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# Effects of Drought on Yield and Some Yield Components of Chickpea

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***Abstract*****—**This research was conducted to determine responses of chickpeas to drought in different periods (early period, late period, no-irrigation, two times irrigation as control). The trial was made in "Randomized Complete Block Design" with three replications on 2010 and 2011 years in Konya-Turkey. Genotypes were consisted from 7 lines of ICARDA, 2 certified lines and 1 local population. The results showed that; as means of years and genotypes, early period stress showed highest (207.47 kg $da^{-1}$) seed yield and it was followed by control (202.33 kg $da^{-1}$), late period (144.64 kg $da^{-1}$) and normal (106.93 kg $da^{-1}$) stress applications. The genotypes were affected too much by drought and, the lowest seed was taken from non-irrigated plots. As the means of years and stress applications, the highest (196.01 kg $da^{-1}$) yield was taken from genotype 22255. The reason of yield variation could be derived from different responses of genotypes to drought.

***Keywords*****—**Chickpea, drought, seed yield.

## I. INTRODUCTION

WATER is such an important source which plays a role in agriculture and all vital activities [1]. Drought is the most common harmful effect of environment. It cause to reduction in crop production on different parts of the world. Human are not able to or has limits to change ecological conditions, but they are able to recognize some characteristics of plants and also can develop new plant species and regulate or eliminate some of the harmful effects of environment on plant quality parameters for adaptation to different climatic conditions. For this purpose; human tries to find solutions about production systems in agriculture which are more quantitative and qualified. The solutions should be environmentally friendly for sustainable agriculture [2].

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If we know the effects of ecological conditions on plants, the definition and improvement of plant quality parameters will be easy [3]. Increasing of yield could be realized both improving cultivars through plant breeding and improved crop management [4].

Pulse crops are the richest source among plant proteins [5]. Chickpea, one of the pulse crops, is an important source of human food and animal feed; it also helps to improve soil fertility, particularly in dry lands. The entire sown area of chickpea is about 446 218 ha, production and yield are 530 634 t and 1190 kg $ha^{-1}$, respectively in Turkey [6]. Chickpea is traditionally sown in the spring in the Mediterranean region, so that, the crop encounters heat and drought stress from flower towards maturity and results in low and variable yields. It is required to develop new cultivars which are tolerant to drought.

Biçer and Anlarsal [7] reported that the height of chickpea varies from 16.8 cm to 38.8 cm in chickpea genotypes. It was reported that number of pod varies between 11 and 36 per plant [8]. According to Ceyhan et al. [9] number of seed varies between 26.5 and 31.1 per plant. A previous study showed that, the weight of 1000 seeds ranged from 449.2 to 478.3 g in several genotypes of chickpea. Bakaoğlu and Ayçiçeği [9] reported that biomass varied from 1518 to 2010 kg $ha^{-1}$in chickpea. A previous study revealed that seed yield changes from 1215 to 1666 kg $ha^{-1}$ in chickpea genotypes. Harvest index in chickpea genotypes ranged from 34.4 % to 42.4 % according to Altınbaş and Sepetoğlu [11].

It is well known that, investigating of plant response to drought is needed to develop new species and, plant breeding programs which are property of drought tolerance is necessary to minimize the negative effects of water scarcity. This study was investigated to determination of yield components and identifying the promising chickpea genotypes which were grown under different levels of water shortage.

## II. MATERIAL AND METHOD

The research was conducted for two years both during 2010-2011 years in the trial filed of "Research Station for Management of Soil, Water and Desertification" in Konya-Turkey. A total of 10 genotypes which were consisted from 7 chickpea line provided from ICARDA (22112, 22108, 22151, 22202, 22222, 22255 and 22135), 1 local population (Derebucak) and two certified lines (Er-99 and Canıtez) were used as control.

The average meteorological data during vegetation period for two years (April, May, June, July and August) as follows: 21.3 $^{0}$C and 19.2 $^{0}$C for average temperature, 110.8 mm and

153.2 mm for total rainfall, 45.2 % and 43.1 % for relative humidity respectively. The soil characteristics of research was conducted showed clay loam structure, lower level of organic matter (1.49 %), a higher level of lime (17.14 %) and alkaline (pH=8.40). There was not salinity (0.05 %) problem in the soil, rich content of available potassium (51.60 kg/da) and lower phosphorus (4.01 kg $da^{-1}$) level.

