Turkish Journal of Agricultural and Natural Sciences
Special Issue: 1, 2014

TÜRK
TARIM ve DOĞA
BİLİMLERİ DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

www.turkjans.com

Genotype x Environmental Interactions and Adaptation Abilities of Chickpea (*Cicer arietinum* L.) in Cukurova Conditions

Dürdane MART
East Mediteranean Agricultural Research Institute, ADANA
Corresponding author email: durdanemart@yahoo.com

Abstract

During the study, at which genotype x environmental interactions and adaptation capacity of 18 chickpea varieties that took place at yield trials conducted in years 2001, 2002 and 2003 at two different locations (Doğankent, Taşçı) in Çukurova region were studied, it has been observed that studied characteristics are significantly affected from trial locations. Chickpea varieties used in the yield trial, demonstrated different adaptation capacities to different environmental conditions in terms of studied characteristics. According to adaptation criteria and results taken according to this criteria, which were based on yields of chickpea varieties FLIP 93-118C, FLIP 82-150C and FLIP 94-88C demonstrated good adaptation to all environmental conditions; FLIP 91-186C, FLIP 92-147C and Aydın-92 demonstrated bad adaptation to all environmental conditions. FLIP 92-142C, FLIP 93-176C and FLIP 82-150C are the varieties which demonstrated special adaptation to good environmental conditions; FLIP 91-186C, FLIP 92-105C and FLIP 91-202C are the varieties which demonstrated special adaptation to bad environmental conditions

Keywords: Chickpea, stability, genotype x environmental interaction

Introduction

Chickpea is an indispensable crop especially for transition zone and for high altitude areas. (Mart, 2005) Varieties that farmers use, as a result of being local varieties, are quite susceptible to Ascochyta Blight and they have low yields, as they are suitable for summer sowing. However, trials in our region showed us that, it is possible to get yields as high as 200-300 kg/da when certain varieties are used for winter sowing. But, Ascochyta Blight (Ascochyta rabiei (pass.)Labr.) appears as a significant problem especially at rainy and mild winters during growing of winter varieties. (Şehrali, 1988) As a result, it is very important for winter varieties to be tolerant to Ascochyta Blight.

Chickpea has a sowing area of 423.557 hectare and a total production of 530.634 metric tones in Turkey and has a significant importance among legumes. (Tüik 2013) Top chickpea production areas are Central Anatolian Region, Mediterranean Region and Aegean Region respectively.

It is desired that, high values about agronomic characteristic that affect yield in legumes are constant, considering that the main target with edible legumes is high yield pod. This being the case, genotypes that constitute commercial varieties should at least demonstrate an acceptable performance at different environmental conditions. However, particularly when quantitative characteristics like yield are the case, different plant genotypes that are grown in a wide region generally demonstrate performance differences. (Altınbaş, 1994) Such a notion leads different magnitudes of genotype X environment interactions. Such statistical interactions might be a result of relative arrangement differences in terms of performances in different environmental conditions or they might be as a result of variation in terms of magnitudes of genotype differences from one environment to another. However, in both situations affects of important and high level genotype X environment interactions lowers the correlation in between fenotypical and genotypical values and lowers efficiency of breeding programs that target development of superior plant genotypes. (Comstock,1963).

Target of this research is identifying adaptation capabilities of related genotypes to the regional conditions by forecasting stability parameters of 18 Chickpea genotypes, which will be grown in two locations for three years in Çukurova, in terms of yield and agronomical characteristics.

