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## Heritability and Correlation Studies in Pea (*Pisum arvense* L.) Lines

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**Abstract:** This study was conducted to determine suitable pea lines for Diyarbakir conditions. The study was carried out as Randomized Block Design with three replications in the research area of Southeastern Anatolian Regional Agricultural Research Institute during 1998-99, 1999-00 and 2001-2002 growing seasons. In the study, 25 pea lines provided from ICARDA were used. According to the average of three years, plant height ranged from 43.33 to 70.33 cm, this character was exhibited moderate heritability (0.40). The mean seed weight of pea genotypes was 209.80 g, seed weight showed moderate heritability (0.69). The grain yield varied from 114.56 to 191.00 kg da<sup>-1</sup>, in respect to seed yield, spring pea 4 was high yielding line. Biological yield, plant height, harvest index had positive and important correlations with the grain yield.

**Key words:** Pea, *Pisum arvense* L., heritability, correlation

### INTRODUCTION

Field pea (*Pisum arvense* L.) is one of the oldest cultivated crops and was grown in farming villages of the China at least as early as 8000 B.C.<sup>[1]</sup>; but origin of field pea is near the Mediterranean<sup>[2]</sup>. This plant is a common forage legume in the semiarid regions of the Anatolia and Mediterranean area (rain fall 350-550 mm). It's performs best on fertile, well drained soils with high moisture holding capacity. Optimum growth is obtained on loams, silt loam, or well texture soils with a pH 6.0-7.5. Field pea is used for seed, hay, pasture, silage and green manure. Plant is rich in high quality protein. It is rich in phosphorus and calcium and also a good source of vitamins, especially vitamins A and D. These qualities make field pea one of the best feeds for animals and almost indispensable for efficient, economical livestock feeding<sup>[3]</sup>. The plant height varies between 50 and 200 cm in field pea genotypes<sup>[4]</sup>. Hatam and Amanullah<sup>[5]</sup> reported that plant height ranged from 115 to 190 cm, days to maturity varied from 143 to 167 days. Hussain *et al.*<sup>[6]</sup> reported that days to maturity ranged from 94 to 150.7 days and 1000-seeds weight was ranged from 319.0 to 191.0 g and grain yield ranged from 1.43 to 1.91 kg ha<sup>-1</sup>. Fomin and Pivovarova<sup>[7]</sup> reported that 1000-seed weight in pea a variety ranged from 165 to 288 g. Tekeli and Ates<sup>[8]</sup> reported that seed yield varied 2.518 to 2.590 t ha<sup>-1</sup>. The aim of this study was to identify variability and heritability estimates of economically important grain yield and yield components in pea.

### MATERIALS AND METHODS

The experiment was carried out in rainfall conditions at the Southeastern Anatolian Regional Agricultural Research Institute Fields at Diyarbakir, Turkey, during winter seasons of 1998/1999, 1999/2000 and 2001/2002. Soil of experimental area was clay loam and 2.03% organic matter and with pH 7.9. Climatic data related to research area are summarized in Table 1.

Twenty-five genotypes of pea which provided from ICARDA were used in this study. One of the genotypes, D-651, due to high yielding, was used as control line. The properties of genotypes were given in Table 2.

The design of experiment was a randomized complete block design with three replications. Each of the 25 line were sown in four rows plots 4 m long, spaced 30 cm apart in the middle of December in all of study years. Fertilizer was applied basally at rate of 30 kg N and 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>

Table 1: Rainfall values of Diyarbakir province between October and June months of experimental years.

Rainfall	1998/1999	1999/2000	2001/2002
October	0.2	2.7	67.0
November	27.2	1.9	52.3
December	62.3	31.5	131.7
January	15.6	70.9	31.2
February	45.5	58.2	46.1
March	52.0	30.7	73.0
April	76.1	33.0	65.0
May	22.4	6.1	34.9
June	0.0	0.0	1.3
Total	301.3	235.0	502.0

Source: Anonymous<sup>[9]</sup>

Table 2: ICARDA entry list of seed

Lines	Accession No.	Origin	FAO statuses
Spring pea 3	638	Australia	U
Spring pea 4	639	Australia	U
DPFPD-8	642	India	U
DDR-11	647	India	U
DDR-14	650	India	U
DMR-26	658	India	U
DMR-27	659	India	U
88P00-1-4-9	661	Australia	U
88P038-4-3	683	Australia	U
88P090-5-15	709	Australia	U
88P090-5-26	714	Australia	U
88P101-10-1	715	Australia	U
Argon	729	Russia	U
Sprut 2	731	Russia	U
Orlovchanin-2	734	Russia	U
Flagman	735	Russia	U
P 7/79	752	Romania	U
Marina	753	Romania	U
P 122/89	756	Romania	U
P 75/87	767	Romania	U
P 157/88	768	Romania	U
P 80/87	775	Romania	U
P 12/95	827	Romania	U
Syria Local Aleppo	225	Syria	D
D-651 Belinda Local			

