

ORIGINAL RESEARCH ARTICLE

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

ABSTRACT

An experiment was conducted during *rabi* season of 2017-18 to estimate the genetic parameters **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 **and** their corresponding genotypic coefficient of variance for all the characters **were observed in good agreement** reflecting the **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 that these **traits were governed by** additive gene effects and phenotypic selection would be effective in early generations for these characters.

Key Words: **Agro-physiological characters,** Chickpea, genetic parameters, genetic variability 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, 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 9.55 million ha and production of 9.94 million

36 tons with productivity of 1041 kg per ha. In Madhya Pradesh, it covers an area
37 of 31.03 lakh ha with production of 39.97 lakh tons and productivity of 1288 kg
38 per ha (Anonymous, 2019-20). Chickpea seeds contain on an average 23 **per**
39 **cent** protein, 64 **per cent** total carbohydrates (47 **per cent** starch, 6 **per cent**
40 soluble sugar), 5 **per cent** fat, 6 **per cent** crude fiber and 2 **per cent** ash. It is
41 also reported to contain high mineral content: phosphorus (340 mg/100 g),
42 calcium (190 mg/100 g), magnesium (140 mg/100 g), iron (7 mg/100 g), zinc (3
43 mg/100 g) (Jukanti *et al.*, 2012). Hence, it is considered **as one of the important**
44 component of the **indian diet**.

45 Its productivity in the country and state is low because chickpea is grown
46 on low input marginal lands and mostly cultivated on residual moisture in the
47 Indian subcontinent. Among various constraints for its low productivity, drought
48 stress particularly at the end of the growing season is a major constraint to
49 chickpea production and yield stability in rainfed regions. With unpredictability
50 of the drought stress and continuous population explosion, there is a **high** need
51 to develop high-yielding chickpea varieties with improved drought tolerance
52 (Maqbool *et al.*, 2017). Thus, for improving chickpea productivity under rainfed
53 situations, it is essential to explore the knowledge on genetic variability in the
54 experimental materials. The success of any crop improvement programme
55 depends upon the nature and magnitude of genetic variability and heritability,
56 which provides better opportunity in selecting desired types (Meena and
57 Kumar, 2014). The high heritability combined with high genetic advance **for any**
58 **trait** indicates **effectiveness of** selection. It is essential to increase the
59 production of chickpea to fulfill the protein requirement of increasing population.
60 The seed yield of chickpea is a complex and multiplicative character, which is
61 highly influenced by environmental variations. Success of crop improvement
62 programme depends upon the extent of genetic variability, choice of parents for
63 hybridization and selection procedure adopted. Information on nature and
64 magnitude of variability present due to genetic and non genetic causes is an
65 important prerequisite for systematic breeding programme. Therefore, the
66 present investigation aimed to estimate genetic variability, heritability and
67 genetic advance for agro-physiological traits of in a set of genotypes of
68 **chickpea** under rainfed condition **of Indore, Madhya Pradesh, India**.

69

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 GCV and PCV were computed as percent 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

104 (1952). For recording root length, the soil from the roots is removed by rinsing
105 the roots in running water. The total length of root is obtained by measuring the
106 length of tap and branch roots of the chickpea root system. Relative water
107 content (RWC) in chickpea crop upper portion node 5th, 6th, 7th leaves was
108 plugged and removed leaf from leaflets for calculating the RWC (Kramer,
109 1980).

