E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(1): 643-649
Received: 15-11-2025
Accepted: 16-12-2025

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Dissection of yield components through correlation, path analysis and selection indices in multi-parent F_2 progenies of Okra

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DOI: https://www.doi.org/10.33545/2618060X.2026.v9.i1i.4755a

Abstract
This study investigated the genetic association of fruit yield and its contributing traits in a large F_2 population comprising 800 progenies developed from multi-parent crosses of okra (*Abelmoschus esculentus* L.). Twelve quantitative morphological and yield-related traits were evaluated during *kharif* 2021 to quantify phenotypic correlations; partition direct and indirect effects using path coefficient analysis and formulate efficient selection indices for yield improvement. Fruit yield per plant was positively and significantly correlated with traits including the number of fruits per plant, average fruit weight, plant height, number of internodes, and fruit dimensions, highlighting their substantial contribution to overall yield. Path coefficient analysis revealed that the number of fruits per plant (0.7234) and average fruit weight (0.5443) had the strongest direct effects on yield, whereas other traits, such as plant height and internode number, affected yield indirectly by influencing these primary yield components. Selection index analysis demonstrated that indices incorporating multiple traits were superior to straight selection for fruit yield. Among the 31 indices tested, the five-trait index comprising fruit yield per plant, number of fruits per plant, average fruit weight, number of internodes and plant height recorded the highest genetic gain and relative efficiency (116.74%). Overall, the findings emphasize that simultaneous improvement of fruit number, fruit weight and associated plant architecture traits would substantially enhance the effectiveness of okra breeding programmes aimed at developing high-yielding cultivars.

Keywords: Okra, selection indices, trait associations, path coefficient analysis, genetic improvement.

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) is a valuable vegetable crop in the Malvaceae family, with a chromosome number of 2n=8x=72 or 144. It is believed to have originated in Southeast Asia (Sutar *et al*., 2013) [1]. The crop is highly versatile, owing to its ease of cultivation, suitability to moderate rainfall regions, good export potential, and high economic returns (Reddy, 2010). India leads the world in okra production, though it ranks 12th in productivity, producing 6.46 million tonnes from 5.30 lakh hectares, with an average yield of 12.19 t/ha.

Okra is extensively consumed as a vegetable in diverse culinary preparations and is valued for its nutritional content. The fruit is rich in vitamin C (30 mg/100 g), vitamin A (20 mg/100 g), zinc (6 mg/100 g), and β-carotene (300 µg/100 g), and also provides a good source of folic acid (300 µg/100 g), (Liu *et al*., 2021) [3]. Its high dietary fiber, low calorie content, and abundance of minerals such as calcium, phosphorus, potassium, and magnesium make it a significant component of the human diet. Additionally, okra is a natural source of iodine, which can aid in managing goitre, while its leaves have traditional uses in treating dysentery. The seeds further contain essential vitamins, minerals, and bioactive compounds with medicinal importance (Kumar *et al*., 2010) [4].

Okra is classified as an often cross-pollinated crop, with natural outcrossing ranging from 4 to 15 per cent (Kumar *et al*., 2010) [4]. Its monadelphous stamens and large flowers make emasculation easier and permit the production of a large number of seeds from a single pollination. India possesses rich germplasm diversity for okra, largely due to geographical spread and varied evolutionary pathways.

The availability of diverse cultivars is essential for regional adaptation and to meet farmers' preferences for different phenotypic traits.

Assessing the variability present in a crop is a fundamental requirement for designing an effective breeding programme. Yield is a polygenic trait influenced by numerous genes and significantly affected by environmental factors, making direct selection based solely on yield often inconsistent and less reliable. Greater emphasis should be placed on selecting yield component traits that are less affected by environmental variation to improve yield more effectively (Yan *et al*., 2022) [6].

While correlation analysis indicates the relationships among traits, it does not distinguish the extent to which each trait directly or indirectly influences yield. Path coefficient analysis (Dewey and Lu, 1959) [15] addresses this limitation by decomposing correlation coefficients into direct and indirect effects, allowing the identification of key yield-contributing traits and providing insights into their interrelationships. Direct selection for fruit yield in okra is not always efficient. The value of selecting based on component traits has been recognized by several researchers (Bandyopadhyay *et al*., 1985; Dobariya *et al*., 2008) [8, 9]. The discriminant function developed by Smith (1936) [10] enables the development of selection indices that combine multiple traits for simultaneous selection. Such multi-trait selection increases the probability of success in breeding programmes.

