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CORRELATION AND PATH COEFFICIENT ANALYSIS OF ECONOMICALLY IMPORTANT TRAITS IN LENTIL (*LENS CULINARIS* MEDIK.) GERMPLASM

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ABSTRACT
An investigation was carried out with 80 lentil genotypes with 3 checks in augmented block design, to study correlation among the agronomical 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 (0.945), number of pods per plant (0.876), plant height (0.730), number of secondary branches per plant (0.576) and biological yield per plant (0.4930). Significantly inter correlation among traits is useful for breeding programme to improvement of yield and its components. Path analysis identified biological yield per plant (0.638) followed by number of pods per plant (0.286) and harvest index (0.198) as highly desirable components for direct effects on seed yield. 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

Pulses are the principal source of protein in diet and are an integral part of daily diet because of their high protein content and good amino acid balance in several forms worldwide (Kumar *et al.*, 2013). Lentil is bushy annual autogamous diploid (2x = 2n = 14) legume crop belonging to Fabaceae family, generally grown for its lens shaped seed as rainfed crop during rabi season. Approximately, a third of the worldwide lentil production is from India, most of which is consumed in the domestic markets. In India, lentil occupied 1.59 million hectare area with 0.94 million tones production and productivity of 591 kg/ha in 2011 (Anonymous, 2012). It is a rich source of protein in diet ranges from 22% to 34.6% (Callaway, 2004). Although lentil has been cultivated as early as 8000 BC, but it remained an under-exploited crop, compared to other early domesticated crops.

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 lentil 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. Tyagi and Khan (2010) reported that number of pods per plant, 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. Sarwar *et al.* (2010) reported that number of pods per plant and harvest index exerted high positive direct effects on seed yield. Azizi *et al.* (2009) observed that positive indirect effects on seed yield exerted by number of pods per plant and 100-seed weight. Hence, these traits could be used in breeding for seed yield in lentil. The adequate information on extent of variability may also be helpful to improve the yield by selecting the yield component traits (Mehandi *et al.,* 2013).

Identification and selection of major yield components is an essential prerequisite for lentil 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 lentil germplasm at Genetics and Plant Breeding Research Farm of N.D. University of Agriculture and Technology, Faizabad, India during winter (*rabi*) season of 2011-2012 under irrigated and normal soil condition. The experiment was laid in Augmented Block Design with eighty test genotypes of lentil and three check varieties viz., NDL1, NDL2 and DPL62. These genotypes exhibited wide spectrum of variation for various agronomical and morphological characters. The entire experimental field was divided into 8 blocks of equal size and each block had 13 plots. Out of 13 plots in a block, 10 plots were used for accommodating the test genotypes which were not replicated while remaining 3 were allocated to checks i.e. NDL1, NDL2, DPL62. The three checks were randomly allocated along with the test genotypes in a block. Each plot was consisted of single row of 4 m length, following inter and intra row spacing of 30 cm and 15 cm, respectively. The data were recorded from 5 randomly selected competitive plants from each plot on 11 distinct morphological characters. The data on days to 50% flowering, days to maturity plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight, seed yield per plant, biological yield per plant and harvest index were recorded for statistical analysis.

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 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 11 characters presented in Figure 1 and Table 1. Seed yield per plant showed highly significant

Table 1: Simple correlation coefficients between different characters in lentil germplasm

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches per plant	No. of pods per plant	No. of seeds per plant	Biological yield per plant (g)	Harvest index (%)	100-seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	1.00	0.412 **	0.195	0.198	0.389 **	0.145	0.175	-0.263*	0.199	-0.437	0.066
Days to maturity		1.00	0.507 **	0.027	0.377 **	0.476 **	-0.118	0.212	0.539 **	-0.182	0.465 **
Plant height (cm)			1.00	-0.069	0.489 **	0.637 **	0.019	0.394 **	0.766 **	-0.087	0.729 **
Number of primary branches per plant				1.00	0.315 **	0.046	0.113	-0.274*	0.006	-0.040	-0.041
Number of secondary branches per plant					1.00	0.658 **	0.199	-0.069	0.634 **	-0.103	0.576 **
Number of pods per plant						1.00	0.026	0.151	0.847 **	0.115	0.876 **
Number of seeds per pod							1.00	-0.399**	0.066	-0.073	0.062
Biological yield per plant (g)								1.00	0.392 **	0.370	0.493 **
Harvest index (%)									1.00	-0.037	0.945**
100-seed weight (g)										1.00	0.253*
Seed yield per plant (g)											1.00

* Significant at 5 % probability level, ** Significant at 1 %probability level.

