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Correlation and Path Coefficient Studies of Economically Promising Traits of Linseed (Linum usitatissimum L.) Genotypes

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Abstract:

The present investigation was undertaken to obtain the information on nature and magnitude of genotypic and phenotypic correlation coefficient, and path coefficient. The experiment consisting of fifteen linseed cultivar/varieties were laid out in Research farm, Genetics and Plant Breeding, AKS University Sherganj, Satna, Madhya Pradesh during Rabi, 2022-23. The characters studied were days to 50 % flowering, branches per plant (TPP), days to maturity (DM), plant height (cm) (PH), number of capsules per plant (NCPP), number of seed per capsule (NSPC), test weight (1000 seed) (g), biological yield per plant (g) BYPP, harvest index (%) (HI), seed yield per plant (g) (SYPP). The design of the experiment indicated highly significant differences for all the characters among treatments. Wide range of variation was found for all the characters. Genotypic correlation was higher than phenotypic ones in magnitude for all the characters except correlation between correlation between days to maturity with number of seed per capsule and days to maturity with biological yield per plant. The characters showed high positive and significant associations with seed yield are days to 50 % flowering; number of capsules per plant, biological yield per plant and harvest index. Some characters are also showed negative but significant associations with seed yield are branches per plant, plant height and number of seed per capsule. Path coefficient analysis revealed that biological yield per plant followed by harvest index, number of capsules per plant, had exerted maximum positive direct effect on seed yield at both genotypic and phenotypic level. Branches per plant had exhibited negative direct effect on seed yield at genotypic level.

Keyword: correlation coefficient, path coefficient and Linseed

Introduction

Linseed, also known as flaxseed, is a significant oilseed crop. According to Adugna and Labuschange, (2002) its seeds containing a substantial amount of oil ranging from 32% to 45% which is high in unsaturated fatty acids, especially linolenic acid (Khan et al., 2010). In the United States, linseed oil is also utilized in the road cementing process (Weiss, 2000). It possesses nutritional, medicinal, and industrial applications. Due to its seed oil's rich linolenic acid content, it finds utility as a drying oil within the paints and varnish sector (Mc Hughen, 1992). It is a versatile oilseed crop that belongs to the Linaceae family, consisting of 14 genera (Gill 1987). In addition to its medicinal properties, linseed possesses remarkable health benefits such as its ability to lower cholesterol levels and prevent cancer. Moreover, it plays a crucial role in the growth and development of brain and retinal tissues in infants (Payne, 2000).

The genus is most commonly recognized for its species, Linum usitatissimum L., which has been cultivated since ancient times and possesses 30 somatic chromosomes. The reported somatic chromosome number in different species of the Linum genus ranges from 16 to 80 (Ray, 1944; Darlington and Wylie, 1956; Gill, 1966; Harris, 1968). Among the various oilseed crops cultivated in India, it is considered a rabi oilseed crop. The genus Linum comprising more than 230 species, viz., Linum alatum, Linum allredii, Linum arenicola, Linum aristatum, Linum austral, Linum australe var. austral, Linum australe var. glandulosum, Linum berlandieri, Linum bienne, Linum angustifolium, Linum carteri, Linum catharticum, Linum compactum, Linum rigidum, Linum elongatum etc., exhibits great diversity in Karyotypic, morphological and biochemical attributes. Flax holds a significant role in the Indian economy owing to its extensive industrial applications. However, the productivity of linseed seeds in India is considerably lower than that of other nations (Srivastava, 2009). Madhya Pradesh is the leading state both in area and production followed by Jharkhand and Uttar Pradesh. (Anonymous 2020-21).

