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Research Article

CORRELATION AND PATH ANALYSES FOR FRUIT YIELD AND ITS COMPONENT TRAITS IN OKRA [*Abelmoschus esculentus* L. Moench] GENOTYPES

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Abstract- In the present study twenty diverse okra genotypes were used to estimate the correlation and path analysis for fruit yield and its contributing characters. The genotypes were evaluated for the following fifteen characters: plant height (PH), stem diameter (SD), number of nodes on main stem (NNMS), first branching node (FBN), number of branches per plant (NB/P), days taken to first flowering (DFF), first flowering node (FFN), first fruiting node (FFr.N), number of flowers per plant (NF/P), number of fruits per plant (NFr/P), fruit diameter (FD), fruit length (FL), fruit weight (FW), number of seeds per fruit (NS/F) and yield/ha (Y/h). Number of flowers per plant and number of fruits per plant showed highest positive and very high significant correlation with yield per hectare followed by nodes on the main stem and plant height. Plant height and nodes on the main stem showed positive and significant correlation with yield per hectare. Stem diameter showed negative and significant correlation with first branching node and plant height with number of branches per plant and days taken to first flowering. Path coefficient analysis on various yield contributing characters revealed that fruits per plant, fruit length, number of seeds per fruit, number of branches per plant, plant height, fruit weight and number of flowers per plant showed direct positive effect towards yield.

Keywords- Okra, correlation, Path coefficient, Direct and indirect effects

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Introduction

Okra [*Abelmoschus esculentus* L. Moench] is commonly known by many local names in different parts of the world. It is known as Guino-Gombo in Spanish, Guibeiro in Portuguese and Bhindi in India. Even within India, different names have been given in different regional languages [1]. Young immature pods of okra can be consumed in different forms [2]. It has been grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. In India, it is cultivated around the year in one or other region due to wide range of climatic condition in different parts of the country. In India, the major okra producing states are West Bengal, Bihar, Orissa, Andhra Pradesh, Gujarat, Jharkhand, Chhattisgarh and Maharashtra. Physiologically, it is a day neutral plant. The crop remains in bearing almost throughout the year except during winter from mid November to mid January in the plains. In the present investigation fruit yield and yield related traits among the 20 different treatments have been studied. Biometrical techniques like correlation and path coefficient analysis provide information about the relative contribution of various yield related traits. As correlation measures the mutual relationship between different traits of a plant, it helps to determine the yield contributing components [3]. Correlation itself does not reflect the cause of association between two variables. To understand the actual relationship between the dependent traits and various independent traits, it is advisable to partition the correlation coefficient into direct and indirect effects, which was facilitatedby path coefficient analysis. These biometrical techniques help in selection of superior plant genotype for future breeding programme. Therefore this study was undertaken to estimate the correlation and path coefficient for various traits of okra genotypes.

Materials and Methods

The present experiment was carried out at Vegetable Research Farm, Department of Horticulture, IAS, BHU, Varanasi, during the rainy season of 2013 [Table-1]. The experimental farm comes under the Indo-gangatic alluvial track in eastern Uttar Pradesh. The experimental material consisted of 20 promising germplasm of okra [Table-2] and the experiment was laid out in a Randomized Complete Block Design with three replications. Standard agronomic practices were followed to ensure a good crop stand. Seeds of okra were sown in summer season on last week of June at the spacing of 60 x 45 cm. Since the experiment conducted during rainy season due to which weeds problem was relatively higher. Regular weeding was done manually to remove weeds. Because of sufficient rainfall, no need of irrigation was noticed during trail period. One earthing-up was done to support the plant and remaining dose of nitrogenous fertilizer (1/4) applied at this time. The observations were recorded from five randomly selected plants from each treatment and their average values were used for statistical analysis. The data on various characters *viz.*, plant height, stem diameter, number of nodes on the main stem, first branching node, number of branches per plant, days taken to first flowering, first flowering node, first fruiting node, numbers of flowers per plant, number of fruits per plant, diameter of fruits, length of fruits, weight of fruit, number of seeds per fruit and yield per hectare were recorded. The mean data were subjected to statistical analysis to estimate correlation coefficient [4] and path coefficient analysis [5].

