Original Research Article

Character association and path analysis for okra (Abelmoschusesculentus (L.) Moench.) yield, fruit quality, and resistance to yellow vein mosaic

Abstract

Objective: To find the best parents for desirable traits, particularly earliness, yield, and fruit quality, as well as YVMV (Yellow Vein Mosaic Virus) resistance, in order to create novel hybrids or varieties.

Experimental- Design: The experiment was carried out using a randomised block design with three replications.

Place and Duration of Experiment: The study was conducted in the 2016 kharif seasons at the Department of Horticulture's field experimentation centre at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj (U.P.). At 78 metres above mean sea level, this location is situated between 25.87° N latitude and 81.15° E longitude. The experimental area's soils have a sandy to sandy loam texture, are moderately well to well drained, and include a provision for ground water irrigation..

Methodology: 25 genotypes were collected for this Trail during the 2016 kharif season. To grow the crop, good agricultural methods were used. Plant height (cm), number of branches/plant, number of leaves/plant, first flowering (in days), 50% flowering (in days), first flowering node, fruit length (cm), fruit diameter (cm), fresh fruit weight (g), number of fruits/plant, fruit yield/plant (g), fruit yield/plot (g), YVMV incidence (%), YVMV severity (%), and crude were the observations to be recorded for five randomly chosen plants from each genotype in each replication To calculate the genetic correlation coefficient analysis, the data were subjected to statistical analysis. The Miller et al. algorithm was used to determine the genetic and phenotypic correlation coefficients

Results: Based on collected and analysed data, a substantial and positive connection between Days to First Flowering and Days to 50% Flowering (0.94) and between Fruit Weight (g) and Fruit Yield/plant (g) was found (0.91). demonstrating that okra could experience real improvement thanks to these characteristics. At both the genotypic and phenotypic levels, fruit weight demonstrated the highest beneficial direct impact on fruit yield per plant. The genotype Kashi Satdhari had the lowest YVMV incidence (%), followed by Kashi Vardan (16.38%), whereas 151-10-1-2-3 had the highest YVMV incidence (79.17%), followed by Larem-1 (75.31%).**Conclusion:**A very strong positive and significant correlation was recorded between Days to First Flowering with Days to 50% Flowering and Fruit Weight with Fruit Yield/plant. Negative and significant association of YVMV Incidence % with Fruit Yield/plant (g) indicates that fruit yield/plant decreases with increase in YVMV incidence %.Fruit weight showed maximum positive direct effect on fruit yield per plant at both genotypic and phenotypic level indicating that effective improvement through these characters could be achieved in okra.

Key words: Okra, Character association, Genotypic, Phenotypic, Pathanalysis

Introduction

"Due to their role in obtaining nutritional security from human malnutrition, vegetables are gaining worldwide recognition as well as in India. Okra [Abelmoschusesculentus (L.) (Moench)] is a vegetable crop growing in tropical and subtropical regions of the world that is significant economically. Among vegetables, okra has seized a significant role. It is a well-known fruit and vegetable that is widely cultivated in tropical and subtropical regions of the world. Its soft green fruits, which are marketed primarily in fresh form but are occasionally available in canned or dehydrated form, are used as vegetables. Assam, West Bengal, and Karnataka are the country's top producers of okra, followed by Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, and Orissa" (Anon., 2006).

"Although this vegetable primarily self-pollinates, the chance of insect cross-pollination cannot be fully ruled out because to its stunning corolla. Due to insect assisted pollination, cross pollination is seen to a degree of 4.0-19.0% (Purewell and Randhawa, 1947) and up to 42.2%". (Mitrideri and Vencovsky, 1974 and Kumar, 2006). This explains a significant portion of the variety in fruit yield and its associated characteristics. In addition to soil and climate issues, the cultivar itself is essential to the plant's performance in terms of earliness, disease resistance, and yield.

