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Determination of Some Agricultural Characters of Pea (*Pisum sativum* L.) Genotypes

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Abstract: This research was made during the 2011 and 2012 growing periods in the trial filed of research station for management of soil water and desertification according to randomized blocks design with 3 repulications. Research material was the following pea lines; PS3029-B, PS3048, PS3053, PS3055, PS3057, PS4021, PS4023, PS4028, PS4053-B and other 2 commercial varieties named as Bolero and Ultrello. Some agronomical characteristics such as plant height (cm) number of pod per plant number of seed per pod number of seed per plant 1000 seed weight (g) and seed yield (kg/ha) were determined. Means of the 2 years showed the range for plant height was from 94.67 (PS3048) to 31.83 cm (PS3055), number of pod per plant was from 9.83 (Bolero) to 20.17 (PS3053), number of seed per pod was from 3.25 (Ultrello) to 5.00 (PS3029-B), number of seed per plant was from 35.50 (Ultrello) to 83.83 (PS3053), 1000 seed weight was from 117.83 (PS4053-B) to 303.33 g (Ultrello) and seed yield was from 1406.67 (Bolero) to 2700.00 kg ha^{-1} (PS4021). Results of the research implicated that the new developed lines were superior compared with the control (commercial) varieties by means of most of the characteristics. Nevertheless similar researches should be continued in different locations and years.

Key words: Agricultural characters, pea, seed yield, plant, Bolero

INTRODUCTION

Pea is a good source of vegetable protein besides being a pulse crop containing 20-30% protein in seeds sufficient for carbohydrates; rich in calcium iron and especially phosphorus and has various vitamins (Akcin, 1988). Although, the most consumed pulse in many countries of the world during the year (Oz and Karasu, 2010) it takes the last place in point of sowing area and production quantity in Turkey. But consumption in the food industry as fresh canned or frozen is quite common (Ceyhan *et al*., 2005).

Data of statistics in the year of 2012 shows that pulse crops (bean chickpea lentil pea cowpea and broad bean) has a sowing area of 755170 ha and 1.168.665 tons of production in Turkey. The share of pea is a sowing area of 1219 ha and 2686 tons of production.

Sowing time plant density fertilizing and many other factors have effects on the yield of pea beside high importance of the characteristics of new developed genotypes (Demirci and Unver, 2005). Main purposes of breeding works are increasing the yield (Tyagi and Srivastava, 2002) and prepare a background for the future researches (Ada, 2013). As it seen in many plants which have economically importance breeding works in pea still continues intensively over the world. The present research was made to determination of yield and its components in new developed pea lines.

MATERIALS AND METHODS

The research was conducted for 2 years both during 2011 and 2011 years in the trial filed of Research Station for Management of Soil Water and Desertification in Konya-Turkey. Seven cycles of pedigree selection were made and 1000 pea crosses from pea breeding program of Assoc. Prof. Dr. Ercan Ceyhan were selected from those promising lines based on seed yield and different agronomical traits. The plant materials which were used in this study consisted from nine pea lines (PS3029-B, PS3048, PS3053, PS3055, PS3057, PS4021, PS4023, PS4028, and PS4053-B and two cultivars (Bolero and Ultrello) as controls.

The average meteorological data during vegetation period for 2 years (April to July) as follows: 18.1 and 20.0°C for average temperature 147.6 and 66.8 mm for total rainfall 46.8 and 46.8% for relative humidity, respectively (Table 1). The soil characteristics of research was conducted showed clay loam structure lower level of organic matter (1.49%) a higher level of lime (17.14%) and alkaline (pH = 8.40). There was not salinity (0.05%) problem in the soil rich content of available potassium (51.60 kg day^{-1}) and lower phosphorus (4.01 kg day^{-1}) level.

The trial was conducted in Randomized Complete Block Design for both 2 years with 3 replications. For both of 2 years sowing was made by hand in a five-row

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Table 1: Total monthly rainfall, relative air humidity and mean air temperature during 2011 and 2012 growing seasons and 30 years average

	Rainfall (mm)			Main air temperature (°C)			Relative air humidity (%)		
Months	30 years ave.	2011	2012	30 years ave.	2011	2012	30 years ave.	2011	2012
April	35.9	57.0	4.6	10.9	10.6	14.4	57.7	58.9	56.0
May	38.6	62.8	51.0	15.5	15.2	16.3	55.4	55.9	51.2
June	20.5	27.8	11.0	20.1	20.3	23.0	47.2	45.1	42.7
July	7.8	0.0	0.2	23.4	26.4	26.2	42.3	27.4	37.4
Total/mean	102.8	147.6	66.8	17.5	18.1	20.0	50.7	46.8	46.8