Table 1 *Weekly meteorological data during the rainy season of the year 2013*

Week No.	Month & Date	Rainfall (mm)	Temperature (ºC)		R.H. (%)		Wind Speed (km/hr)	Sunshine (hours)	Evaporation (mm)
			Max	Min	Morn.	Even			
27	July 02-08	39.4	33.3	26.7	82	71	2.5	4.0	3.2
28	09-15	81.5	32.2	26.6	86	72	3.9	3.4	3.5
29	16-22	0.0	34.8	28.3	83	67	5.9	6.9	5.0
30	23-29	48.2	32.2	26.3	86	77	6.6	5.8	4.3
31	30-05	69.5	32.5	25.5	84	75	5.8	6.7	4.3
32	Aug 06-12	28.6	32.5	26.0	91	76	3.7	4.6	4.1
33	13-19	37.4	31.8	25.7	88	80	2.4	6.9	3.8
34	20-26	32.3	32.1	26.2	83	74	5.3	6.9	4.2
35	27-02	150.3	28.7	25.7	92	87	3.0	1.5	2.5
36	Sep 03-09	3.2	32.5	25.3	80	66	4.2	7.6	3.7
37	10-16	0.0	33.7	26.9	85	66	1.9	7.2	3.7
38	17-23	4.6	31.6	25.3	81	76	5.2	8.0	3.9
39	24-30	12.2	31.6	25.5	86	77	2.8	6.8	2.9
40	Oct 01-07	83.9	28.8	24.3	93	85	5.9	3.9	3.3
41	08-14	44.0	29.1	23.8	84	78	5.5	6.5	2.6
42	15-21	17.0	26.7	21.1	92	80	1.5	4.2	1.7
43	22-28	0.0	29.6	21.1	88	72	2.2	8.9	2.9
44	29-04	0.0	29.6	17.3	80	76	1.6	7.8	2.3
45	Nov 05-11	0.0	27.7	15.5	84	60	0.6	7.6	1.6
46	12-18	0.0	26.2	11.5	90	48	1.2	7.9	1.5
47	19-25	0.0	26.7	25.0	89	41	1.0	8.5	1.8
48	26-02	0.0	26.4	13.7	87	46	1.9	8.1	1.6
49	Dec 03-09	0.0	25.4	13.7	89	43	1.3	8.2	1.5
50	10-16	0.0	24.0	10.6	88	48	2.5	8.3	1.7
51	17-23	0.0	23.5	11.5	83	57	2.0	7.5	1.6
52	24-31	0.0	21.1	10.3	85	49	3.1	7.8	1.4

Results and Discussion

Correlation coefficient analysis

Phenotypic and genotypic correlation coefficients for various traits were estimated and are presented in the [Table-3] and [Table-4] respectively. The graphical representations of the same with shaded correlation matrix are given in the [Fig-1, 2, 3 and 4] respectively.

Table-2 *List of varieties/germplasm included in the trial*

Symbol used	Name of Varieties/Germplasm
T_1	BO-2
T_2	DOV-91-4
T_3	Larma 1
T_4	VRO-6
T_5	HRB-9-2
T_6	EC-169366
T_7	Bhindi Vaphy
T_8	D-1-87-5
T_9	HRB-55
T_{10}	P-7
T_{11}	ArkaAbhay
T_{12}	VRO-5
T_{13}	VRO-3
T_{14}	EMS-8-1
T_{15}	PusaMukhmali
T_{16}	Punjab Padmini
T_{17}	PusaSawani
T_{18}	ArkaAnamika
T_{19}	No. 315
T_{20}	VRO-4

Phenotypic correlation coefficient

In the present study, a highly significant correlation was found between number of fruits per plant and yield per hectare (0.778). This finding has the similarity with the findings of [6-8]. Phenotypically yield per hectare positively and significantly correlated with number of flowers per plant (0.7667), plant height (0.3014) and number of nodes on the main stem (0.3011). [9] have reported the same from their experiments in okra. Plant height positively and significantly correlated with number of nodes on the main stem (0.7339), fruit per plant (0.2965) and number of flowers per plant (0.2964), while it was negatively and significantly correlated with number of branches of per plant (-0.3684) and days taken to first flowering (-0.3611). Stem diameter positively and significantly correlated with number of branches of per plant (0.5240) and fruit weight (0.2929). First branching node (-0.3872) was negatively and significantly correlated with stem diameter. Number of nodes on the main stem positively and significantly correlated with number of flowers per plant (0.2724) and fruit per plant (0.2680). Number of branches per plant positively and significantly correlated with number of seeds per fruit (0.3465), while negatively and significantly correlation showed with first fruiting node (-0.2578). First flowering node positively and significantly correlated with first fruiting node (0.6223), while negatively and significantly correlated with fruit weight (-0.2794). Number of flowers per plant positively and significantly correlated with fruit per plant (0.9670) and number of fruits per plant negatively and significantly correlated with fruit length (-0.2678).

