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Bestha Jaya Sai Krishna
Ph.D. Scholar, Department of
Genetics and Plant Breeding, Sam
Higginbottom University of
Agriculture, Technology and
Sciences, Prayagraj, Uttar
Pradesh, India

GM Lal
Professor, Department of Genetics
and Plant Breeding, Sam
Higginbottom University of
Agriculture, Technology and
Sciences, Prayagraj, Uttar
Pradesh, India

Corresponding Author:
Bestha Jaya Sai Krishna
Ph.D. Scholar, Department of
Genetics and Plant Breeding, Sam
Higginbottom University of
Agriculture, Technology and
Sciences, Prayagraj, Uttar
Pradesh, India

Genetic variability, correlation and path analysis of quantitative and biochemical parameters associated with yield in Okra (*Abelmoschus esculentus* (L.) Moench)

Bestha Jaya Sai Krishna and GM Lal

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Abstract

This study was carried out during Zaid 2024 at Field experimental center of Department of Plant breeding to assess 17 okra genotypes for fourteen quantitative traits and two biochemical traits. The analysis of variance revealed significant genetic differences for traits associated with flowering, branching, plant height, fruit length, and fruiting behavior, while yield and seed traits showed comparatively low variability. Estimates of genetic parameters indicated that phenotypic coefficients of variation were consistently higher than genotypic coefficients, underscoring the role of environmental factors. High heritability coupled with notable genetic advance was observed for days to 50% flowering, days to first picking, and first fruiting node, suggesting additive gene action and the potential for improvement through direct selection. Correlation analysis demonstrated that fruit yield per plant was positively and strongly associated with earliness traits, number of branches, and number of fruits per plant at both genotypic and phenotypic levels. Path coefficient analysis further confirmed that number of fruits per plant, average fruit weight, and earliness traits exerted the greatest direct influence on yield, whereas seed index, fruit length, and internode length had negative effects. The study identified earliness and fruit number as the most dependable selection criteria for improving yield in okra. These traits provide a practical foundation for selecting superior parents in heterosis and combining ability programs aimed at developing heat-tolerant, high-yielding cultivars.

Keywords: Okra genotypes, genetic variability, heritability, correlation analysis, path coefficient analysis

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench], also known as lady's finger or bhindi, is an important warm-season vegetable crop belonging to the family Malvaceae. It is widely cultivated in tropical, subtropical, and warm temperate regions for its immature green pods, which are consumed as a fresh vegetable (Chandramouli *et al.*, 2016; Reddy *et al.*, 2012) [5, 15].

The crop is valued for its nutritional and medicinal properties. Okra pods are rich in dietary fibre, vitamins (A, B, C), minerals, and mucilage, which provide several health benefits including antidiabetic, anti-inflammatory, and cholesterol-lowering effects. Due to its short duration, high market demand, and adaptability to varied climatic conditions, okra plays a significant role in the livelihood of small and marginal farmers in India (Yonas *et al.*, 2014; Alam *et al.*, 2020) [23, 2].

Despite its importance, okra productivity is often limited by narrow genetic base, biotic stresses (particularly yellow vein mosaic virus), and abiotic factors. Therefore, the assessment of genetic variability and identification of superior genotypes are essential prerequisites for crop improvement programmes (Koundinya *et al.*, 2013; Reddy *et al.*, 2012; Sharma and Prasad, 2015) [8, 15, 17].

Genetic variability provides the raw material for selection and breeding. Studies on variability, heritability, correlation, and path coefficient analysis help in understanding the nature and magnitude of character associations and direct and indirect effects of various traits on pod yield (Alam *et al.*, 2020; Vijay and Manohar, 1990; Sharma and Prasad, 2015; Dhali *et al.*, 2000) [2, 20, 17, 6]. Such information is highly useful for identifying desirable parents for hybridization and exploiting heterosis (Ranga *et al.*, 2024; Elangaimannan *et al.*, 2025) [13, 7].

Several workers have reported significant variability, correlation, and path coefficients for yield and its contributing traits in okra and it is valued not only for its yield but also for its important biochemical constituents, particularly moisture and mucilage content, which influence nutritional quality, processing suitability, and consumer acceptance. These biochemical traits are heritable and genetically correlated with yield components, making them viable targets for simultaneous improvement in breeding programs (Singh *et al.*, 2007; Yadav *et al.*, 2016; Rathava *et al.*, 2019; Abdalla, 2025; Yogesh *et al.*, 2025) ^[18, 21, 14, 1, 22]. However, continuous evaluation of available genotypes is necessary to identify potential parents for future hybrid breeding programmes.

The present investigation was carried out during 2024 to estimate the genetic variability, character associations, and path coefficients among okra genotypes. This study will serve as a foundation for subsequent heterosis and combining ability analysis planned for 2025.

Materials and Methods

Seventeen okra genotypes were evaluated during the Zaid season, 2024 at the Field Experimentation Centre, Department of Genetics and Plant Breeding. The experiment was conducted in a Randomized Block Design (RBD) with three replications keeping a spacing of 30 cm × 45 cm (plant × row). Data were recorded on sixteen important traits: days to 50% flowering (DF50), days to first picking (DFP), number of branches per plant (NBPP), plant height (PH, cm), internodal length (IL), fruit length (FL, cm), seed index (SI), number of fruits per plant (NFPP), number of seeds per pod (NSPP), average fruit weight (AFW, g), days to last picking (DLP), Number nodes per plant (NDP), fruits per first node (FFN), fruit yield per plant (FYPP, g), Moisture content (MC) and Mucilage content (MUC).

