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Correlation and Path Analysis Studies in Okra (*Abelmoschus esculentus* L.) Genotypes

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ABSTRACT: The Present experiment was conducted on study of correlation and path analysis in okra (*Abelmoschus esculentus* L.) Genotypes was carried out during *Rabi* season are sown in October month, in the year 2021-22. The study was under taken on 37 genotypes of okra using randomized block design (RBD) with three replications. From correlation studies , it was observed from that fruit yield per plant registered positive significant correlation plant height (0.7038 P, 0.7191 G), number of primary branches (0.6308 P, 0.6529 G), internodal length (0.5986 P, 0.6255 G), fruit length (0.3727 P, 0.3883 G), number of seeds per fruit (0.4039 P, 0.4258 G), number of fruits per plant (0.7977 P, 0.8229 G), seeds weight per fruit (0.3750 P, 0.3942 G), test weight (0.3575 P, 0.3704 G), germination percent (0.3096 P, 0.3356 G), seedling dry weight (0.2877 P, 0.2966 G), vigour index I (0.2764 P, 0.2955 G), vigour index II (0.3669 P, 0.3823 G) and chlorophyll content (0.7795 P, 0.8005 G) were also recorded. The results of a Path analysis showed that the following characters had a positive direct effect on pod yield per plant, plant height, fruit length, fruit diameter, number of fruits per plant, seeds weight per fruit, test weight, germination (%), seedling length, vigour index II, and chlorophyll content.

Keywords: Okra, genotypes, correlation, path coefficient.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is an annual herbaceous plant belongs to the family "Malavaceae" having a somatic chromosome number of 2n=130 and is considered to be an amphidiploid (Siemonsmo, 1982). It is generally known as 'bhendi' or lady's finger in India. Okra be in an often cross pollinated crop, an extent of 20 per cent out-crossing by insects was reported, which renders a considerable amount of variability (Patil, 1995). It is the best vegetable and is widely cultivated in temperate, tropical, and subtropical regions of the world. It is a costly vegetable produced in India for its tender fruits.

India, the world's largest producer of okra, accounts for roughly 72.9 per cent of global okra production. Okra is grown on an area of 526 hectares in India and contributes 3.9 per cent of nation's total vegetable production. Its annual production is 6,505 million tonnes, and its productivity is 11.90 metric tonnes per hectare. Okra is 11.90 metric tonnes per hectare. Okra is grown on 10,881 hectares in Telangana, with an annual output of 55,054 tonnes per year. The major okra producing states are Andhra Pradesh, West Bengal, Bihar, Orissa, Gujarat, Jharkhand, Karnataka and Tamil Nadu (NHB, 2021).

Tender fruits of okra are used as vegetable or culinary preparation as sliced and fried pieces. The leaves are sometimes used as cattle feed. The ripe seeds are roasted, grinded and used as a substitute for coffee. It is also used for thickening soups and gravies, because of its high mucilage content. Okra fruits are also sliced for sun drying or canning or pickling for off season use. It has good nutritive value *viz*., 86.10 per cent water, 2.20 per cent protein, 0.02 per cent fat, 9.70 per cent carbohydrate, 1.0 per cent fibre and 0.80 per cent ash (Saifullah and Rabbani 2009) and also rich in vitamin C (30 mg /100 g), Calcium (90 mg /100 g) and iron (1.5 mg /100 g) (Pal *et al*., 1952).

Correlation and path coefficient analysis elucidate the intrinsic nature of observed association between yield and its component and reveals the extent of contribution made by different traits in building up the ultimate yield. Correlation measures the relationship between two or more variables and the extent of association is measured by correlation coefficient. Correlation studies provide information that selection for one character will results in progress for all positively correlated characters. This information may be used to direct selection in the construction of selection indices. The utility of estimates of correlation increased by partitioning into phenotypic, genotypic and environmental components (Burton, 1952). Additionally, understanding the genetic association among production characters and between production and other traits helps to increase the effectiveness of favourable combination of characters and reduces the retarding effect of negative correlation. Mishra *et al.* (2016). reported that fruit yield per plant had highly significant and positive association with number of nodes per plant, number of fruits per plant, days to first flowering, internodal length, number of branches per plant and plant height. Saryam *et al.* (2017) evaluated okra genotypes and reported that yield per plant had positive association with fruit diameter, fruit length, number of fruits per plant, fruit weight, number of seeds per fruit and fruit diameter.

Path coefficient analysis helps dives the total correlation into direct and indirect effects and is useful for selecting the most useful traits to be used for yield improvement through selection. By taking use of genetic diversity available in the crop, High yielding okra varieties have been developed. By exploiting the genetic diversity available in the crop. The importance of genetic diversity for selecting parents in combination with breeding of different autogamous crops to obtain transgressive segregants has been very well emphasized by Singh and Ramanujam (1981). Knowledge, nature and magnitude of variation existing in available breeding material are pre-requisite to choose desirable genotypes to undertake planned breeding programme. Kumar *et al*. (2019). Studied sixty eight genotypes of okra for different yield contributing characters and reported that total fruit yield per plant had positive direct effect with fruit girth, number of fruits per plant and internodal distance. Hence the present study was conducted to realize the importance of developing high yielding okra genotypes.

MATERIAL AND METHODS

The present experiment was conducted at the PG research block in department of Vegetable Science, College of Horticulture, Mojerla, Wanaparthy district, Sri Konda Laxman Telangana state Horticultural university, Mulugu, Siddipet, Telangana during *Rabi*, 2021-2022. The monthly mean maximum temperature ranged from 24.9^{o}C to 32.4 ^{o}C with an average of 30.50 ^{o}C while the monthly mean minimum temperature ranged from 12.7^{o}C to 21.4^{o}C with an average of 17.5^{o}C during the crop growth period. Relative humidity forenoon and afternoon fluctuated between 86% to 90% and 38% to 71% respectively. Rainfall received during the crop growth period. The monthly mean sunshine hours varied from 3.3 to 8.2 with an average of 5.6 hours per day and mean evaporation ranged from 2.8 to 5.1 mm with an average of 4.1 mm per day. The mean wind speed ranged from 2.8 to 11.2 km hr^{-1} with an average of 5.4 km hr^{-1}. At all stages of the crop growth the weather was congenial for growth and development of okra crop during Rabi- 2021-22.

