

Performance of some winter chickpea (*Cicer arietinum* L.) genotypes in mediterranean conditions

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Abstract

The research was carried out to determine suitable chickpea (*Cicer arietinum* L.) genotypes with large seed and high yield to be able to grown in winter. Yield and yield components were investigated in 22 chickpea genotypes, which were obtained from ICARDA, and Aydın-92 (check) in 1999-2000, 2000-2001 and 2003-2004 growing seasons. According to the combined analysis of three years, seed yield was ranged from 1582 to 2132 kg ha⁻¹. X 93 TH 56-3/2, and FLIP 90-58 C genotypes were determined to be adaptable to Mediterranean conditions and produce larger seeds and higher yield than Aydın-92. Besides, significant and positive correlations between seed yield and total pod number, full pod number, seed number, seed weight, and harvest index were determined in this research.

Keywords: chickpea, seed yield, yield components, correlation

Introduction

Chickpea is an important source of protein in the diets of people who do not consume enough animal products in specially developing or under developed countries besides, it plays a significant role in the farming systems. Chickpea seeds contain about 16.4-31.2 % crude protein, 38.1-73.3 % carbohydrate, 1.5-6.8 % fat, and 1.6-9.0 % fiber (Şehrali, 1988). Chickpea harvest area, production, and yield are about 660.000 ha, 650.000 t and 945 kg ha⁻¹ respectively in Turkey (Anonymous, 2004). In mediterranean environments, temperate climates with winter rainfall, chickpea is traditionally sown in spring; therefore, the crop encounters heat and drought stress towards maturity; resulting in low and variable yields. However, with developing new cultivars, winter sowing of chickpea in mediterranean environments has recently been increased, since winter sowing provides higher and more stable productivity and better water-use efficiency (Pacuacci et al., 2006). It was reported that seed yields were ranged from 842 to 3780 kg ha⁻¹, in case of growing chickpea as a wintery crop (Engin, 1989; Mühür, 1996; Özdemir et al. 1992, 1996; Singh and Reddy, 1996). Also, Anlarsal et al. (1999), and Mart (2000), stated that in mediterranean condition, seed yield ranged from 2256 to 1093 kg ha⁻¹, and 1786 to 2719 kg ha⁻¹ respectively. According to many researches carried out in chickpea in Mediterranean, they were reported that pod number, seed number, and 100 seed weight ranged between 5.3-100.1 per plant, 4.1-107.8 per plant, and 26.7-38.4 g, respectively (Anlarsal et al., 1999; Özer and Anlarsal, 2005; Mart, 2000 and Korkmaz and Anlarsal, 2005). Besides, Özer and An-

larsal (2005) found negative and non significant correlations between seed yield and plant height, seed number, and 100 seed weight; positive and non significant correlation between 100 seed weight and total pod, full pod, and seed number. Improved seed weight in chickpea was due primarily to increased total pod, full pod and seed number (Anlarsal et al., 1999). Özveren Yücel et al. (2006) reported that, positive and significant correlation between seed number and total pod, full pod number, also improved total pod number has been responsible for full pod number. Islam et al. (1984) reported that, while selection high yielding genotypes from chickpea, genotypes with high branch number should be selected. Choudhury and Khaleque Mian (1988) reported that positive and significant associations of seed yield were observed pod number per plant besides, seed yield was directly influenced by pod and branch number. Positive and significant correlation between seed yield and plant height was reported by Rahman and Parh, (1988), and Ali (1990). Uddin et al. (1990), reported that, 100 seed weight, pod number, and harvest index were the most important characters to increasing seed yield.

In this research, with determining the suitable chickpea genotypes having the features of high yield and large seed size, and be able to be grown winter, correlations between seed yield and seed yield components were examined in the Mediterranean region of Turkey.

