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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

Thirty germplasm lines of okra (*Abelmoschus esculentus* (L.) Moench) were evaluated in a randomized block design with three replications at Vegetable Research Farm, College of Horticulture, Rajendranagar, SKLTSHU, Hyderabad during *Rabi*, 2015-16. Thirty 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 fruits per plant, internodal length, last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings 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 internodal 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, internodal length, days to 50% flowering, days to last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and iodine 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

Bhendi (*Abelmoschus esculentus* (L.) Moench) is popularly known as lady's finger or okra. 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 (Camciuc *et al.*, 1981). Okra seed oil is rich in unsaturated fatty acids such as linoleic acid (Savello *et al.*, 1980), 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 polygenes 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 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 30 germplasm lines of okra. All germplasm lines were evaluated in a randomized block design with three replications at the Vegetable Research Farm, College of Horticulture, Rajendranagar, Hyderabad, during *rabi*, 2015-16. 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, internodal length, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit,100 seed weight, number of pickings, ascorbic acid content, crude fibre content, protein content, iodine content and yellow vein mosaic virus disease infestation and fruit yield per plant.

Correlation coefficient analysis

Simple correlation coefficients between yield and yield components and inter correlation 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 (1961).

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, internodal length, last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings and iodine 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 Bendale *et al.,* (2003), Jaiprakashnarayan and Mulge (2004), Somasekhar *et al.,* (2011) 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) and Yonus *et al.,* (2014) in okra. The results of the present study also revealed negative association of fruit yield per plant with internodal length and days to first flowering. These results corroborate the findings of Reddy *et al.,* (2013) and Simon *et al.,* (2013) in okra.

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, internodal length, last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings, ascorbic acid and iodine content. Reddy *et al.,* (2013) also observed positive and significant correlation of plant height with internodal length, fruit length and number of fruits per plant in okra. while it exhibited negative and significant correlation with days to first flowering, days to 50% flowering, days to first harvest and yellow vein mosaic virus disease incidence per cent. 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 internodal length, last harvest, fruit length, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings and iodine content. Internodal length showed positive and significant correlation with last harvest, fruit length, fruit weight, number of fruits per plant, number of seeds per fruit, number of pickings and iodine content (Table 1). 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 and days to last harvest. Days to 50% flowering showed significant positive correlation with days to first harvest. Days to last harvest showed positive and significant correlation with fruit girth, fruit weight, number of fruits per plant, 100 seed weight and number of pickings. Similar results were reported by Simon *et al.,* (2013). Fruit length showed positive and significant correlation with fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings and iodine content, while it exhibited negative and significant correlation with crude fibre content and protein content. Similar results were reported by Singh *et al.,* (2006) and Reddy *et al.,* (2013).

Fruit girth showed positive and significant correlation with fruit weight, number of fruit per plant, number pickings and ascorbic acid 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 number of fruits per plant, number of seeds per fruit, 100 seed weight, number of pickings and iodine content, which was accordance with the findings of Yonus *et al.,* (2014).

Number of fruits per plant showed positive and significant correlation with number of seeds per fruit, 100 seed weight, number pickings and ascorbic acid content.

Number of seeds per fruit showed positive and significant correlation with 100 seed weight, number pickings and iodine content. Number pickings showed positive and significant correlation with ascorbic acid content and iodine content. Similar results were reported by Singh *et al.,* (2006), Bendale *et al.,* (2003), Reddy *et al.,* (2013), Simon *et al.,* (2013), Yonus *et al.,* (2014), Niranjan and Mishra (2003).

Ascorbic acid content exhibited positive and significant correlation with crude fibre content, protein content and iodine content. Crude fibre content exhibited positive and significant correlation with protein content and iodine content. Similar results were reported by Das *et al.,* (2012).

Further, it indicates plant height, number of branches per plant, internodal 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 and iodine 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. Plant height, internodal length, days to 50% flowering, days to last harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and iodine content showed positive direct effect on fruit yield per plant.

