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ESTIMATION OF THE HERITABILITY DEGREE OF CHARACTERISTICS EFFECTING YIELD IN SOME CHICKPEA GENOTYPES

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This study which was carried out to determine the primary characteristics required for breeding of chickpea genotypes and to determine the heritability of these characteristic was carried out for three years on Ahi Evran University Agricultural Research and Application Land. 58 domestic chickpea genotypes collected and identified from Kirsehir province were the material of this study. Descriptive statistics of the studied variables, variances of the variables and degrees of inheritance were revealed in the study which was established in a Randomized Block Design Pattern with three replications. As a result of the study, it was found that the heritability values of seed yield per plant, 100-seed weight and the number of pods per plant were above 50% and it was determined that the heritability of the other examined properties were below 50%. In order to increase the success of breeding studies, it is of importance to determine the inheritability of the characteristics that will be examined for the selection of genotypes to be transferred to future generations.
Keywords: chickpea, genotypes, features, variance, degree of heredity.

INTRODUCTION

Chickpea, which is a legume plant, has a special importance for Turkey in terms of production (TSI, 2019) and consumption (Bolat *et al.,* 2017). Especially, it can be grown successfully in arid conditions and its effect on soil fertility makes this plant essential. Chickpea, which has the ability to contain between 18-31% proteins in the grain, also contains important amino acids (lysine, methionine, tryptophan, valine) as the essential elements of the human body, elements such as K, P, Ca, Mg, S, Fe, Mn and important (A, B1, B2 and D) vitamins (Babagil, 2011). They enter into an endosymbiosis with *Rhizobium* spp. bacteria in their roots and they can bind free nitrogen in amounts ranging between 6.4-21.6 kg da^{-1} by taking the free nitrogen of the air. In addition, C/N coefficient was found to be very low in the study carried out in the plant debris after harvesting (Karakullukçu and Adak, 2008). This increases the importance of 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).

Chickpea, which ranks second after beans in the world with 14.5 million ha cultivation area and 14.7 million tons of edible legumes production, comes first in front of lentils and dry beans with 392,673 ha cultivation area and 470,000 tons production. While the world average of chickpea yield is 1015 kg per hectare, this value has reached to 119.7 kg with the performance of superior varieties developed in recent years and conscious application of cultivation techniques. The chickpea import and export figures of the world and our country are important as well as the cultivation area and production amount data in the world. The total chickpea imports in the world in 2016 are 1.9 million tons and its monetary value corresponds to 1.75 billion dollars. In our country, according to the data of the same year, a total of USD 39.867 million was paid abroad for 30,446 tons of imported chickpeas. While the total amount of chickpea exports in the world is 2.4 million tons and 1.9 million dollars in monetary terms, in 2013, our country made a gain of 31,270 million dollars for 22,975 tons (Anonymous, 2016). 52 chickpea varieties, with 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).

Heritability can be defined as the amount of the effects of the mother and father appear in baby (Li *et al.,* 1991). Genetic development depends on the state of the differences of plants from previous generations. If the difference is in good direction, development is successful. However, if there is a negative development, then it can be considered as failure (Rasal *et al.,* 1991). Estimating the heritability is very important in this respect. Knowing the genetic characteristics of the parents and the characters to be examined will increase the success of the studies (Korkut *et al.,* 1981). Demir *et al.* (1980) stated in their study that parental selection is important and that knowing parents makes it easier to make choices according to real values and this increases the success. Lonc and Zalewski (1991), on the other hand, stated that high yield is the dominant feature compared to low yield in general and this is an important advantage for breeders. Similarly, Erkul and Ünay (2009) stated that the selection of advanced

Table 1. Climate data for the Kirsehir.