U: undesignated

at sowing time. Plant height, 1000 seed weight, biological yield ( $\text{kg da}^{-1}$ ), grain yield ( $\text{kg da}^{-1}$ ) and harvest index were recorded. Analysis of variance was computed by MSTATC packet program. Association among characters was also determined<sup>[9]</sup> at 5 and 1% probability levels. Variance components were estimated from expected mean squares. Heritability of these characters was estimated as a ratio genotypic variance to phenotypic variance<sup>[10]</sup>.

## RESULTS AND DISCUSSION

A combined analysis of variance, estimated of variances components and heritability of some characters on 25 pea genotypes over three years given in Table 3.

Differences among genotypes for days to maturity were significant. The earliest genotype was DP FPD-8 (159.7 days) and latest genotype was DMR-26 (163.44 days) (Table 4). Present findings are in agreement

with of Hatam and Amanullah<sup>[5]</sup> who reported that this character varied from 143 to 167 days. Present findings opposite Hussain *et al.*<sup>[6]</sup> reported that this character ranged from 94 to 150.7 days; this findings may resulted from different environment conditions, that is, genotypes may affected by climatic conditions. Genotype x year interaction was significant; days to maturity varied from year to year. This character showed low heritability (0.23).

Plant height ranged from 43.33 to 70.33 cm with a mean 59.73 cm. Spring pea 4 had maximum plant height followed by Syria local/Aleppo (68.56 cm) and DMR-27 (68.11 cm) (Table 4). Hatam and Amanullah<sup>[5]</sup> reported that this character ranged from 115 to 190 cm. The genotype x year interaction was significant; this result revealed that environmental effect with respect to this character was significant. Genotype DMR-27 had maximum plant height in 1998/1999 growing season, while genotypes of Syria local/Aleppo and Mariana, in 1999/2000 and 2001/2002 growing seasons, respectively were found taller than other genotypes. Bicer and Sakar<sup>[11]</sup> reported that this character ranged from 36.7 to 82.6 cm. Tekeli and Ates<sup>[8]</sup> reported that plant height varied from 107.46 to 124.37 cm. The difference in plant height may be attributed to genetic and climatic factors. Plant height was exhibited moderate heritability (0.40). It was found that the effect of phenotypic was higher than that of genotypic for this character. Opposite present findings; Kumar and Dubey<sup>[12]</sup> reported that plant height had high heritability at grass pea.

The mean seed weight of pea genotypes was 209.80 g. Differences among genotypes were significant; this character varied 153.04 to 244.89 g (Table 5). Present results are in agreement with of Fomin and Pivovarova<sup>[7]</sup> who reported that 1000-seed weight in pea a variety ranged from 165 to 288 g. The present results are not agreement with of Hussain *et al.*<sup>[6]</sup> who reported that 1000-seeds weight was ranged from 319.0 to 191.0 g. Genotype x year interaction was significant; the maximum seed weight was record in spring pea 4 in both 1998/1999

Table 3: Analysis of variance, variance components estimated and heritability of some characters at 25 pea genotypes over three years

Variation	D.F	Days to maturity	Plant height	1000 seed weight	Biological yield	Grain yield	Harvest index
Year	2	18811.6930	3068.964**	13442.333**	535683.8530**	100872.3730**	789.0310**
Error	6	1.2220	131.022	90.502	8838.6760	651.5560	18.5910
Genotype	24	9.9810	470.334**	5071.065**	21506.6100**	4623.3240**	54.2900**
Genotype x Year	48	8.8690	272.802**	1617.690**	12338.3210**	2221.1420**	34.7260**
Error	144	3.3890	59.180	392.595	2642.9580	516.3010	9.1840
v (%)		1.1000	12.880	9.440	12.6700	14.6000	8.0900
Variance components estimated from expected mean squares heritability							
Genotype		0.1236	21.948	383.701	1018.6981	266.9090	2.1737
Genotype x year		1.8267	71.200	408.365	3231.7876	568.2800	8.1540
Phenotype		0.5413	54.440	563.440	2389.6200	513.7027	6.0314
Heritability		0.2300	0.400	0.690	0.4300	0.5200	0.3600

