**Original Research Article**

 **Study on Genetic Variability for Yield and Yield Contributing Traits in Linseed (*Linum usitatissimum* L.)**

 **ABSTRACT**

The present study was conducted to estimate the extent of genetic variability, heritability and genetic advance. The experimental material comprising of 40 linseed genotypes were evaluated at Experimental Farm, Department of Genetics and Plant Breeding, College of Agriculture, Latur during *Rabi*-2023. The material was sown in Randomized block design with two replications with the spacing of 30 cm x 5 cm. Observations were recorded for ten characters. Analysis of variance showed substantial amount of genetic variability had been found for all the characters, which was indicated by significant differences among and between treatments. The magnitude of genotypic and phenotypic coefficients of variation was found to be high for the number of branches per plant, number of capsules per plant, harvest index and seed yield per plant. The highest broad sense heritability values were certainly found for all ten characters. High heritability coupled with high genetic advance as per cent of mean were associated with characters days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, 1000 seed weight, harvest index and seed yield per plant which indicated that heritability is most likely due to additive gene effects and simple phenotypic selection may be effective.

 ***Keywords:*** *Linseed, variability, heritability, genetic advance, GCV, PCV*

1. **INTRODUCTION**

Linseed (*Linum usitatissimum* L.) commonly referred to as flax, is an annual plant belonging to the Linaceae family and the Linum genus. It is a diploid species (2n = 30) and is widely known as "Alsi." It is believed to have originated in Southwest Asia, with particular emphasis on India, according to Vavilov (1935).

 It thrives on fertile, medium-to-heavy, well-drained soils, particularly silty loam, clay loam and silty clays. During the flowering stage, high temperatures (over 320C) combined with moisture stress limit the production of seeds. The plant features narrow, lance-shaped leaves and produces small, blue or white flowers. The seeds of linseed are small, flat and oval in shape with a hard outer shell that protects the inner oil-rich core. This crop is grown in three different ecosystems: irrigated, rainfed and uterine. Linseed is a versatile winter (*rabi*) oilseed crop, cultivated primarily for its oil.

Linseed is mainly cultivated for its seeds, which are processed to produce linseed oil and for its fibers, which are used in the production of linen. Linseed is a multipurpose resource with applications in the textile industry, manufacturing and medicine. Beyond being an oilseed, it is available in various forms, including whole seeds, meals, flour and oil. It is incorporated into a wide range of commercial products, such as food, animal feed and non-food items. Linseed enhances the nutritional value and functionality of several food products including cereals, baked goods, snacks and beverages. Additionally, it improves the quality of animal feed, making it a valuable addition to livestock diets. Its versatility and nutritional profile have made it a valuable crop both for industrial uses like oil production, textile manufacturing and for its health benefits in food products. Linseed is the best source of omega-3 fatty acids, which are necessary because they cannot be manufactured by the body and must be obtained through food.

# **MATERIAL AND METHODS**

 **Testing location and layout of experiment**

An experiment was conducted with 40 genotypes of linseed during *rabi*-2023 at Experimental farm of the Department of Genetics and Plant Breeding, College of Agriculture, Latur. The material of linseed genotypes for the present study were collected from Oilseed Research Station, Latur. The trail was carried out in Randomized block design with two replications having 30 cm x 5 cm spacing. The observations were recorded on days to 50 per cent flowering, days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, number of seed per capsule, 1000 seed weight (g), harvest index (%), oil content (%) and seed yield per plant (g).

 **Experimental material**

 The experiment was conducted using 40 linseed genotypes namely; Meera, Mutant-02, LSL-01, FR-11, Neelam, RLC-04, T-397, EX-6-3, EC-1474, EC-704, GS-27, GS-119, ES-1534, Divya, GS-111, EC-1386, GA-85, LSL-93, ES-1462, GS-109, GS-64, NL-94, EC-99001, GS-68, EC-41741, EC-41623, GS-15, GS-61, EC-1463, TL-99, ES-14230, FR-111, EC-1066, ES-1476, GS-40, GS-20, GS-82, EI-5511, JLS-395 and ES-1445.

