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STATISTICAL ANALYSIS OF SOME CHARACTERS AFFECTING YIELD IN CHICKPEA VARIETIES WHICH CAN BE BREEDED IN ARID CLIMATE CONDITIONS

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This study was carried out for two years during 2017-18 in order to reveal the yield components of some chickpea varieties in Kirsehir ecological conditions was established in Kirsehir Ahi Evran University's trial field. Fourteen chickpea varieties were cultivated and studied their agronomic characteristics (plant height, the first pod height, number of main branches per plant, number of pods per plant, number of seeds per plant, seed yield per plant, 100-seed weight and harvest index).It was revealed that chickpea varieties significantly varied for studied yield characteristics. The lowest seed yield per plant was obtained in Aksu variety with 8.14 g, and the highest seed yield per plant was recorded inHasanbey variety (15.84 g).
Keywords: Legume, chickpea, soil fertility, arid climate, yield, yield components.

INTRODUCTION

Chickpea, which is a edible legume plant, has a special importance for our country. Chickpea, which has 14.5 million ha cultivation area and 14.7 million tons of production worldwide, ranks second in the world edible legume production after dried beans. In Turkey, it ranks in the first place in edible legumes production with 393 thousand ha of cultivation area and 470 thousand tons of production (FAO, 2017). In Turkey, serious studies have been carried out in recent years in terms of breeding and development of chickpea materials (Anonymous, 2018), consumption and production trend (Doğan *et al.,* 2019a; Doğan *et al.,* 2019b) and production problems (Bolat *et al.,* 2017). It is known that in order to increase the yield, the characters that affect the yield should be improved first (Kumar ve Dubey, 2001; Kumari ve Prasad, 2005). All these are for increasing yield and quality. Because the potential which can be used for increasing the chickpea cultivation areas across the country has been approached to the limit. Fifty two chickpea varieties, 7 of which having production permits and which have been developed and registered to date, have a significant effect of economic contribution on our agriculture (TTSM, 2019). However, due to the fact that drought has started to make a significant impact in our country in recent years, it is being tried to grow plant species and varieties suitable for arid climate conditions (Özdemir *et al.,* 1999). Chickpea has started to gain importance due to its ability to grow successfully in arid conditions and to increase soil fertility. Besides, it contains 18-31% protein and it has important essential amino acids (lysine, methionine, tryptophan, valine) and some elements (K, P, Ca, Mg, S, Fe, Mn) and important vitamins (A, B1, B2 and D) which are the basic building blocks of human body (Babagil, 2011). Fertilization in arid climate conditions emerges as a major problem. In particular, due to the lack of sufficient moisture in commercial fertilizers, dissolution does not take place sufficiently and as a result, they can be harmful rather than useful to the plant. When evaluated from this point of view, the main aspect and advantage of legume plants is that they enter into endosymbiosis with *Rhizobium* spp. bacteria existing in their roots and they can bind the pure nitrogen to the soil in amounts ranging between 6.4-21.6 kg da^{-1} by taking the free nitrogen from the air. In addition, the plant residues remaining in the field after harvesting plants provide great benefits in terms of soil (Sözen and Karadavut, 2017). These superior properties increase the importance of edible legume plants. Another feature of legume plants is that they do not adversely affect the field as a structure in the period from planting to harvesting and even leave it in better condition than before (Sözen and Karadavut, 2017).

The study carried out for two years in Kirsehir ecological conditions was aimed to show the performance of different registered chickpea varieties in terms of yield and yield components.

MATERIALS AND METHODS

This study was carried out for two years during 2017-18 in the research and application trial lands of Ahi Evran University under Kirişşehir ecological conditions. In this study, 14 registered chickpea varieties (Azkan, Akcin-91, Cagatay, Gokce, Zuhal, Aksu, Uzunlu 99, Yasa-05, Cakir, Akca, Sezenbey, Inci, TAEK-Sagel and Hasanbey) were used

Table 1. Climate data for the Kirsehir*.