Source of Seed Materials. The 37 genotypes of okra were collected from NBPGR, Regional station, New Delhi. IC33823, IC33853, IC34124, IC39132, IC39133, IC39134, IC39135, IC39136, IC39137, IC39143, IC40289, IC42451, IC42456, IC42464, IC42470, IC42472, IC42484, IC42490, EC329362, EC329364, EC329365, EC329366, EC329367, EC329368, EC329369, EC329370, EC329371, EC329372, EC329384, EC329384, EC329406, EC329418, EC329420, EC329421, EC329422, EC329423, Kashi Lalima (Check), IIVR, Varanasi and Arka Anamika (Check) IIHR, Bangalore the data was recorded on following parameters.

Experimental Design. The experiment was under taken on 37 genotypes of okra using randomized block design (RBD) with three replications at College of Horticulture, SKLTSHU, Mojerla, Wanaparthy district. The crop was sown during *Rabi* season, in the year 2021-2022.

Preparation of Experimental Plot. The experiment field was brought to fine tilth by ploughing thrice followed by harrowing. Before final harrowing, FYM @ 25 tonnes per hectare was applied at the time of last ploughing and incorporated well into the soil. Ridges and furrows were formed at a spacing of 45 cm. The recommended basal dose of fertilizer at the rate of 25 kg Nitrogen, 50 kg Phosphorus and 50 kg Potash per hectare was applied in the form of urea, single super phosphate and muriate of potash and mixed with soil. The seeds of each accession were dibbled on one side of ridges at a spacing of 30 cm at the rate of two seeds per hill in a plot size of 3.9 m × 33.6 m. Gap filling was done a week after sowing. After establishment, the seedlings were thinned out to one plant per hill. Thirty days after sowing, 25 kg of Nitrogen per hectare was applied as top dressing. Other cultural operations including plant protection measures were done regularly.

Correlation 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).

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

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 *et al*. (1967).

Path coefficient Analysis. Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (1921) and illustrated 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). Standard path coefficients which are the standardized partial regression coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using above package.

P01+ P02 r12+ P0P r1P = r01

P01+ P12 r02 + P0P r2P = r02

P01+ r1P + P02 r2P + P0P = r0P

Where, P01, P02, P0P are the direct effects of variables 1,2, p on the dependent variable 0 and r12, r13, r1P, r P(P-1) are the possible correlation coefficients between various independent variables and r01, r02, r03 r0P are the correlation between dependent and independent variables.

The indirect effects of the i^{th} variable *via* j^{th} variable is attained as (P_{oj} x r_{ij}). The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

P^2ox = 1-[$P^2$01+2P01P02r12+2P01P03r13+ $P^2$02+ 2P02P03r13 + $P^2$0P

Residual-factor = √ (P^2ox)

Negligible : 0.00 to 0.09

Low : 0.10 to 0.19

Moderate : 0.20 to 0.29

High : 0.30 to 1.00Very high : > 1.00

RESULTS AND DISCUSSION

Correlation coefficients studies. The phenotypic (P) and genotypic correlation (G) coefficients were carried out for nineteen characters in thirty seven okra genotypes and the data is presented in Table 1

Phenotypic and genotypic correlation coefficient. Plant height exhibited positive and significant correlations in both phenotypic and genotypic level with number of primary branches (0.87 P, 0.89 G), intermodal length (0.88 P, 0.89G), fruit length (0.57 P, 0.58G), number of seeds per fruit (0.45 P, 0.46 G), number of fruits per plant (0.80 P, 0.81 G), seeds weight per fruit (0.19 P, 0.2 G), test weight (0.55 P, 0.58 G), germination percent (0.34 P, 0.36 G), seedling dry weight (0.43 P, 0.46G), vigour index I (0.26 P, 0.26 G), vigour index II (0.50 P, 0.52 G) and chlorophyll content (0.64 P, 0.65 G) and negative significant correlations with fruit diameter (-0.37 P,-0.43 G) and number of locules per fruit (-0.30 P, -0.3 G) in both phenotypic and genotypic level were also recorded. similar results for number of primary branches, fruit length, number of fruits per plant were given by Sumil *et al* (2018) and ; for inter nodal length, number of primary branches, fruit length, Jeetendra *et al.* (2019). Fruit length Ashraf *et al*. (2020).

Number of primary branches per plant showed positive and significant correlations with plant height (0.87 P, 0.89 G), internodal length (0.83 P, 0.86 G), fruit length (0.52 P, 0.54 G), number of seeds per fruit (0.46 P, 0.47 G), number of fruits per plant (0.78 P, 0.8 G), seed weight per fruit (0.19 P, 0.19 G), test weight (0.65 P, 0.7 G), germination percent (0.35 P, 0.38 G), seedling dry weight (0.39 P, 0.42 G), vigour index I (0.22 P, 0.22 G), vigour index II (0.47 P, 0.5 G) and chlorophyll content (0.58 P, 0.59 G) both in phenotypic and genotypic level but at genotypic level, it was positive and significant correlations with seedling length (0.66 G) was registered. Negative significant correlation with fruit diameter (-0.20 P, -0.26 G) and number of locules per fruit (-0.31 P, -0.32 G) both in phenotypic and genotypic level were also registered. Similar results for fruit length, no of fruits per plant were reported by Sunil *et al*. (2018).

Intermodal length showed positive and significant correlations both in phenotypic and genotypic level with plant height (0.88 P, 0.89 G), number of primary branches (0.83 P, 0.86 G), fruit length (0.64 P, 0.65 G), number of seeds per fruit (0.49 P, 0.5 G), number of fruits per plant (0.71 P, 0.72 G), seeds weight per fruit (0.22 P, 0.23 G), test weight (0.62 P, 0.66 G), germination percent (0.31 P, 0.33 G), seedling dry weight (0.45 P, 0.49 G), vigour index II (0.51 P, 0.54 G) and chlorophyll content (0.54 P, 0.54 G) and negative significant correlations with number of locules per fruit (-0.33 P, -0.33 G) both in phenotypic and genotypic level but at genotypic level it was negative correlation with fruit diameter (-0.19 G) and were also recorded. Similar results for plant height, fruit length were reported by Jeetendra *et al*. (2019).