Table 2: Means squares of investigated characteristics in the pea genotypes

Variance sources	df	Plant height	Pods per plant	Seeds per pod	Seed per plant	1000 seed weight	Seed yield
Blocks	2	35.4129	1.40909	0.001970	15.0152	0.04545	11909.3
Year (Y)	1	29.3333	7.33333	0.094700	12.7424	5436.38*	550320.0
$Error_1$	2	26.0492	15.46970	0.747420	37.4697	58.7424	37212.9
Genotype (G)	10	2276.0500**	71.76060**	1.773480	1887.0900**	13020.3**	1338769.0**
Y×G Int.	10	10.8750*	10.30000	0.461360	70.4758**	145.045**	91346.4**
$Error_2$	40	4.1810	8.78940	0.414697	21.7760	37.090	18563.0

*p<0.05; **p<0.01

plot with 3 m long on 4 April, 2011 and 6 April, 2012 dates. The rows were spaced with 50 cm distance and plants were spaced every 5 cm inside a row. The fertilizer was applied 150 kg ha^{-1} DAP (Diammonium Phosphate 18-46%) for both 2 years. The experimental crops were irrigated two time (during flowering initiation and pod filling time) for the 1st year three times (during flowering initiation and two times during pod filling time) for 2nd year. The hoeing was made for two times to weed and soil ventilation for both of 2 years. The harvest was made by hand after the maturing and being yellow colored period of whole plants on plots.

The investigated characteristics in the research were as follows: Plant height (cm); pod per plant (number); seed per pod (number); seed per plant (number) 1000; seed weight (g); biological yield (kg ha^{-1}) and seed yield (kg ha^{-1}), respectively (Ali Avci, 2005; Ceyhan *et al*., 2005, 2012). Analysis of variance and LSD test was made by using JUMP computer based statistical program.

RESULTS

The heights of plants in 2nd year (57.61 cm) were found higher than the heights of (56.27 cm) 1st year (Table 2). The effects of genotypes on plant height were found important (Table 2). As the means of years the highest plant height was taken from genotype PS3048 (94.67 cm) while PS3055 showed the lowest (31.83 cm) plant height (Table 3). Considering the year x genotype interaction ($p<0.05$), the maximum plant height (98.33 cm) was obtained from PS3048 genotype in 2012 (Table 3).

The variation was significant at the $p<0.01$ level between the genotypes. Averaging years, the highest value was taken from PS3053 genotype (20.17 number) while Bolero showed the lowest (9.83) pod per plant. The other genotypes which were used in the research showed their values between these intervals (Table 3).

According to the results of variance analysis for number of seeds per pod among genotypes found unimportant statistically (Table 2). The number of seeds per pod were changed between 3.25 (Ultrello) and 5.00 (PS3029-B) among genotypes (Table 3).

Number of seeds per plant in 1st year (64.91) were higher than number of pod per plant (64.03) in 2nd year (Table 3). Analysis of variance for number of seeds per plant among genotypes found important (Table 2). Seed number per plant was varied from 35.50 (Ultrello) to 83.83 (PS3053) in genotypes (Table 3). For number of seed per plant, the interaction of year x genotypes was found statistically important according to variance analysis (Table 2). The highest (87.00) value was taken from PS4053-B genotype in 2011, the lowest (30.67) value was taken from Bolero genotype in 2012 (Table 3).

The effects of years on 1000 seed weight were found important (Table 2). The values in 2nd year (198.03 g) were found higher than the values of (179.88 g) 1st year (Table 3). According to the results of variance analysis among genotypes for 1000 seed weight found statistically important (Table 2). The weights were varied between 117.83 (PS4053-B) and 303.33 g (Ultrello) for 1000 seeds (Table 3). The variance analysis which was made for 1000 seed weight was found as statistically important for year x genotypes interactions (Table 2). The highest (313.33 g) value was taken from Ultrello genotype in 2012 while 1st year had the lowest (112.67 g) value of PS4053-B genotype (Table 3).

