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STUDY OF PATH ANALYSIS IN OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH)

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ABSTRACT

The present investigation was carried out during *kharif* 2020 at Experimental Farm, Department of Agricultural Botany, VNMKV, Parbhani. The experimental material consists of forty-two genotypes (including two checks) of which forty genotypes were the derivatives of segregating generations *i.e*. F_2 and Back crosses of Parbhani Kranti × VROR-159, Parbhani Kranti × Kashi Pragati, Kashi Satadhari × BO-2, Kashi Satadhari × VROR-159. These genotypes were evaluated for twelve traits in RBD design with two replications and data was recorded. Path analysis has revealed that the traits *viz*., days to 50% flowering, number of nodes on main stem, number of branches per plant, number of fruits per plant and number of seeds per fruit has exhibited significant and positive direct effect on fruit yield per plant at both genotypic and phenotypic level, while the traits like fruit length, number of ridges per fruit and 100 seed weight has shown direct effect on fruit yield per plant at phenotypic level only. Hence for improving the fruit yield in okra, the traits which are exhibiting direct and positive association with yield and yield contributing characters are selected, which indicates the importance of these traits in improvement of fruit yield in okra.

Key words : Okra, Genotypes, Segregating, Path analysis, Yield.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable and annual herbaceous crop. It is grown in subtropical and tropical parts of the world for its immature green fruits and fresh leaves. It is generally self-pollinated in nature, but it is being an often-cross pollinated crop with an extent of 4-10 per cent out crossing in which insect assisted pollination occurs up to maximum of 42.2 per cent which provide a considerable amount of variability (Kumar *et al*., 2006). It is amphidiploid in nature with chromosome number 2n=130 and is belonging to the family Malvaceae. *Abelmoschus esculentus*is the only species which is known to be cultivated extensively as commercial vegetable among 34 species of *Abelmoschus*.

Origin of okra is Ethiopia and then it was propagated in North Africa, in Mediterranean, in Arabi and by 12th century BC, it was cultivated in India. (Nzikou *et al*., 2006). It is popularly called as *Lady'sfinger* in English. It is known by various names all over the world. In Spanish it is known as *guino-gumbo*, in Hindi as *bhindi*, in Marathi as *bhendi*, in Portuguese as *guibeiro*, in French as *gombo*, *gandhmula* in Sanskrit, *bamiah* in Arabic and it is called as *bhendekaayi* in Kannada.

Abelmoschus species occurs in the world as *A. moschatus*, *A. manihot*, *A. esculentus*, *A. tuberculatus*, *A. ficulneus*, *A. crinitus* and *A. angulosus* (Charrier, 1984). Significant variation in chromosome number and ploidy level is seen in case of *Abelmoschus* species. Highest chromosome number is reported for *Abelmoschus manihot* var. *cailli i.e*., close to 200, whereas lowest chromosome number was reported in

Abelmoschusanguloses (Ford, 1938 and Siemonsmo, 1982). The most commonly observed chromosome number of okra is 2n=130.

In India, the Okra crop is cultivated in an area of 0.51 million hectare with 6.18 million tonnes of produce with an average productivity of 12.04 tonnes per hectare (Anonymous, 2019). The states which are majorly involved in okra production are west Bengal, Gujarat, Orissa, Bihar and Andhra Pradesh. Okra contributes about 60 percent to the total fresh vegetable export, excluding potato, garlic and onion. The okra occupies an area of 13.98 thousand hectare in Maharashtra state with an annual production of 139.40 thousand tonnes and is having an average productivity of 9.97 tonnes per hectare (Ananymous, 2018).

