ESTIMATES OF GENETIC PARAMETERS AND PATH ANALYSIS IN LENTIL (*Lens culinaris* Medik)

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These studies were conducted to determine the genetic parameters and character association in elite lines of lentil (*Lens culinaris* Medik). Genetic parameters like genotypic and phenotypic variances, coefficients of variation, heritability, genetic advance, correlation coefficients and path coefficients were estimated. Significant variation was noted for all the traits. High heritability estimates were observed for all the traits except number of primary branches per plant. In general phenotypic coefficients of variability were greater than their corresponding genotypic coefficient of variability. Higher estimates of heritability and genetic advance were observed for seed yield (97.10%, 90.71%), harvest index (96.20%, 63.29%) and maturity days (95.90%, 63.39%) indicating that these characters are mainly controlled by additive genes and selection of such traits might be effective for the improvement of seed yield. Days to flower, plant height, number of primary branches, biological yield, harvest index and hundred seed weight had positive direct effect on seed yield. Biological yield, hundred seed weight and harvest index also had positive and highly significant genotypic and phenotypic correlation with seed yield. Hence these traits could be used for the improvement of seed yield resulting in the evolution of high yielding varieties of lentil.

Keywords: *Lens culinaris* Medik, heritability, correlation, genetic parameters, path analysis and seed yield

INTRODUCTION

Lentil seed is indigestible, constipating tonic and useful in diseases of chest and for ulcer treatment. Lentil is called poor man's meat because the seed is rich in protein (24.8%), carbohydrates (28.5%) and nitrogen (13.3%) (Gupta, 1982). In Pakistan, it is grown as a winter crop on an area of 39.0 thousand hectares with an annual production of 21.1 thousand tones having an average seed yield of 541 kg per hectare (Anonymous, 2008). The study of inheritance of various developmental and productive traits through the estimation of different genetic parameters like components of variances, genotypic and phenotypic coefficients of variability, heritability and genetic advance is helpful for framing an effective breeding programme.

Inability to visually recognize small differences in quantitative traits among single plant have led to frequent attempts to find associated traits more amenable to visual selection. The correlation coefficient gives a measure of the relationship between traits and provides the degree to which various characters of a crop are associated with productivity. Selection based on yield components is advantageous if different yield related traits have been well documented (Poehlman, 1991; Singh *et al*. 1995).

Higher genotypic correlation than that of corresponding phenotypic correlation has been observed by Sharma (1999). Whereas Rakesh *et al*. (1999) reported high genotypic and phenotypic coefficients of variability for seed yield per plant. Low heritability for days to flower, seed yield, biological yield, harvest index, days to mature, hundred seed weight, pods per plant and plant height was observed by Bicer and Sarkar (2004). Gowda *et al*. (1997) found higher estimates of heritability and genetic advance for seed yield in black gram (*Vigna mungo* L. Hepper). Similar estimates were also observed for most of the quantitative characters in chickpea (*Cicer arietinum* L.) by Yadav *et al*. (2003). Positive and significant correlations of seed yield with 100-seed weight, harvest index and plant height have also been reported in lentil (Om-Vir *et al*. 2001; Kumar *et al*. 2004) and Chick pea *(Cicer arietinum* L.) (Arshad *et al*. 2004). Priti *et al*., 2004 observed positive direct and indirect effect of days to flower, plant height, number of primary branches and hundred seed weight on seed yield in black gram (*Vigna mungo* L. Hepper.

MATERIALS AND METHODS

Study was conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during the year 2006-2007. The experimental material comprised of fourteen elite lines/varieties, namely, NL 56-1, NL 96, NL 9710, NL 9727, NL 96475A, NL 96617, NL 96625, NL 96635, NL 96639, NL 96680, NL 66184, NL 96475B, NIAB Masoor 2006 and Masoor 93. Each line consisted of 4 rows, 4m in length and 0.3m apart, sown in a randomized complete block design with three replications. Days to flower were recorded at 50% flowering and days to mature at 90% maturity. Five guarded plants of each genotype were taken from each replication at maturity and data on plant height, number of primary branches, pods per plant, biological yield, hundred seed weight, harvest index and seed yield were recorded. Mean values were taken for all the traits and their averages were used for statistical analysis according to Steel *et. al*. (1997). Genetic parameters (variance components, genotypic and phenotypic coefficients of variation, heritability, genetic advance and path coefficients were estimated according to Singh and Chaudhary (1985) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

