International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:7, No:11, 2013

Determination of Some Agricultural Characters of Chickpea (*Cicer arietinum* 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 replications. Research material was the following chickpea genotype; CA119, CA128, CA149, CA150, CA222, CA250, CA254 and other 2 commercial varieties named as Gökçe and Yaşa. 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^{-1}) were determined. Statistically significant variations were found amongst the genotypes for all variables except seeds per pod. Means of the two years showed the range for plant height was from 52.83cm (Gökçe) to 73.00cm (CA150), number of pod per plant was from 14.00 (CA149) to 26.83 (CA261), number of seed per pod was from 1.10 (Gökçe) to 1.19 (CA149 and CA250), number of seed per plant was from 16.28 (CA149) to 31.65 (CA261), 1000 seed weight was from 295.85g (CA149) to 437.80g (CA261) and seed yield was from 1342.73 kg ha^{-1} (CA261) to 2161.50 kg ha^{-1} (CA128). 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.

***Keywords*—**Agricultural characters, chickpea, seed yield.

I. Introduction

PULSES are rich, not only in protein and starch, but also in other nutrients such as fiber, vitamins and minerals, which are well suited to meet the demands of health conscious consumers. Pulses have shown many health benefits such as lower glycemic index for persons with diabetes and cancer prevention [1]-[3]. Chickpea, one of the pulse crops, is an important source of human food and animal feed; it also helps to improve soil fertility, particularly in dry lands. The entire sown area of chickpea is about 446 218 ha, production and yield are 530 634 t and 1190 kg ha^{-1}, respectively in Turkey [4].

Biçer and Anlarsal [5] reported that the height of chickpea varies from 16.8cm to 38.8cm in chickpea genotypes. It was reported that number of pod varies between 11 and 36 per plant [6]. According to Ceyhan et al. [7] number of seed varies between 26.5 and 31.1 per plant. A previous study showed that, the weight of 1000 seeds ranged from 449.2 to 478.3g in several genotypes of chickpea. Bakaoğlu and Ayçiçeği [8] reported that biomass varied from 1518 to 2010 kg ha^{-1} in chickpea. A previous study revealed that seed yield changes from 1215 to 1666 kg ha^{-1} in chickpea genotypes.

Chickpea is traditionally sown in the spring in the Mediterranean region, so that, the crop encounters heat and drought stress from flower towards maturity and results in low and variable yields. It is required to develop new cultivars which are tolerant to drought. The present research was made to determination of yield and its components in new developed chickpea lines.

II. Material and Method

The research was conducted for two years both during 2011 and 2011 years in the trial filed of "Research Station for Management of Soil Water and Desertification" in Konya-Turkey. The plant materials which were used in this study consisted from eight chickpea lines (CA119, CA128, CA149, CA150, CA222, CA250 and CA254 and two cultivars (Gökçe and Yaşa) as controls.

The average meteorological data during vegetation period for two years (April May June and July) as follows: 18.1^{0}C and 20.0^{0}C for average temperature 147.6mm and 66.8mm for total rainfall 46.8% and 46.8% for relative humidity respectively (Table I). 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/da) and lower phosphorus (4.01 kg da^{-1}) level.

The trial was conducted in "Randomized Complete Block Design" for both two years with 3 replications. For both of two years sowing was made by hand in a five-row plot with 3m long on 04 April 2011 and 06 April 2012 dates. The rows were spaced with 40cm 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 two years. The experimental crops were irrigated one time (during flowering initiation) for the both two years. The hoeing was made for two times to weed and soil ventilation for both of two 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) and seed yield (kg ha^{-1}) respectively [7], [9]. Analysis of

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variance and LSD test was made by using "JUMP" computer based statistical program.

III. Results and Discussions

A. Results

The effects of years on plant height were found important (Table II). The heights of plants in second year (68.20cm) were found higher than the heights of (59.40cm) first year (Table III). The effects of genotypes on plant height were found important (Table II). As the means of years the highest plant height was taken from genotype CA150 (73.00cm), while Gökçe showed the lowest (52.83cm) plant height (Table III). Considering the year x genotype interaction ($P < 0.01$), the maximum plant height (79.33cm) was obtained from CA150 genotype in 2012 (Table III).

