Songklanakarin J. Sci. Technol.
35 (3), 243-250, May - Jun. 2013

SONGKLANAKARIN JOURNAL OF SCIENCE AND TECHNOLOGY
http://www.sjst.psu.ac.th

Original Article

Correlation and path coefficient analysis of quantitative characters in okra (*Abelmoschus esculentus* (L.) Moench)

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Received 28 February 2012; Accepted 9 April 2013

Abstract

One hundred germplasm lines of okra (*Abelmoschus esculentus* (L.) Moench) were evaluated in a randomized block design with two replications at the Vegetable Research Station, Rajendranagar, Hyderabad, Andhra Pradesh, India, during *kharif*, 2008. Correlation and path coefficient analysis were carried out to study the character association and contribution, respectively, for thirteen quantitative characters, namely plant height (cm), number of branches per plant, internodal length (cm), days to 50% flowering, first flowering node, first fruiting node, fruit length (cm), fruit width (cm), fruit weight (g), total number of fruits per plant, number of marketable fruits per plant, total yield per plant (g) and marketable yield per plant (g) for the identification of appropriate selection indices. Phenotypic and genotypic correlation coefficient analysis revealed that plant height, fruit length, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant and total yield per plant had significant positive correlation, while number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node had significant negative correlation with marketable yield per plant. Genotypic path coefficient analysis revealed that fruit weight, total number of fruits per plant and number of marketable fruits per plant had positively high direct effect on marketable pod yield per plant. Correlation and path coefficient analyses revealed that fruit weight, total number of fruits per plant and number of marketable fruits per plant not only had positively significant association with marketable pod yield per plant, but also had positively high direct effect on marketable pod yield per plant and are regarded as the main determinants of marketable pod yield per plant. The improvement in marketable pod yield per plant will be efficient, if the selection is based on fruit weight, total number of fruits per plant and number of marketable fruits per plant.

Keywords: character association, character contribution, okra germplasm lines, pod yield, yield components

1. 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.*,

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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). Path coefficient analysis permits the separation of correlation coefficient into direct and indirect effects. It is basically a standardized partial regression analysis and deals with a closed system of variables that are linearly related. Such information provides a realistic basis for allocation of appropriate weightage to various yield components.

In okra, correlation and path coefficient analyses have been used by several researchers to measure the associations between yield and other traits and to clarify interrelationships between pod yield and other traits, respectively. Highly significant associations of pod yield were observed with plant height (Bello *et al*., 2006; Mehta *et al*., 2006; Patro and Sankar, 2006; Somashekhar *et al*., 2011), number of branches per plant (Mehta *et al*., 2006; Patro and Sankar, 2006; Singh *et al*., 2006; Rashwan, 2011; Somashekhar *et al*., 2011), internodal length (Mohapatra *et al*., 2007; Somashekhar *et al*., 2011), days to 50% flowering (Bello *et al*., 2006; Mehta *et al*., 2006; Singh *et al*., 2006; Rashwan, 2011; Somashekhar *et al*., 2011), first flowering node (Jaiprakashnarayan and Mulge, 2004; Singh *et al*., 2006), first fruiting node (Jaiprakashnarayan and Mulge, 2004), fruit length (Bendale *et al*., 2003; Jaiprakashnarayan and Mulge, 2004; Mehta *et al*., 2006; Patro and Sankar, 2006; Singh *et al*., 2006; Pal *et al*., 2008; Somashekhar *et al*., 2011), fruit width (Mohapatra *et al*., 2007; Pal *et al*., 2008; Rashwan 2011; Somashekhar *et al*., 2011), fruit weight (Bendale *et al*., 2003; Jaiprakashnarayan and Mulge, 2004; Mehta *et al*., 2006; Patro and Sankar, 2006; Singh *et al*., 2006; Mohapatra *et al*., 2007; Pal *et al*., 2008; Rashwan, 2011; Somashekhar *et al*., 2011), and total number of fruits per plant (Bendale *et al*., 2003; Jaiprakashnarayan and Mulge, 2004; Bello *et al*., 2006; Singh *et al*., 2006; Mohapatra *et al*., 2007; Pal *et al*., 2008; Rashwan, 2011; Somashekhar *et al*., 2011). Pod yield has been reported to be influenced by strong direct effects of plant height (Mehta *et al*., 2006), number of branches per plant (Mehta *et al*., 2006), internodal length (Mohapatra *et al*., 2007), fruit length (Mehta *et al*., 2006; Patro and Sankar, 2006), fruit weight (Jaiprakashnarayan and Mulge, 2004; Mehta *et al*., 2006; Patro and Sankar, 2006), and total number of fruits per plant (Jaiprakashnarayan and Mulge, 2004; Patro and Sankar, 2006; Mohapatra *et al*., 2007). Plant height, number of branches per plant, internodal length, fruit length, fruit weight and number of fruits per plant were identified as potential selection criteria in breeding programs aiming at higher yield.