110 RESULTS AND DISCUSSION

111 Analysis of variance **revealed** highly significant differences among
112 genotypes for all the characters studied (Table 2) which **indicated** highly
113 significant differences among the genotypes for all the characters viz., plant
114 height (cm), number of branches per plant, number of pods per plant, number
115 of seeds per plant, biological yield per plant (g), 100-seed weight (g), days to
116 flower initiation, days to 50 **per cent** flowering, days to maturity, harvest index
117 (%), seed yield per plant (g), root length (cm) and relative water content
118 indicating the genotypes under study were genetically diverse for all the
119 quantitative traits. These findings were in conformity with the findings of
120 Vaghela *et al.* (2009) for seed yield per plant and number of pods per plant;
121 Borate *et al.* (2010) for days to first flower initiation, number of branches, plant
122 height; Malik *et al.* (2010), for pods per plant, branches per plant, biological
123 yield per plant, grain yield and harvest index; Shweta *et al.* (2013) for seed yield
124 per plant and pods per plant; Ramanappa *et al.* (2013) for days to 50 **per cent**
125 flowering, plant height (cm), number of branches per plant, days to maturity,
126 100 seed weight (g), harvest index in chickpea; Kuldeep *et al.* (2014) for seed
127 yield per plant, 100-seed weight, harvest index, number of effective pods per
128 plant, total number of pods per plant and number of branches; Dev *et al.* (2017)
129 for 100-seed weight, number of pods per plant and plant height. Hasan and
130 Deb (2017) for number of pods per plant and number of seeds per plant.

131 The parameters of genetic variability viz., mean, range, phenotypic
132 coefficient of variation (PCV), genotypic coefficient of variation (GCV),
133 heritability in broad sense (h^2_{bs}) and expected genetic advance as **per cent** of
134 mean were estimated for all these characters (Table 3). The plant height
135 ranged from 32.27 (Vishal) to 42.92 (JG 322) cm, with an average of 38.16 cm.
136 Genotypes viz., Ujjain 21, JG 14, JG 130, RVG 202, Green Gram, KAK 2, RVG
137 201, IG 593 and JG 322 showed more plant height (cm) than the average. The

138 number of branches per plant ranged from 3.12 (JG 130) to 7.18 (IG 370) with
139 an average of 4.44 branches per plant. Six genotypes viz., JG 412, JG 11, IG
140 593, Ujjain 21, JG 6 and IG 370 exhibited more branches per plant. The pods
141 per plant ranged from 49.54 (IG 593) to 87.24 (JG 16) with an average of
142 65.22. Twelve genotypes viz., KAK 2, Ujjain 21, JG 11, IG 370, JG 322, JG
143 218, JG 12, JG 130, RVG 201, RVG 202, Green Gram and JG 16 exhibited
144 higher number pods per plant. The number of seeds per plant ranged from
145 39.83 (JG 6) to 107.46 (JG 16) with an average of 61.61. Nine genotypes viz.,
146 JG 338, RVG 201, JG 322, JG 130, Green Gram, JG 12, Ujjain 21, Vishal and
147 JG 16 exhibited higher seeds per plant. The biological yield per plant ranged
148 from 18.16 g. (JAKI 9218) to 37.08 g. (JG 130). The 100-seed weight (g)
149 ranged from 15.27 (Ujjain 21) to 35.74 (KAK 2) with an average of 23.20 g. The
150 days to flower initiation ranged from 47.38 (RVG 203) to 53.90 (RVG 202) days,
151 with average of 51.16 days. The days to 50 **per cent** flowering ranged from
152 51.50 (RVG 203 and KAK 2) to 60.43 (JG 6) with general mean of 56.36 days.
153 The days to maturity ranged from 119.48 (RVG 203) to 124.97 (JG 12) with an
154 average of 122.69 days. Out of 20 genotypes, seven genotypes viz., RVG 203,
155 Vishal, JG 412, JG 338, JG 130, Ujjain 21 and JG 14 exhibited earliness for
156 maturity. The harvest index (%) ranged from 44.63 (JG 130) to 61.04 % (RVG
157 201) with an average of 54.63. The seed yield per plant (g) ranged from 10.12 g
158 (JAKI 9218) to 18.61 g (IG 593), with an average of 13.54 g. Eight genotypes
159 viz., JG 12, RVG 201, Vishal, JG 130, JG 322, KAK 2, JG 16 and IG 593
160 showed higher seed yield per plant (g). The root length (cm) ranged from 12.64
161 (JG 14) to 18.62 (JG 130) cm, with an average of 15.06 cm. Out of 20
162 genotypes, nine genotypes viz., Green Gram, IG 370, JAKI 9218, JG 338, JG
163 11, JG 218, Vishal, IG 593 and JG 130 **identified as deep rooting genotypes**
164 **which may have the advantage of accessing subsoil reserves of water when**
165 **the top soil dried out later in the season. Chen et al. (2017) reported the role of**
166 **root system as the capacity of roots to grow into the subsoil is significant for**
167 **avoiding terminal drought stress in water-limited soils.** The range for RWC was
168 56.93 (RVG 201) to 76.78 % (JG 322) with general mean of 66.01 *per cent*.
169 Eight genotypes viz., JG 6, KAK 2, Green Gram, IG 593, IG 370, JG 412, JG
170 130 and JG 322 showed higher relative water content. **Sachdeva et al. (2020)**