Genotypic correlation coefficient

Genotypically yield showed positive and significant correlation with number of flowers per plant (0.6684), number of fruits per plant (0.6179) plant height (0.3682), stem diameter (0.3360), number of nodes on the main stem (0.2685), while yield showed negative and significant correlation with days taken to first flowering (-0.2733). Plant height positively and significantly correlated with number of nodes on the main stem (0.9885), number of fruits per plant (0.3794), number of flowers per plant (0.3663) and first fruiting node (0.2923) whereas, negatively correlated with days taken to first flowering (-0.4822), number of branches per plant (-0.4576) and branching node (-0.2743). Stem diameter positively and significantly correlated with number of branches of per plant (0.6376), number of flowers per plant (0.3368), number of nodes on the main stem (0.3133), fruit weight (0.2920) and number of fruits per plant (0.2837). The negative and significant correlation recorded with first branching node (-0.5028).

Table-3 *Phenotypic Correlation coefficient among the different traits in okra*

Characters	SD	NNMS	FBN	NB/ P	DFF	FFN	FFr.N	NF/ P	NFr/ P	FD	FL	FW	NS/ F	Y/ h
PH	0.1629	0.7339***	-0.2179	-0.3684**	-0.3611**	0.1480	0.2289	0.2964*	0.2965*	-0.0700	-0.0646	-0.2134	-0.1998	0.3014*
SD		0.1758	-0.3872**	0.5240***	-0.1441	-0.1245	-0.0329	0.2035	0.1617	0.1039	0.0962	0.2929*	0.1743	0.2141
NNMS			-0.0518	-0.0858	-0.2485	0.0530	0.0622	0.2724*	0.2680*	-0.2053	0.0017	-0.1366	-0.1223	0.3011*
FBN				-0.0436	0.2126	-0.0360	0.1018	-0.1552	-0.1611	0.0229	0.2430	0.1225	0.0686	-0.1486
NB/P					-0.0284	-0.1671	-0.2578*	-0.0371	-0.0786	0.0683	0.1177	0.1975	0.3465**	0.0435
DFF						-0.2471	-0.2246	-0.0666	-0.0755	-0.1339	-0.0384	0.2267	-0.1114	-0.0991
FFN							0.6223***	-0.1056	-0.0756	0.0226	0.0031	-0.2794*	0.1039	-0.0450
FFr.N								-0.0647	-0.0406	0.0839	0.2420	-0.2152	0.0680	0.0627
NF/P									0.9670***	0.1185	-0.2392	0.0167	-0.1713	0.7667***
NFr./P										0.1296	-0.2678*	-0.0099	-0.2021	0.7778***
FD											-0.1170	-0.0174	-0.0231	-0.0876
FL												-0.0077	0.7116***	0.1106
FW													0.0133	0.0942
NS/F														0.1386

(Whereas, **PH**-plant height, **SD**-stem diameter, **NNMS**-number of nodes on main stem, **FBN**-first branching node, **NB/P**-number of branches per plant, **DFF**-days taken to first flowering, **FFN**-first flowering node, **FFr.N**-first fruiting node, **NF/P**-number of flowers per plant, **NFr/P**-number of fruits per plant, **FD**-fruit diameter, **FL**-fruit length, **FW**-fruit weight, **NS/F**-number of seeds per fruit and **Y/h**-yield/ha)

Table-4 *Genotypic Correlation coefficient among the different traits in okra*

Characters	SD	NNMS	FBN	NB/ P	DFF	FFN	FFr.N	NF/ P	NFr./ P	FD	FL	FW	NS/ F	Y/ h
PH	0.1657	0.9885***	-0.2743*	-0.4576***	-0.4822***	0.2432	0.2923*	0.3663**	0.3794**	-0.1203	-0.0669	-0.2467	-0.2448	0.3682**
SD		0.3133*	-0.5028***	0.6376***	-0.1785	-0.1447	-0.0921	0.3368**	0.2837*	0.1824	0.0832	0.2920*	0.2010	0.3360**
NNMS			-0.2229	-0.2950*	-0.6503***	0.0270	0.0909	0.1990	0.1910	-0.3094*	-0.0124	-0.1395	-0.1186	0.2685*
FBN				-0.1277	0.3807**	0.1195	0.0536	-0.2372	-0.1953	-0.1888	0.3148*	0.1799	0.2335	-0.1595
NB/P					-0.1168	-0.4360**	-0.4001**	-0.0475	-0.0976	0.1823	0.2266	0.2257	0.4336***	0.0914
DFF						-0.2744*	-0.2482	-0.3244*	-0.2468	-0.0394	-0.0844	0.2975*	-0.1328	-0.2733*
FFN							0.5042***	-0.2741	-0.2679	0.0809	0.1513	-0.4326**	0.0146	-0.1861
FFr.N								-0.0351	-0.0582	0.1109	0.2087	-0.3547**	0.1887	0.1108
NF/P									0.5181***	0.4391***	-0.4098**	0.0101	-0.3030*	0.6684***
NFr./P										0.3923**	-0.4665**	-0.0267	-0.3700**	0.6179***
FD											-0.1352	0.0108	0.0224	0.0081
FL												-0.0171	0.5647***	0.0972
FW													0.0184	0.1387
NS/F														0.2050

