Estimation of Genetic Variability, Correlation and Heritability among Forty-nine Genotypes of Chickpea (*Cicer aritinum* L.)

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Received: 22/05/2021 Accepted: 20/07/2021

Abstract

Forty-nine genotypes of chickpea (*Cicer aritinum* L.) were evaluated in two winter seasons in Duhok during seasons 2014/2015 and 2015/2016 using Randomize Complete Block Design (RCBD) with three replications in order to estimate genetic variability, correlation and heritability. The results exhibited highly significant effect for interaction between seasons and genotypes on 1000-seed weight, plant height, seed yield, days to flowering and maturity, first pod height, and number of pods/plant. The genotype Flipo 7-223c was superior in the most characters followed by genotypes Flipi 7-245c and Flipo 7-31c. The highest genetic coefficient was observed for number of pods/plant (23.95), moderate for seed yield (11.50 gm) and low for the other characters, while the phenotypic coefficient was high for number of pods/plant (28.68) and moderate for 1000-seeds weight, seed yield and first pod height with values of (11.15 gm, 18.17 gm and 13.00 cm) respectively, also the result revealed that, the heritability in broad sense was high for plant height and moderate for 1000-seeds weight and number of pods/plant with a value of 0.69 for both characters .Low heritability was observed for the other characters. The genetic advance was high for number of pods/plant (35.19) and moderate for 1000-seeds weight (13.57 gm) and (12.81gm) for seed yield. For this study, the characters were having moderate to low heritability coupled in high to low genetic advance as percentage of mean indicated that, the role of non-additive genetic components control this character, so using selection is ineffective to improve these characters.

Key words: Genetic variability, Correlation, Chickpea heritability, Genetic advance.

Introduction:

Chickpea (*Cicer arietinum* L.) is the most planted grain legume in the world after dry bean and field pea (Alam *et al*., 2017). It is cultivated in the arid and semi-arid regions of world (Najm and Ahmed, 2015). Chickpea is a good source of proteins and carbohydrate and minerals for millions of people in developing countries, it contains 25% proteins, which is the maximum provided by any pulse and 60% carbohydrate (Gaur *et al*., 2008), also it is one of pulse using to improve the physical, chemical and

biological properties of soil and also increasing the soil fertility status through biological nitrogen fixation from the atmosphere (Upadhyaya *et al*., 2006).

The new genotypes of chickpea can play an important role in producing high yield because different genotypes respond differently for their genotypic characters, input requirements, growth process and prevailing environment during growing season. Good quality chickpea genotype produces good quality seed and good quality seed produces high yield. Genotypes of chickpea vary morphologically and the variation is distinctly visible at different growth stages, due to inherent characters (Alam *et al*., 2017; Peyman *et al.,* 2018).

Genetic variation is important in breeding programs for characters and for selecting desirable genotypes. It is important in crop yield to evaluate the genetic variability that available in breeding material and the extent to which the yield components characters are heritable from generation to generation. The genetic variability can thus be a choice for selecting suitable parents. Analysis of correlation among parents is essential for determining selection criteria (Yucel *et al*., 2006). Plant breeders are continuously trying to improve and increasing production so that need information on nature and extent of genetic variation regarding quantitative characters and their inter relationship in population including diverse genotypes, which are pre-requisites for efficient breeding program. The quantitative characters are prone for environmental influence that necessitates the partitioning of overall variances are heritable and non-heritable components for efficient breeding program (Allard, 1960). Shanmugan and Kalaimagal, (2019) indicated that the heritability and expected genetic advance are useful for yield improvement and using the value to know the scope of improvement in the yield of chickpea genotypes. Therefore, the present study aims to study genetic variability, genetic advance, genotypic and phenotypic correlation in forty-nine genotypes of chickpea for yield and its components.