Days to 50 % flowering registered positive and significant correlation in phenotypic and genotypic level with days to 1^{st} picking (0.57 P, 0.581 G) and negative significant correlations with number of locules per fruit (-0.19 P, -0.19 G) both in phenotypic and genotypic level. The results were in accordance with Jeetender *et al*. (2018).

Fruit length showed positive and significant correlation with plant height (0.57 P, 0.58 G), number of primary branches (0.52 P, 0.54 G), intermodal length (0.64 P, 0.65 G), number of seeds per fruit (0.44 P, 0.45G), number of fruits per plant (0.37 P, 0.37G), test weight (0.39 P, 0.41 G), seedling dry weight (0.36 P, 0.38 G), vigour index II (0.28 P, 0.3 G) and chlorophyll content (0.35 P, 0.36 G) were recorded. The negative and significant correlations with fruit diameter (-0.19 P, -0.22 G) both in phenotypic and genotypic level was also recorded. The results for plant height and internodal length were according to Jeetender *et al*. (2018).

Negative and significant correlation were registered by fruit diameter with plant height (-.037 P, -0.43 G), number of primary branches (-0.20 P, -0.26 G), fruit length (-0.19 P, -0.22 G), number of fruits per plant (-0.42 P, -0.48 G), seedling length (-0.23 P, -0.27 G), vigour index I (-.022 P, -0.26 G) and chlorophyll content (-0.27 P, -0.32 G) but at genotypic level, negative and significant correlation with internodal length (-0.19 G) was noticed.

The positive and significant correlations with days to 50 % flowering (0.57 P, 0.581 G), test weight (0.24 P, 0.26 G), seedling dry weight (0.19 P, 0.2G) and vigour index I (0.29 P, 0.29 G) both in phenotypic and genotypic level were observed. Days to 1st picking recorded negative and significant correlation with number of locules per fruit (-0.22 P, -0.22 G), number of seeds per fruit (-0.29 P, -0.3 G), seeds weight per fruit (-0.23 P, -0.24 G) both in phenotypic and genotypic level was also recorded. Negative significant correlation with seedling length (-0.35 P) at phenotypic level, positive significant correlation with seedling length (0.35 G) at genotypic level were also registered. Similar results for days to 50% flowering were given by Jeetender *et al.* (2018).

Number of locules per fruit registered negative significant correlation plant height (-0.30 P, -0.3 G), number of primary branches (-0.31 P, -0.32 G), internodal length (-0.33 P, -0.33 G), days to 50 % flowering (-0-19 P, -0.19 G), days to 1st picking (-0.22 P, -0.22 G), test weight (-0.50 P, -0.54G), germination percent (-0.41 P,-0.43 G), seedling length (-0.37 P, -0.38 G), seedling dry weight (-0.45 P, -0.49 G), seed vigour index I (-0.46 P, -0.47 G) and vigour index II (-0.51 P, -0.54 G) were also recorded.

Number of seeds per fruit found positive significant correlation with plant height (0.45 P, 0.46 G), number of primary branches (0.46 P, 0.47 G), internodal length (0.49 P, 0.5 G), fruit length (0.44 P, 0.45 G), number of fruits per plant (0.42 P, 0.43 G), seeds weight per fruit (0.49 P, 0.51 G), test weight (0.33 P, 0.35 G), and chlorophyll content (0.37 P, 0.37 G) both in phenotypic and genotypic level. While, at phenotypic and genotypic level, negative significant correlation with days to 1st picking (-0.29 P, -0.3 G), seedling length (-0.31 P, -0.32 G) and vigour index I (-0.19 P, -0.2 G) was observed.

Number of fruits per plant found positive significant correlation with plant height (0.80 P, 0.81 G), number of primary branches (0.78 P, 0.8 G), internodal length (0.71 P, 0.72 G), fruit length (0.37 P, 0.37 G), number of seeds per fruit (0.42 P, 0.43 G), seeds weight per fruit (0.23 P, 0.23 G), test weight (0.45 P, 0.48 G), germination percent (0.32 P, 0.34 G), seedling dry weight (0.28 P, 0.3 G), vigour index I (0.29 P, 0.3 G), vigour index II (0.37 P, 0.39 G) and chlorophyll content (0.69 P, 0.7 G). Negative significant correlation with fruit diameter (-0.42 P, -0.48 G) in both phenotypic andgenotypic level were also observed.

Seeds weight per fruit noticed positive and significant correlation with plant height (0.19 P, 0.2G), number of primary branches (0.19 P, 0.19 G), intermodal length (0.22 P, 0.23 G), number of seeds per fruit (0.49 P, 0.51 G), number of fruits per plant (0.23 P, 0.23 G) and chlorophyll content (0.32 P, 0.33 G) both in phenotypic and genotypic level. Negative and significant correlation with days to first picking (-0.23 P, -0.24 G) in both phenotypicand genotypic level were also noticed.

This trait recorded positive and significant correlation with plant height (0.55 P, 0.58 G), number of primary branches (0.65 P, 0.7 G), internodal length (0.62 P, 0.66 G), fruit length (0.39 P, 0.41 G), days to first picking (0.24P, 0.26 G), number of seeds per fruit (0.33 P, 0.35 G), number of fruits per plant (0.45 P, 0.48 G), germination percent (0.23 P, 0.26 G), seedling length (0.23 P, 0.24 G), seedling dry weight (0.59 P, 0.64 G), vigour index I (0.29 P, 0.31 G), vigour index II (0.58 P, 0.63 G) and chlorophyll content (0.47 P, 0.5 G). Negative and significant correlation with number of locules per fruit (-0.50 P, -0.54 G) in both phenotypic and genotypic level were also noticed.