The correlation coefficient is a statistical tool for determining the magnitude and direction of a relationship between two or more variables. Utilized in plant breeding, correlation coefficient analysis evaluates the interactions between numerous plant traits and identifies the character traits that selection might be focused on to increase genetic yield.

Positive correlations between desired features are advantageous to the plant breeder because they promote the simultaneous growth of the two traits. A negative correlation, on the other hand, will prevent two characters with high values from expressing themselves at the same time. By using strong selection on a character who is genetically related to the dependent character, it is possible to genetically strengthen dependent features (Al-Jibouri et al., 1958). The selection process is significantly influenced by the genetic link between the desired traits and other attributes (Falconer and Mackay, 1996).

To emphasise the importance of unintentional causes, the route coefficient analysis separates correlation coefficients into direct and indirect effects. Understanding genetic variation, the connections between different traits, and the direct and indirect contributions of each feature to the overall pea yield are the key objectives of the current research.

Materials and methods

The present trail was carried out at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment will be conducted in Randomized Block Design having 25 genotypes collected from IIVR, Varanasi. The allocations of treatments in the individual plots are done by using random number using 3 replications.

The site is located between 25.87°N latitude and 81.15^o E longitude at 78 m above the meansea level. The soils of the study areas are sandy to sandy loam in texture and moderately well to well drained with ground water irrigation facility. Soils are medium in fertility status. Climate of this district is characterized by dry summer and cool winter with average rainfall is 1013.4 mm during *kharif* season.Good agricultural practices were done to grow the crop.The observations on 5 randomly selected plants from each genotypes in each replication were recorded for 15 quantitative and qualitative traits viz. plant height (cm), no. of branches/plant, no of leaves/plant, days to first flowering, days to 50% flowering, first flowering node, fruit length (cm), fruit diameter (cm), fresh fruit weight (g), no. of fruits/plant, fruit yield/plant (g), fruit yield/plot (g), YVMV incidence (%) YVMV severity (%) and crude fibre content (%).The data were subjected to statistical analysis to estimate the genetic correlation coefficient analysis.Genotypic and phenotypic correlation coefficients were calculated according to the formula given by ***Miller et al.*** **(1958)**

Results and Discussion

The degree of association between two characters is measured by character association or correlation. A measure of the intrinsic relationship between the genes governing any two features is provided by genotypic correlation. The degree of the observed association between two features is shown by the phenotypic correlations. Therefore, the genotypic correlation coefficients for okra fruit production and its components were calculated for the current study. The correlation coefficients between the characters at genotypic and phenotypic level were presented in Table 1. In general magnitude of genotypic correlation coefficient was higher than phenotypic correlation coefficients.

Correlation analysis

“Character associationor correlation is a measure of the degree of association betweentwo characters.The phenotypic correlations indicate the extent of theobserved relationship between two characters. This does not givetrue genetic picture of the relationship because it includeshereditary as well as environmental influences. Genotypiccorrelation provides an estimate of inherent association betweengenes controlling any two characters. Hence, it is of greatersignificance and could be effectively utilized in formulating aneffective selection scheme" (Ramya*et al. (2010))*. Therefore, in the present study, the genotypic correlation coefficients were workedout for cluster bean for vegetable fruit yield and its components.

"Correlation studies on vegetable fruit yield andits component traits revealed that the values of genotypiccorrelation coefficients were higher than phenotypiccorrelationcoefficient this was in confirmation"with Patel and Chaudhary (2001). This suggests the strong inherent association among thetraits.The correlation coefficients between the characters atgenotypic and phenotypic level were presented in Table1. In general magnitude of genotypic correlation coefficient washigher than phenotypiccorrelation coefficients.

