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Correlation and Path Coefficient Analysis for Yield Attributes in Lentil (*Lence culinaris* L.)

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Abstract: ***An investigation was carried out at Genetics and Plant Breeding Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during rabi, 2011-12 on 96 genotypes with 4 checks varieties in augmented block design to study correlation and path coefficient analysis for yield attributes in lentil (Lence culinaris L.) on 11 quantitative characters. Results revealed that the seed yield per plant showed highly significant and positive correlation with plant height (0.541**), days to maturity (0.257**), secondary branches per plant (0.552**), pods per plant (0.506**), 100 seed weight (0.530**), biological yield (0.330**), harvest index (0.488**), and positively significant correlated with primary branches per plant (0.197*) and negative correlation with number of seeds pod^{-1}(-0.123). Significantly inter correlation among traits are useful in breeding programme for improvement of yield and its component traits. The highest positive direct effects on seed yield per plant was exerted by harvest index (0. 807) followed by biological yield per plant (0.757), number of secondary branches (0.183) and 100 seed weight (0.107).The inter-relationship among the characters identified above may be utilized in the breeding programme to exploit the yield potential and to develop high yielding varieties with ease and target oriented research.***

Keywords: Lentil; Lence culinaris L.; Correlation; Path analysis.

1. Introduction

The pulse is an annual leguminous crop, which cantain one to twelve seeds per pod of variable size, shape and color within a pod. Pulses are used for food for humans and other animals. Pulses are very important sources of protein in Indian diets, as majority of population are vegetarian. Pulses are the third most important group of crops after cereals. Pulses includes; chickpea, dry beans like pinto beans, kidney beans and navy beans, dry peas; and others among which lentil is a most important food legume. Lentil is eaten as *Dhal*, either whole or split. Lentil seeds protein ranged from 22.0 to 34.6 per cent and 100 g dried seeds contain 340-346 kcal, 20.2 g protein, 0.6g fat, 65.0 g total carbohydrates, about 4g fiber, 2.1 g ash, 68 mg Ca, 325 mg P, 7 mg Fe, 29 mg Na, 780 mg K, 0.46 mg thiamine, 0.33 g riboflavin and 1.3 mg niacin (Muehlbauer *et al.*, 1985 and Adsule, *et al.* 1989). It also contains some antinutritional factors such as trypsin inhibitors, hemagglutinnins and oligasaccharides that cause flatulence. It also adds 32.8 kg/ha nitrogen as well as 5.6 t/ha organic matter to the soil. Lentil belongs to tribe- Vicieae, order- Rosales, suborder- Rosneae, family- Fabaceae (Leguminoceae) sub family- Papilonaceae, genus *Lens* and species *culinaris* with chromosome number 2n =14. Its probable progenitor is *Lens orientalis* with Mediterranean region as the centre of genetic diversity (Zohari, 1973; Ladizinsky, 1979). Lentil has been classified under two groups *viz.*, *Macrosperma* (bold seeded, average 5.4g/100 seeds) and *Microsperma* (small seeded, average 1.8/100 seeds) on the basis of seed size and cotyledons colour. Cotyledons colour of *Macrosperma* are yellow, while *Microsperma* cotyledons colour are light red. India's rank 2nd in the world in respect of production as well as acreages followed by Turkey. In India, it is grown in about 1.48 m ha with total production of 1.03 mt, and productivity 697 Kg/ha. Uttar Pradesh occupies 0.59 m ha area with 0.48 tonnes production and productivity 803 kg/ha. (Anonymous,2012). Yield is the major complicated traits that is an outcome of interaction of plant characters and is highly influenced by environmental changes. The direct selection of plants on the basis of seed yield may be misleading. Therefore, characters association and path analysis must be studied to understand the contribution of genotype and environment towards the final yield before selection of plants.