The trial was conducted in "Randomized Complete Block Design" for both two years with 3 replications and was set up as 4 trials. There was not any irrigation in the first trial (normal conditions), the performance of genotypes were determined with regard to rainfall which depend on the climate. The morphological changes and yields were tried to determine within this natural condition [12]. In the second trial (late period water stress); the maximum yield potential of plants in optimum conditions was determined by none stress application and, irrigation was made during pre-flower and pod set according to climatically conditions. The third trial (early period water stress) was made to investigation the effects of early term drought stress in terms of flowering period. For this purpose, no irrigation was made during flowering period, but the irrigation was made during pod set according to the effective root depth (60 cm) humidity which was determined by gravimetrical method, then irrigation was made to complete field capacity [13]. The fourth trial (later period water stress) was made to determine the late period (pod set) drought effect by making irrigation during flowering period to the level of field capacity by determining gravimetrical method in effective root (60 cm) depth [13]. For both of two years, sowing was made by hand in the rows with length of 2 m, 50 x 5 cm width of inter row distance, 4-5 cm depth on 01 April 2010 and 04 April 2011 dates. The fertilizer was applied 15 kg $da^{-1}$ DAP (Diammonium phosphate, 18-46%) for both two years. The hoeing was made for two times to weed and soil ventilation. The harvest was made by hand after the maturing and being yellow colored period of whole plants on plots.

The investigated characteristics in the research were as fallows: plant height (cm), number of pod per plant, rate of fertile pod (%), seed per plant, 1000 seed weight (g), biological yield (kg $da^{-1}$), seed yield (kg $da^{-1}$) and harvest index (%) respectively [12,13]. Analysis of variance and LSD test was made by using "JUMP" computer based statistical program.

## III. Results and Discussions

### A. Plant Height

The effects of years on plant height were found important (Table I). The heights of plants in first year (46.07 cm) were found higher than the heights of (43.25 cm) second year (Table II).

The heights of plants showed statistically importance by means of different stress applications (Table I). As the both means of years and genotypes were highest (45.92 cm) in control plots while normal stress applications had the lowest (42.78 cm) height (Table II). Many researchers revealed that the height of plant depend on sowing density, climate and environment conditions besides genetically structure [7,14].

Thus, Pundir and Rajagophan [15] suggested that plant height is effected too much by environmental factors especially soil humidity and mineral content, and also sowing density.

Analysis of variance for plant height among genotypes found important (Table I). As the means of years and stress applications the highest plant height was taken from genotype Derebucak (51.38 cm), while 22135 showed the lowest (34.38 cm) plant height (Table III). The similar results were found previously [7,8,9,10,11,14].

### B. Number of Pod

Number of pod per plant in first year (29.08) were higher than number of pod per plant (25.28) in second year (Table 2). As the means of years and genotypes, the highest (29.53) value was in control plots while late period stress application had the lowest (22.55) value for number of pod per plant (Table 3). Kumar et al. (1981) reported that number of pod per plant was varied from 12 to 256 and it was affected too much by environmental factors.

As the means of years and stress applications the highest value was taken from genotype 22222 (33.29 number), while 22255 showed the lowest (23.46) pod per plant. The other genotypes which were used in the research showed their values between these intervals (Table 3). The other researchers found similar results for number of pod per plant [7,8,9].

### C. Rate of Fertile Pod

The rate of fertile pod showed a rate of 83.08 % in first year and 78.46 % in the second year. As the means of years and genotypes, the highest (84.09 %) rate was in control plots while normal stress application had the lowest (77.78 %) rate for number of fertile pod (Table III). According to the results of variance analysis for fertile pod rate among genotypes found important statistically (Table I). The rates of fertile pods were changed between 72.78 (22255) and 85.84% (22202) among genotypes (Table III). The results of the research showed accordance with Leport et al. [13]'s results.