Material and Methods:

The experiment site was located in Kurdistan Region, Central Agricultural Research of Duhok. The experimental materials comprised of 49 genotypes obtained from ICARDA (Table 2). The experiment was laid out in Randomized Complete Block Design with three replications. The genotypes were sown in winter seasons 2014/2015 and 2015-/2016 by hand dibbing in each plot by imposing randomization in each replication along with local variety. The spacing was 30 cm between rows and 10 cm between plants with 5 m length of rows. The number of rows for each experimental unit consists of four rows. All recommended package of agricultural practices with necessary plant protection measurements were followed on time. The data were recorded on ten randomly selected plants in the two middle lines in each replication for the five characters, i.e., plant height, first pod height, days to maturity, 1000-seeds weight and seed weight. Analysis of variance was estimated according to Steel and Torri C (1980). Genotypic and phenotypic coefficients of variation (Gcv and Pcv) were calculated by formula given by heritability in broad sense, and genetic advance was estimated by formula given by Singh and Chaudhary (1979).

$$Gcv = \frac{\text{pσ g}}{\bar{x}} \text{ x } 100$$

$$Pcv = \frac{\text{pσ g}}{\bar{x}} x\ 100$$

Where: x = grand mean of the character. The classification for genotypic coefficient of variation was as follows: Low (< 10%), Moderate (10–20%) and High (> 20%).

Heritability in broad sense is expressed as a percentage of the ratio of the genotypic variance (σ^2g) to the phenotypic variance (σ^2p) estimated on genotype mean. It was computed by adopting the formulae presented by Allard as: Heritability (H^2) = $\sigma^2g/\sigma^2p)*100$, where, H^2 =Heritability in broad sense, σ^2p = Phenotypic variance, σ^2g =Genotypic variance. Estimate of Genetic advance GA for all characters was computed as percentage of the mean expected from selection of the best 5% of the genotypes were estimated as:

Expected genetic advance $\mathbf{(GA) = h^2 \times k\sigma\rho}$

Expected genetic advance as percentage of mean = (GAx100)/$\bar{x}$

Where, k is a constant value depending on selection intensity of 5% (k = 2.06), σ p: is the phenotypic standard deviation; h^2 is broad sense heritability; and μ is the grand population mean for the trait under consideration.

Table 1. Name and pedigree of the studied inbred lines of chickpea

Entry	Name	Pedigree	FAO Status*
1	FLIP05-11C	X00TH 39/FLIP98-29CXS99001	U
2	FLIP05-22C	X00TH 21/FLIP98-64CXFLIP98-47C	U
3	FLIP05-156C	X01TH 23/(FLIP98-132CXS99093XFLIP98-9C	U
4	FLIP05-160C	X01TH 24/(S98588XS99093)XS99358	U
5	FLIP06-19C	X02TH 21/S00787 X FLIP97-261C	U
6	FLIP06-40C	X02TH 39/FLIP97-149C X FLIP98-022C	U
7	FLIP07-13C	X03TH138/FLIP98-130CXFLIP9934C	U
8	FLIP07-16C	X03TH146/FLIP98-130CXFLIP97-25C	U
9	FLIP07-17C	X03TH150/FLIP98-131CXFLIP98-50C	U
10	FLIP07-21C	X03TH152/FLIP97-131CXFLIP97-111C	U
11	FLIP07-22C	X03TH152/FLIP97-131CXFLIP97-111C	U
12	FLIP07-24C	X03TH152/FLIP97-131CXFLIP97-111C	U
13	FLIP07-31C	X03TH153/FLIP98-133CXFLIP98-117C	U
14	FLIP07-32C	X03TH153/FLIP98-133CXFLIP98-117C	U
15	FLIP07-47C	X02TH 61/S99520XLebanes-1	U
16	FLIP07-119C	X02TH 76/S99858 X FLIP97-26C	U
17	FLIP07-125C	X03TH-58/[FLIP98-28CXsel01th12124]XFLIP98-22C	U
18	FLIP07-142C	X03TH-59/(FLIP98- 38CXsel01th12179)XFLIP 98-50C	U
19	FLIP07-176C	X02TH107/FLIP98-28CXsel01th 12124	U
20	FLIP07-183C	X03TH-138/FLIP98-130CXFLIP99-34C	U
21	FLIP07-214C	X03TH148/FLIP97-220CXFLIP98-178C	U
22	FLIP07-223C	X03TH185/FLIP98-128CXLebenese -1	U
23	FLIP07-229C	X03TH9/(FLIP97-81CXFLIP97-281C)XFLIP98-22C	U
24	FLIP07-232C	X03TH9/(FLIP97-81CXFLIP97-281C)XFLIP98-22C	U
25	FLIP07-234C	X03TH137/FLIP98-131CXFLIP98-113C	U
26	FLIP07-241C	X03TH150/FLIP98-131CXFLIP98-50C	U
27	FLIP07-245C	X03TH153/FLIP98-133CXFLIP98-117C	U
28	FLIP07-248C	X03TH153/FLIP98-133CXFLIP98-117C	U
29	FLIP07-260C	X03TH176/FLIP98-130CXLebanes-1	U
30	FLIP07-263C	X02TH 57/S00787XLebanes-1.	U

