A Study to Determine Yield and Yield Component Interactions on ICARDA Spring Chickpea (*Cicer arietinum* L.) Varieties in Eastern Mediterranean Conditions

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Abstract

This study has been conducted in years 1998 and 1999 on research fields of Eastern Mediterranean Agricultural Research Institute, at Adana/Turkey location in order to identify the yield and the yield component interactions in chickpea (*Cicer arietinum* L.) for Eastern Mediterranean conditions. In addition, the flowering date, plant height and tolerance to Ascochyta Blight were also taken into account as a criteria for the selection. The distribution of rainfall was also effective on the performances of lines and varieties. The area of the research was located between the geographic latitudes of 36° 51' 17.21 North and 35° 20' 41.61 East with an altitude of 23 m. The planting was performed in December and the varieties were evaluated for their fitness to winter conditions. According to the highest and the lowest values accumulated during two years of a study at Adana location; yield values were changed in between 246.5-39.74 kg/da, flowering period was changed in between 144.0-137.8 days, plant height was changed in between 76.17-51.83 cm at the winter sowing conditions.

Keywords

Spring Chickpea, Varieties, Yield

1. Introduction

Turkey is an important natural gene bank for chickpeas. Chickpea is able to grow in the arid regions of Turkey, where many other crops can not be grown owing to its surviving ability under strong conditions such as poor soil, warmth and drought [1-2]. In 2019, the chickpea production was 630.000 tonnes with the sowing area of 517.785 ha while the grain yield was 122.00 kg/da [3]. For the Eastern Mediterranean region, chickpea is a crucial plant in the sowing alternation. Being rich in protein and leaving a high nutrition soil afterwards are main beneficial points for legumes to become essential crop in the sowing alternation [4]. In addition to the use of edible legumes in human nutrition, grains and stems are also used in animal feeding. Furthermore, the digestibility ratings (78%) of the proteins found in legume stalks and grains are significantly higher than those of cereals.

In edible grain legumes, it is desired that the high yield and quality as well as the components that effect the yield are consistent and optimum. For this reason, the yield and quality values of the elite varieties should stay at good levels. In this research, it was aimed to determine the adaptations of the related genotypes to the regional conditions in terms of yield and yield components of the chickpea cultivars in Eastern Mediterranean region at Adana location for two years and at the winter sowing [5-6].

2. Materials and Methods

In this study, a total of 23 spring chickpeas (*Cicer arietinum* L.) obtained from ICARDA were evaluated in the Eastern Mediterranean region and the native chickpea landraces were used as controls. The experiments were planted in December under winter conditions at the Adana location and the observations and evaluations were made based on 23 chickpea varieties.

The research was carried out at the Eastern Mediterranean Agricultural Research Institute trial sites during the years 1998 and 1999. The study was conducted with three replications according to randomized block trial design. The parcel was formed from 4 rows with 45 cm between rows and 8 cm above the rows. The hand sowing was applied in this study. The plot and the harvest plot area in trial was $5\text{ m} \times 1.8\text{ m} = 9\text{ m}^2$; The harvest for each plot were made by hand. In both years, commercial fertilizers were given after sowing as 3 kg/da N and 6 kg/da P_2O_5 . The climatic characteristics during the production period such as monthly rainfall (mm), temperature ($^{\circ}\text{C}$) and relative humidity (%) rates of Adana where the research was conducted can be seen in Figure 1. Adana's average climate values for many years and for the specific two years in which the study was conducted are given in Table 1.

Table 1. Eastern Mediterranean region (Adana) during long years and the years of research (1998-1999)

Months	Average Temperature ($^{\circ}\text{C}$)			Rain (mm)			Moisture (%)		
	Long Years (1929-90)	1. Year	2. Year	Long Years (1929-90)	1. Year	2. Year	Long Years (1929-90)	1. Year	2. Year
November	15.1	16.2	15.4	67.2	13.6	107.3	63	62.2	74.7
December	11.1	12.7	10.7	118.1	122.5	177.8	66	76.8	79.3
January	9.9	9.2	8.5	111.7	38.0	46.4	66	67.5	69.6
February	10.4	8.0	9.9	92.8	67.0	6.3	66	67.6	63.9
March	13.1	10.2	11.3	67.9	19.4	92.9	66	65.3	71.7
April	17.1	14.2	18.2	51.4	104.4	56.2	69	72.9	68.7
May	21.4	22.6	21.6	46.7	20.1	32.9	67	68.2	70.5
Jun.	25.2	25.5	26.2	22.4	11.4	0.2	66	73.3	74.9
Jul.	29.7	28.7	28.6	5.4	0.9	9.7	68	72.7	77.9
Total				583.6	397.3	529.7	66.3	69.6	72.35

In this study, variance analysis was applied according to randomized blocks trial design in the MSTAT-C package program. The average values were grouped by LSD 5%.