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.

2. Materials and Methods

Experimental material comprised 100 germplasm lines of okra. All germplasm lines were evaluated in a randomized block design with two replications at the Vegetable Research Station, Rajendranagar, Hyderabad, Andhra Pradesh, India, during *kharif*, 2008. Each line was grown in a single-row plot of 3 m length and 60 cm width. Rows were spaced at 60 cm, while plants were spaced at 30 cm in the rows so as to accommodate 10 plants per plot, row and genotype. 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 (cm), number of branches per plant, internodal length (cm), fruit length (cm), fruit width (cm) and fruit weight (g) and on whole plot basis for days to 50% flowering, first flowering node, first fruiting node, total number of fruits per plant, number of marketable fruits per plant, total yield per plant (g) and marketable yield per plant (g). The mean for each trait over two replications was computed for each genotype and analyzed statistically. The analysis was carried out by applying standard statistical techniques for analysis of variance to establish significance level among genotypes as described by Singh and Chaudhary (1985) and Steel and Torrie (1980). The correlation coefficient analysis was performed according to the method suggested by Weber and Moorthy (1952). Path coefficient analysis was carried out following the methods of Singh and Chaudhary (1985) and Steel and Torrie (1980).

3. Results and Discussion

Complex characteristics such as yield must be related to many individually distinguishable characteristics. It is obvious that fruit yield is a complex character that depends up on many independent yield contributing characters, which are regarded as yield components. All changes in the components need not however, be expressed by changes in yield. This is due to varying degree of positive and negative associations between yield and its components and among components themselves. Therefore, selection should be based on these component characters after assessing their association with fruit yield per plant.

3.1 Correlation coefficient analysis

From the perusal of the estimates of phenotypic and genotypic coefficients of variation (Table 1), in general, it was observed that estimates of genotypic correlation coefficients were in most cases higher than their corresponding phenotypic correlation coefficients. The present findings are in consonance with the earlier findings of Akinyele and Osekita (2006), Bello *et al*. (2006), Mehta *et al*. (2006), Rashwan (2011) and Somashekhar *et al*. (2011). More significant genotypic association between the different pairs of characters than the phenotypic correlation means that there is strong association between those characters genetically, but the phenotypic value is lessened by the significant interaction of environment.

Plant height, number of branches per plant and internodal length largely determine the fruit bearing surface and thus are considered as growth attributes. Okra bears pods at almost all nodes on main stem. The higher the plant height, as the higher is the number of fruits per plant because of accommodation of a greater number of nodes for a given internodal length. A shorter distance between nodes accommodates a greater number of nodes on the main stem, which will ultimately lead to higher fruit number and higher fruit production. In the present study, plant height had significant positive correlation with internodal length, fruit length, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant and had significant negative correlation with number of branches per plant, days to 50% flowering, first flowering node and first fruiting node. Similar positive association of fruit yield was reported by Jaiprakashnarayan and Mulge (2004), Bello *et al*. (2006), Dakahe *et al*. (2007) and Somashekhar *et al.* (2011) for plant height, Mehta *et al*. (2006) for number of branches per plant and Singh *et al*. (2006) for fruit length, fruit weight and number of fruits per plant, while negative association of total yield with internodal length was reported by Somashekhar *et al.* (2011), and first flowering and fruiting node was reported by Jaiprakashnarayan and Mulge (2004). Positive association of plant height with internodal length and total number of fruits per plant was reported by Somashekhar *et al.* (2011). Number of branches per plant had significant positive correlation with days to 50% flowering, first flowering node, first fruiting node and had significant negative correlation with plant height, internodal length, fruit length, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant. Mehta *et al*. (2006) also reported negative association of number of branches per plant with total yield per plant in okra. Internodal length had significant positive correlation with plant height and had significant negative correlation with number of branches per plant, first flowering node, first fruiting node, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant. These findings are in agreement with the earlier findings of Somashekhar *et al.* (2011) who also observed positive association between plant height and internodal length. Of these three growth attributes, plant height had positive association, while number of branches per plant and internodal length had negative association with total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable pod yield per plant.

