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Assessing Genetic Parameter, Correlation and Path Coefficient in Spontaneous Mutant Progenies of Lentil (*Lens culinaris* Medikus ssp. *culinaris*) Variety DPL 62

Sunaina Yadav[1,2], Rajesh Yadav, Ravika[1], S. Bhaskar Reddy[1], Samita, Deepak Kumar[1] 10.18805/LR-4983

ABSTRACT

Background: Lentil is one of the most significant pulse crops, frequently referred to as "poor man's meat" because of its high protein content and inexpensive price. The present study was assessed for eleven morphological and yield variables to determine genetic variability, correlation and path co-efficients.

Methods: The experiment was conducted in a randomized complete block design using 56 different homogeneous progenies of a spontaneous mutant of lentil variety DPL 62 and four control varieties in triple replica during *rabi* 2017-18.

Result: Significant amount of variability was observed for all the traits. High phenotypic coefficients of variance and genotypic coefficients of variance coupled with high heritability and genetic advance were observed for peduncle length, number of pods per plant, seed width, seed yield per plant suggesting that these traits are genetically controlled by additive gene action. Seed yield per plant exhibited significant positive association with number of branches/plant and number of pods/plant while number of pods/plant revealed highest positive direct effect on seed yield per plant followed by 100-seed weight, number of branches per plant, days to maturity and leaflet breadth. Therefore, selection for these characters will directly lead to improvement in the yielding ability of lentil genotypes.

Key words: Correlation, Genetic advance, Heritability, Lentil, Path analysis, Variability.

INTRODUCTION

Lentil (*Lens culinaris* Medikus ssp. *culinaris*) is the third most important cool season and oldest food legume after chickpea and dry peas in the world which can be cultivated well on low fertility and limited rainfall areas of the world (Oplinger and Hardman 1990). It is considered one of the first domesticated grain legume, originating from the Near East centre of origin (Zohary, 1999), cultivated worldwide in the fertile crescent 7000-9000 years ago which subsequently spread to central Asia and the Mediterranean Basin (Cubero, 1981; Lev-Yadun *et al.,* 2000). Though India ranks second in the world with respect to production and acreage, its position in average productivity is 23rd. Highest productivity (2111 kg/ha) has been reported from Australia which is more than double as compared to India's which envisage the scope of further improvement in this crop (Singh *et al*., 2018).

Main concern with lentil is low yield potential because of narrow genetic base of the local cultivars that restricts the breeding progress (Dikshit *et al*., 2015). Yield is a complex character and depends on number of component characters, which are quantitatively inherited and have considerable environmental influence. Therefore, before launching any breeding programme, a thorough knowledge of the nature and magnitude of genetic variability and extent of association between yield and other components is very essential. Further, path coefficient analysis helps in partitioning of genetic correlation coefficients into direct and indirect effects leading to assessment of relative contribution of each component characters directly or indirectly to the yield. A single plant was isolated from a commercial population of DPL-62 in 2007-08 assuming it to be a mutant of DPL-62 by Punia *et al*. (2014b). Progenies of this presumed spontaneous mutant segregated up to sixth generation and wide variation was observed for morphological and seed traits. Considering the above facts, the present study was planned to study the M_7 progenies derived from a spontaneous mutant of lentil variety DPL 62.

[1]Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125 004, Haryana, India.
[2]ICAR-Indian Agricultural Research Institute, New Delhi-110 012, India.

Corresponding Author: Sunaina Yadav, ICAR-Indian Agricultural Research Institute, New Delhi-110 012, India.
Email: sunainay780@gmail.com

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MATERIALS AND MATHODS

The experimental material comprising of 56 diverse homogeneous progenies of a spontaneous mutant of variety DPL 62 along with four check varieties (DPL 62, HM-1, Sapna and Garima) were evaluated at Pulses Section Research Farm, CCS HAU, Hisar (India) in a randomized

block design with three replications during *rabi* 2017-18. Observations were recorded on five randomly selected plants for days to flowering, leaflet length (mm) and leaflet breadth (mm), peduncle length (mm), days to maturity, plant height (cm), number of branches/plant, number of pods/plant, seed width (mm), 100-seed weight (g) and seed yield/plant (g). Leaflet length, leaflet breath, peduncle length, plant height and seed width are measured manually with the help of measurement ruler.

