HERITABILITY AND PATH ANALYSIS OF SOME ECONOMICAL CHARACTERISTICS IN LENTIL

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ABSTRACT

Twenty-nine lentil (Lens culinaris Medik) genotypes were grown from 1997/98 to 1998/2001 at Dicle University, Faculty of Agriculture in Diyarbakir The heritability for days to flowering and maturity, plant height, height of lowest pod, number of pod per plant, 1000 seed weight and seed yield were estimated as 0.94, 0.78, 0.52, 0.72, 0.37, 0.87 and 0.53, respectively. The path analysis indicated that total biological yield and number of clusters and pods per plant had very high positive direct effect on seed yield.

Key words: Lentil, Lens culinaris, Heritability, Path analysis

INTRODUCTION

Information on genetic variability and heritability is useful to formulate selection criteria for improvement of seed yield. Since lentil (Lens culinaris Medik) is primarily a rain fed crop, yield stability is a major objective in any breeding program. This could be achieved through a better understanding of the components contributing to final yield. However, these components vary from year to year and from location to location, even for the same lentil genotype (Muehlbauer et al. 1985 from [15]). Negative correlations are often found between morphological components of yield in crop plants. They probably arise primarily from developmentally-induced relationships [14]. The moderate heritability estimates for days to maturity and seed weight and low heritability for biological yield and seed yield per plant were reported by Rao and Yadav (1988) [11]. However, other researchers [3] suggested that low heritability estimate for plant height and high heritability estimate for 100 seed weight and this was followed by days to maturity, number of pods per plant, biological yield/plant and seed yield/plant. Also, they indicated that identification of important yield contributing characteristics is also helpful to establish a successful breeding program. The direct effects of days to flower, plant height and 100 seed weight on grain yield were negative [2], in other studies, the direct effect of seed weight on seed yield was positive and low; days to maturity had a negative direct effect [5]; also, biological yield and clusters per plant had the highest positive direct effect on seed yield per plant [13]. Correlations showed that seed yield showed highly significant and positive association with number of pods/plant and biological yield/plant [9]. The aim of this work was to identify variability and heritability estimates of economically important plant characteristics and to determine the characteristics contributing to seed yield in lentil, collected from Southeastern Anatolia, Turkey, a famous region in lentil production.

MATERIAL AND METHODS

The present study was carried out at the Experimental Farm of Dicle University, Faculty of Agriculture in Diyarbakir, during 1997/98, 1998/99, 1999/2000, and 2000/2001 seasons. Three checks and 26 lentil lines collected from South-eastern Anatolia of Turkey were used as material. Twenty-nine lentil genotypes were planted in the late fall; in a randomised block design with four replications, in plots of 4 rows, each 3m long and spaced 20 x 2.5 cm. The days to flower and maturity were recorded on a whole plot basis, and biological yield and seed yield per plant, plant height, first pod height, number of clusters and pods per plant were recorded from a random sample of ten plants in each plot. Harvest area was 1.2 m^2 each plot. Analysis of variance, were conducted and means of genotypes over years were determined for all characters, using by MSTATC statistical program (Michigan State University, East Lansing, MI). Variance components were estimated from expected mean squares (genotypic variance:$\sigma^2 e + r^2_{gy} + ry\sigma^2_g$, genotype x year variance: $\sigma^2 e + 4^2\sigma_{gy}$, phenotypic variance:$\sigma^2_g + \sigma^2_{gy}/4 + \sigma^2 e/16$) and value of broad-sense heritability of characters were by estimated the ratio of genotypic variance to phenotypic variance ($\sigma^2_g / \sigma^2 p$) [4]. Path coefficient analysis was conducted to determine direct and indirect contribution of various yield components to seed yield, using by TARIST statistical program [1].

RESULTS AND DISCUSSION

The analysis of variance and estimated variance components and broad-sense heritability of investigated characters were shown in Table 1. Correlation and path coefficient results were given in Table 2. Genotypes, years and genotype x year interaction of genotypes were significant for all the characteristics.

The range for days to 50% flowering was 141-157 days. This character exhibited the highest broad-sense heritability as 0.94 (Table 1). Direct effect of days to flowering on seed yield was negative, but the correlation between these characters was positive (0.232**). This was mainly due to positive indirect effects through total biological yield and number of clusters per plant and number of pods per plant (Table 2). Days to maturity varied from 185 to 196 days. The broad-sense heritability for this character was observed as 0.78. High heritability value was suggested that both characters were not affected by the growing environment. The direct effect of this character on seed yield was negligible. The moderate positive relationship between days to maturity and seed yield was due to the indirect effects via total biological yield, number of clusters and pods per plant was, but indirect effect of days to maturity via biological yield per plant were negative. According to Kusmenoglu and Muehlbauer from [15], high seed yield has been obtained through development of cultivars with shorter vegetative and generative growth periods.