Table 2: Direct and indirect effects of different characters on seed yield in lentil germplasm

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches/ per plant	Number of pods per plant	Number of seeds per plant	100 Seed Weight (g)	Biological Yield per plant (g)	Harvest Index (%)	Seed Yield per plant (g)
Days to 50% flowering	**0.0198**	-0.0072	0.0041	-0.0032	-0.0038	0.0414	0.0154	-0.0412	0.1276	-0.0864	0.0664
Days to maturity	0.0081	**-0.0174**	0.0106	-0.0004	-0.0037	0.1363	-0.0103	0.0333	0.3445	-0.0361	0.4648
Plant height (cm)	0.0039	-0.0088	**0.0208**	0.0011	-0.0048	0.1823	0.0017	0.0617	0.4889	-0.0171	0.7296
Number of primary branches plant^{1}	0.0039	-0.0005	-0.0014	**-0.0160**	-0.0031	0.0131	0.0099	-0.0429	0.0038	-0.0080	-0.0411
Number of secondary branches per plant	0.0077	-0.0066	0.0102	-0.0050	**-0.0098**	0.1883	0.0175	-0.0109	0.4046	-0.0203	0.5756
Number of pods per plant	0.0029	-0.0083	0.0133	-0.0007	-0.0064	**0.2860**	0.0023	0.0236	0.5407	0.0227	0.8759
Number of seeds per plant	0.0035	0.0021	0.0004	-0.0018	-0.0020	0.0076	**0.0876**	-0.0627	0.0419	-0.0145	0.0622
100 Seed weight (g)	-0.0052	-0.0037	0.0082	0.0044	0.0007	0.0431	-0.0350	**0.1567**	0.2505	0.0732	0.4929
Biological yield per plant (g)	0.0039	-0.0094	0.0159	-0.0001	-0.0062	0.2422	0.0058	0.0615	**0.6384**	-0.0073	0.9448
Harvest index (%)	-0.0086	0.0032	-0.0018	0.0006	0.0010	0.0328	-0.0064	0.0580	-0.0235	**0.1977**	0.2529

Residual factor = 0.101, Bold figures indicate the direct effect

and positive association with harvest index (0.945), number of pods per plant (0.876), plant height (0.730), number of secondary branches per plant (0.576) and biological yield per plant (0.4930). This finding was in agreement with Naresh *et al.* (2009), Tyagi and Khan (2010) and Kayan *et al.* (2012). Number of pods per plant showed highly significant and positive correlation with seed yield per plant (0.876), harvest index (0.847), secondary branches per plant (0.658) and plant height (0.637). Simillar result was also reported by Singh et al. (2009). Biological yield per plant showed highly significant positive correlation with seed yield per plant (0.493), plant height (0.394) and harvest index (0.392). Simillar result was also reported by Sirohi *et al.* (2007). Harvest index showed highly significant and positive association with seed yield per plant (0.945), pods per plant (0.847), plant height (0.766), secondary branches per plant (0.634) and days to maturity (0.540) and biological yield per plant (0.392). Similar result was reported by Singh *et al.* (2009). Days to 50% flowering showed highly significant and positive association with days to maturity (0.412) and secondary branches per plant (0.390) while it was significantly and negatively associated with biological yield per plant (-0.263). This finding is in conformity with Hamdi *et al.* (2003). Days to maturity exhibited highly significant and positive correlation with harvest index (0.539), plant height (0.507). Plant height showed highly significant and positive association with harvest index (0.766), seed yield/plant (0.730), pods per plant (0.637), days to maturity (0.507). This finding was also reported by Mahajan *et al.* (2006). Number of primary branches per plant showed highly significant and positive correlation with secondary branches per plant (0.315). Number of secondary branches per plant expressed highly significant positive correlation with pods per plant (0.658), harvest index (0.634), seed yield per plant (0.576), plant height (0.49). This finding is in conformity with Rathi (2004). 100-seed weight showed significant and positive association with seed yield per plant (0.253). Simillar result was also reported by Barghi *et al.* (2012).

