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Genetic divergence, character association and path co-efficient analysis in seed yield and yield attributing traits in Summer Sesame (*Sesamum indicum* L.)

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Abstract

Genetic divergence is very crucial in selection of high yielding genotypes of sesame for its summer cultivation. Seed yield correlated significantly and positively with number of seeds per capsule, 1000 seed weight, number of capsules per plant, plant height and oil percent both phenotypically and genetically. Path analysis revealed that number of capsules per plant, 1000 seed weight and plant height were having the highest positive direct effects on seed yield. Cluster analysis based on Mahalanobis D2 statistics considering 22 characteristics categorized the sixteen genotypes into five main clusters showing wide genetic divergence. The traits such as number of branches per plant (13.47%), days to maturity (12.52%), number of seeds per capsule (10.92%), 1000 seed weight (10.83%) and seed yield per plant (10.41%) have been identified as most divergent ones.

Keywords: *Sesamum indicum* L., genetic divergence, character association, path coefficient analysis, seed yield, summer sesame.

Introduction

One of the ancient cultivated oilseeds is Sesame (*Sesamum indicum* L.) and is also referred to as "Queen of Oilseeds" owing to the quality of its edible oil and nutritional value (Bedigian, 2011)^[1]. Sesame belongs to Pedaliaceae family and is cultivated widely in tropical and subtropical Asia and Africa. Among the major producers of sesame, India ranks as one of them and produces around 11.8% of total production with 11.07% share of the world's sesame acreage and contributing 21.07% of global sesame exports. The country produced nearly 9.34 lakh tonnes of sesame during 2025–26, of which West Bengal, Uttar Pradesh, Gujarat and Madhya Pradesh contributed more than 80%. Productivity of West Bengal was the highest (1,019 kg ha⁻¹) while that of Uttar Pradesh was moderate (437 kg ha⁻¹) despite being the second largest producer and there is huge potential of improvement through genetics and better crop management practices (UPAg 2025-26, DA&FW)^[2]. About 50-60% of the weight of sesame seeds consists of oil, 18-25% of protein and small amount of carbohydrates, vitamins, minerals and antioxidants like sesamin, sesamolin etc. Owing to its excellent nutritional composition and industrial applications, sesame is widely utilized in the food, pharmaceutical and cosmetic industries.

Seed yield in sesame (*Sesamum indicum* L.) is a complex quantitative trait governed by the interaction of several yield-attributing characters and is strongly influenced by environmental factors. Consequently, direct selection for seed yield alone is often less effective, highlighting the need to identify component traits that can serve as reliable selection criteria in breeding programmes (Johnson *et al.*, 1955)^[3], (Parameshwarappa *et al.*, 2009)^[4]. Character association analysis provides valuable information on the magnitude and direction of relationships among agronomic traits however, it alone does not adequately explain the direct and indirect contributions of individual traits. Therefore, path coefficient analysis, proposed by (Wright, 1921)^[5] and applied to plant breeding by (Dewey and Lu, 1959)^[6], is used to partition correlation coefficients into direct and indirect effects, providing a better understanding of the causal relationships among yield components.

In recent years, summer sesame has gained considerable importance because it is less affected insect pests and diseases, utilizes irrigation water efficiently and generally produces higher and more stable yields than rainy-season sesame. Therefore, the present investigation is an attempt to identify the important traits directly affecting the seed yield in summer sesame. Drip fertigation at 100% Epan with 50% RDN significantly enhanced growth, yield, oil content, nutrient uptake, and water use efficiency in summer sesame (Chauhan *et al.*, 2016)^[7].

The experiment was conducted during the summer season of 2024 at the experimental farm of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. Sixteen sesame genotypes obtained from the ICAR–Project Coordinating Unit (Sesame and Niger), Jabalpur, representing diverse geographical origins, constituted the experimental material. The genotypes were evaluated in a Randomized Block Design (RBD) with three replications under recommended agronomic practices. Each genotype was grown in five rows maintaining a spacing of 30 cm between rows and 10 cm between plants. Standard crop management practices were followed throughout the crop-growing period to ensure a healthy crop stand.