Germination percent showed positive significant correlation with plant height (0.34 P, 0.36 G), number of primary branches (0.35 P, 0.38 G), internodal length (0.31 P, 0.33 G), number of fruits per plant (0.32 P, 0.34 G), test weight (0.23 P, 0.26 G), seedling length (0.20 P, 0.21 G), seedling dry weight (0.30 P, 0.33 G), vigour index I (0.60 P, 0.6 G) and vigour index II (0.61 P, 0.63 G) both in phenotypic and genotypic level. Negative and significant correlation with number of locules per fruit (-0.41 P, -0.43 G) in both phenotypic and genotypic level were also recorded.

This trait recorded positive and significant correlation both inphenotypic and genotypic kevel with number of primary branches (0.66 G), days to first picking (0.35 G), test weight (0.23 P, 0.24 G), germination percent (0.20 P, 0.21 G), seedling dry weight (0.28 P, 0.3 G), vigour index I (0.90 P, 0.9 G), vigour index II (0.28 P, 0.3 G) and chlorophyll content (0.26 P, 0.26 G) and negative and significant correlation with fruit diameter (-0.23 P, -0.27 G), number of locules per fruit (-0.37 P, -0.38 G) and number of seeds per fruit 0.31 P, -0.32 G) but at phenotypic level, negative significant correlation withdays to first picking (-0.35 P) were also observed.

Seedling dry weight showed positive significant correlation with plant height (0.43 P, 0.46 G), number of primary branches (0.39 P, 0.42 G), internodal length (0.45 P, 0.49 G), fruit length (0.36 P, 0.38 G), days to first picking (0.19 P, 0.2 G), number of fruits per plant (0.28 P, 0.3 G), test weight (0.59 P, 0.64 G), germination percent (0.30 P, 0.33 G), seedling length (0.28 P, 0.3 G), vigour index I (0.35 P, 0.38 G), vigour index II (0.93 P, 0.93 G) and chlorophyll content (0.39 P, 0.41 G). Negative and significant correlation with number of locules per fruit (-0.45 P, -0.49 G) in both phenotypic and genotypiclevel were also recorded.

This trait registered positive and significant correlation with plant height (0.26 P, 0.26 G), number of primary branches (0.22 P, 0.22 G), days to first picking (0.29 P, 0.29 G), number of fruits per plant (0.29 P, 0.3 G), test weight (0.29 P, 0.31 G), germination percent (0.60 P, 0.6 G), seedling length (0.90 P, 0.90 G), seedling dry weight (0.35 P, 0.38 G), vigour index II (0.49 P, 0.5 G) and chlorophyll content (0.29 P, 0.29 G). Negative and significant correlation with fruit diameter (-0.22 P, -0.26 G), number of locules per fruit (-0.46 P, -0.47 G), number of seeds per fruit (-0.19 P, -0.2 G) in both phenotypic and genotypic level were also registered.

This trait recorded positive and significant correlation with plant height (0.50 P, 0.52 G), number of primary branches (0.47 P, 0.5 G), internodal length (0.51 P, 0.54 G), fruit length (0.28 P, 0.3 G), number of fruits per plant (0.37 P, 0.39 G), test weight (0.58 P, 0.63 G), germination percent (0.61 P, 0.63 G), seedling length (0.28 P, 0.3 G), seedling dry weight (0.93 P, 0.93 G), vigour index I (0.49 P, 0.5 G), chlorophyll content (0.38 P, 0.39 G). Negative and significant correlation with number of locules per fruit (-0.51 P, -0.54 G) in both phenotypic and genotypic level were also registered.

This trait recorded positive and significant correlation with plant height (0.64 P, 0.65 G), number of primary branches (0.58 P, 0.59 G), internodal length (0.54 P, 0.54 G), fruit length (0.35 P, 0.36 G), number of seeds per fruit (0.37 P, 0.37 G), number of fruits per plant (0.69 P, 0.7 G), seeds weight per fruit (0.32 P, 0.33 G), test weight (0.47 P, 0.5 G), seedling length (0.26 P, 0.26 G), seedling dry weight (0.39 P, 0.41 G), vigour index I (0.29 P, 0.29 G), vigour index II (0.38 P, 0.39 G). Negative and significant correlation with fruit diameter (-0.27 P, -0.32 G) in both phenotypic and genotypic level but at genotypic level, negative and significant correlation withnumber of locules per fruit (-0.54 G) were also recorded. The result for number of fruits per plant is in collaboration with Jeetendera *et al*. (2018).

Fruit yield per plant registered positive significant correlation plant height (0.7038 P, 0.7191 G), number of primary branches (0.6308 P, 0.6529G), intermodal length (0.5986 P, 0.6255 G), fruit length (0.3727 P, 0.3883 G), number of seeds per fruit (0.4039 P, 0.4258 G), number of fruits per plant (0.7977 P, 0.8229 G), seeds weight per fruit (0.3750 P, 0.3942 G), test weight (0.3575 P, 0.3704 G), germination percent (0.3096 P, 0.3356 G), seedling dry weight (0.2877 P, 0.2966 G), vigour index I (0.2764 P, 0.2955 G), vigour index II (0.3669 P, 0.3823 G) and chlorophyll content (0.7795 P, 0.8005 G) were also recorded. Negative and significant correlation with days to 50 % flowering (-0.1894 P, -0.1946 G) and fruit diameter (-0.2560 P, -0.3027 G) in both phenotypic and genotypic level were also recorded. The results of the present study on plant height, fruit length were in conformity with Yonas *et al*. (2014); Thulasiram *et al*. (2017); Jeetendra *et al*. (2019) in okra; and for number fruits per plant Jeetendra *et al*. (2019), number of fruits per plant, fruit length and plant height had positive and significant correlation with fruit yield per plant Kumar *et al*. (2020).

Path coefficient analysis. Each component has two path actions *viz*., direct effect on yield andindirect effect through components which are not revealed by correlation studies. The results of phenotypic path coefficient are presented in Table 2 and genotypic coefficient in and the path showing the cause and effect relationship is shown for genotypic in Fig. 1 and phenotypic in Fig. 2.