Results and Discussion

Anova

The mean sum of squares derived from the analysis of variance for Sixteen traits across 17 okra genotypes are presented in Table 1. The results revealed that the genotypic mean squares were highly significant ($P < 0.01$) for several traits, including days to 50% flowering, days to first picking, number of branches per plant, plant height, fruit length, days to last picking, number of nodes per plant, first fruiting node, moisture content and Mucilage content. The presence of significant variation among genotypes for these traits indicates ample genetic diversity, which can be effectively exploited in breeding programs. Comparable findings have been documented by Alam *et al.* (2020) ^[2], Sharma and Prasad (2015) ^[17], and Yogesh *et al.* (2025) ^[22], further supporting the reliability of these results.

Variability

Estimates of genetic variability parameters, including genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad-sense heritability, genetic advance (GA), and genetic advance as percent of mean (GAM), for fourteen quantitative and biochemical traits are presented in Table 3.

Across all traits, PCV values were consistently higher than GCV, reflecting the influence of environmental factors on trait expression. The greatest variability was observed for first fruiting node (GCV = 8.97%, PCV = 13.49%), followed by number of nodes per plant (GCV = 6.90%, PCV = 9.39%). Moisture content showed low variability with GCV = 0.808% and PCV = 0.808%, Mucilage content exhibited high variability (GCV = 12.448%, PCV = 12.449%). Moderate levels of

variation were recorded for days to 50% flowering, days to first picking, and number of branches per plant, while fruit yield per plant, average fruit weight, and seed index showed very low variability.

Heritability estimates ranged from as low as 1.79% for average fruit weight to as high as 73.96% for days to 50% flowering. High heritability ($>60\%$) was observed for days to 50% flowering (73.96%), Moisture content (71.43%) and days to first picking (71.71%), indicating strong genetic control. Moderate heritability (40–60%) was noted for number of branches per plant, days to last picking, number of nodes per plant, Mucilage content and first fruiting node.

Genetic advance as percent of mean (GAM) was highest for first fruiting node (12.30%), followed by number of nodes per plant (10.46%), days to first picking (9.50%), and days to 50% flowering (9.49%). In contrast, Moisture content (1.665%), fruit yield per plant (0.25%), average fruit weight (0.30%), and seed index (0.39%) exhibited very low GAM values.

The combination of high heritability with high GAM for days to 50% flowering, days to first picking, and first fruiting node suggests that these traits are largely governed by additive gene action and can be effectively improved through direct phenotypic selection. Moisture content low genetic advance indicating most variation is genetic but expected selection gain is small Mucilage content moderate suggesting good scope for improvement through selection. These results are consistent with earlier findings reported by Alam *et al.* (2020) ^[2] and Elangaimannan *et al.* (2025) ^[7].

On the other hand, traits such as fruit yield per plant, average fruit weight, and seed index showed very low heritability and genetic advance, indicating that they are strongly influenced by environmental factors and non-additive genetic effects. The limited genetic variability for yield highlights the vulnerability of okra to high temperatures, which often leads to flower drop and poor fruit set, as noted by Ranga *et al.* (2024) ^[13] and Abdalla (2025) ^[1].

Correlation Analysis

The correlation coefficients among fourteen quantitative and two biochemical traits of 17 okra genotypes grown during Zaid 2024 are presented in Tables 4 and 5.

Fruit yield per plant (FYPP) showed strong positive genotypic associations with days to 50% flowering (0.73), days to first picking (0.60), number of branches per plant (0.60), and number of fruits per plant (0.51). At the phenotypic level, FYPP also correlated significantly with number of fruits per plant (0.65), days to 50% flowering (0.50), days to first picking (0.50), and number of branches per plant (0.38*). These results emphasize that earliness and fruit number are key contributors to yield.

Number of fruits per plant (NFPP) exhibited strong positive genotypic correlations with days to first picking (0.67) and number of branches per plant (0.67), while its phenotypic correlation with FYPP (0.65) confirmed its role as a major direct yield component. Days to last picking (DLP) was positively associated with fruit length (0.80 genotypic, 0.63** phenotypic), number of nodes per plant (0.75** genotypic), and days to first picking (0.73** genotypic). Plant height correlated significantly with number of seeds per pod (0.83) and number of nodes per plant (0.65). First fruiting node (FFN) also showed positive associations with most yield-related traits at both levels. Moisture content (MC) and mucilage content (MUC) were strongly and positively correlated at both phenotypic and genotypic levels (phenotypic 0.93**, genotypic 0.93).

In contrast, seed index (SI) displayed significant negative

correlations with FYPP at both genotypic (-0.54*) and phenotypic (-0.26) levels, as well as with several other yield components. This suggests that genotypes with smaller seed size tend to allocate assimilates more effectively towards pod development rather than seed filling, thereby enhancing pod yield.

Overall, the correlation analysis revealed that FYPP was strongly and positively associated with days to 50% flowering, days to first picking, number of branches per plant, and number of fruits per plant at both levels. These traits therefore represent important yield-contributing characters in okra. The findings are consistent with earlier reports by Alam *et al.* (2020) [2], Sharma and Prasad (2015) [17], and Yogesh *et al.* (2025) [22].

The strong positive correlation between NFPP and FYPP highlights fruit number as the most direct contributor to yield. Thus, direct selection for higher fruit number, combined with earliness traits, would be highly effective in improving productivity. Similar conclusions have been drawn by Vijay and Manohar (1990) [20] and Rathava *et al.* (2019) [14]. Furthermore, the positive inter-relationships among earliness traits (DF50 and DFP) with yield components suggest the possibility of simultaneous improvement of both earliness and yield potential.

Path Analysis

Path coefficient analysis was employed to dissect the correlation coefficients into direct and indirect contributions of various quantitative and biochemical traits towards fruit yield per plant (FYPP). The findings at both phenotypic (Table 5) and genotypic (Table 6) levels provided valuable insights into the relative importance of different traits.

