PATH ANALYSIS FOR YIELD AND YIELD COMPONENTS IN LENTIL (*Lens culinaris* Medik.)

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ABSTRACT

This study was carried out to investigate relationships between yield and yield components by using a correlation and path coefficient analysis path coefficient in a population of 24 small seeded lentil varieties (*Lens culinaris* Medik.) and a control varieties, named 'Kışlık kırmızı-51'. The positive and significant were found between the yield and biological yield (r = 0.833**) and yield and harvest index (r = 0.687**). Biological yield and harvest index had significant direct effect (0.6969 and 0.4947, respectively) on seed yield. According to results, biological yield and harvest index should be considered in the breeding programs to increase yield.

Keywords: Lens, correlation, path analysis, yield, yield component

INTRODUCTION

The principal aim of lentil production is to obtain high yield. Therefore, we must use the available lentil species towards this aim. Genotype and environmental conditions are dominant factors influencing the amount of harvested yield. Even though environmental conditions are partially controllable, genotype of the plant can only be changed by breeding. It is well known that while there is a positive and significant relationships among the number of pod, biological yield and the number of seed/plant; a negative significant correlation between yield and the number of seed in pod and 1000 seed weight were reported (Luthra and Sharma, 1990). Tikka *et al.* (1997) reported that seed yield is a function of plant height, the number of the pod/per plant and the number of seed/per pod and there are positive correlations among the given traits. Biological yield, harvest index, the number of seed/per plant, the number of the pod/per plant the number of main and lateral branches and the number of seed/per pod are the yield components determining the amount of seed yield (Çiftçi *et al.*, 1998).

Path analysis is used to determine the amount of direct and indirect effects of the causal components on the complex component (Güler et al., 2001). The relationships between yield and plant characters affecting yield and in between these characters are usually neglected and often reported as meaningless (Sing *et al.*, 1973). Ghafoor et al. (1990) has found a positive direct effect of harvest index and biological yield on yield. According to path analysis, there were strong direct effects of the biological yield, harvest index and number of seeds per plant on the seed yield (Çiftçi *et al.*, 2004). Yadav et. al. (2003) indicated that seed yield/per plant showed a positive and significant association with biological yield/per plant and harvest index. Biological yield/per plant had the positive direct effect on seed yield. Kakde et. al. (2005) reported that seed yield/plant was positive correlated with harvest index but it was negatively correlated with pods number/per plant. Harvest index and biological yield showed direct relationship with seed yield. However, days to maturity and pods/per plant had direct

effect towards seed yield/per plant. Biçer and Şakar (2008) reported that total biological yield and number of clusters and pods per plant had high positive direct effects on seed yield. Younis et. al. (2008) explained that days to flowering, plant height, number of primary branches, biological yield, harvest index and hundred seed weigh had positive direct effects on seed yield. Biological yield, hundred seed weigh and harvest index also had positive and highly significant genotypic and phenotypic correlation with seed yield. Hence these traits could be used in the breeding for seed yield in lentil.

In breeding studies, it would be useful to understand both the direct and indirect relationships between yield and the other plant characters in order to select the lentil genotypes with high yield potential. The purpose of this study was to determine the direct and indirect relationships between yield and certain plant characters by using path analysis.

MATERIALS AND METHODS

This study was conducted under Hatay ecological conditions. Twenty four small seeded lentil genotypes obtained from the ICARDA (International Center for Agricultural Research in Dry Areas) and one local species 'Kışlık Kırmızı-51' were used in this study. The elevation of the experiment area is 80 meter from the sea level. The soil was clay textured, calcareous, and rich in potassium. It had medium organic matter content. The amount of precipitation during the vegetation period was 988.8 and 1129 mm in the first and the second year, respectively (Anonimous, 2000). A Randomized Complete Block Design with replicates having a plot size 5x1.8=9.0 m^2 were used and 4x1.2=4.8 m^2 of each plot was harvested. Sowing (200 seeds/m^2) was made by hand on 20, 25 November in the first and the second year, respectively. 3 kg N/da (21% Ammonium Sulfate) and 5 kg P_2O_5 (43% Triple Super Phosphate) fertilizer were given at sowing time.

Measurements and observation of examined characters were done on five plants randomly chosen in the mid-row of each plot. The following measurements and observations were made; seed yield (kg/ha), plant height (cm), the first pod height (cm), the number branches/per plant (numbers), number of pod/per plant (numbers), flowering time (days), maturity time (days), 1000 seed weight (g), biological yield (kg/ha) and harvest index (%). The data were analyzed by the TARİST V4 statistical programs. All of the relationships between plant characters were investigated and the direct and indirect effects of plant characters on yield were determinated (Steel and Torrie, 1985).