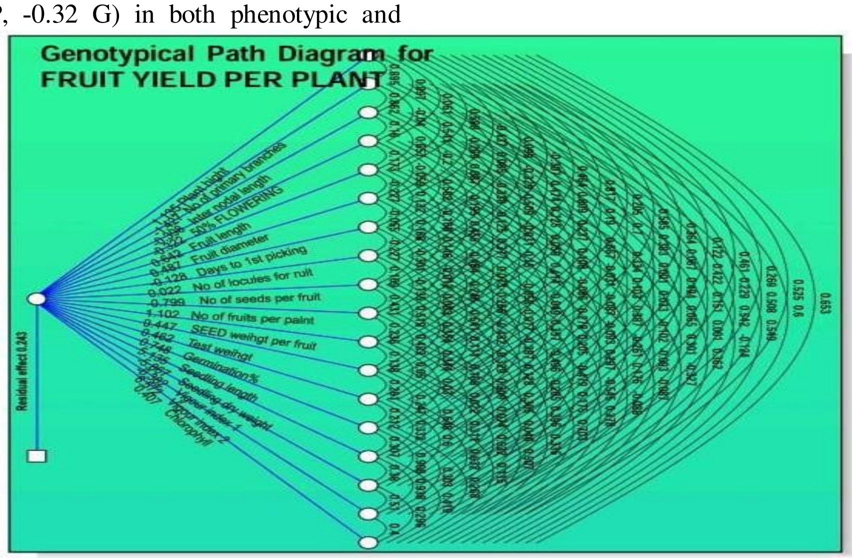

Fig. 1. Genotypic path diagram representing direct and indirect effects for fruityield per plant in okra.

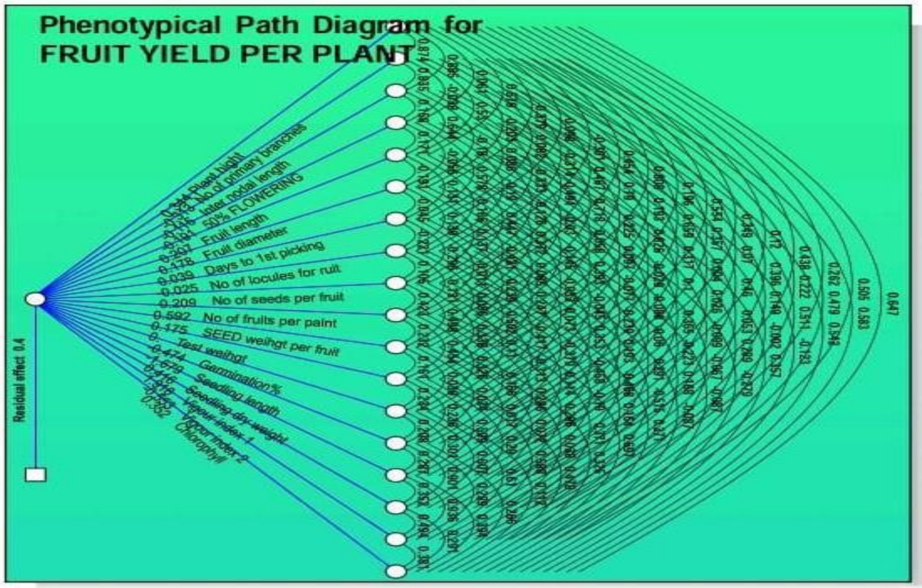

Fig. 2. Phenotypic path diagram representing direct and indirect effectsfor fruit yield per plant in okra.

The trait showed high direct positive effect on fruit yield per plant at phenotypic level (0.34 P) and very high positive direct effect at genotypic level (1.13 G). Similar result were given by Jeethendra *et al*. (2018).

Number of primary branches per plant exhibited high negative direct effect (- 0.31 P) on fruit yield per plant at phenotypic level. At genotypic level, this trait exhibited very high negative direct effect (**-**1.42 G) on fruit yield perplant.

Internodal length was recorded to have low negative direct effect (-0.11 P) on fruit yield per plant at phenotypic level. At genotypic level, this trait showed high negative direct effect (-0.39 G) on fruit yield per plant. Similar results were given by Kumar *et al.* (2020).

Days to 50 % flowering showed low direct negative effect on fruit yield per plant at phenotypic level (-0.19 P) and high negative direct effect at genotypic level (-0.32 G). The findings were according to Sunil *et al.* (2018); Jeethendra *et al*. (2018); Kumar *et al*. (2020).

At phenotypic level, fruit length revealed that moderate positive direct effect (0.20 P) on fruit yield per plant. At genotypic level recorded highpositive direct effect (0.64 G). The findings were according to Jeethendra *et al.* (2018); Kumar *et al.* (2020).

Fruit diameter was recorded to have low positive direct effect (0.17 P) on fruit yield per plant at phenotypic level. At genotypic level, this trait showed high positive direct effect (0.48 G) on fruit yield per plant. The results are in accordance with Ashraf *et al*. (2020).

At phenotypic level, Days to 1st picking showed negligible positive directe effect (0.03 P) on fruit yield per plant. At genotypic level, this character exhibited low direct negative effect (**-**0.12 G) on fruit yield per plant **(**Ashraf *et al*., 2020).

Number of locules per fruit exhibited negligible negative direct effect (**-** 0.02) on fruit yield per plant at phenotypic level. At genotypic level, this trait exhibited negligible direct positive effect (0.02) on fruit yield per plant.

This character noticed moderate negative direct effect on fruit yield per plant (-0.20) at phenotypic level. At genotypic level, this trait found high direct negative effect (-0.79) on fruit yield per plant.

At phenotypic level, number of fruits per plant manifested high positive direct effect (0.59) on fruit yield per plant. At genotypic level, very high positive direct effect was exhibited (1.10) on fruit yield per plant. The findings are in agreement with Jeethendra *et al*. (2018); Ashraf *et al*. (2020).

