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INHERITANCE OF SEED YIELD AND RELATED TRAITS IN SOME LENTIL *(Lens culinaris* Medik*)* GENOTYPES

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The study was conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during the year 2006-2007. Fifteen lentil lines/varieties were evaluated to exploit yield components to the maximum extent and to formulate selection criteria for the improvement of seed yield. Significant genetic variation was observed for all the traits. All the traits under study had high heritability values except number of primary branches. Higher values of heritability coupled with genetic advance were observed for seed yield (98.30%, 128.20%), harvest index (97.10%, 79.40%), biological yield (94.30%, 56.10%) and hundred seed weight (88.30%, 50.80%) which indicates the role of additive genes to control these traits. Hundred seed weight (0.67, 0.65), harvest index (0.94, 0.93) and biological yield (0.81, 0.80) had positive and highly significant correlation with seed yield at both genotypic and phenotypic levels. Number of primary branches, hundred seed weight, harvest index and biological yield showed positive direct effect along with positive genotypic correlation with seed yield. Finally, it was concluded that the traits like hundred seed weight, harvest index and biological yield can be exploited for the improvement of seed yield in lentil.

Keywords: *Lens culinaris* Medik*,* genetic variation, heritability, genetic advance, correlation, seed yield

INTRODUCTION

Lentil *(Lens culinaris* Medik*)* belongs to family papilionaceae originated in India, where it is most widely grown and highly esteemed legume. The major lentil growing countries in South Asia are India, Nepal, Bangladesh and Pakistan. These countries produce about 0.9 million tones of lentil annually from an area of 1.3 million hectares, which represent about 36% of the world area. Lentil often called the "poor man" meat for its rich protein content (24.8%). In Pakistan lentil is grown 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/ha (Anonymous, 2007-08), which is low that cannot meet the demand of ever rising population. There is a dire need to increase the seed yield per hectare of lentil to meet day to day requirement. The success of any plant breeding programme aimed at the evolution of high yielding, better quality, fertilizer responsive and disease resistant varieties depends upon the selection of suitable plants to be utilized in breeding programme. There is a need for new genes and improved genetic recombinants not found either in the cultivated varieties or their relatives. The correlation coefficient (r) gives the measure of relationship between traits and provides the degree to which various characters are associated with productivity. It is the result of direct and indirect effects of a number of plant traits. Thus, selection based on these characters rather than seed yield would be more effective. Higher estimates of different genetic parameters has been observed by various workers (Byregowda *et al*. 1997; Gill *et al*. 1995; Wahid and Ahmad, 1998). Selection based on yield components is advantageous if different yield related traits have been well documented (Poehlman, 1991; Singh and Singh, 1995). Path coefficient analysis separates the direct effects from indirect effects by partitioning correlation coefficients (Dewey and Lu, 1959).

Positive and significant correlation of seed yield with number of primary branches and pods per plant have been reported by Naseem *et al*. (1995) and Ayub *et al*. (2001). However, negative correlation of days to flower with seed yield has been noted by Byregowda *et al*. (1997) and Gill *et al*. (1995). Positive direct effect of plant height, number of branches per plant and number of pods per plant has also been reported in literature (Amarah *et al*. 2005; Kar *et al*. 1995; Veerabandhiran and Jahangir, 1995).

MATERIALS AND METHODS

The study was conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during the year 2006-2007.The experimental material comprised of fifteen candidate lines/varieties of lentil, namely, NL-56-1, NL-96625 NARC-06-1, NARC-06-2, NARC-06-3, NARC-06-4, NARC-06-5, AEL-23/40, 98CL-008, 00518, 98502, 01505,01512, Masoor 93 and NIAB Masoor 2006. The material was sown in Randomized Complete Block Design (RCBD) with three replications in plot measuring 4.8m^2 having row to row distance of 0.3m and plant to plant distance of 0.1m. Four rows of each genotype having 4m length were sown. Days to flower were recorded at 50% flowering and days to maturity were recorded at 90% maturity. Five guarded plants were selected from central two rows in each genotype (repeat wise) and data on plant height, number of primary branches, number of pods per plant, biological yield and seed yield were recorded. Biological yield was recorded after sun drying of plants for seven days (constant weight). Hundred seeds were counted randomly and weighed at digital electronic balance. The mean data were subjected to the analysis of variance as suggested by Steel and Torrie (1984). Components of variance, coefficients of variation, heritability and expected genetic advance (as % of mean) were computed by following the method proposed by Robinson *et al*. (1951). Correlation coefficient analysis was performed according to Singh and Chaudhary (1985). The methodology proposed by Dewey and Lu (1959) was used to perform the path analysis for seed yield and its components by keeping seed yield as resultant variable and other traits as causal variables.