\*, \*\* significant at 0.05 and 0.01 probability levels, respectively

Table 4: Mean values for days to maturity and plant height in pea lines in diyarbakir, Turkey

Pea lines	Days to maturity				Plant height (cm)			
	1998/1999	1999/2000	2000/2001	Mean	1998/1999	1999/2000	2001/2002	Mean
Spring pea 3	167.330	153.00	164.00	161.440b-f	63.67	70.330	65.330	66.440a-d
Spring pea 4	165.000	152.00	163.33	160.110e-g	66.67	69.000	75.330	70.330a
DPPFD-8	164.000	152.00	163.00	159.670g	39.67	47.000	62.000	49.560l-n
DDR-11	166.670	151.67	164.00	160.780c-g	50.33	44.670	76.000	57.000g-k
DDR-14	171.000	154.00	163.67	162.890ab	48.67	46.000	79.670	58.110e-j
DMR-26	170.670	154.00	165.67	163.440a	52.00	70.330	52.330	58.220e-j
DMR-27	165.670	152.00	165.00	160.890c-f	69.00	76.330	59.000	68.110a-c
88P00-1-4-9	167.670	153.00	164.67	161.780a-e	57.00	74.330	61.330	64.220a-f
88P038-4-3	168.330	153.00	163.67	161.670b-f	55.67	67.670	68.670	64.00a-g
88P090-5-15	170.330	152.33	164.33	162.330a-c	53.67	68.670	66.000	62.780b-g
88P090-5-26	172.670	151.00	163.33	162.330a-c	50.33	72.330	68.670	63.78a-g
88P101-10-1	171.670	153.00	163.67	162.780ab	43.67	71.670	70.330	61.890g-h
Argon	169.670	152.33	163.33	161.780a-e	41.00	47.670	52.670	47.110mn
Sprut 2	171.330	153.00	163.67	162.670ab	56.00	59.000	63.000	59.330d-j
Orlovchanin-2	167.330	152.67	164.33	161.440b-f	51.33	49.670	71.670	57.560f-j
Flagman	164.670	151.33	164.67	160.220d-g	60.00	77.330	66.670	68.000a-c
P 7/79	168.000	152.67	165.00	161.890a-d	49.00	58.000	58.330	55.110h-j
Marina	166.000	151.33	164.00	160.440d-g	52.33	44.670	86.670	61.220c-l
P 122/89	165.670	153.00	166.00	161.560b-f	62.67	79.670	56.670	66.330a-d
P 75/87	165.330	153.00	163.33	160.560d-g	40.00	41.330	48.670	43.330n
P 157/88	164.000	152.67	163.67	160.110e-g	43.33	46.670	60.000	50.000k-n
P 80/87	163.670	152.00	164.33	160.000f-g	43.00	51.330	65.000	53.110j-m
P 12/95	166.000	151.67	165.00	160.890c-g	43.00	44.670	75.000	54.220i-m
Syria local/Aleppo	172.670	152.00	163.33	162.670ab	63.67	82.000	60.000	68.560ab
D-651Belinda local	166.000	152.33	163.67	160.670c-g	62.67	69.000	63.000	64.890a-e
Mean	167.650	152.44	164.11	161.400	52.73	61.170	65.280	59.730
LSD 5%	4.352**			1.715**	18.20**	8.973**	8.158**	7.1680**
LSD 5% Int.				2.971**				12.420**
LSD Year 5%				0.4417**				4.574**

Means followed by different letter(s) differ significantly at p<0.05 level

Table 5: Mean values for 1000 seed weight and biological yield in pea lines in diyarbakir, Turkey