### D. Number of Seed per Plant

As the both means of years and genotypes were highest (32.53) in control plots while late stress applications had the lowest (25.55) seed per plant (Table III). Seed number per plant was varied from 25.33 (Canıtez and 22255) to 35.08 (22222) in genotypes. For number of seed per plant, the interaction of genotypes x stress applications was found statistically important according to variance analysis (Table I).The highest (43.83) value was taken from 22222 on control plots and, the lowest (16.00) value was taken from Er-99 genotype on normal stress application (Table 3). The results of the study were compatible with Ceyhan et al. [9] and Altınbaş and Sepetoğlu [11]'s outcomes.

### E. Thousand Seed Weight

The effects of years on 1000 seed weight were found important (Table I). The values in first year (400.90 g) were found higher than the values of (374.65 g) second year. For 1000 seed weight, the variations of genotypes that were used in the trial were found statistically important in terms of the different stress applications (Table 1). As the both means of years and genotypes, the highest (429.11 g) value was in normal stress application while late period stress application had the lowest (371.80 g) value for 1000 seed weight (Table 2). According to the results of variance analysis among genotypes for 1000 seed weight found statistically important (Table I).

The weights were varied between 348.02 g (22222) and 431.89 g (22108) for 1000 seeds (Table 3). The variance analysis which was made for 1000 seed weight was found as statistically important for genotypes x stress applications interactions (Table I). The highest (498.63 g) value was taken from 22108 genotype on normal stress application while late period stress application had the lowest (269.80 g) value of genotype 22222. The previous findings for 1000 seed weight had been found in accordance with these results [7,8,9,11].

TABLE I
MEANS SQUARES OF INVESTIGATED CHARACTERISTICS IN CHICKPEA GENOTYPES UNDER DIFFERENT LEVELS OF DROUGHT

| Sources | DF | Plant height | Number of pod | Rate of fertile pod | Number of seed per plant |
|---|---|---|---|---|---|
| **Replication** | **2** | 24.2792 | 284.788 | 378.925 | 318.987 |
| **Year (Y)** | **1** | 476.017** | 866.4 | 1277.48* | 1113.7 |
| **$Error_1$** | **2** | 0.70417 | 224.788 | 85.3868 | 214.154 |
| **Stress Applications (SA)** | **3** | 106.494** | 602.161 | 572.86 | 805.015 |
| **Y X SA Interaction** | **3** | 0.82778 | 428.278* | 1081.98** | 601.026** |
| **$Error_2$** | **6** | 4.00694 | 206.949 | 148.757 | 217.449 |
| **Genotype (G)** | **9** | 1053.4** | 221.128 | 391.092** | 223.43 |
| **Y XG Interaction** | **9** | 0.48889 | 71.7333 | 53.0992 | 70.7597 |
| **SA X G Interaction** | **27** | 3.81235 | 418.791** | 330.802** | 417.17** |
| **Y X SA X G Interaction** | **27** | 0.74444 | 63.5247 | 36.2474 | 60.6745 |
| **$Error_3$** | **150** | 2.987 | 284.788 | 89.837 | 147.709 |
| **Sources** | **DF** | **1000 Seed weight** | **Biological yield** | **Seed yield** | **Harvest index** |
| **Replication** | **2** | 3063.41 | 115866 | 1048.9 | 902.098 |
| **Year (Y)** | **1** | 38327** | 460107* | 119852** | 660.116 |
| **$Error_1$** | **2** | 304.491 | 16547.8 | 90.1913 | 47.2296 |
| **Stress Applications (SA)** | **3** | 44940* | 252314** | 139671** | 2448.7900 |
| **Y X SA Interaction** | **3** | 167.851 | 199282** | 62573.6** | 564.441** |
| **$Error_2$** | **6** | 5821.22 | 14644.9 | 4480.66 | 423.451 |
| **Genotype (G)** | **9** | 21494.8** | 42506** | 12080.8** | 379.83900 |
| **Y XG Interaction** | **9** | 97.6684 | 7566.82 | 1372.39 | 40.3583 |
| **SA X G Interaction** | **27** | 8989.52** | 24131.7** | 5782.77** | 262.379** |
| **Y X SA X G Interaction** | **27** | 152.73 | 7948.31 | 1684.35 | 59.2998 |
| **$Error_3$** | **150** | 3836.45 | 10449.1 | 1708.1 | 94.223 |