(Whereas, **PH**-plant height, **SD**-stem diameter, **NNMS**-number of nodes on main stem, **FBN**-first branching node, **NB/P**-number of branches per plant, **DFF**-days taken to first flowering, **FFN**-first flowering node, **FFr.N**-first fruiting node, **NF/P**-number of flowers per plant, **NFr/P**-number of fruits per plant, **FD**-fruit diameter, **FL**-fruit length, **FW**-fruit weight, **NS/F**-number of seeds per fruit and **Y/h**-yield/ha)

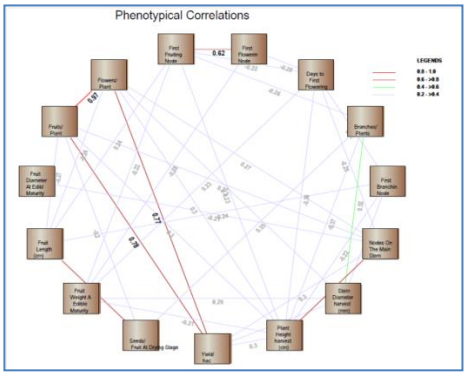

Fig-1 Diagrammatic representation of phenotypic correlation between yield and yield contributing characters

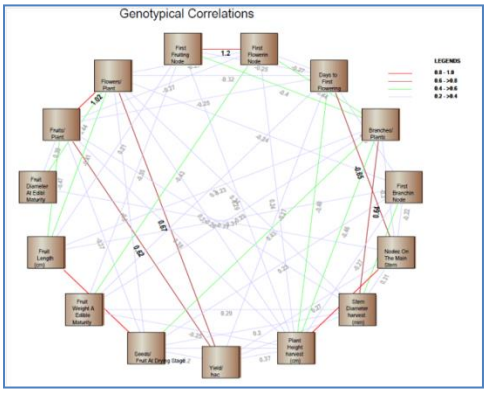

Fig-3 Diagrammatic representation of genotypic correlation between yield and yield contributing characters

