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GENETIC VARIABILITY, CHARACTER ASSOCIATION AND PATH ANALYSIS OF YIELD AND ITS COMPONENT CHARACTERS IN LENTIL

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Genetic variability, character association and path analysis between yield and its contributing traits were studied in 41 genotypes of cultivated lentil. Highly significant differences between genotypes were recorded for most of the characters studied except internode length, number of seeds/pod and seed weight. High phenotypic and genotypic coefficients of variation coupled with high heritability and high genetic advance in 100 seed weight, harvest index, biological and grain yields per plant and also seeds and pods per plant indicate the predominance of additive gene effects in controlling these traits. Correlation and path coefficient analysis revealed that biological yield/plant, 100 seed weight, number of pods and seeds per plant were the most important characters for realizing improvement in grain yield in lentil.

Key words : Lentil, genetic variability, path analysis, gcv, pcv

Development of high yielding cultivars requires a thorough knowledge of the existing genetic variation and also the extent of associations among yield contributing characters. The observed variability is a combined estimate of genetic and environmental causes, of which only the former one is heritable. However, the estimate of heritability alone does not provide an idea about the expected gain in the next generation but it has to be considered in conjunction with genetic advance. Correlation and path analysis will establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects and thus give a clear understanding of their association with yield. The present paper deals with the above genetic constants and character associations in 41 genotypes of lentil.

MATERIALS AND METHODS

Forty one genotypes of cultivated lentil (mostly cultivars) belonging to microsperma group of *Lens culinaris* Med. procured from different research institutes/universities of Uttar Pradesh were grown in a randomized block design with three replications at the Department of Agricultural Botany Research Farm, Ch. Charan Singh University, Meerut during rabi 1997-1998. Each genotype was evaluated in a plot of two rows of 5-m length. Observations were recorded on five random plants per genotype in each replication for 11 quantitative characters including plant height, number of leaves, pods and seeds per plant, seeds per pod, biological and grain yields per plant, seed weight and harvest index. Standard statistical procedures were followed for estimating genetic constants - phenotypic and genotypic coefficients of variation (Burton, 1952), heritability (Hanson *et al.*, 1956) and genetic advance (Johnson *et al.*, 1955). Genotypic and phenotypic correlation coefficients were calculated following Searle (1961) and path analysis following the method of Dewey and Lu (1955).

RESULTS AND DISCUSSION

A wide range of phenotypic variability was observed for almost all the characters studied. The analysis of variance recorded highly significant differences between genotypes for most of the characters studied with the exception of internode length, number of seeds/pod and 100 seed weight. This suggests that there is considerable amount of intervarietal variability in lentil.

The data on yield and its contributing traits, phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (H^2) and genetic advance (GA) are presented in Table 1. The variability estimates, in general, reveal that the phenotypic variance (PCV) was higher than the corresponding genotypic variance (GCV) for different characters though the extent of difference between the two was relatively low. The estimates of PCV and GCV indicated the existence of fairly high degree of variability for grain and biological yields, seed weight, number of pods and seeds per plant and harvest index. Moderate variability was observed for plant height and internode length. Relatively low PCV and GCV were recorded for days to maturity and seeds per pod. The genotypic coefficient of variation ranged from a minimum of 2.2 per cent for days to maturity to a maximum of 41.1 per cent for plant grain yield. The number of leaves per plant showed the highest PCV value of 49.81 in comparison to GCV of 14.69 suggesting more environmental influence on this character, which was confirmed by its low heritability. The difference between PCV and GCV was minimum for days to maturity; harvest index and 100 seed weight suggesting that these traits are least affected by environment. This observation draws support from the very high values of heritability (> 92.5) recorded for these traits (Table 1).

Since broad sense heritability includes both additive and epistatic effects, it will be reliable only when accompanied by high genetic advance. Heritability estimates along with genetic advance are more useful than heritability alone in predicting the effectiveness of selection. High estimates of heritability (> 85%) and genetic advance (> 47%) were obtained for traits like grain yield and biological yield per plant, seed weight and harvest index. Selection for these traits is likely to