31	FLIP07-274C	X03TH7/(S00835XFLIP98- 053C)XFLIP97-24C	U
32	FLIP07-275C	X03TH20/(S00784 XFLIP97-281C)XICCV2	U
33	FLIP07-278C	X03TH21/(S00791XFLIP98-23C)XICCV2	U
34	FLIP07-284C	X03TH132/FLIP97-185CXFLIP99-47C	U
35	FLIP07-299C	X03TH149/FLIP97-116CXFLIP 97-85C	U
36	FLIP07-304C	X03TH151/FLIP98-130CXFLIP 97-120C	U
37	FLIP07-307C	X03TH151/FLIP98-130CXFLIP97-120C	U
38	FLIP07-308C	X03TH151/FLIP98-130CXFLIP97-120C	U
39	FLIP07-315C	X03TH153/FLIP98-133CXFLIP98-117C	U
40	FLIP07-322C	X03TH153/FLIP98-133CXFLIP98-117C	U
41	FLIP07-342C	X02TH 40/FLIP98-28C X FLIP98-079C	U
42	FLIP07-284C	X02TH 69/S00792XFLIP98-28C	U
43	FLIP08-23C	X01TH4/(FLIP98-134CXsel99ter85074)XFLIP97-22C	U
44	FLIP08-189C	X03TH146/FLIP98-130CXFLIP97-25C	U
45	ILC482	Long term check	U
46	FLIP 82-150C	X79TH101/ILC 523 X ILC 183 (Improved check)	U
47	FLIP88-85C	X85 TH143/ILC 629 x FLIP 82-144C	U
48	FLIP93-93C	X89TH258/ (FLIP 85-122CXFLIP 82-150C)/FLIP 86-77C	U
49	Local check	-	-

*** D = Designated, U = Undesignated**

Results and Discussion:

Analysis of variance (Table 2) reveals highly significant differences between genotypes for all characters under study in the seasons 2014/2015 and 2015-2016, also the same table exhibited that the years showed high significant effect on all traits except 1000-seeds weight and first pod height, while the genotypes of chickpea exhibited highly significant effect for all studied characters in both years. Highly significant differences for interaction between years and genotypes were observed in 1000-seeds weight, plant height, yield, days to flowering and maturity, fist pod height and number of pods/plant. These results are in confirmation with those of Mieso *et al*., (2018), Sarker *et al*., (2013) and Malik *et al*., (2011). Who reported highly influence of years and genotypes on yield and its components.

Table 2. Analysis of variance for the studied traits of chickpea genotypes.

SOV	df	Mean Square						
		1000-seed weight (g)	Plant height (cm)	Seed yield (g)	Days to flowering	Days to maturity	First pod height (cm)	No. of plants
2014/2015								
Reps	2	3.491	254.619	0.009	6.557	1.367	12.170	1261.312
Genotypes	48	34.727**	46.558**	0.108**	12.590**	8.658**	54.949**	271.030**
Error	96	3.563	6.646	0.013	1.245	0.554	4.451	47.812
2015/2016								
Reps	2	1.433	10.183	0.001	0.843	4.251	73.149	16.333
Genotypes	48	36.753**	80.676**	0.093**	12.318**	26.334**	78.458**	526.819**
Error	96	1.362	2.21	0.027	0.968	10.064	4.073	6.256
Combined analysis								
Env.	1	0.746	538.789**	2.659**	2829.06	12564.9**	24.000	2326.28**
Reps/Env	4	2.462	132.401	0.005	3.700	2.809	42.659	638.823
Genotypes	48	62.918**	113.973**	0.148**	14.181**	20.178**	84.051**	704.811**
Env x gen	48	8.562**	13.261**	0.053**	10.727**	14.814**	49.355**	93.039**
Error	192	2.462	4.283	0.021	1.106	5.309	4.262	27.035

The means of genotypes for yield and some characters in chickpea in both years are presented in Table (3). A perusal of the table indicated that the genotypes of chickpea had significant variation for 1000-seeds weight, and the genotype (31) gave the maximum value of this trait (41.3 g), followed by genotypes (3) and (32) with values of (39.95 and 39.00 g) respectively, while the genotype (16) recorded the minimum value (25.42 g).

