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Studies on Correlation and Path Coefficient for Yield and its Component Traits in Lentil (*Lens Culinaris* Medikus)

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Abstract

The field experiment under present investigation was conducted at Agriculture Research Farm of B.R.D. Post Graduate College (Campus), Deoria (U.P.) during *rabi* 2018-19 in normal soil, timely sown and irrigated conditions. Total 25 genotypes including five checks were evaluated under Randomized Block Design. The data were recorded for the twelve metric characters *viz*., days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant (g), 100-seed weight (g), biological yields (g), number of seeds per plant and harvest index (%). Analysis of correlation coefficients revealed that generally the amount of genetic correlation coefficients were very close to phenotypic correlation coefficient in most cases, suggesting the existence of inherent associations among the traits studied. At phenotypic level seed yield per plant showed highly significant and positive association with harvest index (0.597), 100-seed weight (0.451), but significant and negative correlation with days to maturity (-0.377). Number of seeds per pod showed highly significant positive correlation with number of pods per plant (0.293). Path coefficient analysis revealed that the highest positive direct effects on seed yield per plant exerted by biological yield per plant (0.247) followed by 100 seed weight (0.169), harvest index (0.652), number of pods per plant (-0.140). However, other characters contributing substantially positive direct effect on seed yield were, days to 50% flowering (0.030) and number of primary branches per plant (0.009).Number of seeds per plant showed substantial amount positive indirect effect on grain yield *via* no. of pods per plant (0.345), no. of seeds per pods (0.181), 100 seed weight (0.190) and biological yield per plant (0.115).

Key words : *Lentil, correlation coefficient, path coefficient and seed yield.*

Introduction

Traditionally pulses have been considered important elements of cropping systems. They are popular because of their importance as a source of protein and ability to fix atmospheric nitrogen (N) and thus improve soil fertility (1). Pulses are the crops of national importance in India and have been grown since time immemorial. India is the largest producer and consumer of pulses in the world and also a key player with 25 per cent share in the global pulse basket from an area about 33 per cent (2).

Lentil (*Lens culinaris* Medikus subsp. *culinaris*), is one of the most important pulse crop of India, grown in winter season and belonging to family-Fabaceae, sub-family-Faboideae with chromosome number 2n = 14. Lentil has versatile uses as food, feed, fuel and fodder. It is known by at least 30 common names in various parts of the world *viz.,* Massour, Mangu/Margu, Masura, Renuka, Mangalaya etc. (Kay, 1979). Lentil seeds contain protein concentration ranging from 22-34.6 per cent and 100g dried seeds contain 340- 346 kcal, 20.2g protein, 0.6g fat, 65.0g total carbohydrates, about 4g fiber, 2.1g ash, 68 mg Ca, 325 mg P, 7.0 mg Fe, 29 mg Na, 780 mg K, 0.46 mg thiamine, 0.33 mg riboflavin and 1.3 mg niacin (3). It also contains some anti-nutritional factors, such as, trypsin inhibitors, hemagglutinins and oligosaccharides that cause flatulence. These problems can be greatly reduced by heating and sprouting (4). However, India's rank in the world in respect of production as well as acreages followed by Turkey. In India, lentil is mostly grown in northern plains, central and eastern part of India. It is grown in about 1.62 m ha with total production 1.23 mt, and productivity 841 Kg/ha (5).

Grain yield is a complex quantitative trait, considerably affected by environment (6). It is important to determine the contribution of the traits which has the greatest influence on grain yield (7). The most important factor responsible for unfurling such pleasant scenario in wheat production has been the release of dwarf and semi-dwarf, fertilizer responsive, lodging resistant, day length insensitive and widely adopted high yielding varieties of wheat.

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Table-1 : Phenotypic correlation coefficients between different characters in lentil germplasm.