TABLE I
Total Monthly Rainfall, Relative Air Humidity, and Mean Air Temperature during 2011 and 2012 Growing Seasons and 30-Year Average

Month	Rainfall (mm)			Main air temperature (^{0}C)			Relative air humidity (%)		
	30-year ave.	2011	2012	30-year ave.	2011	2012	30-year 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 II
Means Squares of Investigated of Investigated Characteristics in the Chickpea Genotypes

Sources	DF	Plant height	Number of pod per plant	Number of seeds per pod	Number of seed per plant	1000 seed weight	Seed yield
Blocks	2	1.55	4.55	0.00266	2.6745	226.625	6252.49
Year (Y)	1	1161.6**	84.0167*	0.01633	64.896*	3973.95**	698394*
Error$_1$	2	2.15	1.51667	0.00294	3.4895	33.7447	11066.1
Genotype (G)	9	278.252**	102.498**	0.00426	154.934**	10224.1**	417134**
Y x G Int.	9	20.9333**	7.46111**	0.00523*	5.55193	86.3878*	27915.2*
Error$_2$	36	5.276	2.0519	0.002176	2.8713	29.49	11942

** P< 0.05; ** P< 0.01*

The effects of years on number of pod per plant were found important (Table II). Number of pod per plant in second year (21.03) were higher than number of pod per plant (18.67) in first year (Table III). The variation was significant at the $P < 0.01$ level between the genotypes. Averaging years, the highest value was taken from CA149 genotype (26.83 number), while CA261 showed the lowest (14.00 number) pod per plant. The other genotypes which were used in the research showed their values between these intervals (Table III). For number of pod per plant, the interaction of year x genotypes was found statistically important according to variance analysis (Table II). The highest (30.00) value was taken from CA149 in 2012 and, the lowest (13.33) value was taken from Yaşa genotype in 2011 (Table III).

According to the results of variance analysis for number of seeds per pod among genotypes found unimportant statistically (Table II). The number of seeds per pod were changed between 1.10 (Gökçe) and 1.19 (CA149 and CA250) among genotypes (Table III).

For number of pod per plant, the effects of years were found statistically important according to variance analysis (Table II). Number of seeds per plant in second year (24.01) were higher than number of pod per plant (21.93) in first year (Table III). Analysis of variance for number of seeds per plant among genotypes found important (Table II). Seed number per plant was varied from 16.28 (CA261) to 31.65 (CA149) in genotypes (Table III).

The effects of years on 1000 seed weight were found important (Table II). The values in second year (399.87g) were found higher than the values of (383.59g) first year (Table III). According to the results of variance analysis among genotypes for 1000 seed weight found statistically important (Table II). The weights were varied between 295.85g (CA149) and 437.80g (CA261) for 1000 seeds (Table III). The variance analysis which was made for 1000 seed weight was found as statistically important for year x genotypes interactions (Table II). The highest (449.67g) value was taken from CA261 genotype in 2012 while first year had the lowest (289.37 g) value of CA149 genotype (Table III).

According to the results of variance analysis for seeds yield among genotypes found important statistically (Table II). The amount in second year (1772.39 kg ha^{-1}) was higher than the amount of (1556.62 kg ha^{-1}) the first year (Table III). Analysis of variance for seed yield among genotypes found important (Table II). As the means of years, seed yield that is the main object of the breeding works was the highest with 2161.50 kg ha^{-1} in the CA128 genotype and the lowest value was obtained in the genotype of CA261 (1342.73 kg ha^{-1}) as the means of the years (Table III). For seed yield, the interaction of year x genotypes was found statistically important in variance analysis (Table II). The highest (2283.33 kg ha^{-1}) value was taken from CA218 genotype in 2012 and, the lowest (1191.67 kg da^{-1}) value was taken from genotype Yaşa in 2011 (Table III). The chickpea lines of the CA128, CA119, CA250 and

CA149 were the main genotypes of the research.