The mean performance of forty-nine genotypes in both years, for plant height exhibited that highest plants among all genotypes were (20,19 and 25) with values of (93.33, 89.16 and 88.83 cm) respectively, while the shortest plants were recorded in the genotype (46) with a value of 71.00 cm, Also Table (3) reveals that the highest seed yield (1.55 g) was recorded by genotype (27) followed by the genotypes (22) and (13) with values of (1.5 and 1.47 g) respectively, while the lowest seed yield (0.86 g) was recorded by the genotype (20). Concerning the days to flowering and maturity, the genotype (49) gave the earliest days to flowering (117.33 days), while the genotype (11) recorded latest days to flowering (123.83 days), whereas the genotypes (44) recorded the earliest days to maturity (160.66 days), and the genotype (21) gave the latest days to maturity with value of (168.00 days). Similar results were recorded by several authors like Mieso *et al*., (2018), Tejbir, (2016); Borate *et al*., (2010); and Saki *et al*., (2009).

The results in the Table (3) clarifies the first pod height, was attained by the genotype (19) which produced the maximum value (54.00 cm) and the genotype (2) gave the minimum pod height (37.6 cm). The number of pods/plant was very significant among the chickpea genotypes, where the highest number of this trait produced by the genotypes (37) and (38) with values of (74.5 and 62.80) respectively, whereas the lowest number remarked by the genotype (15) with a value of (19.33).

Similar findings related to high variability of genotypes for most of studied characters has reported by Mieso *et al*., (2018); Barad *et al*., (2018) and Tebir, (2016). Results in Tables (1 and 2), showed that

there is sufficient genetic variation for most of the studied characters in the genetic material for seed yield. This would help in designing the selection methodology which can further be utilized in breeding program for improvement seed yield.