The amount in 2nd year (2189.09 kg ha^{-1}) was higher than the amount of (2006.46 kg ha^{-1}) the 1st year (Table 3). Analysis of variance for seed yield among genotypes found important (Table 1). As the means of years, seed yield that is the main object of the breeding works was the highest with 2700.0 kg ha^{-1} in the PS4021 line and the lowest value was obtained in the commercial variety of Bolero (1406.7 kg ha^{-1}) as the means of the

Table 3: Means of investigated characteristics by years in the pea genotypes

	Plant height (cm)			Pods per plant (number)		
Genotypes	2011	2012	Mean	2011	2012	Mean
PS3029-B	46.50^{efg}	47.00^{ef}	46.75^{de}	15.67	13.67	14.67^{bcd}
PS3048	91.00^{b}	98.33^{a}	94.67^{a}	13.67	15.67	14.67^{bcd}
PS3053	43.33^{gh}	46.00^{efg}	44.67^{ef}	19.33	21.00	20.17^{a}
PS3055	32.67^{i}	31.00^{i}	31.83^{g}	13.00	13.67	13.33^{cde}
PS3057	46.17^{efg}	46.00^{efg}	46.08^{de}	15.00	16.67	15.83^{abc}
PS4021	83.00^{c}	82.67^{c}	82.83^{b}	20.67	16.33	18.50^{ab}
PS4023	70.83^{d}	70.00^{d}	70.42^{c}	14.33	12.00	13.17^{cde}
PS4028	68.17^{d}	71.00^{d}	69.58^{c}	17.33	18.67	18.00^{ab}
PS4053-B	40.00^{h}	44.33^{fg}	42.17^{f}	22.67	17.00	19.83^{a}
Bolero	48.83^{e}	49.33^{e}	49.08^{d}	10.33	9.33	9.83^{e}
Ultrello	48.50^{e}	48.00^{e}	48.25^{d}	10.67	11.33	11.00^{de}
Mean	56.27	57.61	56.94	15.70	15.03	15.36
	Seeds per pod (number)			Seeds per plant (number)		
Genotypes	2011	2012	Mean	2011	2012	Mean
PS3029-B	4.67	5.33	5.00	73.00^{c-f}	71.67^{c-f}	72.33^{c}
PS3048	4.67	4.33	4.50	63.00^{fg}	66.33^{efg}	64.67^{de}
PS3053	4.33	4.33	4.33	83.33^{ab}	84.33^{ab}	83.83^{a}
PS3055	4.67	4.33	4.50	58.67^{gh}	59.33^{gh}	59.00^{e}
PS3057	5.00	4.67	4.83	74.67^{b-e}	77.33^{a-d}	76.00^{bc}
PS4021	3.33	4.67	4.00	67.33^{d-g}	75.67^{b-e}	71.50^{cd}
PS4023	3.67	3.67	3.67	50.67^{hi}	44.00^{ij}	47.33f
PS4028	4.67	4.67	4.67	80.33^{abc}	84.67^{ab}	82.50^{ab}
PS4053-B	4.00	4.33	4.17	87.00^{a}	73.33^{c-f}	80.17^{ab}
Bolero	4.00	3.33	3.67	42.00^{ij}	30.67^{k}	36.33^{g}
Ultrello	3.17	3.33	3.25	34.00^{ijk}	37.00^{ijk}	35.50^{g}
Mean	4.20	4.27	4.23	64.91	64.03	64.47
	1000 seed weight (g)			Seed yield (kg ha^{-1})		
Genotypes	2011	2012	Mean	2011	2012	Mean
PS3029-B	173.00^{ij}	193.00^{efg}	183.00^{e}	2271.10^{def}	2484.43^{bcd}	2377.77^{b}
PS3048	147.33^{k}	170.67^{j}	159.00^{h}	1671.10^{ijkl}	2044.47^{f-i}	1857.78^{e-d}
PS3053	164.00^{j}	177.33^{hij}	170.67^{g}	2453.33^{b-e}	2675.57^{bc}	2564.45^{ab}
PS3055	184.33^{ghi}	204.33^{e}	194.33^{d}	1951.13^{g-j}	2173.33^{efg}	2062.23^{c}
PS3057	173.33^{ij}	190.00^{fgh}	181.67^{ef}	2337.77^{def}	2644.43^{bc}	2491.10^{ab}
PS4021	198.00^{ef}	221.33^{d}	209.67^{c}	2400.00^{cdf}	3000.00^{a}	2700.00^{a}
PS4023	164.00^{j}	167.33^{j}	165.67^{gh}	1488.90^{lmn}	1333.30^{mn}	1411.10^{e}
PS4028	168.67^{j}	177.33^{hig}	173.00^{fg}	2435.53^{b-e}	2702.23^{ab}	2568.88^{ab}
PS4053-B	112.67^{l}	123.00^{l}	117.83^{i}	1764.43^{i-l}	1622.23^{klm}	1693.33^{d}
Bolero	200.00^{ef}	240.67^{c}	220.33^{b}	1502.23^{k-n}	1311.10^{n}	1406.67^{e}
Ultrello	293.33^{b}	313.33^{a}	303.33^{a}	1795.57^{h-k}	2088.90^{fgh}	1942.23^{c}
Mean	179.88	198.03	188.95	2006.46	2189.09	2097.78