Pea lines	1000 seed weight				Biological yield (da <sup>-1</sup> )			
	1998/1999	1999/2000	2000/2001	Mean	1998/1999	1999/2000	2001/2002	Mean
Spring pea 3	260.67	241.00	202.00	234.560a-c	427.70	385.70	550.70	454.70a-c
Spring pea 4	275.67	253.00	206.00	244.890a	423.30	504.00	579.30	502.20a
DPPFD-8	221.33	235.33	204.00	220.220b-f	310.00	434.70	589.00	444.60b-e
DDR-11	210.00	227.33	186.67	208.000e-h	299.00	404.70	477.00	393.60f-l
DDR-14	218.67	213.33	199.00	210.330e-h	376.30	391.00	606.00	457.80a-c
DMR-26	281.33	244.33	218.67	248.110a	334.00	344.30	396.00	358.10j
DMR-27	201.00	223.67	207.33	210.670e-h	329.00	462.00	429.00	406.70d-h
88P00-1-4-9	196.33	224.33	204.00	208.220e-h	394.30	445.70	565.00	468.30a-c
88P038-4-3	170.67	209.00	207.67	195.780h-l	362.30	478.70	521.70	454.20b-d
88P090-5-15	182.00	223.67	178.00	194.560h-j	411.00	436.30	435.00	427.40c-g
88P090-5-26	175.67	196.33	176.00	182.670ij	288.00	526.70	504.30	439.70b-f
88P101-10-1	164.67	195.00	231.00	196.890g-l	271.00	438.30	481.70	397.00e-l
Argon	232.33	243.00	220.67	232.000a-d	197.70	407.30	580.30	395.10f-l
Sprut 2	278.67	240.33	153.67	224.220b-e	257.00	395.00	404.00	352.00ij
Orlovchanin-2	257.33	230.67	224.67	237.560ab	311.00	369.30	393.30	357.90ij
Flagman	256.33	227.33	169.33	217.670c-f	318.00	389.00	439.00	382.00
P 7/79	218.00	222.67	168.67	203.110f-h	315.30	383.00	446.00	381.40g-l
Marina	214.33	239.33	213.00	222.220b-e	295.70	360.30	514.70	390.20g-l
P 122/89	210.00	230.00	186.67	208.890e-h	254.30	476.30	324.00	351.50ij
P 75/87	131.33	202.67	195.67	176.560jk	224.30	432.30	313.00	323.20j
P 157/88	148.33	172.67	160.67	160.560kl	258.30	495.70	419.00	391.00g-l
P 80/87	141.67	153.00	164.33	153.000l	208.70	363.30	520.30	364.10h-j
P 12/95	221.00	229.00	195.67	215.220b-g	366.70	358.30	605.70	443.50b-e
Syria local/Aleppo	233.33	217.33	192.33	214.330d-g	385.30	560.70	491.30	479.10ab
D-651Belinda local	232.67	232.33	209.33	224.780b-e	201.30	424.30h	362.00	329.20j
Mean	213.33	221.07	195.00	209.800	312.80	426.70	477.90	405.79
LSD 5%	37.37**	41.00**	59.65**	18.460**	109.70**	80.55**	53.29**	47.90**
LSD 5% Int.				31.980**				82.97**
LSD 5% Year				3.801**				37.50**

Means followed by different letter(s) differ significantly at p<0.05 level

Table 6: Mean values for grain yield and harvest index in pea lines in diyarbakir, Turkey

Pea lines	Grain yield (da <sup>-1</sup> )				Harvest index (%)			
	1998/1999	1999/2000	2000/2001	Mean	1998/1999	1999/2000	2001/2002	Mean
Spring pea 3	161.00	166.67	181.00	169.56b-e	35.67	43.000	33.00	37.220c-g
Spring pea 4	148.00	216.33	208.67	191.00a	37.33	42.670	35.67	38.560a-f
DPFPD-8	134.67	203.33	223.00	187.00ab	42.67	44.330	37.00	41.330a
DDR-11	105.00	151.33	142.67	133.00g-j	35.00	37.000	29.33	33.780h-j
DDR-14	144.33	149.00	236.00	176.44a-c	38.00	38.670	38.33	38.330b-f
DMR-26	123.67	130.33	185.00	146.33f-h	29.67	38.000	42.00	36.560e-h
DMR-27	106.33	204.00	196.00	168.78b-e	31.67	44.330	45.33	40.440ab
88P00-1-4-9	145.00	200.00	224.00	189.67ab	36.33	44.330	39.33	40.000a-c
88P038-4-3	139.67	199.33	194.67	177.89ab	38.33	43.000	36.67	39.330a-e
88P090-5-15	147.00	196.67	182.67	175.44a-d	35.33	41.670	41.33	39.440a-d
88P090-5-26	101.00	186.67	179.33	155.67c-f	34.00	35.670	35.00	34.890g-j
88P101-10-1	87.67	164.00	216.67	156.11c-f	32.33	37.000	45.00	38.110b-f
Argon	61.67	165.33	227.67	151.56e-h	31.00	40.000	39.00	36.670d-g
Sprut 2	85.00	163.00	104.00	117.33ij	33.00	41.000	25.00	33.000j
Orlovchanin-2	123.30	145.00	146.67	138.33f-i	35.67	39.330	36.67	37.220c-g
Flagman	118.67	164.00	176.67	153.11g-l	36.67	41.670	40.00	39.000a-d
P 7/79	126.00	175.33	163.33	154.89d-f	39.67	45.330	36.00	40.330ab
Marina	102.67	153.33	168.33	141.44f-h	34.33	42.000	32.33	36.220f-i
P 122/89	89.33	217.33	117.00	141.22f-h	34.67	45.330	35.67	38.560d-f
P 75/87	77.67	170.33	106.00	118.00ij	27.67	39.000	32.33	33.000j
P 157/88	89.33	198.33	169.67	152.44f-h	34.67	40.670	40.00	38.440b-f
P 80/87	68.67	155.33	168.67	130.89h-j	32.33	42.330	38.33	37.670b-g
P 12/95	145.67	157.67	220.00	174.44a-d	39.33	43.330	36.00	39.560a-c
Syria local/Aleppo	141.00	221.00	162.67	174.89a-d	33.00	39.000	32.67	34.890g-j
D-651Belinda local	59.00	161.00	123.67	114.56j	29.67	37.330	33.33	33.440ij
Mean	113.25	176.59	176.96	155.60	34.72	41.040	36.61	37.460
LSD 5%	47.16**	32.32**	30.10**	21.17**	5.07**	4.947**	13.09**	2.824**
LSD 5% Int.				36.67**				4.891**
LSD 5% Year				10.20**				1.723