Table 1. Long Years and 3 Year (2001, 2002, 2003) Average Climatic Averages of Adana

Months	Average Temperature C^0				Rainfall mm				Relative Humidity %			
	Long year	2001	2002	2003	Long Year	2001	2002	2003	Long Year	2001	2002	2003
November	15.1	13.6	13.9	16.4	67.2	28.25	88.1	25.7	63	60.5	67.4	64.2
December	11.1	8.6	10.7	8.8	118.1	54.7	320.9	77.9	66	69.4	78.9	61.0
January	9.9	8.4	7.9	11.1	111.7	10.8	109.2	84.5	66	72.2	66.2	75.1
February	10.4	8.7	12.3	8.2	92.8	67.1	68.1	111.7	66	75.8	64.7	68.8
March	13.1	14.08	14.7	11.5	67.9	41.3	40.3	92.3	66	79.5	67.4	64.0
April	17.1	16.1	16.5	17.1	51.4	2.8	88.8	61.1	69	71.2	76.0	68.9
May	21.4	21.8	21.4	24.3	46.7	130.4	22	36.1	67	60.2	68.3	56.1
June	25.2	26.6	26.5	25.2	22.4	-	0.8	15.0	66	62.2	62.8	70.8
July	27.7	28.4	29.1	27.9	5.4	-	4.8	3.6	68	76.4	70.8	74.7
Total					583.6	335.4	743.0	507.9				

Material and Method

Material

In this research, material that belongs to 18 winter type Chicpea (*Cicer arietinum L.*) varieties that are gained from selections from prior researches in the region and material taken from ICARDA are used. Aydın-92.is used as control variety.

Climatic data of Adana both for the years the trials were set and for long year averages are given at Table 1.

This study has been conducted at Doğankent and Taşçı trial locations of Çukurova Agricultural Research Institute in years 2001, 2002 and 2003. Research has been designed as triple repetitions in random trial blocks. Parcels were constructed as 4 rows with 45 cm row spacing and 8 cm of intra-row spacing. All three years 3 kg /da N and 6 kg /da P2O5 of commercial fertilizer have been applied during plantation. Plantations are made in between 15-17 December at Doğankent and Taşçı locations.

Table 2. Variance Analysis Results for Yield, Plant Height, First Pod Height, Flowering Period and 100 seed weight of Chickpeas Grown in Çukurova Region for last 3 Years at 2 Locations

Variation Sources	d.f.	Mean of Squares				
		Yield (kg/da)	100 seed weight (gr)	Flowering Period (gün)	Plant Height (cm)	First Pod Height (cm)
Year	2	131396.941**	255.165**	33306.333**	13083.153**	706.740**
Location	1	459587.942**	53.680	4548.753**	207.520**	360.578**
Year X Loc.	2	903722.450**	1067.558**	1942.457**	22297.196**	6830.649**
Replication	12	12296.699**	27.983	7.009	54.625	123.259**
Varieties	17	19398.694**	37.206**	73.895**	114.997**	48.013**
Year X Variety	34	4090.294*	15.595	13.510**	34.170	13.091
Loc. X Variety	17	5741.489**	19.170	12.910**	33.405	35.703
Year X Loc X Variety	34	5849.523**	26.306*	7.398	57.973*	35.514
Error	204	2529.482	17.211	5.130	34.582	24.936
General	323					

* % 5 importance level, ** % 1 importance level

Data obtained in this study has been subject to variance analysis as used in MSTAT-C software on basis of random blocks trial design repeated at different locations in different years. Averages are grouped according to Duncan %5. (Düzgüneş,1983). Linear Regression Analysis has been used to identify genotype adaptations of 18 winter type chickpea varieties that are planted for three years in two different locations with triple repetition. In this analysis, average values of the characteristics in different trial locations that belong to studied genotypes are taken as (Y) dependant variable and trial averages of trial places in this environment is taken as (X) independent variable. (Özdemir,1996). MSTAT-C software has been used for linear regression analysis conducted for identifying adaptation of genotypes. In the analysis Finlay and Wilkinson model, which take both average of observed characteristics and regression coefficients into

account when identifying adaptation has been employed. (Finlay,1966). Average of characteristics (x) regression coefficient (b) average of separation from regression squares (S^2d) and determination coefficient (R^2) are calculated when identifying adaptation of all the varieties in the study.