Days to 50% flowering, first flowering node and first fruiting node are the indicators of earliness in okra. Early flowering not only gives early pickings and better returns but also widens the fruiting period of the plant. Flowering and fruiting at lower nodes are helpful in increasing the number of fruits per plant as well as getting early yields. In the present study, days to 50% flowering had significant positive correlation with number of branches per plant, first flowering node and first fruiting node and had significant negative correlation with plant height, fruit length, fruit weight, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant. Positive association of days to 50% flowering with first flowering node and first fruiting node was also reported by Jaiprakashnarayan and Mulge (2004). Somashekhar *et al.* (2011) also observed negative association between days to 50% flowering and fruit yield. First flowering node had significant positive correlation with number of branches per plant, days to 50% flowering and first fruiting node and had significant negative correlation with plant height, internodal length, fruit length, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant. First fruiting node had significant positive correlation with number of branches per plant, days to

Table 1. Phenotypic and genotypic correlation among thirteen quantitative traits of okra

Trait		Plant height (1)	No. of branches/ plant (2)	Internodal length (3)	Days to 50% flowering (4)	First flowering node (5)	First fruiting node (6)	Fruit length (7)	Fruit width (8)	Fruit weight (9)	Total no. of fruits/ plant (10)	No. of marketable fruits/plant (11)	Total yield /plant (12)	Marketable yield /plant (13)
1	r_p	1.000	-0.309**	0.381**	-0.524**	-0.245**	-0.254**	0.316**	0.028	0.041	0.771**	0.747**	0.640**	0.679**
	r_g	1.000	-0.407**	0.394**	-0.590**	-0.271**	-0.278**	0.347**	0.050	0.060	0.788**	0.786**	0.670**	0.700**
2	r_p		1.000	-0.171*	0.354**	0.231**	0.224**	-0.147*	0.100	-0.511	-0.262**	-0.234**	-0.248**	-0.234**
	r_g		1.000	-0.213**	0.473**	0.295**	0.294**	-0.160*	0.084	-0.060	-0.339**	-0.283**	-0.298**	-0.289**
2	r_p			1.000	-0.033	-0.168*	-0.173*	-0.015	-0.177*	-0.173*	-0.220**	-0.202**	-0.246**	-0.227**
	r_g			1.000	-0.051	-0.193**	-0.203**	-0.013	-0.192**	-0.188**	-0.228**	-0.210**	-0.260**	-0.238**
4	r_p				1.000	0.375**	0.382**	-0.234**	0.116	-0.182**	-0.586**	-0.611**	-0.608**	-0.639**
	r_g				1.000	0.413**	0.417**	-0.267**	0.118	-0.209**	-0.652**	-0.661**	-0.660**	-0.705**
5	r_p					1.000	0.996**	-0.179*	0.064	-0.052	-0.375**	-0.365**	-0.319**	-0.335**
	r_g					1.000	1.001**	-0.196**	0.076	-0.064	-0.393**	-0.387**	-0.341**	-0.352**
6	r_p						1.000	-0.180*	0.072	-0.057	-0.377**	-0.366**	-0.323**	-0.339**
	r_g						1.000	-0.197**	0.084	-0.067	-0.396**	-0.390**	-0.346**	-0.355**
7	r_p							1.000	-0.067	0.487**	0.355**	0.339**	0.525**	0.487**
	r_g							1.000	-0.076	0.513**	0.375**	0.359**	0.547**	0.505**
8	r_p								1.000	0.247**	0.127	0.112	0.188**	0.152*
	r_g								1.000	0.383**	0.129	0.106	0.204**	0.155*
9	r_p									1.000	0.161*	0.152*	0.580**	0.484**
	r_g									1.000	0.181**	0.172*	0.622**	0.523**
10	r_p										1.000	0.965**	0.867**	0.904**
	r_g										1.000	0.986**	0.893**	0.907**
11	r_p											1.000	0.844**	0.914**
	r_g											1.000	0.870**	0.930**
12	r_p												1.000	0.963**
	r_g												1.000	0.993**
13	r_p													1.000
	r_g													1.000

r_g = Genotypic correlation coefficient; r_p = Phenotypic correlation coefficient