Materials and methods

The plant materials used in this research were 22 genotypes selected from F4 (12 genotypes), winter and ascochy-

Table 1 Monthly mean temperature (°C) and total rainfall (mm) of Adana 1999-2004 years

Months	Mean Temperature (°C)					Total Rainfall (mm)				
	1999	2000	2001	2003	2004	1999	2000	2001	2003	2004
November	15.5	15.4	13.9	15.4	15.7	3.0	30.8	88.1	22.3	141.1
December	12.1	10.9	11.0	11.0	9.6	36.8	37.7	320.9	167.2	27.0
January	10.6	6.8	10.7	11.1	9.1	83.1	93.6	8.6	84.5	252.1
February	10.6	9.4	10.9	8.2	9.8	102.3	120.4	74.9	111.7	117.5
March	13.3	11.8	16.5	11.5	14.7	40.0	33.1	46.6	92.3	5.6
April	17.3	18.2	18.7	17.1	17.7	99.1	86.0	8.8	61.1	24.8
May	23.2	21.4	21.8	24.5	21.1	6.2	68.1	130.4	14.8	19.8
June	25.8	27.3	26.6	26.5	25.6	22.6	0	0	6.7	0

ta blight nurseries (10 genotypes) obtained from ICAR-DA along with 1 cultivar (as a check, Aydın-92) originated in Turkey.

The research region has a typical coastal Mediterranean climate with cool, wet winters and hot dry summers. According to the long-term average from 4 decades of records, there is yearly total precipitation of 625 mm and a mean temperature of 18.7 °C. Mean temperature and total precipitation of the growing season in 1999-2004 years are presented in Table 1.

The soil of the research area was 20-30 cm deep and clayey. Values of pH, and salt content ranged from 6.5 to 7.0, and 0.07 to 0.10 mmhos cm⁻¹ respectively.

During the winter seasons of 2000, 2001, and 2004, field evaluation of the 23 chickpea genotypes were conducted by randomized complete blocks design (RCBD) with 3 replications under the upland conditions in the Research Area of the Department of Field Crops of Çukurova University in Adana, Turkey (35° 18'E, 37° 01'N; 23 m above the sea level). Each genotype was sown 4 m in length, with 35 cm inter-row spacing, in 4 rows; there were 44 plants per square metre. Sowings were carried out November, 8 1999 for the 1st year, November, 28 2000 for the 2nd year and December, 8 2003 for the last year. Before sowing, 30 kg ha⁻¹ N and 60 kg ha⁻¹ P₂O₅ fertilizers were applied in each year (Şehirli, 1988). Flowering date was recorded during 50 % flowering of the plants in each plot. Accordingly, the flowering of the plant were occurred in April, between 17 and 28, 2000 for the 1st year, March, between 26 and 28 2001 for the 2nd year and April, between 3 and 7 2004 for the last year. Maturity date was also noted in 95 % maturity of the plants for each plot. With references to this, the plants were matured in June, between 15 and 19 2000 for the 1st year, between May, 22 and June, 6 2001 for the 2nd year and May, 31 2004 for the last year.

In the research, agronomical traits were measured considering the methods used in international pulses experiments of ICARDA. Plant height (PH: cm), branch number (BN: number per plant), total pod number (TPN: number per plant), full pod number (FPN: number per

plant), seed number (SN: number per plant), seed weight (SW: g per plant) and harvest index (HI: %) were measured on 10 plants selected randomly from the mid-row of each plot all years. After harvest, 100 SW (100 SW: g) was calculated by weighting of counted 100 seeds in four replications. Seed yields (SY: kg ha⁻¹) were calculated by adding the seeds from 10 plants to the seeds from each plot after harvesting collectively the 5.6 m² area, and the data were transformed to kg ha⁻¹.

The data was variance analyzed separately and combine the experimental years by using MSTATC, a computer software package. Correlation was calculated by using the "CORRELATION" subprogram of the same package.

Results and discussion

According to variance analysis, years, genotypes and year x genotype interaction in each year and combined analysis of three years were found statistically significant for PH and 100 SW; however, genotypes and year x genotypes interaction were found statistically significant in 2000, 2001 and combined analysis of the years for SW per plant. On the other hand, in terms of BN, TPN, FPN, SN, SY and HI, differences among the years were found statistically significant, but genotypes and year x genotype interaction were found statistically significant in 2000, 2001 and combined analysis of the years.

Mean values and groups of 2000, 2001, and 2004 years and combined year about plant height, branch number, and total pod number obtained from some chickpea genotypes were given Table 2.

According to Table 2, PH values were ranged between 72.0 - 96.1 cm, 85.9 - 103.7 cm, and 52.3 - 64.3 cm in 2000, 2001 and 2004 respectively; combined values of three years were also changed between 72.3 and 84.7 cm. PH values of the genotypes in 2001 were higher than the other years. Because of the low temperature at the initiation of the flowering in 2000 and 2004, vegetative development of the plants was less than the 2nd year. X 93 TH 11-12/15 genotype in 2000 and X 93 TH 18-5/10 genotype in 2001 had the highest PH values, but in the last year

and the combined year X 93 TH 53-14/4 genotype had the highest value.