A thorough understanding of how fruit yield relates to its component traits is therefore crucial for the development of effective selection indices. Path analysis helps establish cause-and-effect relationships and ranks traits based on their influence on yield. This information is vital for formulating robust selection indices and predicting correlated responses, which ultimately enhances the efficiency of crop improvement programmes.

Materials and Methods

The present study was carried out at Zonal Agricultural and Horticultural Sciences (ZAHRS), Keladi Shivappa Nayaka University of Agricultural and Horticultural, Shivamogga (KSNUAHS), India, which is situated at 13.28º North latitude and 75.34º East longitude and an altitude of 617.0 meters above mean sea level during the spring-summer and rainy season of the year 2021.

Experimental design and layout

The 800 F_2 progenies genotype from the multiparent cross (Sandeep, 2022) were grown in augmented design. Each genotype was grown in two rows of 4.5 m in length with a spacing of 90 × 45 cm. The recommended crop production and protection practices were followed to raise a healthy crop. Preventive and curative sprays were given as and when required to ensure pest and disease-free crop.

Sampling of plants and data collection

Observations were recorded on each F_2 plant for twelve traits, namely: days to 50% flowering, plant height (cm), number of primary branches, number of internodes on the main stem, internodal length (cm), fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits per plant, number of seeds per fruit, test weight (g), and fruit yield per plant (g).

Correlation coefficient analysis

The correlation coefficient among all possible character combinations at phenotypic (r_p) level was estimated employing formula. The analysis was performed by using the 'correlation' package of R software (v 4.1.3).

$$\text{Phenotypic correlation} = r_{xy}(p) = \frac{Cov_{xy}(p)}{\sqrt{V_x(p) \times V_x(p)}}$$

Where,

Cov_{xy} (p) = Phenotypic covariance between x and y

V_x (p) = Phenotypic variance of character 'x'

V_y (p) = Phenotypic variance of character 'y'

The test of significance for association between characters was done by comparing table 'r' values at n-2 error degrees of freedom for phenotypic and genotypic correlations with estimated values respectively. The range of correlation coefficients were classified as suggested by Searle (1965) [13].

Scales	Value of Correlation Coefficients
Very strong	More than 0.65
Moderately strong	0.50 to 0.64
Moderately weak	0.30 to 0.49
Very weak	Less than 0.30

Path coefficient analysis

Path coefficient analysis is a standardized partial regression approach that partitions correlation coefficients into direct and indirect effects. Initially proposed by Wright (1934) [14] and later expanded by Dewey and Lu (1959) [15], this method allows visualization of the relationships among variables through a diagram known as a path diagram.

Path coefficient is the ratio of the standard deviation of the effect due to a given cause to the total standard deviation of the effect *i.e.* if seed yield per plant (Y) is the function of the causal factor X_1, then path coefficient for the path from causal factor X_1 to the effect Y is given by the formula, σ_{X_1}/σ_Y.

In this experiment seed yield per plant (Y) was taken as an effect of the other traits (X) like the number of days to 50 per cent flowering, number of days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, hundred seed weight, seed yield per plant, biomass yield per plant, biological yield per plant and harvest index as the causal factors. The analysis was performed by using the *'biotools'* package of R software (v 4.1.3).

Selection indices

The discriminant function is applied to simultaneously evaluate multiple traits with the objective of distinguishing desirable genotypes from less desirable ones based on their phenotypic performance. The concept of the selection index was first introduced by Smith (1936) [10], building on Fisher's (1936) [16] discriminant function. The model proposed by Robinson *et al.* (1951) [17] was employed to construct selection indices and develop the necessary discriminant function. All analyses were conducted using the '*plant breeding'* package in R software (v4.1.3).

Results and Discussion

Association studies in F_2 population for yield attributing traits

The F_2 population derived from multi-parent crosses was analysed to assess the phenotypic correlations among total fruit yield and the principal yield-contributing traits. This analysis provides crucial insights into the degree and direction of association among traits that collectively determine productivity in okra, a crop in which yield is multigenic and strongly influenced by the interaction of growth and reproductive attributes. Understanding these correlations is essential for strategic selection, particularly in early generations where indirect selection for easily measurable traits can enhance breeding efficiency.