Statistical analysis

Descriptive statistics of data to assess the variability in each trait were calculated in excel and are given in Supplementary Table 1. Data on the above eleven quantitative traits of 60 lentil genotypes were subjected to analysis of variance (ANOVA) as per the standard procedure suggested by Panse and Sukhatme (1995). PCV and GCV were estimated using method suggested by Burton and Devane (1953). Heritability in broad sense, genetic advance and genetic advance as per cent mean was calculated using formula given by Falconer, (1981); Hanson *et al*. (1956) and Johnson *et al*. (1955), respectively. Correlation coefficients worked out as per Al-Jibouri *et al*. (1958) and path analysis as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Descriptive statistics

High variability for each trait was demonstrated by result with the following range of values: 67-82 (days to flowering), 1.0-2.5 mm (leaflet length), 0.3-0.7 mm (leaflet breadth), 2.0-6.0 mm (peduncle length), 125-134 (days to maturity), 35.3-80.3 cm (plant height), 3.0-7.0 (number of branches/plant), 63.7-215.3 (number of pods/plant), 2.2-7.5 mm (seed width), 4.1-11.76 g (100-seed weight) and 2.58-13.5 g (seed yield/plant) (Supplementary Table 1). The high variability in all these traits can be due to difference in the genetic composition of the lentil mutants.

Analysis of variance

Highly significant mean squares owing to genotypes for all the characters in the current analysis revealed a large level of variability among the genotypes for the characters analysed (Table 1). Furthermore, almost all of the quantitative characters have marginally larger phenotypic coefficients of variance (PCV) than their genotypic coefficients of variance (GCV), indicating that the environment had a modest confounding effect on the expression of the traits under investigation (Table 2). Hussan *et al.,* (2018); Kumar, (2020) and Kumar *et al.* (2020) also observed higher magnitude of PCV than that of GCV for all the traits. The findings demonstrated that observed traits were largely resistant to environmental changes and also trait variation was mostly due to heritable factors.

Phenotypic and genotypic coefficient of variation

Among all the characters, high PCV was estimated only for seed yield/plant (32.85%). Moderate PCV was observed for seed width (25.35%), number of pods/plant (22.74%) and peduncle length (22.45%) whereas, low PCV was recorded for leaflet breadth (19.13%), number of branches/plant (16.67%), leaflet length (16.23%), plant height (14.82%), 100-seed weight (14.50%), days to flowering (5.32%) and days to maturity (2.10%). As far as GCV is concerned, high magnitude was observed for seed yield/plant followed by seed width (24.36%) and peduncle length (21.78%) whereas, moderate GCV was observed for number of pods/plant (19.86%), leaflet breadth (15.55%), plant height (14.02%), number of branches/plant (13.94%), leaflet length (13.77%) and 100-seed weight (12.02%) and low GCV was observed for days to flowering (5.03%) and days to maturity (1.53%).

Heritability and genetic advance

All the characters exhibited high heritability (broad sense) except days to maturity which showed moderate heritability (55.66%). These results were in partial concurrence with

Supplementary Table 1: Descriptive statistics of various for yield and its components in lentil.