171 concluded that maintaining higher RWC (%) enabling genotypes to perform
172 better in terms of physiological processes under stress and decreasing in RWC
173 signifying their vulnerability to drought stress. The values of mean and range
174 revealed that there were wide ranges of genetic variability among genotypes for
175 various agro-physiological traits.

176 The phenotypic coefficient of variation was marginally higher than the
177 corresponding genotypic coefficient of variation for all the characters (Table 3).
178 The genotypic coefficient of variation and phenotypic coefficient of variation
179 were categorized as low (<10 %), moderate (10-20 %) and high (>20 %) as
180 suggested by Sivasubramanian and Madhavamenon (1973). The phenotypic
181 coefficient of variation (PCV) was recorded high for number of branches per
182 plant (25.71 %), followed by number of seeds per plant (25.47 %), 100-seed
183 weight (22.42 %), seed yield per plant (20.68 %) and biological yield per plant
184 (20.33 %). While, number of pods per plant (15.44 %), harvest index (13.79 %),
185 root length (13.90 %) and relative water content (12.43 %) recorded moderate
186 PCV. The genotypic coefficient of variation (GCV) was recorded the highest for
187 number of branches per plant (25.31 %) followed by number of seeds per plant
188 (24.50 %) and 100-seed weight (21.75 %). While, the moderate GCV was
189 recorded for biological yield per plant (18.47 %), seed yield per plant (16.80 %),
190 number of pods per plant (14.35 %) and root length (10.41 %). The estimated
191 GCV and PCV helped in getting a clear understanding of the variability present
192 among various genotypes.

193 Genetic variability has to be confirmed by the magnitude of variance also
194 because range can provide only a preliminary idea about the variability.
195 Furthermore, for comparing the variation of one character with another, the
196 coefficient of variation which was independent of unit of measurement is
197 preferred. The presence of narrow difference between phenotypic coefficient of
198 variation (PCV) and genotypic coefficient of variation (GCV) for all the
199 characters under study suggested that expression of these characters were not
200 much influenced by environmental factor. High PCV was recorded for number
201 of branches per plant followed by number of seeds per plant, 100-seed weight,
202 seed yield per plant and biological yield per plant and high GCV was recorded
203 for number of branches per plant followed by number of seeds per plant and
204 100-seed weight indicating that there is considerable scope for selection to

205 improve these characters. Results were in accordance with the findings of
206 Vaghela *et al.* (2009), Borate *et al.* (2010), Sreelakshmi *et al.* (2010), Babbar *et*
207 *al.* (2012), Dar *et al.* (2012), Shweta *et al.* (2013), Jain *et al.* (2014), Kuldeep *et*
208 *al.* (2014), Dev *et al.* (2017) and Hasan and Deb (2017). The characters
209 showing less difference between the GCV and PCV are more governed by
210 genetic factors for the expression of them. Thus, desired improvement of these
211 traits may be achieved by simple selection procedure. The results were in
212 agreement with the findings of Mohamed *et al.* (2015).

213 Heritability measures the contribution of genetic variability to phenotypic
214 variability observed for quantitative characters. The classification for estimate of
215 $h^2_{(BS)}$ was made as suggested by Robinson *et al.* (1949) as low (<50 %),
216 moderate (50-70 %) and high (>70 %). A illustrious heritability was observed for
217 the characters viz., number of branches per plant (93.93 %), followed by, 100-
218 seed weight (91.33 %), number of seeds per plant (89.73 %), number of pods
219 per plant (83.72 %) and biological yield per plant (79.81 %). While the moderate
220 heritability was observed for characters viz., plant height (66.56 %), followed by
221 seed yield per plant (63.99 %), days to 50 % flowering (60.96 %), days to flower
222 initiation (58.37 %) and root length (54.45 %) (Table3).