Table 3. Three Year Average Yield (kg/da), 100 seed weight (gr), Flowering Period (day), Plant Height (cm), First Pod Height (cm), of Chickpea Varieties Planted in Two Different Locations and Groups Formed

Locations	Yield (kg/da)	100 seed weight (gr.)	Flowering Period (day)	Plant Height (cm)	First Pod Height (cm)
Doğankent	263.58 A	35.77 A	120.78 A	75.45 A	35.60 A
Taşçı	188.25 B	34.96 B	113.29 B	73.85 B	33.49 B
Average	225.92	35.37	117.04	74.65	34.55

Table 4. Two Locations Average Yield (kg/da), 100 seed weight (gr), Flowering Period (day), Plant Height (cm), First Pod Height (cm), of Chickpea Varieties Planted in Three Year Different and Groups Formed

Years	Yield (kg/da)	100 seed weight (gr.)	Flowering Period (gün)	Plant Height (cm)	First Pod Height (cm)
2000-2001	188.00 *	34.19 *	119.37 B	62.63 B	35.71 *
2001-2002	233.12	37.11	98.43 C	84.24 A	36.32
2002-2003	256.64	34.79	133.32 A	77.07A	31.62
Average	225.92	35.37	117.04	74.65	34.55

*Values that belong to similar letter groups are no different according to EGF %5 test

Findings and Discussion

According to variance analysis results of the study, year, year X location and varieties interaction showed statistical importance in all observed characteristics, where interaction of year X location X variety is found statistically important for yield. (Table 2)

Characteristics about yield and 3-year average yield obtained from the study are given at Table 3. As shown in Table 3, highest values among the characteristics observed were taken from Doğankent location. This is a result of soil and climate differences among locations.

Characteristics about 3 year average of yield and yield are shown in Table 4

As shown in Table 4 the highest yield was 256.64 kg/da in year 2003 and the lowest yield was respectively 233.12 kg/da in year 2002 and 188.00 kg/da in year 2001 although they were in the same group. In terms of 100-yield, same group gave 37.11 g in 202, 34.79g in 2003 and 34.19 g in 2001. Flowering period was longest with 133.32 days in 2003 and was 119.37 in 2001 and 98.43 in 2002. 2003 and 2002 were in the same group in terms of plant height respectively with 84.24 cm and 77.07 cm, although the height was 62.63 cm in 2001. It is reported that plants grown in dry and light soil are flowering and growing pods faster, while heavy and more humid soils causes delays and very fertile soils lower number of pods due to excess humidity of soil. (Şehirali,1988). Irrigation is reported to increase number of pods and to have a positive affect on yield (Saxena,1980).

Table 5 shows three average yields obtained from the study as well as characteristics about those yields. As shown in Table 5 rows and varieties didn't show too much difference in terms of yield averages. Average yield when years and locatons are consolidated changes in between 272,45-157,62 kg/da, where the highest value is obtained from FLIP 92-142C row and the lowest from FLIP 92-105C variety. Phadnis (1970), reported that yield is most affected by number of pods and seed count and shows a negative correlation with plant height. Average of 100 seed weight changes in between 37,81-32,50 g, where FLIP 92-105C gave the highest value and FLIP 92-105C the lowest. Variations in terms of amount of rainfall and its distribution had a negative affect on pod size. For instance the fact that amount of rainfall was lower in fist year than long year average caused number of pods to be more than usual but pods not to reach sufficient size. Parallel to our findings Dahiya, 1982 reports that there is a negative or weak relationship in between 100 seed weight and yield and number of pods. Flowering period average has been observed as 120,17-114,06 days, where the highest value was observed with FLIP 82-150C and the lowest with FLIP 91-202C and FLIP 91-186 rows. Flowering has been positively affected by winter sowing of the plants, amount of rainfall and distribution of it as well as the fact that there wasn't any excess heat.