TABLE III
MEANS OF INVESTIGATED CHARACTERISTICS BY YEARS IN CHICKPEA GENOTYPES

Genotypes	Plant Height (cm)			Pods per Plant (number)		
	2010	2011	Mean	2010	2011	Mean
CA119	57.33 fgh	67.00 cd	**62.17 c**	22.00 b-e	24.33 bc	**23.17 bc**
CA128	66.33 d	77.00 ab	**71.67 ab**	22.67 b-e	24.00 bc	**23.33 b**
CA149	56.33 ghi	65.00 de	**60.67 c**	23.67 bcd	30.00 a	**26.83 a**
CA150	66.67 d	79.33 a	**73.00 a**	16.67 hij	16.00 h-k	**16.33 f**
CA222	62.33 def	77.00 ab	**69.67 ab**	20.67 def	21.33 cde	**21.00 cd**
CA250	60.00 efg	66.33 d	**63.17 c**	20.00 efg	24.67 b	**22.33 bc**
CA254	56.00 ghi	67.00 cd	**61.50 c**	16.67 hij	17.33 ghi	**17.00 ef**
CA261	64.67 de	72.00 bc	**68.33 b**	13.67 jk	14.33 ijk	**14.00 g**
Gökçe	51.67 i	54.00 hi	**52.83 d**	17.33 ghi	20.67 def	**19.00 de**
Yaşa	52.67 hi	57.33 fgh	**55.00 d**	13.33 k	17.67 fgh	**15.50 fg**
Mean	**59.40**	**68.20**	**63.80**	**18.67**	**21.03**	**19.85**
	LSD_G: 3.606; **LSD_{YXG}:** 5.100			**LSD_G:** 2.249; **LSD_{YXG}:** 3.181		

Genotypes	Seeds per Pod (number)			Seeds per Plant (number)		
	2010	2011	Mean	2010	2011	Mean
CA119	1.15 c-f	1.17 b-e	**1.16**	25.33	28.63	**26.98 b**
CA128	1.16 b-f	1.19 a-d	**1.18**	26.20	28.63	**27.42 b**
CA149	1.25 a	1.12 def	**1.19**	29.67	33.63	**31.65 a**
CA150	1.17 b-e	1.09 f	**1.13**	19.47	17.47	**18.47 def**
CA222	1.15 c-f	1.15 c-f	**1.15**	23.77	24.57	**24.17 c**
CA250	1.23 ab	1.14 c-f	**1.19**	24.67	28.27	**26.47 bc**
CA254	1.18 a-e	1.14 c-f	**1.16**	19.43	19.83	**19.63 de**
CA261	1.14 c-f	1.18 a-e	**1.16**	15.63	16.93	**16.28 f**
Gökçe	1.11 ef	1.09 f	**1.10**	19.20	22.50	**20.85 d**
Yaşa	1.20 abc	1.12 def	**1.16**	15.93	19.63	**17.78 ef**
Mean	**1.17**	**1.14**	**1.16**	**21.93**	**24.01**	**22.97**
	LSD_{YXG}: 0.07725			**LSD_G:** 2.661		

Genotypes	1000 Seed Weight (g)			Seed Yield (kg ha^{-1})		
	2010	2011	Mean	2010	2011	Mean
CA119	365.80 i	390.67 g	**378.23 f**	1742.43 de	2100.00 b	**1921.22 b**
CA128	414.60 cd	424.67 b	**419.63 bc**	2039.67 bc	2283.33 a	**2161.50 a**
CA149	289.37 k	302.33 j	**295.85 h**	1611.80 efg	1908.33 cd	**1760.07 bc**
CA150	399.63 efg	428.33 b	**413.98 cd**	1462.10 gh	1408.33 hi	**1435.22 ef**
CA222	358.83 i	375.67 h	**367.25 g**	1601.60 efg	1733.33 de	**1667.47 cd**
CA250	360.90 i	379.67 h	**370.28 fg**	1673.27 ef	2016.67 bc	**1844.97 b**
CA254	423.43 bc	429.33 b	**426.38 b**	1548.77 fgh	1600.00 efg	**1574.38 de**
CA261	425.93 b	449.67 a	**437.80 a**	1253.20 ij	1432.27 ghi	**1342.73 f**
Gökçe	399.90 ef	411.67 d	**405.78 de**	1441.67 gh	1741.67 de	**1591.67 cde**
Yaşa	397.50 fg	406.67 de	**402.08 e**	1191.67 j	1500.00 fgh	**1345.83 f**
Mean	**383.59**	**399.87**	**391.73**	**1556.62**	**1772.39**	**1664.51**
	LSD_G: 8.526; **LSD_{YXG}:** 8.992			**LSD_G:** 171.6; **LSD_{YXG}:** 181.0		

