



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP 10(10): 734-737
www.biochemjournal.com
Received: 28-07-2026
Accepted: 25-09-2026
Published: 09-10-2026

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Correlation assessment of morphophysiological and biochemical traits with seed yield in linseed (*Linum usitatissimum* L.) under irrigated and utera conditions

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i10Si.10374>

ABSTRACT

A field experiment was conducted during rabi 2024-25 at AICRP farm on Linseed, College of Agriculture, Nagpur, to evaluate the association of morpho-physiological and biochemical traits of linseed genotypes with seed yield under irrigated and utera conditions. Twenty diverse linseed genotypes were tested under irrigated and utera conditions using a factorial randomized block design with three replications. The correlation study demonstrated that seed yield per hectare had a highly significant positive relationship with plant height at 60 DAS ($r^2 = 0.68^{**}$) and total dry matter at 90 DAS ($r^2 = 0.65^{**}$). Other traits that showed a significant positive association with yield included harvest index ($r^2 = 0.55^{**}$), total leaf chlorophyll content at 60 DAS ($r^2 = 0.48^{**}$), and the number of leaves per plant at 60 DAS ($r^2 = 0.46^{**}$). Conversely, traits like test weight ($r^2 = 0.42$), days to maturity ($r^2 = 0.25$) and seed oil content ($r^2 = 0.14$) displayed positive but statistically non-significant correlations with seed yield. The findings emphasize that breeding strategies aimed for enhancing linseed productivity across varying moisture regimes should prioritize early vegetative vigor, efficient dry matter accumulation, prolonged chlorophyll retention, and better assimilate partitioning.

Keywords: Linseed, correlation coefficient, yield attributes, harvest index, chlorophyll content, utera condition, moisture stress

Introduction

Linum usitatissimum L., commonly known as flax or linseed, belongs to the *Linaceae* family and has a chromosome number of $2n = 30$. It is an annual plant growing 30-100 cm tall, with a main stem and shallow, branching taproot that can extend 90-120 cm into light soils. In dense planting for fiber production, it tends to produce a single stem, while sparse planting encourages branching. The fruit is a five-celled capsule containing around ten seeds (Bisen *et al.*, 2025) [1]. It is an important rabi oilseed crop valued for its nutrient-rich oil and industrially useful fibre. In India, it is predominantly grown under rainfed conditions (accounting for about 63% of the area) and in rice-fallows under the utera or paira system (25%), while only a minor fraction (17%) receives assured irrigation. The utera cropping system relies entirely on the receding residual moisture left after the rice harvest (Bhowmick *et al.*, 2005) [2]. Under such moisture-limited conditions, the crop frequently faces terminal drought and heat stress, which negatively impacts plant growth, physiological functioning, and ultimately, the seed yield (Anastasiu *et al.*, 2016) [3]. Seed yield itself is a highly complex, polygenic trait that is heavily influenced by environmental variations. Direct selection for higher yield is often difficult because of strong genotype-by-environment interactions. Therefore, plant breeders rely on indirect selection by identifying secondary morpho-physiological and biochemical traits that are genetically linked to yield. Understanding the degree and direction of association between yield and these component traits is essential for designing an effective breeding program. By assessing these correlations under both irrigated and utera conditions, researchers can identify the specific plant characteristics that contribute to drought adaptation and yield stability. The objective of this study was to examine the correlation of individual morpho-physiological and biochemical parameters with seed yield to help for linseed improvement.

Materials and Methods

The experimental material comprised twenty diverse linseed genotypes, including two checks, PKV NL-260 and LSL-93, obtained from AICRP on Linseed, College of Agriculture, Nagpur. The field experiment was conducted during rabi 2024-25 at the AICRP on Linseed farm, College of Agriculture, Nagpur. The experiment was laid out in a factorial randomized block design with three replications under irrigated and utera conditions. A spacing of 30 cm $\times$ 10 cm was maintained, with a gross plot size of 3.00 m $\times$ 2.20 m.