RESULTS AND DISCUSSION

Highly significant differences were observed for all the traits except number of pods per plant (Table 1). This considerable variability provides a good chance for the improvement in lentil. Different genetic parameters, i.e. genotypic and phenotypic variances, genotypic and phenotypic coefficient of variability, heritability and expected genetic advance as % of mean are presented in Table 2. Heritability values were high for all the traits except number of primary branches per plant. In general the estimates of phenotypic coefficient of variability were higher than their corresponding genotypic coefficient of variability for all the traits, which demonstrated the effect of environment upon the characters. However, the results do not agree those of Gill *et al*. (1995). The highest genotypic and phenotypic coefficients of variability were observed for biological yield (28.01%, 28.85%), seed yield (62.75%, 63.28%) and harvest index (38.94%, 39.51%). It means such traits are mainly controlled genetically but also influenced by the environment. Highest estimates of heritability coupled with moderate to high genetic advance were observed for days to flower (99.30%, 21.60%) and harvest index (97.10%, 79.40%). Such characters are mainly controlled by additive types of genes. Additive type of genes may be exploited more efficiently for selecting high yielding genotypes. High values of heritability and genetic advance for seed yield has also been reported by Johnson *et al*. (1955) and Panse (1957).

The relationship among various traits has been given in Table 3. Days to flower showed positive correlation with days to mature, plant height, number of primary branches and number of pods per plant and negative correlation with biological yield, and also had negative but significant correlation with hundred seed weight,

Table 1. Analyses of variance of different morphological and economic traits of lentil

SOV	Days to flower	Days to mature	Plant height	No. of Primary branches	Pods/plant	100-Seed weight	Harvest index	Biological Yield	Seed yield
Sum of squares	3889.70	455.80	524.40	5.24	46275.25	6.55	6644440.000	1919990.00	3402.60
Mean Squares	277.80**	32.50**	37.40**	0.37**	3305.30^{NS}	0.46**	243.40**	474602.90**	13742.50**
F value	450.17	61.55	17.11	1.36	17.95	23.80	50.74	177.55	102.90

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

Table 2. Genetic parameters for different morphological traits in lentil

Traits	V_P	PCV%	V_G	GCV%	h^2	G.A
Days to flower	93.02	10.63	92.41	10.59	99.30	21.60
Days to mature	11.20	2.64	10.68	2.58	95.30	5.19
Plant height (cm)	13.94	9.02	11.75	8.27	84.30	15.60
No. of primary branches	0.31	10.76	0.03	3.541	10.80	2.36
Pods/plant	1224.51	14.61	1040.43	13.45	85.00	25.50
100-seed weight (g)	0.17	25.75	0.15	24.19	88.30	50.80
Harvest index	82.59	39.51	80.23	38.94	97.10	79.40
Biological yield (g)	164435.80	28.85	155083.00	28.02	94.30	56.10
Seed yield (kg/ha)	46229.10	63.28	45456.70	62.76	98.30	128.00

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 harvest index and seed yield. The results were in line with Wahid and Ahmad (1998). Days to mature had positive correlation with all the traits. Plant height also had positive correlation with number of primary branches, pods per plant, biological yield and seed yield but negative with hundred seed weight and harvest index. Likewise, number of primary branches had positive correlation with all the traits except harvest index. These results support those of Naseem *et al*. (1995) who reported that seed yield was positively associated with number of primary branches and pods per plant. Pods per plant had positive and significant correlation with biological yield and number of primary branches. Naseem *et al*. (1995) reported similar results. There was positive and non significant correlation between seed yield and pods per plant at both genotypic and phenotypic levels. However, Ayub *et al*. (2001) reported positive and significant correlation between seed yield and pods per plant.