Plant height averages are recorded in between 78,56-67,74 cm, where the highest value was at FLIP 93-118C and the lowest at FLIP 91 – 186C row. In order to enable machinery harvest, a tall plant is requested. In addition to winter sowing, amount of rainfall and its distribution also had a positive affect on plant height. Average first pod height is recorded in between 37,7-29,8 cm, where the lowest value was at FLIP 93-118C and the highest at FLIP 91-186C row. In order to enable machinery harvest and prevent seed loss, a high first pod s requested.

Table 5. Three Years and Two location Average Yield (kg/da), 100 seed weight (gr), Flowering Period (day), Plant Height (cm), First Pod Height (cm), of Chickpea Varieties and Groups Formed

Varieties	Yield (kg/da)	100 seed weight (gr)	Flowering Period (day)	Plant Height (cm)	First Pod Height (cm)
FLIP91– 202C	181.86 AB	34.93 *	114.06 E	76.33 *	35.3 *
FLIP 92 – 147C	209.44 AB	37.15	118.28 A-E	76.31	35.3
FLIP 93 – 119C	216.58 AB	35.87	119.67 A	75.22	35.2
FLIP 93 – 64C	200.37 AB	35.26	114.67 C-E	75.22	33.3
FLIP 94 – 111C	228.84 AB	32.50	114.39 DE	72.32	33.6
FLIP 93 – 166C	194.98 AB	35.15	117.56 A-E	75.28	34.4
FLIP 92 – 105C	157.62 B	37.81	116.00 A-E	78.28	35.8
FLIP 93 – 118C	228.73 AB	35.68	116.06 A-E	78.56	37.7
FLIP 82 – 150C	265.66 A	35.33	120.17 A	75.87	35.5
FLIP 93 – 144C	259.19 A	37.30	118.78 A-D	76.08	35.6
FLIP 94 – 88C	271.56 A	32.64	117.33 A-E	72.04	32.9
FLIP 92 – 142C	272.45 A	34.36	114.78 B-E	71.56	34.6
FLIP 93 – 176C	264.04 A	35.37	118.83 A-C	74.42	34.7
FLIP 94 – 61C	237.30 AB	35.15	116.94 A-E	74.22	34.8
FLIP 91 – 186C	197.80 AB	37.26	114.06 E	67.74	29.8
FLIP 91– 188C	226.09 AB	35.65	118.78 A-D	75.02	35.3
FLIP 93 – 51C	241.51 AB	34.41	119.11 AB	74.33	34.8
Aydın-92	212.50 AB	34.76	117.22 A-E	74.85	33.2
Average	225.92	35.37	117.04	74.65	34.6

*Values that belong to similar letter groups are no different according to Duncan %5 test

Table 6. Observed Adaptation Criteria for Characteristics of Yield (kg/da), 100 seed weight (gr), Flowering Period (day) of 21 Chickpea Winter Varieties Planted in Yield Trials at Two Locations

	Yield (kg/da)				100 seed weight (gr)			
Varieties	X	b	S^2d	R^2	X	b	S^2d	R^2
FLIP 91 – 202C	181.86	0.684	1203.10	0.820	34.93	1.270	0.984	0.953
FLIP 92 – 147C	209.44	0.909	510.49	0.950	37.15	1.302	1.058	0.952
FLIP 93 – 119C	216.58	0.788	1398.99	0.839	35.87	1.316	1.462	0.937
FLIP 93 – 64C	200.37	0.827	1455.90	0.846	35.26	1.012	6.061	0.679
FLIP 94 – 111C	228.84	0.876	3867.28	0.699	32.50	0.129	22.726	0.009
FLIP 93 – 166C	194.98	0.787	373.64	0.951	35.15	1.192	1.028	0.945
FLIP 92 – 105C	157.62	0.508	917.28	0.767	37.81	1.536	0.755	0.975
FLIP 93 – 118C	228.73	1.021	472.45	0.963	35.68	1.253	3.745	0.840
FLIP 82 – 150C	265.66	1.277	1381.45	0.933	35.33	1.194	1.370	0.929
FLIP 93 – 144C	259.19	1.230	1814.21	0.907	37.30	0.927	19.370	0.357
FLIP 94 – 88C	271.56	1.022	2230.97	0.846	32.64	0.468	4.260	0.392
FLIP 92 – 142C	272.45	1.372	2915.78	0.883	34.36	1.031	2.944	0.819
FLIP 93 – 176C	264.04	1.341	1550.63	0.931	35.37	1.020	0.397	0.970
FLIP 94 – 61C	237.30	1.124	876.63	0.944	35.15	1.134	1.009	0.941
FLIP 91 – 186C	197.80	0.993	2212.57	0.839	37.26	1.380	3.133	0.884
FLIP 91– 188C	226.09	1.099	551.99	0.962	35.65	1.153	0.535	0.969
FLIP 93 – 51C	241.51	1.140	590.76	0.963	34.41	1.464	0.507	0.981
Aydın-92	212.50	1.003	1243.22	1.003	34.76	1.072	1.429	0.909
Average	225.918	1.000	1420.41	0.891	35.37	1.103	4.043	0.802