Genotypic level correlation

"Fruit yield per plot (kg) showed (Table)significant and positive correlation with fruit weight (gm) (0.91), fruits/plant (0.46), and leaves/plant (0.40) while it showed non-significant and positive correlation with fruit yield per plant (g) (1.00),branches/plant (0.29), first flowering node (0.27), days to first flowering (0.03) and days to 50% flowering (0.01). It showed non-significant and negative correlation with fruit diameter (cm) (0.25), fruit length (cm) (0.06) and and plant height (cm) (0.06). These results were similar to those found" by Guddadamath*et al*. (2011); Nwangburuka*et al.* (2012) and Celestin *et al.* (2012).

Phenotypic Correlation

"Fruit yield per plot (kg) showed (Table1) significant and positive correlation with fruits/plant (0.68), fruit weight (gm) (0.67) and leaves/plant (0.28) while it showed non-significant and positive correlation with fruit yield per plant (g) (1.00), first flowering node (0.11), branches/plant (0.09), days to first flowering (0.04), days to 50% flowering (0.03)and plant height (cm) (0.03). It showed non-significant and negative correlation with fruit length (cm) (0.09) andfruit diameter (cm) (0.02). These results were similar to those found" by **Guddadamath*et al*. (2011); Nwangburuka*et al.* (2012) and Celestin *et al.* (2012).**

Table 1: Genotypic and Phenotypic Correlation Coefficient (r_g&r_p) for fruit yield and its contributing traits in okra.

S.N.	Character		PH	LP	BP	DFF	DF	FNN	FP	FL	FD	FW	FYP	FPP	YVMI	YVMS	CFC
1	PH	r_g	**1.00**	0.39**	0.17	-0.30	-0.33	0.30	0.05	-0.30*	-0.26	-0.10	-0.06	-0.06	0.20	0.07	-0.24*
		r_p	**1.00**	0.37**	0.04	-0.19	-0.23	0.21	0.09	-0.29*	-0.20	-0.06	0.03	0.03	0.19	0.06	-0.23*
2	LP	r_g		**1.00**	0.18	0.18	0.29*	0.06	0.01	-0.14	0.09	0.09	0.09	-0.21	-0.32**	0.27*	0.27*
		r_p		**1.00**	0.26*	-0.12	-0.16	0.41**	0.09	-0.25*	-0.01	0.33**	0.28*	0.28*	-0.06	-0.20	0.03
3	BP	r_g			**1.00**	0.18	0.18	0.29*	0.06	0.01	-0.14	0.09	0.09	0.09	-0.21	-0.32**	0.27*
		r_p			**1.00**	0.18	0.18	0.29*	0.06	0.01	-0.14	0.09	0.09	0.09	-0.21	-0.32**	0.27*
4	DFF	r_g				**1.00**	0.94**	-0.25	-0.23	0.76**	0.47	0.17	0.03	0.03	-0.30	-0.07	0.27
		r_p				**1.00**	0.90**	-0.10	-0.01	0.52**	0.17	0.05	0.04	0.04	-0.20	-0.02	0.19
5	DF	r_g					**1.00**	-0.43	-0.20	0.79**	0.37	0.12	0.01	0.01	-0.18	-0.03	0.14
		r_p					**1.00**	-0.21	-0.04	0.56**	0.13	0.06	0.03	0.03	-0.13	-0.02	0.12
6	FNN	r_g						**1.00**	0.16	-0.16	-0.14	0.20	0.27	0.27	-0.01	0.04	0.33**
		r_p						**1.00**	0.08	-0.10	-0.21	0.09	0.11	0.11	-0.03	0.08	0.27*
7	FP	r_g							**1.00**	-0.24	-0.18	-0.03	0.46**	0.46**	-0.48**	-0.48**	-0.12
		r_p							**1.00**	-0.17	0.01	-0.05	0.68**	0.68**	-0.30**	-0.30**	-0.08
8	FL	r_g								**1.00**	0.17	0.08	-0.06	-0.06	-0.05	0.11	0.47**
		r_p								**1.00**	0.14	0.03	-0.09	-0.09	-0.04	0.08	0.44**
9	FD	r_g									**1.00**	-0.14	-0.25	-0.25	0.19	0.21	-0.08
		r_p									**1.00**	-0.08	-0.02	-0.02	0.15	0.11	-0.05
10	FW	r_g										**1.00**	0.91**	0.91**	-0.37**	0.40**	0.29*
		r_p										**1.00**	0.67**	0.67**	-0.35**	-0.38**	0.28*
11	FYP	r_g											**1.00**	1.00	-0.61**	0.65**	0.18
		r_p											**1.00**	1.00	-0.42**	-0.45**	0.13
12	FPP	r_g												**1.00**	-0.61**	-0.65**	0.18
		r_p												**1.00**	-0.42**	-0.45**	0.13
13	YVMI	r_g													**1.00**	0.84**	-0.22
		r_p													**1.00**	0.80**	-0.21
14	YVMS	r_g														**1.00**	-0.14
		r_p														**1.00**	-0.23
15	CFC	r_g															**1.00**
		r_p															**1.00**

