ORIGINAL RESEARCH ARTICLE

Assessment of variability and genetic parameters in agro-physiological traits of Chickpea (*Cicer arietinum* L.) under ~~Rainfed~~ rainfed ~~Condition~~ condition

ABSTRACT

An experiment was conducted during *rabi* season of 2017-18 to estimate the genetic parameters ~~like genetic variability,~~of variation including heritability and genetic advance for agro-physiological characters *viz.*, days to flower initiation, days to 50 ~~%~~ *~~per cent~~* flowering, days to maturity, plant height, branches per plant, pods per plant, seeds per plant, biological yield per plant (g), seed yield per plant (g), 100-seed weight (g), root length (cm), relative water content and harvest index (%) in 20 genotypes of chickpea. High phenotypic coefficient of variance (PCV) and genotypic coefficient of variance (GCV) were observed for characters *viz.*, number of branches per plant, seeds per plant and 100-seed weight. The magnitude of phenotypic coefficient of variance ~~was higher than~~and their corresponding genotypic coefficient of variance for all the characters were observed in good agreement reflecting the ~~important role~~narrow range of environmental influence in the manifestation of the characters. High heritability was recorded for number of branches per plant, 100-seed weight, seeds per plant, pods per plant and biological yield per plant. High heritability combined with high genetic advance was observed for seeds per plant, pods per plant and 100-seed weight which indicated ~~s~~ that ~~most likely~~ these traits ~~heritability is due to~~were governed by additive gene effects and phenotypic selection would be effective in early generations for these characters.

Key Words: Chickpea, genetic variability, genetic parameters, agro-physiological characters~~Relative Water Content~~ and Seed yield.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a self-pollinated diploid (2n = 2x =16) food legume that belongs to family Leguminosae. It is also known as Gram,

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Indian pea and Bengal gram. It is most important pulse crop of India contributing about 30 ~~%~~ *per cent* of total pulse acreage and about 40 ~~%~~ *per cent* of total pulse production of the nation. India ranked first in area and production in the world with cultivated area of 9.53 m ha and production of 9.07 mt with productivity of 951 kg/ha. ~~and i~~In Madhya Pradesh, ~~i~~It covers an area of 30.7 lakh ha with production of 33.98 lakh tonnes and productivity of 1105 kg/ha (Anonymous, 2016-17). Chickpea seeds contain on an average 23 ~~%~~ *per cent* protein, 64 *per cent*~~%~~ total carbohydrates (47 *per cent*~~%~~ starch, 6 *per cent*~~%~~ soluble sugar), 5 *per cent*~~%~~ fat, 6 *per cent*~~%~~ crude fiber and 2 *per cent*~~%~~ ash. It is also reported to contain high mineral content: phosphorus (340 mg/100 g), calcium (190 mg/100 g), magnesium (140 mg/100 g), iron (7 mg/100 g), zinc (3 mg/100 g) (Jukanti *et al.,* 2012). Hence, it is considered ~~an~~ as one of the important important component of the ~~subsistence farming~~indian diet.

Its productivity in the country and state is low because chickpea is grown on low input marginal lands and mostly cultivated on residual moisture in the Indian subcontinent. Among various constraints for its low productivity, drought stress particularly at the end of the growing season is a major constraint to chickpea production and yield stability in rainfed regions. With unpredictability of the drought stress and continuous population explosion, there is a ~~great~~ high need to develop high-yielding chickpea varieties with improved drought tolerance (Maqbool *et al.*, 2017). Thus, for improving chickpea productivity under rainfed situations, it is essential to explore the knowledge on genetic variability in the experimental materials. The success of any crop improvement programme depends upon the nature and magnitude of genetic variability and heritability, which provides better opportunity in selecting desired types (Meena and Kumar, 2014). The high heritability combined with high genetic advance ~~was observed~~ for ~~grain yield~~any trait indicate~~d~~ ~~that~~ effectiveness of selection ~~may be effective for this character~~. It is essential to increase the production of chickpea to fulfill the protein requirement of increasing population. The seed yield of chickpea is a complex and multiplicative character, which is highly influenced by environmental variations. Success of crop improvement programme depends upon the extent of genetic variability, choice of parents for hybridization and selection procedure adopted. Information on nature and

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magnitude of variability present due to genetic and non genetic causes is an important prerequisite for systematic breeding programme. Therefore, the present investigation aimed to estimate genetic variability, heritability and genetic advance for agro-physiological traits of in a set of genotypes of ~~Chickpea~~ chickpea under rainfed condition of Indore, Madhya Pradesh, India.