Table 1. Data on mean, range and genetic parameters in 41 genotypes of lentil

S. No.	Character	Mean	Range	PCV (%)	GCV (%)	H (%)	GA	GA as % of mean
1.	Plant height (cm)	36.51	30.55-43.70	18.29	16.84	20.5	12.32	33.75
2.	Internode length (cm)	2.24	2.04-2.55	8.20	5.68	48.0	0.18	8.03
3.	Leaves/plant	114.68	72.87-149.0	49.81	14.69	8.7	10.24	8.92
4.	Days to maturity	147.93	141.0-154.0	2.28	2.20	92.5	6.44	4.35
5.	No. of pods/plant	75.21	38.0-111.2	24.75	19.32	61.0	23.37	31.07
6.	No. of seeds/plant	109.49	56.93-154.8	24.54	19.57	63.0	35.21	32.15
7.	No. of seeds/pod	1.48	1.33-1.60	5.98	3.58	35.9	0.06	4.05
8.	Grain yield/plant (g)	1.99	0.65-3.75	43.81	41.18	88.4	1.59	79.89
9.	Biological yield/plant	6.85	2.89-11.42	33.59	31.12	85.9	4.07	59.41
10.	100 seed weight (g)	1.81	0.93-3.34	31.42	30.63	95.0	1.12	61.87
11.	Harvest index (%)	28.94	19.66-46.01	23.66	23.37	97.5	13.76	47.54

H: heritability, G.A : genetic advance

accumulate more additive genes leading to further improvement of their performance and hence, these traits may be used as selection criteria. Simple selection procedures like mass selection, family selection would be effective for improvement of these traits. Moderate heritability with moderately high genetic advance was observed for number of pods and seeds per plant, which indicate that additive gene effects also govern these traits.

Moderate heritability with low genetic advance was found in respect of internode length, and number of seeds per pod indicating non-additive gene action. The heritability is being exhibited due to favourable influence of environment rather than genotype and selection for such traits may not be rewarding. Low heritability with moderate genetic advance was observed for plant height. It reveals that additive gene effects govern plant height. The low heritability is being exhibited due to high environmental effects and selection may be effective in such cases. Low heritability with low genetic advance was found in respect of number of leaves per plant indicating that this character is highly

Table 2. Phenotypic (P) and genotypic (G) correlation coefficients among eleven characters in lentil

S. No.	Character		1	2	3	4	5	6	7	8	9	10	11
1	Plant height	P	-	0.306	0.073	0.232	0.289	0.308	0.039	0.157	0.17	0.289	0.264
		G	-	0.344	0.322	0.262	0.337*	0.364*	0.03	0.163	0.172	0.314	0.298
2	Internode length	P		-	–0.002	–0.213	0.262	0.28	0.009	0.209	0.163	0.231	0.29
		G		-	0.400**	–0.31	0.284	0.328*	0.229	0.238	0.223	0.315*	0.392*
3	Leaves/plant	P			-	0.142	–0.05	–0.031	0.096	–0.004	0.035	–0.008	0.013
		G			-	0.417**	–0.238	–0.189	0.277	–0.037	0.246	–0.09	0.028
4	Days to maturity	P				-	0.007	0.028	0.125	0.093	0.197	–0.029	0.101
		G				-	0.032	0.055	0.199	0.11	0.21	–0.034	0.116
5	Pods/plant	P					-	0.971**	–0.148	0.666**	0.33*	0.466**	0.732**
		G					-	0.982**	–0.052	0.661**	0.442**	0.555**	0.756**
6	Seeds/plant	P						-	0.077	0.715**	0.395**	0.494**	0.791**
		G						-	0.137	0.713**	0.517**	0.588**	0.822**
7	Seeds/pod	P							-	0.204	0.265	0.026	0.217
		G							-	0.384*	0.460**	0.094	0.412**
8	Biological yield/plant	P								-	0.828**	0.558**	0.868**
		G								-	0.910**	0.588**	0.869**
9	100 seed weight	P									-	0.122	0.722**
		G									-	0.129	0.795**
10	Harvest index	P										-	0.433**
		G										-	0.454**
11	Plant grain yield	P											-
		G											-

**Significant at 1% level; *Significant at 5% level.

influenced by environmental effects and selection would be ineffective. Thus, expression of this trait can be modified through hybridization followed by selection. Singh and Singh (1969), Singh and Dixit (1970), Nandan and Pandya (1980), Singh (1981) and Luthra (1986) reported similar observations.