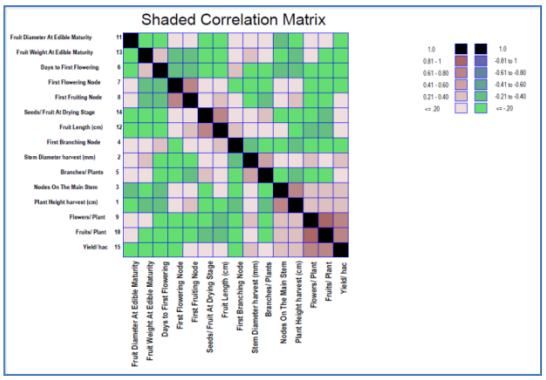

Fig-2 Shaded correlation matrix for phenotypic correlation

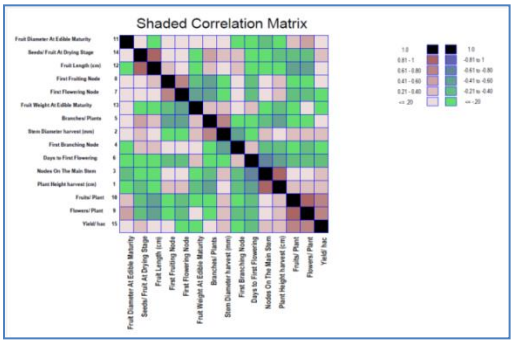

Fig-4 Shaded correlation matrix for genotypic correlation

Number of nodes on the main stem negatively and significantly correlated with days taken to first flowering (-0.6503), fruit diameter (-0.3094) and number of branches per plant (-0.2950). First branching node positively and significantly correlated with days taken to first flowering (0.3807) and fruit length (0.3148). Number of branches per plant positively and significantly correlated with number of seeds per fruit (0.4336), while negatively and significantly correlated with first flowering node (-0.4360) and first fruiting node (-0.4001). Days taken to first flowering positively and significantly correlated with fruit weight (0.2975) and negatively and significantly correlated with flower per plant (-0.3244) and first flowering node (-0.2744). First flowering node positively and significantly correlated with first fruiting node (0.5042), while negatively and significantly with fruit weight (-0.4326). First fruiting node negatively and significantly correlated with fruit weight (-0.3547). Number of flowers per plant positively and significantly correlated with fruit per plant (0.5181), fruit diameter (0.4391), while negatively and significantly correlated with fruit length (-0.4098) and number of seeds per fruit (-0.3030). Number of fruits per plant positively and significantly correlated with fruit diameter (0.3923), however, negative and significant correlation was observed with fruit length (-0.4665) and number of seeds per fruit (-0.3700). Fruit length positively and significantly correlated with number of seeds per fruit (0.5647).

Path coefficient analysis

Fruit yield and yield contributing attributes are interrelated among themselves. This creates hindrance in drawing a clear picture of association between characters. The mutual relationship expressed as correlation coefficient between the traits is either positive or negative but complex in nature and sometimes fails to give a meaningful interpretation. In such a situation a biometrical tool, path coefficient analysis in used to measure the different ways of contribution of independent traits on the dependent one (yield). Path coefficient analysis breaks the correlation coefficients into the measures of direct and indirect effect and points out the precise causes of association. Path coefficient analyses at phenotypic and genotypic level are given in the [Table-5] and [Table-6] and diagrammatically represented in the [Fig-5 and 6] respectively.

Table-5 *Phenotypic path coefficient analysis for yield*

Characters	PH	SD	NNMS	FBN	NB/ P	DFF	FFN	FFr.N	NF/ P	NFr/ P	FD	FL	FW	NS/ F	Y/ h
PH	**0.1296**	0.0211	0.0951	-0.0282	-0.0477	-0.0468	0.0192	0.0297	0.0384	0.0384	-0.0091	-0.0084	-0.0277	-0.0259	0.3014*
SD	-0.0080	**-0.0493**	-0.0087	0.0191	-0.0258	0.0071	0.0061	0.0016	-0.0100	-0.0080	-0.0051	-0.0047	-0.0144	-0.0086	0.2141
NNMS	-0.0212	-0.0051	**0.0288**	0.0015	0.0025	0.0072	-0.0015	-0.0018	-0.0079	-0.0077	0.0059	-0.0001	0.0039	0.0035	0.3011*
FBN	0.0136	0.0242	0.0032	**-0.0624**	0.0027	-0.0133	0.0022	-0.0064	0.0097	0.0101	-0.0014	-0.0152	-0.0076	-0.0043	-0.1486
NB/P	-0.0529	0.0752	-0.0123	-0.0063	**0.1435**	-0.0041	-0.0240	-0.0370	-0.0053	-0.0113	0.0098	0.0169	0.0283	0.0497	0.0435
DFF	-0.0148	-0.0059	-0.0102	0.0087	-0.0012	**0.0409**	-0.0101	-0.0092	-0.0027	-0.0031	-0.0055	-0.0016	0.0093	-0.0046	-0.0991
FFN	-0.0104	0.0087	-0.0037	0.0025	0.0117	0.0173	**-0.0701**	-0.0436	0.0074	0.0053	-0.0016	-0.0002	0.0196	-0.0073	-0.0450
FFr.N	0.0244	-0.0035	0.0066	0.0109	-0.0275	-0.0240	0.0664	**0.1068**	-0.0069	-0.0043	0.0090	0.0258	-0.0230	0.0073	0.0627
NF/P	0.0169	0.0116	0.0155	-0.0088	-0.0021	-0.0038	-0.0060	-0.0037	**0.0569**	0.0550	0.0067	-0.0136	0.0010	-0.0097	0.7667***
NFr./P	0.2401	0.1309	0.2170	-0.1304	-0.0636	-0.0611	-0.0612	-0.0329	0.7830	**0.8097**	0.1049	-0.2169	-0.0080	-0.1636	0.7778***
FD	0.0123	-0.0183	0.0362	-0.0040	-0.0120	0.0236	-0.0040	-0.0148	-0.0209	-0.0228	**-0.1762**	0.0206	0.0031	0.0041	-0.0876
FL	-0.0126	0.0187	0.0003	0.0472	0.0229	-0.0075	0.0006	0.0470	-0.0465	-0.0521	-0.0227	**0.1943**	-0.0015	0.1383	0.1106
FW	0.0160	-0.0220	0.0102	-0.0092	-0.0148	-0.0170	0.0209	0.0161	-0.0013	0.0007	0.0013	0.0006	**0.0750**	0.0010	0.0942
NS/F	-0.0317	0.0277	-0.0194	0.0109	0.0550	-0.0177	0.0165	0.0108	-0.0272	-0.0321	-0.0037	0.1129	-0.0021	**0.1587**	0.1386
Partial R^2	0.0391	-0.0105	-0.0087	0.0093	0.0062	-0.0041	0.0032	0.0067	0.0436	0.6298	0.0154	0.0215	0.0071	0.0220	