Data were recorded on ten quantitative traits, namely plant stand per plot, days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, capsule length (cm), number of seeds per capsule, 1000-seed weight (g), oil content (%) and seed yield per plant (g). Observations for all characters, except plant stand per plot and days to maturity, were recorded from five randomly selected competitive plants in each replication and the mean values were used for statistical analyses. Analysis of variance (ANOVA) was performed to assess the significance of differences among genotypes. Direct and indirect effects of yield-attributing characters on seed yield were estimated through path coefficient analysis using the procedure proposed by (Wright, 1921)^[5] and modified by (Dewey and Lu, 1959)^[6]. Genetic divergence among the genotypes was assessed using Mahalanobis D² statistics (Mahalanobis, 1936)^[8] and clustering of genotypes was performed according to Tocher's method to identify genetically diverse groups for use in future breeding programmes.

3. Results and Discussion

The analysis of variance revealed highly significant ($P \leq 0.01$) differences among the sixteen sesame genotypes for all the studied traits, indicating the presence of substantial genetic variability and providing ample scope for effective selection and genetic improvement. The observed variability among the genotypes suggests that the experimental material possesses sufficient genetic diversity for the development of superior sesame cultivars. These findings are consistent with those reported by (Divya *et al.*, 2018)^[9], (Gangarde *et al.*, 2009)^[10] and (Khuntia *et al.*, 2024)^[11].

Characters correlation analysis found that seed yield per plant was significantly and positively correlated with seed number per capsule, 1000 seed weight, capsule number per plant, plant height, and oil percentage both phenotypically and genetically. Genotypic correlation values were higher than their respective phenotypic correlations which implied that these associations were mainly controlled by genetic effects with relatively low environmental effect. This study implies that improvement in the above characters will lead to improved seed yield. This observation is in agreement with (Khuntia *et al.*, 2024)^[11].

Path coefficient analysis revealed that number of capsules per plant exerted the highest positive direct effect on seed yield, followed by 1000-seed weight and plant height, indicating their major contribution towards yield improvement. Although some traits exhibited positive correlations with seed yield, their effects were mainly indirect through other yield-contributing characters. Therefore, simultaneous selection based on number of capsules per plant, 1000-seed weight, plant height, and number of seeds per capsule would be more effective for improving seed yield in summer sesame. These findings corroborate the reports of (Gangarde *et al.*, 2009)^[10], (Khuntia *et al.*, 2024)^[11]. Path coefficient analysis indicated that simultaneous selection for a higher number of productive capsules and increased primary branches per plant would be effective for improving yield performance in sesame (Singh *et al.*, 1997)^[12].

High genetic variability, heritability, and genetic advance for number of capsules per plant, harvest index, and seed yield per plant, along with their positive direct effects on seed yield, indicate that these traits are effective selection criteria for sesame yield improvement. (Ved Narain *et al.*, 2004)^[13].

Genetic divergence analysis grouped the sixteen genotypes into distinct clusters, indicating the existence of considerable genetic diversity among the experimental material. The maximum inter-cluster distance suggested the presence of highly divergent genotypes that could be utilized as potential parents in hybridization programmes to obtain superior recombinants. The substantial contribution of traits such as days to maturity, plant stand per plot, and number of branches per plant towards total genetic divergence emphasized their importance in genotype differentiation. Similar observations have been reported by (Tripathy *et al.*, 2022)^[14] and (Khuntia *et al.*, 2024)^[11].

The present study identified number of capsules per plant, number of seeds per capsule and 1000-seed weight as the most important yield-contributing traits. Selection based on these characters, together with the utilization of genetically diverse parents identified through Mahalanobis D² analysis, would be effective for developing high-yielding summer sesame cultivars.