MATERIAL AND METHODS

The experimental material used in the present study comprised of twenty genotypes of chickpea. The present experiment was laid down during *Rabi* 2017-18 in a Randomized Complete Block Design (RCBD) in three replications of 5.00 m × 1.50 m plot size with maintaining the plant geometry at 30 cm × 10 cm. The investigation was carried out at the Research Farm, AICRP on Dryland Agriculture, College of Agriculture, Indore (M.P.), which is situated between latitude 20°43' N and longitude 76°54' E and at an altitude of 567 meters above the mean sea level in *Malwa* plateau of western part of Madhya Pradesh. It has sub-tropical and semi-arid climate having a temperature ranged from 5.7°C to 43.5°C in winter and summer, respectively. All recommended package of practices were adopted to raise good and healthy crop. Observations were recorded on plot as well as single plant basis. Observations on plot basis were recorded for days to flower initiation, days to 50 *per cent*~~%~~ flowering, days to maturity, while observations on single plant basis were recorded from five randomly selected plants from each entry and each replication for number of branches per plant, plant height (cm), number of pods per plant, number of seeds per plant, biological yield per plant (g),100-seed weight (g), seed yield per plant (g), harvest index (%), relative water content and root length (cm) were used for statistical analysis. The genotypic and phenotypic variances were estimated according to the formula suggested by Johnson *et al*. (1955). Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (-PCV) were computed as *per cent* following the method suggested by Burton & Devane (1953). Heritability in broad sense (h^2 bs) was computed using the formula adopted by Allard (1960). The expected genetic advance (GA) for different characters under selection was estimated using the formula suggested by Johnson *et al.* (1955). Genetic advance over mean was estimated by using the following formula proposed by Comstock & Robinson (1952). For recording

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root length, the soil from the roots is removed by rinsing the roots in running water. The total length of root is obtained by measuring the length of tap and branch roots of the chickpea root system. Relative water content (RWC) in chickpea crop upper portion node 5^{th}, 6^{th}, 7^{th} leaves was plugged and removed leaf from leaflets for calculating the RWC (Kramer, 1980).

Table 1: List of Genotypes of chickpea under experiment.

S.No.	Name of Genotypes	S. No.	Name of Genotypes
1	Ujjain-21	11	JG-130
2	JG-14	12	Green Gram
3	JG-218	13	JG-370
4	Vishal	14	JG-338
5	IG-593	15	JAKI-9218
6	RVG-203	16	KAK-2
7	JG-322	17	JG-412
8	JG-6	18	JG-12
9	RVG-201	19	RVG-202
10	JG-16	20	JG-11

RESULTS AND DISCUSSION

Analysis of variance ~~exhibited~~ revealed highly significant differences among genotypes for all the characters studied (Table 2) which ~~revealed~~ indicated highly significant differences among the genotypes for all the characters *viz.,* plant height (cm), number of branches per plant, number of pods per plant, number of seeds per plant, biological yield per plant (g), 100-seed weight (g), days to flower initiation, days to 50 ~~% *per cent*~~ flowering, days to maturity, harvest index (%), seed yield per plant (g), root length (cm) and relative water content indicating the genotypes under study were genetically diverse for all the quantitative traits. These findings were in conformity with the findings of Thakur and Shirohi (2008) for biological yield per plant; Vaghela *et al.* (2009) for seed yield per plant and number of pods per plant; Borate *et al.* (2010) for days to first flower initiation, number of branches, plant height; Malik *et al*. (2010), for pods per plant, branches per plant, biological yield per plant, grain yield and harvest index; Shweta *et al.* (2013) for seed yield per plant and

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pods per plant; Ramanappa *et al*. (2013) for days to 50 ~~%~~ *per cent* flowering, plant height (cm), number of branches per plant, days to maturity, 100 seed weight (g), harvest index in chickpea; Kuldeep *et al.* (2014) for seed yield per plant, 100-seed weight, harvest index, number of effective pods per plant, total number of pods per plant and number of branches; Dev *et al.* (2017) for 100-seed weight, number of pods per plant and plant height. Hasan and Deb (2017) for number of pods per plant and number of seeds per plant.

