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Genetic Variability and Association Analysis for Various Agro Morphological Traits in Lentil (*Lens culinaris M.*)

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ABSTRACT

Background: Lentil is an oldest domesticated grain legume in the world. It is cultivated during winter season in India which is a major source of protein (28%) for human consumption. The present study was undertaken to study association analysis of grain yield with other quantitative traits and to estimate direct and indirect effects of various traits on grain yield.

Methods: The experiment was carried out using 53 advance breeding lines of lentil in a Randomized Complete Block Design and replicated thrice.

Result: The investigation revealed that days to 50% flowering, days to 75% maturity, plant height, pods/plant, biological yield/plant and grain yield/plant have significant differences and wide range of variations during both the year. Pods/plant exhibited high genotypic coefficient of variation, heritability and genetic advance signifying the effects of additive gene effect. Pods/plant and biological yield/ plant showed positive and significant correlations with grain yield /plant and also have positive direct effects on grain yield. Therefore, this investigation suggested that pods/plant and biological yield/plant may be focused during selection for genetic gain in lentil.

Key words: Genotype, Grain yield, Heritability, Lentil, Path analysis.

INTRODUCTION

Lentil is an important leguminous crop grown for its grain in India. It is a self-pollinating diploid (2n=2x=14) *Rabi* pulse crop. It is cultivated in semi-arid regions of the world especially in the Indian sub-continent and the dry areas of the Middle East. Pulses are good source of nutrients like protein, carbohydrates and minerals (Dar *et al*., 2016) and it is among the ancient domesticated grain legume crop (Bahal *et al*., 1993). It plays a significant role in rainfed cropping system, providing an alternative to cereal grains (Hamayun *et al*., 2011). It also improves the soil fertility through biological nitrogen fixation. In India, it occupies an area of 1657.5 thousand ha with a production of 1220.0 thousand tonnes (Anonymous, 2017) however, it is being cultivated on 0.8 thousand hectares with a production of 0.5 thousand tonnes (Anonymous 2017-18) in Punjab. In any crop improvement programme, genetic variability is a prerequisite. The variability existed in the germplasm and association of characters with yield is of great importance to plant breeders for making an improvement in a complex characters like grain yield. Selection for grain yield may be easy when contribution of various attributes to yield is quantified through path coefficient analysis (Dewey and Lu, 1959). Hence, the present investigation was executed to generate more informations on genetic variability, association of grain yield with other quantitative characters and to estimate direct and indirect effects of various characters on grain yield.

MATERIALS AND METHODS

The experiment was carried out at PAU, Regional Research Station, Gurdaspur, Punjab. The experimental materials consisting of 53 advance breeding lines (F_7 generations) developed through hybridization of four well adapted high yielding but rust susceptible genotypes of lentil with six rust resistant lines which include four indigenous and two exotic lines grown in a randomized block design and replicated thrice during *Rabi* 2015-2016 and 2016- 2017. Each genotype was sown in paired rows of 2m length and spaced at 22.5 cm. All the recommended agronomic practices were followed to raise a healthy crop. The data were recorded on randomly selected plants for each genotype on seven morphologicalcharacters *viz*., Days to 50% flowering, Days to 75% maturity, Plant height (cm), Pods/plant, Seeds/plant, Biological yield/plant (g) and Grain yield/plant (g).

Analysis of variance (ANOVA) was performed to estimate the variations among the genotypes using CPCS1 programme. Genetic parameters (Variance components, Genotypic and phenotypic coefficients of variation, heritability, genetic advance, correlations and path coefficients) were estimated according to Dewey and Lu (1959) and Singh and Choudhary (1985).

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RESULTS AND DISCUSSION

The analysis of variance for grain yield and yield attributing traits were analysed and presented in Table 1. The analysis of variance exhibited significant differences among the genotypes for all the traits, except seeds/pod indicating the presence of sufficient genetic variability in the materials under study during both the years (*Rabi* 2015-2016 and 2016- 2017). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for various characters studied are presented in Table 2. It was observed that genotypic coefficient of variation for pods/plant (12.48 and13.92) during both the years and for biological yield (16.79) during first year was moderate and it was high for grain yield (36.73) during first year. However, for rest of the characters it showed low values for genotypic coefficient of variation. On the other hand, similar trend was observed for phenotypic coefficient of variation, except for biological yield/ plant (22.89 and 25.18) and grain yield /plant (37.83 and 45.75) which showed high phenotypic coefficient of variation during both the years. Maximum (genotypic and phenotypic) variation was exhibited by biological yield/plant and grain yield /plant. Similar results on variability for different characters were reported by Haddad (2004) and Singh and *et al.* (2005). Low variability for other yield contributing traits was reported by Ayaz *et al.* (2004) and Singh *et al.* (2004). Genetic variability in a population is very important for improvement of crop plants. More the variability, greater the chances for producing desirable plant types.