Days to 50% flowering exhibited positive and significant correlations with plant height, number of internodes on the main stem and number of fruits per plant, while the associations with number of primary branches, internodal length, test weight and fruit yield were positive but non-significant (Figure 1). Traits such as fruit length, average fruit weight and number of seeds per fruit showed weak negative correlations. These patterns reflect the findings of Karadi *et al*. (2018) [18], Shuirkar *et al*. (2018) [19], who also reported positive associations with plant height and related traits, while Meena *et al*. (2017) [21] noted its positive influence on internodes and fruit number. Plant height, a major structural determinant, showed highly significant positive correlations with internode number, number of fruits per plant, average fruit weight and fruit yield per plant, indicating its strong role in enhancing the sink capacity. The negative correlation with internodal length was consistent with earlier reports, while the positive associations with fruit weight and fruit number agreed with findings of Raval *et al*. (2019) [23] and Alam *et al*. (2020) [24]. Number of primary branches displayed positive and significant correlations with internode number, fruit number and yield, while showing negligible associations with most other traits. These results were in agreement with Thulisaram *et al*. (2017) for internode number and with Raval *et al*. (2019) [23] and Janarthanan and Sundaram (2020) [25] for fruit number. Number of internodes on the main stem, a key architectural trait, recorded strong positive correlations with days to flowering, plant height, number of primary branches, average fruit weight, fruit number and yield. Its strong negative association with internodal length confirms earlier observations by Das *et al*. (2012) [26], while positive associations with flowering and branches align with Alam *et al*. (2020) [24]. Overall, internode number emerged as one of the most influential contributors to yield formation.

Internodal length showed significant negative correlations with plant height, number of internodes, fruit number and total yield, reinforcing its role as an unfavourable trait for productivity. Similar trends were documented by Sood *et al*. (2016) [27]. Fruit length showed a significant negative association with fruit diameter, while its positive correlations with average fruit weight and yield highlight its importance in determining marketable fruit size. These results match those of Badiger *et al*. (2017) [28], whereas the positive influence on fruit weight and yield agrees with Mohammad and Marker (2017) [30]. Fruit diameter exhibited similar correlation trends negatively associated with fruit length, yet significantly and positively associated with average fruit weight and yield again corroborating the results of Aminu *et al*. (2016) [29] and Mohammad and Marker (2017) [30].