(R SQUARE = 0.7805, RESIDUAL EFFECT = 0.4685)

(Whereas, **PH**-plant height, **SD**-stem diameter, **NNMS**-number of nodes on main stem, **FBN**-first branching node, **NB/P**-number of branches per plant, **DFF**-days taken to first flowering, **FFN**-first flowering node, **FFrN**-first fruiting node, **NF/P**-number of flowers per plant, **NFr/P**-number of fruits per plant, **FD**-fruit diameter, **FL**-fruit length, **FW**-fruit weight, **NS/F**-number of seeds per fruit and **Y/h**-yield/ha)

Table-6 *Genotypic path coefficient analysis for yield*

Characters	PH	SD	NNMS	FBN	NB/ P	DFF	FFN	FFr.N	NF/ P	NFr/ P	FD	FL	FW	NS/ F	Y/ h
PH	**0.8929**	0.2109	0.5583	-0.3492	-0.5824	-0.6138	0.3096	0.3720	0.4663	0.4829	-0.1532	-0.0851	-0.3140	-0.3116	0.3682**
SD	-0.0642	**-0.3875**	-0.1214	0.1948	-0.2471	0.0692	0.0561	0.0357	-0.1305	-0.1099	-0.0707	-0.0322	-0.1131	-0.0779	0.3360**
NNMS	-0.4138	-0.3530	**-0.3267**	0.2511	0.3324	0.7327	-0.0304	-0.1024	-0.2243	-0.2152	0.3485	0.0140	0.1572	0.1336	0.2685*
FBN	0.0993	0.1821	0.0807	**-0.3621**	0.0462	-0.1379	-0.0433	-0.0194	0.0859	0.0707	0.0684	-0.1140	-0.0651	-0.0846	-0.1595
NB/P	-0.3478	0.4846	-0.2243	-0.0970	**0.7601**	-0.0888	-0.3314	-0.3041	-0.0361	-0.0742	0.1385	0.1723	0.1716	0.3296	0.0914
DFF	0.0005	0.0002	0.0006	-0.0004	0.0001	**-0.0009**	0.0003	0.0002	0.0003	0.0002	0.0000	0.0001	-0.0003	0.0001	-0.2733*
FFN	0.0642	-0.0382	0.0071	0.0315	-0.1150	-0.0724	**0.2638**	0.3176	-0.0723	-0.0707	0.0214	0.0399	-0.1141	0.0038	-0.1861
FFr.N	-0.0383	0.0121	-0.0119	-0.0070	0.0525	0.0326	-0.1580	**-0.1312**	0.0046	0.0076	-0.0146	-0.0274	0.0465	-0.0248	0.1108
NF/P	-0.1900	-0.1747	-0.1033	0.1231	0.0246	0.1683	0.1422	0.0182	**0.3187**	-0.5281	-0.2278	0.2126	-0.0052	0.1572	0.6684***
NFr./P	0.6163	0.4609	0.3103	-0.3172	-0.1585	-0.4009	-0.4351	-0.0945	0.6539	**0.8244**	0.6373	-0.7578	-0.0434	-0.6011	0.6179***
FD	0.0706	-0.1070	0.1814	0.1107	-0.1069	0.0231	-0.0475	-0.0650	-0.2575	-0.2301	**-0.5864**	0.0793	-0.0063	-0.0131	0.0081
FL	-0.0718	0.0893	-0.0133	0.3381	0.2435	-0.0907	0.1626	0.2242	-0.4402	-0.5011	-0.1452	**0.8742**	-0.0184	0.6437	0.0972
FW	-0.0389	0.0461	-0.0220	0.0284	0.0356	0.0470	-0.0683	-0.0560	0.0016	-0.0042	0.0017	-0.0027	**0.1579**	-0.0029	0.1387
NS/F	0.1094	-0.0899	0.0530	-0.1044	-0.1938	0.0594	-0.0065	-0.0844	0.1354	0.1654	-0.0100	-0.4759	0.0082	**-0.4470**	0.2050
Partial R^2	0.4687	-0.1302	-0.3025	0.0578	0.0694	0.0003	-0.0491	-0.0145	-0.3467	0.5037	-0.0048	0.1044	-0.0219	-0.0916	