Table 3. Means of genotypes for the studied traits of chickpea genotypes

Genotypes	1000 S W (g)	Height (cm)	Yield (g)	Flowering (days)	Maturity (days)	1st pod height (cm)	Pod. No.
1	32.36 i-m	85.33 c-g	1.10 m-q	121.33 d-g	164.33 e-k	46.25 c-g	47.67 f-k
2	36.42 e-h	82.33 i-n	1.06 n-q	121.0 e-i	166.17 a-g	37.58 q	37.33 n-q
3	39.95 ab	82.5 i-m	1.16 k-p	120.33 g-l	164.17 c-k	38.08 q	52.83 d-f
4	29.5433 o	85.5 c-f	1.29 i-m	119.83 i-m	163.0 h-l	39.75 o-q	53.83 c-f
5	31.0 l-o	84.83 c-g	1.36 b-j	118.33 n-q	164.17 c-i	38.33 pq	57.67 b-d
6	32.0 k-n	84.33 d-h	1.45 a-d	119.83 i-m	163.83 e-l	47.5 b-e	35.0 p-u
7	34.58 h-g	74.33 s-u	1.36 a-j	120.67 f-k	164.67 c-i	45.08 e-i	28.67 u
8	35.84 e-h	85.33 c-g	1.25 e-n	120.17 h-k	163.67 e-l	41.58 l-o	36.83 n-s
9	35.91 e-h	81.0 k-p	1.35 c-k	119.0 l-p	161.33 kl	44.75 e-k	35.5 p-t
10	30.27 m-o	79.33 o-q	1.46 a-d	120.0 h-m	165.33 a-h	43.0 h-n	56.83 b-e
11	35.98 e-h	83.33 e-k	0.92 qr	123.83 a	167.17 a-d	43.0 h-n	28.83 u
12	33.31 i-k	74.33 s-u	0.98 p-r	123.5 b	165.83 e-i	44.08 g-k	41 k-p
13	31.96 k-n	85.67 c-f	1.47 a-c	118.67 m-q	163.83 e-l	43.75 g-m	37.17 n-r
14	31.90 k-n	80.33 l-o	1.38 a-h	118.33 n-q	161.17 kl	45.83 d-g	37.83 n-q
15	36.52 e-g	81.83 i-n	1.17 i-o	121.5 d-g	164.83 a-i	37.58 q	43.83 h-n
16	25.42 p	80.67 k-p	1.39 a-g	119.83 i-m	164.83 e-i	43.58 g-n	30.17 ut
17	31.94 k-n	82.67 i-m	1.24 e-n	118.67 m-q	164.67 c-j	48.0 b-d	39.0 m-q
18	37.36 c-f	85.83 c d e	1.23 e-n	123.17 a-c	166.33 a-f	48.75 bc	48.83 g-j
19	33.53 i-k	89.17 b	1.29 e-m	119.67 i-n	165.67 a-h	54.0 a	50.33 e-h
20	33.37 i-k	93.33 a	0.86 r	120.17 h-l	167.33 a-c	54.0 a	47.33 g-k
21	38.90 b-d	87.5 c d	1.19 i-n	123.33 ab	168.0 a	45.0 e-k	40.17 l-p
22	34.35 h-j	80.83 k-p	1.51 ab	122.17 b-e	163.33 g-l	45.08 e-j	62.67 b
23	36.70 e-g	80.67 k-p	1.13 l-p	120.0 h-m	165.83 e-i	43.5 g-n	42.83 j-o
24	36.43 e-h	87.33 c b	10.09 n-q	121.33 d-h	165.5 a-i	45.58 d-i	52.33 d-g
25	36.93 e-f	88.83 b	1.42 a-e	121.83 c-f	161.5 j-l	46.5 d-f	36.33 o-t
26	35.76 f-h	81.0 k-p	1.35 c-k	119.17 k-n	162.83 h-l	43.5 g-n	37.83 n-q
27	31.51 k-o	83.0 i-l	1.56 a	117.83 o-q	162.5 i-l	43.58 g-n	38.83 n-q
28	37.22 c-f	75.83 r-t	10.10 m-q	119.83 i-m	164.33 c-k	45.58 d-i	49.5 f-i
29	29.99 no	80.33 l-o	1.36 c-k	119.67 i-n	167.67 b a	49.58 b	60.17 bc
30	36.04 e-h	84.0 d-h	1.62 j-p	122.33 b-d	166.83 a-d	48.0 b-d	47.83 g-k
31	41.34 a	81.67 i-p	1.37 a-i	122.17 b-e	166.33 a-f	42.08 l-o	33.83 p-u
32	39.01 b c	80.5 k-p	1.23 e-n	118.33 n-q	166.0 a-h	41.08 m-o	60.33 bc
33	32.38 j-m	77.0 qr	1.42 a-e	119.33 j-n	163.83 e-k	56.58 c-e	37.83 n-q
34	36.25 e-f	82.0 i-o	1.27 c-n	121.17 d-i	166.83 a-d	45.83 e-h	38.5 n-q
35	38.89 b c d	79.83 m-p	1.47 a-c	120.83 e-h	162.83 h-l	43.25 h-n	32.33 q-t
36	37.99 b-e	80.67 k-p	1.32 i-k	121.17 e-h	165.67 a-i	43.5 g-n	74.5 a
37	32.22 i j k	78.83 pq	1.43 a-e	119.33 j-n	162.67 h-l	44.33 g-l	62.83 b
38	30.89 l-o	81.0 k-p	1.40 a-f	120.5 f-l	161.33 kl	44.83 e-l	45.5 h-m
39	37.0 e-f	81.33 k-p	1.35 e-k	120.0 h-m	165.33 a-i	43.0 h-n	46.83 g-l

40	30.56 m-o	79.5 n-q	1.24 e-n	120.0 h-m	163.83 e-l	40.0 o-q	29.83 tu
41	35.76 f g h	82.17 i-n	1.16 k-n	120.33 g-l	161.5 j-l	42.25 j-n	52.333 d-g
42	30.44 m-o	73.83 tu	1.32 c-i	120.67 f-j	163.67 e-l	45.5 e-i	30.83 r-u
43	36.86 d-f	86.17 cd	1.16 l-o	120.33 g-l	162.83 h-l	33.25 f-l	43.0 i-n
44	33.63 i j k	79.83 m-p	1.18 h-o	117.83 o-q	160.67 l	44.0 f-l	52.17 d-g
45	34.33 h-j	79.33 opq	1.33 c-k	119.33 j-n	163.5 g-l	38 q	52 d-g
46	30.49 m-o	71.0 v	1.08 n-q	119.67 i-n	163.0 g-l	42.75 i-n	50 e-h
47	32.96 i-l	73.0 u v	1.21 i-o	117.67 pq	162.5 i-l	42.83 i-n	46.67 f-k
48	31.68 k-n	81.83 i-n	1.02 o-r	119.33 j-n	164.33 c-j	40.75 n-p	50.83 d-h
49	30.48 m-o	76.83 q-s	1.39 a-f	117.33 q	164.0 e-j	117.33 b	164 b