X: Characteristics Average.; b:Regression Coefficient; S^2d: Average of Separation from regression Squares; R2: Determination Coefficient

Identification of Adaptation of Genotypes

Table 6-7 shows adaptation criteria for the studied characteristics of chickpea. When adaptation criteria identified by yields of chickpea varieties and the results reached from these are studied, varieties FLIP 93-118C, FLIP 82-150C and FLIP 94-88C that have higher than average yield and that have a close to 1 regression coefficient are identified by varieties that show good adaptation to all environmental conditions and varieties FLIP 91-186C, FLIP 92-147C and Aydın-92 that have lower than average yields and that have close to 1 regression coefficients are identified as varieties that show bad adaptation to all environmental conditions. Varieties FLIP 92-142C, FLIP 93-176C, FLIP 82-150C that have higher than average yield and that have higher than 1 regression coefficients are identified as varieties that show special adaptation to good environmental conditions, varieties FLIP 91-186C, FLIP 92-105C and FLIP 91-202C that have lower than average yields and that have lower than 1 regression coefficients are identified as varieties that show special adaptation to bad environmental conditions.

Varieties FLIP 93-118C, FLIP 94-61C and FLIP 91-188C that have high average yield and regression coefficient and that have low average of separation from regression squares are identified as varieties that can respond to changing environmental conditions and they can repeat this characteristic in certain environments. In other words they are varieties that can adapt to favorable environmental conditions and therefore superior to other varieties.

Table 7. Observed Adaptation Criteria for Characteristics of Plant Height (cm) and First Pod Height (cm) of 21 Chickpea Winter Varieties Planted in Yield Trials at Two Locations