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Recommended cultural practices were followed to raise a healthy crop under both conditions. Five plants were randomly selected from each plot for recording plant-based observations. Plant height (cm) at 60 DAS, Number of leaves at 60 DAS, total dry weight (g plant^{-1}) at 90 DAS were recorded. Biochemical traits like total chlorophyll content in leaves (mg g^{-1}) by colorimetric method were recorded at 60 DAS and seed oil content (%) was estimated by soxhlet's procedure. At harvest, test weight (g), harvest index (%), and seed yield per hectare (qt) were recorded. Pearson's correlation coefficients were calculated using the mean data of the different characters to evaluate their association with seed yield, with significance tested at the 5% and 1% levels of probability according to standard statistical methodology. The experimental data were statistically analysed according to the procedure described by Panse *et al.* (1967) [4].

Results

and discussion

The correlation analysis provided deep insights into how individual growth and biochemical parameters influence seed yield. The per-hectare seed yield showed a positive relationship with all the evaluated morpho-physiological and biochemical traits. A detailed, trait-by-trait discussion of these correlations is presented below. (Table No.1).

Plant height at 60 DAS

Among all the studied parameters, plant height at 60 DAS exhibited the strongest and most highly significant positive correlation with seed yield per hectare ($r^2 = 0.68^{**}$). Plant height also displayed a significant positive correlation with total dry weight ($r^2 = 0.49^*$). The 60 DAS stage marks a crucial phase where the plant transitions from vegetative growth to reproductive development. A taller and more robust main stem offers a larger structural framework, allowing the plant to accommodate more primary and secondary branches. This directly translates into a higher capsule-bearing capacity. Furthermore, strong vertical growth under utera conditions indicates better early-stage vigor, helping the plant establish itself before residual soil moisture depletes. Similar findings were reported by Kumar (2016) [5] and Patel *et al.* (2025) [6].

Number of leaves at 60 DAS

The number of leaves per plant at 60 DAS showed a significant positive association with seed yield ($r^2 = 0.46^*$). It also possessed a strong positive inter-correlation with total dry weight ($r^2 = 0.67^{**}$) and total chlorophyll content ($r^2 = 0.55^*$). Leaves are the primary photosynthetic organs of the plant. A higher number of leaves results in a denser canopy and an optimal leaf area index, maximizing the interception of sunlight. In moisture-limited utera conditions, a well-developed canopy is highly beneficial because it provides ground cover, shading the soil and reducing direct moisture evaporation. This ensures that the plant can sustain carbon assimilation and produce more photosynthates to feed the developing seeds. These results are consistent with the findings of Khatun *et al.* (2023) [7].

Total dry weight at 90 DAS

The accumulation of dry matter at 90 DAS recorded a highly significant positive correlation with seed yield per hectare ($r^2 = 0.65^{**}$). Total dry weight serves as a direct indicator of the plant's overall physiological efficiency, growth vigor, and net assimilation over its lifespan. While adequate irrigation naturally favors continuous dry matter production, maintaining high biomass under utera conditions requires significant drought tolerance. Genotypes that accumulate higher total dry weight possess a greater source capacity. During the grain-filling stage, these stored reserves are effectively mobilized to the capsules, leading to higher seed yields. Similar findings were reported by Dabalo *et al.* (2020) [8] and Kunte *et al.* (2024) [9].

Total chlorophyll content at 60 DAS

Total leaf chlorophyll content at the 60 DAS stage exhibited a significant positive correlation with seed yield ($r^2 = 0.48^*$) and a highly significant correlation with total dry weight ($r^2 = 0.62^{**}$). Chlorophyll is the fundamental pigment driving photosynthesis. As the crop enters the reproductive phase around 60 DAS, sustained photosynthetic activity is crucial for capsule formation and seed filling. Under moisture stress, plants often experience early leaf yellowing and pigment degradation. A positive correlation suggests that genotypes displaying a "stay-green" trait retaining their chlorophyll content for a longer duration can continue to produce assimilates during critical reproductive stages, thereby safeguarding the final yield. These results are consistent with the findings of Khatun *et al.* (2023) [7].

Seed oil content %

Seed oil content exhibited a weak positive and non-significant correlation with seed yield per hectare ($r^2 = 0.14$). The absence of a significant correlation signifies that the biological processes governing lipid synthesis (oil content) function independently of the pathways that drive total seed biomass accumulation. From a crop improvement standpoint, this is highly advantageous. It implies that researchers can confidently select for high-yielding varieties without worrying about a negative trade-off causing a decline in seed oil quality. These observations are consistent with those of Singh *et al.* (2018) [10].