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The parameters of genetic variability *viz.,* mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h^2_{bs}) and expected genetic advance as per cent of mean (GAM) were estimated for all these characters (Table 3). The plant height ranged from 31.33 (Vishal) to 41.67 (JG-322) cm, with an average of 37.05 cm. Genotypes *viz.,* Ujjain-21, JG-14, JG-130, RVG-202, Green Gram, KAK-2, RVG-201, IG-593 and JG-322 showed more plant height (cm) than the average. The number of branches per plant ranged from 3.03 (JG-130) to 6.97 (JG-370) branches per plant, with an average of 4.31 branches per plant. Six genotypes *viz.,* JG-412, JG-11, IG-593, Ujjain-21, JG-6 and JG-370 exhibited more branches per plant. The pods per plant ranged from 48.10 (IG-593) to 84.70 (JG-16) with an average of 63.32. Twelve genotypes *viz.,* KAK-2, Ujjain-21, JG-11, JG-370, JG-322, JG-218, JG-12, JG-130, RVG-201, RVG-202, Green Gram and JG-16 exhibited higher number pods per plant. The number of seeds per plant ranged from 38.67 (JG-6) to 104.33 (JG-16) with an average of 59.82. Nine genotypes *viz.,* JG-338, RVG-201, JG-322, JG-130, Green Gram, JG-12, Ujjain-21, Vishal and JG-16 exhibited higher seeds per plant. The biological yield per plant ranged from 17.63 g. (JAKI-9218) to 36.00 g. (JG-130). The 100-seed weight (g) ranged from 14.83 (Ujjain-21) to 34.70 (KAK-2) with an average of 22.52 g. The days to flower initiation ranged from 46.00 (RVG-203) to 52.33 (RVG-202) days, with average of 49.67 days. The days to 50% flowering ranged from 50.00 (RVG-203 and KAK-2) to 58.67 (JG-6) days, with general mean of 54.72 days. The days to maturity ranged from 116.00 (RVG-203) to 121.33 (JG-12) days with an average of 119.12 days. Out of 20 genotypes, seven genotypes *viz.,* RVG-203, Vishal, JG-412, JG-338, JG-130, Ujjain-21 and JG-14 exhibited earliness for maturity. The harvest index (%) ranged from 43.33 (JG-130) to 59.26 % (RVG-201) with an average of 53.04.

The Seed yield per plant (g) ranged from 9.83 g (JAKI-9218) to 18.07 g (IG-593), with an average of 13.15 g. Eight genotypes *viz.,* JG-12, RVG-201, Vishal, JG-130, JG-322, KAK-2, JG-16 and IG-593 showed higher seed yield per plant (g). The root length (cm) ranged from 12.27(JG-14) to 18.27 (JG-130) cm, with an average of 14.62 cm. Out of 20 genotypes, nine genotypes *viz.,* Green Gram, JG-370, JAKI-9218, JG-338, JG-11, JG-218, Vishal, IG-593 and JG-130 showed deep root length (cm) that is more adaptive in drought condition. The range obtained for RWC was 55.27 (RVG-201) to 74.54 (JG-322) per cent with general mean of 64.09 per cent. Eight genotypes *viz.,* JG-6, KAK-2, Green Gram, IG-593, JG-370, JG-412, JG-130 and JG-322 showed higher relative water content. The values of mean and range revealed that there was wide range of genetic variability among genotypes for various agro-physiological traits.

The phenotypic coefficient of variation was marginally higher than the corresponding genotypic coefficient of variation for all the characters (Table 3). The genotypic coefficient of variation and phenotypic coefficient of variation were categorized as low (<10 %), moderate (10-20 %) and high (>20 %) as suggested by Sivasubramanian and Madhavamenon (1973). The phenotypic coefficient of variation (PCV) was recorded high for number of branches per plant (26.51 %), followed by number of seeds per plant (26.26 %), 100-seed weight (23.11 %), seed yield per plant (21.32 %) and biological yield per plant (20.99%). While, number of pods per plant (15.92 %), harvest index (14.22 %), root length (14.33 %) and relative water content (12.81 %) recorded moderate PCV. The genotypic coefficient of variation (GCV) was recorded the highest for number of branches per plant (26.09 %) followed by number of seeds per plant (25.26 %) and 100-seed weight (22.42 %). While, biological yield per plant (19.04 %), seed yield per plant (17.32 %), number of pods per plant (14.79 %) and root length (10.73 %) recorded moderate GCV. The estimated GCV and PCV helped in getting a clear understanding of the variability present among various genotypes.