The estimates of heritability in broad sense was high for days to 50% flowering (97.10 and 99.64), days to maturity (96.31 and 88.55) during both the years and plant height (68.57), pods/plant (74.57), seeds /pod (72.59) and Grain yield/ plant (94.29) during first year while it was moderate for pods/ plant (35.61) during second year. The high value of expected genetic gain was observed for pods/plant (22.15), biological yield/plant (25.36) and grain yield/plant (73.47) during first year. Other characters showed moderate to low expected genetic gain particularly in the second year. Only two characters *i.e.* days to 50% flowering and days to 75% maturity showed high heritability during both the years. It indicated that these characters were less influenced by the environment. Bicer and Sarkar (2004), Singh *et al.* (2005) and Jeberson *et al.,* 2019 also estimated high heritability for these traits.

The results pertaining to correlation coefficients are presented in Table 3. Days to 50% flowering is positively and significantly correlated with days to 75% maturity during both the years at both levels while it was correlated with seeds /pod at genotypic levels during both the years. Days to 75% maturity is negatively and significantly correlated with plant height at genotypic level only during both the years. Pods/plant is positively and significantly correlated with biological yield /plant (rg 0.23* and 0.55* and rp 0.23*

Table 1: Analysis of variance for different agronomical traits in lentil.

Source of variation		DF	Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Pods/ plant	Seeds/ pod	Biological yield /plant (gm)	Grain yield /plant (gm)
Replication	Y1	2	1.21	2.46	13.66	17.41	0.00	393.98	10.37
	Y2	2	0.47	7.14	30.30	446.28	0.02	303.82	49.33
Genotypes	Y1	52	48.98*	30.30*	27.38*	145.37*	0.02	144.24*	37.66*
	Y2	52	110.68*	12.66*	20.13*	162.88*	0.01	63.88*	14.65*
Error	Y1	104	0.48	0.38	3.63	15.06	0.00	32.13	0.75
	Y2	104	0.13	0.52	13.30	61.09	0.01	40.16	12.90

Table 2: Estimates of mean, phenotypic and genotypic variance for different agronomical traits in lentil.

Parameters		Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Pods/ plant	Seeds/ pod	Biological yield /plant (gm)	Grain yield /plant (gm)
Mean	Y1	107	143	43.16	52.81	1.81	36.42	9.55
	Y2	111	146	35.92	41.84	1.77	27.35	8.02
Range	Y1	101-117	137-151	36.27-50.33	38.13-68.0	1.30-1.90	24.67-49.00	1.92-20.07
	Y2	92-118	142-151	31.10-46.53	24.33-63.60	1.57-1.90	20.67-41.0	3.0-12.6
PCV	Y1	3.82	2.25	7.87	14.48	5.59	22.89	37.83
	Y2	5.45	1.46	10.99	23.30	5.0	25.18	45.75
GCV	Y1	3.76	2.21	6.52	12.48	4.76	16.79	36.73
	Y2	5.44	1.38	4.20	13.92	2.73	9.84	9.52
Heritability (Broad sense)	Y1	97.10	96.31	68.57	74.57	72.59	53.77	94.29
	Y2	99.64	88.55	14.60	35.61	29.69	15.28	4.33
Expected genetic gain (% of mean)	Y1	7.64	4.46	11.12	22.15	8.35	25.36	73.47
	Y2	11.18	2.67	3.31	17.14	3.06	7.92	4.08

and 0.36*) and grain yield /plant (rg 0.31* and 0.27* and rp 0.31* and 0.57*) during both the years at both the levels. Grain yield is positively and significantly correlated with biological yield (rp 0.37* and 0.44*) during both the years. Similar results were also reported by Alom *et al.* (2014), Pushpavalli *et al* (2017) and Husain *et al*. (2018). So, these characters may be considered as important selection criteria for making significant gain in grain yield. Correlation provides an opportunity for assessing the relationship of these characters with grain yield. The correlation over a wide range of environments is likely give a true picture about the relationship between these traits which will help in formulation of strategies for indirect selection.

Path coefficient analysis (Table 4) for grain yield revealed that pods/plant and biological yield /plant showed positive direct effects at both genotypic and phenotypic levels during both the years while days to 50% flowering, plant

Table 3: Genotypic (bold) and Phenotypic correlation coefficients for different agronomical traits in lentil.