# **RESULTS AND DISCUSSION**

 The analysis of variance revealed that there are highly significant differences between genotypes for all ten variables examined in (Table 1). Days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight, harvest index, oil content and seed yield per plant all showed a significant difference between genotypes. This suggests that there is a broad range of variability across genotypes for yield and its contributing attributes and that selection can be beneficial for another trait in relation to the genotypes studied. A similar outcome was earlier reported by Kumar *et al*. (2015), Choudhary *et al*. (2017), Kumar *et al*. (2017), Meena *et al*. (2020), Terfa and Gurmu (2020), Patil *et al*. (2023) and Paliwal *et al*. (2024).

 In general (Table 2), the phenotypic variance was greater than the genotypic variances for the characters *viz*., days to 50 per cent flowering, days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, number of seed per capsules, 1000 seed weight (g), harvest index (%), oil content (%) and seed yield per plant (g).

 Results of genetic variability parameters indicated that the estimates of phenotypic coefficient of variation were greater than the genotypic coefficient of variation for the majority of the characters that indicating the influence of environment on the traits under study (Table 2). similar results were reported by Paul and Kumari (2018), Thakur *et al*. (2022) and Singh *et al*. (2019). High values of PCV and GCV were obtained for traits *viz*., number of branches per plant, number of capsules per plant, harvest index and seed yield per plant. Similar findings were reported by Awasthi and Rao (2005), Krishnan *et al*. (2012), Vardhan and Rao (2012), Kumar *et al*. (2015), Kumar *et al*. (2019), Singh *et al*. (2019), Meena *et al*. (2020), Dogra *et al*. (2020), Terfa and Gurmu (2020), Patil *et al*. (2023), Shankar *et al*. (2024). Whereas, the lowest PCV and GCV values were observed for the traits Number of seed per capsule (7.18 and 6.36 % respectively) and oil content (5.72 and 5.39 % respectively). Similar results were observed by Thakur *et al*. (2022), Shankar *et al*. (2024), Yadav *et al*. (2024), Meena *et al*. (2020) and Thakur *et al*. (2020).

 The broad sense heritability high for the all the ten characters (Table 2).The characters days to 50 per cent flowering (97.61, 23.54 per cent respectively), days to maturity (98.52, 23.76 per cent respectively), plant height (96.60, 20.54 per cent respectively), number of branches per plant (91.47 per cent, 36.31 per cent respectively), number of capsules per plant (95.65 per cent, 36.78 per cent respectively), 1000 seed weight (96.17, 24.25 per cent respectively), harvest index (94.46 per cent, 38.17 per cent respectively) and seed yield per plant (89.38 per cent, 39.26 per cent respectively) showed high heritability coupled with high genetic advance as per cent of mean which indicated that heritability is most likely due to additive gene effects and simple phenotypic selection may be effective. Similar results were obtained by Naik and Satapathy (2002), Awasthi and Rao (2005), Tadesse *et al*. (2010), Dandigadasar *et al*. (2011), Gauraha *et al*. (2011), Krishnan *et al*. (2012), Kumar *et al*. (2012), Kanwar *et al*. (2014) and Kumar *et al*. (2015).

Number of seed per capsule (78.53 per cent, 11.62 per cent respectively) and oil content (88.92 per cent, 10.48 per cent respectively) recorded high heritability coupled with moderate genetic advance as per cent of mean which indicated the presence of non-additive gene action. High heritability is due to favourable influence of environment rather than genotype and selection for such trait may not be rewarding. Similar result was obtained by Naik and Satapathy (2002), Tadesse *et al*. (2010), Krishnan *et al*. (2012) and Patil *et al*. (2023).

1. **Conclusion**

 Genetic variability study demonstrated that the material used in the current research had significant variability which provided a suitable basis for selection. Higher values of phenotypic coefficient of variation than genotypic coefficient of variation for a trait indicate that the traits are influenced by their environment. While there was a close correspondence between GCV and PCV for the majority of the characters, environmental factors had less influence on the appearance of these characters. The GCV and PCV were reported to be high for seed yield per plant, harvest index, number of capsules per plant and number of branches per plant indicate the good scope for genetic improvement of these characters by selection. High heritability with high genetic advance as per cent of mean observed for the characters such as days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, 1000 seed weight, harvest index and seed yield per plant are most likely governed by additive genes suggesting that simple selection may effectively improve them.