Highly significant differences were observed for all the traits except number of primary branches per plant (Table 1). This considerable variability provides a good chance of improvement in lentil. In general, phenotypic coefficient of variability was higher than corresponding genotypic coefficient of variability for all the traits which demonstrated the effect of environment upon the traits (Table 2). The highest phenotypic coefficient of variability was recorded for seed yield (45.29%), harvest index (31.89%) and biological yield (31.79%). The highest estimates of genotypic coefficient of variability were observed for seed yield (44.63%), harvest index (31.27%) and biological yield (31.23%) that indicates the presence of exploitable genetic variability for these traits. Heritability estimates were greater for traits like flowering days (99.70%), seed yield (97.10%), biological yield (96.50%), harvest index (96.20%), maturing days (95.90%), hundred seed weight (93.80%), pods per plant (88.40%) and plant height (80.30%). In general, all the traits except number of primary branches per plant had higher heritable variation. Hence it can be assumed that phenotypes of almost all the traits except primary branches are mainly determined by their genotypes. The results do not agree with Bicer and Sarkar (2004). Higher estimates of genetic advance were observed for seed yield (90.71%), harvest index (63.29%) and days to mature (63.39%). High heritability values coupled with high genetic advance were observed for seed yield, harvest index and days to mature. From the results it can be concluded that all these traits are controlled by additive type of gene action as reported by other workers (Johnson *et al*. 1955 and Panse, 1957). Similar results were also obtained by Gowda *et al*. (1997) in black gram (*Vigna mungo* L. Hepper) who reported high heritability coupled with high genetic advance for most of the quantitative characters. Improvement in these traits, i.e. seed yield, harvest index and maturity days can be achieved through mass selection. High values of heritability and genetic advance for seed yield, harvest index and days to mature showed that all these traits are controlled by additive type of gene action. Similar results have been reported by Yadav *et al*. (2003).

The estimates of correlation coefficient between seed yield and yield related traits indicated that in general genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients (Table 3). Similar results were also obtained by Sharma (1999). Days to flower had negative correlation with all the traits except pods per plant. Negative and significant correlation of days to flower with harvest index has also been observed. Days to mature had positive and significant genotypic and phenotypic correlation with all the traits including seed yield. Hence the results revealed that long duration genotypes have all the desirable traits. The results are in line with Arshad *et al*. (2004). Plant height had positive correlation with biological yield and seed yield. Positive correlation of plant height with seed yield has also been reported by Kumar *et al*. (2004). Number of primary branches had positive correlation with biological yield, 100-seed weight and harvest index. Positive and significant correlation of pods per plant with biological yield and seed yield has been observed. Pods per plant also had positive correlation with hundred seed weight and harvest index. Similar results were observed by Om-Vir *et al*. (2001). Biological yield had significant positive genotypic and phenotypic correlation with hundred seed weight and seed yield and positive correlation with harvest index. Positive and significant correlation of 100-seed weight and seed yield has been observed. Harvest index showed highly significant and positive correlation with seed yield at both the genotypic and phenotypic levels. From the results of correlation coefficients it can be concluded that indirect selection for maturity days, pods per plant, biological yield, hundred seed weight and harvest index would be more effective for the improvement of seed yield in lentil.

Direct and indirect effects of different seed yield components (Table 4) indicated that flowering days, plant height, number of primary branches, biological yield, harvest index and hundred seed weight showed positive direct effect, while the traits like days to mature and pods per plant have negative direct effects on seed yield. These results do not agree with Priti *et al*. (2003). Days to flower affect seed yield negatively and indirectly through all the traits except days to mature.

Table 1. Analysis of variance for different morphological and economic trait in lentil

Sr. #	Traits	Sum of Squares	Mean Squares	F-value
1	Days to flower	4015.63	308.89	862.42**
2	Days to mature	570.43	43.88	70.48**
3	Plant height (cm)	585.83	45.07	13.19**
4	No. of primary branches	18.00	1.39	2.23^{NS}
5	Pods per plant	68454.25	5265.71	23.97**
6	Biological yield (g)	1.23	949577.9	83.97**
7	I00-seed weight (g)	7.19	0.56	46.17**
8	Harvest index	5181.23	398.56	76.17**
9	Seed yield (Kg/ha)	3572314	274793.4	102.80**