Months	Average Temperature (^{0}C)				Total Rainfall (mm)				Average Relative Humidity (%)			
	2016	2017	2018	Long Years	2016	2017	2018	Long Years	2016	2017	2018	Long Years
March	7.1	7.3	5.3	5.5	44.8	41.5	37.6	37.4	60.7	60.8	67.9	68.2
April	13.8	10.7	9.7	10.6	24.0	29.0	45.0	45.6	47.4	52.4	50.8	64.3
May	14.9	15.2	13.6	15.3	98.2	49.9	40.8	43.9	63.7	59.4	61.4	61.4
June	21.0	20.7	19.5	19.4	18.5	18.4	36.2	36.9	53.0	54.3	56.1	55.1
July	24.2	26.0	23.0	23.0	5.8	0.4	9.3	9.6	42.5	36.0	48.4	48.7
Average	16.2	16.0	14.2	14.8					53.5	52.6	56.9	59.5
Total					191.3	139.2	173.0	244.0				

*Kirsehir Provincial Meteorology Directorate

generations may be more effective in bread wheat due to the dominance and epistatic gene effects in terms of spikelet count, number of grains per spike, single spike yield, 1000-seed weight, number of fertile siblings and seed yield. It is known that in order to increase the yield, the characters that affect the yield should be improved first (Kumar and Dubey, 2001; Kumari and Prasad, 2005). The aim of this study is to determine the priority characters required for breeding domestic chickpea genotypes collected from Kirsehir region.

MATERIALS AND METHOD

This study was carried out under Kirsehir ecological conditions for 3 years between 2016-2018. The study was carried out under controlled conditions in the Research and Application Trial Lands of Ahi Evran University. Advanced 58 domestic genotypes collected and identified from Kirsehir were used as the material. The climate and soil characteristics of the land where the experiment was conducted are given in Tables 1 and 2.

For the growing season in the trial area where the research is carried out; the average temperature in all three years was measured as the lowest in March (7.1 ^{o}C, 7.3 ^{o}C and 5.3 ^{o}C) and the highest in July (24.2 ^{o}C, 26.0 ^{o}C and 23.0 ^{o}C). These values are very close to the average values of long years. As the amount of precipitation was the highest rainfall in May (98.2 mm ve 49.9 mm) for the first two years, in the third year April (45.0 mm) was the month with the highest rainfall, and the rainfall in all three years was similar to the rainfall for long years. There was no significant change in moisture content for three years and relative humidity values were determined between 36.0-67.9% (Table 1).

In the experiment, the soil structure of the land; slightly alkaline, organic substance is low, sufficient potassium is available. The available phosphorus was found to be high, and the salt content was determined as salt-free with lime content (Table 2).

The study was carried out for a period of 3 years and it was established in randomized block design pattern with three replications. Planting process was performed in four rows to the parcels which were formed by hand 5 meters in length.

Table 2. Physical and chemical properties of soil of experiment land

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 da^{-1})	2.14	2.29
Potassium (K_2O)	66.62	51.47

The distance between rows is set to 30 cm. The parcel size was set to 5 x 1.2 m = 6 m^2. Planting was carried out in the third week of March in all three years ((First year March 18, the second year is March 21 and the third year is March 15). 2 kg of pure nitrogen and 5 kg of phosphorus were given as DAP fertilizer to the parcels by the planting. As from the planting, weed control was carried out manually. In all three years, harvesting was carried out in the second week of July. Harvest operations have been removed by hand and blended since the pods begin to ripen and dry.

While measuring the plants, 10 plants were selected randomly from each parcel and measurements were made on these plants. The characters examined in the research were plant height, first pod height, number of main branches, biological yield, number of pods per plant, number of grains per plant, seed yield per plant, hundred grain weight and harvest index. The data were analysed by SPSS 21 statistical package program. Using the variance elements model, variances and degree of stratification were calculated in broad sense (Comstock and Moll, 1963).

RESULTS AND DISCUSSION

Descriptive statistics of genotypes are given in Table 3. When Table 3 is examined, it is seen that the standard deviation value is quite low in the number of main branches. Therefore, the standard error value is low. This shows that there is no

Table 3. Descriptive statistics of the examined variables.