Fresh mature edible fruits contain 88% moisture and Vit. A 88 IU, Vit. B 63 IU, Vit. C 13 mg/100 gm. Whereas, unripen fruits of okra contains 1.8 gm Protein, 90 mg Calcium, 3100 calorie Energy and 1mg Iron. Composition per 100 g of edible portion of okra contains, calories 35.0 mg, calcium 66.0 mg, iron 0.35 mg, carbohydrates 6.4 g, potassium 103.0 mg, protein 1.9 g, magnesium 53.0 mg, fat 0.2 g, copper 0.19 mg, fibre 1.2 g, riboflavin 0.01 mg, minerals 0.7 mg, thiamine 0.07 mg, phosphorus 56.0 mg, nicotinic acid 0.06 mg, sodium 6.9 mg, vitamin C 13.10 mg, sulphur 30.0 mg and oxalic acid 8.0 mg (Gopalan *et al*., 2007). The composition of okra leaves per 100 gm edible portion contains 81.50 g water, 235.00 KJ or 56.00 Kcal energy, 4.40 g Protein, 0.60 g Fat, 11.30 g Carbohydrate, 2.10 g Fiber, 532.00 mg Calcium, 70.00 mg Phosphorous, 0.70 mg iron, 59.00 mg Ascorbic acid, 385.00 mg β carotene, 0.25 mg Thiamine, 2.80 mg Riboflavin and 0.20 mg Niacin (Varmudy, 2011). Carbohydrates are present mainly in the form of mucilage (Kumar *et al*., 2009). The young fruits contain a long chain of molecules with molecular weight of 170000 and made up of sugar units and amino acids and contains the main components like Galactose, Rhamnose, Galacturonic acid. Its mucilage is highly soluble in water. It is a good source of iodine it controls goiter (Chadha, 2001).

Yield is a complex trait which involves various components, of which some contribute directly towards yield, while other contribute indirectly. By correlation we can have information only about the magnitude of association of yield with its component traits but it does not provide the information about direct and indirect contribution of various independent variables on yield, so path analysis is important to know the direct and indirect effect of independent variables on yield.

Materials and Methods

The present investigation was conducted at Experimental Farm, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, during *kharif* 2020. The experimental material consists 42 genotypes as indicated in Table 1 (including two checks), which are the derivatives of segregating generations *i.e*. F_2 and Back crosses of Parbhani Kranti × VROR-159, Parbhani Kranti × Kashi Pragati, Kashi Satadhari × BO-2, Kashi Satadhari × VROR-159. The study was carried out in Randomized Block Design with two replications and having a spacing of 60 cm × 30 cm in row to row: plant to plant, respectively. The seeds were sown by dibbling 2-3 seeds on a plot of size 1.20 × 3 m^2, the basal dose of 100:50:50 Kg/ha was given to crop. The agronomic and plant protection measures were given as per requirement. These genotypes were evaluated and observations were recorded on twelve characters *viz*., Days to 50%

Table 1 : List of genotypes of okra utilized for genetic variability analysis.

S. no.	Name of genotypes	Pedigree	S. no.	Name of genotypes	Pedigree
1	PBNLF 1	Parbhani Kranti × VROR-159 (F_3)	22	PBNLF 22	Kashi Satadhari × BO-2 (F_3)
2	PBNLF 2	Parbhani Kranti × VROR-159 (F_3)	23	PBNLF 23	Kashi Satadhari × BO-2 (F_3)
3	PBNLF 3	Parbhani Kranti × VROR-159 (F_3)	24	PBNLF 24	Kashi Satadhari × BO-2 (F_3)
4	PBNLF 4	Kashi Satadhari × VROR-159 (F_2)	25	PBNLF 25	Kashi Satadhari × BO-2 (F_3)
5	PBNLF 5	Parbhani Kranti × Kashi Pragati (F_2)	26	PBNLF 26	Kashi Satadhari × BO-2 (F_3)
6	PBNLF 6	Parbhani Kranti × Kashi Pragati (F_2)	27	PBNLF 27	Parbhani Kranti × Kashi Pragati (F_3)
7	PBNLF 7	(Kashi Satadhari × VROR-159) × Kashi Satadhari (BC_1F_2)	28	PBNLF 28	Kashi Satadhari × BO-2 (F_3)
8	PBNLF 8	(Kashi Satadhari × VROR-159) × Kashi Satadhari (BC_1F_2)	29	PBNLF 29	Kashi Satadhari × BO-2 (F_3)

Table 1 continued...