Characters	Days to 50% Flowering	Days to maturity	Plant height (cm)	No. of primary branches/ Plant	No. of secondary branches/ Plant	No. of pods/plant	No. of seeds/pod	No. of seed/plant	100-seed weight (g)	Biologicalyield/plant (g)	Harvest index (%)	Seed yield/plant (g)
Days to 50% flowering	1.000	0.473**	0.137^{NS}	-0.018^{NS}	0.247*	0.124^{NS}	-0.136^{NS}	0.004^{NS}	0.218^{NS}	-0.045^{NS}	-0.164^{NS}	-0.130^{NS}
Days to Maturity		1.000	-0.048^{NS}	-0.005^{NS}	0.210^{NS}	0.130^{NS}	-0.186^{NS}	0.072^{NS}	-0.223^{NS}	0.080^{NS}	-0.431**	-0.377**
Plant Height (cm)			1.000	0.226*	0.053^{NS}	0.109^{NS}	0.181^{NS}	0.148^{NS}	0.018^{NS}	-0.026^{NS}	-0.266*	-0.150^{NS}
No. of Primary branch				1.000	0.081^{NS}	0.215^{NS}	-0.114^{NS}	0.067^{NS}	-0.250*	-0.008^{NS}	-0.114^{NS}	-0.112^{NS}
No. of secondary Branch					1.000	0.034^{NS}	0.107^{NS}	0.045^{NS}	0.051^{NS}	-0.159^{NS}	0.112^{NS}	-0.119^{NS}
No. of pods per Plants						1.000	0.293**	0.906**	0.456**	0.333**	-0.209^{NS}	0.183^{NS}
No. of Seeds per Pods							1.000	0.474**	0.192^{NS}	-0.054^{NS}	-0.035^{NS}	0.013^{NS}
No. of Seed/ plant								1.000	0.500**	0.302**	-0.224*	0.199^{NS}
Seed weight (100 grains)									1.000	0.111^{NS}	0.205^{NS}	0.451**
Biological yield/plant										1.000	-0.216^{NS}	0.215^{NS}
Hardest Index											1.000	0.597**
Seed yield plan												1.000

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

Table-2 : Genotypic correlation coefficients between different characters in lentil germplasm.

Characters	Days to 50% Flowering	Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ Plant	No. of pods/plant	No. of seeds/pod	No. of seed/plant	100-seed weight (g)	Biological Yield/plant (g)	Harvest index (%)	Seed yield/plant (g)
Days to 50% flowering	1.000	0.509**	0.151^{NS}	-0.026^{NS}	0.379**	0.129^{NS}	-0.148^{NS}	0.009^{NS}	0.238*	-0.040^{NS}	-0.177^{NS}	-0.165^{NS}
Days to Maturity		1.000	-0.033^{NS}	-0.013^{NS}	0.273*	0.139^{NS}	-0.253*	0.076^{NS}	-0.236*	0.128^{NS}	-0.514**	-0.480**
Plant Height (cm)			1.000	0.233*	0.021^{NS}	0.116^{NS}	0.225*	0.152^{NS}	0.012^{NS}	-0.080^{NS}	-0.349**	-0.156^{NS}
No. of Primary branch				1.000	0.112^{NS}	0.226*	-0.187^{NS}	0.070^{NS}	-0.261*	-0.045^{NS}	-0.180^{NS}	-0.152^{NS}
No. of secondary Branch					1.000	0.026^{NS}	0.113^{NS}	0.041^{NS}	0.083^{NS}	-0.178^{NS}	-0.005^{NS}	-0.338**
No. of pods per Plants						1.000	0.348**	0.917**	0.488**	0.368**	-0.252*	0.215^{NS}
No. of Seeds per Pods							1.000	0.564**	0.266*	-0.100^{NS}	-0.051^{NS}	0.012^{NS}
No. of Seed/ plant								1.000	0.540**	0.333**	-0.298**	0.223^{NS}
Seed weight (100 grains)									1.000	0.142^{NS}	0.326**	0.545**
Biological yield/plant										1.000	-0.324**	0.360**
Hardest Index											1.000	0.623**
Seed yield plant												1.000

Table-3 : Direct and indirect effects of Phenotypic correlation, different characters on seed yield per plant in lentil germplasm.