BN values were ranged between 5.5 - 14.1, 9.6 - 19.1 and 2.9 - 4.4 number per plant in 1999, 2000 and 2001 respectively. Combined values of three years were ranged between 6.4 and 12.2 number per plant (Table 2). BN values of the genotypes in 2001 were higher than the other years like the PH values. Furthermore, PH was positively and significantly correlated with BN (Table 5). In terms of BN, X 93 TH 47-5/11 genotypes were ranked as the first in 2000, 2001 and combined years. However, differences among the genotypes were not found significant in the last year.

TPN values were ranged between 17.2 - 47.2, 13.1 - 61.3, 15.9 - 25.9 and 18.1 - 43.9 numbers per plant in 2000, 2001, 2004 and combined years respectively (Table

2). Many researchers stated that TPN ranged from 5.3 to 100.1 per plant (Anlarsal et al., 1999; Özer and Anlarsal 2005; Mart, 2000 and Korkmaz and Anlarsal, 2005). TPN of the genotypes in 2001 and 2004 was lower than the 1st year. Although the values of the monthly mean temperatures after flowering (April and May) in the 2nd and the 3rd years were similar to the temperature values of the 1st year, since daily maximum temperatures were above 30 °C in some days during this stage in these years, the TPN declined (Şehirli, 1988). With regard to mentioned character, while FLIP 94-30 C genotype ranked as the first in 2000, Aydın-92 cultivar ranked as the first in 2001, 2004 and combined of three years. There were no statistically differences among the genotypes in the last year.

Mean values and groups of 2000, 2001, 2004 years and combined year about full pod number, seed number and

Table 2 Mean values and groups of PH (cm), BN (number per plant), and TPN (number per plant) in some chickpea (*Cicer arietinum* L.) genotypes

	PH (cm)				BN (number per plant)				TPN (number per plant)			
	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year
FLIP 90-58 C	84.8	100.4	59.7	81.6	12.1	9.8	3.5	8.5	22.6	25.1	19.2	22.3
FLIP 93-106 C	82.2	99.9	59.7	80.6	12.1	14.8	4.4	10.4	29.4	25.8	25.5	26.9
FLIP 93-128 C	90.7	94.1	55.3	80.0	5.5	10.1	3.7	6.4	24.7	26.0	24.5	25.1
FLIP 90-4 C	91.3	90.9	52.3	78.2	12.2	10.7	3.5	8.8	42.8	17.1	19.1	26.3
FLIP 93-83 C	87.2	93.2	56.1	78.8	9.1	12.5	3.9	8.5	17.2	17.6	22.8	19.2
FLIP 93-114 C	89.8	93.5	56.3	79.9	11.4	11.5	3.7	8.9	34.0	21.1	22.8	25.9
FLIP 93-130 C	82.9	85.9	56.3	75.0	10.8	10.3	3.5	8.2	21.5	14.8	23.1	19.8
FLIP 94-23 C	85.1	94.7	53.5	77.8	11.6	16.5	3.4	v	31.9	31.3	22.1	28.4
FLIP 94-30 C	88.1	99.6	56.0	81.2	11.8	9.6	2.9	8.1	47.2	21.5	25.3	31.4
FLIP 94-32 C	87.2	94.2	57.2	79.5	11.5	13.0	3.1	9.2	27.5	26.1	24.7	26.1
X 93 TH 2-3/12	91.9	100.4	56.6	82.9	9.3	11.2	3.3	8.0	32.7	21.6	25.1	26.5
X 93 TH 11-9/17	93.8	95.9	56.4	82.0	6.7	12.8	3.0	7.5	17.7	19.3	18.7	18.6
X 93 TH 11-12/15	96.1	93.9	52.5	80.8	8.7	12.8	3.0	8.2	24.3	22.7	15.9	21.0
X 93 TH 18-5/10	88.3	103.7	54.5	82.2	11.5	10.1	3.0	8.2	35.9	13.1	20.6	23.2
X 93 TH 18-15/5	89.4	96.4	59.3	81.7	12.0	15.4	3.1	10.2	34.1	25.3	22.2	27.2
X 93 TH 46-5/8	93.1	89.3	56.7	79.7	11.3	13.9	3.4	9.5	33.1	27.0	22.5	27.5
X 93 TH 46-5/9	92.0	98.8	62.5	84.4	11.3	16.4	3.0	10.2	32.3	26.4	19.1	25.9
X 93 TH 47-5/11	92.0	92.5	61.9	82.2	14.1	19.1	3.5	12.2	26.0	13.1	20.0	19.7
X 93 TH 49-15/2	93.2	93.8	60.8	82.6	9.2	12.4	2.9	8.2	28.7	21.7	24.2	24.9
X 93 TH 53-14/4	90.4	99.5	64.3	84.7	9.1	10.3	2.9	7.4	17.9	14.7	21.8	18.1
X 93 TH 53-14/9	84.8	101.1	63.2	83.0	12.4	14.0	3.6	9.9	22.6	18.4	25.8	22.3
X 93 TH 56-3/2	83.3	92.0	61.6	79.0	13.7	16.0	4.1	11.3	36.5	24.3	21.9	27.5
Aydın-92	72.0	89.9	55.1	72.3	11.0	15.3	3.4	9.9	44.7	61.3	25.9	43.9
Grand Mean	88.2	95.4	57.7	80.5	10.8	13.0	3.4	9.1	29.8	23.3	22.3	25.1
LSD 5%	7.82	7.99	5.59	4.09	3.68	5.24	NS	2.12	8.68	7.0	NS	4.74
CV (%)	5.39	5.09	5.89	5.45	20.7	24.56	17.97	25.13	17.69	18.3	25.17	20.22

