlation analysis provides information about yield components and thus helps in selection of superior genotypes from diverse genetic populations. The correlation studies simply measure the associations between yield and other traits. Usefulness of the information obtained from the correlation coefficients can be enhanced by partitioning into direct and indirect effects for a set of a pair-wise cause-effect inter relationships (Kang *et al.,* 1983). In this study, an attempt was made to study the interrelationship among characters and the direct and indirect effects of some important yield components on pod yield in germplasm lines by adopting correlation and path coefficient analysis.

Materials and Methods

Experimental material comprised 20 germplasm lines of okra. All germplasm lines were evaluated in a randomized block design with two replications at the Vegetable Research. The field experiment was carried out at Horticulture Research Scheme (Vegetable) and Department of Horticulture, College of Agriculture, VNMKV, Parbhani, during the *Kharif* season,2016-17.Cultural and agronomic practices were followed as per the standard recommendations and need based plant protection measures were taken up to maintain healthy crop stand. Observations were recorded on five competitive plants excluding border plants in each replication in each genotype for plant height, number of branches, inter nodal length, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, fruit length, fruit girth, Average fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of harvests, crude fiber content, iodine content, iron content and fruit yield per plant.

Correlation coefficient analysis

Simple correlation coefficients between yield and yield components and intercorrelation among the various components were calculated using the formula suggested by Panse and Sukhatme (1967).

$$\text{Correlation coeffient 'r'} = \frac{\text{Cov. (X.Y)}}{\sqrt{\text{(Var X) (Var Y)}}}$$

Where,

r	=	Simple correlation coefficient between variable X and Y
Cov. (X.Y)	=	Simple covariance between X and Y
V (x)	=	Variance of X
V (y)	=	Variance of Y

The significance of genotypic correlation coefficient was tested by referring to the standard table given by Snedecor and Cochran (1967).

Path coefficient analysis

Path coefficient analysis was carried out as suggested by Dewey and Lu (1959) by partitioning the simple correlation coefficients into direct and indirect effects. The direct and indirect effects were ranked based on the scales of Lenka and Misra (1973) as given below

Negligible	:	0.00 to 0.09
Low	:	0.10 to 0.19
Moderate	:	0.20 to 0.29
High	:	0.30 to 0.99
Very high	:	> 1.00

Results and Discussion

Correlation coefficient analysis

Based on the simple correlation coefficients, the characters plant height, number of fruits per plant, inter nodal length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings, crude fibre content and iron content were found to possess significant and positive association with fruit yield per plant. Such high association between fruit yield per plant, number of fruits per plant and average fruit weight was reported by Bendal *et al.*, (2003), Jaiprakashnarayan and Mulge (2004), Soma sekhar *et al.*, (2011), Das *et al.*, (2012) and Reddy *et al.*, (2013)in okra. The results of the present study on plant height, fruit length and fruit girth were in conformity with Niranjan and Mishra (2003), Singh *et al.*, (2006), Nirosha *et al*., (2014) and Yonus *et al.*, (2014) in okra. The results of the present study also revealed negative association of fruit yield per plant with days to first flowering, days to 50%

flowering, days to first harvest, days to last harvest and iodine content. These results corroborate the findings of Mehta *et al.,* (2006), Yadav *et al.,* (2010), Koundinya and Dhankhar (2013), Reddy *et al.,* (2013) and Nirosha *et al.,* (2014) in okra (Table 1).

Inter correlations among yield attributing components

The inter correlation among component characters of yield may provide likely consequences of selection for simultaneous improvement of desirable characters. The present study revealed that plant height exhibited significant and positive correlation with number of branches, Inter nodal length, fruit length, fruit girth, fruit weight, number of seeds per fruit. Mehta *et al.,* (2006), Das *et al.,* (2012), Reddy *et al.,* (2013) also observed positive and significant correlation of plant height with inter nodal length, fruit length and number of seeds per fruit in okra. And plant height exhibited negative and significant correlation with days to first flowering, days to 50% flowering, days to first harvest. Similar results were reported by Mehta *et al.,* (2006) Yadav *et al.,* (2010). Singh *et al.,* (2006) also recorded negative and significant correlation of plant height with fruit girth among 19 diverse okra genotypes.