Seed development is greatly impacted by elevated temperatures in the later stages of growth, leading to a notable decrease in seed yield (Dash et al., 2011). One of the main reasons for low productivity in India could be the unavailability of high-yielding linseed varieties. This issue may stem from the complexity of yield as a trait, which is influenced by multiple genes with small additive effects in crops that are self-pollinated. As a result, yield has low heritability and is challenging to enhance (Slinkard 2000). Consequently, directly selecting for high yield is not effective. Instead, indirect selection through various yield components has been more successful, as it considers the interactions among different traits, their correlation with grain yield, and their direct impact on grain yield (Tadesse et al., 2009). Selection criteria will essentially play a role in the selection process by considering the direct impacts (Yucel 2004; Copur and Oglakci 1998).

The analysis of correlation and path estimates the level of association between various yield components, both among themselves and with the overall yield. It also measures the direct and indirect contributions of individual attributes towards seed yield (Rajanna et al., 2014). Consequently, the utilization of correlation along with path coefficient analysis enables the measurement of the direct and indirect impact of one characteristic on another (Dewey and Lu, 1959). As a result, this research was undertaken to evaluate the association between traits, and path coefficient analysis for different linseed genotypes. The objective was to identify and select plant varieties with desirable traits such as high yield, other component traits suitable for cultivation in the Vindhya region of Madhya Pradesh, India.

Materials and Methods

The present investigation entitled **Correlation and Path Coefficient Studies of Economically Promising Traits of Linseed (Linum usitatissimum L.) Genotypes** was conducted during Rabi, 2022-23 at Research farm, Genetics and Plant Breeding, AKS University, Sherganj, Satna, Madhya Pradesh. The collections of 15 varieties/strains of Lineseed (Linum usitatissimum L.) germplasm comprising indigenous genotypes, constituted the experimental materials for this study. These genotypes exhibiting wide spectrum of variability for various agronomic and morphological characters.

All genotypes were obtained from the CSA-Kanpur, U.P. The experiment was conducted to evaluate 15 linseed germplasm under irrigated condition, following Completely Randomized Block Design. The entire experimental field divided in 3 blocks of equal size and each block had 15 plots. Each plot was consisted of four rows 2 meters length, following row to row spacing of 30 cm. and plant to plant spacing of 15 cm. Recommended cultural and agronomic practices were applied to raise a good crop. Total plant population of cultivated area are 1800 plants.

The characters studied were days to 50 % flowering, branches per plant (TPP), days to maturity, plant height (cm), number of capsules per plant (NCPP), number of seed per capsule, test weight (1000 seed) (g), biological yield per plant (g), harvest index (%), seed yield per plant (g). The analysis of variance for the design of the experiment was carried out according to the procedure outlined by Panse and Sukhatme (1967). The simple correlations between different characters at genotypic and phenotypic levels were worked out between characters as suggested by Searle, (1961). Path coefficient analysis was carried out by formula suggested by Dewey & Lu (1959).

Result and Discussion

Analysis of variance (ANOVA) for the design of experiment.

The analysis of variance for the design of the experiment involving 15 linseed genotypes/varieties were evaluated in Completely Randomized Block Design (CRBD) with three replications for the ten quantitative characters expressed in **Table 1.** The design of the experiment indicated highly significant differences for all the evaluated characters. The maximum variances due to replication were found for number of capsules per plant (133.92955) and highest variances due to treatment also found for number of capsules per plant (444.518508**). Non-significant differences due to replications were observed for all the characters. Similar results were reported by Upadhyay and Mehta (2019), Dabalo et al. (2020), Dogra et al. (2020), Terfa and Gurmu (2020), Prameela et al. (2022), Thakur et al. (2022), Choudhary et al. (2023), Meena et al. (2023), Patel et al. (2023), Patil et al. (2023).

Correlation coefficient:

In the present study correlation coefficient was worked out at genotypic and phenotypic levels for all the ten traits of linseed and has been presented in **Table 2.** In general, genotypic correlation was higher than phenotypic ones in magnitude for all the characters except correlation between days to maturity with number of seed per capsule and days to maturity with biological yield per plant.