(R SQUARE = 0.7428, RESIDUAL EFFECT = 0.5071)

(Whereas, **PH**-plant height, **SD**-stem diameter, **NNMS**-number of nodes on main stem, **FBN**-first branching node, **NB/P**-number of branches per plant, **DFF**-days taken to first flowering, **FFN**-first flowering node, **FFr.N**-first fruiting node, **NF/P**-number of flowers per plant, **NFr/P**-number of fruits per plant, **FD**-fruit diameter, **FL**-fruit length, **FW**-fruit weight, **NS/F**-number of seeds per fruit and **Y/h**-yield/ha)

Phenotypic path coefficient analysis for yield

In the present investigation, the phenotypic path coefficient analysis revealed that there was a very high significant direct positive effect of the number of fruits per plant (0.8097) on the fruit yield/ha. Thus, very high significant positive correlation between the number of fruits per plant and fruit yield/ha was mainly due to its direct effect on the fruit yield/ha. The results are in confirmation with the findings of [6,10,11]. Fruit length (0.1943), plant height (0.1296) and the number of flowers per plant (0.0569) also had shown the significant direct positive effect on the fruit yield/ha. Similar results were also found by [8,12,13]. The highest indirect positive effect on yield/ha was exhibited by the number of fruits per plant via number of flowers per plant (0.7830). Fruits per plant had shown the high indirect positive effect on the yield/ha, via characters like plant height (0.2401) and the number of nodes on the main stem (0.2170).The highest direct negative effect on the yield/ha were exhibited by fruit diameter (-0.1762). Other traits showing direct negative

effect on yield/ha are first flowering node (-0.0701), first branching node (-0.0624) and stem diameter (-0.0493). [13] have also reported the same from their studies in okra. The maximum indirect negative effect on fruit yield/ha was also exhibited by number of fruits/plant via characters, fruit length (-0.2169) and via first branching node (-0.1304). Number of branches per plant (-0.0636) and days to first flowering (-0.0611) had shown the indirect negative effect on fruit yield/ha via number of fruits per plant.