Number of branches showed positive and significant correlation with inters nodal length, last harvest, fruit length, fruit weight, number of seeds per fruit, number of pickings. Similar result was recorded by Bendale *et al.,* (2003), Kumar and Singh (2012), Simon *et al.,* (2013).

Inter nodal length showed positive and significant correlation with days to first harvest, last harvest, fruit length, fruit weight, number of fruits per plant, number of seeds per fruit, number of pickings and iodine content. Similar results were reported by Singh *et al.,* (2006) and Reddy *et al.,* (2013).

Days to first flowering showed positive and significant correlation with days to 50% flowering, days to first harvest and days to last harvest. Days to 50% flowering showed significant positive correlation with days to first harvest, days to last harvest. Days to last harvest showed positive and significant correlation with fruit girth, fruit weight, number of fruits per plant, 100 seed weight. Similar results were reported by Simon *et al.,* (2013). Fruit length showed positive and significant correlation with fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and iodine content, while it exhibited negative and significant correlation with crude fiber content. Similar results were reported by Reddy *et al.,* (2013).

Fruit girth showed positive and significant correlation with fruit weight, 100 seeds weight and crude fiber content. Niranjan and Mishra (2003) observed positive and significant correlation of fruit girth with plant height, number of branches, fruit length, average fruit weight, number of fruits per plant and number of seeds per fruit.

Fruit weight exhibited positive and significant correlation with 100 seed weight, number of pickings and iodine content, which was accordance with the findings of Das *et al.,* (2012), Yonus *et al.,* (2014).

Number of fruits per plant showed positive and significant correlation with number pickings.

Number of seeds per fruit showed positive and significant correlation with crude fiber content, Number of picking. Number pickings showed positive and significant correlation with crude fiber content. Similar results were reported by Singh *et al.,* (2006), Bendal *et al.,* (2003), Simon *et al.,* (2013), Yonus *et al.,* (2014).

Table.1 Phenotypic (P) and genotypic (G) correlation coefficients of yield and yield attributes in twenty genotypes of okra