Days to maturity

The duration required for the crop to reach maturity displayed a positive but non-significant association with seed yield ($r^2 = 0.25$). The crop matured faster under utera conditions (111.72 days) compared to irrigated conditions (118.97 days), acting as a natural mechanism to escape terminal drought. However, the weak correlation with yield suggests that crop duration was not the primary deciding factor for productivity in this experiment. High-yielding genotypes achieved their performance through superior physiological mechanisms like high biomass and chlorophyll retention rather than strictly by altering their growth cycle. The evaluation of crop duration and its varying impact on productivity under different environmental stresses has been documented in the variability assessments by Triveni *et al.* (2024) [11].

Test weight

The test weight showed a positive but non-significant correlation with seed yield per hectare ($r^2 = 0.42$). While test weight decreased from 7.61 g under irrigated conditions to 7.07 g under utera conditions due to moisture limitations, this trait is generally under strong genetic control and remains relatively stable. The lack of statistical significance indicates that variations in overall seed yield among these twenty genotypes were primarily driven by differences in the total number of capsules per plant, rather than the individual size or weight of the seeds. The relative stability of test weight and its complex interaction with overall seed yield have been similarly explored by Akbar *et al.* (2003) [12].

Harvest index

Harvest index (HI), which measures the efficiency of a plant in converting its total biological yield into economic seed yield, exhibited a significant positive correlation with productivity ($r^2 = 0.55^*$). Additionally, it was positively correlated with test weight ($r^2 = 0.47^*$) and dry weight ($r^2 = 0.54^*$). This relationship highlights that merely producing a large vegetative mass is not enough; the plant must also efficiently partition those resources into the seeds. Under utera conditions, moisture stress often limits the development of reproductive parts. Therefore, genotypes with a high harvest index are highly desirable, as they demonstrate an efficient source-to-sink translocation mechanism even under stress. These observations are consistent with those of by Kunte *et al.* (2024) [9] and Patel *et al.* (2025) [6].

Table 1. Correlation coefficients among morphophysiological, biochemical and yield characters of linseed

	Plant height @60 DAS	No. of leaves @ 60 DAS	Dry weight @ 90 DAS	Days to maturity	Total chloro- phyll @60 DAS	Oil content (%)	Test weight	HI (%)	Yield per hectare
Plant height @60 DAS	1								
No. of leaves @ 60 DAS	0.23								
Dry weight @ 90 DAS	0.49*	0.67**							
Days to maturity	0.41	0.24	0.50*						
Total chlorophyll @60 DAS	0.14	0.55*	0.62**	0.54*					
Oil content (%)	0.12	0.21	0.09	0.08	0.27				
Test weight	0.03	0.29	0.40	0.21	0.26	0.03			
HI (%)	0.31	0.46*	0.54*	0.15	0.34	-0.08	0.47*		
Yield per hectare	0.68**	0.46*	0.65**	0.25	0.48*	0.14	0.42	0.55*	1

*Significant at 5% level ($r = 0.4438$)** Significant at 1% level ($r = 0.5614$)d.f. = 18 ($n = 20$)

Conclusion

The correlation analysis of twenty diverse linseed genotypes underscores the critical importance of vigorous vegetative growth and physiological efficiency for realizing high seed yield. The highly significant positive correlations of yield with plant height at 60 DAS ($r^2 = 0.68^{**}$) and total dry weight at 90 DAS ($r^2 = 0.65^{**}$) indicate that early establishment and sustained biomass production are the primary drivers of productivity. Additionally, positive associations with harvest index ($r^2 = 0.55^*$), total chlorophyll content at 60 DAS ($r^2 = 0.48^*$), and leaf number at 60 DAS ($r^2 = 0.46^*$) highlight the necessity of an active photosynthetic canopy and efficient dry matter partitioning to the seeds, especially under moisture-limited utera conditions. Because test weight ($r^2 = 0.42$), days to maturity ($r^2 = 0.25$), and seed oil content ($r^2 = 0.14$) showed non-significant correlations with yield, improvement programs can effectively target vegetative and partitioning traits to enhance total seed yield without negatively impacting oil quality. These findings provide valuable selection criteria for developing climate-resilient linseed cultivars suited for varied moisture environments.