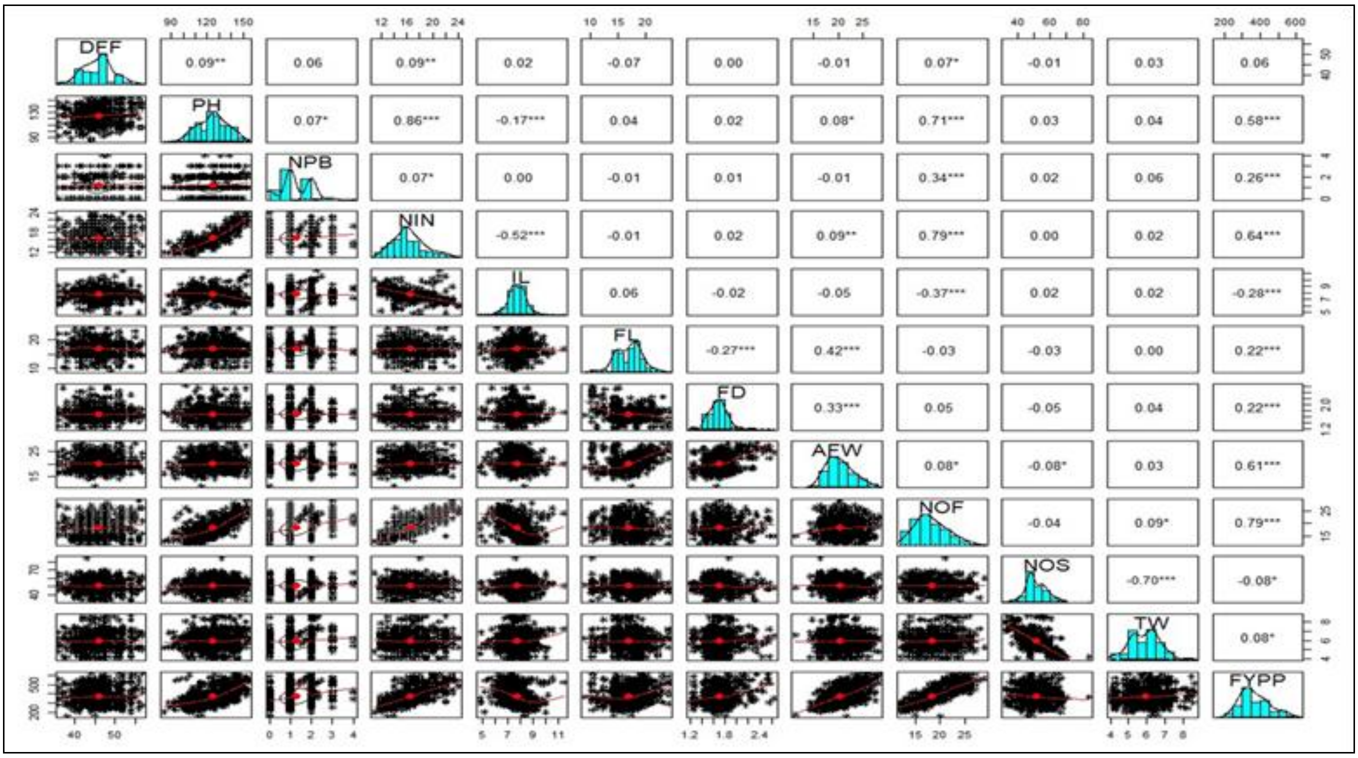

Fig 1: Phenotypic correlation for fruit yield and its contributing traits in the F_2 population of okra

Average fruit weight recorded strong and significant correlations with fruit length, fruit diameter, number of internodes, fruits per plant and total yield, indicating its direct contribution to yield enhancement. The negative association with number of seeds per fruit suggests compensation between seed number and per-fruit biomass allocation. Number of fruits per plant, one of the strongest yield predictors, showed highly significant positive correlations with days to flowering, plant height, branches, internodes, test weight, average fruit weight and yield, while exhibiting a strong negative correlation with internodal length. These trends align with earlier works by Karadi *et al*. (2018) [18] and Rathava *et al*. (2019) [31]. Number of seeds per fruit displayed significant negative correlations with average fruit weight, test weight and fruit yield, reflecting an inverse relationship between seed load and per-fruit mass, consistent with the observations of Kumari *et al*. (2019) [32] and Pithiya *et al*. (2017) [33].

Test weight showed a strong negative correlation with number of seeds per fruit and a positive association with yield, while its correlations with other traits were weak and non-significant. These results correspond with those of Mohammad and Marker (2017) [30]. Fruit yield per plant, the key trait of interest, was strongly and positively correlated with plant height, number of primary branches, number of internodes, fruit length, fruit diameter, average fruit weight, number of fruits per plant, and test weight. In contrast, internodal length and number of seeds per fruit showed significant negative associations with yield. These results confirm that fruit number, fruit size (both length and diameter), and fruit weight are the primary contributors to yield in okra, in agreement with earlier reports by Sood *et al*. (2016) [27] and Mohammad and Marker (2017) [30]. Collectively, the results highlight number of fruits per plant, average fruit weight, internode number and plant height as the most influential traits for improving fruit yield in segregating populations derived from multi-parent crosses.

Path coefficient analysis for fruit yield and its component traits

As the number of traits included in a correlation analysis increases, the relationship between yield and any single component trait becomes increasingly complex. Therefore, path coefficient analysis is essential, as it partitions the observed correlations into direct and indirect effects, allowing a clearer understanding of how each trait contributes to yield. In the present investigation, path analysis was performed using fruit yield per plant as the dependent variable.

The direct and indirect effects of all component traits are presented in Table 1. The analysis revealed that the number of fruits per plant and average fruit weight had the strongest direct positive effects on fruit yield, with path coefficients of 0.7234 and 0.5443, respectively, while their indirect contributions through other traits were relatively small. Number of internodes on the main stem also showed a positive direct effect (0.0980) on yield, accompanied by a substantial positive indirect contribution via number of fruits per plant (0.5683). Plant height recorded a negative direct effect on fruit yield (-0.0508), although it contributed positively through its strong indirect effect via number of fruits per plant (0.5117). Days to 50% flowering and number of primary branches showed small positive direct effects (0.0093 and 0.0149), supported by considerable indirect effects mediated through number of fruits per plant (0.0533 and 0.2459, respectively).

