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# CORRELATION AND PATH COEFFICIENT ANALYSIS FOR YIELD AND YIELD RELATED TRAITS IN LINSEED (*LINUM USITATISSIMUM* L.)

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**ABSTRACT**
An investigation was carried out with 160 linseed genotypes with 3 checks in augmented block design, to study correlation among the agronomically yield components and, their direct and indirect effect on seed yield. Correlation studies showed that seed yield per plant showed highly significant and positive correlation with harvest index (0.892), no. of capsules/ plant (0.799), no. of seed/ capsule (0.636), biological yield/plant (0.570), plant height (0.444). Significantly inter correlation among traits is useful for breeding programme to improvement of yield and its components. Path analysis identified harvest index (0.8520) followed by biological yield per plant (0.4652) as highly desirable components for direct effects on seed yield. Number of capsule/plant (0.5425), number of seed/ capsule (0.5343), test weight (0.5145), no. secondary branches (0.4093), plant height (0.3170), no. of primary branches (0.2412), days to maturity (0.2117) and biological yield per plant (0.1275) exerted substantial positive indirect effect on seed yield via harvest index. The inter-relationship among the characters identified above used in the breeding programme to exploit the yield potential and to develop high yielding improved varieties with ease and target oriented research.

## INTRODUCTION

Linseed belongs to genus *Linum,* largest genus of family Linaceae. It is the sole species of agricultural importance in family *Linaceae* and belongs to group of founder crops that initiated agriculture in "old world" (Zohary, 1999). Linseed is one of the important rabi oilseed crops of India, cultivated in light soil under one or two irrigation in Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Maharashtra, Rajasthan, West Bengal, Karnataka, Orissa and Bihar. In Chhattisgarh, linseed is grown mostly rainfed as "utera" as well as in crop fields whereas in overseas countries it is widely grown in cool temperate regions of Argentina,Northern Europe, China, Russia, USA and Canada (Gauraha *et al.,* 2011).This crop is grown for fibre (fibre flax), seed oil (linseed) or both seed oil as well as fibre (example dual purpose flax linseed), but recently it has gained a new interest in the emerging market of functional food due to its high content of fatty acids, alpha linolenic acid (ALA), an essential Omega-3 fatty acid and lignin oligomers which constitute about 57 % of total fatty acids in linseed (Reddy *et al.,* 2013).

For any crop improvement programme, systematic study and evaluation of germplasm is of great importance for agronomic and genetic improvement of the crop (Meena and Baha, 2013). Seed yield is a complex trait and highly influenced by many genetic and environmental factors. So, direct selection for yield as such could be misleading. A successful selection depends upon the information on the association of morpho-agronomic traits with seed yield (Kumar *et al.,* 2013). The inter-relationship between important yield components is best estimated by correlation coupled with path coefficient analysis. These techniques used in the breeding programme to exploit the yield potential for enhancing the productivity of the linseed and to develop high yielding improved varieties.

Correlation is the mutual relationship between the variables, it aids in determining the most effective procedures for selection of superior genotypes. When there is positive correlation between major yield components, breeding strategies would be very effective but on the reverse, selection becomes very difficult. (Kanwar *et al.,* 2013) reported that number of capsule per plant, number of seed per pod, biological yield and harvest index were positive and significant correlated with seed yield. The estimates of correlation coefficients alone may be often misleading due to mutual cancellation of component characters. So, study of correlation coupled with a path analysis is more effective tool in the study of yield contributing characters (Mahajan *et al.,* 2011).

Path coefficient analysis is an important technique for partitioning the correlation coefficient into direct and indirect effect of the causal components on the complex component. Ramakant *et al.* (2008) reported harvest index exerted high positive direct effects on seed yield. Pal *et al.* (2000) observed that plant height exerts substantial negative direct effect on seed yield.The adequate information on extent of variability may also be helpful to improve the yield by selectingthe yield component traits (Mehandi *et al.,* 2013).

Identification and selection of major yield components is an essential prerequisite for linseed improvement. Keeping these considerations in mind, an attempt was made to assess the

correlation among the yield components and their direct and indirect effect on seed yield.