Seeds weight per fruit manifested low positive direct effect on fruit yield per plant (0.17) at phenotypic level. At genotypic level, this character showed high positive direct effect (0.44) on fruit yield per plant.

This character observed negligible negative direct effect on fruit yield per plant (-0.00) at phenotypic level. At genotypic level, this character recorded high positive direct effect (0.46) on fruit yield per plant.

Germination percent revealed high negative direct effect on fruit yield per plant (-0.47) at phenotypic level. At genotypic level, it noticed high positive direct effect (0.74) on fruit yield per plant.

This character observed very high negative direct effect on fruit yield per plant (-1.67) at phenotypic level. At genotypic level, this character recorded very high positive direct effect (5.13) on fruit yield per plant.

At phenotypic level, seedling dry weight manifested high positivedirect effect (0.41) on fruit yield per plant. At genotypic level, very highnegative direct effect was exhibited (-5.86) on fruit yield per plant.

Table 1: Phenotypic (P) and genotypic (G) path coefficient analysis indicating direct and indirect effects of component characters on fruityield per plant in thirty seven genotypes of okra.

Characters		Plant height (cm)	Number of primary branches per plant	Internodal length (cm)	Days to50% flowering	Fruit length(cm)	Fruit diameter(cm)	Days to first picking	Number of locules per fruit	Number of seeds perfruit	Number of fruits per plant	Seeds weight per fruit(g)	Test weight(g)	Germination (%)	Seedling length(cm)	Seedlingdry weight(g)	Vigour index1	Vigour index 2	Chlorophyll content (mg/100g)
Plant height(cm)	P	0.34	0.30	0.30	0.02	0.19	-0.13	0.03	-0.10	0.15	0.27	0.06	0.19	0.11	0.04	0.15	0.08	0.17	0.22
	G	**1.13**	1.01	1.01	0.06	0.66	-0.49	0.11	-0.34	0.52	0.92	0.23	0.66	0.41	0.13	0.52	0.30	0.59	0.74
Number of primary branches	P	-0.27	**-0.31**	-0.26	0.01	-0.16	0.06	-0.02	0.09	-0.14	-0.24	-0.06	-0.20	-0.11	-0.02	-0.12	-0.06	-0.15	-0.18
	G	-1.27	**-1.42**	-1.23	0.05	-0.77	0.38	-0.12	0.46	-0.67	-1.15	-0.27	-0.99	-0.54	-0.09	-0.60	-0.32	-0.72	-0.85
Internodal length (cm)	P	-0.10	-0.09	**-0.11**	-0.01	-0.07	0.02	-0.0099	0.03	-0.05	-0.08	-0.02	-0.07	-0.03	-0.0005	-0.05	-0.01	-0.05	-0.06
	G	-0.35	-0.34	**-0.39**	-0.06	-0.26	0.07	-0.03	0.13	-0.02	-0.28	-0.09	-0.26	-0.13	-0.00	-0.19	-0.06	-0.21	-0.21
Days to50 % flowering	P	-0.01	0.0072	-0.03	**-0.19**	-0.03	0.01	-0.11	0.03	0.02	0.0058	-0.01	-0.01	0.0055	-0.01	-0.0050	-0.01	0.0005	0.02
	G	-0.01	0.01	-0.05	**-0.32**	-0.05	0.01	-0.18	0.06	0.04	0.00	-0.01	-0.03	0.00	-0.03	-0.01	-0.01	-0.00	0.03
Fruitlength(cm)	P	0.12	0.10	0.13	0.03	**0.20**	-0.03	0.02	-0.03	0.09	0.07	0.03	0.08	-0.01	-0.01	0.07	-0.02	0.05	0.07
	G	0.37	0.34	0.42	0.11	**0.64**	-0.14	0.08	-0.10	0.29	0.24	0.09	0.26	-0.05	-0.05	0.24	-0.06	0.19	0.23
Fruit diameter (cm)	P	-0.06	-0.03	-0.03	-0.01	-0.03	**0.17**	-0.008	0.02	0.02	-0.07	0.01	-0.005	-0.008	-0.04	-0.01	-0.03	-0.01	-0.04
	G	-0.21	-0.13	-0.09	-0.02	-0.11	**0.48**	-0.02	0.08	0.07	-0.23	0.03	-0.02	-0.02	-0.13	-0.04	-0.12	-0.04	-0.15
Days to 1st picking	P	0.0038	0.0032	0.0033	0.02	0.0051	-0.0017	**0.03**	-0.0086	-0.01	-0.0004	-0.0093	0.0096	0.0028	0.01	0.0075	0.01	0.0065	-0.0034
	G	-0.01	-0.01	-0.01	-0.07	-0.01	0.00	**-0.12**	0.02	0.03	0.00	0.03	-0.03	-0.00	-0.04	-0.02	-0.03	-0.02	0.01
Number of loculesper fruit	P	0.0075	0.0079	0.00	0.0048	0.0041	-0.0035	0.0055	**-0.02**	-0.0026	0.0033	-0.0021	0.01	-0.01	0.0095	0.01	0.01	0.01	0.0022
	G	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	**0.02**	0.00	-0.00	0.00	-0.01	-0.00	-0.00	-0.01	-0.01	-0.01	-0.00
Number of seeds for fruit	P	-0.09	-0.09	-0.10	0.02	-0.09	-0.02	0.06	-0.02	**-0.20**	-0.08	-0.10	-0.07	-0.02	0.06	-0.02	0.03	-0.03	-0.07
	G	-0.37	-0.37	-0.40	0.09	-0.36	-0.11	0.24	-0.08	**-0.79**	-0.34	-0.41	-0.28	-0.08	0.23	-0.10	0.16	-0.14	-0.30
Number offruits perplant	P	0.47	0.46	0.42	-0.01	0.21	-0.24	-0.0066	-0.07	0.25	**0.59**	0.13	0.26	0.19	0.09	0.16	0.17	0.21	0.41
	G	0.90	0.89	0.79	-0.03	0.41	-0.53	-0.01	-0.14	0.47	**1.10**	0.26	0.53	0.37	0.18	0.34	0.33	0.43	0.77
Seeds weight for	P	0.03	0.03	0.03	0.01	0.02	0.01	-0.04	0.01	0.08	0.04	**0.17**	0.02	0.0069	0.0060	0.0029	0.01	0.0066	0.05

