

Estimates of Broad-Sense Heritability for Seed Yield and Yield Components of Grass Pea (*Lathyrus sativus* L.)

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Abstract: This study was carried out to estimate the broad-sense heritability for seed yield and some yield components of 15 grass pea (*Lathyrus sativus* L.) genotypes in 2000-2002 at Bursa, in the Marmara region of Turkey. The experimental design was a randomized complete block design with 3 replications. The heritabilities for seed yield, plant height, pod number, seed number per pod, seed number per plant, 1000-seed weight, biologic yield, and harvest index were estimated as 30%, 42%, 61%, 19%, 56%, 75%, 82%, and 49%, respectively. It was found that biologic yield was the trait least affected by environment, followed by 1000-seed weight. On the other hand, seed number per pod, harvest index, seed yield, plant height, seed number per plant, and pod number were the traits affected most by environmental conditions. According to the results, the biologic yield and 1000-seed weight could be used as selection criteria in early generations.

Key Words: Grass pea, heritability, seed yield, 1000-seed weight

Mürdümükte (*Lathyrus sativus* L.) Tohum Verimi ve Verim Unsurlarına Ait Geniş Anlamda Kalıtım Derecelerinin Hesaplanması

Özet: Bu çalışma, 2000-2002 yılları arasında 15 mürdümük hattında tohum verimi ve bazı verim unsurlarının kalıtım derecesinin hesaplanması amacıyla Marmara Bölgesi Bursa lokasyonunda yürütülmüştür. Deneme, Tesadüf blokları deneme desenine göre üç tekerrürlü olarak kurulmuştur. Tohum verimi, bitki boyu, bakla sayısı, baklada tohum sayısı, bitkide tohum sayısı, 1000 tane ağırlığı, biyolojik verim ve hasat indeksine ait kalıtım dereceleri sırasıyla % 30, % 42, % 61, % 19, % 56, % 75, % 82 ve % 49 olarak hesaplanmıştır. Biyolojik verimin çevre koşullarından en az etkilenen özellik olduğu ve bunu 1000 tane ağırlığının takip ettiği belirlenmiştir. Öte yandan baklada tohum sayısı, hasat indeksi, tohum verimi, bitki boyu, bitkide tohum sayısı ve bakla sayısı çevre koşullarından en fazla etkilenen özellikler olmuştur. Araştırmadan elde edilen sonuçlara göre, biyolojik verim ve 1000 tane ağırlığı erken dönemde yapılacak seleksiyonda başarıyla kullanılabilir.

Anahtar Sözcükler: Mürdümük, kalıtım derecesi, tohum verimi, 1000 tane ağırlığı

Introduction

Grass pea (*Lathyrus sativus* L.) was cultivated in the Balkans around 8000 BC. In archaeological excavations in Turkey and Iraq, seeds of *Lathyrus* species were found as collected or cultivated items. Grass pea is also known as chickling pea, khesari, or sabberi. It is a major crop in parts of Asia (Bangladesh, China, India, Nepal, and Pakistan) and to a lesser extent in the Middle East (Iraq, Iran, Afghanistan, Syria, and Lebanon), in southern Europe (France and Spain), and in northern Africa

(Ethiopia, Egypt, Morocco, Algeria, and Libya) (Miczak et al., 2001).

Plant height, pod number, seed number per pod, seed number per plant, 1000-seed weight, biologic yield, and harvest index are the most important characters in grass pea improvement for increasing seed yield (Kumar and Dubey, 2001; Miczak et al., 2001; Mera et al., 2003; Kumari and Prasad, 2005) because of direct and indirect correlation with seed yield. Some genotypes are more affected by one environment than another due to

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environmental differences. To measure environmental interaction and to see interaction variance, different genotypes are reared or grown in a range of specific environments (Falconer and Mackay, 1996). Each breeder is faced with an array of environments in which his or her breeding program is to achieve results (Welsh, 1981). Thus, an estimate of heritability should be determined for an optimum breeding program. In this study, heritability through variance components and genotype x location interactions for seed yield, plant height, pod number, seed number per pod, seed number per plant, 1000-seed weight, biologic yield, and harvest index were determined on grass pea genotypes in Marmara region conditions in Turkey.