RESULTS AND DISCUSSION

Correlation coefficients between the traits were given in Table 1. Highly significant correlation between yield and biological yield (r=0.833**) and harvest index (r=0.687**) were found. These results are in agreement with findings of other researchers (Ramgiry *et al.*, 1989; Zaman *et al.*, 1989; Luthra *et al.*, 1990; Anjam *et. al.,* 2005). While plant height had highly significant correlation with first pod height (r=0.521**), it had a negative significant correlation with flowering time (r=-0.282*). Positive and significant correlation (r = 0.373**) between the number of branches/plant and the number of pods/plant was found. Similar results were obtained by some researchers (Ramgiry *et al.*, 1989; Zaman *et al.*, 1989). However it was previously

reported that yield was positively correlated with the number of branch/per plant and the number of pod/per plant. Negative and significant correlation (r = - 0.255**) between the number of branches/per plant and first pod high/per plant was found. And Negative and significant correlations were shown between 1000 seed weight and plant height (r= -0.433**). The number of pod/per plant insignificantly correlated with yield (r = 0.144) and negatively and significantly correlated with 1000 seed weight (r = -0.236*). There are similar results in the literature (Luthra and Sharma, 1990; Çiftçi *et al.*, 1998). Whereas 1000 seeds weight negatively and significantly correlated with harvest index (r = -0.282*), the number of pod/per plant (r = -0.236*) and the number of branch/per plant (r = -0.389**).

Path coefficients between the plant characteristics are given in Table 2. Biological yield had a significant direct effect (0.6969) on seed yield/ha. It is followed by harvest index (0.4947) and 1000 seed weight (0.0901). Plant height had small direct effect (0.0025). Maturity time had the highest direct negative effect (-0.0913) and it was followed by the number of pod/plant (-0.0305) and height to the first pod (-0.0157). Indirect effect of biological yield occurred through the harvest index (0.1638), maturity time (0.003); whereas negative indirect effects occurred through 1000 seed weight (-0.0182), the number of branches/plant (-0.0061) and the number of pod/plant (-0.0044). While the positive indirect effect of harvest index followed biological yield (0.2307) and flowering time (0.0003); the negative indirect effect could be through 1000 seed weight (-0.0254). However, the number of pod was positively and indirectly affected (0.0072); biological yield (-0.1409) and harvest index (-0.1394) were negatively and indirectly affected by 1000 seed weight, respectively.

Results of this study are in agreement with the findings of Luthra and Sharma (1990). Çiftçi et. al. (1998) found the number of main branch as a significant factor. In contrast to the findings of Dixit and Dubey (1984) and Balyan and Singh (1986) the direct effect of the number of pod/per plant was no significant. Plant characteristics such as plant height, number of branch and 1000 seed weight are highly similar to reported values in the literature (Dixit and Dubey, 1984; Balyan and Singh, 1986; Chauhan and Sinha, 1988; Anjam et. al., 2005). The effect of maturity time on yield, in contrast to the findings of some researchers (Balyan and Singh, 1986), was considerably high and negative. The reason of such effect may be attributed to the sudden increase in temperature in April when instance flowering occurred. This may force the plant to maturity and prevent flower setting, pod formation and pod lodging. The higher precipitation during growth period promoted the high quantity of fresh material.

Table 1. Correlation coefficients between the plant characters

Characters	First pod height	Number branch	Number pod	Flowering Time	Maturity time	1000 seed weight	Biological yield	Harvest index	Yield
Plant height	0.521**	-0.017	0.052	-0.282*	-0.166	-0.433**	0.040	-0.164	-0.053
First pod height		-0.255**	0.030	-0.137	-0.063	-0.050	-0.040	0.155	0.082
Number of branch			0.373**	0.108	-0.023	-0.389	-0.073	-0.051	-0.032
Number pod				0.078	-0.121	-0.236*	-0.144	0.107	0.144
Flowering Time					0.125	0.120	-0.283*	-0.032	-0.163
Maturity time						-0.004	-0.035	0.039	-0.091
1000 seed weight							-0.202	-0.282*	-0.213
Biological yield								0.331**	0.833**
Harvest index									0.687**

*: Significant at the 0.05 probaility level, **: Significant at the 0.01 probability level