At the phenotypic level, the number of fruits per plant (NFPP) emerged as the most influential trait, exerting the highest positive direct effect (2.5873) on fruit yield. Average fruit weight (AFW, 3.5034), days to 50% flowering (DF50, 1.7246), and days to first picking (DFP, 1.2928) also showed strong positive direct effects, highlighting their role in yield improvement. These traits further contributed indirectly through favorable associations with number of seeds per pod, number of nodes per plant, and days to last picking. Conversely, fruit length (FL, -4.7339) and internode length (IL, -4.3447) recorded strong negative direct effects, suggesting that longer fruits and internodes may not necessarily enhance yield under stress

conditions. Seed index (SI) also showed a negative direct effect (0.5202). At the phenotypic level, moisture content (MC) had a large negative direct effect on fruit yield per plant (-6.34), while mucilage content (MUC) had a large positive direct effect (11.52) and unfavorable indirect effects with most yield components, reinforcing its antagonistic relationship with fruit yield. The residual effect (0.6266) indicated that the traits studied explained a substantial proportion of the variation in fruit yield, with the remainder attributable to other unmeasured factors.

At the genotypic level, the magnitude of direct effects was generally higher, reflecting stronger inherent genetic associations. AFW (4.252), DF50 (3.0284), DFP (1.8276), and NFPP (2.0011) exhibited substantial positive direct effects on fruit yield. These traits also contributed positively through indirect pathways, particularly via number of nodes per plant (11.3706), number of seeds per pod (4.3673), and days to last picking (2.3261).

On the other hand, FL (-14.1695), IL (-2.8989), and plant height (PH, -2.0889) showed pronounced negative direct effects, which were only partially compensated by indirect contributions. Seed index (SI, -6.4135) exerted a strong negative direct effect and consistently unfavorable indirect effects, confirming its detrimental role in yield improvement. At the genotypic level, MC had a large negative direct effect on fruit yield (-28.04), while MUC had a large positive direct effect (59.12). The residual effect at the genotypic level (0.4414) was lower than at the phenotypic level, indicating that the studied traits explained a larger proportion of yield variation genetically. This suggests that environmental influences partially masked the true genetic associations.

The combined correlation and path coefficient analyses highlight that selection for earliness (DF50 and DFP), higher fruit number (NFPP), and greater average fruit weight (AFW) would be highly effective for improving fruit yield in okra. The negative association of seed index with yield further suggests that genotypes with smaller seed size may be more productive due to better assimilate partitioning towards pod development. These findings align with earlier reports (Alam *et al.*, 2020; Sharma and Prasad, 2015; Vijay and Manohar, 1990; Rathava *et al.*, 2019; Yogesh *et al.*, 2025) [2, 17, 20, 14, 22].

Table 1: Analysis of Variance among Yield Related Traits of okra genotypes

Source	Mean Sum of Squares		
	Replication	Genotype	Error
	df=2	df=16	df=32
Days to 50% Flowering	22.4118	35.1642**	1.0576
Days to First Picking	15.6078	21.2696**	1.6703
Number of Branches Per Plant	10.4314	26.1887**	3.3689
Plant Height	13.059	51.8173**	15.7086
Inter node Length	0.495	0.0468	0.0514
Fruit Length	0.7592	0.7101**	0.1437
Average Fruit Weight	0.0138	0.1795	0.142
Number of Fruit Per Plant	25.5378	7.5713	10.6195
Number of Seeds Per Pod	0.719	0.2536	0.1532
Days to Last Picking	27.3535	17.1052**	2.7477
Number of Nodes per Plant	1.5343	1.3428**	0.2379
First Fruiting Node	0.7629	1.1593**	0.2798
seed index	0.0468	0.2834	0.235
Fruit yield per plant	693.1961	269.2059	177.904
Moisture Content	0.17	1.5704**	0
Mucilage Content	0.0092	0.4893**	0

Level of significant * and ** at 5% and 1%

Table 2: Estimation of Genetic Variability Parameters among Yield Related Traits of Okra

Traits	GCV	PCV	Heritability	GA	GAM at 5%
Days to 50% Flowering	8.248	8.623	91.489	6.644	16.251
Days to First Picking	6.393	7.164	79.638	4.699	11.753
Number of Branches Per Plant	5.038	6.052	69.305	4.73	8.64
Plant Height	4.063	6.168	43.382	4.707	5.512
Inter node Length	1.767	5.533	20.53	0.15	3.64
Fruit Length	3.534	4.69	56.789	0.675	5.487
Average Fruit Weight	2.303	8.092	8.101	0.066	1.35
Number of Fruit Per Plant	2.377	7.174	18.939	2.226	4.871
Number of Seeds Per Pod	2.817	6.655	17.925	0.16	2.457
Days to Last Picking	1.963	2.463	63.527	3.592	3.223
Number of Nodes per Plant	7.533	9.663	60.761	0.975	12.096
First Fruiting Node	8.885	12.421	51.164	0.798	13.091
seed index	2.579	10.175	6.426	0.066	1.347
Fruit yield per plant	2.468	6.457	14.608	4.343	1.943
Moisture Content	0.808	0.808	71.43	1.49	1.665
Mucilage Content	12.448	12.449	58.982	0.832	25.641