Plant height varied from 29.3 to 35.5 cm. This characteristics exhibited medium heritability (0.52). Kumar and Dubey (2001) [8] noted that broad sense heritability value was the highest (0.74) for plant height. The correlation between plant height and seed yield was positive (0.475**). Its direct effect was also positive (0.1045), indirect effects of this character via

Table 1 Analysis of Variance and Variance Components Estimated and Heritability of Some Characters on 29 Lentil Lines during 1998/2001

Variation Sources	D.F	Days to %50 flowering	Days to maturity	Biological yield/plant	Seed yield/plant	Plant height	First pod height	Number of clusters/plant	Number of pods/plant	1000 seed weight	Seed yield	Total biological yield
Year	3	26680.4**	67184.2**	285.1**	29.27**	10035.3**	3343.9**	8632.2**	19905.4**	33.8**	2171257**	20988187**
Error	12	1.337	5.46	0.89	0.63	51.14	16.37	47.81	87.33	3.08	171568	97918
Genotype	28	238.3**	162.7**	1.15**	1.24**	55.3**	38.9**	89.08**	140.9**	82.4**	40315**	235303**
Genotype x year	84	14.9**	35.8**	1.09**	1.49**	26.3**	10.98	62.89**	88.62**	11.5**	19083**	148775**
Error	336	1.77	2.64	0.52	0.40	12.15	8.28	29.23	52.55	2.21	6638	76776
Total	463	191.3	453.7	2.51	0.843	83.28	32.44	95.18	193.9	8.97	25230	235469
CV%		0.88	0.84	22.1	22.1	10.5	16.6	26.6	26.8	4.3	164	162
Means		150.56	191.4	3.3	1.3	33.1	17.3	20.3	27.0	34.3	1566	5389
Range		141-157	185-196	2.6-3.8	0.9-2.4	29.3-35.5	13.4-19.3	16.8-25.3	20.7-33.4	29.3-39.8	1280-2090	4660-6140
Variance		**Variance Components Estimated From Expected Mean Squares Heritability**										
Genotype		13.96	7.93	0.004	0.015	1.81	1.75	1.64	3.25	4.83	1327	5408.0
Genotype x year		3.28	8.29	0.143	0.27	3.54	0.68	8.42	9.08	2.32	3111.3	17999.8
Phenotype		14.89	10.17	0.072	0.108	3.45	2.43	5.57	8.8	5.55	2512	14706.5
Heritability		0.94	0.78	0.05	0.13	0.52	0.72	0.29	0.37	0.87	0.53	0.37
Phenotypic advance		7.4	5.1	0.03	0.09	1.96	2.28	1.39	2.23	4.16	17.04	28.79
Genotypic advance		7.1	4.5	0.01	0.03	1.42	1.20	0.75	1.35	3.88	12.39	17.46

*, **, Significant at the 0.05 and 0.01 probability level respectively.

total biological yield and number of pods and clusters per plant were also positive and high. But the effects via biological yield per plant were negative. First pod height varied from 13.4 to 19.3 cm. This character exhibited a high heritability (0.72). Direct effects of this trait on seed yield were small and negative. The moderate correlation between first pod height and seed yield (0.414**) was due to positive indirect effects of this character via total biological yield, number of pods and clusters per plant.

Number of clusters per plant ranged from 16.8 to 25.3, and broad sense heritability was (0.29), and indicated that this trait was affected by different environmental conditions. Correlation between number of clusters per plant and seed yield was positive and high (0.612**). This was due to the positive direct effect of this character on seed yield (0.3075). Positive indirect effects were through total biological yield and number of pods per plant. The range for number of pods per plant was 20.7-33.4. This character showed moderate heritability as 0.37 (Table 1). Positive direct effect of number of pods per plant and indirect positive effect via total biological yield and number of clusters per plant were the main reason for strong positive correlation of this character with seed yield (0.608**). But, indirect effect of this character via biological yield per plant was negative. Similar results were reported by [2, 5]. However, in other study, it was determined that number of seeds/plant had the highest direct and indirect effects on seed yield followed by pods/plant [7]. Genotypic advance of the trait was 1.35 (Table 1), and Hamdi et al. (2002) [6] reported low genetic advance for this character.