It is evident from Table 3 that 100-seed weight, harvest index and biological yield had strong positive and highly significant correlations with seed yield at both genotypic and phenotypic levels. In addition, strong positive associations of biological yield with hundred seed weight and harvest index and similar between hundred seed weight and harvest index were also found. From the results it can be concluded that the traits like biological yield, 100-seed weight and harvest index having strong associations with seed yield must be given due consideration for the improvement of seed yield in lentil.

Direct and indirect effects of different yield related traits (Table 4) indicated that days to flower had positive direct effect on seed yield. Days to flower affect seed

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/ plant	100-seed weight (g)	Harvest index	Biological yield (g)
Days to mature	0.11 0.10							
Plant height (cm)	0.17 0.15	0.03 0.03						
No. of primary branches	0.25 0.07	0.70** 0.22	0.12 0.05					
Pods/plant	0.02 0.01	0.43 0.39	0.47 0.41	0.63* 0.18				
100-seed weight (g)	-0.78** -0.74**	0.29 0.26	-0.02 -0.01	0.09 0.12	0.02 0.01			
Harvest index	-0.79** -0.78**	0.22 0.22	-0.02 -0.03	0.01 -0.03	0.28 0.26	0.80** 0.73**		
Biological yield (g)	-0.16 -0.15	0.52* 0.49	0.28 0.26	0.45 0.24	0.63* 0.54*	0.23 0.24	0.60* 0.56	
Seed yield (kg/ha)	-0.60* -0.59*	0.40 0.39	0.06 0.07	0.23 0.09	0.39 0.35	0.67** 0.65**	0.94** 0.93**	0.81** 0.80**

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

Table 4. Direct and indirect effects from path coefficient analysis of different morphological traits in lentil

Traits	Days to flower	Days to mature	Plant height (cm)	No. of primary branches	Pods/plant	100-seed weight (g)	Harvest index	Biological yield (g)	Genetic correlation with Seed yield
Days to flower	(0.7420)	-0.0018	0.0012	0.0460	-0.0040	0.0488	-0.7065	-0.0573	-0.0488
Days to mature	0.0076	(-0.0175)	-0.0002	0.1264	-0.0795	-0.1840	0.1985	0.1877	0.4045
Plant height (cm)	0.0128	-0.0131	(-0.0068)	0.0023	-0.0868	0.0010	0.0184	0.1006	0.0609
No. of primary branches	0.0189	-0.0122	-0.0008	(0.1810)	-0.1158	-0.0059	0.0770	0.1618	0.2346
Pods/plant	0.0016	-0.0076	-0.0032	0.1137	(-0.0184)	-0.0013	0.2435	0.2278	0.3902
100-seed weight (g)	-0.0579	-0.0052	0.0001	0.0171	-0.0039	(-0.0620)	0.7006	0.0836	0.6719
Harvest index	-0.0593	-0.0039	-0.0001	0.0016	-0.0508	-0.0470	(0.8837)	0.2137	0.9351
Biological yield (g)	0.0118	-0.0092	-0.0019	0.0816	-0.1170	-0.0146	0.5261	(0.3589)	0.8121

yield positively and indirectly via the traits, i.e. plant height, number of primary branches and harvest index. Negative direct effects of days to mature and plant height were observed. The results are not in line with Kar *et al*. (1995) who reported that plant height had positive direct effect on seed yield. Number of primary branches had positive direct effects along with positive genotypic correlation with seed yield. The results were similar to Amarah *et al*. (2005). Indirect effects of branches per plant were also positive through the traits like days to flower, biological yield and harvest index and were negative via days to mature, plant height, pods per plant and hundred seed weight. Pods per plant had negative direct effect and indirect effects were also negative through the traits like days to mature, plant height and hundred seed weight. The results did not agree those of Panse (1957) who reported positive direct effect of pods per plant on seed yield. The direct effect of 100-seed weight on seed yield was negative but indirect effects were positive through plant height, primary branches and biological yield. Harvest index also had positive direct effect on seed yield with positive genotypic correlation. But indirect effects were negative through all the traits except plant height, primary branches and biological yield. Positive direct effect along with positive genotypic correlation of biological yield with seed yield has been observed. But indirect effects were negative through all the traits except plant height, primary branches and biological yield. From the results it can be concluded that number of primary branches, biological yield and harvest index had positive direct effects along with positive and highest genotypic correlation with seed yield. Hence these traits can be used for the improvement of seed yield and very useful in the evolution of high yielding lentil genotypes.

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