PH: Plant Height (cm); BN: Branch Number (number per plant); TPN: Total Pod Number (number per plant); NS: Not Significant

Table 3 Mean values and groups of FPN (number per plant), SN (number per plant), and SW (g per plant) in some chickpea (*Cicer arietinum* L.) genotypes

Genotypes	FPN (number per plant)				SN (number per plant)				SW (g per plant)			
	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year
FLIP 90-58 C	16.5	22.5	17.3	18.8	21.1	31.2	23.5	25.3	7.3	10.6	8.0	8.6
FLIP 93-106 C	23.8	24.8	22.5	23.7	30.9	23.8	28.9	27.9	9.7	8.5	9.9	9.3
FLIP 93-128 C	18.5	19.0	23.1	20.2	21.4	26.1	28.7	25.4	6.9	7.9	9.1	8.0
FLIP 90-4 C	33.5	16.2	16.9	22.2	45.9	18.1	20.1	28.0	13.7	11.1	7.1	10.6
FLIP 93-83 C	11.9	15.7	20.0	15.9	15.4	25.6	24.5	21.9	5.4	7.1	8.8	7.1
FLIP 93-114 C	23.7	18.5	20.1	20.7	30.2	21.0	25.3	25.5	9.1	6.8	8.8	8.3
FLIP 93-130 C	17.3	13.7	21.3	17.5	21.1	18.6	27.3	22.3	6.2	7.5	7.9	7.2
FLIP 94-23 C	25.9	26.3	21.0	24.4	28.4	30.2	24.7	27.8	8.2	8.2	7.0	7.8
FLIP 94-30 C	30.9	20.1	22.7	24.6	38.9	25.0	26.4	30.1	8.1	9.3	7.2	8.2
FLIP 94-32 C	22.9	21.5	22.9	2v2.4	27.3	29.3	27.4	28.0	8.1	8.7	8.6	8.5
X 93 TH 2-3/12	27.0	16.9	22.1	22.0	37.1	20.0	26.1	27.8	11.4	6.7	9.1	9.1
X 93 TH 11-9/17	14.9	17.7	16.5	16.3	19.9	22.2	23.2	21.8	6.3	7.7	7.6	7.2
X 93 TH 11-12/15	19.7	21.3	14.3	18.4	30.3	26.3	22.1	26.2	9.8	9.9	7.3	9.0
X 93 TH 18-5/10	28.9	11.8	17.9	19.5	36.3	14.5	24.9	25.2	12.5	5.6	8.9	9.0
X 93 TH 18-15/5	25.9	21.5	19.5	22.3	35.1	23.2	24.5	27.6	11.6	7.7	9.2	9.5
X 93 TH 46-5/8	25.5	21.6	20.9	22.7	31.9	27.1	27.3	28.8	10.5	9.7	9.9	10.0
X 93 TH 46-5/9	26.0	23.3	16.7	22.0	32.5	26.1	21.9	26.8	13.2	10.4	8.7	10.8
X 93 TH 47-5/11	22.1	11.8	17.9	17.3	22.1	17.1	22.9	20.7	6.9	5.8	9.1	7.3
X 93 TH 49-15/2	22.9	16.2	21.3	20.2	27.7	13.6	26.1	22.5	8.9	6.3	8.9	8.0
X 93 TH 53-14/4	13.7	12.6	18.2	14.8	19.3	v	22.9	19.1	6.6	6.3	10.2	7.7
X 93 TH 53-14/9	18.6	14.1	22.6	18.4	23.7	17.3	29.5	23.5	7.8	7.3	11.6	8.9
X 93 TH 56-3/2	30.6	21.2	20.1	23.9	32.2	25.0	26.4	27.9	13.4	6.6	9.9	10.0
Aydın-92	33.1	52.1	23.3	36.2	39.1	52.1	26.7	39.3	14.8	16.1	9.4	13.4
Grand Mean	23.2	20.0	20.0 B	21.1	29.1	23.9	25.3	26.1	9.4	8.3	8.8	8.8
LSD 5%	8.27	7.05	NS	4.53	9.82	2.89	NS	5.40	3.10	2.99	NS	1.93
CV (%)	21.65	21.40	26.20	23.09	20.55	21.06	24.99	22.24	20.04	21.74	27.77	23.35