Table (4) shows the estimates of genetic parameters for yield and some characters of chickpea in first year, the result in the same table indicated that the phenotypic variance was higher than the genotypic variance for all studied characters, indicating more influence of environmental factors. The P_{CV} was higher in magnitude than G_{CV} for all the characters under study. This indicated the effect of environment on the expression of these characters. The high values of genotypic coefficient of variation were reported for number of pods/plant and moderate for seed yield and low for the other characters. The lowest genotypic coefficient of variation was produced for days to flowering and maturity. The highest phenotypic coefficient was noted for number of pods/plant and moderate for 1000-seeds weight, seed yield and first pod height (10.29 g, 18.07 g and 10.44 cm) respectively.

Heritability in broad sense was calculated for each character (Table 5). In the first year a high heritability estimates were recorded for 1000-seeds weight, seed yield, days to flowering, and maturity and first pod height and moderate for plant height and number of pods/plant with values ranged between 60 to 82%. In Table (3), the moderate genetic advance as percentage was recorded for number of pods/plant and seed yield with values 28.49 and 22.55 % respectively, and moderate for 1000-seeds weight and first pod height and low for the other characters. The highest heritability phenotypic coefficient and genetic advance percentage indicating that some of the studied characters may positively respond to phenotypic selection. The current observation is in confirmation with finding of Mieso *et al*., (2018) and Malik *et al*., (2011) who reported similar results in their study on genetic and analysis of phenotypic and genotypic characters of chickpea.

Table (6) exhibits the estimates of genetic parameters for yield and some characters of chickpea in the two seasons. The same table showed that the phenotypic variation was more than the genotypic variation indicating the influence of environment on these studied characters. Phenotypic and genotypic coefficients were estimated according to Burton (1952), and Table (4) showed that P_{CV} was higher than GCV for all studied characters. Higher genotypic variation was noted for number of pods/plant (27.91) and moderate for 1000-seeds yield and first pod height and seed yield with values of 10.02, 11.4 and 10.90 respectively and low for the other characters, while phenotypic coefficient was recorded high value for number of pods/plant (28.41) and moderate for 1000-seeds weight (10.58), seed yield (16.27) and first pod height (12.32) and lower values for other studied characters. In the second season highly heritability was produced for the 1000-seeds weight, plant height, days to flowering, first pod height and number of pods/plant and the value ranged from 0.79 to 0.96. whereas, it was low for seed yield and days to maturity. These results were supported by finding of previous authors, who studied chickpea genotypes by phenotypic and genotypic coefficient (Peyman *et al*., 2018; Barad *et al*., 2018 and *Tejbir*, 2016). For genetic advance as percentage of mean, Table (6) showed that, the higher

genetic advance was observed for seed yield (22.55) and number of pods/plant (28.49). moderate genetic advance was observed 1000-seeds weight and first pod height and low for the other characters. High heritability coupled with low genetic advance, it is an indication of non-additive gene action in their expression, whilst the characters having high heritability and high genetic advance (as number of pods/plant) generally indicates that heritability more due to additive gene effect. These results were recorded this finding with Mieso *et al*., (2015); Barad *et al*., (2018); Peyman *et al*., (2018) and Tejbir, (2016) on this the basis of these results it was suggested that the number of pods/ plant, 1000-seeds weight, seed yield maybe give more importance while making selection for higher yield potential of chickpea genotypes and also the genotype (31) was superior variety among chickpea genotypes and followed by genotype (3) and genotype (32).

Table 4. Estimation of genetic parameters of the studied traits of chickpea genotypes (combined analysis).

Genetic parameters	1000 Seeds Weight (g)	Height (cm)	Yield (g)	Flowering (days)	Maturing (days)	1st pod height (cm)	pods number
V g	10.076	18.265	0.021	2.179	2.478	13.298	112.962
V E	2.462	4.383	0.021	1.106	5.309	4.262	27.035
V g E	2.033	2.959	0.011	3.207	3.168	15.031	22.001
V p	14.571	25.609	0.053	6.492	10.956	32.591	161.999
H BS	0.691	0.713	0.401	0.336	0.226	0.408	0.697
S g	3.174	4.274	0.145	1.476	1.574	3.647	10.628
S p	3.817	5.060	0.229	2.548	3.309	5.709	12.728
I	1.76	1.76	1.76	1.76	1.76	1.76	1.76
Mean	**34.227**	**81.585**	**1.265**	**120.217**	**164.312**	**43.884**	**33.377**
GA	4.646	6.353	0.162	1.505	1.318	4.099	15.620
GA%	13.573	7.786	12.81	1.25211	0.802	9.342	35.199
GCV	9.274	5.23841	11.501	1.228	0.958	8.309	23.950
PCV	11.153	6.203	18.170	2.119	2.014	13.009	28.681