*, **Significant at the 0.05 and 0.01 probability levels, respectively

50% flowering, first flowering node and had significant negative correlation with plant height, internodal length, fruit length, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant. First flowering node had perfect positive correlation with first fruiting node, indicating a 100 per cent fruit set in the early stages of flowering and fruiting in the material under study. On the whole, all these three earliness attributes showed negative correlation with total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable pod yield per plant.

Fruit length, width, weight and number are considered to be the fruit traits in okra. In the present study, fruit length had significant positive correlation with plant height, fruit weight, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant and had significant negative correlation with number of branches per plant, days to 50% flowering, first flowering node and first fruiting node. Fruit width had significant positive correlation with fruit weight, total yield per plant and marketable yield per plant and had significant negative correlation with internodal length. Fruit weight had significant positive correlation with fruit length, fruit weight, total number of fruits per plant, number of marketable fruits per plant, total yield per plant and marketable yield per plant and had significant negative correlation with internodal length and days to 50% flowering. Total number of fruits per plant had significant positive correlation with plant height, fruit length, fruit weight, number of marketable fruits per plant, total yield per plant and marketable yield per plant and had significant negative correlation with number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node. Number of marketable fruits per plant had significant positive correlation with plant height, fruit length, fruit weight, total number of fruits per plant, total yield per plant and marketable yield per plant and had significant negative correlation with number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node. Fruit length had positive correlation with fruit weight, total yield per plant and marketable yield per plant. All the fruit traits like fruit length, fruit width, fruit weight, total number of fruits per plant and number of marketable fruits per plant showed significant positive association with fruit yield per plant and also among themselves except fruit width. The present findings are in consonance with the earlier findings of Bello *et al*. (2006) and Mehta *et al.* (2006) who also reported positive association of fruit length, fruit weight and total number of fruits per plant with total yield per plant in okra. Positive association of fruit length with fruit weight and total yield per plant was reported by Dakahe *et al*. (2007) and Jaiprakashnarayan and Mulge (2004), respectively.

Total yield per plant had significant positive correlation with plant height, fruit length, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant and marketable yield per plant and had significant negative correlation with number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node. Similar association of total yield per plant was also observed by Somashekhar *et al*. (2011) for plant height, internodal length, fruit length, fruit width, fruit weight and total number of fruits per plant, by Mehta *et al*. (2006) for number of branches per plant, days to 50% flowering and Jaiprakashnarayan and by Mulge (2004) for first flowering node and first fruiting node in okra. Marketable yield per plant had significant positive correlation with plant height, fruit length, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant and total yield per plant and had significant negative correlation with number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node. Similar association of marketable yield per plant was also observed by Pal *et al*. (2008) for fruit length, fruit width, fruit weight, total number of fruits per plant and total yield per plant in okra.

In general, in all the crop plants, negative associations exist between the two important yield components. For example boll number and boll weight in cotton, pod number and pod length in pulses, and grain number per spike and grain size in cereals in general, plant height and internodal length and pod number and pod length in okra, in particular. Breeders tend to break these undesirable negative associations between yield components. The undesirable linkages among such characters may occur due to gene reshuffling and breakage of such linkage could be achieved through bi-parental intermating in the early segregating populations.