Months	Average temperature (°C)			Total rainfall (mm)			Average relative humidity (%)		
	2017	2018	Long Years	2017	2018	Long Years	2017	2018	Long Years
March	7.3	5.3	5.5	41.5	37.6	37.4	60.8	67.9	68.2
April	10.7	9.7	10.6	29.0	45.0	45.6	52.4	50.8	64.3
May	15.2	13.6	15.3	49.9	40.8	43.9	59.4	61.4	61.4
June	20.7	19.5	19.4	18.4	36.2	36.9	54.3	56.1	55.1
July	26.0	23.0	23.0	0.4	9.3	9.6	36.0	48.4	48.7
Average	16.0	14.2	14.8	-	-	-	52.6	56.9	59.5
Total				139.2	173.0	244.0			

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as material. The climate and soil characteristics of the land where the research was conducted are given in Tables 1 and 2 and the average temperature for the growing seasons in the trial land in both years was measured as the lowest in March (7.3 and 5.3°C) and the highest in July (26 and 23°C). These values are very close to the values that have been the average for many years. As the amount of precipitation was the highest rainfall in May (49.9 mm) for the first year, in the second year April (45.6 mm) was the month with the highest rainfall, and the rainfall in both years was similar to the rainfall for long years. Humidity did not change significantly in both years and relative humidity values were determined in the range of 36.0-67.9% (Table 1).

The soil of the trial area was slightly alkaline, low organic matter, sufficient intake potassium, high intake phosphorus, salt-free and calcareous (Table 2).

Table 2. Physical and chemical properties of trial area soil.

Depth	0-30 cm	30-60 cm
pH	7.59	7.63
Total salt (%)	0.02	0.02
Lime (% $CaCO_3$)	27.90	28.39
Saturation (%)	55.00	55.00
Organic matter (%)	1.81	1.64
Phosphorus (P_2O_5 kg ha^{-1})	21.40	22.90
Potassium (K_2O)	66.62	51.47

The experiment was established in randomized block trial pattern with three replications. Planting process was carried out in four rows on the parcels which were formed by hand 5 meters in length and the distance between rows was set to 30 cm. The parcel size was set to 5 x 1.2 m=6 m^2. In both years, planting was carried out in the second half of March (first year 17th March, second year 23th March). 3 kg Pure nitrogen (3 Kg) and phosphorus (5 Kg DAP) fertilizer as base fertilizer was applied to the parcels during planting. As from the planting, weed control was carried out manually. Both years, harvesting was carried out in the second week of July by hand and blended since the pods begin to ripen and dry.

While measuring the yield components, 10 plants were randomly selected from each plot. The characteristics examined were plant height, the first pod height, number of main branches, biological yield, number of pods per plant, number of seeds per plant, seed yield per plant, hundred seed weight and harvest index. The data were analyzed by SPSS 21 statistical package program. Variance analysis was used to determine whether there was a difference between the characters belonging to the varieties. Duncan test, which is one of the multiple comparison tests, was applied in order to determine statistical differences in variety or varieties for important characters.

RESULTS AND DISCUSSION

The mean values of squares according to the characters obtained and examined in the study are shown in Table 3. It was observed that all characters are significant at the level of 0.01. The error squares mean is considered to be the best estimator of variance. Therefore, it is actually the variance of important characters. The significant variance shows that there are serious differences between the varieties in which the characters are examined. Although the study was carried out with varieties, the emergence of such diversity was evaluated as such that varieties are not the product of this region and were registered in other regions and different reactions resulting from the subsequent cultivation of these varieties in these regions. In terms of all the characters are significant compared to 0.01 shows that the reaction is above the expected.

Table 3. Error squares mean values of characters.

Examined characters	Error squares mean
Plant height	239.70**
The first pod height	179.84**
No. of branches /plant	1.08**
Biological yield	231.30**
No. of pods /plant	483.11**
No. of seeds /plant	432.06**
Seed yield /plant	73.82**
100-seed weight	162.49**
Harvest index	233.41**

Multiple comparison test results of the examined characters are shown in Table 4. One of the characteristics examined was

Table 4. Multiple comparison test results of characters.