** = Significant at 0.01 probability level, NS = Non significant

Table 2. Genetic parameters for different morphological traits in lentil

Variables	V_G	V_P	GCV%	PCV%	h^2	GA
Days to flower	102.84	103.20	12.07	12.09	99.70%	24.88
Days to mature	14.41	15.04	2.90	2.98	95.90%	63.39
Plant height (cm)	13.89	17.29	8.90	9.94	80.30%	16.48
Number of primary Branches	0.26	0.88	10.81	20.05	29.10%	11.95
Pods per plant	681.99	1901.73	14.64	15.57	88.40%	28.38
Biological yield (g)	312756.10	324065.60	31.23	31.79	96.50%	19.91
100-seed weight (g)	0.18	0.19	19.44	20.08	93.80%	37.99
Harvest index	131.10	136.34	31.27	31.89	96.20%	63.29
Seed yield (Kg/ha)	90706.79	93379.86	44.63	45.29	97.10%	90.71

V_P = Phenotypic variance, V_G = Genotypic variance, PCV% = Phenotypic coefficient of variability, GCV% = Genotypic coefficient of variability, h^2 = heritability, G.A = Genetic advance

Table 3. Estimates of genotypic (top figures) and phenotypic (bottom figures) correlation coefficients in lentil

Traits		Days to flower	Days to mature	Plant height (cm)	No. of primary Branches	Pods per plant	Biological yield (g)	100-seed weight (g)	Harvest index
Days to mature	G P	-0.12 -0.12							
Plant height (cm)	G P	-0.08 -0.15	0.71** 0.61*						
No. of primary branches	G P	-0.02 -0.02	0.59* 0.33	-0.16 -0.02					
Pods per plant	G P	0.16 0.15	0.64* 0.59*	0.32 0.27	0.40 0.24				
Biological yield (g)	G P	-0.22 -0.21	0.76** 0.73**	0.55* 0.51**	0.63 0.36	0.62* 0.57*			
100-seed weight (g)	G P	-0.55* -0.53	0.66* 0.61*	0.63* 0.55*	0.27 0.18	0.45 0.39	0.62* 0.59*		
Harvest index	G P	-0.60 * -0.58*	0.44 0.42	-0.01 0.02	0.33 0.17	0.36 0.36	0.33 0.32	0.66* 0.62*	
Seed yield (Kg/ha)	G P	-0.50 -0.49	0.65* 0.63*	0.21 0.22	0.57* 0.34	0.65* 0.52	0.72** 0.72**	0.77** 0.73**	0.88** 0.87**

*, ** = Significant at 0.05 and 0.01 probability levels, respectively

Table 4. Direct and Indirect effects of different traits on seed yield

Traits	Days to flower	Days to mature	Plant height (cm)	Number of primary branches	Pods/ plant	Biological yield (g)	Harvest index	100-seed weight (g)	Genetic correlation with Seed yield
Days to flower	(0.1321)	0.0199	-0.0001	-0.001	-0.010	-0.1770	-0.4636	-0.0603	-0.5008
Days to mature	-0.0163	(-0.161)	0.0009	0.0382	-0.0405	0.4114	0.3474	0.7220	0.6524
Plant height (cm)	-0.0108	-0.1145	(0.0013)	-0.0102	-0.0202	0.2982	-0.0027	0.0691	0.2102
No. of primary branches	-0.0021	-0.0947	-0.0002	(0.0651)	-0.0251	0.3457	0.2526	0.0301	0.5714
Pods/plant	0.0209	-0.1035	0.0004	0.0259	(-0.063)	0.3380	0.2784	0.0493	0.5463
Biological yield (g)	-0.0285	-0.1216	0.0007	0.0413	-0.0391	(0.5448)	0.2576	0.0682	0.7234
Harvest index	-0.0788	-0.072	0.000	0.0212	-0.0226	0.1806	(0.7770)	0.0723	0.8777
100-seed weight (g)	-0.0723	-0.1055	0.0008	0.0177	-0.0282	0.3367	0.5095	(0.1103)	0.7691

Indirect effects of days to mature were positive through the traits i.e. plant height, primary branches, biological yield and harvest index. Indirect effects of plant height on seed yield were negative through all the traits except biological yield and hundred seed weight. Positive indirect effects of primary branches were observed through the traits like biological yield, harvest index and hundred seed weight. Like wise positive indirect effects of pods per plant through all the traits except days to mature have been observed. Indirect effects of biological yield were positive through the traits like plant height, primary branches, harvest index and 100-seed weight. Harvest index affects seed yield positively and indirectly via primary branches, biological yield and 100-seed weight. No indirect effect of plant height on seed yield has been observed. Indirect effects of 100-seed weight were positive through plant height, primary branches, biological yield and harvest index, while negative through all other traits.

The traits like primary branches, biological yield, harvest index and hundred seed weight had positive direct effects along with positive and highest genotypic correlation with seed yield. From the results it can be concluded that seed yield can be increased by selecting ideotypes having more number of primary branches, pods per plant, hundred seed weight and harvest index.

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