** P< 0.05; ** P< 0.01*

TABLE II
MEANS OF INVESTIGATED CHARACTERISTICS BY YEARS IN CHICKPEA GENOTYPES UNDER DIFFERENT LEVELS OF STRESS APPLICATIONS

| Genotypes | Plant height | | Number of pod | | Rate of fertile pod | | Number of seed per plant | |
|---|---|---|---|---|---|---|---|---|
| | **2010** | **2011** | **2010** | **2011** | **2010** | **2011** | **2010** | **2011** |
| **22108** | 47.67 | 44.67 | 28.08 | 22.92 | 84.53 | 78.52 | 30.25 | 24.50 |
| **22112** | 52.08 | 49.67 | 25.08 | 25.25 | 83.48 | 81.77 | 27.17 | 26.58 |
| **22135** | 35.75 | 33.00 | 35.08 | 24.83 | 85.46 | 80.03 | 37.17 | 26.58 |
| **22151** | 51.17 | 48.25 | 30.42 | 26.08 | 82.01 | 75.97 | 32.67 | 27.83 |
| **22202** | 41.67 | 39.08 | 30.83 | 26.58 | 86.39 | 85.29 | 32.92 | 28.42 |
| **22222** | 51.17 | 48.25 | 33.17 | 33.42 | 84.00 | 83.55 | 35.08 | 35.08 |
| **22255** | 42.25 | 39.42 | 26.42 | 20.50 | 77.92 | 67.64 | 28.58 | 22.08 |
| **Canıtez** | 35.75 | 33.25 | 26.92 | 20.08 | 77.63 | 72.45 | 29.08 | 21.58 |
| **Derebucak** | 53.08 | 49.67 | 27.17 | 26.67 | 84.15 | 80.62 | 29.17 | 28.08 |
| **Er-99** | 50.08 | 47.25 | 27.58 | 26.42 | 85.23 | 78.82 | 29.83 | 28.08 |
| **Mean** | **46.07** | **43.25** | **29.08** | **25.28** | **83.08** | **78.46** | **31.19** | **26.88** |
| **Genotypes** | **1000 Seed weight** | | **Biological yield** | | **Seed yield** | | **Harvest index** | |
| | **2010** | **2011** | **2010** | **2011** | **2010** | **2011** | **2010** | **2011** |
| **22108** | 443.35 | 420.43 | 516.67 | 423.33 | 214.45 | 148.20 | 44.17 | 36.73 |
| **22112** | 410.24 | 384.99 | 435.83 | 380.00 | 204.91 | 156.87 | 47.46 | 41.15 |
| **22135** | 404.33 | 379.49 | 520.00 | 387.92 | 189.24 | 144.90 | 39.21 | 37.60 |
| **22151** | 418.62 | 399.49 | 480.00 | 387.08 | 187.67 | 151.43 | 39.01 | 39.60 |
| **22202** | 368.84 | 342.26 | 490.42 | 398.89 | 200.63 | 146.17 | 39.59 | 34.57 |
| **22222** | 364.73 | 331.31 | 592.08 | 435.83 | 201.68 | 137.05 | 33.21 | 30.75 |
| **22255** | 387.63 | 360.18 | 490.42 | 447.64 | 207.42 | 184.60 | 42.79 | 42.72 |
| **Canıtez** | 359.23 | 339.14 | 450.42 | 360.00 | 186.94 | 134.97 | 42.08 | 38.77 |
| **Derebucak** | 426.04 | 399.38 | 412.71 | 346.80 | 135.22 | 105.61 | 35.68 | 30.94 |
| **Er-99** | 426.03 | 399.62 | 415.21 | 360.56 | 148.75 | 120.17 | 36.51 | 33.73 |
| **Mean** | **400.90** | **375.63** | **480.38** | **392.81** | **187.69** | **143.00** | **39.97** | **36.65** |