Parameters		Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Pods/ plant	Seeds/ pod	Biological yield /plant (gm)	Grain yield /plant (gm)
Days to 50% flowering	Y1		**0.88**	**-0.18**	**-0.12**	**0.17**	**0.09**	**0.01**
	Y2		**0.29**	**0.32**	**-0.17**	**0.24**	**-0.14**	**-0.40**
Days to 75% maturity	Y1	0.85*		**-0.27**	**-0.11**	**0.11**	**0.03**	**0.01**
	Y2	0.28*		**-0.22**	**0.06**	**0.36**	**0.17**	**-0.48**
Plant height (cm)	Y1	-0.18*	0.27*		**0.09**	**0.04**	**0.14**	**0.01**
	Y2	0.13	-0.06		**-0.25**	**-0.42**	**-0.16**	**-0.61**
Pods/plant	Y1	-0.12	-0.11	0.09		**0.19**	**0.23**	**0.31**
	Y2	-0.10	0.03	-0.05		**-0.02**	**0.55**	**0.27**
Seeds/pod	Y1	0.16*	0.11	-0.04	0.19*		**0.24**	**0.12**
	Y2	0.12	0.20	-0.07	0.11		**-0.43**	**0.09**
Biological yield/plant (gm)	Y1	0.09	0.03	0.15*	0.23*	0.24*	**0.37**	
	Y2	-0.06	0.04	0.07	0.36*	-0.08		**-0.43**
Grain yield /plant (gm)	Y1	0.01	0.01	0.01	0.31*	0.12	0.37*	
	Y2	-0.08	-0.09	0.04	0.57*	0.09	0.44*	

Table 4: Direct (bold) and Indirect effects due to genotypes (G) and Phenotypes (P) of different yield attributing traits on grain yield.

Parameters			Days to 50% flowering	Days to 75% maturity	Plant height (cm)	Pods/ plant	Seeds/ pod	Biological yield /plant (gm)
Days to 50% flowering	Y1	G	**0.004**	-0.045	0.031	-0.095	-0.016	0.065
		P	**-0.015**	0.004	0.013	-0.028	-0.001	0.033
	Y2	G	**0.010**	-0.038	0.005	-0.051	0.010	-0.015
		P	**0.097**	-0.005	0.003	-0.031	-0.001	-0.003
Days to 75% maturity	Y1	G	0.003	**-0.051**	0.048	-0.031	-0.011	0.003
		P	-0.013	**0.005**	0.020	-0.026	-0.001	0.011
	Y2	G	0.002	**-0.138**	-0.002	0.014	0.018	0.008
		P	0.026	**-0.018**	0.007	0.006	0.001	-0.038
Plant height (cm)	Y1	G	-0.001	0.016	**-0.151**	0.042	0.008	0.115
		P	0.003	-0.001	**-0.74**	0.003	0.001	0.048
	Y2	G	0.001	0.009	**0.038**	-0.023	-0.006	0.019
		P	0.022	-0.001	**0.140**	0.004	0.001	0.023
Pods/plant	Y1	G	-0.001	0.067	-0.027	**0.236**	-0.018	0.168
		P	0.002	-0.001	-0.007	**0.237**	-0.001	0.077
	Y2	G	-0.001	-0.004	-0.002	**0.472**	0.008	0.097
		P	-0.007	-0.004	0.001	**0.409**	0.001	0.121
Seeds/pod	Y1	G	0.001	-0.007	0.014	0.054	**-0.079**	0.170
		P	-0.003	0.001	-0.003	0.046	**-0.003**	0.079
	Y2	G	0.001	-0.029	-0.003	0.048	**0.081**	-0.003
		P	-0.001	-0.001	0.001	0.065	**0.008**	0.042
Biological yield/plant (gm)	Y1	G	0.001	-0.004	-0.036	0.081	-0.028	**0.490**
		P	-0.002	0.001	-0.011	0.055	-0.001	**0.332**
	Y2	G	-0.001	-0.004	0.003	0.172	-0.001	**0.266**
		P	-0.001	-0.002	0.008	0.130	0.001	**0.381**

height and seeds/pod exhibited positive direct effects in the second year only.

Indirect effects on grain yield /plant were also estimated and it was found that plant height and pods/plant had maximum indirect effect by biological yield/plant. Similarly seeds/pod and biological yield /plant had positive direct effect via pods/plant. It indicated that a slight increase in any one of the above traits may directly contribute towards grain yield. Similar results were also reported by Taygi and Khan (2011) and Yadav *et al.* (2005). The path coefficient analysis revealed that direct and indirect contribution of biological yield /plant and pods/plant was maximum on grain yield. The above findings indicated that whatever traits chosen for increasing grain yield will be achieved mainly through these traits.

CONCLUSION

Lentil is one of the oldest food crop valued for its protein and among one of the easily digested pulse crop. In the present study, experimental results revealed that days to 50% flowering, days to 75% maturity, plant height, pods/ plant, biological yield/plant and grain yield/plant showed significant differences and wide variations during both the years. Pods/plant exhibited high genotypic coefficient of variation, heritability and genetic advance. Pods/plant and biological yield/plant showed positive and significant correlations with grain yield/plant and also have positive direct effects on grain yield.

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