fruit (g)	G	0.09	0.08	0.10	0.02	0.06	0.03	-0.11	0.03	0.23	0.10	**0.44**	0.06	0.02	0.01	0.00	0.03	0.02	0.14
Test weight (g)	P	-0.0001	-0.0002	- 0.0002	0.00	- 0.0001	0.00	-0.0001	0.0001	-0.0001	-0.0001	0.00	**-0.0003**	-0.0001	-0.0001	-0.0002	- 0.0001	-0.0002	0.0001
	G	0.27	0.32	0.30	0.04	0.19	-0.02	0.12	-0.25	0.16	0.22	0.06	**0.46**	0.12	0.11	0.29	0.14	0.29	0.23
Germination (%)	P	-0.16	-0.16	-0.15	0.01	0.03	0.02	-0.03	0.19	-0.05	-0.15	-0.01	-0.11	**-0.47**	-0.09	-0.14	-0.28	-0.28	-0.05
	G	0.27	0.28	0.24	-0.02	-0.06	-0.03	0.05	-0.32	0.08	0.25	0.03	0.19	**0.74**	0.15	0.24	0.44	0.47	0.08
Seedling length (cm)	P	-0.20	-0.11	- 0.0071	-0.16	0.14	0.40	-0.59	0.63	0.52	-0.27	-0.05	-0.39	-0.35	**-1.67**	-0.48	-1.51	-0.48	-0.44
	G	0.62	0.34	0.00	0.52	-0.44	-1.42	1.83	-1.98	-1.68	0.86	0.15	1.27	1.08	**5.13**	1.57	4.65	1.55	1.37
Seedling dry weight(%)	P	0.18	0.16	0.19	0.01	0.15	-0.02	0.08	-0.19	0.04	0.11	0.0070	0.24	0.12	0.11	**0.41**	0.14	0.38	0.16
	G	-2.70	-2.47	-2.89	-0.19	-2.27	0.54	-1.20	2.90	-0.75	-1.81	-0.13	-3.79	-1.94	-1.80	**-5.86**	-2.23	-5.50	-2.45
Vigourindex I	P	0.50	0.42	0.28	0.10	-0.19	-0.42	0.55	-0.89	-0.36	0.56	0.13	0.55	1.16	1.72	0.67	**1.91**	0.94	0.55
	G	-1.71	-1.46	-0.96	-0.35	0.65	1.66	-1.89	3.05	1.31	-1.94	-0.47	-1.98	-3.83	-5.78	-2.42	**-6.38**	-3.25	-1.88
Vigourindex II	P	-0.27	-0.26	-0.28	0.0014	-0.15	0.03	-0.09	0.28	-0.09	-0.20	-0.02	-0.32	-0.33	-0.15	-0.51	-0.27	**-0.55**	-0.21
	G	3.45	3.33	3.56	0.00	1.97	0.61	1.15	-3.58	1.15	2.59	0.29	4.15	4.15	1.98	6.16	3.35	**6.57**	2.62
Chlorophyll content	P	0.22	0.20	0.19	-0.04	0.12	-0.09	-0.03	-0.03	0.13	0.24	0.11	0.16	0.03	0.09	0.13	0.10	0.13	**0.35**
	G	0.26	0.24	0.22	-0.05	0.14	-0.13	-0.03	-0.03	0.15	0.28	0.13	0.20	0.04	0.10	0.17	0.12	0.16	**0.40**
Fruit yieldper plant	P	0.7038	0.6308	0.5986	- 0.1894	0.3727	-0.2560	-0.1478	-o.057	0.4039	0.7977	0.03750	0.3575	0.3096	0.1351	0.2877	0.2764	0.3669	0.7795
	G	0.7191	0.6529	0.6255	- 0.1946	0.3883	-0.3027	-0.1498	-0.0647	0.4258	0.8229	0.3942	0.3704	0.3356	0.1452	0.2966	0.2955	0.3823	0.8005
Partial R^2	P	0.2418	-0.1976	- 0.0688	0.0362	0.0773	-0.0454	-0.0057	0.0014	-0.0842	0.4720	0.0658	-0.0001	-0.1469	-0.2267	0.1195	0.5300	-0.2029	0.2744
	G	0.8163	-0.9316	- 0.2491	0.0626	0.2492	-0.1475	0.0191	-0.0014	-0.3402	0.9067	0.1761	0.1712	0.2509	0.7458	-1.7397	- 1.8857	2.5126	0.3259
Phenotypic Residual effect = 0.3999; Genotypic Residual effect=0.2426 ; Diagonal (under lined) values indicate direct effects																			

Table 2: Phenotypic (P) and genotypic (G) correlation coefficients of yield and yield attributes in thirty seven genotypes of okra.