3.2 Path coefficient analysis

The estimates of direct and indirect effects of the twelve marketable pod yield related characters on marketable pod yield are presented in Table 2. At phenotypic level, number of branches per plant, internodal length, fruit length and total number of fruits per plant had a negligible positive direct effect, while plant height, days to 50% flowering, first fruiting node and fruit width had a negligible positive direct effect on marketable yield per plant. First flowering node and fruit weight had a low positive direct effect on marketable yield per plant. Number of marketable fruits per plant and total yield per plant had a high positive direct effect on marketable yield per plant. At genotypic level, plant height and number of branches per plant had a negligible positive direct effect, while internodal length, fruit length and fruit width had a negligible negative direct effect on marketable yield per plant. Days to 50% flowering had a low negative direct effect on marketable yield per plant. Fruit weight, total number of fruits per plant and number of marketable fruits per plant had a high positive direct effect, while total yield per plant had a high negative direct effect on marketable pod yield per plant. First flowering node and first fruiting node had a high negative and a high positive direct effect on marketable pod yield per plant, respectively. These findings

Table 2. Direct (diagonal) and indirect (off diagonal) effects of quantitative traits on marketable pod yield of okra

Trait		Plant height (1)	No. of branches/ plant (2)	Internodal length (3)	Days to 50% flowering (4)	First flowering node (5)	First fruiting node (6)	Fruit length (7)	Fruit width (8)	Fruit weight (9)	Total no. of fruits/ plant (10)	No. of marketable fruits/plant (11)	Total yield /plant (12)	Correlation coefficient with yield/ plant
1	P	-0.0654	0.0202	-0.0249	0.0343	0.0161	0.0166	-0.0207	-0.0019	-0.0027	-0.0504	-0.0489	-0.0419	0.679**
	G	0.0937	-0.0381	0.0369	-0.0553	-0.0254	-0.0260	0.0325	0.0047	0.0056	0.0739	0.0737	0.0628	0.700**
2	P	-0.0048	0.0157	-0.0027	0.0055	0.0036	0.0035	-0.0023	0.0016	-0.0008	-0.0041	-0.0037	-0.0039	-0.234**
	G	-0.0086	0.0211	-0.0045	0.0100	0.0062	0.0062	-0.0034	0.0018	-0.0013	-0.0072	-0.0060	-0.0063	-0.289**
2	P	0.0186	-0.0083	0.0489	-0.0016	-0.0082	-0.0085	-0.0007	-0.0086	-0.0084	-0.0107	-0.0099	-0.0120	-0.227**
	G	-0.0197	0.0107	-0.0501	0.0026	0.0097	0.0102	0.0007	0.0096	0.0094	0.0114	0.0105	0.0130	-0.238**
4	P	0.0261	-0.0176	0.0016	-0.0498	-0.0187	-0.0190	0.0116	-0.0058	0.0091	0.0291	0.0304	0.0303	-0.639**
	G	0.0958	-0.0768	0.0083	-0.1622	-0.0670	-0.0676	0.0432	-0.0191	0.0338	0.1057	0.1073	0.1064	-0.705**
5	P	-0.0248	0.0234	-0.0169	0.0379	-0.1010	0.1006	-0.0181	0.0065	-0.0053	-0.0378	-0.0369	-0.0322	-0.335**
	G	0.3103	-0.3383	0.2217	-0.4735	-1.1465	-1.1471	0.2242	-0.0871	0.0728	0.4507	0.4440	0.3904	-0.352**
6	P	0.0184	-0.0162	0.0125	-0.0276	-0.0720	-0.0723	0.0130	-0.0052	0.0041	0.0273	0.0264	0.0234	-0.339**
	G	-0.3253	0.3441	-0.2370	0.4878	1.1707	1.1700	-0.2307	0.0982	-0.0780	-0.4628	-0.4562	-0.4051	-0.355**
7	P	0.0032	-0.0015	0.0002	-0.0024	-0.0018	-0.0019	0.0103	-0.0007	0.0050	0.0036	0.0035	0.0054	0.487**
	G	-0.0020	0.0009	0.0001	0.0015	0.0011	0.0011	-0.0057	0.0004	-0.0029	-0.0021	-0.0020	-0.0031	0.505**
8	P	-0.0005	-0.0018	0.0032	-0.0021	-0.0012	-0.0013	0.0012	-0.0178	-0.0044	-0.0023	-0.0020	-0.0033	0.152*
	G	-0.0031	-0.0051	0.0118	-0.0072	-0.0047	-0.0051	0.0046	-0.0612	-0.0173	-0.0079	-0.0065	-0.0125	0.155**
9	P	0.0072	-0.0091	-0.0306	-0.0323	-0.0093	-0.0100	0.0864	0.0439	-0.1774	0.0285	0.0269	0.1028	0.484**
	G	0.0497	-0.0498	-0.1558	-0.1728	-0.0526	-0.0552	0.4251	0.2347	0.8288	0.1503	0.1427	0.5159	0.523**
10	P	0.0636	-0.0216	-0.0181	-0.0483	-0.0309	-0.0311	0.0292	0.0105	0.0133	0.0825	0.0796	0.0716	0.904**
	G	0.3921	-0.1688	-0.1134	-0.3241	-0.1955	-0.1968	0.1863	0.0641	0.0902	0.4974	0.4906	0.4441	0.907**
11	P	0.3997	-0.0252	-0.1082	-0.3270	-0.1953	-0.1958	0.1814	0.0601	0.0811	0.5162	0.5351	0.4517	0.914**
	G	0.7418	-0.2672	-0.1979	-0.6241	-0.3654	-0.3679	0.3386	0.0996	0.1625	0.9306	0.9435	0.8208	0.930**
12	P	0.2379	-0.0921	-0.0913	-0.2260	-0.1186	-0.1201	0.1952	0.0697	0.2154	0.3223	0.3137	0.3716	0.963**
	G	-0.6252	0.2785	0.2421	0.6121	0.3178	0.3231	-0.5102	-0.1904	-0.5808	-0.8331	-0.8118	-0.9332	0.993**