Table 1 continued...

9	PBNLF 9	Kashi Satadhari × BO-2 (F_3)	30	PBNLF 30	(Kashi Satadhari × BO-2) × (BO-2 (BC_1F_3)
10	PBNLF 10	Kashi Satadhari × BO-2 (F_3)	31	PBNLF 31	Kashi Satadhari × VROR-159 (F_3)
11	PBNLF 11	(Parbhani Kranti × Kashi Pragati) × Parbhani Kranti (BC_1F_2)	32	PBNLF 32	Kashi Satadhari × VROR-159 (F_3)
12	PBNLF 12	(Parbhani Kranti × Kashi Pragati) × Parbhani Kranti (BC_1F_2)	33	PBNLF 33	Kashi Satadhari × VROR-159 (F_3)
13	PBNLF 13	(Parbhani Kranti × Kashi Pragati) × Parbhani Kranti (BC_1F_2)	34	PBNLF 34	Kashi Satadhari × VROR-159 (F_3)
14	PBNLF 14	(Parbhani Kranti × Kashi Pragati) × Parbhani Kranti (BC_1F_2)	35	PBNLF 35	Kashi Satadhari × VROR-159 (F_3)
15	PBNLF 15	(Parbhani Kranti × Kashi Pragati) × Parbhani Kranti (BC_1F_2)	36	PBNLF 36	Kashi Satadhari × VROR-159 (F_3)
16	PBNLF 16	Parbhani Kranti × Kashi Pragati (BC_1F_2)	37	PBNLF 37	Kashi Satadhari × VROR-159 (F_3)
17	PBNLF 17	Kashi Satadhari × BO-2 (BC_1F_1)	38	PBNLF 38	Kashi Satadhari × VROR-159 (F_3)
18	PBNLF 18	(Parbhani Kranti × Kashi Pragati) × Kashi Pragati (BC_1F_1)	39	PBNLF 39	Kashi Satadhari × VROR-159 (F_3)
19	PBNLF 19	Parbhani Kranti × VROR-159 (F_2)	40	PBNLF 40	Kashi Satadhari × VROR-159 (F_3)
20	PBNLF 20	Kashi Satadhari × BO-2 (F_3)	41	PBNLF 41	Check
21	PBNLF 21	Kashi Satadhari × BO-2 (F_3)	42	PBNLF 42	Check

flowering, Plant height (cm), Internodal length (cm), Number of nodes on main stem, Number of branches per plant, Fruit length (cm), Fruit diameter (cm), Number of ridges per fruit, Number of fruits per plant, 100 seed weight (g), Number of seeds per fruit and Fruit yield per plant (g). For statistical analysis mean values of five randomly selected plants were taken in each replication. The data were subjected to statistical analysis as per description of Panse and Sukhatme (1985). Path coefficient analysis suggested by Wright (1921) and further outlined by Dewey and Lu (1959) used to partition genotypic correlation coefficient into direct and indirect effects between yield and its components. The component traits which are exhibiting positive correlation with yield can be used in the indirect selection for improvement of yield. The method of path coefficient analysis given by Wright (1921) will help to understand that, whether association of traits with yield is having direct or indirect effect on yield or is a consequence in indirect effect through some other characters.