Branches per plant exhibited significant but negative correlation with Seed yield per plant (-0.9541**) at genotypic level. Plant height showed negative but high significant correlation with seed yield per plant (-0.5467** and -0.4978*) at both genotypic and phenotypic levels, respectively. Number of capsules per plant showed high positive significant correlation with seed yield per plant (0.6911** and 0.3974) at genotypic only. Number of seed per capsule exhibited negative but significant correlation with seed yield per plant (-0.9325** and -0.3117) at genotypic level only. Biological yield per plant showed significant positive correlation with seed yield per plant (0.921** and 0.8851**) at both genotypic and phenotypic levels, respectively. Harvest index showed significant positive correlation with seed yield per plant (0.6445** and 0.4988*) at both genotypic and phenotypic levels, respectively.

The characters showed high positive and significant associations with seed yield are days to 50 % flowering; number of capsules per plant, biological yield per plant and harvest index. Some characters are also showed negative but significant associations with seed yield are branches per plant, plant height and number of seed per capsule.

Similarly the results are accordance to Dabalo et al. (2020) reported positive association of primary branches per plant, secondary branches per plant and plant height on seed yield. Dogra et al. (2020) reported positive and significant correlation of length of flowering period, seeds per capsule, harvest index, primary branches, secondary branches, capsules per plant, aerial biomass and 1000-seed weight with Seed yield per plant. Prameela et al. (2022) reported that, final plant stand, days to first flowering, plant height, number of primary branches, seeds per capsule, harvest index with seed yield per plant. Choudhary et al. (2023) reported significant positive correlation of seed yield with flower diameter, number of primary branches per plant, number of capsules per plant, number of seeds per capsule and 1000-seed weight. Meena et al. (2023) reported that Seed yield per plant had positive and significant correlation with plant height, number of capsules per plant, 1000 seed weight and protein content. Patel et al. (2023) observed significant and positive correlation of Number of capsules per plant, number of seeds per capsule and 1000 Seed weight with Seed yield per plant.

Path coefficient analysis:

Yield is the sum total of the several component characters which directly or indirectly contributed to it. The information derived from the correlation studies indicated only mutual association derived from the correlation studies indicated only mutual association among the characters. Whereas, Path coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent character like grain yield. Partitioning of correlation coefficient into direct and indirect effects provides the information about the nature and magnitude of effects of other characters on grain yield.

The genotypic and phenotypic correlation coefficient of seed yield with the remaining characters under study were further partitioned into direct and indirect effects using path coefficient analysis and are presented in **Table 3., and Table 4.8** it is also showed in figure 1., and figure 2., Respectively.

At genotypic level Path coefficient analysis revealed that biological yield per plant (0.8234) followed by harvest index (0.4028), number of capsules per plant (0.0326), number of seed per capsule (0.0313), test weight (0.0278), plant height (0.0247), days to maturity (0.0053) and days to 50 % flowering (0.004) had exerted maximum positive direct effect on seed yield at genotypic level. Branches per plant (-0.0054) had exhibited negative direct effect on seed yield at genotypic level.

At phenotypic level, path coefficient analysis revealed that biological yield per plant (0.8498), harvest index (0.4269), number of capsules per plant (0.0063) and branches per plant (0.0009) had exerted maximum positive direct effect on seed yield at phenotypic level. Plant height (-0.024) followed by number of seed per capsule (-0.0215), days to 50 % flowering (-0.0163), days to maturity (-0.0028) and test weight (-0.0017) had exhibited negative direct effect on seed yield at phenotypic level.

Biological yield per plant (0.2374) and Branches per plant (0.0308) via Harvest index had exerted positive indirect effect on seed yield at genotypic level. Biological yield per plant (0.0401) and Plant height (0.0179) via Harvest index had exerted positive indirect effect on seed yield at phenotypic level.