Although range can provide a preliminary idea about the variability, it has to be confirmed by the magnitude of variance. Further, for comparing variation of one character with another, the coefficient of variation which was

independent of unit of measurement is preferred. The presence of narrow difference between phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) for all the characters under study suggested that expression of these characters were not much influenced by environmental factor. High PCV was recorded for number of branches per plant followed by number of seeds per plant, 100-seed weight, seed yield per plant and biological yield per plant and high GCV was recorded for number of branches per plant followed by number of seeds per plant and 100-seed weight indicating that there is greater scope for selection, for improvement of these characters. Results were in accordance with the findings of Thakur and Shirohi (2008), Dwevedi and Gaibriyal (2009), Vaghela *et al.* (2009), Borate *et al.* (2010), Sreelakshmi *et al.* (2010), Babbar *et al*. (2012), Dar *et al.* (2012), Shweta *et al*. (2013), Jain *et al.* (2014), Kuldeep *et al.* (2014), Dev *et al.* (2017), and Hasan and Deb (2017) ~~in chickpea~~. The characters ~~like number of branches per plant indicates the negligible differences indicating that the greater role of~~showing less difference between the GCV and PCV, are more governed by genetic factors for the expression of the~~mse characters~~. Thus, ~~it indicated that these traits were influenced by genetic factors and~~ desired improvement of these traits may be achieved by simple selection procedure~~, the utility of such characters showing least differences between PCV and GCV estimates for effective selection amongst genotype for these traits~~. ~~Results~~ The results were in ~~accordance~~ agreement with the findings of Mohamed *et al*. (2015).

Heritability measures the contribution of genetic variability to phenotypic variability observed for quantitative characters. The classification for estimate of $h^2_{(BS)}$ was made as suggested by Robinson *et al.* (1949) as low (<50 %), moderate (50-70 %) and high (>70 %). Greater heritability was observed for the characters *viz*., number of branches per plant (96.83 %), followed by, 100-seed weight (94.15 %), number of seeds per plant (92.51 %), number of pods per plant (86.31 %) and biological yield per plant (82.28 %). While the moderate heritability was observed for characters *viz*., plant height (68.62 %), followed by, seed yield per plant (65.97 %), days to 50 % flowering (62.85 %), days to flower initiation (60.18 %) and root length (56.13 %) (Table3).

Genetic advance as per cent of mean was recorded for yield and its contributing characters (Table 3). It was categorized as suggested by Johanson

et al. (1955) *i.e*., High (> 20%), Medium (10-20%), Low (<10%). Genetic advance as *per cent*~~age~~ of mean was high for number of branches per plant (52.88 %), followed by, number of seeds per plant (50.05 %), 100-seed weight (44.81 %), biological yield per plant (35.58 %), seed yield per plant (28.97 %) and number of pods per plant (28.31 %). Genetic advance as percentage of mean was moderate for root length (16.56%), followed by plant height (11.70 %). While, low genetic advance as percentage of mean were recorded for days to 50% flowering (8.16 %), relative water content (8.12 %), days to flower initiation (6.66 %), harvest index (5.40 %) and days to maturity (1.34 %).

In present investigation higher PCV, GCV, heritability and genetic advance as per cent of mean were observed for number of branches per plant (26.51 %, 26.09 %, 96.83 % and 52.88 %), number of seeds per plant (26.26 %, 25.26 %, 92.51 % and 50.05 %) and 100-seed weight (23.11 %, 22.42%, 94.15 % and 44.81 %). In any crop improvement programme, the most basic information required was the extent of the inheritance capacity of the genotype for different characters under consideration. Thus, the estimates of heritability help in the selection of elite genotypes from genetically diverse population. A higher magnitude of the broad sense heritability (h^2_{BS}) estimate for quantitative characters indicates effectiveness of selection on the basis of phenotypic performance. However, ~~;~~ it does not show any indication of the amount of genetic progress for selecting the best individuals which is possible only by using the estimates of genetic advance.

High heritability along with high genetic advance ~~is due to~~indicate the additive gene action and the selection of such characters may be fruitful. High heritability coupled with low genetic advance is indicative of non-additive gene action. ~~Such studies~~High additive gene action enables the breeder to have maximum selection response for a trait~~, if the variance exhibited by the populations is largely due to additive genetic variance~~. Greater heritability estimate was observed for the characters *viz.,* number of branches per plant, followed by, 100-seed weight, number of seeds per plant, number of pods per plant and biological yield per plant. These results were in accordance with the finding of Durga *et al.* (2007), Sidramappa *et al.*(2008), Vaghela *et al.* (2009), Tomar *et al*. (2009), Farshadfar and Sabaghpour (2011), Khan *et al.* (2011),

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Babbar *et al.* (2012), Sewak *et al*. (2012), Parhe *et al.* (2014) and Mallu *et al*. (2014).