Characters	Days to 50% Flowering	Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ Plant	No. of pods/ plant	No. of seeds/pod	No of seed/plant	100-seed weight (g)	Biological Yield/plant (g)	Harvest index (%)	Seed yield/plant (g)
Days to 50% flowering	0.030	-0.043	0.001	0.000	-0.037	-0.017	0.016	0.001	0.037	-0.011	-0.107	0.030
Days to Maturity	0.014	-0.091	0.000	0.000	-0.032	-0.018	0.022	0.027	-0.038	0.020	-0.281	0.014
Plant Height (cm)	0.004	0.004	0.005	0.002	-0.008	-0.015	-0.022	0.056	0.003	-0.006	-0.174	0.004
No. of Primary branch	-0.001	0.001	0.001	0.009	-0.012	-0.030	0.014	0.025	-0.042	-0.002	-0.075	-0.001
No. of secondary Branch	0.007	-0.019	0.000	0.001	-0.151	-0.005	-0.013	0.017	0.009	-0.039	0.073	0.007
No. of pods per Plants	0.004	-0.012	0.001	0.002	-0.005	-0.140	-0.035	0.345	0.077	0.082	-0.136	0.004
No. of Seeds per Pods	-0.004	0.017	0.001	-0.001	-0.016	-0.041	-0.120	0.181	0.033	-0.013	-0.023	-0.004
No. of Seed/ plant	0.000	-0.007	0.001	0.001	-0.007	-0.126	-0.057	0.381	0.085	0.075	-0.146	0.000
Seed weight (100 grains)	0.007	0.020	0.000	-0.002	-0.008	-0.064	-0.023	0.190	0.169	0.027	0.134	0.007
Biological yield/plant	-0.001	-0.007	0.000	0.000	0.024	-0.046	0.006	0.115	0.019	0.247	-0.141	-0.001
Hardest Index	-0.005	0.039	-0.001	-0.001	-0.017	0.029	0.004	-0.085	0.035	-0.053	0.652	-0.005
Seed yield plant	-0.130	-0.377	-0.150	-0.112	-0.119	0.183	0.013	0.199	0.451	0.215	0.597	-0.130

Residual are 0.38602

Table-4 : Direct and indirect effects of Genotypic correlation, different characters on seed yield per plant in lentil germplasm.

Characters	Days to 50% Flowering	Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ Plant	No. of pods/plant	No. of seeds/ pod	No of seed /plant	100-seed weight (g)	Biologicalyield/plant (g)	Harvest index (%)	Seed yield/ plant (g)
Days to 50% flowering	0.472	-0.162	0.029	0.001	-0.106	-0.128	0.068	0.017	-0.117	-0.022	-0.216	0.472
Days to Maturity	0.240	-0.318	-0.006	0.000	-0.077	-0.138	0.116	0.140	0.116	0.071	-0.624	0.240
Plant Height (cm)	0.071	0.010	0.189	-0.007	-0.006	-0.115	-0.103	0.279	-0.006	-0.044	-0.424	0.071
No. of Primary branch	-0.012	0.004	0.044	-0.030	-0.031	-0.225	0.086	0.128	0.128	-0.025	-0.219	-0.012
No. of secondary Branch	0.179	-0.087	0.004	-0.003	-0.281	-0.026	-0.052	0.075	-0.041	-0.099	-0.007	0.179
No. of pods per Plants	0.061	-0.044	0.022	-0.007	-0.007	-0.994	-0.160	1.687	-0.240	0.204	-0.307	0.061
No. of Seeds per Pods	-0.070	0.080	0.043	0.006	-0.032	-0.346	-0.458	1.037	-0.130	-0.055	-0.062	-0.070
No. of Seed/plant	0.004	-0.024	0.029	-0.002	-0.011	-0.911	-0.258	1.840	-0.265	0.185	-0.362	0.004
Seed weight (100 grains)	0.112	0.075	0.002	0.008	-0.023	-0.485	-0.122	0.994	-0.491	0.079	0.396	0.112
Biological yield/plant	-0.019	-0.041	-0.015	0.001	0.050	-0.366	0.046	0.613	-0.070	0.554	-0.394	-0.019
Hardest Index	-0.084	0.164	-0.066	0.005	0.002	0.251	0.024	-0.548	-0.160	-0.180	1.215	-0.084
Seed yield plant	-0.165	-0.480	-0.156	-0.152	-0.338	0.215	0.012	0.223	0.545	0.360	0.623	-0.165

Residual are 0.02584

The objectives of this study were to estimate the correlations between grain yield and other traits and determine the direct and indirect effects of traits on grain yield in wheat grown under drought stress and non-stress conditions in order to find out suitable traits that could be used for grain yield improvement under both conditions.