On the basis of path coefficient analysis showed that Biological yield per plant, Harvest index (%) and Plant height were important characters that could be taken into consideration for selection and improvement of seed yield in linseed. These results are accordance to Dabalo et al. (2020) reported that seed yield per plant, primary branches per plant, secondary branches per plant and plant height showed positive direct effect on seed yield. Dogra et al. (2020) reported highest direct effects of capsules per plant and 1000-seed weight on seed yield per plant. **Prajapati et al. (2022)** reported path coefficient analysis revealed the positive direct effect at both genotypic and phenotypic levels for days to 50% flower, plant height, number of capsule per plant, 1000 seed weight and primary branches per plant. Prameela et al. (2022) reported maximum positive direct effects by final plant stand, days to first flowering, plant height, number of primary branches, and harvest index on seed yield per plant. Choudhary et al. (2023) reported high positive direct effect of number of capsules per plant and flower diameter on seed yield. Meena et al. (2023) reported that number of capsules per plant has strong positive direct effect on seed yield per plant. Patel et al. (2023) observed positive direct effect of number of seeds per capsule, 1000 Seed weight and Number of capsules per plant on seed yield.

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Table 1. Analysis of variance for ten quantitative characters in Linseed.

Traits	Replicate (df=2)	Treatments (df=14)	Error (df=28)
Days to 50 % flowering	4.571556	91.509841**	6.972508
Branches per plant	0.600889	0.95327**	0.946603
Days to maturity	0.480222	46.773746**	3.186413
Plant height	0.344	228.201524**	3.756381
Number of capsules per plant	133.92955	444.518508**	380.243841
Number of seed per capsule	1.176	0.710095**	0.654095
Test weight	0.002889	2.894984**	0.001698
Biological yield per plant	31.330667	39.78381**	9.628048
Harvest index	12.744667	25.057714**	12.243952
Seed yield per plant	3.002889	3.114984**	0.525746

***Significant at 5% probability level.**

****Significant at 1% probability level.**

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Table 2. Genotypic and Phenotypic correlation coefficient for 10 quantitative traits in Linseed.

Traits		Days to 50 % flowering	Branches per plant	Days to maturity	Plant height	Number of capsules per plant	Number of seed per capsule	Test weight	Biological yield per plant	Harvest index	Seed yield per plant
Days to 50 % flowering	Gen	1.00	0.9467**	0.721**	0.7834**	0.4011	0.4622	-0.0683	-0.2645	-0.9431**	0.568*
	Phe	1.00	0.2855	0.6556**	0.7612**	0.1574	0.1103	-0.0654	-0.2251	-0.5576**	-0.4667
Branches per plant	Gen		1.00	-0.5261*	0.493*	-0.8965**	0.5668*	0.9840**	-0.6229**	-0.9758**	-0.9541**
	Phe		1.00	0.0167	0.2444	0.1231	0.2866	0.4308	-0.0421	-0.3126	-0.1851
Days to maturity	Gen			1.00	0.5767**	-0.6147*	0.018	0.2323	0.0148	-0.716**	-0.264
	Phe			1.00	0.5463*	-0.1375	0.0841	0.2256	0.0153	-0.4654	-0.2153
Plant height	Gen				1.00	0.1285	0.5061*	0.0316	-0.1799	-0.9823**	-0.5467**
	Phe				1.00	0.032	0.1203	0.031	-0.1632	-0.7472**	-0.4978*

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Number of capsules per plant	**Gen**					**1.00**	**-0.9457****	**-0.079**	**0.5735****	**0.6839****	**0.6911****
	Phe					**1.00**	**-0.0798**	**-0.0267**	**0.2935**	**0.3343**	**0.3974**
Number of seed per capsule	**Gen**						**1.00**	**-0.3111**	**-0.9835****	**-0.5469***	**-0.9325****
	Phe						**1.00**	**-0.0862**	**-0.2947**	**-0.0814**	**-0.3117**
Test weight	**Gen**							**1.00**	**0.3711**	**0.0853**	**0.3292**
	Phe							**1.00**	**0.3209**	**0.0646**	**0.3003**
Biological yield per plant	**Gen**								**1.00**	**0.2883**	**0.921****
	Phe								**1.00**	**0.0472**	**0.8851****
Harvest index	**Gen**									**1.00**	**0.6445****
	Phe									**1.00**	**0.4988***
Seed yield per plant	**Gen**										**1.00**
	Phe										**1.00**

***Significant at 5% probability level.**

****Significant at 1% probability level.**

Table 3. Direct and indirect effect for different characters on seed yield per plant at genotypic level in linseed.