Grain yield of a crop is the result of interactions of a number of interrelated characters. Therefore selection should be based on these component characters after assessing their correlation with grain yield. Character associations reveal the mutual relationship between two characters, and it is an important parameter for taking a decision regarding the nature of selection to be followed for improvement in the crop under study. In the present investigation, plant grain yield was found to be significantly and positively correlated with number of pods and seeds per plant, biological yield per plant, seed weight and harvest index (Table 2). Therefore, these characters should be kept in mind while making selection for yield improvement in lentil. Harvest index showed positive and highly significant correlations with 100 seed weight, number of seeds and pods per plant at both genotypic and phenotypic levels and with plant height and internode length at genotypic level only. On the other hand, 100 seed weight showed positive and significant correlation with biological yield, number of seeds and pods per plant at both levels while with number of seeds per pod at genotypic level. Significant positive correlations of biological yield per plant with pods and seeds per plant; number of seeds/plant with number of pods per plant,

Table 3. Path coefficient analysis of phenotypic and genotypic correlation coefficients to determine the direct and indirect effects of different traits on grain yield in yield

S. No.	Character		1	2	3	4	5	6	7	8	9	10	CCwith GY@
1	Plant height	P	**–0.001**	0.009	0.001	0.004	0.084	–0.058	–0.004	0.095	0.031	0.102	0.264
		G	**–0.14**	0.035	0.028	0.036	–0.047	0.062	–0.019	0.177	–0.02	0.186	0.298
2	Internode length	P	0	**0.031**	0	–0.003	0.076	–0.052	0.001	0.127	0.03	0.082	0.29
		G	–0.048	**0.102**	0.035	–0.043	–0.883	0.957	–0.147	0.259	–0.026	0.187	0.392*
3	No. of leaves/plant	P	0	0	**0.01**	0.002	–0.015	0.006	0.009	–0.002	0.006	–0.003	0.013
		G	–0.045	0.041	**0.087**	0.058	0.738	–0.552	–0.178	–0.04	–0.028	–0.053	0.028
4	Days to maturity	P	0	–0.007	0.001	**0.016**	0.02	–0.005	0.011	0.056	0.036	–0.01	0.101
		G	–0.037	–0.032	0.036	**0.139**	–0.099	0.159	–0.127	0.12	–0.024	–0.02	0.116
5	No. of pods/plant	P	0	0.008	0	0	**0.291**	–0.182	–0.013	0.404	0.06	0.164	0.732**
		G	–0.047	0.029	–0.021	0.004	**–0.103**	0.863	0.033	0.719	–0.051	0.329	0.756**
6	No. of seeds/plant	P	0	0.009	0	0	0.282	**0.587**	0.007	0.434	0.072	0.174	0.791**
		G	–0.051	0.033	–0.016	0.008	–0.046	**0.917**	–0.088	0.776	–0.059	0.348	0.822**
7	No. of seeds/pod	P	0	0	0.001	0	–0.043	–0.014	**–0.49**	0.124	0.049	0.009	0.217
		G	–0.034	0.023	0.024	0.028	0.161	0.399	**–0.64**	0.418	–0.053	0.056	0.412**
8	Biological yield/plant	P	0	0.006	0	0.002	0.194	–0.134	0.018	**0.606**	0.132	0.043	0.868**
		G	–0.023	0.024	–0.003	0.015	–0.052	0.08	–0.246	**0.588**	–0.091	0.077	0.869**
9	100 seed weight	P	0	0.005	0	0.003	0.096	–0.074	0.024	0.438	**0.183**	0.153	0.828**
		G	–0.024	0.023	0.021	0.029	–0.371	0.508	–0.295	0.864	**–0.115**	0.269	0.910**
10	Harvest index	P	0	0.007	0	0	0.135	–0.092	0.002	0.074	0.079	**0.353**	0.558**
		G	–0.044	0.032	–0.008	–0.005	–0.724	0.715	–0.06	0.141	–0.052	**0.592**	0.588**

@Correlation coefficient with grain yield. **Significant at 1% level; *Significant at 5% level.

plant height and internode length; number of pods per plant and internode length with plant height; days to maturity with number of leaves per plant; and number of leaves per plant with internode length were recorded (Table 2).

Yield is the sum total of several component characters which directly or indirectly contribute to it. The information derived from the correlation studies indicates only mutual association among the characters. Whereas, path-coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent character like grain yield. Partitioning of correlation coefficient into direct and indirect effects provides the information about the nature and magnitude of effects of other characters on grain yield. The results of the present investigation on path coefficient analysis (Table 3) reveal that characters like number of pods and seeds per plant, biological yield per plant and harvest index had maximum positive direct effect on grain yield, while number of seeds per pod and plant height had direct but negative effects. On the other hand, positive indirect effects on grain yield were realized from characters including biological yield per plant via seed weight, number of pods per plant and number of seeds per plant.

In the light of the above findings it may be concluded that improvement in characters like number of pods and seeds per plant, biological yield, harvest index and seed weight will help in improving the grain yield in lentil both directly and indirectly. Therefore, these characters should be considered for yield improvement in lentil breeding programmes.

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