	Flowering Period (Day)				Plant Height (cm)				First pod height (cm)			
Varieties	X	b	S^2d	R^2	X	b	S^2d	R^2	X	b	S^2d	R^2
FLIP 91 – 202C	114.06	0.991	2.205	0.994	76.33	1.202	6.277	0.987	35.25	0.964	80.546	0.452
FLIP 92 – 147C	118.28	0.975	2.327	0.993	76.31	1.070	32.273	0.921	35.33	0.868	10.863	0.832
FLIP 93 – 119C	119.67	1.046	4.273	0.989	75.22	1.042	5.334	0.985	35.24	0.957	4.293	0.938
FLIP 93 – 64C	114.67	1.008	3.988	0.989	75.22	1.229	14.947	0.971	33.30	1.081	11.580	0.878
FLIP 94 – 111C	114.39	0.982	2.063	0.994	72.32	0.880	8.628	0.967	33.60	0.905	3.929	0.937
FLIP 93 – 166C	117.56	1.022	2.496	0.993	75.28	0.912	1.467	0.995	34.39	0.848	5.779	0.899
FLIP 92 – 105C	116.00	0.968	1.200	0.996	78.28	0.973	4.467	0.986	35.78	0.910	1.670	0.973
FLIP 93 – 118C	116.06	0.893	2.561	0.991	78.56	1.005	15.896	0.954	37.74	1.081	4.450	0.949
FLIP 82 – 150C	120.17	1.096	1.462	0.997	75.87	0.993	7.054	0.979	35.47	1.230	5.115	0.955
FLIP 93 – 144C	118.78	0.988	8.523	0.975	76.08	0.804	12.618	0.944	35.61	0.923	3.435	0.947
FLIP 94 – 88C	117.33	0.963	2.954	0.991	72.04	0.970	16.662	0.949	32.87	1.020	3.366	0.957
FLIP 92 – 142C	114.78	0.978	2.880	0.991	71.56	1.058	10.987	0.971	34.62	0.973	1.984	0.972
FLIP 93 – 176C	118.83	1.114	3.992	0.991	74.42	0.963	4.207	0.986	34.68	1.145	1.455	0.985
FLIP 94 – 61C	116.94	1.037	1.445	0.996	74.22	1.142	4.603	0.989	34.83	1.193	2.712	0.974
FLIP 91 – 186C	114.06	0.967	8.038	0.976	67.74	0.756	24.898	0.883	29.83	0.894	11.135	0.837
FLIP 91– 188C	118.78	1.024	5.735	0.984	75.02	1.014	11.844	0.966	35.29	0.943	1.930	0.971
FLIP 93 – 51C	119.11	1.012	1.818	0.995	74.33	1.144	6.227	0.986	34.81	1.093	7.932	0.915
Aydın-92	117.22	0.936	3.004	0.990	74.85	0.843	24.039	0.907	33.23	0.971	10.678	0.863
Avarage	117.04	1	3.387	0.990	74.65	1	11.802	0.963	34.548	0.999	9.603	0.902

X: Characteristic Average; b:Regression Coefficient; S^2d: Average of Separation from Regression Squares.; R2: Determination Coefficient

According to average yield, regression coefficient, average of separation from regression squares and determination coefficient FLIP 93-118C, FLIP 82-150C and FLIP 94-61C varieties can be identified as varieties that have little respond to changes with environmental conditions and that are not affected much from changes and keep their high yielding characteristics.

When adaptation criteria identified by 100 seed weight and results reached by these are studied, FLIP 93-176C, FLIP 93-144C and FLIP 94-111 varieties are identified as showing good adaptation to all environmental conditions, FLIP 93-64C, FLIP 92-142C and Aydın-92 varieties are identified as showing bad adaptation to all environmental conditions, FLIP 93-144C, FLIP 93-176C and FLIP 91-188C varieties are identified as showing special adaptation to good environmental conditions and , FLIP 94-88C, FLIP 94-111C varieties are identified as showing special adaptation to bad environmental conditions.

Table 7 shows adaptation criteria identified for flowering periods, plant height, first pod height. When adaptation criteria identified by flowering period and results reached by these are studied, FLIP 93-51C, FLIP 93-144C and FLIP 93- 166C varieties are identified as showing good adaptation

to all environmental conditions, FLIP 93-64C, FLIP 91-202C and FLIP 94-111C varieties are identified as showing bad adaptation to all environmental conditions, FLIP 82-150C, FLIP 93-119C and FLIP 93-176C varieties are identified as showing special adaptation to good environmental conditions and FLIP 93-118C, FLIP 92-105C and FLIP 91-186C varieties are identified as showing special adaptation to bad environmental conditions.

When adaptation criteria identified by plant height and results reached by these are studied, FLIP 93-118C, FLIP 92-105C varieties are identified as showing good adaptation to all environmental conditions, FLIP 94-142C, FLIP 94-88C varieties are identified as showing bad adaptation to all environmental conditions, FLIP 91-202C, FLIP 92-147C varieties are identified as showing special adaptation to good environmental conditions and FLIP 91-186C, FLIP 93-176C varieties are identified as showing special adaptation to bad environmental conditions.