* and ** significant at 5% and 1% level of significance, respectively.

Plant Height (cm), LP: Leaves/ Plant, BP Branches/ Plant, DFF: **Days to First Flowering, DF: Days to 50 % Flowering, FFN:First Flowering Node, FP: Fruits/ Plant, FL: Fruit Len:gth (cm), FD: Fruit Diameter (cm), FW Fruit Weight (g, FYP): Fruit Yield/ FPP: Fruit Yield/ Plot (kg Plant (g) YVMI: YVMV Incidence (%), YVMS:YVMV Severity (%), CFC:CrudeFibre Content (%)**

Table: 2Direct (diagonal) and indirect effects of component characters contributing to yield in okra at genotypic level:

Character	PH	**LP**	**BP**	**DFF**	**DF**	**FNN**	**FP**	**FL**	**FD**	**FW**	**YVMI**	**YVMS**	**CFC**
PH	**0.0061**	0.0024	0.0007	-0.0018	-0.0020	0.0018	0.0003	-0.0018	-0.0016	-0.0006	0.0012	0.0004	-0.0015
LP	-0.0172	**-0.0437**	-0.0186	0.0080	0.0117	-0.0274	-0.0073	0.0121	0.0041	-0.0149	0.0031	0.0088	-0.0012
BP	-0.0082	-0.0299	**-0.0704**	-0.0302	-0.0176	-0.0323	-0.0275	-0.0041	0.0106	-0.0043	0.0214	0.0384	-0.0283
DFF	0.0763	0.0461	-0.1077	**-0.2510**	-0.2370	0.0635	0.0580	-0.1902	-0.1177	-0.0430	0.0754	0.0164	-0.0684
DF	-0.1372	-0.1106	0.1039	0.3917	**0.4149**	-0.1771	-0.0819	0.3265	0.1548	0.0497	-0.0742	-0.0105	0.0588
FNN	0.0599	0.1237	0.0907	-0.0500	-0.0844	**0.1978**	0.0325	-0.0323	-0.0269	0.0400	-0.0028	0.0074	0.0643
FP	0.0183	0.0659	0.1541	-0.0913	-0.0780	0.0648	**0.3949**	-0.0957	-0.0719	-0.0118	-0.1897	-0.1908	-0.0462
FL	0.0330	0.0304	-0.0064	-0.0830	-0.0862	0.0179	0.0266	**-0.1096**	-0.0190	-0.0090	0.0056	-0.0119	-0.0517
FD	0.0080	0.0029	0.0046	-0.0145	-0.0115	0.0042	0.0056	-0.0054	**-0.0309**	0.0043	-0.0057	-0.0063	0.0025
FW	-0.0851	0.2838	0.0504	0.1426	0.0998	0.1683	-0.0249	0.0685	-0.1148	**0.8322**	-0.3044	-0.3354	0.2412
YVMI	-0.0018	0.0007	0.0028	0.0028	0.0017	0.0001	0.0044	0.0005	-0.0017	0.0034	**-0.0092**	-0.0078	0.0020
YVMS	-0.0111	0.0318	0.0866	0.0104	0.0040	-0.0060	0.0767	-0.0172	-0.0326	0.0640	-0.1339	**-0.1588**	0.0230
CFC	0.0034	-0.0004	-0.0057	-0.0039	-0.0020	-0.0046	0.0017	-0.0067	0.0011	-0.0041	0.0031	0.0021	**-0.0142**
Fruit Yield/ Plant (g)	**-0.0558**	**0.4030**	**0.2850**	**0.0297**	**0.0131**	**0.2712**	**0.4591**	**-0.0554**	**-0.2466**	**0.9058**	**-0.6100**	**-0.6480**	**0.1803**
Partial R^2	-0.0003	-0.0176	-0.0201	-0.0075	0.0054	0.0537	0.1813	0.0061	0.0076	0.7538	0.0056	0.1029	-0.0026