Table 1: Phenotypic path coefficient analysis showing direct (diagonal) and indirect effects for fruit yield and yield related traits in F_2 population of okra

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	0.0093	0.0009	0.0005	0.0008	0.0002	-0.0006	0.0000	-0.0001	0.0007	-0.0001	0.0003
X_2	-0.0047	-0.0508	-0.0038	-0.0435	0.0085	-0.0020	-0.0012	-0.0041	-0.0360	-0.0017	-0.0018
X_3	0.0009	0.0011	0.0149	0.0011	0.0000	-0.0002	0.0002	-0.0002	0.0051	0.0003	0.0009
X_4	0.0090	0.0838	0.0069	0.0980	-0.0514	-0.0010	0.0017	0.0091	0.0770	0.0002	0.0019
X_5	0.0010	-0.0099	0.0002	-0.0309	0.0589	0.0037	-0.0010	-0.0032	-0.0221	0.0014	0.0009
X_6	-0.0009	0.0005	-0.0002	-0.0001	0.0008	0.0133	-0.0035	0.0056	-0.0005	-0.0004	0.0000
X_7	0.0000	0.0001	0.0001	0.0001	-0.0001	-0.0013	0.0049	0.0016	0.0002	-0.0003	0.0002
X_8	-0.0073	0.0438	-0.0059	0.0503	-0.0293	0.2286	0.1821	0.5443	0.0444	-0.0446	0.0146
X_9	0.0533	0.5117	0.2459	0.5683	-0.2709	-0.0247	0.0343	0.0590	0.7234	-0.0284	0.0615
X_{10}	0.0001	-0.0003	-0.0002	0.0000	-0.0002	0.0003	0.0005	0.0008	0.0004	-0.0101	0.0070
X_{11}	-0.0001	-0.0001	-0.0002	-0.0001	0.0000	0.0000	-0.0001	-0.0001	-0.0003	0.0022	-0.0031
r value	0.0606	0.5808	0.2583	0.6440	-0.2836	0.2161	0.2178	0.6127	0.7925	-0.0815	0.0824

Residual effect= 0.259 r=correlation coefficient of component traits with fruit yield per plant

Where,

X_1=Days to 50% flowering
X_2=Plant height (cm)
X_3=Number of branches
X_4 = Number of internodes
X_5=Internodal length (cm)
X_6=Fruit length (cm)
X_7=Fruit diameter (cm)
X_8=Average fruit weight (g)
X_9 = Number of fruits per plant
X_{10}=Number of seeds per pod
X_{11}=Test weight (g)

Traits related to fruit morphology, fruit length (0.0133) and fruit diameter (0.0049) also exhibited positive direct effects on yield, with additional positive indirect effects transmitted through average fruit weight (0.2286 and 0.1821, respectively). Internodal length showed a small positive direct effect (0.0133), but was offset by a negative indirect effect through average fruit weight (-0.0247). Conversely, number of seeds per fruit (-0.0101) and test weight (-0.0031) recorded negative direct effects on yield.

The residual effect of the path analysis was 0.259, indicating that most of the important traits influencing fruit yield were effectively captured in the model. The predominant positive direct effects of average fruit weight and number of fruits per plant agree with earlier findings reported by Rathod *et al*. (2019) [34], Ranganayaki *et al*. (2020) [35].

Overall, the present study highlights average fruit weight and number of fruits per plant as the most influential traits governing fruit yield. Thus, simultaneous improvement of these two characters would be the most effective strategy for enhancing dry fruit yield in okra.

Selection indices

Discriminant function analysis, developed by Fisher (1936) [16] and first applied by Smith (1936) [10], provides the relative weight to be assigned to individual yield components. For constructing selection indices, traits exhibiting both desirable correlations and moderate to high direct effects on fruit yield per plant were considered. Accordingly, fruit yield per plant (X_1) along with four key contributing traits number of fruits per plant (X_2), average fruit weight (X_3), number of internodes (X_4), and plant height (X_5) were selected for the development of selection indices.