223 Genetic advance as per cent of mean was recorded for yield and its
224 contributing characters (Table 3). It was categorized as suggested by Johanson
225 *et al.* (1955) i.e., High (>20%), Medium (10-20%), Low (<10%). Genetic
226 advance as per cent of mean was high for number of branches per plant
227 (51.29 %) followed by number of seeds per plant (48.55 %), 100-seed weight
228 (43.47 %), biological yield per plant (34.51 %), seed yield per plant (28.10 %)
229 and number of pods per plant (27.46 %). Genetic advance as per cent of mean
230 was moderate for root length (16.06 %) followed by plant height (11.35 %).
231 While, low genetic advance as percentage of mean were recorded for days to
232 50 per cent flowering (7.92 %), relative water content (7.88 %), days to flower
233 initiation (6.46 %), harvest index (5.24 %) and days to maturity (1.30 %).

234 In present investigation higher PCV, GCV, heritability and genetic
235 advance as per cent of mean were observed for number of branches per plant
236 (25.71 %, 25.31 %, 93.93 % and 51.29 %), number of seeds per plant (25.47
237 %, 24.50 %, 89.73 % and 48.55 %) and 100-seed weight (22.42 %, 21.75 %, 91.33 %
238 and 43.47 %). In any crop improvement programme, the most basic

239 information required was the extent of the inheritance potential of the
240 genotypes for the various traits under consideration. Thus, heritability estimates
241 help in the selection of elite genotypes from genetically diverse populations. A
242 higher **magnitude of** the broad sense heritability (h^2_{BS}) estimate for quantitative
243 characters indicates effectiveness of selection on the basis of phenotypic
244 performance. **However**, it does not show any indication of the amount of
245 genetic progress for selecting the best individuals which is possible **only** by
246 using the estimates of genetic advance.

247 High heritability **along** with high genetic advance **indicates** the additive
248 gene action and the selection of such characters may be fruitful. High
249 heritability coupled with low genetic advance is indicative of non-additive gene
250 action. **High additive gene action** enables the breeder to have maximum
251 selection response **for a trait**. Greater heritability estimate was observed for the
252 characters *viz.*, number of branches per plant, followed by, 100-seed weight,
253 number of seeds per plant, number of pods per plant and biological yield per
254 plant. These results were in accordance with the finding of Vaghela *et al.*
255 (2009), Khan *et al.* (2011), Babbar *et al.* (2012), Sewak *et al.* (2012), Parhe *et*
256 *al.* (2014) and Mallu *et al.* (2014).

257 High genetic advance as **per cent** of mean was recorded for number of
258 branches per plant, followed by number of seeds per plant, 100-seed weight,
259 biological yield per plant, seed yield per plant and number of pods per plant.
260 The above results were in agreement with the findings of Vaghela *et al.* (2009),
261 Babbar *et al.* (2012), Shweta *et al.* (2013), Arif *et al.* (2014) and Bharadwaj *et*
262 *al.* (2016). High heritability coupled with high genetic advance as **per cent** of
263 mean were recorded for number of branches per plant, number of seeds per
264 plant and 100-seed weight. Such results indicated, predominantly the presence
265 of additive gene action in the expression of these characters and consequently
266 chance of improving these characters through simple selection procedures
267 **appears to be more**. These findings were in agreement with Vaghela *et al.*
268 (2009), Borate *et al.* (2010), Jadhav *et al.* (2012), Arif *et al.* (2014), Parhe *et al.*
269 (2014), Yadav *et al.* (2015), Roy *et al.* (2015) **and** Bharadwaj *et al.* (2016).