* and ** significant at 5% and 1% level of significance, respectively.

Plant Height (cm), LP: Leaves/ Plant, BP Branches/ Plant, DFF: **Days to First Flowering, DF: Days to 50 % Flowering, FFN:First Flowering Node, FP: Fruits/ Plant, FL: Fruit Len:gth (cm), FD: Fruit Diameter (cm), FW: Fruit Weight (g), YVMI: YVMV Incidence (%), YVMS:YVMV Severity (%), CFC:CrudeFibre Content (%)**

Table3: Direct (diagonal) and indirect effects of component characters contributing to yield in okra at phenotypic level:

Character	PH	LP	BP	DFF	DF	FNN	FP	FL	FD	FW	YVMI	YVMS	CFC
PH	**0.0245**	0.0091	0.0010	-0.0045	-0.0055	0.0051	0.0023	-0.0070	-0.0048	-0.0016	0.0047	0.0014	-0.0057
LP	-0.0125	**-0.0335**	-0.0088	0.0041	0.0055	-0.0137	-0.0031	0.0083	0.0003	-0.0112	0.0022	0.0068	-0.0011
BP	-0.0004	-0.0023	**-0.0089**	-0.0016	-0.0016	-0.0026	-0.0006	-0.0001	0.0013	-0.0008	0.0018	0.0029	-0.0024
DFF	0.0026	0.0017	-0.0025	**-0.0138**	-0.0124	0.0014	0.0002	-0.0071	-0.0024	-0.0007	0.0027	0.0003	-0.0027
DF	-0.0078	-0.0057	0.0061	0.0310	**0.0345**	-0.0074	-0.0014	0.0190	0.0046	0.0020	-0.0044	-0.0006	0.0042
FNN	0.0010	0.0020	0.0014	-0.0005	-0.0010	**0.0049**	0.0004	-0.0005	-0.0010	0.0004	-0.0001	0.0004	0.0013
FP	0.0670	0.0675	0.0464	-0.0082	-0.0304	0.0561	**0.7270**	-0.1245	0.0061	-0.0373	-0.2154	-0.2214	-0.0599
FL	0.0026	0.0023	-0.0001	-0.0047	-0.0050	0.0009	0.0016	**-0.0091**	-0.0013	-0.0003	0.0004	-0.0007	-0.0040
FD	-0.0053	-0.0003	-0.0038	0.0047	0.0036	-0.0056	0.0002	0.0038	**0.0270**	-0.0021	0.0040	0.0031	-0.0012
FW	-0.0468	0.2444	0.0630	0.0363	0.0419	0.0641	-0.0376	0.0255	-0.0568	**0.7330**	-0.2536	-0.2788	0.2025
YVMI	0.0055	-0.0019	-0.0060	-0.0058	-0.0037	-0.0008	-0.0086	-0.0013	0.0044	-0.0101	**0.0292**	0.0234	-0.0062
YVMS	0.0008	-0.0027	-0.0043	-0.0003	-0.0002	0.0010	-0.0041	0.0011	0.0015	-0.0051	0.0108	**0.0134**	-0.0018
CFC	-0.0021	0.0003	0.0024	0.0017	0.0011	0.0024	-0.0007	0.0039	-0.0004	0.0025	-0.0019	-0.0012	**0.0089**
Fruit Yield/ Plant (g)	**0.0293**	**0.2809**	**0.0859**	**0.0384**	**0.0267**	**0.1057**	**0.6754**	**-0.0879**	**-0.0215**	**0.6688**	**-0.4197**	**-0.4512**	**0.1319**
Partial R^2	0.0007	-0.0094	-0.0008	-0.0005	0.0009	0.0005	0.4910	0.0008	-0.0006	0.4903	-0.0122	-0.0060	0.0012