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

Characters		Plant height (cm)	No. of branches per plant	Internodal 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	Ascorbic acid (mg/ 100g)	Crude fibre content (%)	Protein content (mg/100g)	Iodine content (mg/100g)	YVMV DIP (%)	Fruit yield per plant (g)
Plant height (cm)	P	**1.0000**	0.7778 **	0.3676 **	-0.5410 **	-0.5241 **	-0.5577 **	0.6211 **	0.2644 *	0.2207 *	0.6704 **	0.7225 **	0.4837 **	0.4734 **	0.7082 **	0.1694	0.0064	0.0302	0.3806 **	-0.5213 **	0.7160 **
	G	**1.0000**	0.8662 **	0.4200 **	-0.7339 **	-0.6352 **	-0.7305 **	0.6965 **	0.2914 **	0.2362 **	0.7152 **	0.7946 **	0.5080 **	0.5069 **	0.7746 **	0.1695	0.0091	0.0505	0.4118 **	-0.5513 **	0.7599 **
Number of branches per plant	P		**1.0000**	0.5129 **	-0.5974 **	-0.5682 **	-0.6190 **	0.6977 **	0.3641 **	0.1460	0.7907 **	0.7750 **	0.5664 **	0.4425 **	0.7872 **	0.2028	-0.0672	0.0091	0.4468 **	-0.5555 **	0.7977 **
	G		**1.0000**	0.5632 **	-0.6653 **	-0.6159 **	-0.6796 **	0.7497 **	0.3926 **	0.1585	0.8349 **	0.8296 **	0.5974 **	0.4693 **	0.8445 **	0.2209	-0.0713	0.0092	0.4539 **	-0.5827 **	0.8365 **
Intermodal length (cm)	P			**1.0000**	-0.3694 **	-0.3701 **	-0.3681 **	0.2732 **	0.5426 **	-0.1619	0.5258 **	0.4505 **	0.4989 **	0.1162	0.4994 **	0.0207	-0.2779 **	-0.2585 *	0.3837 **	-0.3295 **	0.5007 **
	G			**1.0000**	-0.4401 **	-0.4308 **	-0.4355 **	0.3326 **	0.5902 **	-0.1865	0.5644 **	0.4903 **	0.5429 **	0.1197	0.5560 **	0.0303	-0.2910 **	-0.2822 *	0.4152 **	-0.3490 **	0.5332 **
Days to first flowering	P				**1.0000**	0.9362 **	0.9763 **	-0.3380 **	-0.2142 *	-0.3154 **	-0.5843 **	-0.4804 **	-0.4790 **	-0.3333 **	-0.4671 **	-0.0775	-0.0195	-0.0526	-0.2970 **	0.5939 **	-0.4971
	G				**1.0000**	0.9920 **	0.9811 **	-0.4037 **	-0.2495 *	-0.3634 **	-0.6699 **	-0.6228 **	-0.5551 **	-0.3903 **	-0.5876 **	-0.0954	-0.0232	-0.0673	-0.3436 **	0.6915 **	-0.5725
Days to 50% flowering	P					**1.0000**	0.9470 **	-0.2964 **	-0.2359 *	-.03080	-0.5663 **	-0.5678 **	-0.4906 **	-0.3204 **	-0.4701 **	-0.1886	-0.0670	-0.1135	-0.3411 **	0.6476 **	-0.5028
	G					**1.0000**	0.9930 **	-0.3190 **	-0.2451 *	-0.3342	-0.5989 **	-0.6425 **	-0.5239 **	-0.3422 **	-0.5382 **	-0.2095	-0.0689	-0.1228	-0.3619 **	0.6925 **	-0.5357
Days to first harvest	P						**1.0000**	-0.3380 **	-0.2107 *	-0.2927 **	-0.5689 **	-0.5406 **	-0.4873 **	-0.3827 **	-0.4697 **	-0.1359	-0.1033	-0.1342	-0.3240 **	0.6292 **	-0.5020
	G						**1.0000**	-0.3994 **	-0.2351 *	-0.3335 **	-0.6384 **	-0.6750 **	-0.5489 **	-0.4356 **	-0.5730 **	-0.1590	-0.1180	-0.1593	-0.3642	0.7117 **	-0.5618
Days to last harvest	P							**1.0000**	0.1398	0.3151 **	0.7172 **	0.5964 **	0.2010	0.2318 *	0.7579 **	0.0747	-0.0562	0.0795	0.1719	-0.3798 **	0.7384 *
	G							**1.0000**	0.1512	0.3435 **	0.7690 **	0.6451 **	0.2155	0.2471 *	0.8404 **	0.0791	-0.0585	0.0898	0.1828	-0.4026 **	0.7860 *
Fruit length (cm)	P								**1.0000**	-0.0838	0.3987 **	0.3725 **	0.5435 **	0.3545 **	0.3523 **	0.0696	-0.2514 *	-0.3241 **	0.4972 **	-0.3311 **	0.4670 **
	G								**1.0000**	-0.0868	0.4039 **	0.3963 **	0.5592 **	0.3614 **	0.3730 **	0.0697	-0.2551 *	-0.3298 **	0.5098 **	-0.3359 **	0.4753 **
Fruit girth (cm)	P									**1.0000**	0.3604 **	0.2727 **	-0.2118	0.1003	0.3268 **	0.2212 *	0.1362	0.0673	-0.0314	-0.4429 **	0.3452 **
	G									**1.0000**	0.3700 **	0.2921 **	-0.2150	0.1018	0.3469 **	0.2268 *	0.1381	0.0683	-0.0263	-0.4487 **	0.3513 **