A total of 31 selection indices were constructed using all possible combinations of four yield-contributing traits along with fruit yield per plant. The corresponding genetic advances were calculated, and the relative efficiency of each discriminant function was compared with direct selection for fruit yield. Data on selection indices, discriminant functions, genetic gain, and relative efficiency are presented in Table 2, with the efficiency of direct selection for fruit yield per plant taken as 100%. The results indicated that, in general, selection based on component traits was more efficient than direct selection, and this efficiency increased when two or more traits were included. The highest efficiency was observed when four or five traits were considered simultaneously. Among single-trait indices, fruit yield per plant itself exhibited the maximum efficiency of 100%. Among the combinations involving two component characters, fruit yield per plant and number of internodes (X_3+X_5) exhibited maximum relative efficiency of 105.33 per cent followed by fruit yield per plant and number of fruits per plant (X_1+X_2) exhibited103.07 per cent. The selection index based on three characters combinations indicated that a discriminant function with fruit yield per plant, number of fruits per plant and number of internodes (X_1+X_2+X_4) possessed maximum relative efficiency of 112.39 per cent followed by fruit yield per plant, average fruit weight and number of internodes [(X_1+X_3+X_4), 111.45%] and number of fruits per plant, number of internodes and plant height [(X_1+X_4+X_5), 111.24%].

Table 2: Selection index, discriminate function, expected genetic advance for yield and relative efficiency from the use of different selection indices in okra

Sl. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	X_1: Fruit yield per plant (g)	$0.8630X_1$	161.61	100.00
2	X_2: Number of fruits per plant	$0.6319X_2$	5.40	3.34
3	X_3: Average fruit weight (g)	$0.5409X_3$	4.26	2.63
4	X_4: Number of internodes	$0.4167X_4$	17.06	10.55
5	X_5: Plant height (cm)	$0.3468X_5$	3.30	1.87
6	X_1X_2	$0.8933X_1$-$0.1183X_2$	166.58	103.07
7	X_1X_3	$0.8950X_1$-$0.6520X_3$	164.97	102.07
8	X_1X_4	$0.9225X_1 + 0.2020X_4$	176.57	4.34
9	X_1X_5	$0.9028X_1 – 1.0623X_5$	164.93	14.68
10	X_2X_3	$0.6425X_2 + 0.5480X_3$	7.16	5.46
11	X_2X_4	$1.6529X_2 + 0.3258X_4$	23.73	11.21
12	X_2X_5	$0.8768X_2 + 0.2417X_5$	8.83	3.42
13	X_3X_4	$0.6407X_3 + 0.4180X_4$	18.11	13.52
14	X_3X_5	$0.5611X_3 + 0.3520X_5$	5.53	105.33
15	X_4X_5	$0.3875X_4 + 1.1306X_5$	21.85	112.39
16	$X_1X_2X_3$	$0.9926X_1$-$1.4950X_2$-$1.7386 X_3$	170.22	105.12
17	$X_1X_2X_4$	$0.9279X_1 + 0.6780X_2 + 0.1999X_4$	181.63	112.39
18	$X_1X_2X_5$	$0.9111X_1 + 0.6128X_2$-$1.1091X_5$	169.88	105.12
19	$X_1X_3X_4$	$0.9848X_1$-$1.5805X_3 +0.1008X_4$	180.12	111.45
20	$X_1X_3X_5$	$0.9595X_1$-$1.3132X_3$-$1.5252X_5$	168.51	104.27
21	$X_1X_4X_5$	$0.9423X_1 + 0.2709X_4$-$0.4500 X_5$	179.78	111.24
22	$X_2X_3X_4$	$1.6617X_2 + 0.6151X_3 + 0.3269X_4$	24.59	15.22
23	$X_2X_3X_5$	$0.8868X_2 + 0.5612X_3 +0.2417X_5$	10.18	6.30
24	$X_2X_4X_5$	$1.6001X_2 + 0.3369X_4 +0.7359X_5$	27.78	17.19
25	$X_3X_4X_5$	$0.6185X_3 + 0.3891X_4 +1.1298X_5$	22.7613	14.08
26	$X_1X_2X_3X_4$	$1.0540X_1$-$0.9377 X_2$-$2.3570 X_3 +0.1420X_4$	185.34	114.68
27	$X_1X_2X_3X_5$	$1.0237X_1$-$0.8318X_2$-$2.0350X_3$--.$3212X_5$	173.62	107.42
28	$X_1X_2X_4X_5$	$0.9392X_1 +1.0975X_2 +0.2579X_4$-$0.6171X_5$	184.90	114.41
29	$X_1X_3X_4X_5$	$1.0231X_1 – 1.0975X_3 +0.1795X_4$---$0.9444X_5$	183.49	113.53
30	$X_2X_3X_4X_5$	$1.6065X_2 + 0.6103X_3 + 0.3381X_4 + 0.7328X_5$	28.52	17.64
31	$X_1X_2X_3X_4X_5$	$1.0745X_1$-$0.5437X_2$-$2.5571X_3 + 0.2041X_4$-$0.8207 X_5$	188.67	116.74