FPN: Full Pod Number (number per plant); SN: Seed Number (number per plant); SW: Seed Weight (g per plant); NS: Not Significant

seed weight obtained from some chickpea genotypes were given at Table 3.

According to Table 3, FPN values were ranged between 11.9 - 33.5, 11.8 - 52.1, 14.3 - 23.3, and 14.8 - 36.2 numbers per plant in 2000, 2001, 2004 and combined years respectively. Similar to TPN, FPN values of the genotypes in the 1st year were higher than the other years. According to the correlation coefficients (Table 5), there was positive and significant correlation between TPN and FPN. These results are in agreement with the study carried out by Özveren Yücel et al. (2006). In terms of mentioned character, while FLIP 90-4 C genotype ranked as the first in 2000, Aydın-92 cultivar ranked as the first in 2001, 2004 and combined of the years. There were no differences among genotypes in the last year.

SN values were ranged between 15.4 - 45.9, 13.6 - 52.1, 20.1 - 29.5, and 19.1 - 39.3 numbers per plant in 2000, 2001, 2004 and combined years respectively (Table 3). Many researchers stated that TPN ranged from 4.1 to 107.8 per plant (Anlarsal et al., 1999; Özer and Anlarsal, 2005; Mart, 2000 and Korkmaz and Anlarsal, 2005). SN

values of genotypes were higher in the 1st year than the other years like total and FPN values. As it is seen Table 5, there were positive and significant correlations between SN and TPN, and FPN. These results are in agreement with the study carried out by Özveren Yücel et al. (2006). In terms of mentioned character, while FLIP 90-4 C genotype ranked as the first in 2000, Aydın-92 cultivar ranked as the first in 2001 and combined of the years. There were no differences among genotypes in the last year.

SW values were ranged between 5.4 - 14.8, 5.6 - 16.1, and 7.0 - 11.6 g per plant in 2000, 2001, 2004 and combined years respectively (Table 3). Similar to total pod, full pod, and SN values, Aydın-92 cultivar ranked as the first in 2000, 2001, and combined of the years, however there were no differences among genotypes in the last year. Besides, positive and significant relationships were found between SW and TPN, FPN, SN in this research (Table 5). These results are in agreement with the study carried out by Anlarsal et al. (1999).