Fruit weight (g)	P										**1.0000**	0.6923**	0.3932**	0.2406*	0.7907**	-0.042	-0.281	-0.154	0.2200*	-0.518	0.921
	G										**1.0000**	0.7438**	0.4009**	0.2435*	0.8262**	-0.046	-0.285	-0.149	0.2258*	-0.522	0.931
Number of fruits per plant	P											**1.0000**	0.4438**	0.3812**	0.8029**	0.4217**	0.0146	0.0847	0.5717**	-0.602	0.843
	G											**1.0000**	0.4773**	0.4009**	0.8658**	0.4529**	0.0191	0.0880	0.5818**	-0.631	0.888
Number of seeds per fruit	P												**1.0000**	0.4966**	0.4277**	0.0811	0.0473	-0.226	0.4263**	-0.196	0.402
	G												**1.0000**	0.5026**	0.4534**	0.0813	0.0474	-0.226	0.4375**	-0.198	0.406
100 seed weight (g)	P													**1.0000**	0.2756**	0.2510*	0.2134*	-0.009	0.2815**	-0.338	0.271
	G													**1.0000**	0.2852**	0.2548*	0.2138*	-0.009	0.2840**	-0.339	0.273
Total number of picking	P														**1.0000**	0.3139**	-0.151	-0.132	0.4487**	-0.589	0.853
	G														**1.0000**	0.3350**	-0.158	-0.136	0.4700**	-0.613	0.890
Ascorbic acid content (mg/100g)	P															**1.0000**	0.2074*	0.3011**	0.4611**	-0.450	0.129
	G															**1.0000**	0.2101*	0.3071**	0.4745**	-0.453	0.131
Crude fibre content (%)	P																**1.0000**	0.3375**	-0.025	-0.073	-
	G																**1.0000**	0.3429**	-0.025	-0.073	-
Protein content (mg/100g)	P																	**1.0000**	-0.092	-0.086	-
	G																	**1.0000**	-0.095	-0.087	-
Iodine content (mg/100g)	P																		**1.0000**	-0.415	0.389
	G																		**1.0000**	-0.419	0.394
YVMV disease incidence (%)	P																			**1.0000**	-
	G																			**1.0000**	-
Fruit yield per plant (g)	P																				**1.000**
	G																				**1.000**