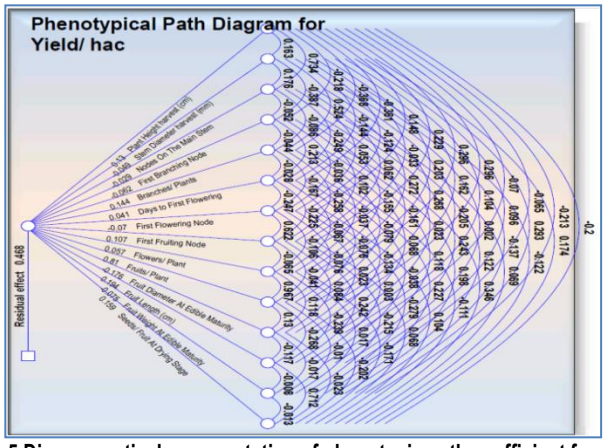

Fig-5 Diagrammatical representation of phenotypic path coefficient for yield

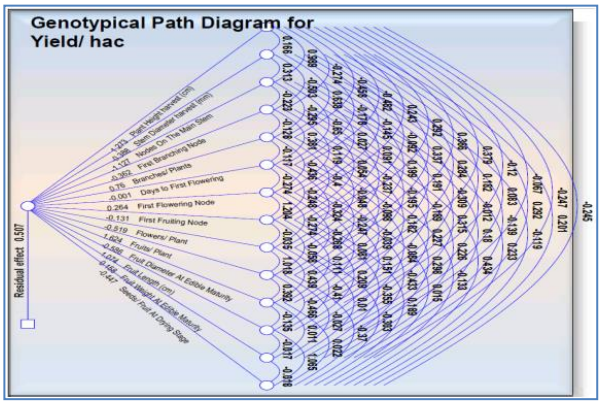

Fig-6 Diagrammatic representation of genotypic path coefficient for yield

Genotypic path coefficient analysis for yield

The path coefficient, which is calculated from the genotypic correlation coefficients, reflects the inherent cause of association between the traits. Genotypic path analysis breaks the genotypic correlations in to direct and indirect effects. In the present study, plant height has highest direct genotypic positive (0.8929) effect on fruit yield/ha. Fruit length (0.8742) and number of fruits per plant (0.8244) had shown very high direct genotypic positive effect on fruit yield/ha. Number of branches per plant (0.7601), first flowering node (0.2638) and fruit weight (0.1579) also had shown high direct positive genotypic effect. The highest indirect genotypic positive effect on fruit yield/ha (0.7327) was exhibited by number of nodes on the main stem via days to first flowering. Fruit length had shown a very high indirect genotypic positive effect on fruit yield via number of seeds per fruit (0.6437). Number of fruit per plant has shown very high indirect genotypic positive effect (0.6373) on fruit yield/ha via fruit diameter. Plant height has reflected very high indirect genotypic positive effect (0.5583) on fruit yield/ha via number of node on the main stem.

The maximum direct genotypic negative effect on fruit yield per hectare was exhibited by the fruit diameter at edible maturity (-0.5864) followed shortly by number of seed per fruit (-0.4470). Stem diameter (-0.3875) and first branching node (-0.3621) also have shown high direct negative effect on fruit yield/ha. Plant height had shown high indirect genotypic negative effect on fruit yield/ha via days to first flowering (-0.6138) and via number of branches per plant (-0.5824). Number of flowers per plant had exhibited indirect genotypic negative effect on fruit yield/ha via fruit diameter at edible maturity with their degree of -0.2575 and -0.2301 respectively.

Conclusion

The nature and extent of correlation among various characters varied. The highest and positive correlation observed between number of fruits per plant and yield per hectare followed by number flowers per plant and yield per hectare. Number of fruit per plant and number of flowers per plant showed highest direct positive effect on the yield. This indicates the importance of these characters in yield improvement through selection.

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Author contributions

Rajeev K. Yadav- conception and design of the work, data collection, data analysis and interpretation, drafting the article, approval of the version to be published

M.M. Syamal- conception and design of the work, critical revision of the article, final approval of the version to be published

Manish Kumar- data analysis and interpretation, critical revision of the article, final approval of the version to be published

P. Pandiyaraj, Kattula Nagaraju and Ashish Kaushal- critical revision of the article

Abbreviations

The abbreviations used in this study are-

PH-plant height, SD-stem diameter, NNMS-number of nodes on main stem, FBN-first branching node, NB/P-number of branches per plant, DFF-days taken to first flowering, FFN-first flowering node, FFr. N-first fruiting node, NF/P-number of flowers per plant, NFr/P-number of fruits per plant, FD-fruit diameter, FL-fruit length, FW-fruit weight, NS/F-number of seeds per fruit and Y/h-yield/ha.

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Chauhan D.V.S. (1972) Vegetable Production in India. 3rd ed., Ram Prasad and Sons, Agra.
[2] Ndunguru J. and Rajabu A.C. (2004) *Sci. Hort.*, 99, 225-235.
[3] Wright S. (1921) Correlation and causation. *J. Agric. Res.*, 20, 557-585.
[4] Al-Jibouri, H.A., Miller P.A. and Robison H.F. (1958) *Agron. J.*, 50, 633-636.
[5] Kamal R.V., Yadav J.R., Singh B., Tiwari S.K. and Singh S.K. (2003) *Pl. Arch.*, 3(2), 299-302.
[6] Dhankhar B.S. and Dhankhar S.K. (2002) *Veg. Sci.*, 29(1), 63-65.
[7] Kamal R.V., Yadav J.R., Singh B., Tiwari S.K. and Singh S.K. (2003) *Pl. Arch*., 3(2), 299-302.
[8] Magar R.G. and Madrap I.A. (2009) *Int. J. Pl. Sci.*, 4(2), 498-501.
[9] Nasit M.B., Dhaduk L.K., Vachhani J.H. and Savaliya J.J. (2009-10) *Asian J. Hort.*, 4(2), 394-397.
[10] Mehta D.R., Dhaduk L.K. and Patel, K.D. (2006) *Agric. Sci. Digest*, 26(1), 15-18.
[11] Prakash K. and Pitchaimuthu M. (2010) *Elec. J. Pl. Breed.*, 1(6), 1426-1430.
[12] Wright S. (1921) *J. Agric. Res.*,20, 557-585.
[13] Adiger S., Shanthkumar G., Gangashetty P.I. and Salimath P.M. (2011) *Elec. J. Pl. Breed*., 2(4), 568-573.