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TABLE III
MEANS AND LDS VALUES OF INVESTIGATED CHARACTERISTICS IN CHICKPEA GENOTYPES UNDER DIFFERENT LEVELS OF STRESS APPLICATIONS

| Genotypes | Plant height | | | | | Number of pod | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Late | Early | Control | Mean | Normal | Late | Early | Control | Mean |
| **22108** | 44.50 | 46.67 | 47.17 | 46.33 | **46.17** | 26.67 | 19.17 | 35.33 | 20.83 | **25.50** |
| **22112** | 49.00 | 51.17 | 51.17 | 52.17 | **50.88** | 31.67 | 19.83 | 14.33 | 34.83 | **25.17** |
| **22135** | 32.67 | 33.67 | 34.50 | 36.67 | **34.38** | 33.17 | 19.00 | 21.17 | 46.50 | **29.96** |
| **22151** | 47.83 | 49.67 | 50.17 | 51.17 | **49.71** | 30.50 | 13.67 | 43.00 | 25.83 | **28.25** |
| **22202** | 37.50 | 40.33 | 42.33 | 41.33 | **40.38** | 31.33 | 22.17 | 24.83 | 36.50 | **28.71** |
| **22222** | 47.17 | 50.67 | 49.17 | 51.83 | **49.71** | 27.17 | 31.67 | 33.50 | 40.83 | **33.29** |
| **22255** | 38.67 | 42.17 | 40.67 | 41.83 | **40.83** | 19.50 | 31.00 | 20.83 | 22.50 | **23.46** |
| **Canıtez** | 33.00 | 34.83 | 35.67 | 34.50 | **34.50** | 34.00 | 19.33 | 23.83 | 16.83 | **23.50** |
| **Derebucak** | 50.00 | 51.33 | 51.67 | 52.50 | **51.38** | 26.50 | 20.00 | 33.00 | 28.17 | **26.92** |
| **Er-99** | 47.50 | 47.83 | 48.50 | 50.83 | **48.67** | 17.17 | 29.67 | 38.67 | 22.50 | **27.00** |
| **Mean** | **42.78** | **44.83** | **45.10** | **45.92** | **44.66** | **27.77** | **22.55** | **28.85** | **29.53** | **27.18** |
| | **$LSD_{SA}$:** 1.355; **$LSD_{G}$:** 1.302 | | | | | **$LSD_{SAXG}$:** 25.42 | | | | |

| Genotypes | Rate of fertile pod | | | | | Number of seed per plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Late | Early | Control | Mean | Normal | Late | Early | Control | Mean |
| **22108** | 79.32 | 77.34 | 89.32 | 80.12 | **81.52** | 25.17 | 22.17 | 38.33 | 23.83 | **27.38** |
| **22112** | 83.66 | 84.85 | 70.37 | 91.62 | **82.62** | 29.50 | 22.83 | 17.33 | 37.83 | **26.88** |
| **22135** | 79.61 | 73.02 | 86.66 | 91.69 | **82.74** | 31.83 | 22.00 | 24.17 | 49.50 | **31.88** |
| **22151** | 79.49 | 70.18 | 88.91 | 77.38 | **78.99** | 29.50 | 16.67 | 46.00 | 28.83 | **30.25** |
| **22202** | 82.24 | 82.02 | 87.20 | 91.90 | **85.84** | 30.17 | 25.17 | 27.83 | 39.50 | **30.67** |
| **22222** | 79.46 | 80.14 | 84.74 | 90.74 | **83.77** | 25.33 | 34.67 | 36.50 | 43.83 | **35.08** |
| **22255** | 59.66 | 85.27 | 66.21 | 79.99 | **72.78** | 18.00 | 34.00 | 23.83 | 25.50 | **25.33** |
| **Canıtez** | 83.78 | 76.81 | 74.38 | 65.18 | **75.04** | 32.33 | 22.33 | 26.83 | 19.83 | **25.33** |
| **Derebucak** | 78.33 | 73.97 | 91.25 | 85.97 | **82.38** | 24.33 | 23.00 | 36.00 | 31.17 | **28.63** |
| **Er-99** | 72.23 | 81.76 | 87.79 | 86.31 | **82.03** | 16.00 | 32.67 | 41.67 | 25.50 | **28.96** |
| **Mean** | **77.78** | **78.54** | **82.68** | **84.09** | **80.77** | **26.22** | **25.55** | **31.85** | **32.53** | **29.04** |
| | **$LSD_{G}$:** 7.139; **$LSD_{SAXG}$:** 14.28 | | | | | **$LSD_{SAXG}$:** 18.31 | | | | |