Characters	Descriptive Statistics						
	Average	Standard Error	Standard Deflection	Variance	Change Coefficient	Minimum Value	Maximum Value
Plant Height	39.99	0.30	6.99	48.90	17.48	4.0	56.6
The First Pod Height	21.11	0.29	6.79	46.11	32.16	6.0	48.0
Number of Major Branches	2.14	0.05	1.20	1.45	56.29	1.0	17.5
Biological Yield	19.37	0.45	10.51	110.56	54.27	2.0	66.6
Number of Pods Per Plant	26.64	0.60	13.98	195.69	52.51	4.0	133.0
Number of Seeds Per Plant	25.02	0.57	13.27	176.09	53.03	4.0	124.0
Seed Yield Per Plant	9.77	0.22	5.25	27.57	53.73	1.8	36.0
100-Seed Weight	38.98	0.26	6.07	36.95	15.59	5.9	52.2
Harvest Index	50.81	0.36	8.51	72.53	16.76	7.4	145.7

significant change in the number of main branches compared to genotypes. On the other hand, it was observed that the standard deviation values of the number of pods per plant and number of seeds per plant were significantly higher than the other variables. When the coefficient of variation is observed, it is seen that it is in the number of main branches, followed by biological yield. When the smallest and largest values were examined, it was found that the largest change was seen in the harvest index with 7.430-145.700. These changes were considered to be expected due to the fact that the variation was high according to the characteristics of the genotypes and that the cultivated region had different climatic and soil characteristics.

Variance analysis results of the studied variables are given in Table 4. When Table 4 is examined, it is seen that the effect of the years is significant in all examined characteristics except the number of main branches. The fact that the number of main branches is insignificant suggests that the variation is very small, as can be seen in Table 3. The number of main branches appears as a minimum variable character. When the genotypes were examined, it was determined that all characteristics were statistically significant. However, the difference of importance levels is remarkable.

Table 4. Variance of mean squares for variables

	Sources of Change		
	Year	Genotype	Year x Genotype
Plant Height	11674**	2411**	1196
The First Pod Height	4536**	1315**	1188
No. of Major Branches	632	1206*	1154
Biological Yield	1983*	36457**	21677*
Harvest Index	6981**	1264**	1258*
No. of Pods per Plant	11638**	2597*	1318
No. of Seeds Per Plant	628*	1157*	1211
100-Seed Weight	7428**	1713**	1254
Seed Yield Per Plant	13667**	1364**	1291*

Significance was observed according to 0.05 in the number of seeds per plant, number of pods per plant, number of major branches, while the other variables were significant according to 0.01. In terms of year x genotype interactions, insignificance can be seen in general. While biological yield, seed yield per plant and harvest index were found to be significant compared to 0.05, it was not found significant in other variables.

Variance factors and heritability of variables are given in Table 5. According to Table 5, the highest variances were observed in the genotype. The high value of the variances seen in the genotype clearly shows the differences between the genotypes. As the difference between genotypes collected from different regions increases, the variance increases. The effect of the genotype was very high, followed by the environment. The variance of the genotype ranged from 475 to 1502. Grain yield per plant, which is one of the genotypic characteristics, had the highest variance, followed by the number of pods per plant. The lowest variance was determined in the number of main branches. Accordingly, these variables made the greatest contribution to the change in the total variance of the genotypes used in the study. The fact that the number of main branches has the least variance is seen as allowing the genetically branching of the plant at certain intervals. Although the environmental conditions vary, the number of main branches does not respond to it much.

It is known that environmental factors can directly affect yield and yield components in plants. Environmental variances varied between 328-983. It is seen that the environment is the second factor in the formation of genotypes. The greatest variance under the influence of the environment is grain yield per plant, followed by plant height. The lowest variance was again in the number of main branches. This was followed by the first pod height. The main feature of crop production is yield. Since grain yield per plant shows the highest variance, it is understood that all kinds of changes are affected at the highest rate. Reducing the variance in grain yield per plant is important in terms of yield stability. Since the responses of

Table 5. Variances and inheritance degrees for variables.

