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RESEARCH REGARDING THE AGRONOMIC VALUES OF SEVERAL CHICKPEA GENOTYPES

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Abstract. Chickpea (*Cicer arietinum* L.) is the third most important pulse crop (after dry bean and pea) and makes up 20% of the world pulse production. Twelve chickpea crosses, from ILC482 and Diyar 95 crossing, and four chickpea varieties were evaluated for yield and its components over three years in Diyarbakir, Turkey. Days to flowering in crosses was changed from 75.42 to 79.92 days. Days to maturity were varied from 109.0 to 120.2 days. Parents had the minimum and maximum time to flowering and maturity. Some crosses were taller than their parents were. Seed weight of all crosses was larger than the small seeded parent ILC 482. Grain yield was not changed among lines, and selection was done for earliness, plant height and seed weight.

Key words: Chickpea, *Cicer arietinum* L., yield, breeding

INTRODUCTION

Chickpea is native to the Middle East and has been grown traditionally throughout the semiarid regions of India and the Mediterranean. Today, chickpea is the third most important pulse crop (after dry bean and pea) and makes up 20% of the world pulse production (Pulse Production Manual, 2000). It was cultivated on 11 155 425 hectares in the world with 8 583 139 tones produced. In Asia, India accounts for 65.3% of the area and 67.2% of the production. Other important Asian countries such as Iran, Myanmar, Pakistan, and Turkey account for about 23% of the area and 20% of the production. The productivity in these countries ranges from 0.41 t ha^{-1} in Iran to 1.10 t ha^{-1} in Myanmar. The average world productivity of 7.964 t ha^{-1} is rather low (FAO, 2004). Improving the genetic potential of this crop for yield is the major objective in most improvement programs. In view of the importance of the crop and the low average yields (1016.822 kg/ha) in Southeastern Anatolia. An improvement programme was initiated at the Faculty of Agriculture, Dicle University in 1994 to develop a variety or varieties including high yielding, large seeded and tolerance of anthracnose. Such varieties had to be developed using the current varieties as some of the parents, by using proper breeding procedures.

MATERIAL AND METHODS

The study was carried out at the experimental area of Dept. of Field Crops in the Faculty of Agriculture, Dicle University, Diyarbakir (latitude: 37° 53' N, longitude: 40° 16' E, 680 m above sea level) in the Southeastern Anatolia part of Turkey during 2003, 2004 and 2005 spring seasons. The soil was a clay-loam, moderate in organic matter content (1.2%), low in phosphorus contents (1.615 kg/da) and potassium content (8.16 kg/da) and the pH: 7.6. Climatic data related to experimental area are summarized in Table 1. The maximum rainfall

was the 1st year with total 394 mm; minimum rainfall was the 3rd year with total 168 mm during the growing season (from February to early July). Rainfall in the 3rd year was lower than that of both two years and long-term, but good distribution on growing periods. Rainfall and relative humidity in the month of March of 2004 year was the lowest 9.3 mm and 5.4%, respectively. The monthly average temperature for all years was approximately the same with the long-term mean.

Table 1

Meteorological data at the experimental area including crop season (2003-2005)

Years		Months						
		January	February	March	April	May	June	July
L. term	Temp.	2.8	3.5	8.1	13.3	19.3	26.7	31.7
	Humidity	73	69	64	63	52	31	21
	Precipitation	58.8	67.6	74.8	56.5	38.7	9.4	1.0
2003	Temp.	4.0	2.5	6.5	13.4	20.4	26.4	31.7
	Humidity	78	76	64	66	45	25	14
	Precipitation	68.4	151.8	80.7	80.6	5.4	26.9	0.0
2004	Temp.	3.3	2.7	9.6	12.8	18.0	26.4	31.1
	Humidity	82	80	54	50	54	23	12
	Precipitation	84.6	93.4	1.5	54.9	97.5	16.0	0.0
2005	Temp.	2.3	3.0	8.4	14.1	19.6	25.8	0.0
	Humidity	66	62	53	52	44	25	11
	Precipitation	58.7	46.8	58.4	36.8	26.5	33.1	32.4

State Meteorology Institute (Diyarbakir, Turkey)