Characters		Plant height (cm)	No. of branches per plant	Inter nodal length (cm)	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Number of seeds per fruit	100 seed weight (g)	Total number of picking	Crude fiber content (%)	Iodine content(mg/100g)	Iron content(mg/100g)	Fruit yield per plant (g)
Plant height (cm)	P	**1.0000**	0.4284**	0.2480**	-0.0653**	-0.0586**	-0.0035**	0.2511	0.7599***	0.5528***	0.4969**	0.0548	0.3581*	0.4271**	0.1218	-0.1679	0.1721	-0.0023	**0.0148**
	G	**1.0000**	0.4518	0.2545**	-0.0905**	-0.0606**	-0.0049**	0.2663	0.8615	0.5994	0.5213	0.0491	0.3616	0.4402	0.1300	-0.1701	0.2019	0.0048	**0.0137**
Number of branches per plant	P		**1.0000**	0.1747**	-0.0808**	-0.0544**	-0.1122**	0.1064*	0.3931*	0.2145	0.2253**	-0.0627	0.5113***	-0.1240	0.2047**	-0.2715*	0.1780	0.1281	**0.2443**
	G		**1.0000**	0.1869**	-0.0441**	-0.0464**	-0.1197**	0.1133*	0.4929*	0..2155	0.2786**	-0.0564	0.5330	-0.1374	0.2203**	-0.3040*	0.2518	0.1311	**0.2568**
Intermodal length (cm)	P			**1.0000**	-0.0404**	0.0027	0.0545**	0.1761*	0.2395**	0.0121	0.1925*	0.2764**	-0.1762**	-0.2279**	0.0052	-0.1600*	-0.0523*	0.0364	**0.0147**
	G			**1.0000**	-0.0546**	0.0012	0.0429**	0.1825*	0.3462**	0.0327	0.2212*	0.2888	-0.1746**	-0.2467	0.0235	-0.1648*	-0.0644*	0.0492	**0.0102**
Days to first flowering	P				**1.0000**	0.9593***	0.9215***	0.7540***	-0.1848*	-0.0010	-0.4442**	-0.1794*	0.0760	-0.0702*	-0.8056***	0.4891**	-0.1010**	0.1488	**-0.2503**
	G				**1.0000**	1.0266	0.9897	0.8239	-0.2110*	0.0330	-0.4673	-0.2386*	0.0844	-0.0864*	-0.8722***	0.5457**	-0.1258**	0.1545	**-0.2680**
Days to 50% flowering	P					**1.0000**	0.9539***	0.8094***	-0.1402	0.0558	-0.4513**	-0.2144**	0.0696	-0.0449**	-0.8261***	0.5440***	-0.0560*	0.1432	**-0.2956**
	G					**1.0000**	0.9595	0.8262	-0.1736	0.0655	-0.4732	-0.2127	0.0706	-0.0445	-0.8335	0.5518	-0.0761	0.1468	**-0.2980**
Days to first harvest	P						**1.0000**	0.7257***	-0.1133**	0.0405	-0.3552*	-0.2347	-0.0456	-0.0007	-0.9336***	-0.4696**	-0.0521	0.1175	**-0.3822**
	G						**1.0000**	0.7387	-0.1064	0.0421	-0.3683	-0.2567	-0.0398	0.0028	-0.9353	-0.4749	-0.0589	0.1273	**-0.3868**
Days to last harvest	P							**1.0000**	0.1922	0.2828**	-0.2917	0.1076**	0.2888**	0.0494	-0.4511**	0.4543**	0.0533	0.2496	**-0.0762**
	G							**1.0000**	0.2432	0.3095**	-0.2973	0.1112	0.2949	0.0396	-0.4674	0.4707	0.0562	0.2606	**-0.0769**
Fruit length (cm)	P								**1.0000**	0.4906**	0.4306**	0.0178	0.4328**	0.3164*	0.2097	-0.3245*	0.3560*	0.1873	**-0.0789**
	G								**1.0000**	0.4955	0.4624	0.0738	0.4844	0.3712	0.2058	-0.3884	0.3804	0.1819	**-0.0805**
Fruit girth (cm)	P									**1.0000**	0.4361**	-0.0808**	0.1567	0.5319***	0.1363	0.3797*	0.0675	0.2053	**0.1696**

	G									1.0000	0.4463	-0.0986	0.1895	0.5902	0.1428	0.3971	0.0763	0.2239	0.1832
Fruit weight (g)	**P**										1.0000	0.0237	-0.1238**	0.1496**	0.3283*	-0.3500*	-0.1300	0.1665*	0.1278
	G										1.0000	-0.232	-0.1238	0.1864	0.3486	-0.3680	-0.1566	0.1845	0.1361
Number of fruits per plant	P											1.0000	0.0152	0.0454	0.3630*	-0.0246*	-0.0721*	0.2081**	0.3278
	G											1.0000	0.0379	0.0283	0.3944	-0.0126	-0.0541	0.2451	0.3453
Number of seeds per fruit	P												1.0000	0.0768	0.1869**	-0.0286*	0.2306**	0.0563	0.2649
	G												1.0000	0.0790	0.1830	-0.0318	0.2404	0.0504	0.2676
100 seed weight (g)	P													1.0000	0.0313	0.2424**	0.0586	0.0953	0.1010
	G													1.0000	0.0242	0.2634	0.0733	0.1089	0.1041
Total number of picking	P														1.0000	-0.3493*	0.0855*	-0.0434**	0.5250
	G														1.0000	-0.3516	0.0943	-0.0573	0.5353
Crude fiber content (%)	P															1.0000	-0.1597**	0.1822**	0.0405
	G															1.0000	-0.1687	0.1837	0.0413
Iodine content(mg/100g)	P																1.0000	-0.1371**	-0.1701
	G																1.0000	-0.1479	-0.1805
Iron Content (mg/100g)	P																	1.0000	0.1501
	G																	1.0000	0.1528
Fruit yield per plant(g)	P																		1.0000
	G																		1.0000

