CORRELATION AND PATH ANALYSIS FOR YIELD AND YIELD COMPONENTS IN LINSEED 
(LINUM USITATISSIMUM L.)

Danish Ibrar, Rafiq Ahmad*, M. Yasin Mirza**, Talat Mahmood*, Mubashir Ahmad Khan** and Muhammad Shahid Iqbal***

ABSTRACT

The present study was carried out to estimate genotypic and phenotypic correlation coefficients to create a path for the improvement in yield of linseed (Linum usitatissimum L). For this purpose nine linseed accessions (LS-1, LS-15, LS-16, LS-20, LS-27, LS-29, LS-35, LS-40, LS-48) and a check variety Chandani were tested at Department of Plant Breeding and Genetics, PMAS, Arid Agriculture University, Rawalpindi, Pakistan during 2011-12. The experiment was laid out in RCBD. Genotypic correlation estimates showed that seed yield of a plant is positively affected by primary branches, number of capsules per plant, number of seeds in each capsule, thousand seed weight and oil content while days to flower initiation, number of days to complete flowering and number of days to physiological maturity has a negative impact on seed yield of plant. Phenotypic correlation estimate results showed the similar findings except the thousand seed weight which has a significantly positive effect on seed yield. Estimates of the genotypic correlation coefficients were further used to determine the path coefficient of analysis by partitioning the correlation into indirect and direct effects. Path coefficient analysis depicted that the number of capsules per plant (0.432), oil content (0.194 %), number of primary branches of each plant (0.196), thousand seed weight (0.100 g) and number of seeds in each capsule (0.116) had a direct influence on seed yield in positive direction. This predicted that while designing a breeding strategy for the improvement of linseed a trait should be kept in mind to enhance seed yield in linseed. Therefore focusing on these traits, would improve breeding efficiency of linseed in the future breeding programs.

KEYWORDS: Linum usitatissimum; linseed; agronomic characters; genotypic correlation; phenotypic correlation; agronomic characters; path analysis; Pakistan.
INTRODUCTION

Linseed (*Linum usitatissimum* L.) or flax seed belongs to family *Linaceae*. It is the only economically important specie of the family. Its suitability for cultivation is because of its non-dehiscent and semi-dehiscent types of capsules (6). The exact origin of linseed is unknown, but greatest genetic diversity, suggests its origin from Indian sub-continent (5). Cross-pollination has been found only 2 percent, so it is self pollinated crop (14). The main economic product of linseed i.e oil is non-edible, drying in nature due to saturated fatty acids that include: palmitic acid (about 7%), acid (3.4 - 4.6%) unsaturated fatty acids like oleic acid (18.5-22.6%), linoleic acid (14.2-17%) and the omega-3 fatty acid α-linolenic acid 51.9-55.2 percent (10).

The effectiveness of various characters that influence seed yield is the outcome of a complex relationship among several plant traits. All yield and quality related traits of plant interact with each other associated either directly or indirectly. It is vital for a plant breeder perspective to know the correlation of various plant traits their direct and indirect input towards seed yield to devise a more comprehensive and precise breeding procedure (1, 2, 7). Present study was carried out to analyze the relationship of yield with its causative factors and investigate the direct and indirect effects of morphologically independent characters on yield.

MATERIALS AND METHODS

The present study was conducted at Department of Plant Breeding and Genetics PMAS Arid Agriculture University, Rawalpindi, Pakistan during 2011-12 on nine different linseed accessions (LS-1, LS-15, LS-16, LS-20, LS-27, LS-29, LS-35, LS-40, LS-48) with one check variety Chandani. Data were recorded for ten parameters including days to flower initiation, days to flower completion, days to maturity, plant height (cm), number of primary branches per plant, number of capsules per plant, number of seeds per capsule, 1000 seeds weight (g), seed yield (g) and oil content (%). The data collected were used to work out the genotypic and phenotypic correlation coefficients. Genotypic correlation estimates were then utilized to compute the direct and indirect effects on yield. Correlation estimates at both genotypic and phenotypic level were calculated by using the formula given by Miller *et al.* (9)

\[
rg = \frac{COV_{gxy}}{(b^2_g x b^2_y)^{1/2}}
\]

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Where,

\[ r_g = \text{Genetic correlation coefficient} \]
\[ \text{COV}_{gx} = \text{Genotypic covariance of } x \text{ and } y \]
\[ \sigma^2_{gx} = \text{Genotypic variance of } x \]
\[ \sigma^2_{gy} = \text{Genotypic variance of } y \]

\[ rp = \frac{\text{COV}_{pxy}}{(\sigma^2_{px} \times \sigma^2_{py})^{1/2}} \]