	Mean	Range	Minimum	Maximum	Sum	Median	Mode	Sample variance	Standard deviation	Standard error	Kurtosis	Skewness
DF	75.1	15	67	82	13526	75	80	15.89	3.99	0.297	-1.112	0.210
LL	1.72	1.5	1.0	2.5	308.9	1.7	1.6	0.08	0.28	0.021	-0.253	0.205
LB	0.458	0.4	0.3	0.7	82.4	0.45	0.4	0.01	0.09	0.006	-0.599	0.177
PL	3.44	4.0	2.0	6.0	618.5	3.4	3.5	0.59	0.77	0.057	0.418	0.581
DM	128.4	9.0	125	134	23108	127	127	7.16	2.68	0.199	-1.369	0.257
PH	50.5	45	35.3	80.3	9082.7	49.5	50	55.74	7.47	0.556	2.230	1.184
NB	5.33	4.0	3.0	7.0	958.7	5.0	5.0	0.78	0.88	0.066	-0.532	-0.262
NP	129.1	151.7	63.7	215.3	23234	127	126.7	855.64	29.25	2.180	0.350	0.186
SW	4.88	5.3	2.2	7.5	879	5.0	4.5	1.52	1.23	0.092	-0.596	0.039
100-SW	7.40	7.66	4.1	11.76	1331.9	7.51	6.4	1.15	1.07	0.080	1.068	0.180
SY	7.39	10.9	2.58	13.5	1330.1	7.46	8.2	5.84	2.42	0.180	-0.611	0.197

DF: Days to flowering; LL: Leaflet length (mm); LB: Leaflet breadth (mm); PL: Peduncle length (mm); DM: Days to maturity; PH: Plant height (cm); NB: Number of branches/plant; NP: Number of pods/plant; SW: Seed width (mm); SW: 100-seeds weight (g); SY: Seed (g).

Table 1: Analysis of variance for yield and its components in lentil.

Source	d.f.	Mean squares										
		DF	LL	LB	PL	DM	PH	NB	NP	SW	SW	SY
Replication	2	6.94	0.02	0.001	0.28	0.67	59.37	0.06	317.82	0.02	0.98	1.34
Genotype	59	44.60**	0.19**	0.02**	1.72**	15.29**	156.05**	1.89**	2175.31**	4.36**	2.74**	16.55**
Error	118	1.69	0.02	0.003	0.04	3.21	5.84	0.24	204.42	0.12	0.36	0.57
C.D(P=0.01)		2.10	0.24	0.08	0.30	2.9	3.91	0.79	23.15	0.56	0.97	1.22
CV (%)		1.73	8.60	11.15	5.47	1.40	4.79	9.14	11.07	7.03	8.11	10.18

DF: Days to flowering, LL: Leaflet length (mm), LB: Leaflet breadth (mm), PL: Peduncle length (mm), DM: Days to maturity, PH: Plant height (cm), NB: Number of branches/plant, NP: Number of pods/plant, SW: Seed width (mm), SW: 100-seeds weight (g), SY: Seed yield/plant (g).

Table 2: Estimates for PCV, GCV, heritability, genetic advance and genetic advance as per cent of mean for yield and its components in lentil.

Traits	PCV (%)	GCV (%)	Heritability(BS) (%)	Genetic advance	Genetic advance per cent of mean
DF	5.32	5.03	89.47	9.45	12.57
LL	16.23	13.77	72.00	0.53	30.84
LB	19.13	15.55	66.05	0.16	33.36
PL	22.45	21.78	94.06	1.92	55.76
DM	2.10	1.56	55.66	3.95	3.08
PH	14.82	14.02	89.55	17.68	35.03
NB	16.67	13.94	69.92	1.64	30.03
NP	22.74	19.86	76.27	59.10	45.78
SW	25.34	24.36	92.31	3.01	61.79
100-SW	14.50	12.02	68.71	1.95	61.18
SY	32.85	31.24	90.40	5.79	78.40

DF: Days to flowering, LL: Leaflet length (mm), LB: Leaflet breadth (mm), PL: Peduncle length (mm), DM: Days to maturity, PH: Plant height (cm), NB: Number of branches/plant, NP: Number of pods/plant, SW: Seed width (mm), SW: 100-seeds weight (g), SY: Seed yield/plant (g).