Table.2 Phenotypic (P) and genotypic (G) path coefficient analysis indicating direct and indirect effects of component characters on fruit yield in twenty genotypes of okra

Characters		Plant height	No. of branches per plant	Inter nodal length (cm)	Days to first flowering	Days to 50% flowering	ys to first harvest	Days to last harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Number of seeds per fruit	100 seed weight	Total number of picking	Crude fiber content (%)	Iodine Content (mg/100g)	Iron Content (mg/100g)	Fruit yield per plant (g)
lant height (cm)	P	**-0.2453**	-0.1051	-0.0608	0.0160	0.0144	0.0009	-0.0616	-0.1834	-0.1356	-0.1219	-0.0134	-0.0878	-0.1048	-0.0299	0.0412	-0.0422	0.0006	**0.0148**
	G	**-0.1585**	-0.0716	-0.0403	0.0143	0.0096	0.0008	-0.0422	-0.1365	-0.0950	-0.0826	-0.0078	-0.0573	-0.0698	-0.0206	0.0270	-0.032	-0.0008	**0.0137**
Number of branches per plant	P	0.0740	**0.1728**	0.0302	-0.0140	-0.0094	-0.0194	0.0183	0.0679	0.0371	0.0389	-0.0108	0.0883	-0.0214	0.0354	-0.0465	0.0307	0.0221	**0.2443**
	G	0.2247	**0.4974**	0.0930	-0.0220	-0.0231	-0.0595	0.0563	0.2452	0.1072	0.1386	-0.0280	0.2651	-0.0683	0.1096	-0.1512	0.1252	0.0652	**0.2568**
Intermodal length (cm)	P	0.0484	0.0341	**0.1953**	-0.0079	0.0005	0.0107	0.0344	0.0468	0.0024	0.0376	0.0540	-0.0344	-0.0445	0.0010	-0.0313	-0.0102	0.0071	**0.0147**
	G	0.0405	0.0297	**0.1592**	-0.0087	0.0002	0.0068	0.0290	0.0551	0.0052	0.0352	0.0460	-0.0278	-0.0393	0.0037	-0.0262	-0.0103	0.0078	**0.0102**
Days to first flowering	P	-0.0061	-0.0075	-0.0038	**0.0930**	0.0892	0.0857	0.0701	-0.0172	-0.0001	-0.0413	-0.0167	0.0071	-0.0065	-0.0749	0.0455	-0.0094	0.0138	**-0.2503**
	G	0.0408	0.0199	0.0246	**-0.4507**	-0.4627	-0.4461	-0.3713	0.0951	-0.0149	0.2106	0.1075	-0.0380	0.0389	0.3931	-0.2459	0.0567	-0.0696	**-0.2680**
Days to 50% flowering	P	0.1026	0.0953	-0.0046	-1.6808	**-1.7521**	-1.6714	-1.4182	0.2631	-0.0978	0.7907	0.3757	-0.1220	0.0787	1.4474	-0.9532	0.0982	-0.2509	**-0.2956**
	G	0.2818	0.2161	-0.0054	-4.7772	**-4.6534**	-4.4648	-3.8446	0.8078	-0.3047	2.2022	0.9899	-0.3285	0.2073	3.8786	-2.5677	0.3544	-0.6829	**-0.2980**
Days to first harvest	P	-0.0236	-0.7496	0.3643	6.1544	6.3707	**6.6786**	4.8467	-0.7569	0.2706	-2.3723	-1.5673	-0.3044	-0.0048	-6.2349	3.1361	-0.3480	0.7846	**-0.3822**
	G	-0.0821	-1.9888	0.7129	16.4500	15.9468	**16.6203**	12.2777	-1.7684	0.7000	-6.1208	-4.2661	-0.6607	0.0469	-15.5451	7.8933	-0.9789	2.1150	**-0.3868**
Days to last harvest	P	-0.3278	-0.1385	-0.2299	-0.9844	-1.0567	-0.9474	**-1.3055**	-0.2510	-0.3692	0.3808	-0.1404	-0.3770	-0.0645	0.5890	-0.5931	-0.0695	-0.3258	**-0.0762**
	G	-0.7491	-0.3188	-0.5134	-2.3180	-2.3245	-2.0784	**-2.8135**	-0.6844	-0.8707	0.8364	-0.3129	-0.8297	-0.1114	1.3152	-1.3242	-0.1580	-0.7331	**-0.0769**
ruit length (cm)	P	-0.2500	-0.1293	-0.0788	0.0608	0.0494	0.0373	-0.0632	**-0.3290**	-0.1614	-0.1416	-0.0059	-0.1424	-0.1041	-0.0690	0.1067	-0.1171	-0.0616	**-0.0789**
	G	0.0543	0.0311	0.0218	-0.0133	0.0109	-0.0067	0.0153	**0.0630**	0.0312	0.0291	0.0047	0.0305	0.0234	0.0130	-0.0245	0.0240	0.0115	**-0.0805**
Fruit girth (cm)	P	-0.2643	-0.1026	-0.0058	0.0005	-0.0267	-0.0194	-0.1352	-0.2345	**-0.4781**	-0.2085	0.0386	-0.0749	-0.2543	-0.0651	-0.1815	-0.0323	-0.0981	**0.1696**
	G	**-1.0211**	**-0.3672**	**-0.0557**	**-0.0562**	**-0.1115**	**-0.0718**	**-0.5272**	**-0.8442**	**-1.7037**	**-0.7603**	**0.1680**	**0.3228**	**-1.0056**	**-0.2434**	**-0.6765**	**-0.1301**	**-0.3815**	**0.1832**