Twelve chickpea crosses, from ILC482 and Diyar 95 crossing, and four chickpea varieties, namely Aziziye, Gökçe, ILC 482 and Diyar 95, as check were used. ILC 482 and Diyar 95 were formerly bred for the Southeast Anatolia region of Turkey. ILC 482 is small (7 mm) early, short and presents good yield potential. However, Diyar 95 is large seeded (9 mm), late and tall. Aziziye and Gökçe were from East Anatolia and Central Anatolia of Turkey, respectively. Chickpea crosses/varieties were sown in the forth week of Feb. 2003, the first week of March 2004, and the second week of Feb. 2005 cropping seasons. Since rainfall was not enough in March 2004 (Table 1), the experimental area was irrigated by supply irrigation water after a week sown, to obtain seedling emergence,. A randomized complete blocks design with four replications was used in every year. Seed was sown in plots (4 m long with 6 rows at 20 cm spacing) at a plant density of 50 plants m^{-2}. The two side rows of the plots were discarded as border and thus, the net plot area consisted of four rows of 3.0 m length. Seed harvested was by hand when the crop reached 90% maturity. The characters days to flowering and maturity and 100 seeds weight were measured on the whole plot. The rest of the agro/morphological data, plant height, number of pods $plant^{-1}$, number of seeds $plant^{-1}$ and seed yield $plant^{-1}$ were scored on ten plants sampled from the middle of the plot. Data on investigated characters were subjected to analysis of variance and means were separated according to the LSD Multiple Range Test at $p<0.01$ and <0.05 by the MSTATC programme (Michigan State University, East Lansing, MI).

RESULTS AND DISCUSSION

The results of the combined analysis of variance analysis were given in Table 2.

Differences among genotypes for all characters, except for grain yield and seed yield $plant^{-1}$ were significant. Genotype x year interaction was significant for all characters. The

differences between years were significant days to flowering and maturity, plant height and 100 seeds weight.

Table 2

Combined analysis of variance for different characters on 16 chickpea cult./lines over three years

Traits	Mean squares			CV%
	Years	Genotypes	Genotype x year	
Days to flowering	1286.521**	41.543**	4.226**	1.37
Days to maturity	1795.849**	79.432**	7.977**	1.03
Plant height	340.005**	45.954**	14.705*	7.56
Number of pods per plant	43.186	32.795**	23.356*	25.44
Number of seeds per plant	46.431	26.689*	26.382**	25.11
Seed yield per plant	1.743	2.129	4.010**	26.72
100 seed weight	19.128**	147.844**	3.744**	3.01
Grain yield	1959.484	2877.723	2289.748**	24.57

*, ** Significantly different at P= 0.05 and P= 0.01 levels, respectively

The mean of years were given in Table 3. Data for days to flowering and maturity were recorded from sown dates. Differences among years for days to flowering were resulted from different sowing dates. Days to maturity ranged from 109.1 to 119.7 days. The maturity was limited by low precipitation in the duration of the reproductive phase of 2003, and plants were quickly matured. Plant height varied from 37.89 to 41.89 cm. When plant height of 2003 year was compared to other years, plant height was lower than for the others; this situation might be the result of low rainfall (5.4 mm), relative humidity (45%) and high temperature (20.4°C) during flowering, including May. Sell (1993) reported that maximum plant height occurs with cool growing conditions, good fertile soil and adequate moisture. Relationships between rainfall and plant height were positive and significant, but temperature and this character had a negative association (Agsakalli et al., 2001). In most Mediterranean, Asian, American, and African chickpea-growing areas, the duration of the reproductive phase of the crop is limited by the initiation of flowering and the summer drought that terminates seed set. Furthermore, because of the indeterminate growth habit of the chickpea, the duration of its flowering period is a major yield determinant (Bonfil and Pinthus, 1995; Eshel, 1967, from Or et al., 1999).

Table 3

The means of years for different characters in 16 chickpea cult./lines

Traits	Years			
	2003	2004	2005	LSD 5%
Days to flowering	74.34	74.38	82.13	0.667**
Days to maturity	109.1	113.9	119.7	0.8112**
Plant height	37.89	41.88	41.89	0.8187**
Number of pods per plant	14.51	15.03	13.42	-
Number of seeds per plant	14.16	15.694	14.280	-
Seed yield per plant	5.385	5.659	5.362	-
100 seed weight	37.22	36.36	36.20	0.6048**
Grain yield	155.54	144.95	153.04	-

*, ** Significantly different at P= 0.05 and P= 0.01 levels, respectively.