Genotypes	Plant height (cm)	The first pod height (cm)	No. of main branches	Biological yield (g)	No. of pods per plant	No. of seeds per plant	Seed yield per plant (g)	100-Seed weight (g)	Harvest index (%)
Azkan	45.14 bc	20.16 bc	2.53 a	21.09 b	31.00 ab	25.13 bc	10.19 b	40.75 b	49.59 ab
Akcin-91	46.41 bc	21.97 b	2.20 ab	21.78 b	29.40 b	26.87 bc	10.78 b	41.30 b	49.27 ab
Cagatay	41.10 d	18.13 c	2.53 a	23.72 ab	31.93 ab	26.07 bc	11.24 ab	42.39 b	47.66 ab
Gokce	39.33 d	15.12 d	2.27 ab	27.47 ab	34.47 ab	32.60 ab	14.13 a	42.85 ab	51.43 ab
Zuhal	42.97 bc	17.23 cd	2.27 ab	25.52 ab	36.80 ab	27.80 bc	11.91 ab	43.33 ab	46.74 ab
Aksu	47.77 b	21.17 b	2.20 ab	17.98 b	22.73 bc	19.07 c	8.14 c	43.37 ab	45.44 b
Uzunlu 99	52.37 a	27.91 a	1.73 b	24.97 ab	22.73 bc	20.47 bc	9.63 bc	45.74 a	36.24 c
Yasa-05	38.79 d	18.99 c	2.00 ab	17.20 b	30.00 b	25.93 b	8.41 bc	34.61 c	48.91 ab
Cakır	44.29 bc	15.06 d	2.47 a	23.55 ab	30.07 b	27.47 bc	11.40 ab	41.27 b	48.31 ab
Akca	40.27 cd	19.37 c	2.20 ab	22.19 b	27.53 b	24.00 bc	10.19 b	42.76 ab	45.73 b
Sezenbey	38.67 d	16.34 d	2.27 ab	23.38 b	31.80 ab	26.80 bc	11.31 b	43.14 ab	46.81 ab
Inci	39.15 d	16.79 d	1.73 b	20.99 b	37.27 ab	31.73 ab	10.54 b	33.71 c	52.19 a
TAEK-Sagel	42.32 c	16.01 d	1.80 b	28.38 ab	41.00 a	36.60 ab	14.55 a	40.27 b	51.58 ab
Hasanbey	41.15 c	16.12 d	2.27 a	31.73 a	40.60 a	37.73 a	15.84 a	41.25 b	49.58 ab

plant height, which varied between 38.67-52.37 cm. The shortest plant height was measured in Sezenbey chickpea variety while the longest was determined in Uzunlu 99 chickpea variety. The large difference in height is the matter of importance. Since plant height is a desirable feature for machine harvesting and is always recommended to focus on varieties with height stature. Demir *et al.* (1980) stated that plant height is an important determinant especially in breeding studies and it is a character that should be taken into consideration. Sharma *et al.* (1990) indicated that genetic progression started primarily in plant height. In present study, a wide range of variation was considered as a great chance for selection.

When the varieties were examined in terms of first pod height, it is seen that the first pod height in varieties ranged 16.01-27.91 cm. The shortest first pod height value was observed in TAEK-Sagel variety while the longest first pod height value was recorded in Uzunlu 99 variety just likewise plant height. This feature is directly proportional to plant height. As the plant height increases, the first pod height increases. Uzunlu 99 chickpea variety has the longest plant height and the highest first pod height. At the same time, the difference between TAEK-Sagel with the lowest value of 16.01 cm and Sezenbey variety with the value of 16.34 cm was statistically non-significant. For this reason, Sezenbey chickpea variety has the shortest plant height and has the shortest first pod height. The first pod height can actually be considered as a function of plant height (Kumari and Prased, 2005). Because as the plant height increases, the first pod height increases as long as there is no important setback.

The number of main branches generally showed significant differences in genotypes that were generally tested for the yield components. The lowest number of main branches was detected as 1.733 in Uzunlu 99 and Inci chickpea varieties, while the highest number of main branches was observed as 2.47 in Cakir chickpea varieties. Both plant height and long pod height in Uzunlu 99 chickpea varitey was high, which indicates that the number of main branches lead to a decrease. Since the number of main branches has genetically low inheritance, large changes are considered as an unexpected character. The number of main branches is among the features affecting the yield of plants. Kir *et al.* (2018) stated that the increase in the number of main branches in legumes increases the yield. Similarly, it was found that the number of main branches in Karadavut and Genc (2010) significantly affected the yield.