	P	**0.0560**	0.0254	0.0217	-0.0500	-0.0508	-0.0400	-0.0329	0.0485	0.0491	**0.1127**	-0.0027	-0.0139	0.0169	0.0370	-0.0394	-0.0146	0.0188	0.1278
	G	**-0.2288**	-0.1223	-0.0971	0.2050	0.2077	0.1616	0.1305	-0.2029	-0.1958	**-0.4388**	0.0102	0.0543	-0.0818	-0.1530	0.1615	0.0687	-0.0810	0.1361
	P	**-0.0143**	0.0164	-0.0721	0.0468	0.0559	0.0612	-0.0281	-0.0046	0.0211	**0.0062**	-0.2608	-0.0040	-0.0118	-0.0946	0.0064	0.0188	-0.0543	0.3278
	G	**-0.0522**	0.0599	-0.3069	0.2536	0.2261	0.2728	-0.1182	-0.0785	0.1048	**0.0247**	-1.0626	-0.0402	-0.0300	-0.4191	0.0134	0.0575	-0.2605	0.3453
	P	**0.1441**	0.2058	-0.0709	0.0306	0.0280	-0.0183	0.1162	0.1742	0.0631	**-0.0498**	0.0061	0.4025	0.0309	0.0752	-0.0115	0.0928	0.0227	0.2649
	G	**0.0709**	0.1044	-0.0342	0.0165	0.0138	-0.0078	0.0578	0.0949	0.0371	**-0.0243**	0.0074	0.1959	0.0155	0.0359	-0.0062	0.0471	0.0099	0.2676
	P	**0.1679**	-0.0487	-0.0895	-0.0276	-0.0177	-0.0003	0.0194	0.1243	0.2090	**0.0588**	0.0178	0.0302	0.3930	0.0123	0.0953	0.0230	0.0374	0.1010
	G	**0.3183**	-0.0993	-0.1784	-0.0625	-0.0322	0.0020	0.0286	0.2684	0.4286	**0.1348**	0.0204	0.0571	0.7231	0.0175	0.1904	0.0530	0.0788	0.1041
	P	**0.6052**	1.0171	0.0257	-4.0019	-4.1036	-4.6375	-2.2411	1.0419	0.6768	**1.6310**	1.8031	0.9284	0.1553	4.9675	-1.7352	0.4249	-0.2154	0.5250
	G	**1.4877**	2.5216	0.2689	-9.9851	-9.5419	-10.7073	-5.3512	2.3559	1.6352	**3.9907**	4.5151	2.0954	0.2765	11.4479	-4.0250	1.0794	-0.6556	0.5353
	P	**-0.0232**	-0.0375	-0.0221	0.0676	0.0752	0.0649	0.0628	-0.0448	0.0525	**-0.0484**	-0.0034	-0.0039	0.0335	-0.0483	0.1382	-0.0221	0.0252	0.0405
	G	**-0.1040**	-0.1858	-0.1008	0.3336	0.3374	0.2904	0.2878	-0.2374	0.2428	**-0.2250**	-0.0077	-0.0194	0.1610	-0.2150	0.6114	-0.1032	0.1123	0.0413
	P	**-0.0285**	-0.0294	0.0087	0.0167	0.0093	0.0086	-0.0088	-0.0589	0.0112	**0.0215**	0.0119	-0.0381	-0.0097	-0.0142	0.0264	-0.1655	0.0227	-0.1701
	G	**-0.1121**	-0.1397	0.0358	0.0698	0.0423	0.0327	-0.0312	-0.2111	-0.0424	**0.0869**	0.0300	-0.1334	-0.0407	-0.0523	0.0937	-0.5557	0.0821	-0.1805
	P	**-0.0005**	0.0258	0.0073	0.0299	0.0288	0.0236	0.0502	0.0377	0.0413	**0.0335**	0.0419	0.0113	0.0192	-0.0087	0.0367	-0.0276	0.2013	0.1501
	G	**0.0026**	0.0702	0.0263	0.0827	0.0786	0.0681	0.1395	0.0974	0.1199	**0.0988**	0.1312	0.0270	0.0583	-0.0307	0.0983	-0.0792	0.5354	0.1528