* and ** significant at 5% and 1% level of significance, respectively.

Plant Height (cm), LP: Leaves/ Plant, BP Branches/ Plant, DFF: **Days to First Flowering, DF: Days to 50 % Flowering, FFN:First Flowering Node, FP: Fruits/ Plant, FL: Fruit Len:gth (cm), FD: Fruit Diameter (cm), FW Fruit Weight (g), YVMI: YVMV Incidence (%), YVMS:YVMV Severity (%), CFC:CrudeFibre Content (%)**

Path coefficient analysis

"Path coefficient analysis is an important tool for partitioning the correlated coefficients into the direct and indirect effects of independent variables on a dependent variable with the inclusion of more variables in correlated study. Their indirect association becomes more complex. Two characters may show correlated, just because they are correlated with a common third one. In such circumstances, path coefficient analysis provides an effective means of a critical examination of specific forces action to produce a given correlated and measure the relative importance of each factor. Path coefficient analysis can explain the extent of relative contribution" (Ramya*et al. (2010))*. In this analysis, fruit yield per plant was taken as dependent variable and the rest of the characters were considered as in dependable variables.

Genotypic path analysis

"The path coefficient analysis (presented in table 2) which splits total correlated coefficient of different characters into direct and indirect effects on fruit yield per plant in such a manner that the sum of direct and indirect effects is equal to total genotypic correlated.Data revealed that fruit weight (0.83) showed the highest direct positive effect on green pod yield per plant followed by days to 50 % flowering (0.41), fruits per plant (0.39), first flowering node (0.19), plant height (0.00) While other traits like days to first flowering (-0.25), YVMV severity (-0.15), fruit length (-0.10), branches per plant (-0.07), leaves per plant (-0.04), fruit diameter (-0.03), crude fibre content % (-0.01) and YVMV incidence (-0.00) showed direct negative effect on fruit yield per plant at genotypic level.These finding are conformity of the findings" ofPatil, et al. (2016) Kumar and Reddy (2016), Kerure et al. (2017).

Phenotypic path analysis

Data revealed that fruit weight (0.73) showed (Table3) the highest direct positive effect on green pod yield / plant followed by fruits / plant (0.72), YVMV incidence (0.02), fruit diameter (0.02), plant height (0.02), YVMV severity (0.01), crude fibre content % (0.00) and first flowering node (0.00) While other traits leaves / plant (-0.03), days to first flowering (-0.01), fruit length (-0.00) and branches per plant (0.00) showed direct negative effect on fruit yield per plant at phenotypic level.

Conclusion:

Days to First Flowering with Days to 50% Flowering, Fruit Weight with Days to Fruit Yield/plant, and other variables all showed a very strong positive and significant link. Fruit yield/plant falls with an increase in YVMV incidence%, according to a negative and significant relationship between the two variables (g). Fruit weight had the greatest beneficial direct impact on fruit yield/plant at the genotypic and phenotypic levels, showing that these traits might be improved upon in a significant way.

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