## MATERIALS AND METHODS

The present investigation was carried out on linseed germplasm at Genetics and Plant Breeding Research Farm of N.D. University of Agriculture and Technology, Faizabad, India during winter (rabi) season of 2010-2011 under irrigated and normal soil condition. The experiment was laid in Augmented Block Design with one sixty test genotypes of linseed and three check varieties viz., T 397, *Mukta* and *Hira* were obtained from Linseed Section of Department of Genetics and Plant Breeding and Project Coordinating Unit Linseed ICAR, CSAUA and T Campus Kanpur. The entire experimental field was divided into 8 blocks of equal size and each block had 23 plots. The checks were distributed in each block. Each plot consisted of single row of 5 meter length spaced 30 cm apart with plant to plant distance of 10 cm. All the recommended cultural practices were followed to raise a good crop. Observations were recorded on 12 quantitative / qualitative traits. Days to 50% flowering, Plant height(cm), Days to maturity, Number of primary branches per plant, Number of secondary branches per plant, Number of capsule per plant, Number of seed per capsule, Biological yield per plant(g), Seed yield per plant (g), Harvest index (%), 1000-seed weight (g) and Oil Content (%). Oil Content was estimated by Oxford Analytical Newport 4000 NMR method. The correlations between yield and its contributing traits were estimated using the method described by Searle (1961) and the estimates of direct and indirect contribution of various characteristics to seed yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

## RESULTS AND DISCUSSION

The correlation coefficient provides symmetrical measurement of degree of association between characters. It determines character association for improvement of yield and other economic characters. Since the association pattern among yield contributing traits helps to select the superior genotypes from divergent population based on more than one interrelated characters. Thus, the information on correlation of seed yield with related traits is the prerequisite to form an effective selection strategy aimed at its improvement. In the present investigation, simple correlation coefficients were computed among 12 characters presented in Table 1. Seed yield per plant showed highly significant and positive association with harvest index (0.892), number of capsule per plant (0.799), number seeds per capsule (0.636), 1000-seed weight (g) (0.606), biological yield/ plant (g) (0.570), number of secondary branches /plant (0.554), plant height (0.444) and number of primary branches /plant (0.386). The available literature has also identified the above characters have important association with seed yield in linseed. The similar agreements was reported by Rama Kant *et al*. (2008); Gauraha *et al*. (2011); Savita *et.al,*(2011); and Muhammad *et al*(2014). But seed yield per plant had non significant and positive correlation with oil content (0.037) and days to 50% flowering (0.030). Number of capsule/plant showed significant and positive correlation with seed yield /

**Table 1: Estimates of simple correlation coefficients between different characters in linseed germplasm**

| Character | Days to 50% flowering | Days to maturity | Plant height (cm) | Primary branches/ plant | Secondary branches/ plant | Capsules/ plant | Seeds/ capsule | Biological yield/ plant (g) | Harvest index (%) | Test weight (g) | Oil content (%) | Seed yield/ plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering | 1.000 | 0.355** | 0.176* | 0.0310 | -0.345** | -0.052 | 0.009 | 0.068 | -0.006 | 0.093 | 0.028 | 0.030 |
| Days to maturity | | 1.000 | 0.022 | 0.037 | 0.132 | 0.225** | 0.072 | 0.055 | 0.248** | 0.166* | 0.084 | 0.238** |
| Plant height (cm) | | | 1.000 | 0.250** | 0.209** | 0.428** | 0.094 | 0.320** | 0.372** | 0.354** | 0.046 | 0.444** |
| Primary branches/ plant | | | | 1.000 | 0.419** | 0.458** | 0.118 | 0.304** | 0.283** | 0.101 | 0.039 | 0.386** |
| Secondary branches/plant | | | | | 1.000 | 0.671** | 0.215** | 0.327** | 0.480** | 0.241** | -0.079 | 0.554** |
| Number of capsules/ plant | | | | | | 1.000 | 0.330** | 0.613** | 0.636** | 0.270** | -0.042 | 0.799** |
| Number of seeds/ capsule | | | | | | | 1.000 | 0.294** | 0.627** | 0.106 | 0.042 | 0.636** |
| Biological yield/ plant (g) | | | | | | | | 1.000 | 0.149 | 0.214** | -0.036 | 0.570** |
| Harvest index (%) | | | | | | | | | 1.000 | 0.603** | 0.057 | 0.892** |
| Test weight (g) | | | | | | | | | | 1.000 | 0.039 | 0.606** |
| Oil content (%) | | | | | | | | | | | 1.000 | 0.037 |
| Seed yield/ plant (g) | | | | | | | | | | | | 1.000 |