Phenotypic Residual effect = 0.47; Genotypic Residual effect=0.14 ; Diagonal (under lined) values indicate direct effects

Crude fibre content exhibited positive and significant correlation with iodine content. Iodine content exhibited positive and significant correlation with iron content. Similar results were reported by Yadav *et al.,* (2010), Das *et al.,* (2012).

Further, it indicates plant height, number of branches per plant, inter nodal length, days to last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and number of pickings, ascorbic acid content, iodine content and iron content had positive and significant association with fruit yield and these characters are highly reliable components of fruit yield and could very well be utilized as yield indicators, while exercising selection.

Path coefficient analysis

The estimation of coefficients indicates only the extent and nature of association between yield and its components, but does not show the direct and indirect effects of different yield attributes on yield *per se*. Fruit yield is dependent on several characters which are mutually associated. These will in turn impair the true association existing between a component and fruit yield. A change in any one component is likely to disturb the whole network of cause and effect. Thus, each component has two paths of action *viz.*, the direct influence on fruit yield, indirect effect through components which are not revealed from the correlation studies (Table 2).

Among all the traits under study, the traits number of branches per plant, inter nodal length, days to first flowering, days to first harvest, fruit weight, fruit girth, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings, iron content and iodine content also recorded positive with yield. This suggested that direct selection based on these traits will be rewarding for crop yield improvement.

Plant height, Number of branches per plant, inter nodal length, days to first flowering, days to first harvest, fruit length, fruit weight, Number of fruit per plant, number of seeds per fruit, 100 seed weight, crude fibre content and iron content showed positive direct effect on fruit yield per plant.This observation was in agreement with the results of Ramya and Kumar (2009), Das *et al.,* (2012), Adiger *et al.,* (2011), Reddy *et al.,* (2013), Simon *et al.,* (2013), Nirosha *et al.,* (2014) and Yonus *et al.,* (2014).

Days to first flowering showed high positive indirect effect through total number of pickings. Days to 50% flowering showed very high positive indirect effect through fruit length, fruit weight, number of fruits per plant, and iodine content. Number of pickings also exhibited high positive indirect effect through plant height, fruit length, fruit girth, fruit weight, Number of branches per plant, number of fruits per plant, number of seeds per fruit, crude fibre content and iron content on fruit yield per plant. This observation was in agreement with the results of Alam and Hossain (2006), Alam and Hossain (2008), Adiger *et al.,* (2011), and Reddy *et al.,* (2013)

The direct effect of all above mentioned traits on fruit yield per plant favours yield improvement through selection. This suggested that indirect selection based on plant height will be effective in yield improvement.

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