the results reported by Rasheed *et al.* (2008) and Bicer and Sarkar (2008). Genetic advance as percentage of mean was observed to be high for almost all the characters except days to flowering and days to maturity where it was observed moderate (12.57%) and low (3.08%), respectively. Peduncle length, number of pods/plant, seed width and seed yield/ plant exhibited high PCV and GCV coupled with high heritability and genetic advance suggesting that additive gene action are responsible for inheritance of these characters and hence can be improved through direct selection. Low GCV coupled with low heritability and genetic advance were observed for days to maturity indicated presence of non-additive gene action and high GXE interaction. Leaflet length and plant height revealed moderate GCV along with high heritability and genetic advance which pointed towards presence of lesser variability for these traits in the material studied; however, they can be improved through selection to a limited extent. These results are in partial agreement with the findings of Hussan *et al.* (2018); Chowdhury *et al.* (2019); Kumar (2020); Kumar *et al.* (2020) and Sharma *et al.* (2022).

Correlation coefficient analysis

The higher magnitude of genotypic correlation coefficients than the phenotypic correlation coefficients for most of the cases indicated highly heritable nature of the associations (Table 3). The results indicated that seed yield/plant was positively associated with number of branches/plant (0.215) and number of pods/plant (0.420) but it was negatively associated with days to flowering (-0.182), leaflet length (-0.207), days to maturity (-0.150) and plant height (-0.179). The results obtained in the present study were in consonance with the findings of Kumar *et al.* (2017); Chowdhury *et al.* (2019); Maurya *et al.* (2020) and Girgel *et al.* (2021). Number of pods/plant showed positive association with seed yield/plant (0.420) but showed negative association with leaflet length (-0.181), leaflet breadth (-0.161), days to maturity (-0.338) and seed width (-0.184). Number of branches/plant was found positively associated with plant height (0.203) but negatively associated with seed width (-0.221) and 100-seed weight (-0.240). Occurrence of significant positive association 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 favourable 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 remain in close agreements with the observations reported by Kumar *et al.* (2017); Chopdar *et al.* (2017); Kumar *et al.* (2020) and Sharma *et al.* (2020) which may be obviously due to

Table 3: Estimates for phenotypic (below diagonal) and genotypic (above diagonal) correlation coefficients yield and its components in lentil.

	DF	LL	LB	PL	DM	PH	NB	NP	SW	100-SW	SY
DF⁺	1.000	0.477	0.443	-0.296	0.774	0.759	0.146	-0.174	-0.091	-0.405	-0.206
LL	0.352**	1.000	0.747	0.067	0.506	0.513	-0.106	-0.230	0.244	0.118	-0.220
LB	0.307**	0.599**	1.000	0.060	0.458	0.438	0.122	-0.143	0.108	-0.034	-0.102
PL	-0.268**	0.060	0.065	1.000	-0.097	-0.184	0.046	0.072	0.431	0.440	-0.065
DM	0.536**	0.328**	0.356**	-0.069	1.000	0.514	-0.002	-0.401	0.185	-0.057	-0.209
PH	0.694**	0.432**	0.338**	-0.171*	0.406**	1.000	0.212	-0.145	-0.258	-0.454	-0.215
NB	0.111	-0.076	-0.010	0.035	-0.049	0.203**	1.000	0.064	-0.256	-0.265	0.230
NP	-0.129	-0.181*	-0.161*	0.067	-0.338**	-0.108	0.107	1.000	-0.210	-0.128	0.451
SW	-0.083	0.209**	0.111	0.414**	0.147*	-0.242**	-0.221**	-0.184*	1.000	0.768	-0.135
100-SW	-0.349**	0.066	0.018	0.354**	-0.028	-0.373**	-0.240**	-0.143	0.626**	1.000	0.053
SY	-0.182*	-0.207**	-0.085	-0.057	-0.150*	-0.179*	0.215**	0.420**	-0.113	0.043	1.000

DF: Days to flowering, LL: Leaflet length (mm), LB: Leaflet breadth (mm), PL: Peduncle length (mm), DM: Days to maturity, PH: Plant height (cm), NB: Number of branches/plant, NP: Number of pods/plant, SW: Seed width (mm), SW: 100-seeds weight (g), SY: Seed yield/plant (g).
*Significance at α=0.1.
**Significance at α=0.1.