$^{a-n}$Figures in the same line column a common letter are not significantly different. Plant height (cm): LSD_G: 3.374; LSD_{YXG}: 3.193; Pods per plant (number): LSD_G: 4.629; Seeds per plant (number): LSD_G: 10.30; LSD_{YXG}: 7.286; 1000 seed weight (g): LSD_G:13.45; LSD_{YXG}: 9.509; Seed yield (kg ha^{-1}): LSD_G: 300.9; LSD_{YXG}: 212.7

years (Table 2). For seed yield, the interaction of year x genotypes was found statistically important in variance analysis (Table 2). The highest (3000.00 kg ha^{-1}) value was taken from PS4021 genotype in 2012 and the lowest (1311.10 kg da^{-1}) value was taken from genotype Bolero in 2012 (Table 3). The pea lines of the PS3029-B, PS3053, PS3055, PS3057, PS4021 and PS4028 were the main genotypes of the research.

DISCUSSION

Plant height is affected by environment and genotype in pea (Ali Avci, 2005; Ceyhan *et al*., 2005, 2012). Related former researches was reported the plant height as between 40.87-53.48 cm by Oz and Karasu (2010), 43.96-59.12 cm by Demirci and Unver (2005). The mentioned data is behind of the present study. On the other hand, Ceyhan *et al*. (2005) found the plant height in pea as 34.0-72.3 cm and also the finding of Ceyhan *et al*. (2012) was 36.59-75.84 cm. This situation exposes plant height is affected by environment besides genotype characteristics.

Number of pod per plant is affected by environment and quite effective on the yield (Ceyhan *et al*., 2008, 2012). Earlier findings on this characteristics were in between 18.3-38.3 (Ceyhan *et al*., 2005), 7.00-87.00 (Karayel and Bozoglu, 2008), 12.34-23.99 (Ceyhan *et al*., 2012) and 35.18-39.17 (Khan *et al*., 2013). The mentioned results are similar except being lower than the data of Khan *et al*. (2013). The reason of the difference could be appeared

due to genotype climate and soil. Pea has a high positive correlation between seed yield and seed per pod and seed per plant (Avci and Ceyhan, 2001). For this reason, these characteristics are used as selection criteria (Ceyhan *et al*., 2008, 2012). Some researchers stated 3.0-6.3 (Ceyhan *et al*., 2008), 3.40-5.80 (Ashraf *et al*., 2011), 5.62-6.73 (Nleya and Rickertsen, 2011) and 5.08-7.67 (Ceyhan *et al*., 2012) for number of seed per pod in pea genotypes. Similar results were also found in the present study.

Thousand seed weight an important yield component is affected by environment conditions and also by the genetic structure of genotypes (Ceyhan *et al*., 2012). A positive correlation formed between 1000 seed weight and seed yield (Kosev and Mikic, 2012). Data of recent studies showed the 1000 seed weight in pea as 99-194 g (Ceyhan, 2003), 243.81-253.81 g (Ashraf *et al*., 2011), 187.2-271.6 g (Alan and Geren, 2012) and 87.08-183.08 (Ceyhan *et al*., 2012). Weight of 1000 seed in pea usually varies depending on genotypes and climatic factors.

As it be in all plants higher seed yield is also the most important feature in pea. For the highest protein ratio of the plants is in the seeds (Santalla *et al*., 2001). Seed yield a quantitative character (Singh and Singh, 2004; Ali Avci, 2005) is a feature that is affected by genetic structure and environment-especially temperature (Ali Avci, 2005; Ceyhan *et al*., 2005). Akcin (1988) and Ceyhan *et al*. (2005) stated that seed yield is negatively affected by high temperature and insufficient precipitation during the flowering period. In the present study, the seed yield differences between the research years may be welded by the climatic factors especially by the differences on precipitation.

Seed yield differences of the genotypes occurred owing to genetic structure of the genotypes and climatic differences between the years (McPhee and Muehlbauer, 2001; Ceyhan *et al*., 2005). Related studies are as following: McPhee and Muehlbauer (2001) 1280-3090 kg ha^{-1}, Nleya and Rickertsen (2011) 408.0-1822.0 kg ha^{-1}, Rasaei *et al*. (2012) 1000.5-2160.5 kg ha^{-1}, Alan and Geren (2012) 1430.0-3490.0 kg ha^{-1} and Ceyhan *et al*. (2012) 720-1440 kg ha^{-1}. These findings are in accordance with the present study.

CONCLUSION

The prominent pea lines PS3029-B, PS3053, PS3055, PS3057, PS4021 and PS4028 that used in the research are promising genotypes due to higher seed yield than commercial varieties.

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