Eco. Env. & Cons. 30 (October Suppl. Issue) : 2024; pp. (S239-S243)
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ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i06s.036

Correlation and path coefficient analysis for identifying important traits contributing to seed yield in Linseed (*Linum usitatissimum* L.)

Uttej Karla[1]*, Hemlata Sharma[1], Praduman Yadav[2], Amit Dadeech[1], R.B. Dubey[1] and Devendra Jain[3]

[1]Department of Genetics and Plant Breeding, Maharana Pratap University of Agriculture and Technology, Udaipur 313 001, Rajasthan, India
[2]ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad 500 030, Telangana, India
[3]Department of Molecular Biology and Biotechnology, Maharana Pratap University of Agriculture and Technology,
Udaipur 313 001, Rajasthan, India

(Received 19 March, 2024; Accepted 28 May, 2024)

ABSTRACT

The current experiment was conducted to evaluate correlation and path coefficient analysis for yield and yield contributing traits in eighty-seven linseed genotypes. Augmented design was used to investigate the experiment during *rabi* 2022-23. Seeds per capsule, capsules per plant, branches per plant, thousand seed weight and capsule size exhibited positively significant association with seed yield per plant. Path coefficient analysis recorded those seeds per capsule, branches per plant, capsules per plant, harvest index and thousand seed weight had direct positive effects on seed yield per plant, implying these traits were major contributors to the seed yield and these traits can be further used in crop improvement programs to develop better yielding linseed varieties.

Key words: *Linseed, Correlation, Path coefficient analysis, Association*

Introduction

Linseed (*Linum usitatissimum* L.), generally known as flax, belongs to Linaceae family. The word "*Linum*" is derived from the Celtic word lin, which means "thread," and "*usitatissimum*" is Latin for "most useful" (Udenigwe *et al.,* 2010). It is the only Linaceae species with economic significance (Tadesse *et al.,* 2010). It is grown for flax all over the world, but it is grown for oil in India (Wakjira *et al.,* 2004). India is the fifth largest linseed growing country in the world. Among the *rabi* oil seed crops in India, linseed occupies the second position next to rapeseed-mustard in production as well as in area.

Linseed is gaining popularity as a nutritious and functional food due to its abundance of health-promoting substances. These include omega-3 fatty acids, soluble and insoluble fiber, and lignin. This versatility extends to its incorporation in various food items such as bread, breakfast muesli bars, and cereals. The crushed seeds and flour derived from linseed contribute to value addition and the creation of diverse nutritious food preparations.

Linseed, a underestimated oilseed crop in developing countries, is commonly cultivated on less-than-ideal lands with inadequate methods of cultivation. The primary obstacle hindering its productivity is the absence of enhanced cultivars that are suitable for diverse agro-climatic conditions, late maturing, vulnerability to diseases and pests, and

Orcid: 0000-0003-1744-5471

the cultivation of the crop under inadequate agronomic operations on low fertile lands. In tropical and sub-tropical regions, the cultivation of linseed encounters difficulties due to rising temperatures, which hasten the maturity and aggravate soil moisture stress.

Since yield is a complex and quantitative trait influenced by poly genes, selection based on multiple traits is always preferable to selection based on yield alone. Adequate knowledge of the magnitude and degree of correlation of yield with its contributing traits is of vital importance for breeders, as it allows them to effectively assess the strength of correlated traits when selecting for simultaneous improvement of more than one trait. Correlation, on the other hand, fails to offer insights into the contribution of linked traits, necessitating the investigation of the cause and effect relationship of diverse characters among themselves. As a result, path analysis can offer the precise relationship between traits, which provides more information than correlation alone.Therefore,this study examines the relationship between seed yield and component traits in linseed germplasm.

Materials and Methods

The experiment was conducted at Krishi Vigyan Kendra, Maharana Pratap University of Agriculture and Technology, Chittorgarh, situated in southern Rajasthan which is located at 24.88^0 North, 74.63^0 East with an average mean sea level of 394.6 meters, during *rabi* 2022-23. Eighty-seven linseed genotypes including three checks T-397, Sheela and Swetha were used for current experiment. The genotypes were evaluated using augmented design with six blocks, and checks were repeated in all the blocks. Every genotype was sown in two rows of 2 m length with row to row and plant to plant distance kept at 25 cm and 10 cm, respectively. All the recommendations pertaining to cultural practices and protection practices were performed to raise a good and healthy crop.