Characters		Plant height(cm)	Number of primary branchesper plant	Internodal lengt (cm)	Days to 50 % flowering	Fruit length(cm)	Fruit diameter (cm)	Days to first picking	Number of locules perfruit	Number of seeds per fruit	Number of fruits perplant	Seeds weightper fruit(g)	Test weight(g)	Germination(%)	Seedling length(cm)	Seedling dry weight(g)	Vigour index1	Vigour index 2	Chlorophyll content (mg/100g)	Fruit yield per plant
Plant height(cm)	P	**1.0000**	0.87***	0.88***	0.06	0.57***	-0.37**	0.09	-0.30**	0.45***	0.80***	0.19*	0.55***	0.34***	0.12	0.43***	0.26**	0.50***	0.64***	0.7038***
	G	**1.0000**	0.89***	0.89***	0.06	0.58***	-0.43**	0.098	-0.3***	0.46***	0.81***	0.2*	0.58***	0.36***	0.12	0.46***	0.26**	0.52***	0.65***	0.7191***
Number of primary branches	P		**1.0000**	0.83***	- 0.03	0.52***	-0.20*	0.08	-0.31**	0.46***	0.78***	0.19*	0.65***	0.35***	0.07	0.39***	0.22*	0.47***	0.58***	0.6308***
	G		**1.0000**	0.86***	-0.03	0.54***	-0.26**	0.084	-0.32**	0.47***	0.8***	0.19*	0.7***	0.38***	0.66***	0.42***	0.22*	0.5***	0.59***	0.6529***
Internodal length (cm)	P			**1.0000**	0.15	0.64***	-0.17	0.08	-0.33**	0.49***	0.71***	0.22*	0.62***	0.31***	0.00	0.45***	0.14	0.51***	0.54***	0.5986***
	G			**1.0000**	0.15	0.65***	-0.19*	0.087	-0.33**	0.5***	0.72***	0.23*	0.66***	0.33***	0.001	0.49***	0.15	0.54***	0.54***	0.6255***
Days to50 % flowering	P				**1.00**	0.17	-0.05	0.57***	-0.19*	-0.12	-0.03	0.05	0.09	-0.02	0.09	0.02	0.05	-0.00	-0.12	-0.1894*
	G				**1.00**	0.17	-0.05	0.581***	-0.19*	-0.12	-0.03	0.05	0.1	-0.03	0.1	0.03	0.05	0.001	-0.12	0.1946*
Fruit length(cm)	P					**1.0000**	-0.19*	0.13	-0.16	0.44***	0.37***	0.14	0.39***	-0.07	-0.08	0.36***	-0.09	0.28**	0.35***	0.3727***
	G					**1.0000**	-0.22*	0.131	-0.16	0.45***	0.37***	0.15	0.41***	-0.08	-0.08	0.38***	-0.1	0.3***	0.36***	0.3883***

Fruit diameter (cm)	P						**1.0000**	-0.04	0.13	0.13	-0.42**	0.08	-0.03	-0.04	-0.23*	-0.06	- 0.22	-0.06	-0.27**	-0.2560***
	G						**1.0000**	-0.05	0.16	0.14	-	0.07	-0.05	-0.04	-	-0.09	-	-0.09	-0.32***	-0.3027***
Days to 1st picking	P							**1.0000**	-0.22*	- 0.29*	-0.01	- 0.23	0.24**	0.07	- 0.35*	0.19*	0.29**	0.16	-0.08	-0.1478
	G							**1.0000**	-0.22*	-0.3**	-0.01	-0.24	0.26**	0.07	0.35***	0.2*	0.29***	0.17	-0.08	-0.1498
Number of loculesper fruit	P								**1.0000**	0.10	-0.13	0.08	- 0.50*	-0.41**	- 0.37*	-45***	- 0.46	-0.51***	-0.08	-0.0577
	G								**1.0000**	0.1	-0.13	0.08	- 0.54***	-0.43***	- 0.38***	-0.49***	- 0.47***	-0.54***	-0.08	-0.0647
Numberof seeds for fruit	P									**1.000**	0.42**	0.49	0.33*	0.10	-	0.11	-	0.16	0.37***	0.4039***
	G									**1.0000**	0.43***	0.51***	0.35***	0.11	- 0.32*	0.12	-0.2*	0.17	0.37***	0.4258***
Number of fruits per plant	P										**1.0000**	0.23*	0.45***	0.32***	0.16	0.28**	0.29**	0.37***	0.69***	0.7977***
	G										**1.0000**	0.23*	0.48***	0.34***	0.16	0.3***	0.3***	0.39***	0.7***	0.8229***
Seeds weight forfruit (g)	P											**1.0000**	0.15	0.03	0.03	0.01	0.07	0.03	0.32***	0.3750***
	G											**1.0000**	0.13	0.04	0.03	0.02	0.07	0.04	0.33***	0.3942***
Test weight(g)	P												**1.0000**	0.23*	0.23*	0.59***	0.29**	0.58***	0.47**	0.3575***
	G												**1.0000**	0.26**	0.24*	0.64***	0.31***	0.63***	0.5***	0.3704***
Germination (%)	P													**1.0000**	0.20*	0.30**	0.60***	0.61***	0.11	0.3096
	G													**1.0000**	0.21*	0.33***	0.6***	0.63***	0.11	0.3356***
Seedling length (cm)	P														**1.0000**	0.28**	0.90***	0.28**	0.26**	0.1351***
	G														**1.0000**	0.3***	0.9***	0.3***	0.26**	0.1452
Seedling dry weight(%)	P															**1.0000**	0.35***	0.93***	0.39***	0.2877
	G															**1.0000**	0.38***	0.93***	0.41***	0.2966***
Vigour index I	P																**1.0000**	0.49***	0.29**	0.2764***
	G																**1.0000**	0.5***	0.29***	0.2955***
Vigour index II	P																	**1.0000**	0.38***	0.3669***
	G																	**1.0000**	0.39***	0.3823***
Chlorophyll content (mg/100g)	P																		**1.0000**	0.7795***
	G																		**1.0000**	0.8005***
Fruit yieldper plant (Kg)	P																			**1.0000**
	G																			**1.0000**

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

This character observed very high positive direct effect on fruit yield per plant (1.91) at phenotypic level. At genotypic level, this character recorded very high negative direct effect (-6.38) on fruit yield per plant.

At phenotypic level, vigour index II manifested high negative direct effect (-0.55) on fruit yield per plant. At genotypic level, very high positive direct effect was exhibited (6.57) on fruit yield per plant.

Chlorophyll content revealed high positive direct effect on fruit yield per plant (0.35) at phenotypic level. At genotypic level, it noticed high positivedirect effect (0.40) on fruit yield per plant.

CONCLUSION

Result showed highly significant differences among the genotypes for all the character studied and genetic variation less than phenotypic variance showed the highest genotypic variance plant height (cm), number of primary branches, number of fruits per plant and vigour index-II there is also significant correlation genotypic, phenotypic and environmental is number of fruits for plant. Path coefficient the number of fruits per plant had the highest positive direct effect followed by plant height (cm), number of primary branches.

FUTURE SCOPE

Therefore, this character shall be given prime importance for further improvement of yield in future breeding programme.

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