Table 3: Estimation of mean performance of Okra Germplasm

Genotype	DF50	DFP	NBPP	PH	IL	FL	AFW	NFPP	NSPP	DLP	NDP	FFN	SW100	FYPP	MC	MUC
Pusha Makhamali	35.33	38.67	54	80.87	3.97	12.25	4.77	42.33	6.43	110.83	8.57	6.43	5.35	218	90.8	3.8
SB-14	43.67	42	55.33	89.63	4.18	12.43	5.34	46.6	6.7	111.03	7.97	6.83	4.64	236.67	89.7	3.1
VRO-214	42.33	45.33	60	85.93	4.17	12.41	4.56	48.73	6.47	114.07	7.67	5.97	4.46	236.67	88.9	2.95
Kashi Kranthi	45.33	40.67	56.33	84.6	4.11	12.64	4.8	45.6	6.67	113.43	8.57	5.77	5.11	224	89.4	3.25
Kashi Lalima	34.67	36.33	52.67	82.83	3.9	12.01	4.94	43.77	6.2	109.27	7.6	5.3	5.02	202	90.2	3.6
Arka Abhay	40	41.33	55.33	87.27	3.99	12.68	4.61	46.27	6.53	112.73	8.33	6.03	4.83	225	88.7	2.75
HRB-55	45	39.33	57	90.27	4.34	12.78	4.87	44.87	6.67	112.43	8.3	6.13	4.6	229.33	89.1	3.05
Phule Utkarsh A	39.33	41.67	57.67	83.67	4.08	12.41	4.92	44.87	6.43	111.27	8.23	5.3	4.87	221	90.5	3.7
Pusa Swamini	39.33	37	52.33	84.2	4.25	12.45	4.77	44.83	6.03	112.03	8.03	5.77	4.87	212	89.8	3.35
PUSA A-5	44	38.67	59.33	82.9	4.04	12.01	4.89	46.23	6.33	112.8	7.67	5.67	4.57	239.33	88.5	2.85
PRABHANI	38.33	40.67	51.33	83.93	3.99	12.49	4.67	44.77	6.53	111.3	8.13	5.87	4.83	224.67	90.1	3.55
Punjab Padmini	43	41.33	57	88.3	4.18	12.75	5.05	46.03	6.77	112.1	8.77	6.47	4.79	243	89.9	3.9
CO-4	39.33	40.67	55.67	86.1	4.12	12.79	4.98	46.5	6.53	111.27	8.1	6.03	4.87	219.33	88.8	2.7
P8	40.67	40.33	53.67	80.13	4.06	12.47	4.58	45.53	6.1	111.33	8.03	6.43	4.87	219.67	89.3	3.15
GO-6	43.67	39.67	51.67	90.47	3.92	12.37	4.86	45.13	6.87	112.47	8.3	6.33	4.92	231.33	88.4	2.6
Kashi Pragathi	44.67	40.67	51.67	86.13	4.06	11.86	4.63	44.67	6.4	109.57	7.03	6.37	5.02	224.67	90.3	3.65
Roma	36.33	33	49.67	75.53	4.07	11.02	4.5	41.33	5.83	104.23	6.5	4.33	5.27	217	89.6	3.2
Min	34	33	49	74.7	3.75	10.78	4.14	37.8	5.3	101.4	6.2	3.4	3.83	186	88.4	2.6
Max	46	46	61	97	4.79	13.48	5.58	51.2	7.2	116.8	9.7	9.1	5.78	260	90.8	3.9
Std. Dev.	3.85	2.92	3.45	5.12	0.25	0.72	0.35	2.68	0.48	3.45	0.85	0.98	0.52	13.85	0.724	0.404
CV (%)	9.45	7.35	6.45	6.12	6.15	5.78	7.25	5.95	7.45	3.12	10.2	16.8	10.45	6.12	0.81	12.45
SEm	2.22	1.68	1.99	2.95	0.14	0.42	0.2	1.55	0.28	1.99	0.49	0.57	0.3	7.99	0.175	0.098
CD at 5%	6.58	4.98	5.9	8.75	0.43	1.23	0.6	4.58	0.82	5.9	1.45	1.68	0.89	23.7	0.505	0.282

DF50: Days to 50% Flowering, DFP: Days to First Picking, NBPP: Number of Branches Per Plant, PH: Plant Height, IL: Inter-node Length, FL: Fruit Length, AFW: Average Fruit Weight, NFPP: Number of Fruit Per Plant, NSPP: Number of Seeds Per Pod, DLP: Days to Last Picking, NDP: Number of nodes per Plant, FFN: First Fruiting Node, SI: Seed Index, FYPP: Fruit Yield Per Plant, MC: Moisture Content and MUC: Mucilage Content

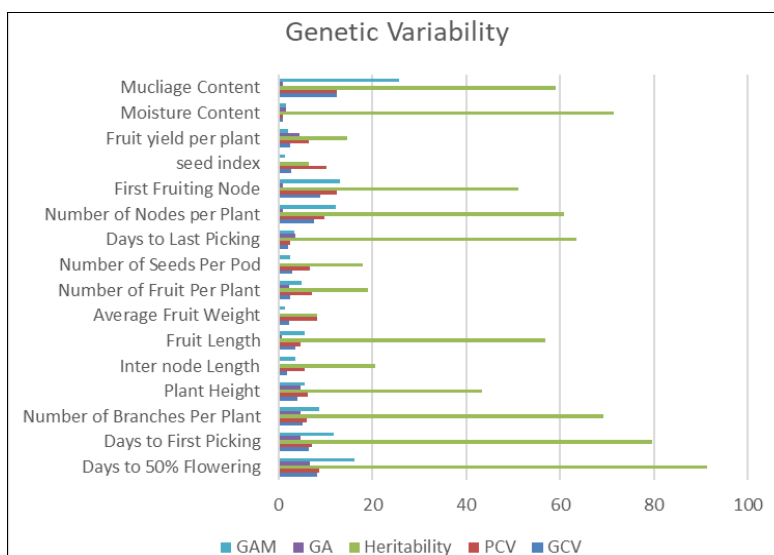
**Fig 1:** Bar Diagram Representing the estimates of Genetic Variability Parameters