The mean of genotypes were given in Table 4. Days to 50% flowering was ranged from 73.58 to 79.92 days. Progenies of Diyar 95xILC 482 were varied from 75.42 in C-409 to 79.92 in C-548. Gökçe, Aziziye and ILC 482, as check cultivars, were early flowering, but Diyar 95, was take maximum time for flowering (79.50 days). Difference between the earliest

and the latest flowering cultivars was about 6 days. According to Anbessa et al. (2006), in a given genotype, at a given latitude and altitude, flowering date may be modified, according to the sowing date. Flowering date is generally dependent on germination date, the seasonal temperature profile, and the photothermal response of the plant (Or et al. 1999).

The Diyar 95 cultivar, 120.2 days, exhibited the maximum number of days to maturity, whereas the ILC 482 cultivar matured in 109.0 days only. The difference between the earliest and the latest seed maturing cultivars was 11.2 days. Days to maturity of lines ranged from 111.0 in C-409 to 117.3 days in C-548. Data of C-409 and C-218 for maturity were given similar to ILC 482, one of the parents. Although genotype x year interaction was significant, the early flowering cultivars were also, almost in all years, quick maturing. Generally, days to maturity of lines were were more than those of checks, except Diyar 95. As results of three experimental years, Aziziye and Gökçe were found as earliness cultivars, and these may be suggested for the region, due to their earliness.

Plant height among lines varied from 37.08 cm for C-86 to 44.25 cm for C-623. Among cultivars, Diyar 95 had exhibited the maximum plant height (42.67 cm) followed by Aziziye (41.08 cm) and Gökçe (38.42 cm). ILC 482 had low plant height (36.83 cm), and this value was the lowest of experiment. Average values of lines were almost higher than those of cultivars. Significant mean square genotype x year interaction suggested that the cultivars behaved differentially with respect to the character, over three experimental years. According to Wanjari et al. (1996) and Jahargirdar et al. (1996), yield and yield components are inherited traits, though influenced by environment.

A maximum number of pods and seeds per plant was produced by ILC 482 (17.93 pods, and 18.01 seeds), followed by C-409, which gave 16.32 pods and 16.81 seeds. A minimum number of pods and seeds per plant was produced by C-86 (12.0 pods, and 12.39 seeds). Diyar 95 produced minimum pods and seeds. Although, among cultivars, ILC 482 showed the best performance, lines produced more pods and seeds than the checks. The cultivar x year interaction was significant, that is, the effect of the year on this character seemed of high variation from one year to another, and these characters are more affected by environment due to low heritability (Muehlbauer and Singh, 1987).

Seed yield per plant ranged from 4.727 to 6.151 g, but differences among cultivars for this were not significant.

The maximum seed yield per plant was recorded for ILC 482. Also, it was determined that this variety had maximum pods and seeds per plant, and an earlier cultivar. Early flowering might make it possible to prolong the reproductive phase in such environments and may lead to yield increase, through more efficient water use (Kumar and Abbo, 2001). Also, Güler et al. (2001) informed that the direct effect of the number of pods per plant on seed yield was significant. Similarly, Khan and Qureshi (2001) have reported that number of pods per plant is positively correlated with seed yield. As result of cultivar x year interaction, this character was significantly affected by the years.

The weight of 100 seed varied significantly from 27.41 g to 41.57 g. The maximum seed weight was observed for the C-548 (41.57 g), followed by Diyar 95 (41.00 g) and C-275 (40.49 g). The minimum seed weight was recorded for ILC 482 (27.41 g), followed by C-343 (33.51 g). The progenies of ILC482xDiyar 95 produced larger seeded lines (Table 4). Muehlbauer and Singh (1987 from Toker, 2004) advised that large seeded genotypes should be used as parents to increase seed weight in chickpea breeding, owing to the dominant characteristic of large seed size.

Cultivar x year interaction for the character was significant. Seed weight in the chickpea is under polygenic control with high heritability and additive gene action, and

affected by the growing environment (Niknejad et al. 1971, Singh et al. 1992 from Hovav, 2003).