Materials and Methods

This research was conducted at the Agricultural Research and Experiment Station of the Agriculture Faculty, Uludağ University, during 2000-2002 in Bursa province (40°13' N, 28°49' E, elevation 155 m), which is located in the Marmara region. Fifteen lines of grass pea (*Lathyrus sativus* L.) provided by ICARDA were used as genetic materials. Some major soil characteristics determined by the method described by Rowell (1996) were as follows: the soil texture was clay, organic matter was 1.1%, total salt was 0.1%, CaCO₃ was 3%, pH was

7.1, level of P was 250 kg ha⁻¹, and level of K was 880 kg ha⁻¹.

A summary of the meteorological data on average temperatures, precipitation, and relative humidity for the site is given in Table 1. Average temperature, relative humidity, and precipitation were 12.9 °C, 62.5%, and 292.1 mm in 2000-2001; 11.3 °C, 68.3%, and 754.6 mm in 2001-2002; and 11.6 °C, 71.2%, and 557.3 mm in long year (1928-1999) averages, respectively.

The trial was arranged with 3 replications in the randomized complete block design. Sowing was done by hand in 4-m-long rows with 0.3-m row spacing. The seeding was performed on November 10 in 2000 and November 26 in 2001. Plots were fertilized with 100 kg ha⁻¹ compost fertilizer (20-20-0). All plots were harvested for seed yield on June 7 in 2001 and June 18 in 2002. Measurements and observations of investigated characters were performed on 10 plants randomly chosen from the mid-row of each plot. The following characteristics were observed and measured: seed yield, plant height, pod number, seed number per pod, seed number per plant, 1000-seed weight, biologic yield, and harvest index.

Analysis of variance was performed on seed yield and its components' data using the SAS (1998) program. Broad sense heritability (H) for mean values over the

Table 1. Monthly precipitation, mean temperature and relative humidity in the experimental area.

Months	Precipitation (mm)			Temperature (°C)			Humidity (%)		
	Long period	2000-2001	2001-2002	Long period	2000-2001	2001-2002	Long period	2000-2001	2001-2002
November	76.3	22.4	140.3	12.3	12.5	10.4	74.6	74.1	65.6
December	99.9	50.1	219.2	7.7	6.2	5.0	74.2	83.5	71.1
January	91.2	7.6	62.3	5.5	7.9	3.2	75.1	59.9	65.4
February	77.7	68.2	42.7	6.2	7.6	9.1	72.8	62.2	67.2
March	69.5	50.1	87.9	8.2	14.4	10.3	72.0	54.0	71.3
April	61.0	85.9	126.5	12.9	14.1	11.7	69.9	61.8	76.0
May	50.7	2.5	50.5	17.8	17.7	17.5	69.4	57.8	67.9
June	31.0	5.4	25.2	22.1	23.0	23.0	61.3	46.3	62.1
Total	557.3	292.1	754.6	-	-	-	-	-	-
Mean	-	-	-	11.6	12.9	11.3	71.2	62.5	68.3

years was calculated following Toker (2004) and Çakmakçı et al. (2006) from components of variance:

$h^2 = \sigma_g^2 / (\sigma_g^2 + \sigma_{gy}^2 / y + \sigma_g^2 / ry)$, where y, g and r are number of year, genotype, and replication, respectively; σ_g^2 and σ_g^2 are components of variance for genotypes and error, respectively.

Results and Discussion

The average, minimum, and maximum values of the seed yield and yield components are shown in Table 2. Means of seed yield were between 242 and 3313 kg ha⁻¹. Biologic yield ranged from 1667 to 7917 kg ha⁻¹. The seed number per pod was between 2.4 and 9.3, whereas seed number per plant was between 25 and 283. The plant height, pod number, 1000-seed weight, and harvest index were between 46 and 153 cm, 11 and 100, 51 and 326 g, and 5 and 82, respectively.