3. Results and Discussion

According to the results of analysis of variance (ANOVA) in 0.01 significance level that obtained in the study, the year was significant for the yield, the flowering date and the plant height while the variety was significant for the yield and the plant height. On the other hand, we need to consider that the annual precipitation rates are also highly effective on the yield and the other components. The variance analysis results are given in Table 2.

Table 2. Results of Variance Analysis of Specified Chickpea Cultivars Grown in Different Years during two years in Eastern Mediterranean Region

Variation sources	Degrees of freedom	Squares Mean		
		Seed Yield	Flowering (day)	Plant Height (cm)
Replication	2	6,925.508	16.355	52.457
Variety	22	22,290.996**	10.586	244.360**
Year	1	545,568.113**	3,042.783**	3,331.043**
Variety x Year	22	24,212.344**	19.222*	353.165**
Error	90	3,836.241	9.851	77.894
General	137	1,927,754.278	4,617.884	23,591.913

* 5% significant level, ** 1% significant level.

As seen in Table 3, the average value of respective two years for the grain yield was 141.594 kg/da, the number of flowering days was 139.363 days and the plant height was 65.57 cm.

Table 3. The average values for two respective years in grain yield, flowering time and plant height for the chickpea varieties

Years	Seed Yield (kg/da)	Flowering Days (day)	Plant Height (cm)
1. Year	204.470	144.058	60.652
2. Year	78.718	134.667	70.478
Average	141.594	139.3625	65.565

Values of the same letter group are not different from EGF 5% test.

As can be seen from Table 4, when the grain yields obtained from varieties were examined, the highest yields were found at FLIP 92-142C (205.5 kg/da), FLIP 93-178C (194.7 kg/da) in the first year and at FLIP 94-166C (424.2 kg/da), FLIP 93-133C (384.6 kg/da) in the second year. The lowest values were found at FLIP 93-133C (24.56 kg/da) in the first year and at FLIP 92-202C (23.48 kg/da) in the second year. In addition to the low amount of precipitation in the first and the second years, the irregularity of the distribution also affected the yields in both years. The highest values were obtained for FLIP 94-88C (246.5 kg/da) and FLIP 93-58C (43.07 kg/da) and FLIP 93-51C (47.06 kg/da) for the two year average grain yields. In their study [7] were investigated the interactions between the yield and the yield components on 30 chickpea lines. They stated that the yield and the number of pods have strong positive correlation and selection based on the pod number expected to be effective. [8] were conducted a study on 23 chickpea lines for two years under the winter conditions in Eastern Mediterranean region and they found the values ranged between 67.9-84.2 cm for plant height, 16-28 for number of pod, 26.7-37.5 g for 100-grain weight, 28.37%-34.93% for harvest index and 178.6-271.9 kg/da for the grain yield [9-12].

Table 4. Grain Yield, Flowering Date, Anthracnose and Plant Length Values in Different Two Years for Twenty Five Chickpea Lines in Eastern Mediterranean Region