Table 1: Grouping of 16 sesame genotypes into 5 clusters on the basis of D² analysis

Clusters	Number of genotypes	Genotypes
I	3	GT-11(C), VS-20-001, BRT-10-01
II	2	AT-468, JCS-3603
III	3	AT-482, BRT-08, Pragati (ZC)
IV	4	VS-20-008, VS-19-045, TLT-10, GT-10(NC)
V	4	JCS-3287, JCS-3993, AT-471, TKG-22(NC)

Table 2: Contribution to each character to genetic divergence in sesame

S. No.	Traits	Contribution% towards divergence
1.	Plants stand per plot	4.80
2.	Days to maturity	12.52
3.	Plant height(cm)	8.83
4.	Number of branches per plant	13.47
5.	Number of capsules per plant	9.58
6.	Capsule length(cm)	10.32
7.	Number of seeds per capsule	10.92
8.	1000 seed weight (gm)	10.83
9.	Oil content (%)	8.32
10.	Seed yield per plant (gm)	10.41

Table 3: Direct and indirect effects of ten characters on seed yield of sesame as independent variable at genotypic level

Characters	Plant stand/plot	Days to maturity	Plant height (cm)	Number of branches	Number of capsules/plant	Capsule length (cm)	No. of seeds/capsule	1000 Seed weight (g)	Oil content (%)	Seed yield (g/plant)
Plants stand/plot	-0.0790	0.0029	0.0207	0.0648	-0.0034	0.0242	0.2819	-0.0256	-0.0001	0.286*
Days to maturity	0.0116	-0.0199	-0.0241	-0.1098	0.2477	0.0319	0.0349	-0.0106	-0.0004	0.161
Plant height (cm)	-0.0158	0.0046	0.1036	0.0431	-0.1752	0.0206	0.3789	0.0457	-0.0005	0.405**
No. of branches	0.0176	-0.0075	-0.0154	-0.2905	0.3153	0.0086	-0.0452	-0.1058	0.0009	-0.122
No. of capsules/Plant	0.0004	-0.0073	-0.0269	-0.1356	0.6757	-0.0114	0.0141	0.0712	-0.0010	0.579**
Capsule length (cm)	-0.0176	-0.0059	0.0197	-0.0230	-0.0707	0.1084	0.0558	-0.0110	-0.0012	0.055
No. of seeds/capsule	-0.0363	-0.0011	0.0639	0.0214	0.0155	0.0099	0.6139	0.0139	0.0004	0.701**
1000 Seed weight (g)	0.0089	0.0009	0.0209	0.1357	0.2124	-0.0053	0.0376	0.2265	-0.0026	0.635**
Oil content (%)	-0.0011	-0.0019	0.0122	0.0673	0.1668	0.0327	-0.0565	0.1533	-0.0038	0.369**

Resi - 0.0218

*, ** significant at 5% and 1% level, respectively

Conclusion

From the current study, the presence of genetic variation was evident in all the sixteen genotypes of summer sesame, indicating great possibilities for crop improvement using selection and hybridization methods. Correlation and path coefficient analysis indicated that capsule per plant, 1000-seed weight, plant height, and number of seeds per capsule are the key traits and determinants of seed yield. Since the genotypic correlation values were significantly higher than the phenotypic correlation values, it could be stated that these traits were mostly under genetic control and not environmental influences. Analysis of genetic divergence showed great genetic variability among the selected genotypes, which could help in developing recombinants from genetically divergent parents. Traits like number of branches per plant, days to maturity, number of seeds per capsule and 1000-seed weight played vital roles in genetic divergence and hence, these traits should be considered in breeding programs. Thus, simultaneous selection for these traits, along with the use of genetically divergent parents, will help in improving seed yield and developing high-yielding cultivars of sesame suitable for Uttar Pradesh summer conditions.

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