270 **Conclusions**

271 From the preceding discussion, it can be culminated that the analysis of
272 variance revealed highly significant differences among genotypes for all the

273 characters studied indicating the existence of sufficient genetic variability in the
274 experimental material. Higher PCV, GCV, heritability and genetic advance as
275 **per cent** of mean were observed for number of branches per plant, number of
276 seeds per plant and 100-seed weight indicating the prevalence of additive gene
277 action was playing major role for expression of these characters and simple
278 selection methods may be effective for improvement of these traits.

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 384 chickpea (*Cicer arietinum*) under late sown conditions. *Ind J Agric*
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386 **Table 1:** List of genotypes studied along with their pedigree.

S.No.	Name of Genotypes	Pedigree
1	Ujjain 21	Selection from local material
2	JG 14	(GW 5/7 × P 327) × ICCL 83149
3	JG 218	ICCV 4 × P 1353
4	Vishal	K 850 × ICCL 80074
5	IG 593	-
6	RVG 203	(ICCV 37 × GW 5/7) × ICCV 107
7	JG 322	CHAFFA × BG 1
8	JG 6	(ICCV 10 × K 850) × (H 208 × RS 11)
9	RVG 201	PG 5 × BHEEMA
10	JG 16	ICCC 4 × ICCV 10
11	JG 130	(Phule G 5 × Narsinghpur Bold) × JG 74
12	Green Gram	BGD 112 × JSC 37
13	IG 370	-
14	JG 338	-
15	JAK I9218	(ICCV 37 × GW 5/7) × ICCV 107
16	KAK 2	(ICCC 2 × Surutato 77) × ICC 7344-ICCX 870026 PB-PB-14P-BP-62 AK-7AK-BAK
17	JG 412	(Phule G 5 × Narsinghpur Bold) × ICCV 37
18	JG 12	(N. Bold × PG 5) × PG 5
19	RVG 202	(JAKI-9226 × DCP 20) × JG 412
20	JG 11	[(Phule G 5 × Narsinghpur Bold) × ICCL 37] ICCX-860263-BF-BP-91BP

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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)	0.64	21.65**	2.95
2	No. of branches per plant	0.01	4.33**	0.04
3	No. of pods per plant	3.68	276.09**	13.91
4	No. of seeds per plant	1.27	703.81**	18.80
5	Biological yield per plant (g)	9.35	70.89**	4.89
6	100-seed weight (g)	0.29	77.06**	1.59
7	Days to flower Initiation	2.80	14.56**	2.83
8	Days to 50 % flowering	6.47	25.92**	4.41
9	Days to maturity	2.55	7.03**	2.41
10	Harvest Index (%)	1.57	76.55**	45.40
11	Seed yield per plant (g)	1.82	18.22**	2.77
12	Root length (cm)	6.97	9.31**	1.89
13	Relative water content	219.91	108.90**	45.77

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)	38.16	32.27	42.92	8.02	6.64	66.56	4.20	11.35
2	No. of branches per plant	4.44	3.12	7.18	25.71	25.31	93.93	2.21	51.29
3	No. of pods per plant	65.22	49.54	87.24	15.44	14.35	83.72	17.38	27.46
4	No. of seeds per plant	61.61	39.83	107.46	25.47	24.50	89.73	29.04	48.55
5	Biological yield per plant (g)	25.77	18.16	37.08	20.36	18.47	79.81	8.63	34.51
6	100-seed weight (g)	23.20	15.27	35.74	22.42	21.75	91.33	9.79	43.47
7	Days to flower Initiation	51.16	47.38	53.90	5.21	4.04	58.37	3.21	6.46
8	Days to 50 % flowering	56.36	51.50	60.43	6.11	4.84	60.96	4.33	7.92
9	Days to maturity	122.69	119.48	124.97	1.62	1.01	37.74	1.54	1.30
10	Harvest Index (%)	54.63	44.63	61.04	13.79	5.93	17.87	2.77	5.24
11	Seed yield per plant (g)	13.54	10.12	18.61	20.68	16.80	63.99	3.70	28.10
12	Root length (cm)	15.06	12.64	18.82	13.90	10.41	54.45	2.35	16.06
13	Relative water content	66.01	56.93	76.78	12.43	6.90	29.85	5.04	7.88