2. Materials and Methods

The experimental material was comprised of 96 diverse lentil germplasms and four check varieties *viz*., NDL 1, NDL 2, Precoze ,and DPL 62.These genotypes exhibited wide spectrum of variation for various agronomical and morphological characters, which were obtained from Indian Institute of Pulses Research (IIPR), Kanpur and Pulse Section Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad. The checks used in experiment are well adopted varieties of the region. Data were recorded on five randomly selected plants for days to 50 per cent flowering, days to maturity, primary branches per plant, secondary branches per plant, plant height (cm), pods per plant, seeds per pod, biological yield per plant (g), seed yield per plant (g), harvest index (%) and 100-seed weight (g). Data on eleven quantitative traits of lentil genotypes were subjected to statistical analysis fallowing Panse and Sukhatme (1978), correlation coefficients worked out as per Johanson *et.al.*(1955) and path analysis suggested by Dewey and Lu (1959) were used to partition the correlation coefficient in to direct and indirect effects.

3. Results and Discussion

The progresses in plant breeding depends upon effective selection scheme based on the correlated and non-correlated response. The seed yield or economic yield in almost all the crops is referred as super character which results from the multiplicative interactions of several other characters which are termed as yield components. Thus, genetic architecture of seed yield in lentil as well as other crops is based on balanced or overall net effect produced by various yield components directly with one another. Therefore, identification of important yield components and information about their association with yield and also with each other is very useful for selecting efficient genotypes for evolving high yielding varieties. In this respect, the correlation coefficient which provides symmetrical measurement of degree of association between two variables or characters, help us in understanding the nature and magnitude of association among yield and yield The phenotypic correlation coefficients are presented in **Table(1).** The attributes revealed that seed yield per plant showed highly significant and positive correlation with plant height, days to maturity, primary branches per plant, secondary branches per plant, pods per plant, 100-seed weight, biological yield and harvest index. Thus, these characters emerged as most important associates for seed yield per plant in lentil. The available literature has also identified the above characters as important associates of seed yield in lentil (Naresh *et al.*, 2009 and Tyagi and Khan, 2010). Biological yield per plant showed highly significant and positive correlation with seed yield per plant , number of pods per plant , number of seeds per pod , number of secondary branches per plant and 100-seed weight while significant negative association with harvest index , days to 50% flowering, plant height and number of primary branches per plant. Harvest index showed highly significant and positive association with plant height, secondary branches per plant, pods per plant and 100-seed weight while negative but significant correlation was recorded for harvest index with biological yield per plant. Occurrence of positive association at significant level of seed yield with most of its component traits and positive association between most of the yield components revealed less complex inter relationship between yield and yield components. Such situation is favorable from breeding point of view because selection for one trait may bring correlated response for improvement of other traits which are positively associated with it. These findings are broadly in agreement with some of the earlier reports (Karadavut *et al.*, 2009 and Tyagi and Khan, 2010). Path coefficient analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of independent variables (yield) on the dependent (component) variable to provide clearer picture of character associations for formulating efficient selection strategy. The concept of path-coefficient analysis was developed by Wright (1921) and this technique was first used for plant selection by Dewey and Lu (1959). Path analysis differs from simple correlation which points out the causes and their relative importance, whereas, the later measures simply the mutual association ignoring the causation. Path analysis has emerged as a powerful and widely used technique for understanding the direct and indirect contribution of contributing traits. In this study, the path coefficient analysis was carried out using simple correlation coefficients among 11 characters. (**Table 2**). Highest positive direct effects on seed yield per plant exerted by harvest index followed by biological yield per plant, number of secondary branches and 100-seed weight. However, other characters contributing substantially positive direct effect on seed yield were days to maturity , number of seeds per pod , number of pods per plant and number of primary branches per plant. Days to 50% flowering and plant height were substantial in negative direct effects on seed yield per plant. These characters have also been identified as major direct contributors towards seed yield in lentil. These results are similar to earlier workers (Karadavut, 2009 and Naresh *et al.*, 2009). Highly positive indirect effects on seed yield per plant was exerted by plant height (0.3561), secondary branches per plant (0.294), number of pods per plant (0.2160) and days to flowering (0.155) via biological yield per plant. However, days to 50% flowering (-0.0624) via biological yield, primary branches per plant (-0.05) and plant height (-0.012), showed highly negative indirect effects on seed yield per plant. The remaining estimates of the indirect effects in the analysis were too low to be considered important. The estimate of residual effect (0.1672) was negligible which reflects that majority of the yield contributing traits have been included in the study. Similar findings have been reported by Karadavut, 2009. In this study, path analysis identified biological yield per plant, harvest index, 100-seed weight, number of pods per plant and number of secondary branches per plant as the most important direct contributors to seed yield. While, number of pods per plant, number of secondary branches per plant, number of primary branches per plant, harvest index and 100-seed weight, via biological yield per plant; number of pods per plant, number of secondary branches per plant, 100-seed weight, biological yield per plant and number of primary branches per plant via harvest index were the most important indirect contributors to seed yield per plant. The characters mentioned above should be given due consideration at the time of formulating selection strategy in lentil (Tyagi and Khan, 2010).