\*\*Means followed by different letter(s) differ significantly at  $p < 0.05$  level

Table 7: Association among characters

Characters	Grain yield	1000 seed weight	Plant height	Harvest index	Days to maturity
Biological yield	0.848**	0.01	0.515**	0.218**	-0.262**
Grain yield		0.111	0.487**	0.582**	-0.402**
1000 seed weight			0.109	0.213**	-0.131
Plant height				0.079	-0.157*
Harvest index					-0.49**

and 1999/2000, while genotype of 88P101-10-1 had maximum seed weight in 2001/2002. Significant genotype x year interaction and genotypes suggested that particularly genotypes differentially behaved at three years with respect to this character. This character showed moderate heritability (0.69); this finding indicated that both effect of phenotypic and genotypic was significant on this character. Opposite the present findings Milczak *et al.*<sup>[13]</sup> reported that seed weight of lathyrus had high heritability (0.94). Kumar and Dubey<sup>[12]</sup> noted that seed weight of lathyrus was showed moderate heritability (0.64).

Differences among genotypes for biological yield were significant and the highest biological yield per decar (502.22 kg) was observed in genotype spring pea 4 (Table 5). Genotype x year interaction was significant. Genotypes of spring pea 4, Syria local/Aleppo and P12/95 were produced higher biological yield than other genotypes in 1998/1999, 1999/2000 and 2001/2002

growing seasons, respectively. The result indicated that the genotypes differentially behaved at three years with respect to this character. The highest values record in 2001/2002 growing season. Heritability of this character was moderate (0.43).

Differences among genotypes with respect to grain yield were significant. Grain yield ranged from 114.0 to 191.0 kg. The maximum grain yield was record in spring pea 4 (Table 6). Zubov *et al.*<sup>[14]</sup> recorded seed yield of 3.9 t ha<sup>-1</sup>; this result different from our findings and we can say grain yield varied from genotype to genotype. Hussain *et al.*<sup>[6]</sup> reported that this character ranged from 1.43 to 1.91 kg ha<sup>-1</sup>. Tekeli and Ates<sup>[8]</sup> reported that seed yield varied from 2.518 to 2.590 t ha<sup>-1</sup> in Turkey. Seed yield potential in peas varies from cultivar to cultivar as reported by Kamur *et al.*<sup>[15]</sup> and Zubov *et al.*<sup>[14]</sup>. Genotype x year interaction was significant; this result indicated that grain yield affected not only by environment but yield performance of genotypes is important. This character showed moderate heritability (0.52).

Harvest index varied from 33.0 to 41.33% with mean of 37.46% (Table 6). Genotype x year interaction was significant. This character was highly affected by environment. Genotypes exhibited different responses to against years. Harvest index was showed low heritability (0.36).

**Association among characters:** Table 7 shows that grain yield had a significant positive correlation with biological yield, plant height and harvest index. Harvest index was positively associated with biological yield, grain yield and 1000 seed weight. Days to maturity had significant negative correlation with all investigated characters. If the aim is high yield, biological yield, plant height and harvest index are important in direct selection.

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