	Sources of Change				
	Genotypic Variance	**Environment Variance**	**Phenotypic Variance**	**Genotype x Year Variance**	**Inheritance Degree (%)**
Plant Height	1026	967	256	412	42
The First Pod Height	684	512	216	389	18
Number of Major Branches	475	328	192	191	11
Biological Yield	967	644	352	297	16
Harvest Index	911	833	418	294	26
Number of Pods Per Plant	1247	961	418	302	55
Number of Seeds Per Plant	933	811	328	294	37
100-Seed Weight	1005	792	442	329	68
Seed Yield Per Plant	1502	983	516	347	56

stable genotypes can be predetermined, they are always considered as preferred and reliable.

Phenotype was in the third rank. In terms of phenotype, variances were lower than genotype and environment. Phenotype variances ranged between192-516. Grain yield per plant had the highest variance in phenotype. This was followed by a hundred grain weight. When the genotype x year interaction is examined, it is seen that the variances vary between 191-412. The highest variance in genotype x year interaction was observed in plant height. It is understood that plant height is affected at a higher rate than other characteristics over the years. Plant height was followed by the first pod height. The first pod height is the most affected characteristic by the plant height. Therefore, it is expected that the change in plant height will affect the height of the first pod and cause the variance to be high. The lowest variance was in the number of main branches as in other characteristics.

When the heritability is examined, it is seen that the values vary between 11-68%. The highest heritability was observed to be one hundred grain weight, followed by grain yield per plant. The heritability of grain yield per plant was determined as 56%. Grain yield per plant and heritability of one hundred grain weights are high, which means that any improvement in these properties can be transferred to next generations at a high rate. It is seen that the degree of main branches in the number of main branches is quite low as 11%. It is understood that the studies to be carried out in terms of the number of main branches will be difficult to transfer to the next generations. After the number of main branches, the lowest value was observed in biological yield. Regardless of the changes in the characteristics affecting the yield, it is understood that the transfer of the studies to be made in the next generations in terms of biological yield will be very small.

The effect of the first pod height and plant height on the yield of the studied characteristics shows that the environmental effects in place and year are higher than the genotype x environment interaction in the study. This is important in terms of showing that the environment has a significant effect on all genotypes. The results obtained are similar to those of Schuler *et al.* (1995). In addition, the studies of Sharma *et al.* (1990) are compatible with the studies of Altınbaş and Sepetoğlu (2002). The high variance of genotype x year interaction also increases the importance of perennial study. It is known that this is not evident in one-year studies, but the year effect is more clearly demonstrated in perennial studies (Baker *et al.*, 1968). In a study conducted, it was emphasized that the effects of the factors affecting the yield in arid region conditions may change depending on the effect of drought (Kır *et al.*,2018). Our study was conducted in arid areas and therefore it shows all the characteristics of arid climatic conditions and is affected by climatic conditions.

Chauhan *et al.* (1998) state that if the expected genetic progress could not be achieved in the genotypes, it would not make sense to have a high heritability. It is important that genotypes have sufficient phenotypic variability. If the phenotypic variability is not required, we cannot expect a high heritability, nor will there be genetic progression (Özdemir *et al.*, 1999). Singh (1988) obtained an inheritability of 39% in 38 different genotypes. This is defined as the medium level heritability. In the study conducted, the average heritability was 36%. Accordingly, it is seen that the heritability of medium level is realized over all genotypes. However, it is a fact that the heritability of any characteristic studied is obtained only specific to that environment (Falconer ve Mackay, 1996). Changing the location of the study may cause changes in heritability (Isık, 1998).

***Conclusion*:** The degree of heritability is of great importance in terms of transferring the developments in the plants to the next generations. However, for this, the degree of heritability has to be increased. In this study, it is seen that the heritability values of 100-seed weight, seed yield per plant and the number of pods per plant are above 50%, but the heritability of other characteristics remain below this value. Significantly revealing the heritability will increase the success of the breeding activities. Heritability obtained from the study is genotypes grown locally in Kırşehir province and no studies

have been conducted on them. These results were found to be important in terms of their identification and future use in breeding and hybridization studies. Giving priority to one hundred grain weight, grain yield per plant and number of pods per plant will be able to increase the success of breeding activities.

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