*Significant at 5 per cent level; ** Significant at 1 per cent level

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

Characters		Plant height (cm)	No. of branches per plant	Internodal 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	Total number of picking	Ascorbic acid (mg/ 100g)	Crude fibre content (%)	Protein content (mg/100g)	Iodine (mg/100g)	YVMV DIP (%)	Fruit yield per plant (g)
Plant height (cm)	**P**	**0.0304**	0.0236	0.0112	-0.0164	-0.0159	-0.0169	0.0189	0.0080	0.0067	0.0204	0.0219	0.0147	0.0144	0.0215	0.0051	0.0002	0.0009	0.0116	-0.0158	0.7160**
	G	**-0.2438**	-0.2112	-0.1024	0.1790	0.1549	0.1781	-0.1698	-.0.0711	-0.0576	-0.1744	-0.1938	-0.1239	-0.1236	-0.1889	-0.0412	-0.0022	-0.0123	-0.1004	0.1344	0.7599**
Number of branches per plant	**P**	-0.0790	**-0.1060**	-0.0521	0.0607	0.0577	0.0629	-0.0709	-0.0370	-0.0148	-0.0804	-0.0788	-0.0576	-0.0450	-0.0800	-0.0206	0.0068	-0.0009	-0.0454	0.0565	0.7977**
	G	-0.0756	**-0.0873**	-0.0492	0.0581	0.0538	0.0593	-0.0654	-0.0343	-0.0138	-0.0729	-0.0724	-0.0521	-0.0410	-0.0737	-0.0193	0.0062	-0.0005	-0.0396	0.0509	0.8365**
Intermodal length (cm)	**P**	-0.0269	-0.0375	**-0.0731**	0.0270	0.0271	0.0269	-0.0200	-0.0397	0.0118	-0.0384	-0.0329	-0.0365	-0.0085	-0.0365	-0.0015	0.0203	0.0189	-0.0280	0.0241	0.5007**
	G	0.1274	0.1709	**0.3034**	-0.1335	-0.1307	-0.1321	0.1009	0.1791	-0.0566	0.1713	0.1487	0.1647	0.0363	0.1687	0.0092	-0.0883	-0.0856	0.1260	-0.1059	0.5332**
Days to first flowering	**P**	0.0796	0.0879	0.0543	**-0.1471**	-0.1377	-0.1436	0.0497	0.0315	0.0464	0.0860	0.0707	0.0705	0.0490	0.0687	0.0114	0.0029	0.0077	0.0437	-0.0874	-0.4971
	G	1.9712	1.7869	1.1821	**-2.6858**	-2.6644	-2.6351	1.0843	0.6700	0.9761	1.7992	1.6727	1.4908	1.0484	1.5782	0.2563	0.0623	0.1808	0.9228	-1.8573	-0.5725
Days to 50% flowering	**P**	-0.1471	-0.1595	-0.1039	0.2628	**0.2807**	0.2658	-0.0832	-0.0662	-0.0865	-0.1590	-0.1594	-0.1377	-0.0899	-0.1320	-0.0529	-0.0188	-0.0318	-0.0957	0.1818	-0.5028
	G	0.0801	0.0777	0.0543	-0.1251	**-0.1261**	-0.1252	0.0402	0.0309	0.0421	0.0755	0.0810	0.0661	0.0431	0.0679	0.0264	0.0087	0.0155	0.0456	-0.0873	-0.5357
Days to first harvest	**P**	0.0048	0.0053	0.0032	-0.0084	-0.0081	**-0.0086**	0.0029	0.0018	0.0025	0.0049	0.0046	0.0042	0.0033	0.0040	0.0012	0.0009	0.0012	0.0028	-0.0054	-0.5020
	G	-2.5289	-2.3526	-1.5076	3.3965	3.4375	**3.4619**	-1.3825	-0.8137	-1.1544	-2.2101	-2.3368	-1.9004	-1.5080	-1.9835	-0.5505	-0.4086	-0.5514	-1.2609	2.4640	-0.5618
Days to last harvest	**P**	0.0627	0.0704	0.0276	-0.0341	-0.0299	-0.0341	**0.1009**	0.0141	0.0318	0.0724	0.0602	0.0203	0.0234	0.0765	0.0075	-0.0057	0.0080	0.0173	-0.0383	0.7384*
	G	1.0423	1.1219	0.4977	-0.6042	-0.4774	-0.5976	**1.4965**	0.2263	0.5140	1.1508	0.9654	0.3225	0.3697	1.2576	0.1174	-0.0876	0.1344	0.2436	-0.6024	0.7860*
Fruit length (cm)	**P**	0.0258	0.0356	0.0530	-0.0209	-0.0231	-0.0206	0.0137	**0.0978**	-0.0082	0.0390	0.0364	0.0531	0.0347	0.0344	0.0068	-0.0246	-0.0317	0.0486	-0.0324	0.4670**
	G	-0.0854	-0.1150	-0.1729	0.0731	0.0718	0.0689	-0.0443	**-0.2929**	0.0254	-0.1183	-0.1161	-0.1638	-0.1059	-0.1093	-0.0203	0.0747	0.0966	-0.1494	0.0984	0.4753**
Fruit girth (cm)	**P**	0.0039	0.0026	-0.0029	-0.0056	-0.0054	-0.0052	0.0056	-0.0015	**0.0177**	0.0064	0.0048	-0.0037	0.0018	0.0058	0.0039	0.0024	0.0012	-0.0006	-0.0078	0.3452**
	G	0.0568	0.0381	-0.0449	-0.0875	-0.0804	-0.0803	0.0827	-0.0209	**0.2407**	0.0891	0.0703	-0.0518	0.0245	0.0835	0.0546	0.0332	0.0164	-0.0063	-0.1080	0.3513**