Biological yield refers to all plant parts produced by the plant on the soil. Lack or multiplicity of biological yield can give valuable information about the growth and development of plants. In this study, the lowest biological value was obtained from Yasa-05 variety with 17.20 g and the highest biological yield value was determined in Hasanbey chickpea variety with 31.73 g. However, lack or multiplicity of biological yield does not provide information about yield. This value gives information about the development of above-ground parts of plants. High biological yields indicate that it cannot provide sufficient growth if it consists of above-ground organs other than seeds. However, the high biological yield indicates that the yield is high if it results from seed (Ereifej *et al.*, 2001; Palta *et al.*, 2010).

The number of pods per plant can be an important determinant among the yield elements provided that the pods are filled pods. Empty pods are also a burden for the plant. The variation among the varieties in terms of number of pods per plant was quite high. The minimum number of pods per plant was observed in Aksu and Uzunlu 99 chickpea varieties with 22.73, and the maximum number of pods per plant was determined in the TAEK-Sagel chickpea variety with 41.00. The high number of pods per plant is always considered to be a desirable and preferred feature. The increase in the number

of pods per plant is not always desirable. The important thing is the high number of filled pods (Riberio and Melo, 1990). Excessive number of pods can also increase the number of empty pods (Ashango *et al.,* 2016; Sözen *et al.,* 2018).

The number of seeds per plant varies with the number of pods per plant. In general, if the number of seeds per plant is increasing, it is understood that the pods are filled and the yield is high. However, as the number of pods per plant increases, the yield is less if the number of grains does not increase at the same rate. In present study, it has been shown that the varieties varied between 19.07 (Aksu) - 37.73 (Hasanbey) in terms of seeds number. It is known that the number of pods per plant and number of seeds per plant do not always increase in parallel proportions and sometimes change in inverse proportion (Karadavut *et al.,* 2010; Sözen, 2012). For this reason, it is recommended to focus on variety and genotypes that cause the increase in number of pods per plant and seed number together (Genc *et al.,* 2005).

High yield is always one of the basic features that are desired to be achieved in agriculture. Keeping the high productive varieties in the foreground and evaluating the high productive genotypes as a priority in breeding programs is for the successful conclusion of the study. It was found in present study that chickpea varieties had values between 8.14 – 15.84 g in terms of grain yield per plant. The lowest seed yield per plant was determined in Aksu chickpea variety and the highest seed yield per plant was determined in Hasanbey chickpea variety just like the number of seeds per plant. However, to evaluate efficiency alone is not accepted as a correct approach in breeding studies. Instead, it is possible to contribute to obtaining more healthy and stable varieties by focusing on the characteristics affecting the yield.

In addition to the high yield, quality also plays an important role. The seeds being full and coarse depends on the weight of a hundred seeds; high or low. Genotypes with a high hundred grain weight are generally high yielder. In present study, the lowest hundred seed weightwas observed in Inci chickpea variety (33.71 g) and the highest hundred seed weight value was observed in Uzunlu 99 chickpea variety (45.74 g). The variation in hundred seed weight can be regarded as the most significant effect of the reaction of the varieties to the environment. Evaluating the yield with hundred seed weight would be a more accurate approach because there is a linear relationship between yield and hundred seed weight (Cinsoy and Yaman, 1998; Karadavut *et al.,* 2005.

The varieties examined in terms of harvest index indicated significant differences as in other characteristics. The harvest index can be considered as a more specific biological yield. It is obtained by proportioning the seed yield per plant of the plant to the part of the soil. In our study, the lowest harvest index value was obtained in Uzunlu 99 chickpea variety (36.24%), while the highest harvest index value was obtained in Inci chckpea variety (52.19%). The larger the harvest index, the higher seed yield and vice versa. Therefore, it is recommended to focus on varieties with high harvest index (Kumari and Prasad, 2005; Sözen and Karadavut, 2017).

Conslusion: Kirsehir is an area where the effect of drought is felt day by day. Increasing drought necessitates to substitute new varieties with old ones. This study was aimed to select the most suitable candidate variety for aregion with arid conditions. The results indicates that Uzunlu 99 chickpea variety had the highest hundred seed weight and plant height and first pod height, and is considered to be suitable for machine harvest. However, TAEK-Sagel and Hasanbey chickpea varieties showed good performance in terms of biological yield, harvest index, number of pods and seeds and seed yield per plant which indicates that these chickpea varieties can also be cultivated. However, low plant height and first pod heights are seen as a feature that will challenge the machine harvest.

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