Results and Discussion

The path matrix of 42 genotypes under study at genotypic and phenotypic level are presented in Tables 2 and 3, respectively. The result of path analysis of 42 studied genotypes in okra revealed that, the trait number of seeds per plant (1.148) have exerted highest significant and positive direct effect on fruit yield per plant, followed

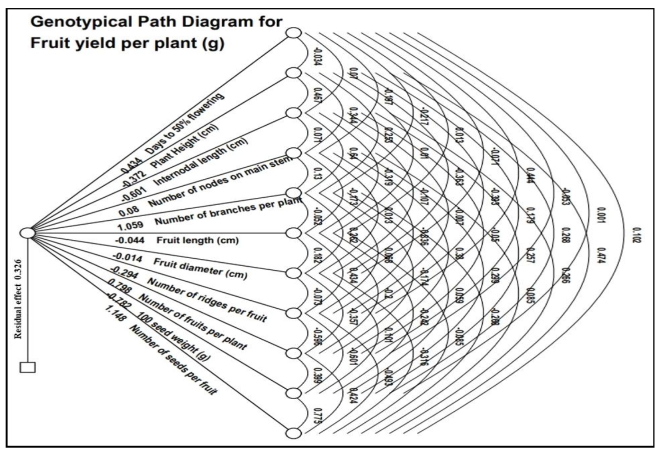

Fig. 1 : Genotypic path diagram for fruit yield per plant in okra.

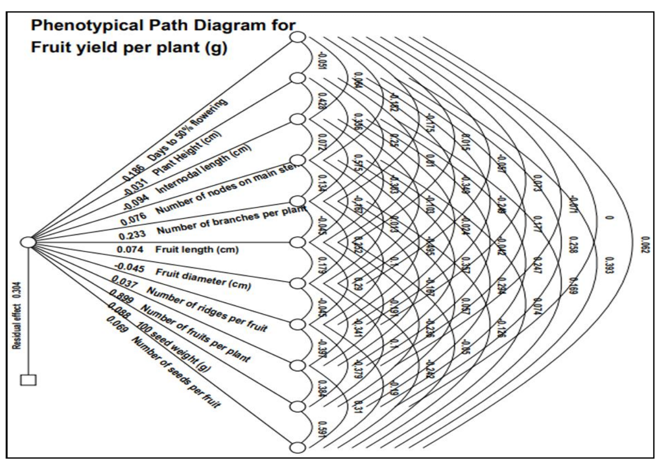

Fig. 2 : Phenotypic path diagram for fruit yield per plant in okra.

Table 2 : Direct and indirect Genotypic effect of twelve variables on fruit yield in okra.

Characters	Days to 50% flowering	Plant height (cm)	Internodal length (cm)	Number of nodes on main stem	Number of branches per plant	Fruit length (cm)	Fruit diameter (cm)	Number of ridges per fruit	Number of fruits per plant	100 seed weight (g)	Number of seeds per fruit	Fruit yield per plant (g)
Days to 50% flowering	**0.434****	-0.015	0.031	-0.086	-0.094	0.006	-0.031	0.193	-0.023	0.0006	0.044	**0.103**
Plant height (cm)	0.013	**-0.372****	-0.174	-0.128	-0.094	-0.004	0.135	0.146	-0.066	-0.099	-0.176	**0.226***
Internodal length(cm)	-0.042	-0.280	**-0.601****	-0.043	-0.384	0.192	0.064	0.004	0.029	-0.154	-0.159	**0.023**
Number of nodes on main stem	-0.016	0.027	0.006	**0.080**	0.010	-0.014	0.001	-0.067	0.030	0.024	0.007	**0.382****
Number of branches per plant	-0.229	0.268	0.678	0.138	**1.059****	-0.055	0.278	0.072	-0.184	0.062	-0.284	**-0.017**
Fruit length (cm)	-0.0006	-0.001	0.014	0.008	0.002	**-0.044**	-0.008	-0.019	0.009	0.011	0.004	**-0.116**
Fruit diameter (cm)	0.001	0.005	0.002	-0.001	-0.004	-0.003	**-0.014**	0.001	0.005	-0.001	0.004	**-0.279***
Number of ridges per fruit	-0.131	0.116	0.002	0.246	-0.020	-0.128	0.022	**-0.294****	0.176	0.177	0.145	**-0.535****
Number of fruits per plant	-0.042	0.143	-0.039	0.303	-0.139	-0.159	-0.285	-0.476	**0.798****	0.319	0.338	**0.948****
100 seed weight (g)	-0.001	-0.209	-0.201	-0.234	-0.046	0.189	-0.079	0.469	-0.312	**-0.782****	-0.606	**0.446****
Number of seeds per fruit	0.117	0.544	0.306	0.098	-0.308	-0.097	-0.363	-0.566	0.487	0.891	**1.148****	**0.465****
Partial R^2	0.045	-0.084	-0.014	0.030	-0.018	0.005	0.004	0.158	0.757	-0.349	0.534	