[a] *Figures in the same line column a common letter are not significantly different*

B. Discussion

Many researchers revealed that the height of plant depend on sowing density, climate and environment conditions besides genetically structure [5], [9], [10]. Thus, Pundir and Rajagophan [11] suggested that plant height is effected too much by environmental factors especially soil humidity and mineral content, and also sowing density. Related former researches was reported the plant height as between 24.2-42.0 cm by Eser et al. [12], 35.3-40.0cm by Altınbaş and Sepetoğlu [13], 22.2-32.8cm by Bakaoğlu and Ayçiçeği [8], 16.8-38.3cm by Biçer ve Anlarsal [5], 33.1-41.3cm by Ceyhan et al. [7] and 34.38-51.38cm by Ceyhan et al. [9]. These findings were in agreement with the ones obtained in this study.

Number of pod per plant is affected by environment and quite effective on the yield [7], [9]. Previous findings on these characteristics were in between 15.8-27.3 (Anlarsal et al. [14]), 26.5-31.1 (Ceyhan et al. [7]) and 23.46-33.29 (Ceyhan et al. [9]). The results of present study showed similarity with previously reported data.

Chickpea has a high positive correlation between seed yield and seed per pod and seed per plant [9]. For this reason these characteristics are used as selection criteria (Ceyhan et al. [9]).

Some researchers stated 26.5-43.9 (Altınbaş et al. [15]) and 17.0-28.8 (Anlarsal et al. [14]) for number of seed per plant in chickpea 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 [9]. Data of recent studies showed the 1000 seed weight in chickpea as 347–494g (Altınbaş and Sepetoğlu [13]), 290-446.6g (Öztaş et al. [16]), 449.2–478.3g (Ceyhan et al. [7]) and 348.02-431.89g (Ceyhan et al. [9]). Weight of 1000 seed in chickpea usually varies depending on genotypes and climatic factors.

As it be in all plants higher seed yield is also the most important feature in chickpea. For the highest protein ratio of the plants is in the seeds [7]. Seed yield a quantitative character [5], [9], [10] is a feature that is affected by genetic structure and environment - especially temperature [5], [9], [10]. Many researchers implicated that seed yield is effected too much by climate and environment conditions [5, [7], [17]. Furthermore, Toker and Çağıran [18] obtained specified that seed yield of chickpea was decreased significantly in drought conditions. Related studies are as following: Kulaz and Çiftçi [19] 1230-1449 kg ha^{-1}, Anlarsal et al. [14] 1786-2555 kg ha^{-1}, Altınbaş and Sepetoğlu [13] 1233-2215 kg ha^{-1}, Türk and Koç (2003) 1316-1851 kg ha^{-1}, Biçer and Anlarsal [5] 1215-1666 kg ha^{-1}, Ceyhan et al. [7] 1309.2-1584.3 kg ha^{-1}, Ceyhan et al. [9] 1354.2-2110.1 kg ha^{-1}. These findings are in accordance with the present study.

IV. Conclusion

The prominent chickpea lines CA128, CA119, CA250 and CA149 that used in the research are promising genotypes due to higher seed yield and some agricultural characters than commercial varieties.

Acknowledgment

We are heartily thankful to support of Selcuk University Scientific Research Project (BAP) Konya–Turkey.

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