| Genotypes | 1000 Seed weight | | | | | Biological yield | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Late | Early | Control | Mean | Normal | Late | Early | Control | Mean |
| **22108** | 498.63 | 390.77 | 403.10 | 435.07 | **431.89** | 399.03 | 474.72 | 537.50 | 468.75 | **470.00** |
| **22112** | 431.17 | 381.30 | 426.07 | 351.93 | **397.62** | 306.67 | 403.06 | 514.31 | 407.64 | **407.92** |
| **22135** | 408.63 | 370.30 | 387.27 | 401.43 | **391.91** | 306.11 | 470.84 | 608.34 | 430.56 | **453.96** |
| **22151** | 412.12 | 421.97 | 361.00 | 441.13 | **409.05** | 336.39 | 528.33 | 354.86 | 514.58 | **433.54** |
| **22202** | 413.87 | 345.50 | 344.17 | 318.67 | **355.55** | 278.20 | 458.06 | 489.58 | 552.78 | **444.65** |
| **22222** | 423.17 | 269.80 | 345.00 | 354.10 | **348.02** | 371.94 | 484.58 | 553.47 | 645.83 | **513.96** |
| **22255** | 368.20 | 408.70 | 398.53 | 320.20 | **373.91** | 367.36 | 482.92 | 462.64 | 563.19 | **469.03** |
| **Canıtez** | 468.80 | 355.93 | 272.37 | 299.63 | **349.18** | 367.22 | 398.06 | 413.89 | 441.67 | **405.21** |
| **Derebucak** | 446.00 | 417.57 | 379.83 | 407.43 | **412.71** | 370.00 | 462.22 | 360.42 | 326.39 | **379.76** |
| **Er-99** | 420.50 | 422.13 | 420.13 | 388.53 | **412.83** | 299.31 | 416.39 | 392.09 | 443.75 | **387.88** |
| **Mean** | **429.11** | **378.40** | **373.75** | **371.81** | **388.27** | **340.22** | **457.92** | **468.71** | **479.51** | **436.59** |
| | **$LSD_{SA}$:** 34.09; **$LSD_{G}$:** 46.45; **$LSD_{SAXG}$:** 93.30 | | | | | **$LSD_{SA}$:** 81.91; **$LSD_{G}$:** 76.99; **$LSD_{SAXG}$:** 154.0 | | | | |

| Genotypes | Seed yield | | | | | Harvest index | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Late | Early | Control | Mean | Normal | Late | Early | Control | Mean |
| **22108** | 107.77 | 146.41 | 269.76 | 201.34 | **181.32** | 29.96 | 36.39 | 51.09 | 44.36 | **40.45** |
| **22112** | 107.57 | 171.07 | 200.55 | 244.38 | **180.89** | 35.90 | 42.80 | 39.05 | 59.46 | **44.30** |
| **22135** | 83.06 | 153.42 | 213.26 | 218.55 | **167.07** | 30.06 | 35.63 | 36.53 | 51.41 | **38.41** |
| **22151** | 90.86 | 158.99 | 184.33 | 244.01 | **169.55** | 27.77 | 30.22 | 50.44 | 48.78 | **39.30** |
| **22202** | 71.29 | 165.37 | 235.80 | 221.14 | **173.40** | 24.10 | 35.80 | 48.49 | 39.92 | **37.08** |
| **22222** | 91.80 | 138.95 | 202.55 | 244.16 | **169.37** | 25.21 | 29.41 | 35.88 | 37.44 | **31.98** |
| **22255** | 157.81 | 148.94 | 273.31 | 203.98 | **196.01** | 42.45 | 31.09 | 59.50 | 37.97 | **42.75** |
| **Canıtez** | 141.60 | 129.91 | 198.05 | 174.26 | **160.95** | 40.87 | 33.71 | 47.41 | 39.72 | **40.42** |
| **Derebucak** | 124.59 | 117.15 | 121.83 | 118.11 | **120.42** | 36.68 | 26.70 | 33.04 | 36.83 | **33.31** |
| **Er-99** | 92.97 | 116.19 | 175.30 | 153.39 | **134.46** | 33.61 | 27.73 | 43.82 | 35.31 | **35.12** |
| **Mean** | **106.93** | **144.64** | **207.47** | **202.33** | **165.34** | **32.66** | **32.95** | **44.52** | **43.12** | **38.31** |
| | **$LSD_{SA}$:** 45.31; **$LSD_{G}$:** 31.13; **$LSD_{SAXG}$:** 62.25 | | | | | **$LSD_{SAXG}$:** 14.62 | | | | |