Where,

\[ rp = \text{Phenotypic correlation coefficient} \]
\[ \text{COV}_{pxy} = \text{Phenotypic covariance of } x \text{ and } y \]
\[ \sigma^2_{px} = \text{Phenotypic variance of } x \]
\[ \sigma^2_{py} = \text{Phenotypic variance of } y \]

Path coefficient of analysis was carried out to determine the direct and indirect effects of all the traits under study by the formula suggested by Dewey and Lu (3).

\[ \text{Path analysis} = r_{ij} = p_{ij} + \sum r_{ik}p_k \]

Where

\[ r_{ij} = \text{mutual relationship of independent variable (i) and dependent variable (j)} \]
\[ p_{ij} = \text{components of direct effects of independent variable (i) on the dependent variable (j) as measured by the path coefficients} \]
\[ \sum r_{ik}p_k = \text{summation for components of indirect effects of a given independent character (i) on a given dependent character (j) through all other independent characters (k).} \]

RESULTS AND DISCUSSION

Correlation coefficient estimates

Results (Table 1 & 2) showed that the traits like number of primary branches per plant (PBr\(^{-1}\)), number of capsules per plant (CP\(^{-1}\)), number of seeds per capsule (SC\(^{-1}\)), 1000 seed weight (TSW) and oil content (OC) had a strong positive relationship with seed yield per plot at both genotypic and phenotypic levels. Although the genotypic correlation coefficient estimates were greater in magnitude than the corresponding phenotypic correlation coefficient

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estimates yet both the phenotypic and genotypic correlations were in the same direction. This low magnitude of phenotypic correlation may be due to the modifying and masking effect of environment on the phenotype of plants. Similar results were also recorded by Gauraha and Rao (4), Sohan et al. (13) and Joshi (4, 8, 13).

Table 1. Genotypic (upper) and phenotypic (lower) correlation estimates among seed yield and various agronomic traits in linseed.

<table>
<thead>
<tr>
<th></th>
<th>DFI</th>
<th>DFC</th>
<th>DM</th>
<th>PH</th>
<th>PBr -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFI</td>
<td>0.283</td>
<td>0.046</td>
<td>0.630*</td>
<td>0.502</td>
<td>0.087</td>
</tr>
<tr>
<td>DFC</td>
<td>0.058</td>
<td>0.597</td>
<td>0.920**</td>
<td>0.650*</td>
<td>0.207</td>
</tr>
<tr>
<td>DM</td>
<td>0.473</td>
<td>0.864**</td>
<td>0.614</td>
<td>0.190</td>
<td></td>
</tr>
<tr>
<td>PH</td>
<td>0.090</td>
<td>0.193</td>
<td>0.262</td>
<td>-0.015</td>
<td></td>
</tr>
<tr>
<td>PBr -1</td>
<td>-0.098</td>
<td>-0.483</td>
<td>0.009</td>
<td>0.456</td>
<td></td>
</tr>
<tr>
<td>CP -1</td>
<td>-0.374</td>
<td>-0.034</td>
<td>0.296</td>
<td>-0.099</td>
<td></td>
</tr>
<tr>
<td>SC -1</td>
<td>-0.055</td>
<td>-0.227</td>
<td>0.162</td>
<td>-0.010</td>
<td></td>
</tr>
<tr>
<td>TSW</td>
<td>0.551</td>
<td>-0.541</td>
<td>-0.141</td>
<td>-0.506</td>
<td></td>
</tr>
<tr>
<td>OC</td>
<td>-0.025</td>
<td>-0.123</td>
<td>-0.143</td>
<td>-0.243</td>
<td></td>
</tr>
<tr>
<td>SY</td>
<td>-0.093</td>
<td>-0.471</td>
<td>-0.052</td>
<td>-0.700***</td>
<td>-0.045</td>
</tr>
<tr>
<td>CP -1</td>
<td>-0.519</td>
<td>-0.031</td>
<td>-0.275</td>
<td>-0.614</td>
<td></td>
</tr>
<tr>
<td>SC -1</td>
<td>0.099</td>
<td>0.307</td>
<td>0.139</td>
<td>-0.243</td>
<td></td>
</tr>
<tr>
<td>TSW</td>
<td>-0.470</td>
<td>-0.130</td>
<td>-0.102</td>
<td>-0.702</td>
<td></td>
</tr>
<tr>
<td>OC</td>
<td>0.525</td>
<td>0.212</td>
<td>-0.617</td>
<td>-0.570</td>
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</tr>
<tr>
<td>SY</td>
<td>0.089</td>
<td>-0.266</td>
<td>0.448</td>
<td>0.570</td>
<td></td>
</tr>
<tr>
<td>SC -1</td>
<td>0.072</td>
<td>-0.019</td>
<td>0.171</td>
<td>0.207</td>
<td></td>
</tr>
<tr>
<td>TSW</td>
<td>-0.265</td>
<td>-0.038</td>
<td>0.089</td>
<td>0.337</td>
<td></td>
</tr>
<tr>
<td>OC</td>
<td>0.387</td>
<td>0.133</td>
<td>0.130</td>
<td>0.353</td>
<td></td>
</tr>
<tr>
<td>SY</td>
<td>0.549</td>
<td>0.180</td>
<td>0.854*</td>
<td>0.261</td>
<td></td>
</tr>
</tbody>
</table>