Table 4: Direct (diagonal) and indirect (off diagonal) path coefficients based on genotypic correlations on seed yield in lentil.

	DF	LL	LB	PL	DM	PH	NB	NP	SW	100-SW
DF⁺	**-0.257**	-0.123	-0.114	0.076	-0.199	-0.195	-0.037	0.045	0.023	0.104
LL	-0.0288	**-0.06**	-0.045	-0.004	-0.031	-0.031	0.006	0.014	-0.015	-0.007
LB	0.0228	0.038	**0.051**	0.003	0.024	0.023	0.006	-0.007	0.005	-0.002
PL	0.0711	-0.016	-0.014	**-0.24**	0.023	0.044	-0.011	-0.017	-0.104	-0.106
DTM	0.210	0.137	0.124	-0.026	**0.271**	0.139	-0.001	-0.109	0.050	-0.015
PH	-0.065	-0.044	-0.038	0.016	-0.044	**-0.086**	-0.018	0.012	0.022	0.039
NB	0.0423	-0.031	0.036	0.013	-0.001	0.062	**0.29**	0.019	-0.074	-0.077
NP	-0.086	-0.114	-0.071	0.036	-0.199	-0.072	0.032	**0.497**	-0.104	-0.064
SW	0.0174	-0.046	-0.020	-0.082	-0.035	0.049	0.049	0.039	**-0.19**	-0.146
100-SW	-0.132	0.039	-0.011	0.143	-0.018	-0.148	-0.086	-0.042	0.250	**0.326**
SY	-0.206	-0.220	-0.102	-0.065	-0.209	-0.215	0.230	0.451	-0.135	0.053

DF: Days to flowering, LL: Leaflet length (mm), LB: Leaflet breadth (mm), PL: Peduncle length (mm), DM: Days to maturity, PH: Plant height (cm), NB: Number of branches/plant, NP: Number of pods/plant, SW: Seed width (mm), SW: 100-seeds weight (g), SY: Seed yield/plant (g).

the fact that estimates may differ from location to location, year to year and even in the same year because of different study material method of estimation used.

Path coefficient analysis

On genotypic basis (Table 4) analysis revealed that among the ten characters studied, five characters exhibited positive direct effect and five negative direct effects on seed yield. Maximum positive direct effect on seed yield/plant was observed to be that of number of pods/plant followed by 100-seed weight, number of branches/plant, days to maturity and leaflet breadth. Seed yield/plant is also contributed by Number of pods/plant *via* days to flowering, leaflet length, plant height, number of branches/plant and by 100-seed weight *via* days to flowering and plant height. Apart from direct effects of number of branches/plant, it also unveiled positive indirect effect *via* leaflet length, leaflet breadth and number of pod/plant. Similarly, days to maturity contributes seed yield/plant *via* leaflet breadth, peduncle length, plant height and seed width. Therefore, for enhancement of seed yield emphasis should more be on the traits having positive and direct effect because of the reason that importance and balanced selection based on these traits would be more rewarding for improvement of lentil. Chowdhury *et al.,* (2019); Kumar *et al.* (2020); Maurya *et al.* (2020); Girgel *et al.* (2021) and Sharma *et al.* (2022) also reported more or less similar results in lentil.

CONCLUSION

In brief, moderate PCV and GCV coupled with high heritability and genetic advance for number of pods per plant and number of branches per plant suggested that additive gene action are responsible for inheritance of these characters and hence can be improved through direct selection. Also, these traits exhibited positive correlation, positive direct effects and positive indirect effects *via* other traits and therefore, can be emphasized upon during selection for seed yield improvement in lentil.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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