*F. Biological Yield*

The effects of years on biological yield were found important (Table I). Biological yield in first year was determined 480.38 kg $da^{-1}$ and 392.81 kg $da^{-1}$ in second year (Table 2). For biological yield, the variations of genotypes showed statistically importance in terms of the different stress applications (Table 1). As the both means of years and genotypes, the variations were measured between 340.22 kg $da^{-1}$ (normal stress application) and 479.51 kg $da^{-1}$ (control stress application) for biological yield (Table II).

Analysis of variance showed there were differences among the genotypes in terms of biological yield (Table 1). As the means of years and stress applications, the highest biological yield was taken from genotype 22222 (513.96 kg $da^{-1}$) and the lowest (379.76 kg $da^{-1}$) amount was taken from genotype Derebucak (Table 3). The interaction of genotypes x stress applications which was calculated for biological yield was found important as statistically (Table 1). The highest (645.83 kg $da^{-1}$) value was taken from 22222 on control period stress application, and normal stress application had the lowest

(278.20 kg da$^{-1}$) value in which genotype 22202. The results of study were similar to the previously studies which were made by other researchers [12,16].

*G.Seed Yield*

Effects of the years showed statistically importance on seed yield (Table 1). The amount in first year (187.69 kg da$^{-1}$) was higher than the amount of (143.00 kg da$^{-1}$) the second year (Table 2).

For seed yield, the variations of genotypes showed statistically importance in terms of the different stress applications (Table 1). As the both means of years and genotypes, the early period stress applied plots showed the highest (207.47 kg da$^{-1}$) value. The other stress applications were fallowed as respectively; control (202.33 kg da$^{-1}$), late period (144.64 kg da$^{-1}$) and normal (106.93 kg da$^{-1}$) by the perspective of seed yield (Table 3). Many researchers implicated that seed yield is effected too much by climate and environment conditions [7, 9, 13]. Furthermore, Toker and Çağıran [12] obtained specified that seed yield of chickpeas was decreased significantly in drought conditions. The present study showed the lowest seed yield from the non-irrigated plots.

As the means of years and stress applications, the highest seed yield was taken from genotype 22135 (211.01 kg da$^{-1}$) and the lowest (135.42 kg da$^{-1}$) value was taken from genotype 22112 (Table 3). For seed yield, the interaction of genotypes x stress applications was found statistically important in variance analysis (Table 1). The highest (273.31 kg da$^{-1}$) value was taken from genotype 22255 in early period stress application and, the lowest (71.29 kg da$^{-1}$) value was taken from genotype 22202 in normal stress application (Table 3). The reason why genotypes showed difference in their seed yield could be explained by genetically difference and effecting different with respect to years [12, 13]. The results of present study showed similarity with previously reported data [7,8,9,10,11,12].

*H.Harvest Index*

Effects of the years showed statistically importance on harvest index (Table 1). Harvest index in first year was determined 39.97% and 36.65% in second year (Table 2). As the both means of years and genotypes, the highest (44.52%) value was taken from early period stress applied plots and, normal stress application had the lowest (32.66%) value for harvest index (Table 3).

Harvest index values were varied from 33.31% (Derebucak) to 44.30 (22112) in chickpea genotypes. For harvest index, the interaction of genotypes x stress applications was found statistically important according to variance analysis (Table 1). The highest (59.46%) value was taken from genotype 22112 in control stress application and, the lowest (24.10%) value was taken from genotype 22202 in normal stress application. The data which collected for harvest index were similar with previously results [8, 11].

## IV. Conclusion

Consequently, the more drought-resistant genotypes: 22155, Derebucak and Canıtez are the promising genotypes for seed yield and some agricultural characteristics.

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