Fruit weight(g)	P	0.3876	0.4572	0.3040	-0.3378	-0.3274	-0.3289	0.4147	0.2305	0.2084	**0.5782**	0.4003	0.2273	0.1391	0.4572	-0.0247	-0.1629	-0.0891	0.1272	-0.2997	0.9214**
	G	-0.1593	-0.1860	-0.1257	0.1492	0.1334	0.1422	-0.1713	-0.0900	-0.0824	**-0.2227**	-0.1657	-0.0893	-0.0542	-0.1840	0.0103	0.0635	0.0333	-0.0503	0.1164	0.9317**
Number of fruits per plant	P	0.3525	0.3781	0.2198	-0.2344	-0.2770	-0.2638	0.2910	0.1817	0.1330	0.3377	**0.4879**	0.2165	0.1860	0.3917	0.2057	0.0071	0.0413	0.2789	-0.2938	0.8430**
	G	1.9529	2.0389	1.2048	-1.5306	-1.5790	-.6589	1.5855	0.9740	0.7179	1.8280	**2.4576**	1.1730	0.9853	2.1278	1.1131	0.0470	0.1672	1.4299	-1.5525	0.8883**
Number of seeds per fruit	P	0.0295	0.0346	0.0305	-0.0292	-0.0300	-0.0298	0.0123	0.0332	-0.0129	0.0240	0.0271	**0.0611**	0.0303	0.0261	0.0050	0.0029	-0.0138	0.0260	-0.0120	0.4027**
	G	0.3368	0.3960	0.3599	-0.3680	-0.3473	-0.3639	0.1429	0.3707	-0.1426	0.2658	0.3164	**0.6629**	0.3332	0.3005	0.0536	0.0311	-0.1502	0.2900	-0.1319	0.4067**
100 seed weight (g)	P	-0.0343	-0.0320	-0.0084	0.0241	0.0232	0.0277	-0.0168	-0.0257	-0.0073	-0.0174	-0.0276	-0.0360	**-0.0724**	-0.0200	-0.0182	-0.0155	0.0007	-0.0204	0.0245	0.2715**
	G	-0.0656	-0.0607	-0.0155	0.0505	0.0443	0.0563	-0.0320	-0.0467	-0.0132	-0.0315	-0.0519	-0.0650	**-0.1294**	-0.0369	-0.0330	-0.0277	0.0012	-0.0367	0.0469	0.2734**
Total number of picking	P	-0.0123	-0.0137	-0.0087	0.0081	0.0082	0.0082	-0.0132	-0.0061	-0.0057	-0.0138	-0.0140	-0.0075	-0.0048	**-0.0174**	-0.0055	0.0026	0.0023	-0.0078	0.0103	0.8536**
	G	-1.9860	-2.1650	-1.4250	1.5065	1.3799	1.4689	-2.1546	-0.9563	-0.8891	-2.1182	-2.2198	-1.1623	-0.7311	**-2.5638**	-0.8590	0.4051	0.3490	-1.2051	1.5722	0.8909**
Ascorbic acid content (mg/100g)	P	-0.0030	-0.0036	-0.0004	0.0014	0.0034	0.0024	-0.0013	-0.0013	-0.0040	0.0008	-0.0076	-0.0015	-0.0045	-0.0056	**-0.0180**	-0.0037	-0.0054	-0.0083	-0.0081	0.1290*
	G	-0.0258	-0.0337	-0.0046	0.0145	0.0319	0.0242	-0.0121	-0.0106	-0.0346	0.0070	-0.0690	-0.0123	-0.0388	-0.0511	**-0.1524**	-0.0320	-0.0468	-0.0723	0.0692	0.1312*
Crude fibre content (%)	P	-0.0004	0.0043	0.0176	0.0012	0.0042	0.0066	0.0036	0.0159	-0.0086	0.0179	-0.0009	-0.0030	-0.0135	0.0096	-0.0132	**-0.0634**	-0.0214	0.0016	0.0047	-0.2440