by number of branches (1.059), number of fruits per plant (0.798), days to 50 per cent flowering (0.434) and number of nodes on main stem (0.080), whereas 100 seed weight (-0.782) has exerted highest significant and negative direct effect on fruit yield per plant, followed by internodal length (-0.601), plant height (-0.372), number of ridges per fruit (-0.294), fruit length (-0.044) and fruit diameter (-0.014) at genotypic level. These above results are in conformity with the findings of Kerure *et al*. (2017) for days to 50 per cent flowering, number of fruits per plant and number of seeds per fruit, Syfullah *et al*. (2018) and Koundinya *et al*. (2013) for days to 50 per cent flowering and number of fruits per plant, Rambabu *et al*. (2019) for number of branches per plant and number of seeds per fruit, Adiger *et al*. (2011) for number of branches per plant, Koundinya *et al*. (2013) for plant height, internodal length and fruit length, Rambabu *et al*. (2019) for plant height and fruit diameter and Kerure *et al*. (2017) for plant height and 100 seed weight.

At phenotypic level, the trait number of fruits per plant (0.899) have contributed highest positive direct effect on fruit yield per plant, followed by number of branches per plant (0.233), days to 50 per cent flowering (0.186), 100 seed weight (0.088), number of nodes on main stem (0.076), fruit length (0.074), number of seeds per fruit (0.069) and number of ridges per fruit (0.037), while internodal length (-0.094) has exerted highest negative direct effect on fruit yield per plant, followed by fruit diameter (-0.045) and plant height (-0.031). Similar results were observed by Kumari *et al*. (2019) for days to 50 per cent flowering, number of nodes per plant and fruit length, Ashraf *et al*. (2020) for number of branches per plant, fruit length and number of fruits per plant, Kerure *et al*. (2017) and Kavya *et al*. (2019) for days to 50 per cent flowering, fruit length and number of fruits per plant, Rambabu *et al*. (2019) for number of branches per plant, number of fruits per plant, 100 seed weight and number of seeds per fruit, Katagi *et al*. (2013) for days to 50 per cent flowering, fruit length and number of fruits per plant, Balai *et al*. (2014) for number of seeds per fruit.

Table 3 : Direct and indirect phenotypic effect of twelve variables on fruit yield in okra.