Table 2. Path coefficients between the plant characteristics

Direct Effect	Indirect Effect	Correlation Coefficients	Path Coefficients	Effect Level (%)
Plant height		-0.053	0.0025	1.7259
	First pod height		-0.0082	5.6860
	Number branch		-0.0014	1.0002
	Number pod		-0.0016	1.1068
	Flowering time		-0.0030	2.0933
	Maturity time		0.0152	10.531
	1000 seed weight		-0.0029	2.0372
	Biological yield		0.0279	19.414
	Harvest index		-0.0812	56.408
First pod height		0.082	-0.0157	10.118
	Plant height		0.0013	0.8332
	Number branch		-0.0212	13.675
	Number pod		-0.0009	0.5968
	Flowering time		-0.0015	0.9408
	Maturity time		0.0057	3.6953
	1000 seed weight		-0.0045	2.9283
	Biological yield		-0.0276	17.806
	Harvest index		0.0767	49.405
Number branch		-0.032	0.0834	39.168
	Plant height		0.0000	0.0201
	First pod height		0.0040	1.8794
	Number pod		-0.0114	5.3503
	Flowering time		0.0012	0.5406
	Maturity time		0.0021	0.9663
	1000 seed weight		-0.0351	16.468
	Biological yield		-0.0506	23.793
	Harvest index		-0.0251	11.815
Number pod		0.144	-0.0305	12.285
	Plant height		-0.0004	0.0522
	First pod height		0.0010	0.1920
	Number branch		-0.0019	12.523
	Flowering time		0.0037	0.3370
	Maturity time		0.0013	4.4433
	1000 seed weight		-0.0004	8.5599
	Biological yield		-0.0227	40.337
	Harvest index		0.0193	21.272
Flowering time		-0.163	0.017	4.1081
	Plant height		-0.0007	0.2700
	First pod height		0.0022	0.8282
	Number branch		0.0090	3.4624
	Number pod		-0.0024	0.9222
	Maturity time		-0.0114	4.3897
	1000 seed weight		0.0108	4.1516
	Biological yield		-0.1970	75.848
	Harvest index		0.0156	6.0194

Table 2 Continue. Path coefficients between the plant characteristics

Direct Effect	Indirect Effect	Correlation Coefficients	Path Coefficients	Effect Level (%)
Maturity time		-0.091	-0.0913	64.286
	Plant height		-0.0004	0.2900
	First pod height		0.0010	0.6944
	Number branch		-0.0019	1.3213
	Number pod		0.0037	2.5957
	Flowering time		0.0013	0.9370
	1000 seed weight		-0.0004	0.2555
	Biological yield		-0.0227	16.0102
	Harvest index		0.0193	13.610
1000 seed weight		-0.213	0.0901	21.832
	Plant height		-0.0001	0.0196
	First pod height		0.0008	0.1923
	Number branch		-0.0325	7.8676
	Number pod		0.0072	1.7472
	Flowering time		0.0013	0.3097
	Maturity time		0.0004	0.0893
	Biological yield		-0.1409	34.149
	Harvest index		-0.1394	33.793
Biological yield		0.833**	0.6969	1.2511
	Plant height		0.0001	0.0111
	First pod height		0.0006	0.0695
	Number branch		-0.0061	0.6760
	Number pod		-0.0044	0.4897
	Flowering time		-0.0030	0.3365
	Maturity time		0.0030	0.3327
	1000 seed weight		-0.0182	22.031
	Harvest index		0.1638	74.802
Harvest index		0.687**	0.4947	64.665
	Plant height		-0.0004	0.0532
	First pod height		-0.0024	0.3183
	Number branch		-0.0042	0.5538
	Number pod		-0.0033	0.4260
	Flowering time		0.0003	0.0441
	Maturity time		-0.0036	0.4666
	1000 seed weight		-0.0254	3.3159
	Biological yield		0.2307	30.157

It was reported that the number of pod and branch/plant had comparatively high direct and indirect effect on seed yield/ha (Çiftçi *et al.*, 1998) and the direct effect of the number of pod/plant was found to be the highest; the effect of plant height and number of branch was high; in contrast, indirect and negative relationships between flowering and maturity time and 1000 seed weight were reported (Ramgiry *et al.*, 1989). Biological

yield was reported to be important factor having direct effect on yield (Ghafoor *et al*., 1990; Luthra and Sharma, 1990; Çiftçi *et al*., 2004). While 1000 seed weight had positive direct effect on yield, number of branch and maturity time had high indirect and positive effect on yield. But, the effect of plant height and flowering time were found to be non significant (Chauhan and Sinha, 1988). On the other hand, Dixit and Dubey (1984) reported that important factor direct effect on yield were number of pod/plant, plant height and the number of branch/per plant. The effect of plant height, number of pod, 1000 seed weight, maturity time on yield were reported to be significant (Balyan and Singh, 1986).

The results of study indicated that the relationships among certain characteristics were statistically significant. According to these results; linear relationships among examined characters are insufficient in plant breeding programs. Although their combined effectiveness is statistically significant, selection should be done by considering to these criteria. Also, it was essential that the amount of direct and indirect effect of the causal component on the effect component should be determined. Results suggested that biological yield and harvest index that has significant direct and indirect effects on yield should be considered in the breeding programs towards increased yields.

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