**Table 2: Direct and indirect effects of different characters on Seed yield per plant in linseed germplasm**

| Character | Days to 50% flowering | Days to maturity | Plant height (cm) | Primary branches/ plant | Secondary branches /plant | Capsules / plant | Seeds/ capsule | Biological yield/ plant (g) | Harvest index (%) | Test weight (g) | Oil content (%) | Correlation with seed yield/ plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering | 0.0114 | 0.0010 | -0.0029 | 0.0005 | -0.0079 | 0.0018 | -0.0003 | 0.0319 | -0.0057 | 0.0002 | 0.0002 | 0.0304 |
| Days to maturity | 0.0040 | 0.0029 | -0.0004 | 0.0006 | 0.0030 | -0.0079 | -0.0022 | 0.0257 | 0.2117 | 0.0003 | 0.0006 | 0.2384 |
| Plant height (cm) | 0.0020 | 0.0001 | -0.0163 | 0.0043 | 0.0048 | -0.0151 | -0.0028 | 0.1493 | 0.3170 | 0.0006 | 0.0003 | 0.4443 |
| Primary branches/ plant | 0.0004 | 0.0001 | -0.0041 | 0.0173 | 0.0095 | -0.0161 | -0.0035 | 0.1415 | 0.2412 | 0.0002 | 0.0003 | 0.3867 |
| Secondary branches/plant | -0.0039 | 0.0004 | -0.0034 | 0.0072 | 0.0227 | -0.0236 | -0.0064 | 0.1523 | 0.4093 | 0.0004 | -0.0005 | 0.5544 |
| Capsules/ plant | -0.0006 | 0.0007 | -0.0070 | 0.0079 | 0.0153 | -0.0352 | -0.0099 | 0.2854 | 0.5425 | 0.0005 | -0.0003 | 0.7993 |
| Seeds/Capsules | 0.0001 | 0.0002 | -0.0015 | 0.0020 | 0.0049 | -0.0116 | -0.0299 | 0.1368 | 0.5343 | 0.0002 | 0.0003 | 0.6358 |
| Biological yield/ plant (g) | 0.0008 | 0.0002 | -0.0052 | 0.0053 | 0.0074 | -0.0216 | -0.0088 | 0.4652 | 0.1275 | 0.0004 | -0.0002 | 0.5708 |
| Harvest index (%) | -0.0001 | 0.0007 | -0.0061 | 0.0049 | 0.0109 | -0.0224 | -0.0187 | 0.0696 | 0.8520 | 0.0011 | 0.0004 | 0.8923 |
| Test weight (g) | 0.0011 | 0.0005 | -0.0058 | 0.0017 | 0.0055 | -0.0095 | -0.0032 | 0.0996 | 0.5145 | 0.0018 | 0.0003 | 0.6065 |
| Oil content (%) | 0.0003 | 0.0002 | -0.0008 | 0.0007 | -0.0018 | 0.0015 | -0.0012 | -0.0169 | 0.0485 | 0.0001 | 0.0068 | 0.0373 |