Table 4: Estimation of Phenotypic Correlation Among Yield Related Traits of Okra Genotypes

Traits	DF50	DFP	NBPP	PH	IL	FL	AFW	NFPP	NSPP	DLP	NDP	FFN	SI	FYPP	MC	MUC
Days to 50% Flowering	1	0.49**	0.38**	0.57**	0.29*	0.36**	0.03	0.22	0.41**	0.45**	0.25	0.3*	-0.32*	0.5**	-0.45**	-0.31*
Days to First Picking		1	0.54**	0.38**	0.31*	0.53**	0.1	0.42**	0.31*	0.62**	0.41**	0.48**	-0.43**	0.5**	-0.19	-0.13
Number of Branches Per Plant			1	0.24	0.25	0.31*	0.15	0.33*	0.3*	0.48**	0.23	0.12	-0.37**	0.38**	-0.29*	-0.16
Plant Height				1	0.03	0.39**	0.19	0.25	0.48**	0.48**	0.47**	0.37**	-0.26	0.32*	-0.31*	-0.23
Inter node Length					1	0.17	0	0.26	0.18	0.3*	0.2	0.14	-0.22	0.23	-0.08	-0.04
Fruit Length						1	0.33*	0.12	0.32*	0.63**	0.62**	0.43**	-0.22	0.14	-0.19	-0.11
Average Fruit Weight							1	-0.02	0.14	0.16	0.26	0.18	-0.2	0.04	0.03	0
Number of Fruit Per Plant								1	0.1	0.37**	0.26	0.29*	-0.22	0.65**	-0.21	-0.22
Number of Seeds Per Pod									1	0.4**	0.42**	0.35*	-0.28*	0.23	-0.22	-0.15
Days to Last Picking										1	0.61**	0.42**	-0.32*	0.36**	-0.29*	-0.21
Number of Nodes per Plant											1	0.47**	-0.23	0.24	-0.15	-0.11
First Fruiting Node												1	-0.31*	0.2	-0.03	-0.02
seed index													1	-0.26	0.16	0.16
Fruit yield per plant														1	-0.28*	-0.21
Moisture Content															1	0.93**
Mucilage Content																1

Level of significant * and ** at 5% and 1%

DF50: Days to 50% Flowering, DFP: Days to First Picking, NBPP: Number of Branches Per Plant, PH: Plant Height, IL: Inter-node Length, FL: Fruit Length, AFW: Average Fruit Weight, NFPP: Number of Fruit Per Plant, NSPP: Number of Seeds Per Pod, DLP: Days to Last Picking, NDP: Number of nodes per Plant, FFN: First Fruiting Node, SI: Seed Index, FYPP: Fruit Yield Per Plant, MC: Moisture Content and MUC: Mucilage Content

Table 4: Estimation of Genotypic Correlation Among Yield Related Traits of Okra Genotypes

Traits	DF50	DFP	NBPP	PH	IL	FL	AFW	NFPP	NSPP	DLP	NDP	FFN	SI	FYPP	MC	MUC
Days to 50% Flowering	1															
Days to First Picking	0.5*	1														
Number of Branches Per Plant	0.44	0.6*	1													
Plant Height	0.72**	0.59*	0.42	1												
Inter node Length	0.41	0.28	0.51*	0.38	1											
Fruit Length	0.34	0.66**	0.41	0.56*	0.27	1										
Average Fruit Weight	-0.01	0.17	0.28	0.43	0	0.33	1									
Number of Fruit Per Plant	0.33	0.67**	0.67**	0.41	0.34	0.4	0.08	1								
Number of Seeds Per Pod	0.49*	0.29	0.36	0.83**	0.13	0.41	0.55*	0.2	1							
Days to Last Picking	0.48	0.73**	0.65**	0.7**	0.29	0.8**	0.3	0.67**	0.53*	1						
Number of Nodes per Plant	0.23	0.48	0.38	0.65**	0.24	0.83**	0.44	0.27	0.66**	0.75**	1					
First Fruiting Node	0.31	0.56*	0.14	0.62**	0.21	0.6*	0.33	0.39	0.5*	0.54*	0.57*	1				
seed index	-0.45	-0.69**	-0.7**	-0.56*	-0.38	-0.42	-0.54*	-0.58*	-0.41	-0.61**	-0.27	-0.39	1			
Fruit yield per plant	0.73**	0.6*	0.6*	0.48	0.29	0.21	0.01	0.51*	0.33	0.44	0.18	0.2	-0.54*	1		
Moisture Content	-0.47	-0.19	-0.31	-0.37	-0.12	-0.22	0.04	-0.43	-0.3	-0.35	-0.18	-0.01	0.26	-0.43	1	
Mucilage Content	-0.32	-0.14	-0.17	-0.29	-0.08	-0.13	0	-0.45	-0.22	-0.26	-0.13	-0.02	0.25	-0.32	0.93	1

Level of significant * and ** at 5% and 1%

DF50: Days to 50% Flowering, DFP: Days to First Picking, NBPP: Number of Branches Per Plant, PH: Plant Height, IL: Inter-node Length, FL: Fruit Length, AFW: Average Fruit Weight, NFPP: Number of Fruit Per Plant, NSPP: Number of Seeds Per Pod, DLP: Days to Last Picking, NDP: Number of nodes per Plant, FFN: First Fruiting Node, SI: Seed Index, FYPP: Fruit Yield Per Plant, MC: Moisture Content and MUC: Mucilage Content

Table 5: Direct (Diagonal)and Indirect Effects at Phenotypic Level in Okra for Fruit Yield