The selection indices based on combinations of four traits indicated that the discriminant function including fruit yield per plant, number of fruits per plant, average fruit weight, and number of internodes (X_1+X_2+X_3+X_4) exhibited a relative efficiency of 114.68%, followed by the combination of fruit yield per plant, number of fruits per plant, number of internodes, and plant height (X_1+X_2+X_4+X_5) at 114.41%, and fruit yield per plant, average fruit weight, number of internodes, and plant height (X_1+X_3+X_4+X_5) at 113.53%. Among all 31 selection indices (Table 17), the index incorporating five traits fruit yield per plant, number of fruits per plant, average fruit weight, number of internodes, and plant height (X_1+X_2+X_3+X_4+X_5) showed the highest genetic gain (188.67) and relative efficiency (116.74%) compared to direct selection for fruit yield per plant.

Keeping in view the basic philosophy of saving time and labour in a selection programme, it would be desirable to base the selection of few characters. Although maximum efficiency in selection for fruit yield per plant was exhibited by discriminant function involving fruit yield per plant, number of fruits per plant, average fruit weight, number of internodes and plant (X_1+X_2+X_3+X_4+X_5) with 188.67 genetic advance and 116.74 per cent relative efficiency. From the present study, it was also observed that the straight selection for pod yield per plant was much rewarding (GA=161.61, RI=100%) as the genetic advance for fruit yield per plant (161.61) was much higher than its component characters *viz.*, number of fruits per plant (5.40), average fruit weight (4.26), number of internodes (17.06) and plant height (3.30). Similarly, Monpara and Chhatrola (2010) [37] reported the highest genetic gain and selection efficiency for the index involving six characters *viz.*, fruit yield per plant, nodes per plant, plant height, internodal length, primary branches and ten fruit weight in okra.

Conclusion

Correlation and path coefficient analyses clearly demonstrated that average fruit weight and number of fruits per plant are the most influential traits governing fruit yield in okra. Both traits exhibited strong positive associations and high direct effects on yield, indicating that direct selection for this combination would effectively enhance productivity in okra improvement programmes. Among the 31 selection indices formulated, the index comprising fruit yield per plant, number of fruits per plant, average fruit weight, number of internodes and plant height proved most efficient, although straight selection for fruit yield per plant alone was found to be highly rewarding.

Correlation analysis further indicated that plant height, number of primary branches, number of internodes, fruit length, fruit diameter, average fruit weight, number of fruits per plant, and test weight all had positive contributions to fruit yield. Path analysis reinforced these results, highlighting average fruit weight and number of fruits per plant as the key determinants exerting the highest direct influence. Hence, these traits should receive prime emphasis during selection to develop high-yielding okra genotypes.

The discriminant function-based selection index emphasized the predominant contribution of fruit yield per plant, while the substantial presence of transgressive segregants in the F_2 population reflected the wide genetic diversity among the parents. This diversity offers excellent scope for identifying superior genotypes and advancing successful breeding strategies aimed at improving yield potential in okra.

Acknowledgements

We extend our gratitude to the Director of Research at KSNUAHS Shivamogga for providing the necessary research facilities.

Competing Interests

The authors declare no competing interests.

Contributions

Conceptualization, BMD and SN, methodology, S.N and B.M.D.; software, S.N; formal analysis, SN; investigation; data curation, SN; writing-original draft preparations. SN, B.M.D.; supervision, BMD; All authors have read and agreed to the published version of the manuscript.

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