Mean value and groups of 2000, 2001, and 2004 years and combine years about 100 seed weight, seed yield, and

Table 4 Mean values and groups of 100 SW (g), SY (kg ha⁻¹), and HI (%) in some chickpea (*Cicer arietinum* L.) genotypes

Genotypes	100 SW (g)				SY (kg ha ⁻¹)				HI (%)			
	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year	2000	2001	2004	Combined Year
FLIP 90-58 C	38.0	37.4	34.2	36.5	2327	1880	1963	2057	24.2	29.8	49.5	34.5
FLIP 93-106 C	32.7	37.6	34.5	34.9	1790	1403	2003	1732	26.3	27.1	50.3	34.6
FLIP 93-128 C	36.8	30.8	31.5	33.1	1437	1897	1810	1714	27.0	32.3	48.5	36.0
FLIP 90-4 C	32.5	34.2	35.4	34.0	1703	1122	1963	1596	30.8	34.6	51.1	38.8
FLIP 93-83 C	32.3	35.7	35.5	34.5	1727	1297	1723	1582	20.2	19.1	49.5	29.6
FLIP 93-114 C	33.8	30.7	34.4	33.0	1510	1690	1960	1720	25.1	31.4	48.5	35.0
FLIP 93-130 C	31.2	32.9	28.3	30.8	1723	1401	1913	1679	25.0	27.8	44.3	32.3
FLIP 94-23 C	31.7	29.3	28.7	29.9	1790	1367	1987	1714	26.9	27.9	51.6	35.5
FLIP 94-30 C	33.7	29.1	27.6	30.1	1520	1653	1833	1669	28.0	28.6	50.6	35.7
FLIP 94-32 C	32.3	31.9	31.7	32.0	1507	1471	1890	1622	25.0	31.7	50.7	35.8
X 93 TH 2-3/12	30.7	33.0	34.2	32.6	1760	1707	1783	1750	29.1	31.4	49.7	36.7
X 93 TH 11-9/17	32.3	35.7	33.0	33.7	1833	1503	1950	1762	28.7	25.6	50.4	34.9
X 93 TH 11-12/15	34.0	35.2	33.2	34.1	1850	1188	1960	1666	25.4	30.2	54.1	36.6
X 93 TH 18-5/10	27.2	34.2	35.6	32.3	1953	1283	1797	1678	29.0	19.7	52.5	33.7
X 93 TH 18-15/5	33.5	37.4	38.0	36.3	1857	1097	2143	1699	22.2	23.0	49.0	31.4
X 93 TH 46-5/8	33.3	37.3	36.5	35.7	1993	1340	2097	1810	29.0	25.2	51.5	35.2
X 93 TH 46-5/9	31.7	38.3	40.1	36.7	1830	1203	2213	1749	24.5	21.2	48.6	31.4
X 93 TH 47-5/11	33.3	35.4	40.0	36.2	1707	1122	2103	1644	18.3	24.9	46.5	29.9
X 93 TH 49-15/2	32.2	34.4	33.9	33.5	2000	1580	1860	1813	23.8	23.7	49.7	32.4
X 93 TH 53-14/4	30.3	43.0	43.7	39.0	1710	1268	1883	1620	24.1	20.8	47.2	30.7
X 93 TH 53-14/9	33.7	37.2	41.3	37.5	1813	1293	2097	1734	19.7	22.1	47.2	29.6
X 93 TH 56-3/2	33.5	36.5	37.5	35.8	2333	1937	2127	2132	29.5	29.2	52.2	37.0
Aydın-92	30.2	34.4	35.6	33.4	1997	2077	1953	2009	34.3	33.0	53.1	40.1
Grand Mean	32.6	34.9	35.0	34.2	1812	1469	1957	1746	25.9	27.0	49.9	34.2
LSD 5%	4.06	3.68	6.79	2.86	35.33	18.84	NS	25.99	5.49	5.92	NS	3.22
CV (%)	7.57	6.42	11.79	8.96	11.85	22.22	14.49	15.96	12.88	13.35	6.84	10.08

100 SW: 100 Seed Weight (g); SY: Seed Yield (kg da⁻¹); HI: Harvest Index (%)
NS: Not Significant

harvest index obtained from some chickpea genotypes were given Table 4.

According to Table 4, values of 100 SW were ranged between 27.2 - 38.0, 29.1 - 43.0, 27.6 to 43.7, and 29.9 to 39.0 g in 2000, 2001, 2004 and combined years respectively. Obtained 100 SW values in this research were found similar to the values reported by Mart (2000), Anlarsal et al. (1999), Korkmaz and Anlarsal (2005), and Özer and Anlarsal (2005). Opposed to TPN, FPN and SN, 100 SW values of the genotypes in 2000 were lower than the other years. Also, significant but negative correlations between 100 SW and TPN, FPN, SN were found (Table 5). Daily maximum temperature reached 35 °C during the pod filling in 2001 and 2004. This situation caused that plants pass from filling stage to maturity in early period. Because of the fewer SN in 2000, SW was increased. In terms of mentioned character, while FLIP 90-58 C genotype ranked as the first in 2000, X 93 TH 53-14/4 genotype ranked as the first in 2001, 2004 and combined of the years.