High genetic advance as per cent of mean was recorded for number of branches per plant, followed by number of seeds per plant, 100-seed weight, biological yield per plant, seed yield per plant and number of pods per plant. The above results were in agreement with the findings of Durga *et al.* (2007), Vaghela *et al.* (2009), Babbar *et al*. (2012), Shweta *et al*. (2013), Arif *et al*. (2014) and Bharadwaj *et al*. (2016). High heritability coupled with high genetic advance as *per cent* of mean were recorded for number of branches per plant, number of seeds per plant and 100-seed weight. Such results indicated, predominantly the presence of additive gene action in the expression of these characters and consequently chance of improving these characters through simple selection procedures appears to be more. These findings were in agreement with Vaghela *et al.* (2009), Borate *et al.* (2010), Jadhav *et al*. (2012), Arif *et al*. (2014), Parhe *et al*. (2014), Yadav *et al.* (2015), Roy *et al.* (2015), and Bharadwaj *et al*. (2016).

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Conclusions

From the preceding discussion, it can be culminated that the analysis of variance revealed highly significant differences among genotypes for all the characters studied indicating the existence of sufficient genetic variability in the experimental material. Higher PCV, GCV, heritability and genetic advance as *per cent* of mean were observed for number of branches per plant, number of seeds per plant and 100-seed weight indicating the prevalence of additive gene action was playing major role for expression of these characters and simple selection methods may be effective for improvement of these traits. ~~Higher PCV, GCV, heritability and genetic advance as *per cent* of mean were observed for number of branches per plant, number of seeds per plant and 100-seed weight indicating the prevalence of additive gene action playing major role for expression of these characters and simple selection methods may be effective for improvement of these traits.~~

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Table 2: Analysis of variance for thirteen agro-physiological traits in chickpea.

S.No.	Characters	Mean Sum of squares		
		Replication (2 df)	Treatment (19 df)	Error (38df)
1	Plant height (cm)	0.65	22.29**	2.95
2	No. of branches per plant	0.01	3.83**	0.04
3	No. of pods per plant	3.60	277.05**	13.91
4	No. of seeds per plant	1.27	703.28**	18.48
5	Biological yield per plant (g)	9.38	72.98**	4.89
6	100-seed weight (g)	0.29	78.08**	1.59
7	Days to flower Initiation	2.82	15.68**	2.83
8	Days to 50% flowering	6.47	26.82**	4.41
9	Days to maturity	2.47	7.03**	2.41
10	Harvest Index (%)	1.57	77.90**	46.44
11	Seed yield per plant (g)	1.86	18.22**	2.67
12	Root length (cm)	6.97	9.31**	1.93
13	Relative water content	220.99	108.90**	46.67

Table: 3: Estimate of various parameters of genetic variability for agro-physiological traits in chickpea.

S.No.	Characters	Mean	Range		PCV (%)	GCV (%)	Heritability (Broad sense %)	Genetic advance (%)	Genetic advance as % of mean
			Mini.	Max.					
1	Plant height (cm)	37.05	31.33	41.67	8.27	6.85	68.62	4.33	11.70
2	No. of branches per plant	4.31	3.03	6.97	26.51	26.09	96.83	2.28	52.88
3	No. of pods per plant	63.32	48.10	84.70	15.92	14.79	86.31	17.92	28.31
4	No. of seeds per plant	59.82	38.67	104.33	26.26	25.26	92.51	29.94	50.05
5	Biological yield per plant (g)	25.02	17.63	36.00	20.99	19.04	82.28	8.90	35.58
6	100-seed weight (g)	22.52	14.83	34.70	23.11	22.42	94.15	10.09	44.81
7	Days to flower Initiation	49.67	46.00	52.33	5.37	4.17	60.18	3.31	6.66
8	Days to 50% flowering	54.72	50.00	58.67	6.30	4.99	62.85	4.46	8.16
9	Days to maturity	119.12	116.00	121.33	1.67	1.04	38.91	1.59	1.34
10	Harvest Index (%)	53.04	43.33	59.26	14.22	6.11	18.42	2.86	5.40
11	Seed yield per plant (g)	13.15	9.83	18.07	21.32	17.32	65.97	3.81	28.97
12	Root length (cm)	14.62	12.27	18.27	14.33	10.73	56.13	2.42	16.56
13	Relative water content	64.09	55.27	74.54	12.81	7.11	30.77	5.20	8.12