DFI = Days to flower initiation, DFC = Days to flower completion, DM = Days to maturity, PH = Plant height, PBr -1 = Number of primary branches per plant, CP -1 = Number of capsule per plant, SC -1 = Number of seeds per capsule, TSW = 1000 seed weight, OC = Oil content and SY = Seed yield. *Significant ** highly significant at 1% and 5% probability levels respectively.

It is inferred from these results that selection strategy based on the number of primary branches per plant, number of capsules per plant, number of seeds per capsule, 1000-seed weight and oil content could provide a better solution for the improvement of seed yield and oil contents in linseed. Whereas, days to flower initiation, days to flower completion and plant height would also be kept in mind while designing a breeding program. Results reported by Pal et al. Tadesse et al. Nagaraja et al. and Yadav (11, 12, 14, 15) were also in partial agreement with the present study.

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Path analysis

The data (Table 2) represent the direct and indirect effects of different component traits towards seed yield for each plot. Process of path analysis was adopted to work out relationship among various characters and seed yield and partitioning the genotypic correlation coefficient into direct and indirect effects through alternating pathways. This form of examination helps in identifying key component characters helpful for indirect improvement of complex traits like yield.

Table 2. Estimates of path coefficient analysis based on genotypic correlation.

| Traits | DFI  | DFC  | DM   | PH  | PBr* 
|--------|------|------|------|-----|------
| DFI    | -0.03086 | -0.01312 | 0    | -0.0006 | 0.0002 
| DFC    | -0.0339 | -0.0894 | -0.0004 | -0.0037 | 0.0004 
| D.M    | -0.0001 | -0.002625 | -0.091495 | 0.003075 | 0.0004 
| P.H    | -0.04352 | -0.0462425 | -0.0425425 | -0.1321725 | 0.0 
| PBr    | -0.0001 | -0.0008 | -0.0001 | 0.035215 | 0.196265* 
| CP*    | 0.0457425 | 0.0479425 | 0.0 | 0.0435425 | 0.001 
| SC*    | 0.01736 | 0.0001 | -0.0002 | 0.01616 | 0.05832 
| TSW    | 0.0001 | 0.001075 | -0.0001 | -0.0005 | -0.0012 
| O.C    | 0.055145 | 0.056945 | 0.054345 | -0.0031 | -0.0001 

DFI = Days to flower initiation, DFC = Days to flower completion, DM = Days to maturity, PH = Plant height, PBr* = Number of primary branches per plant, CP* = Number of capsule per plant, SC* = Number of seeds per capsule, TSW = 1000 seed weight, OC = Oil content and SY = Seed yield. *Significant ** highly significant at 1% and 5% probability levels respectively.

Number of capsules per plant (0.432), oil contents (0.194%) and number of primary branches per plant (0.196) showed a high positive direct effect towards seed yield per plot, while number of seeds per capsule (0.116) and 1000 seed weight (0.100) showed a low positive direct effect on the seed yield per plot. Days to flower initiation (-0.030), days to flower completion (-0.089), days to maturity (-0.091) and plant height (-0.1321725) had a moderate negative direct effect on seed yield per plot.

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negative direct effect on the seed yield per plot. Results of the path coefficient estimates suggest that number of capsules per plant is a major yield contributing factor and importance should be given to this trait for improvement in linseed while designing new breeding programs. Similar results were also reported by Gauraha and Rao and Pal et al. (4, 12).

CONCLUSION

It is concluded from the results of this experiment that the number of primary branches per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight and oil contents are the important selection parameters to improve linseed yield. All the above traits are correlated positively with seed yield at both genotypic as well as phenotypic level. Whereas path analysis also suggested that these parameters had the positive direct effect on the seed yield as their correlation values were also in the positive direction.

REFERENCES


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CONTRIBUTION OF AUTHORS

Danish Ibrar, : Conducted experiment, statistical analysis and prepared writeup.
Rafiq Ahmad : Helped in data collection.
M. Yasin Mirza : Supervised the experiment and field work.
Talat Mahmood : Planned the research and reviewed the literature and was involved in the laboratory work.
Mubashir Ahmad Khan : Assisted in the lab work.
Muhammad Shahid Iqbal : Reviewed the literature.