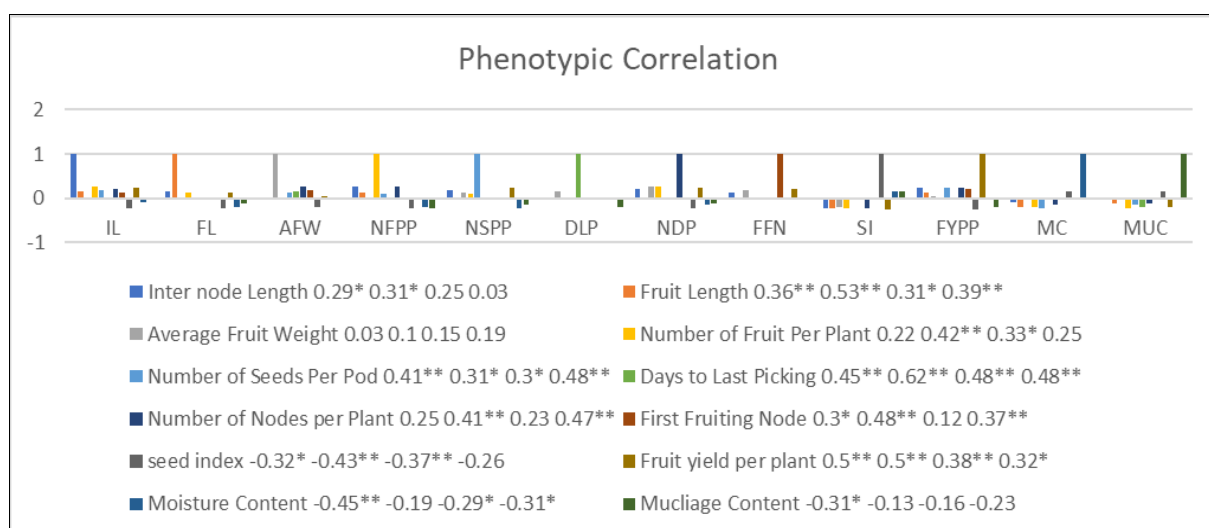
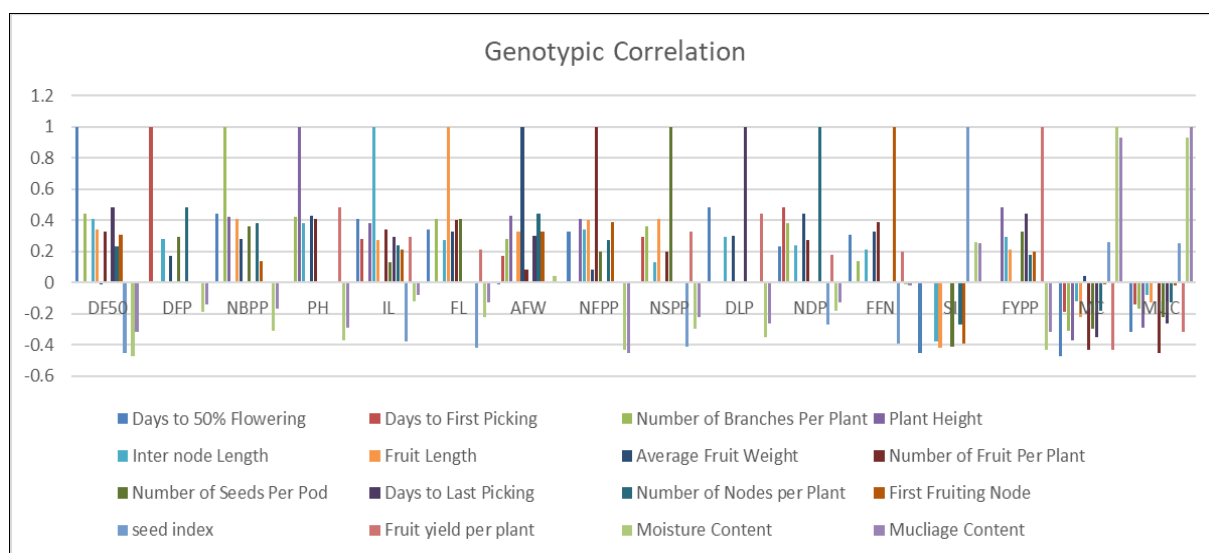
Traits	DF50	DFP	NBPP	PH	IL	FL	AFW	NFPP	NSPP	DLP	NDP	FFN	SI	MC	MUC
Days to 50% Flowering	1.7246	0.6337	-0.0312	-0.1586	-1.2751	-1.7112	0.1021	0.5584	0.8313	-0.0233	0.448	-0.8656	-0.1646	2.8495	-3.5398
Days to First Picking	0.8453	1.2928	-0.0437	-0.1052	-1.3517	-2.5121	0.3431	1.095	0.6354	-0.0322	0.7288	-1.3722	-0.2218	1.2295	-1.5174
Number of Branches Per Plant	0.6619	0.696	-0.0812	-0.0683	-1.0851	-1.445	0.5292	0.8626	0.6167	-0.0252	0.411	-0.3586	-0.1943	1.8373	-1.8183
Plant Height	0.9756	0.4854	-0.0198	-0.2803	-0.1112	-1.8499	0.671	0.6483	0.9872	-0.0251	0.8353	-1.0582	-0.1351	1.944	-2.6761
Inter node Length	0.5061	0.4022	-0.0203	-0.0072	-4.3447	-0.7815	0.0117	0.6733	0.3759	-0.0155	0.3594	-0.4116	-0.1127	0.5157	-0.4742
Fruit Length	0.6234	0.686	-0.0248	-0.1095	-0.7173	-4.7339	1.1412	0.3002	0.6465	-0.0329	1.0989	-1.2267	-0.1124	1.219	-1.3006
Average Fruit Weight	0.0503	0.1266	-0.0123	-0.0537	-0.0146	-1.542	3.5034	-0.0392	0.2928	-0.0082	0.455	-0.5273	-0.1036	-0.1714	0.0405
Number of Fruit Per Plant	0.3722	0.5471	-0.0271	-0.0702	-1.1306	-0.5493	-0.0531	2.5873	0.2118	-0.0191	0.4687	-0.848	-0.1133	1.3534	-2.5529
Number of Seeds Per Pod	0.7023	0.4024	-0.0245	-0.1356	-0.8002	-1.4992	0.5026	0.2685	2.0413	-0.0211	0.747	-1.0078	-0.148	1.3828	-1.7365
Days to Last Picking	0.771	0.7965	-0.0392	-0.135	-1.2925	-2.9868	0.55	0.947	0.8236	-0.0522	1.0918	-1.2034	-0.1682	1.8472	-2.4226
Number of Nodes per Plant	0.434	0.5292	-0.0187	-0.1315	-0.877	-2.9217	0.8953	0.681	0.8565	-0.032	1.7805	-1.339	-0.119	0.9783	-1.2328
First Fruiting Node	0.5191	0.6168	-0.0101	-0.1031	-0.6218	-2.0192	0.6424	0.7629	0.7153	-0.0218	0.829	-2.8759	-0.1591	0.1752	-0.2487
seed index	-0.5457	-0.5512	0.0303	0.0728	0.9416	1.0225	-0.6977	-0.5634	-0.5808	0.0169	-0.4071	0.8795	0.5202	-1.0297	1.8045
Moisture Content	-0.7064	-0.2649	0.08	0.0877	0.3579	0.9757	0.1113	-0.5704	-0.4526	0.0116	-0.254	0.0778	0.0037	-6.3414	10.6944
Mucilage Content	-0.483	-0.1799	0.0436	0.0665	0.1811	0.573	0.0145	-0.5922	-0.3128	0.0083	-0.1762	0.0607	0.0036	-5.8861	11.5216
Residual Effect 0.6266															