Table 4

The means of genotypes for different characters in 16 chickpea cult./lines over three years

Lines cult.	Days to flowering	Days to maturity	Plant height (cm)	No of pods per plant	No of seeds per plant	Seed yield per plant (g)	100 seed weight (g)	Grain yield (kg/da)
C-578	77.92 cd	116.3 cd	40.58 b-e	15.88 a-c	16.00 a-c	5.486	35.21 gh	167.77
C-540	77.67 d	116.7 bc	42.25 a-c	15.57 a-d	15.56 a-d	5.851	35.62 fg	145.03
C-548	79.92 a	117.3 b	42.17 a-c	13.97 b-e	14.05 b-e	6.031	41.57 a	140.44
C-218	77.08 de	112.8 i-k	44.25 a	15.86 a-c	15.61 a-d	5.324	34.46 hi	155.12
C-623	79.33 ab	113.8 gh	41.42 b-d	12.96 c-e	13.45 c-e	4.919	35.15 gh	144.86
C-401	78.67 bc	115.6 de	41.08 b-d	13.73 b-e	13.77 c-e	5.479	39.41 c	147.54
C-409	75.42 g	111.6 l	40.42 b-e	16.32 ab	16.81 ab	5.829	34.18 ij	152.68
C-528	76.58 ef	115.1 ef	41.08 b-d	14.83 b-e	15.42 a-d	5.498	36.26 ef	142.90
C-86	77.17 de	114.2 fg	37.08 fg	12.00 e	12.39 e	4.727	37.05 e	156.59
C-275	76.17 fg	113.0 h-k	39.83 c-e	14.97 b-d	15.27 a-e	6.033	40.49 b	139.88
C-343	76.00 fg	113.2 h-j	39.50 d-f	13.77 b-e	14.77 b-e	5.128	33.51 j	151.04
C-388	76.67 ef	113.7 g-i	40.17 c-e	12.76 de	12.92 de	5.436	38.18 d	162.79
Diyar 95	79.50 ab	120.2 a	42.67 ab	12.77 de	13.60 c-e	5.406	41.00 ab	159.24
ILC 482	73.92 h	109.5 m	36.83 g	17.93 a	18.01 a	6.151	27.41 k	156.25
Aziziye	75.58 g	112.5 j-l	41.08 b-d	12.91 de	13.80 c-e	5.008	38.88 cd	152.72
Gökçe	73.58 h	112.1 kl	38.42 e-g	12.88 de	13.98 b-e	5.187	37.13 e	144.00
Mean	76.948	114.198	40.552	14.32	14.71	5.468	36.59	151.18
LSD (5%)	0.8495	0.9502	2.474	2.941	2.983	-	0.889	-

Means within columns with different letters are significantly different at P: 0.05.

Grain yield ranged from 139.88 kg/da in C-275 to 167.77 kg/da in C-578, and the differences for seed yield among lines were not significant. However, ILC 482 with a high number of pods per plant was given low yield. This difference might be due to the seed size of this genotype. Cultivar x year interaction was significant for the character (Table 4). Other researchers reported that yield and yield components are inherited traits though influenced by the environment (Wanjari et al. 1996; Jahargirdar et al. 1996).

CONCLUSION

Twelve chickpea lines, from ILC482 and Diyar 95 crossing, and four cultivars were evaluated for the yield and its components, over three years in Diyarbakir, Turkey. Days to flowering and maturity in crosses changed from 75.42 to 79.92, from 111.0 to 117.3, respectively, and C-409 accounted for earliness. C-623 (44.25 cm) accounted for plant height. The maximum seed weight was observed for the C-548 (41.57 g) and C-275 (40.49 g), but C-548 was not noticed due to late maturity. Instead, C-275 was preferred. These chickpea lines will be assessed again for grain yield.

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REZUMAT

STUDIUL UNOR GENOTIPURI DE NĂUT

Năutul (*Cicer arietinum* L.) este printre primele trei specii de leguminoase alimentare, ca importanţă a recoltelor obţinute (după fasolea boabe şi mazăre), aducând un plus de 20% la producţia mondială a speciilor respective. În cadrul prezentului studiu, timp de trei ani în Diyarbakir, Turcia, au fost evaluate pentru producţie şi pentru elementele de productivitate douăsprezece combinaţii hibride de năut, provenite din hibrizi ILC482 şi Diyar 95, şi patru soiuri de linte. Durata înfloririi la hibrizi a fost diferită, cuprinsă între 75,42 şi 79,92 zile. Durata de timp până la maturitatea de recoltare a variat de la 190,0 la 120, 2 zile. Formele parentale ale hibrizilor au avut un timp minim şi unul maxim de înflorire şi de maturitate. În câteva combinaţii hibride, descendenţii au avut valori ale înălţimii plantelor superioare formelor parentale. Greutatea seminţelor la hibrizi a fost mai mare decât cea a seminţelor formei parentale ILC 482. Producţia de boabe a fost nesemnificativă între linii şi selecţia acestora a fost efectuată pentru timpurietate, înălţimea plantelor şi greutatea seminţei.