	G	-0.0028	0.0222	0.0904	0.0072	0.0214	0.0367	0.0182	0.0793	-0.0429	0.0886	-0.0059	-0.0146	-0.0664	0.0491	-0.0653	**-0.3107**	-0.1066	0.0078	0.0229	-0.2447
Protein content (mg/100g)	P	-0.0001	0.0000	0.0010	0.0002	0.0004	0.0005	-0.0003	0.0012	-0.0003	0.0006	-0.0003	0.0009	0.0000	0.0005	-0.0011	-0.0013	**-0.0038**	0.0003	0.0003	-0.1093*
	G	-0.0113	-0.0014	0.0631	0.0151	0.0275	0.0356	-0.0201	0.0738	-0.0153	0.0334	-0.0152	0.0507	0.0020	0.0305	-0.0687	-0.0767	**-0.2237**	0.0214	0.0195	-0.1095*
Iodine content (mg/100g)	P	0.0018	0.0021	0.0018	-0.0014	-0.0016	-0.0015	0.0008	0.0023	-0.0001	0.0010	0.0027	0.0020	0.0013	0.0021	0.0021	-0.0001	-0.0004	**0.0046**	-0.0019	0.3896*
	G	-0.0349	-0.0384	-0.0351	0.0291	0.0306	0.0308	-0.0138	-0.0431	0.0022	-0.0191	-0.0492	-0.0370	-0.0240	-0.0398	-0.0402	0.0021	0.0081	**-0.0846**	0.0355	0.3949*
YVMV disease incidence (%)	P	0.0415	0.0442	0.0262	-0.0473	-0.0516	-0.0501	0.0302	0.0264	0.0353	0.0413	0.0480	0.0156	0.0269	0.0469	0.0359	0.0059	0.0068	0.0331	**-0.0796**	-0.5640
	G	0.4118	0.4353	0.2607	-0.5166	-0.5173	-0.5317	0.3007	0.2509	0.3352	0.3903	0.4719	0.1486	0.2533	0.4581	0.3391	0.0550	0.0653	0.3134	**-0.7470**	-0.5652
Phenotypic Residual effect = 0.19; Genotypic Residual effect=0.08; Diagonal (under lined) values indicate direct effects																					

This observation was in agreement with the results of Reddy *et al.,* (2013) and Yonus *et al.,* (2014).

Days to first flowering showed very high positive indirect effect through fruit weight, number of fruits per plant, number of seeds per fruit, 100 seed weight and total number of pickings also exhibited high positive indirect effect on fruit yield per plant. Number of fruits per plant showed very high positive indirect effect through plant height, number of branches, internodal length, days to last harvest, fruit weight, number of seeds per fruit and number of pickings also exhibited high positive indirect effect on fruit yield per plant (Table 2). This observation was in agreement with the results of Alam and Hossain (2006), Adiger *et al.,* (2011), Das *et al.,* (2012) 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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