Table 1: Correlation coefficients between different characters in lentil

Characters	Days to 50% flowering	Days to maturity	Primary branches/ plant	Secondary branches/ plant	Plant height (cm)	Pods/ plant	Seeds/ pod	Biological yield/ plant (g)	Harvest index (%)	100 -seed weight (g)	Seed yield/ plant (g)
Days to 50% flowering	**1.000**	0.045	0.103	0.043	0.110	-0.0008	-0.204*	0.177	-0.082	0.192	0.072
Days to maturity		**1.000**	0.564**	0.244*	0.776**	0.506**	-0.293**	0.331**	-0.016	0.441**	0.541**

Primary branches/ plant			**1.000**	-0.204*	0.388**	0.294**	-0.340**	0.203*	0.016	0.141	0.257**
Secondary branches/ plant				**1.000**	0.548**	0.019	0.022	0.150	-0.062	0.175	0.197*
Plant height (cm)					**1.000**	0.389**	-0.203*	0.306**	0.041	0.364**	0.552**
Pods/ plant						**1.000**	-0.467**	0.410**	0.192	0.267**	0.506**
Seeds/ pod							**1.000**	-0.338**	0.054	-0.138	-0.123
Biological yield/ plant (g)								**1.000**	0.035	0.422**	0.530**
Harvest index (%)									**1.000**	-0.562**	0.330**
100- seed weight (g)										**1.000**	0.488**
Seed yield/ plant (g)											**1.000**

*,** Significant at 5 % and 1% probability levels, respectively.

Table 2: Direct and indirect effects of ten characters on seed yield per plant in lentil

Characters	*Days to 50% flowering*	*Days to maturity*	*Primary branches per plant*	*Secondary branches per plant*	*Plant height (cm)*	*Pods per plant*	*Seeds per pod*	*Biological yield per plant (g)*	*Harvest index (%)*	*100-seed weight (g)*	*Correlation coefficients with seed yield per plant*
Days to 50% flowering	**-0.0565**	-0.0061	0.0009	0.0002	0.0203	0.0000	-0.0088	-0.0624	0.1551	0.0191	0.0722
Days to maturity	-0.0058	**0.0588**	-0.0115	-0.0009	0.0710	0.0123	-0.0146	0.0123	0.1140	0.0220	0.2576**
Primary branches per plant	-0.0026	0.00332	**-0.0204**	-0.0010	-0.1420	-0.0212	-0.0125	-0.0121	0.3561	0.0357	0.5416**
Secondary branches per plant	-00024	-0.0120	-0.0050	**0.0040**	0.1003	0.0008	-0.0010	-0.0474	0.1414	0.0162	0.1970*
Plant height (cm)	-0.0063	0.0228	-0.0158	0.0023	**0.1830**	0.0164	-0.0087	0.0317	0.2939	0.0330	0.5523**
Pods per plant	0.0000	0.0173	-0.0103	0.0001	0.0713	**0.0420**	-0.0200	0.1459	0.2160	0.0442	0.5067**
Seeds per pod	0.0116	-0.0200	0.0060	0.0001	-0.0371	-0.0196	**0.0428**	0.0409	-0.0115	-0.0364	-0.1233
Biological yield per plant (g)	0.0047	0.0010	0.0003	-0.0003	0.0077	0.0081	0.0023	**0.7572**	-0.4540	0.0039	0..3308**
Harvest index (%)	-0.0109	0.0083	-0.0090	0.0007	0.0666	0.0112	-0.0059	-0.4258	**0.8072**	0.0455	0.4881**
100-seed weight (g)	-0.0100	0.0120	0.0067	0.0006	0.0560	0.0172	-0.0145	0.0271	0.3410	**0.1077**	0.5307**

Residual effects = 0.1672; **Bold figures indicate the direct effects;** *,** Significant at 5 % and 1% probability levels, respectively.

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