Data was collected on ten randomly selected plants from each genotype for eleven quantitative traits, including days to 50% flowering (DFF), days to maturity (DM), plant height (PH), number of branches per plant (BPP), capsules per plant (CPP), seeds per capsule (SPC), 1000 seed weight (g) (TSW), capsule size (mm) (CS), harvest index (HI), oil content (%) (OC), and seed yield per plant (g) (SPY). Oil content (%) was determined using Nuclear Magnetic Resonance at ICAR – IIOR, Hyderabad. The correlation was estimated using the methodology given by Al-jibouri *et al.* (1958). The statistical approach proposed by Wright (1921) and elaborated by Dewey and Lu (1959) was used to estimate the direct and indirect contribution of various factors on seed yield determined using path coefficient analysis.

Results and Discussion

Phenotypic correlation coefficients among yield and its related traits were presented in Table 1 and Figure 1. seed yield per plant recorded high positively and significant association with seeds per capsule (0.594) followed by capsules per plant (0.466), branches per plant (0.419), thousand seed weight (0.354), capsule size (0.295). Similar results were reported by Ekhlaque Ahmed (2017), Ranjana *et al.* (2018), Satish *et al.* (2017), Ankit *et al.* (2019) and seed yield per plant showed significant negative association with oil content (-0.250),which is similar finding by Kumari *et al.* (2017). Whereas, seed yield per plant showed non significant positive association with harvest index (0.161), days to maturity (0.03) and non significant negative association with plant height (-0.011) and days to fifty percent flowering (-0.093). These results are in agreement with the findings of Kumari *et al.* (2017) for days to fifty percent flowering and Patel et al (2023) for plant height and Satish *et al.* (2017) Danish *et al.* (2016) for trait days to maturity.

However, oil content reported negatively significant association with days to maturity (-0.224), seeds per capsule (-0.222)indicating late maturing genotypes have low oil content, similar results were reported by Kumari *et al.* (2017), Patel *et al.* (2023) for days to maturity and significant positive association was recorded with plant height (0.295), similar result was reported by Dikshit and Sivaraj (2015).

Whereas days to fifty percent flowering showed positively significant association with days to maturity (0.703), Patel *et al.* (2023), Siddique *et al.* (2023), Singh *et al.* (2023) reported similar research findings and days to fifty percent flowering recorded negatively significant association with capsule size (-0.254) implying late flowering genotypes have smaller capsule sizes when compared to early flowering genotypes which is similar to the findings of Kumari *et al.* (2017). Positively significant correlation was recorded between capsules per plant with seeds per capsule (0.472) and thousand seed weight (0.296) these results were similar to the findings of Siddique *et al.* (2023)and Saikumar *et al.* (2022) respectively. Further seeds per capsule displayed significantly positive correlation with thousand seed weight (0.243), branches per plant (0.259), these findings are in agreement to the results of Meena *et al.* (2023) for thousand seed weight, Ankit *et al.* (2019) for branches per plant. Whereas capsule size was significantly and positively correlated with branches per plant (0.211) and seeds per capsule (0.258), Kumari *et al.* (2017) reported similar findings.

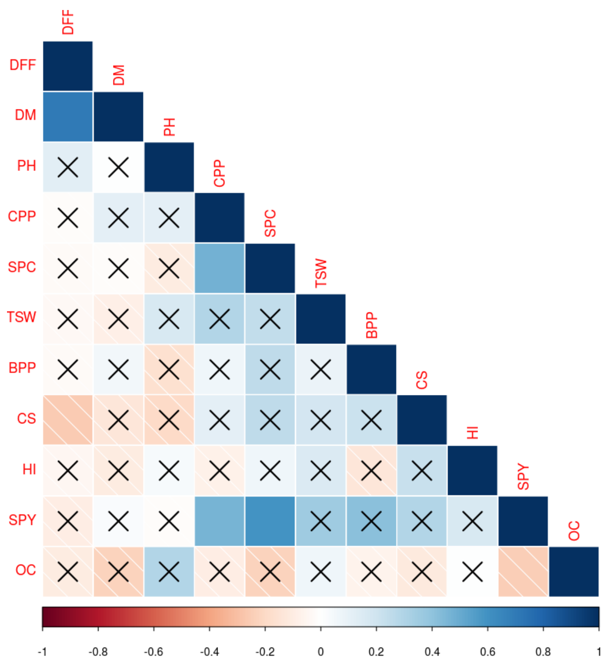

Fig. 1. Heat map depicting correlation among yield and yield attributing traits in Linseed germplasm