DF50: Days to 50% Flowering, DFP: Days to First Picking, NBPP: Number of Branches Per Plant, PH: Plant Height, IL: Inter-node Length, FL: Fruit Length, AFW: Average Fruit Weight, NFPP: Number of Fruit Per Plant, NSPP: Number of Seeds Per Pod, DLP: Days to Last Picking, NDP: Number of nodes per Plant, FFN: First Fruiting Node, SI: Seed Index, FYPP: Fruit Yield Per Plant, MC: Moisture Content and MUC: Mucilage Content

Table 6: Direct (Diagonal) and Indirect Effects at Genotypic Level in Okra for Fruit Yield

Traits	DF50	DFF	NBPP	PH	IL	FL	AFW	NFPP	NSPP	DLP	NDP	FFN	SI	MC	MUC
Days to 50% Flowering	3.0284	0.9058	-0.1846	-1.5129	-1.1927	-4.7819	-0.0409	0.6582	2.1378	-0.2766	2.6622	-0.4101	2.8887	13.0479	-19.0945
Days to First Picking	1.501	1.8276	-0.2548	-1.2292	-0.8139	-9.3696	0.7191	1.3314	1.2881	-0.424	5.433	-0.7531	4.4511	5.3283	-8.0244
Number of Branches Per Plant	1.3252	1.1038	-0.4218	-0.8759	-1.4651	-5.863	1.2082	1.3375	1.5534	-0.375	4.2949	-0.1841	4.4841	8.6408	-10.0399
Plant Height	2.1933	1.0754	-0.1769	-2.0889	-1.0965	-7.8701	1.8371	0.8254	3.6211	-0.4081	7.3546	-0.8263	3.5966	10.5026	-17.3004
Inter node Length	1.246	0.5131	-0.2132	-0.7901	-2.8989	-3.7999	0.0054	0.6772	0.5816	-0.1679	2.694	-0.277	2.4614	3.4971	-4.5396
Fruit Length	1.022	1.2085	-0.1745	-1.1602	-0.7774	-14.1695	1.4145	0.7951	1.7906	-0.4617	9.3955	-0.8097	2.6773	6.1728	-7.9737
Average Fruit Weight	-0.0291	0.3091	-0.1199	-0.9025	-0.0037	-4.7139	4.252	0.1609	2.389	-0.1723	5.0556	-0.4476	3.4491	-1.0699	0.1768
Number of Fruit Per Plant	0.996	1.216	-0.2819	-0.8616	-0.9811	-5.6298	0.342	2.0011	0.8808	-0.3895	3.081	-0.5243	3.7193	12.0975	-26.8126
Number of Seeds Per Pod	1.4824	0.539	-0.15	-1.732	-0.3861	-5.8096	2.3259	0.4036	4.3673	-0.3088	7.5179	-0.6756	2.6055	8.383	-13.1378
Days to Last Picking	1.4451	1.3366	-0.2729	-1.4706	-0.8397	-11.285	1.2641	1.3444	2.3261	-0.5797	8.5561	-0.7184	3.9266	9.7331	-15.2748
Number of Nodes per Plant	0.709	0.8732	-0.1593	-1.3511	-0.6868	-11.7082	1.8905	0.5422	2.8875	-0.4362	11.3706	-0.7587	1.74	5.1478	-7.6945
First Fruiting Node	0.9278	1.0281	-0.058	-1.2894	-0.5999	-8.5703	1.4216	0.7837	2.204	-0.3111	6.4442	-1.3387	2.4823	0.3782	-0.9654
Seed index	-1.364	-1.2684	0.2949	1.1714	1.1126	5.915	-2.2867	-1.1605	-1.7742	0.3549	-3.0849	0.5181	-6.4135	-7.177	14.7698
Moisture Content	-2.0911	-0.0752	1.5921	1.2703	1.3159	5.6049	-0.0151	-4.4888	1.1265	1.6477	-7.1385	0.1129	-12.6961	-28.0416	54.9837
Mucilage Content	-1.4515	-0.0537	0.8774	0.9925	0.8103	3.4342	-0.0012	-4.7191	0.8374	1.2265	-5.0611	0.1367	-12.3932	-26.0805	59.1183
Residual effect 0.4414															