S.N.	Traits	Days to 50 % flowering	Branches per plant	Days to maturity	Plant height	Number of capsules per plant	Number of seed per capsule	Test weight	Biological yield per plant	Harvest index	Seed yield per plant
1	Days to 50 % flowering	0.004	0.0175	0.0029	0.0032	0.0016	0.0019	-0.0003	-0.0011	-0.0038	-0.568
2	Branches per plant	-0.0232	-0.0054	0.0028	-0.0187	0.0255	-0.003	-0.0279	0.0033	0.0308	-2.7216
3	Days to maturity	0.0038	-0.0028	0.0053	0.0031	-0.0033	0.0001	0.0012	0.0001	-0.0038	-0.264
4	Plant height	0.0193	0.0862	0.0142	0.0247	0.0032	0.0125	0.0008	-0.0044	-0.0265	-0.5467
5	Number of capsules/plant	0.0131	-0.1549	-0.02	0.0042	0.0326	-0.1188	-0.0026	0.0187	0.0223	0.6911
6	Number of seed per capsule	0.0145	0.0177	0.0006	0.0158	-0.114	0.0313	-0.0097	-0.0455	-0.0171	-1.5019
7	Test weight	-0.0019	0.1448	0.0065	0.0009	-0.0022	-0.0087	0.0278	0.0103	0.0024	0.3292
8	Biological yield per plant	-0.2178	-0.5129	0.0122	-0.1481	0.4723	-1.1969	0.3056	0.8234	0.2374	0.921
9	Harvest index	-0.3799	-2.3119	-0.2884	-0.4317	0.2755	-0.2203	0.0343	0.1162	0.4028	0.6445

R Square = 1.0002

Residual effect = 0.014142

Note: Diagonal = Direct path & Red Color = Correlation Value

Table 4. Direct and indirect effect for different characters on seed yield per plant at phenotypic level in linseed.

S.N.	Traits	Days to 50 % flowering	Branches per plant	Days to maturity	Plant height	Number of capsules per plant	Number of seed per capsule	Test weight	Biological yield per plant	Harvest index	Seed yield per plant
1	Days to 50 % flowering	-0.0163	-0.0047	-0.0107	-0.0124	-0.0026	-0.0018	0.0011	0.0037	0.0091	-0.4667
2	Branches per plant	0.0002	0.0009	0.0002	0.0002	0.0001	0.0002	0.0004	0.008	-0.0003	-0.1851
3	Days to maturity	-0.0018	0.008	-0.0028	-0.0015	0.0004	-0.0002	-0.0006	0.003	0.0013	-0.2153
4	Plant height	-0.0182	-0.0059	-0.0131	-0.024	-0.0008	-0.0029	-0.0007	0.0039	0.0179	-0.4978
5	Number of capsules/plant	0.001	0.0008	-0.0009	0.0002	0.0063	-0.0005	-0.0002	0.0019	0.0021	0.3974
6	Number of seed per capsule	-0.0024	-0.0062	-0.0018	-0.0026	0.0017	-0.0215	0.0019	0.0063	0.0017	-0.3117
7	Test weight	0.0001	-0.0007	-0.0004	-0.0001	0.006	0.0001	-0.0017	-0.0005	-0.0001	0.3003
8	Biological yield per plant	-0.1913	-0.0358	0.013	-0.1387	0.001	-0.2504	0.2727	0.8498	0.0401	0.8851
9	Harvest index	-0.238	-0.1335	-0.1987	-0.319	0.1427	-0.0347	0.0276	0.0202	0.4269	0.4988