Path coefficient analysis

Path coefficient analysis was utilized to further analyze correlation; this method divides the correlation coefficient into direct and indirect effects through additional traits. Path coefficient analysis (Table 2) revealed that seeds per capsule (0.326) followed by branches per plant (0.319), capsules per plant (0.216), harvest index (0.171) and thousand seed weight (0.149) had highest positive direct effects on seed yield per plant, implying these traits were major contributors to the seed yield these results were also in agreement with the results of Leelavathi *et al.* (2018), Ankit *et al.* (2019), Meena *et al.* (2023), Kumar *et al.* (2018), Siddique *et al.* (2023). The oil content (-0.250) and days to fifty percent flowering (-0.146) reported highest negative direct effects on seed yield per plant confirming their negative association with yield which is similar in findings as those by Kumar *et al.* (2018), Kumari *et al.* (2017), Khandagale *et al.* (2016) who recorded direct negative effects for these traits.

Conclusion

The current experiment reported that the characters, seeds per capsule, capsules per plant, thousand seed weight, branches per plant had significantly positive association and reported major direct and indirect effects on seed yield per plant implying that these traits should be given due Weightage during selection of elite genotype for the enhancement of seed yield in linseed.

Table 1. Phenotypic correlation coefficients of yield and its attributing traits

	DFF	DM	PH	CPP	SPC	TSW	BPP	CS	HI	SPY
DFF										
DM	0.703**									
PH	0.13	0.001								
CPP	-0.018	0.117	0.118							
SPC	-0.027	-0.02	-0.105	0.472**						
TSW	-0.039	-0.086	0.168	0.296**	0.243*					
BPP	-0.029	0.052	-0.167	0.065	0.259*	0.086				
CS	-0.254*	-0.139	-0.199	0.111	0.258*	0.181	0.211*			
HI	-0.048	-0.106	0.035	-0.075	0.062	0.157	-0.134	0.229*		
SPY	-0.093	0.03	-0.011	0.466**	0.594**	0.354**	0.419**	0.295**	0.161	
OC	-0.107	-0.224*	0.295*	-0.095	-0.222*	0.069	-0.069	-0.112	0.009	-0.250*

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

Table 2. Direct (diagonal) and indirect effects of ten yield attributing traits on seed yield

	DFF	DM	PH	CPP	SPC	TSW	BPP	CS	HI	OC
DFF	-0.146	-0.103	-0.019	0.003	0.004	0.006	0.004	0.037	0.007	0.016
DM	0.067	0.096	0.000	0.011	-0.002	-0.008	0.005	-0.013	-0.010	-0.021
PH	0.012	0.000	0.094	0.011	-0.010	0.016	-0.016	-0.019	0.003	0.028
CPP	-0.004	0.025	0.026	0.216	0.102	0.064	0.014	0.024	-0.016	-0.020
SPC	-0.009	-0.007	-0.034	0.154	0.326	0.079	0.085	0.084	0.020	-0.072
TSW	-0.006	-0.013	0.025	0.044	0.036	0.149	0.013	0.027	0.023	0.010
BPP	-0.010	0.016	-0.053	0.021	0.083	0.028	0.319	0.067	-0.043	-0.022
CS	-0.008	-0.004	-0.006	0.003	0.008	0.005	0.006	0.029	0.007	-0.003
HI	-0.008	-0.018	0.006	-0.013	0.011	0.027	-0.023	0.039	0.171	0.002
OC	0.018	0.037	-0.049	0.016	0.037	-0.011	0.011	0.019	-0.002	-0.165
SPY	-0.093	0.03	-0.011	0.466**	0.594**	0.354**	0.419**	0.295**	0.161	-0.250*

Conflict of interest

Authors declare no conflict of interest

Acknowledgement

Authors would like to thank AICRP on Linseed, Nagpur (PDKV, Akola) for providing seed and ICAR-IIOR, Hyderabad for providing funds and equipment for the current study.

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