G= Genotypic; P= Phenotypic

*, **Significant at the 0.05 and 0.01 probability levels, respectively

are in consonance with those of Jaiprakashnarayan and Mulge, (2004); Mehta *et al*. (2006) and Patro and Sankar (2006) for fruit weight and Jaiprakashnarayan and Mulge (2004), Patro and Sankar (2006) and Mohapatra *et al*. (2007) for total number of fruits per plant.

The genotypic direct effect of fruit weight and number of marketable fruits per plant on marketable yield per plant was almost equal to their genotypic correlation coefficient with marketable yield per plant (Table 2). Thus correlation explains the true relationship between fruit weight and marketable yield per plant and number of marketable fruits per plant and marketable yield per plant and direct selection through these traits will be effective. The genotypic path coefficient analysis revealed that first fruiting node had the maximum positive direct effect on marketable yield per plant, though their association was significantly negative. Under these circumstances, a restricted simultaneous selection model is to be followed i.e. restrictions are to be imposed to nullify the undesirable indirect effects via number of branches per plant, days to 50% flowering, first flowering node and fruit width to make use of the direct effect. The genotypic correlation coefficient of total yield per plant, fruit length and fruit width with marketable yield per plant was positive, but their direct effect was negative or negligible (Table 2). Though total yield per plant exhibited significant positive genotypic correlation with marketable yield per plant, it showed high negative direct effect on marketable yield per plant. However, indirect effect of total yield per plant via number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node was observed to be positive and moderate to high in magnitude resulting in a significant positive association with marketable yield per plant. In such a situation, the indirect effects seem to be the cause of correlation and thus the indirect casual factors are to be considered simultaneously for selection.

The residual factor determines how best the casual factors account for the variability of the dependent factor, the marketable pod yield per plant in this case. The residual effects were 0.1638 and 0.0646, which were of low and negligible magnitude at phenotypic and genotypic levels, respectively. The variables studied explain about 83.62% and 93.54% of the variability at phenotypic and genotypic levels, respectively in the marketable pod yield per plant.

In conclusion, the correlation coefficient analysis of thirteen quantitative traits revealed strong association among growth, earliness and yield parameters of okra under study. Marketable yield per plant had significant positive genotypic correlation with plant height, fruit length, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant and total yield per plant and had significant negative correlation with number of branches per plant, internodal length, days to 50% flowering, first flowering node and first fruiting node. Path coefficient analyses revealed that fruit weight, total number of fruits per plant and number of marketable fruits per plant had strong influence on marketable pod yield per plant and are the main determiners of marketable pod yield per plant. The improvement in marketable pod yield per plant will be efficient if the selection is based on fruit weight, total number of fruits per plant and number of marketable fruits per plant.

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