Biological yield per plant ranged from 2.6 to 3.8 g. This character showed the lowest heritability (0.05) among the whole characters. The findings agree with Rao and Yadav (1988) [11], but some researchers reported that biological yield was exhibited high heritability [3]. There was negative direct effect (-0.3536) on seed yield, while correlation of biological yield plant^{-1} and seed yield was positive (0.491**). This positive correlation with seed yield was mainly due to positive indirect effects through total biological yield, number of pods and clusters per plant. Seed yield per plant showed a very low heritability (0.13). These findings agree with Muehlbauer et al. (1994) [10], but in other studies high heritability value was determined for this character [11, 3]. Direct effect was negligible. Moderate correlation with seed yield (0.366**) was due to positive via total biological yield, number of pods and clusters per plant. A wide variability (4660-6140 kg/ha) for total biological yield was observed. This character exhibited moderate heritability (0.37). There was a very high positive direct effect of total biological yield on seed yield (0.6085). The strong

Table 2 The Direct and Indirect Contribution of Various Traits on Grain Yield in Lentil

Traits	Days to %50 flowering	Days to maturity	Biological yield/plant	Seed yield/plant	Plant height	First pod height	Number of clusters/plant	Number of pods/plant	1000 seed weight	Biological yield	**Correlation Coefficient**
Days to %50 flowering	**-0.0412**	-0.0463	-0.1466	0.0131	0.0441	-0.0366	0.1418	0.1146	-0.0031	0.1926	0.232**
Days to maturity	-0.0330	**-0.0578**	-0.2522	0.0214	0.0773	-0.0620	0.1838	0.1905	-0.0037	0.2777	0.342**
Biological yield/plant	-0.0171	-0.0412	**-0.3536**	0.0323	0.0825	-0.0652	0.2454	0.2667	-0.0093	0.3506	0.491**
Seed yield/plant	-0.0094	-0.0216	-0.1991	**0.0573**	0.0427	-0.0330	0.1616	0.1702	0.0045	0.1927	0.366**
Plant height	-0.0174	-0.0427	-0.2790	0.0234	**0.1045**	-0.0805	0.1843	0.2060	-0.0037	0.3801	0.475**
First pod height	-0.0165	-0.0392	-0.2523	0.0207	0.0922	**-0.0913**	0.1624	0.1835	-0.0039	0.3583	0.414**
Number of clusters/plant	-0.0190	-0.0345	-0.2822	0.0301	0.0627	-0.0482	**0.3075**	0.2796	-0.0078	0.3236	0.612**
Number of pods/ plant	-0.0157	-0.0365	-0.3129	0.0324	0.0715	-0.0556	0.2853	**0.3014**	-0.0090	0.3471	0.608**
1000 seed weight	0.0012	0.0020	0.0312	0.0024	-0.0037	0.0033	-0.0226	-0.0258	**0.1057**	-0.0519	0.042ns
Total biological yield	-0.0131	-0.0264	-0.2038	0.0181	0.0653	-0.0538	0.1635	0.1719	-0.0090	**0.6085**	0.721**

*, **, Significant at the 0.05 and 0.01 probability level respectively.

direct effect of this character was the main reason for the strong positive correlation (0.721**) with seed yield. There were also positive and smaller indirect effects via number of pods and clusters per plant and negative via biological yield per plant.

1000 seed weight ranged from 29.3 to 39.8 g. High heritability was noted (0.87), and genotypic advance was 3.88 for this character (Table 1). Hamdi et al. (2002) [6] indicated that 1000 seed weight was showed the relatively high heritability, coefficient of genetic variation and genetic advance. Direct effect of this character on seed yield was positive, but small. The correlation between 1000 seed weight and grain yield was positive, but low and insignificant (0.042). Similarly, Luthra and Sharma (1990) [9] reported that this trait was positive direct effect on grain yield, and he noticed that selection of high yielding and large seeded cultivars were possible.

Seed yield per hectare ranged from 1280 to 2090 kg. This character showed medium heritability (0.53). Genotypic advance was 12.39 (Table 1). Hamdi et al (2002) [4] reported that low genetic advance was obtained for seed yield. Positive correlations with all the characters -except with 100 seed weight - were significant. These findings agree with Singh (1977) [12] who reported that grain yield and plant dry matter showed positive correlation with pod number and plant height, but negative correlation with 100-seed weight. However, it had the highest correlations with biological yield, number of clusters and pods per plant. Hamdi et al (2003) [7] showed that seed yield was positively and significantly correlated with pod numbers, plant height and negatively with flowering duration. In path analysis, biological yield, number of cluster and pods per plants showed the highest direct effect.

CONCLUSIONS

In this study, days to 50% flowering, days to maturity, first pod height and 1000 seed weight appear to have large heritabilities indicating low environmental effects for these characters. Plant height and seed yield showed a moderate heritability, but seed yield per plant, number of branches, pods and seeds per plant and biological yield have low heritabilities indicating high environmental effects on those characters. Biological yield, number of clusters and pods per plants showed the highest direct effects on seed yield, therefore, seem to be the main characters influencing seed yield. Based on this study it is suggested to develop high biological yielded varieties with good pod bearing clusters.

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