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. 2 that the highest positive direct effect on seed yield per plant exerted by biological yield per plant (0.638) followed by number of pods per plant (0.286) and harvest index (0.198). It means a slight increase in any one of the above traits may directly contribute towards seed yield. Similar results have also been reported by Naresh *et al.* (2009) and Sarwar *et al.* (2010).

Highly positive indirect effects on seed yield per plant exerted by number of pods per plant (0.541), plant height (0.489), secondary branches per plant (0.405), days to maturity (0.344) and 100-seed weight (0.250) via biological yield per plant. This suggests that number of pods per plant, plant height, secondary branches per plant, days to maturity and 100-seed weight were the most important indirect contributors to seed yield per plant via biological yield per plant. Azizi et al. (2009) observed that number of pods per plant and 100-seed weight as important indirect contributors towards expression of seed yield in lentil. The characters identified above as important direct and indirect contributors on seed yield are

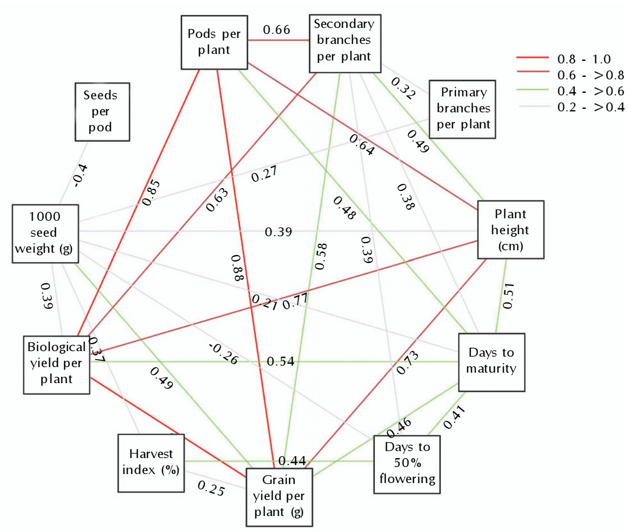

Figure 1: Shows the correlation among yield contributing traits in lentil germplasm

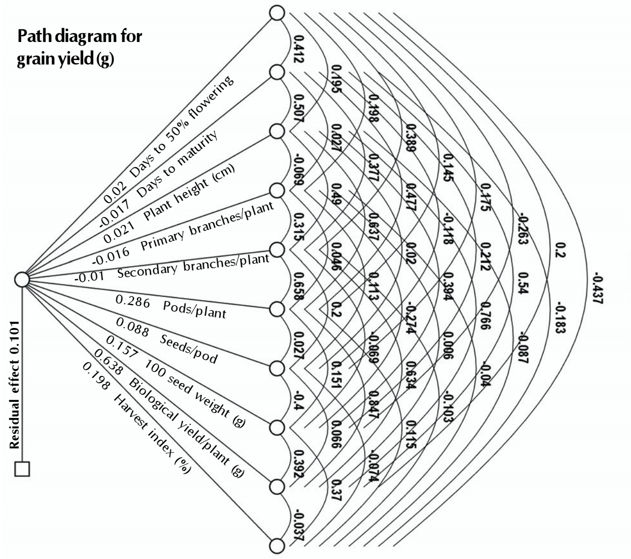

Figure 2: Shows the direct and indirect effects of different traits on seed yield in lentil germplasm

helpful for consideration in formulating selection strategy in lentil 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 (0.101) 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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