The estimation of genetic parameters for the studied characters of chickpea genotypes in the first and second seasons was presented in Table (6). The estimates of phenotypic coefficient were higher than genotypic coefficient for all the characters under study indicating the extent of environmental influences on these characters. The interaction between genotypes and environment was observed in number of pods/plant and first pod height with values of (22.00 and 15.03 cm) compared with other characters. Regarding genetic coefficient, the highest value was observed high for number of pods/plant (23.95) moderate for seed yield (11.50) and low for the other characters, but the phenotypic coefficient, also was high for number of pods/plant (28.68) and moderate for 1000-seeds weight, seed yield and first pod height with a value of (11.15, 18.17 and 13.00) respectively. In terms of heritability in broad sense, the results revelated that estimates of broad sense heritability was high for plant height and moderate for 1000-seeds weight and number of pods/plant with a value of 0.69 for both characters, whereas, low heritability was observed for the other characters. While regarding genetic advance percentage, higher genetic advance was recorded for number of pods/plant (35.19) and moderate for 1000-seeds weight (13.57) and seed yield (12.81) and low for the others characters. In this study, the characters were having moderate to low heritability coupled in high to low genetic advance as percentage of mean indicating the role of non-additive genetic component.

Table 5. Estimates of genetic parameters for the studied characters of chickpea (season 2014/2015).

Genetic parameters	pods number	1st pod height (cm)	Maturing (days)	Flowering (days)	Yield (g)	Height (cm)	1000 Seeds Weight (g)
VG	10.388	13.304	0.032	3.782	2.701	16.833	74.406
VE	3.563	6.646	0.013	1.245	0.554	4.451	47.812
Vp	13.951	19.95	0.045	5.027	3.255	21.284	122.218
H BS	0.745	0.667	0.709	0.752	0.829	0.791	0.609
S g	3.223	3.647	0.178	1.945	1.644	4.103	8.626
Sp	3.735	4.467	0.211	2.242	1.804	4.613	11.055
I	1.76	1.76	1.76	1.76	1.76	1.76	1.76
Mean	**34.176**	**80.231**	**1.169**	**117.115**	**157.775**	**44.17**	**41.564**
GA	4.8945	5.242	0.264	2.969	2.635	6.422	11.845
GA%	14.323	6.534	22.558	2.535	1.670	14.538	28.499
GCV	9.431	4.546	15.223	1.661	1.04172	9.289	20.7532
PVC	10.929	5.567	18.079	1.914	1.144	10.445	26.598

Table 6. Estimates of genetic parameters for the studied characters of chickpea (season 2015/2016).

Genetic parameters	pods number	1st pod height (cm)	Maturing (days)	Flowering (days)	Yield (g)	Height (cm)	1000 Seeds Weight (g)
Vg	11.797	26.185	0.022	3.783	5.423	24.795	173.521
VE	1.362	2.121	0.027	0.968	10.064	4.073	6.256
Vp	13.159	28.306	0.049	4.751	15.487	28.868	179.777
H BS	0.896	0.925	0.449	0.796	0.350	0.859	0.965
d g	3.435	5.117	0.148	1.945	2.329	4.979	13.173
d p	3.628	3.320	0.221	2.179	3.935	5.373	13.408
I	1.76	1.76	1.76	1.76	1.76	1.76	1.76
Mean	**34.277**	**82.938**	**1.36**	**123.319**	**170.85**	**43.598**	**47.19**
GA	5.724	8.662	0.1745	3.055	2.425	8.122	22.777
GA%	16.698	10.444	12.862	2.477	1.419	18.629	48.267
GCV	10.020	6.169	10.906	1.5773	1.363	11.421	27.914
PCV	10.583	6.415	16.276	1.768	2.303	12.324	28.413

Conclusion:

The study concluded that the characters were having moderate to low heritability coupled in high to low genetic advance as percentage of mean indicated that, the role of non-additive genetic components control this character, so using selection is ineffective to improve these characters.

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