**Table 1. Analysis of variance for yield and yield related traits in linseed**

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Characters** | **Mean Sum of Squares** |
|  |  | **Replication** | **Treatments** | **Error** |
|  | **d.f.** | **1** | **39** | **39** |
| 1 | **Days to 50% flowering** | 5.00 | 76.20\*\* | 1.82 |
| 2 | **Days to maturity** | 15.31 | 266.36\*\* | 3.95 |
| 3 | **Plant height (cm)** | 6.05 | 73.05\*\* | 2.48 |
| 4 | **Number of branches per plant** | 0.14 | 0.80\*\* | 0.06 |
| 5 | **Number of capsules per plant** | 31.50 | 200.76\*\* | 8.74 |
| 6 | **Number of seed per capsule** | 0.02 | 0.61\*\* | 0.13 |
| 7 | **1000 seed weight (g)** | 0.09 | 1.78\*\* | 0.06 |
| 8 | **Harvest index (%)** | 1.10 | 46.34\*\* | 2.57 |
| 9 | **Oil content (%)** | 1.09 | 7.48\*\* | 0.82 |
| 10 | **Seed yield per plant (g)** | 0.06 | 2.82\*\* | 0.08 |

**Table 2. Genetic parameters of variability for different traits in linseed**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characters** | **Mean** | **Range** | **GV** | **PV** | **GCV****(%)** | **PCV****(%)** | **h2 (bs)** | **GA** | **GAM (%)** |
| **Min.** | **Max.** |
| **Days to 50% flowering** | 52.73 | 39.00 | 63.50 | 37.19 | 38.10 | 11.56 | 11.70 | 97.61 | 12.41 | 23.54 |
| **Days to maturity** | 98.56 | 72.50 | 113.00 | 131.20 | 133.18 | 11.62 | 11.70 | 98.52 | 23.42 | 23.76 |
| **Plant height (cm)** | 58.53 | 40.00 | 70.00 | 35.28 | 36.52 | 10.14 | 10.32 | 96.60 | 12.02 | 20.54 |
| **Number of branches per plant** | 3.29 | 1.90 | 4.20 | 0.36 | 0.40 | 18.43 | 19.27 | 91.47 | 1.19 | 36.31 |
| **Number of capsules per plant** | 53.66 | 35.50 | 72.00 | 96.01 | 100.38 | 18.25 | 18.67 | 95.65 | 19.74 | 36.78 |
| **Number of seed per capsule** | 7.75 | 6.9 | 8.80 | 0.24 | 0.30 | 6.36 | 7.18 | 78.53 | 0.90 | 11.62 |
| **1000 seed weight (g)** | 7.73 | 6.10 | 9.25 | 0.86 | 0.89 | 12.00 | 12.24 | 96.17 | 1.87 | 24.25 |
| **Harvest index (%)** | 24.53 | 17.24 | 32.66 | 21.88 | 23.16 | 19.06 | 19.61 | 94.46 | 9.36 | 38.17 |
| **Oil content (%)** | 33.79 | 30.09 | 37.43 | 3.32 | 3.74 | 5.39 | 5.72 | 88.92 | 3.54 | 10.48 |
| **Seed yield per plant (g)** | 3.01 | 1.85 | 4.25 | 0.36 | 0.41 | 20.15 | 21.32 | 89.38 | 1.18 | 39.26 |

GV- Genotypic variance, PV- Phenotypic variance, GCV- Genotypic Coefficients of variation,

PCV- Phenotypic coefficient of variation, h2(bs)- heritability (broad sense),

GA- Genetic advance, GAM- Genetic advance as per cent of mean

**Fig.1. GCV and PCV for yield and yield contributing characters in linseed**

**Fig.2. Heritability and Genetic Advance (%) for yield and yield contributing characters in linseed**

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