When adaptation criteria identified by first pod height and results reached by these are studied, FLIP 92-142C, FLIP 91-188C varieties are identified as showing good adaptation to all environmental conditions, FLIP 94-88C and FLIP 93-64C varieties are identified as showing bad adaptation to all environmental conditions, FLIP 82-150C, FLIP 93-176C varieties are identified as showing special adaptation to good environmental conditions and FLIP 93-166C, FLIP 91-186C varieties are identified as showing special adaptation to bad environmental conditions.

Result

FLIP 93-118C, FLIP 82-150C, FLIP 94-61C, FLIP 93-144C and FLIP 94-88C varieties continued demonstrating high yield characteristics in different environmental conditions, due to their high average yield, regression coefficient close to 1, high determination coefficient and low average of separation from regression squares characteristics. As a result above-mentioned varieties should be considered when breeding new varieties suitable for the region.

Sources

Anonymous, 2013. TÜİK.

Açikgöz, N., 1987. Nohut Tarımı, Ege Bölge Zirai Arş. Ens. Müd. Yayın No: 76, Menemen-İzmir, 25 s.

.

Altinbaş, M., Sepetoğlu, H., 1994. Mercimekte *(Lens culinaris Med.)* dane verimi ve Kimi agronomik özelliklerde stabilite parametrelerinin belirlenmesi üzerine bir çalışma . Tarla Bitkileri Kongresi, 25-29 Nisan 1994, E.Ü. Ziraat Fak. Bornova-İzmir, s. 116-120.

Comstock, R.E., Moll, R.H., 1963. Genotype–Environment Interactions. Statistical Genetics and Plant Breeding. NAS-NRC Publ. No.982., Washington DC. s.164-196.

Dahiya, B.S., Kapoor, A.C., Solanki,I.S., Waldia,R.S., 1982. Effect of Cultivar and Location on Seed Protein in Chickpea (*Cicer arietinum* L.) Exp. Agric, 18: 289 –292.

Düzgüneş, O., Kesici, T., Ve Gürbüz, F.,1983. İstatistik Metotları, A.Ü.Ziraat Fak.Yay., Ankara, 363s.

Finlay, K.W., Wilkinson,G.N., 1966. The Analysis of Adaptation in a Plant Breeding Programe. Aust.J.Agric. Res. 14 : 742 – 754.

Mart,D., 2000. Çukurova Koşullarında Nohutta (Cicer arietinum L) Bazı Özellikler Yönünden Genotip X Çevre İnteraksiyonları Ve uyum Yeteneklerinin Saptanması Üzerine Bir Araştırma, Doktora Tezi.

Özdemir, S., Engin, M., 1996. İri Taneli Bazı Nohut Çeşitlerinin Çukurova Bölgesinde Stabilite Analizleri. Tukish Journal of Agriculture and Forestry. 20: 2, 157 – 161.

Saxena, M.C., 1980. Recent Advences İn Chickpea Agronomy. In Proceedings Of The First International Workshop on Chickpea Improvement, 28 Feb- 2 Mar 1979. Icrisat, Hyderabat, India, s.89-96.

Singh, V., Singh, F., 1991. Stability of Yield and Harvest Indeks in Chickpea (*Cicer arietinum* L.). Indian Journal of Agricultural Sciences. 60: 7, 443-447.

Şehirali, S., 1988. Yemeklik Tane Baklagiller. Ank. Ün. Zir. Fak..yayınları :1089, Ankara, 435 s.

Tolukan, M., Engin. M., (1987). A Study for Identification of Winter Type Chickpea *(Cicer arietinum L.) Varieties Suitable for Çukurova Region, Masters Thesis*, Ç.Ü. Science Institute.

Phadnis, B.A., A.P. Ekbote And S.S. Ainchwar.(1970); Path-Coefficient Analysis in Gram (*C.arietinum*). Bibloography of Chickpea Genetics and Breeding., 115:915