DF50: Days to 50% Flowering, DFF: Days to First Picking, NBPP: Number of Branches Per Plant, PH: Plant Height, IL: Inter-node Length, FL: Fruit Length, AFW: Average Fruit Weight, NFPP: Number of Fruit Per Plant, NSPP: Number of Seeds Per Pod, DLP: Days to Last Picking, NDP: Number of nodes per Plant, FFN: First Fruiting Node, SI: Seed Index, FYPP: Fruit Yield Per Plant, MC: Moisture Content and MUC: Mucilage Content

**Fig 2:** Cluster chart representing the phenotypic correlation among the quantitative and biochemical traits of okra**Fig 3:** Cluster chart representing the Genotypic correlation among the quantitative and biochemical traits of okra

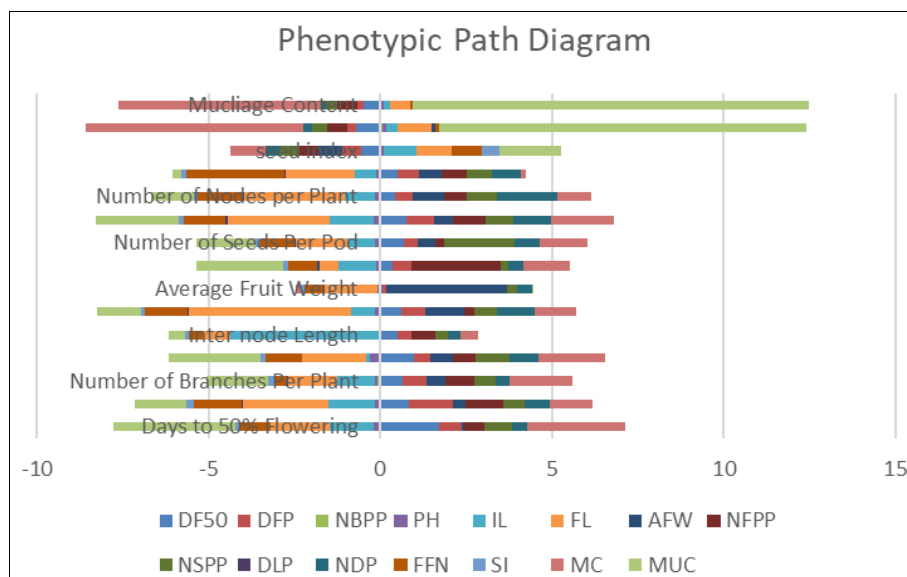


Fig 4: Stacked Bar Diagram representing the phenotypic path effects for Fruit Yield per Plant

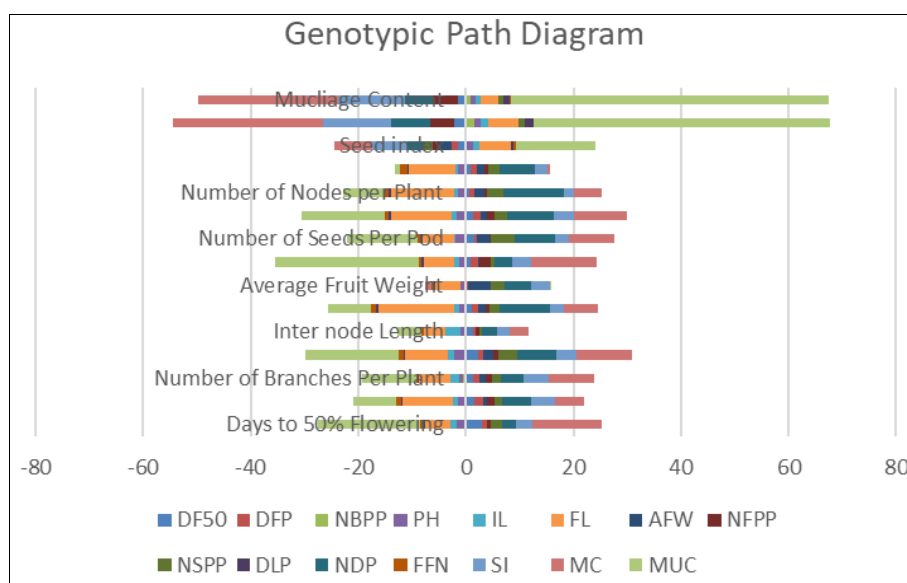


Fig 4: Stacked Bar Diagram representing the Genotypic path effects for Fruit Yield per Plant

Conclusion

This study highlights the highest fruit yield per plant (FYPP) was recorded in Punjab Padmini (243 g), followed closely by Pusa A-5, SB-1. Genetic variability among okra genotypes evaluated under zaid condition. Traits linked to earliness-such as days to 50% flowering, days to first picking, and first fruiting node-along with number of fruits per plant and average fruit weight, consistently showed strong positive contributions to yield. In contrast, seed index, fruit length, and internode length were negatively associated with productivity, underscoring their limited value in selection programs. The results suggest that prioritizing earliness and fruit number as selection criteria will be most effective for enhancing yield potential in okra under high-temperature conditions. These traits provide a reliable basis for identifying superior parents and advancing breeding strategies aimed at developing heat-tolerant, high-yielding cultivars.

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