Characters	Days to 50% flowering	Plant height (cm)	Internodal length (cm)	Number of nodes on main stem	Number of branches per plant	Fruit length (cm)	Fruit diameter (cm)	Number of ridges per fruit	Number of fruits per plant	100 seed weight (g)	Number of seeds per fruit	Fruit yield per plant (g)
Days to 50% flowering	**0.186**	-0.009	0.012	-0.034	-0.033	0.003	-0.011	0.014	-0.013	0.0001	0.012	**0.074**
Plant height (cm)	0.002	**-0.031**	-0.013	-0.010	-0.008	-0.001	0.011	0.008	-0.005	-0.008	-0.012	**0.219***
Internodal length (cm)	-0.006	-0.040	**-0.094**	-0.007	-0.054	0.029	0.009	0.002	0.004	-0.023	-0.016	**0.021**
Number of nodes on main stem	-0.014	0.026	0.006	**0.076**	0.010	-0.013	0.001	-0.038	0.027	0.022	0.006	**0.377****
Number of branches per plant	-0.041	0.058	0.134	0.031	**0.233***	-0.010	0.059	0.023	-0.039	0.013	-0.029	**-0.016**
Fruit length (cm)	0.001	0.001	-0.023	-0.012	-0.003	**0.074**	0.013	0.022	-0.014	-0.018	-0.004	**-0.112**
Fruit diameter (cm)	0.003	0.016	0.005	-0.001	-0.011	-0.008	**-0.045**	0.002	0.015	-0.005	0.011	**-0.278****
Number of ridges per fruit	0.003	-0.009	-0.001	-0.018	0.004	0.011	-0.002	**0.037**	-0.015	-0.014	-0.007	**-0.334****
Number of fruits per plant	-0.064	0.159	-0.038	0.321	-0.150	-0.172	-0.306	-0.357	**0.899****	0.345	0.278	**0.914****
100 seed weight (g)	0.000	0.023	0.022	0.026	0.005	-0.021	0.009	-0.034	0.034	**0.088**	0.052	**0.443****
Number of seeds per fruit	0.004	0.028	0.012	0.005	-0.009	-0.004	-0.017	-0.013	0.022	0.041	**0.069**	**0.359***
Partial R^2	0.014	-0.007	-0.002	0.029	-0.004	-0.008	0.013	-0.012	0.821	0.039	0.025	

Positive indirect effect on fruit yield per plant was exhibited by days to 50 per cent flowering, plant height, internodal length, number of nodes on main stem, number of fruits per plant, 100 seed weight, number of seeds per fruit, whereas negative indirect effect on fruit yield per plant was exhibited by number of branches per plant, fruit length, fruit diameter and number of ridges per fruit at genotypic level. Similar results as mentioned above, were observed by Singh *et al*. (2017) for days to 50 per cent flowering, plant height, internodal length, number of fruits per plant, 100 seed weight and number of seeds per fruit, Rambabu *et al*. (2019) plant height, internodal length, number of fruits per plant, 100 seed weight and number of seeds per fruit, Pithiya *et al*. (2017) for plant height, number of fruits per plant, 100 seed weight, number of seeds per fruit. Positive indirect effect on fruit yield per plant was exhibited by days to 50 per cent flowering, plant height, internodal length, number of nodes on main stem, number of fruits per plant, 100 seed weight, number of seeds per fruit, whereas negative indirect effect on fruit yield per plant was exhibited by number of branches per plant, fruit length, fruit diameter and number of ridges per fruit at phenotypic level. Similar results as mentioned above, were observed by Syfullah*et al*. (2018) and Kerure*et al*. (2017) for plant height and number of fruits per plant, Singh *et al*. (2017) for plant height and 100 seed weight, Rana *et al*. (2020) for internodal length, fruit length and fruit diameter, Kumari *et al*. (2019) for number of nodes per plant and days to 50 per cent flowering, Pithiya *et al*. (2017) for plant height, number of fruits per plant, 100 seed weight, number of seeds per fruit and fruit diameter, Rambabu *et al*. (2019) for plant height, internodal length, number of fruits per plant, 100 seed weight, number of seeds per fruit and fruit diameter.

Conclusion

Present investigation revealed that the trait number of seeds per fruit have exhibited significantly highest positive direct effect on fruit yield per plant followed by, number of branches, number of fruits, days to 50 per cent flowering and number of nodes on main stem at genotypic level and at phenotypic level, the trait number of fruits per plant have contributed significantly highest positive direct effect on fruit yield per plant, followed by number of branches per plant, days to 50 per cent flowering, 100 seed weight, number of nodes on main stem, fruit length, number of seeds per fruit and number of ridges per fruit. Therefore, one can rely on traits *viz*., number of seeds per fruit, number of branches per plant, number of fruits per plant, days to 50 per cent flowering, 100 seed weight, fruit length and number of nodes on main stem while selecting the okra genotypes with high fruit yielding.

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