R Square = 0.9938

Residual effect = 0.0787

Note: Diagonal & Bold = Direct path& Red Color = Correlation Value

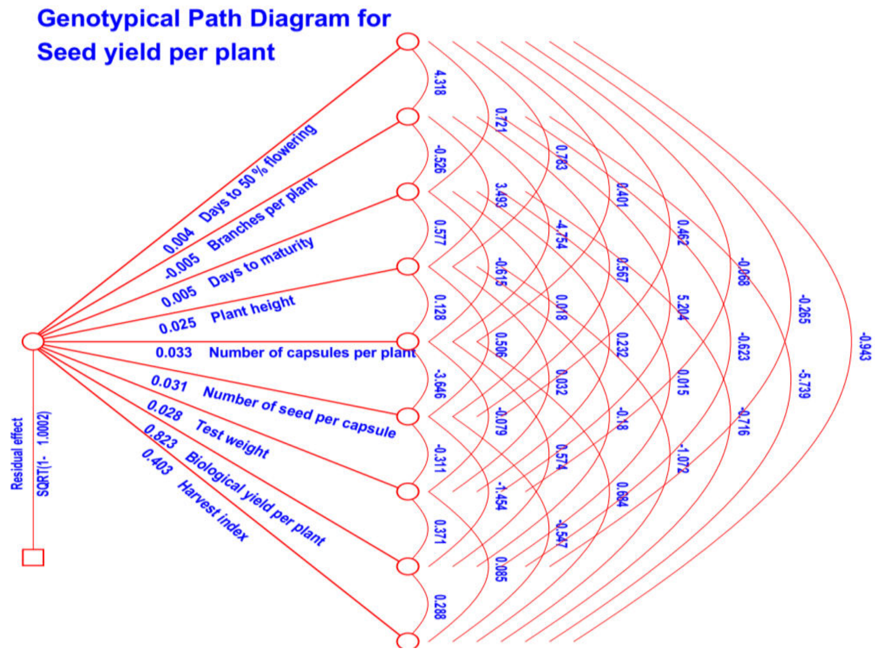

Figure 1. Genotypic path diagram

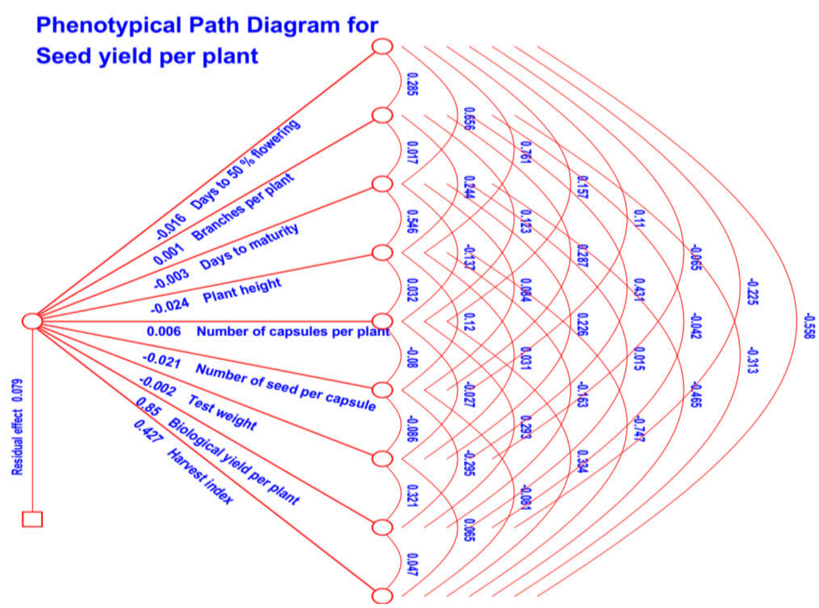

Figure 2. Phenotypic path diagram