SY were ranged between 1437 - 2333, 1097 - 2077, 1723 - 2213, 1582 - 2132 kg ha⁻¹ in 2000, 2001, 2004

and combined years respectively (Table 4). Recorded SY values were similar to the values provided from studies which were carried out in Çukurova region (Engin, 1989; Mühür, 1996; Özdemir et al. 1992, 1996; Mart, 2000; Anlarsal et al. 1999). With regard to SY, X 93 TH 56-3/2 and FLIP 90-58 C genotypes in 2000, Aydın-92 cultivars in 2001 and, X 93 TH 56-3/2 genotype in combined year ranked as the first. There was no difference among genotypes in the last year in terms of mentioned character. On the other hand, although genotype x year interaction were found significant, the highest yield was observed for X 93 TH 56-3/2 genotype followed by FLIP 90-58 C genotype in each and combined year. Besides, these genotypes had also higher or similar yield potential than mean yield and yield of Aydın-92 (check) cultivar. Hence, mentioned genotypes are able to evaluate as winter growing in the mediterranean condition.

HI were ranged between 18.3 - 34.3, 19.1 - 34.6, 44.3 - 54.1, 29.6 - 40.1 % in 2000, 2001, 2004 and combined years respectively (Table 4). HI values were obtained high in the last year to be lower of the PH and BN. When as-

Table 5 Correlation coefficients of yield components in the chickpea (n=207)

Yield Components	2. B.N.	3. TPN	4. FPN	5. SN	6. SW	7. 100 SW.	8. HI	9. SY
1. PH	0.777**	0.128	0.048	0.014	0.001	-0.016	-0.876**	-0.441**
2. BN		0.283**	0.231**	0.137*	0.071	-0.009	-0.773**	-0.421**
3. TPN			0.937**	0.892**	0.685**	-0.164*	-0.087	0.151*
4. FPN				0.914**	0.736**	-0.153*	0.028	0.161*
5. SN					0.745**	-0.177*	0.073	0.182*
6. SW						0.044	0.133	0.204**
7. 100 SW							0.060	-0.063
8. HI								0.449**
9. SY								---

sociations of investigated characters were examined, HI was found negatively and significantly correlated PH and BN. Aydın-92 cultivar in 2000, FLIP 90-4 C genotype in 2001, and X 93 TH 11-12/15 genotype in 2004 had the highest value with regard to HI. There was no difference among genotypes in the last year in terms of mentioned character.

Simple correlation coefficients among the examined traits are showed in Table 5.

Positive and significant relationships were found statistically between PH and BN. SW was positively correlated with total pod, full pod and SN. There were negative and significant correlations between 100 SW and total pod, full pod and SN but not with Özer and Anlarsal (2005). SY was significantly and negatively correlated with PH and BN, but positively correlated with TPN, FPN, SN, SW and HI. Correlations between SY and yield components as connected with material and region condition in studies carried out by different researches were determined. Opposite to our findings, positively and significantly correlation SY and plant height was reported by Rahman and Parh, (1988); Ali, (1990). Similar to the findings, Islam et al. (1984) stated that SY was positive and significant correlated with pod number per plant. On the other hand, Choudhury and Khaleque Mian (1988) found a positive and significant correlation between SY and pod number per plant, and 100 SW. Uddin et al. (1990), reported that, 100 SW, pod number, and HI were the most important characters to increasing SY. Negative associations of SY were observed with plant height, SN, and 100 SW in chickpea (Özer and Anlarsal, 2005).

Conclusions

According to means of combined of three years, SY among examined characters was ranged from 1582 to 2132 kg ha⁻¹ in this research. X 93 TH 56-3/2 and, FLIP 90-58 C genotypes were determined to be adaptable to Çukurova conditions and produce larger seeds and higher SY than Aydın-92 (check). Because of the fact that, men-

tioned genotypes have larger seed size than that of Aydın-92, those are considered promising genotypes.

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