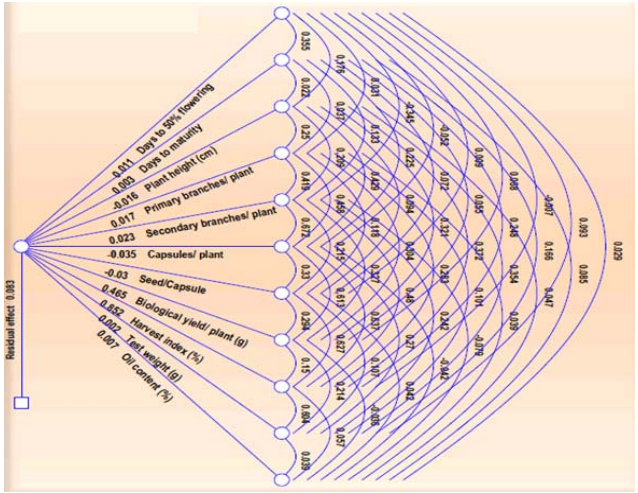


**Figure 1: Shows the direct and indirect effects of different traits on seed yield in linseed germplasm**

plant (0.799), secondary branches /plant (0.671), plant height (0.428), days to maturity (0.225).Similar result was also reported byAdugna and Labuschange(2003); Copur, *et al.*, (2006). Biological yield per plant exhibited high significant and positive correlation with seed yield/plant (0.570), number of capsule per plant (0.613), number of secondary branches /Plant (0.327), plant height (0.320), number of primary branches / Plant (0.304) and number seeds per capsule (0.294), while, this trait was positively and non significant correlated with days to maturity (0.055) and days to 50% flowering (0.068). More or less similar observations have been reported by Naik and Satapathy, (2002) and Al-Kordy *et al*. (2003). Oil content showed non significant and positive association with days to 50% flowering (0.028), days to maturity (0.084), plant height (0.046), primary branches per plant (0.039), seeds per capsule (0.042), harvest index (0.057) and test weight (0.039) while, this trait was negatively and non significantly associated with secondary branches per plant (-0.079), number capsules per plant (-0.042) and biological yield per plant (-0.036). Copur, *et al.* (2006) have also reported the similar results in linseed.

Correlation does not reflect the clear picture of contribution of each component traits. At the same time, as more variables are included in association studies, the direct association becomes complex. Under such situation, path coefficient analysis permits separation of correlation coefficients into components of direct and indirect effects. Partitioning of total correlation into direct and indirect effects provides actual information on contribution of characters and thus forms the basis for selection to improve the yield.

In the present investigation, it can be noticed from Table 2 and Fig. 1 that the highest positive direct effect on seed yield per plant exerted byharvest index (0.8520) followed by biological yield per plant (0.4652). These characters have also identified as major direct contributors of yield by Kanwar*et.al,* (2013), Rama Kant *et al*. (2008). Plant height has negative direct effect on seed yield per plant which is in agreement with previous report Pal *et al*. (2002).The very low value of direct effect recorded in case of remaining eight characters indicated that their direct contribution to seed yield per plant was too

low to be considered of any consequence. Number of capsules per plant (0.2854), number of seeds per capsule (0.1368), number of secondary branches per plant (0.1523), plant height (0.1493) and number of primary branches per plant (0.1415) also exhibits substantial positive indirect effect on seed yield via biological yield per plant. This suggests that number of capsules per plant, plant height, number of secondary branches per plant, and number of seed per capsule were the most important contributor to seed yield via biological yield. Naik and Satapathy, (2002) also identified these characters as important indirect contributors to seed yield in linseed.Indirect effects of number of primary branches per plant (0.2412), Number of capsule/plant (0.5425), number of seed/ capsule (0.5343), test weight (0.5145), no. secondary branches (0.4093), plant height (0.3170), days to maturity (0.2117) and biological yield per plant (0.1275) *via* harvest index was positive. More or less similar observations have been reported by Basavaraj *et al*. (2011).The characters identified above as important direct and indirect contributors on seed yield are helpful for consideration in formulating selection strategy in linseed for developing high yielding varieties. The remaining estimates of the indirect effects in the analysis were too low to be considered important. The estimate of residual effect (0.0834) was negligible. The acquisition of new germplasm and its evaluation is essential to select the new desirable genotypes and to use them in the breeding programme for the development of high yielding varieties.

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