Chickpea Variety	Seed Yield(kg/da)			Flowering days(day)			Ascochyta Blight (1-9)		Plant height(cm)		
	1. Year	2. Year	Average.	1. Year	2. Year	Average.	1. Year	2. Year	1. Year	2. Year	Average
FLIP92-202C	122.8 f-m	23.48 m	148.9a-d	142.3 b	133.7 de	144.0 a	3	7	46.33no	74.33 b-i	61.17 b-e
FLIP92-105C	175.0e-h	298.8 b-d	157.8a-d	145.7 ab	147.7 a	139.5 ab	3	2	76.00 b-h	57.00 j-o	75.67 a
FLIP92-142C	205.5 d-f	82.44h-m	95.59c-e	144.0 ab	133.3 de	139.5 ab	3	4	78.33 a-d	69.00c-k	68.00 a-c
FLIP92- 147C	110.1f-m	339.9a-c	139.4b-e	135.0 de	145.0ab	140.0 ab	3	2	73.00 b-i	61.00i-m	67.50 a-d
FLIP 92- 31C	123.7 f-m	120.5f-m	114.8c-e	143.7 ab	132.3 de	138.3 b	3	3	73.00 b-i	91.33 a	63.00 a-e
FLIP 93- 51C	67.48 i-m	313.0 bc	47.06 e	135.3 de	146.7 ab	138.2 b	5-6	3	63.00 g-k	57.33 j-o	68.83 a-c
FLIP 93- 58C	133.3 f-k	63.70 i-m	43.07 e	144.3 ab	134.7de	138.8 b	3	4	73.67 b-i	77.33 a-f	53.67 de
FLIP 93- 64C	145.5f-i	298.4b-d	116.5 c-e	135.7de	146.3 ab	139.3 ab	4	2	61.33 i-l	55.33 k-o	69.67 abc
FLIP 93- 78C	194.7e-g	40.89j-m	90.26 c-e	142.3 b	130.7 e	138.5 b	3	6	47.67l-o	61.00 i-m	51.83 e
FLIP 93- 118C	34.89k-m	139.0 f-j	102.7 c-e	134.3 de	145.0ab	138.5 b	5-7	3	78.33 a-d	56.33 j-o	69.17abc
FLIP93 - 119C	69.56i-m	32.81 lm	135.8 b-e	143.7 ab	135.0de	140.0 ab	5	6	61.33 i-l	85.33ab	72.67 ab
FLIP 93- 133C	24.56m	384.6 ab	39.74 e	132.7 de	142.0b	138.0 b	7	3	76.33b-g	64.67d-k	60.67 b-e
FLIP 94- 144C	59.48 i-m	57.78 i-m	190.6 a-c	143.0 ab	133.7 de	140.5 ab	5	5	46.00 o	64.67 d-k	63.00 a-e
FLIP94 - 166C	26.67 m	424.2 a	230.2 ab	134.7 de	143.3 ab	138.7 b	6	3	61.33 i-l	63.33 f-k	76.17 a
FLIP 94- 176C	96.22g-m	68.74 i-m	188.4 a-c	144.7 ab	135.0de	140.7 ab	5	6	79.00 a-c	64.00e-k	67.33 a-d
FLIP 94- 182C	136.7f-j	273.2 c-e	169.6a-d	134.0de	141.7 bc	138.5 b	4	3	60.33 i-n	60.33 i-n	58.17 c-e
FLIP 94- 8C	137.9f-j	40.22 j-m	85.93de	143.3 ab	134.3de	140.0 ab	3	6	47.67 l-o	79.33 a-c	70.83 a-c
FLIP 94 - 61C	42.67 j-m	110.4f-m	221.2 ab	133.7de	144.0 ab	137.8 b	5	3	56.00j-o	46.00 o	64.67a-e
FLIP 94- 88C	106.3f-m	121.2 f-m	246.5 a	144.7 ab	136.7 cd	139.2 ab	3	3	74.33 b-i	68.33 c-k	63.67 a-e
FLIP 94- 105C	99.19g-m	373.0 a-c	156.7a-d	132.3de	144.3 ab	138.0 b	4	2	64.00 e-k	61.33 i-l	69.83 a-c
FLIP 94- 111C	131.1f-l	87.70 h-m	115.8 c-e	144.0 ab	135.7de	140.3 ab	3	4	76.00 b-h	77.67 a-e	57.17 c-e
FLIP94 - 150C	140.4f-j	311.7 bc	230.3 ab	136.0 d	145.0 ab	140.0 ab	3	3	69.33 c-k	62.00 h-k	69.50 a-c
Local Chickpea	56.00i-m	67.70 i-m	189.7 a-c	142.3 b	133.0de	139.0 ab	5	5	47.00m-o	69.67 c-j	65.83 a-e
F	*	*	*	*	*	*			*	*	*
CV(%)		43.743			2.252					13.461	

CV: Variation of Coefficient; * Significant.

In terms of the number of flowering days, the highest value were obtained from FLIP 92-105C (145.7 days) and the lowest value from FLIP 94-105C (132.3 days) in the first year (Table 4). In the second year, the highest value were determined from FLIP 92-105C (147.7 days) and the lowest value from FLIP 93-78C (130.7 days). The irregular distribution of the amount of rainfall in April for the both years has had a negative effect on the flowering date especially in the flowering period of the first year. The average number of flowering days for two years varied from 144.0 to 137.8 days. Falling precipitation in this period also increased the intensity of anthracnose disease [13-14] was conducted a study with three different chickpea varieties which were sown in five different sowing time during three years and stated that the flowering time and plant height could be reduced with late sowing and also mentioned that the annual yield would fluctuate related to the annual rainfall and the soil moisture [15].

For the plant height, the highest value was obtained from FLIP 94-176C (79.00 cm) and the lowest value was

detected from FLIP 94-144C (46.00 cm) in the first year (Table 4). The highest value was determined from FLIP 92-31C (91.33 cm) and the lowest value was from FLIP 94-61C (46.00 cm) in the second year. Two-year mean plant height values ranged from 76.17 to 51.83 cm. Our findings for plant height was matched with the findings in a study published by [16].

4. Conclusion

As a result, it was determined that in the selection of the efficient lines and varieties suitable for the winter cultivation in which the research was carried out, it was found that the early flowering date and the plant height suitable for machine harvest were the important components for the optimum yield.

Anthrachnose disease has also been influential in the selection of lines. The study conducted from [17-20] was evaluated 34 chickpea varieties for their tolerance/resistance against the local pathotypes of anthrachnose disease in Eastern Mediterranean region for two years during 2014/2015 and they found that the Pathotype-I has the less pathogenicity while the Pathotype-IV has the most pathogenicity. The grain yield obtained from the winter and the early-spring sowing times were higher than the late-spring sowing time. It can be recommended that the chickpea varieties which are resistant to *Ascochyta blight* (*Ascochyta rabiei*) should be sown in winter or as early as in spring depending on the temperature and the soil moisture content in the East Mediterranean Region. The lines and varieties named FLIP 94-88C, FLIP 94-150C, FLIP 94-166C and FLIP 94-61C were evaluated as promising breeding materials for the winter conditions.

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