Materials and Methods

The present investigation was carried out during *Rabi,* 2018-19 at Agriculture Research Farm of B.R.D. (P.G.) College Campus, Deoria (UP). Geographical, Baba Raghav Das Post Graduate College Deoria is located in the east part of U.P. India, the site of experiment is located at 26.5°N latitude, 83.79°E longitudes and 68 meters (223 feet) above the mean sea level. The experimental materials comprised of 20 lines of lentil genotypes with five checks *viz.,* (LEE-150, LEE- 151, LEE-152, LEE-153 and LEE-154) present in the genetic stock of Department of Genetics and Plant Breeding, B.R.D.P.G. College, Deoria (U.P.). The experiment was laid out in a randomized block design with three replications. The entire experimental field was divided into 03 blocks of equal size and each block had 03 plots. Out of 03 plots in a block, 3 plots were used for accommodating the test genotypes which were not replicated while remaining 5 were allocated to checks *i.e*. LEE-150, LEE- 151, LEE-152, LEE-153, LEE-154. The five 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 25 cm and 10 cm, respectively and the recommended packages of practices were followed for raising a healthy crop and all necessary plant protection measures were taken to control the pest and diseases. Five competitive plants from each plot were randomly selected for recording observations on all the 12 metrict traits, except days to 50 per cent flowering and days to maturity, which was recorded on the plot basis. Averages of the data from the sampled plant of each plot in respect of different characters were used for various statistical analysis. The data were recorded for the twelve metric characters *viz*., days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant (g), 100-seed weight (g), biological yields (g), number of seeds per plant and harvest index (%).

The genotypic and phenotypic correlation coefficients (r) between different characters were estimated according to (8) and Path coefficient analysis was carried out according to (9). Grain yield was assumed to be dependent variable (effect) which is influenced by all other characters, the independent variables (causes), directly as well as indirectly through other.

Results and Discussion

Correlation coefficient : Relationship among yield and its attributing traits were studied through analysis of Correlation among them. Genotypic and Phenotypic correlation coefficients among the twelve traits of 25 lentil genotypes presented in Table-1 and 2 respectively. Correlation analysis revealed that genotypic correlation coefficient in most cases were very close to their phenotypic correlation coefficients indicating the associations were largely due to genetic region (10, 11). The phenotypic correlation coefficient in some cases was higher than their genotypic correlation coefficient, which indicates the suppressing effect of the environment that can alter the expression of traits at the phenotypic level. At phenotypic level days to maturity showed highly significant and positive correlation with days to 50% flowering (0.473). Plant height showed non-significant and positive correlation with days to maturity (0.137). Number of primary branches per plant showed significant and positive correlation with plant height (0.226). Number of secondary branches per plant showed highly non-significant positive correlation with number of primary branches per plant (0.081) but significant positive correlation with days to maturity (0.210). Number of pods per plant showed non-significant and positive correlation with plant height (0.109), number of secondary branch per plant (0.034),days to 50% flowering (0.124) and days to maturity (0.130). Number of seeds per pod showed highly significant positive correlation with number of pods per plant (0.293). Biological yield per plant showed highly significant positive correlation with number of seed per plant (0.302), number of pods per plant (0.333). Harvest index showed highly non-significant positive correlation with 100 seed weight (0.205) and highly significant negative correlation with days to maturity (-0.431) followed by plant height (-0.266).100-seed weight showed significant and positive association with number of pods per plant (0.456), and significant negative correlation with number of primary branch per plant (-0.250). Seed yield per plant showed highly significant and positive association with harvest index (0.597), 100-seed weight (0.451), but significant and negative correlation with days to maturity (-0.377).The overall results revealed that most of these traits were positively correlated with yield per spike and number of grains per spike. Hence these traits can be focused for improvement in breeding programs.

Path Coefficient : Coefficient of correlation measures the degree and association between two characters. However, this may not give true picture under complex situation. Under such conditions, path coefficient analysis

provides a means of measuring the direct as well as indirect effect via other variables on the end product by partitioning correlation coefficients. The direct and indirect effects on grain yield were estimated for all characters under study (Table-3 and 4), which provided a better index for selection rather than correlation coefficient.At phenotypic level (Table-3), revealed that the highest positive direct effects on seed yield per plant exerted by biological yield per plant (0.247) followed by 100 seed weight (0.169), harvest index (0.652), number of pods per plant (-0.140). However, other characters contributing substantially positive direct effect on seed yield were, days to 50% flowering (0.030) and number of primary branches per plant (0.009). Number of secondary branches (-0.151), number of seeds per pod (-0.120), days to maturity (-0.091), plant height (-0.005), were substantial in negative direct effects on seed yield per plant. Number of seeds per plant showed substantial amount positive indirect effect on grain yield via no. of pods per plant (0.345), no. of seeds per pods (0.181), 100 seed weight (0.190) and biological yield per plant (0.115). Rest of the traits did not exerted substantial amount of indirect effects on grain yield via any of the traits. The estimates of phenotypic path coefficient between different characters showed close parallelism in direction with their corresponding genotypic path coefficients (12, 13). Keeping these results in mind a breeder can focused more on these traits in his breeding program.

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