Acknowledgments

I extend my heartfelt gratitude to all those who have been instrumental in the successful completion of this research endeavor. I would like to acknowledge the support of my research guide who shared their expertise and perspectives. My sincere thanks to Professor, agricultural botany section for providing the necessary resources and facilities.

References

1. Bisen NC, Manapure PR, Patil SR, Shende PV, Rathod SR, Manwar RM, Sharanagat AI. Screening of linseed (*Linum usitatissimum* L.) germplasm under rainfed condition. International Journal of Advanced Biochemistry Research. 2025;9(7):105-111.
2. Bhowmick MK, Aich A, Aich SS, Shrivastava MP, Gupta S, Man GC. Crop diversification through paira (utera) cropping with rabi pulses. SATSA Mukhapatra-Annual Technology Issue. 2005;9:43-60.
3. Anastasiu AE, Chira NA, Banu I, Ionescu N, Stan R, Rosca SI. Oil productivity of seven Romanian linseed varieties as affected by weather conditions. Industrial Crops and Products. 2016;86:219-230.
4. Panse VG, Sukhatme PV. Statistical Method for Agricultural Workers. Second edition. Indian Council of Agricultural Research, New Delhi; 1967. p.381.
5. Kumar N. Selection criteria of linseed genotypes for seed yield traits through correlation, path coefficient and principal component analysis. The Journal of Animal & Plant Sciences. 2016;26(6):1686-1693.
6. Patel AY, Wadikar PB, Nakhate VM, Kulkarni PD. Correlation and path coefficient analysis in linseed (*Linum usitatissimum* L.) for yield and yield contributing traits. International Journal of Agriculture and Food Science. 2025;7(8):933-936.
7. Khatun MA, Mollah MRA. Physiological and biochemical traits association with seed yield in linseed (*Linum usitatissimum* L.) genotypes. Bangladesh Journal of Agricultural Research. 2023;48(2):159-168.
8. Dabalo DY, Singh BCS, Weyessa B. Genetic variability and association of characters in linseed (*Linum usitatissimum* L.) plant grown in central Ethiopia region. Saudi Journal of Biological Sciences. 2020;27(8):2192-2206.
9. Kunte SG, Nair BM, Manapure PR, Patil SA, Pardhi KC, Barde YD, Shahare PY. Assessment of genetic variability, correlation and path analysis for yield and yield associate traits in linseed (*Linum usitatissimum* L.). International Journal of Advanced Biochemistry Research. 2024;8:313-317.
10. Singh VK, Singh MK, Singh SK, Singh VK. Genetic variability and association studies in linseed (*Linum usitatissimum* L.). Journal of Experimental Biology and Agricultural Sciences. 2018;6(3):492-498.
11. Triveni, Parihar R, Agarwal AP, Sharma DJ, Pandey D, Chaure NK. Assessment of genetic variability and correlation analysis for yield and yield associated traits in linseed genotypes (*Linum usitatissimum* L.). Int. J. Adv. Biochem. Res. 2024;8(7S):934-936.
12. Akbar M, Mahmood T, Anwar M, Ali M, Shafiq M, Salim J. Linseed improvement through genetic variability, correlation and path coefficient analysis. International Journal of Agriculture and Biology. 2003;5(3):303-305.
13. Singh A, Kumar S, Singh R. Genetic variability, character association and path analysis for yield and yield components in mungbean (*Vigna radiata* L. Wilczek). Legume Research - An International Journal. 2023;46(5):534-540.

14. Yadeta Dabalo D, Chandra Sekhar Singh B, Weyessa B. Genetic variability and association of characters in linseed (*Linum usitatissimum* L.) plant grown in central Ethiopia region. Saudi Journal of Biological Sciences. 2020;27:2192–2206.

How to cite this article: Amarshettiwar S, Ingole AA, Baviskar SB, Nair BM, Kuchanwar O, Shende P, et al. Correlation assessment of morphophysiological and biochemical traits with seed yield in linseed (*Linum usitatissimum* L.) under irrigated and utera conditions. *International Journal of Advanced Biochemistry Research*. 2026;SP-10(10):734-737. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i10Si.10374>

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