The results of combined variance analysis of traits in the 15 grass pea genotypes used in this study are presented in Table 3. There were statistically significant differences within the 2 years for all the yield components except for seed number per pod and biologic yield. Statistically significant genotype x year interactions was observed for harvest index. The analysis of variance revealed significant differences within the genotypes for all the yield components studied. Broad sense heritability (h^2) was highest (82%) for the biologic yield, followed by 1000-seed weight (75%). Seed number per plant and pod number showed moderate heritability values, ranging from 56% to 61%. On the other hand, the lowest heritability was observed for the seed number per pod (19%), harvest index (25%), seed yield (30%), and plant height (42%) (Table 3).

High heritability values for 1000-seed weight have previously been reported in grass pea (Kumar and Dubey,

Table 2. Descriptive statistics of seed yield and yield components of grass pea genotypes (averages of 2 years).

	Seed yield (kg ha ⁻¹)	Plant height (cm)	Pod number	Seed number per pod	Seed number per plant	1000-seed weight (g)	Biologic yield (kg ha ⁻¹)	Harvest index (%)
Mean	1376	81	42	2.9	106	126	5259	27
Minimum	242	46	11	2.4	25	51	1667	5
Maximum	3313	153	100	9.3	283	326	7917	82
LSD (5%)	642	6.6	6.6	5.9	50	16	379	4.5
CV	20.19	19.49	18.49	20.28	22.92	15.14	17.06	19.86
SE	40.65	2.12	1.14	2.81	0.41	3.03	134.04	0.82

Table 3. Results of variance analysis and heritability for seed yield and yield components of grass pea genotypes.

Source of variation	Seed yield	Plant height	Pod number	Seed number per pod	Seed number per plant	1000-seed weight	Biologic yield	Harvest index
Year	1,639,330**	12,731**	12,780**	702	58,252**	8680**	430	7231**
Genotype	75,230**	471	665**	150	4404*	690**	657,730**	199
Genotype x year	52,930	222	257	196	1253	170	22,180	300**
Error	30,897	246	243	192	1871	146	80,498	113
Heritability (%)	30	42	61	19	56	75	82	25

* Significant at $P \leq 0.05$; ** significant at $P \leq 0.01$; ns not significant at $P \leq 0.05$.

2001; Kumari and Prasad, 2005). For 1000-seed weight of grass pea, heritability was determined as 96% by Milczak et al. (2001). Therefore, they pointed out that 1000-seed weight was less affected than other yield criteria. Our results confirm the findings published by Kumar and Dubey (2001), Milczak et al. (2001), and Kumari and Prasad (2005). Toker (2004) reported that biologic yield had low heritability in faba bean. This is contrary to the finding of our results.

Kumar and Dubey (2001) gave heritability estimates for seed number per plant (50%) and pod number (45%). Miczak et al. (2001) reported that estimated heritability ranged from 0.72 to 0.88 in pod number and seed number per plant. In the present study, seed number per plant and pod number had moderate heritability. Broad sense heritability values from 26 to 31 were reported for seed yield in grass pea (Tiwari and Campbell, 1996). Our results are in agreement with those reported by Tiwari and Campbell (1996). Cakmakci et al. (2006) reported that harvest index had high heritability in common vetch, while low heritability was found in

harvest index in the present study. Milczak et al. (2001) reported that the least heritability was obtained for plant height (10%). Our results are in agreement with those reported by Milczak et al. (2001). In contrast, Kumar and Dubey (2001) reported that plant height had high heritability (74%). The heritance of seed number per pod was low in our study. Our results are consistent with those published by Kumar and Dubey (2001). On the other hand, Cakmakci and Acikgoz (1994) reported that seed number per pod had high heritability in common vetch.

Biologic yield was the least affected trait over the years, followed by 1000-seed weight, pod number, and seed number per plant, whereas seed number per pod, harvest index, seed yield, and plant height were the traits most affected by environmental conditions. In conclusion, for successful selection in early generations, the biologic yield and 1000-seed weight could firstly be evaluated because of the fact that these characters were the least affected by environment.

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