Journal of Food Science and Agricultural Technology

International peer-reviewed scientific online journal

Published online: http://jfat.mfu.ac.th

Original Research Article

Variability and stability analysis for seed yield and its components in chickpea (*Cicer arietinum* L.)

Pyare Lal Johnson*, Shailaja Sai, Hem Chand Nanda and Raj Narayan Sharma

Department of Genetics & Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur 492 012, Chhattisgarh, India

ARTICLE INFO

Article history:
Received 30 September 2014
Received in revised form 22 December 2014
Accepted 31 January 2015

Keywords:
Stability
Variability

ABSTRACT

Chickpea is the prime pulse crop of India, grown in an area of 9.51 million hectares with the annual production of 8.88 million tones, reflecting low (929 kg/ ha) productivity. In Chhattisgarh, it is cultivated in about 0.261 million hectare, with an average productivity of 1002 kg/ ha.The genotypic coefficient of variation (GCV) was maximum for the characters *viz.,* biological yield plant^{-1}, 100-seed weight, seed yield plant^{-1}, seed volume, hydration capacity seed^{-1}, hydration index and swelling index in E_1, E_2, E_3 and E_4. Pods plant^{-1} in E_1, E_2 and E_3 and primary branches plant^{-1} in E_2 and E_3. GCV for seed yield was high which imparts good scope for yield improvement through direct selection in chickpea. High heritability coupled with high genetic advance was recorded in characters *viz.,* 100-seed weight, seed volume, hydration capacity seed^{-1}, hydration index and swelling index in E_1, E_2, E_3 and E_4 and pods plant^{-1} in E_1 and E_2. Biological yield plant^{-1} in E_2, E_3 and E_4 and primary branches plant^{-1} in E_2 and E_3 and plant height in E_3, which indicates that the heritability is due to additive gene action and the selection based on these character may be effective. The genotype JG 11 was stable for primary branches plant^{-1} over all environments. GCP 101 was stable for biological yield plant^{-1}. Vaibhav, Indira Chana-1 and JGK 1 were stable for 100-seed weight. JG 14, Indira Chana-1, JG 74 and GCP 101 were stable for seed yield plant^{-1} and JG 14 and JG 74 were stable for harvest index over all the environments.

* *Corresponding author*:
Email: pyrejohnson@gmail.com

Published by School of Agro-Industry, Mae Fah Luang University

ISSN: 2408-1736

INTRODUCTION

Chickpea is the prime pulse crop of India, grown in an area of 9.51 million hectares with the annual production of 8.88 million tones, reflecting low (929 kg/ha) productivity. In Chhattisgarh, it is cultivated in around 0.261 million hectare, with an average productivity of 1002 kg/ ha. (Anonymous, 2011). Generally in Chhattisgarh varieties having adoptability under rainfed ecosystem and rice fallows situation. Genetic variability is the first pre-requisite for any crop improvement programme as it provides opportunity to select an ideal plant type. It helps for choice of the best yield attributes either for selection or hybridization. Genotype (G) × Environment (E) interaction (GEI) is an important aspect of plant breeding programs. It may arise when certain genotypes are grown in diverse set of environments. Stability is the ability of a certain variety to maintain stable yield under changing environmental conditions and assessed through several stability parameters. Among them, regression coefficient (bi) and deviation from regression (S^2di) proposed by Eberhart and Russell (1966) have extensively been used in multi-environment trials.

MATERIALS AND METHODS

The experimental material consisted of 22 genotypes including two standard checks namely, Indira Chana-1 and Vaibhav. The experiment was conducted using Randomized Block Design with two replications in two dates of sowing under rainfed and irrigated conditions separately. Thus, the genotypes were evaluated under four following environments: E1: Early sowing under rainfed condition *i.e.* last week of October, E2: Late sowing under rainfed condition *i.e.* 1st week of December, E3: Early sowing under irrigated condition *i.e.* last week of October, E4: Late sowing under irrigated condition *i.e.* 1st week of December. The row to row and plant to plant spacing were 30 cm and 10 cm respectively and plot size of 4.8 m^2 (1.2 m x 4 m). The crop was raised with all standard agronomical package of practices *i.e.* fertilizer dose ax 20:50:20 kg ha^{-1} N, P and K applied as basal and all plant protection measures were adopted to raise healthy crops. The various genetic parameter *viz*. genotypic and phenotypic coefficients of variation, heritability estimate in broad sense and expected genetic advance were estimated and selection indices were formulated as suggested by Burton *et al*. (1952). Stability is the ability of a certain variety to maintain stable yield under changing environmental conditions and assessed through several stability parameters. Among them, regression coefficient (bi) and deviation from regression (S^2di) proposed by Eberhart and Russell (1966) have extensively been used in multi-environment trials.

RESULTS AND DISCUSSION

Variability

In present investigation high heritability was recorded for hydration capacity $seed^{-1}$ followed by hydration index, days to 50 per cent flowering, swelling index, 100-seed weight, seed volume, biological yield $plant^{-1}$ and days to maturity. Genetic advance as percentage of mean was observed high in hydration capacity $seed^{-1}$ followed by hydration index, swelling index, biological yield $plant^{-1}$, seed volume, 100-seed weight, seed yield $plant^{-1}$ and primary branches $plant^{-1}$. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*. 1955). Estimate of heritability also give some idea about the gene action involved in the expression of various polygenic traits (Table 1). High heritability coupled with high genetic advance was recorded in characters *viz.,* 100-seed weight, seed volume, hydration capacity $seed^{-1}$, hydration index and swelling index in environment E_1, E_2, E_3 and E_4 and pods $plant^{-1}$ in E_1 and E_2. The high heritability is being exhibited due to favorable influence of environment rather than genotypes, hence selection for such traits may not be rewarding. The experimental findings of GCV, PCV, heritability and genetic advance estimates are in general agreement with that of several workers who reported high to low estimates of GCV, PCV, heritability and genetic advance for various yield traits in chickpea *i.e.* Akhtar *et al*. (2011), Jayalakshmi *et al.* (2011), Malik *et al.* (2011), Parameshwarappa *et al*. (2011). Johnson *et al*. (2010), Sharma and Saini (2010).

Stability analysis

Mean performance of seed yield of different environments

Mean grain yield of the twenty two chickpea genotypes at each of the four environments with overall means presented in Table 2. The overall varietal means varied from (2.413 g) in DCP-92-3 to (15.388 g) in Rajas against the grand mean (6.361 g). The overall mean of E_1, E_2, E_3 and E_4 was (8.651 g), (4.435 g), (7.415 g) and (4.945 g). In environment E_4 highest yield was recorded for the JGK 1 followed by Pant G 186 and Subhra, while the lowest yield was recorded for the DCP-92-3.

Mean performance and stability of pods $plant^{-1}$

Pods $plant^{-1}$varied from 23.19 (Pant G 186) to 44.78 (JG 16). Other genotypes having high mean over environment were 30.91 (BGM 547), 44.78 (JG 16), 37.56 (BG 372), 32.61 (DCP-92-3), 37.88 (Subhra), 36.51 (GCP 105), 34.96 (JG 315), 33.36 (GCP 101), 31.90 (JG 322) and 40.44 (JGK 1) (Table 3). For this character twelve genotypes have the significant values for regression coefficient and five genotypes have the significant values for deviation from regression. Based on stability parameters of high mean value bi =1 and S^2 di =0, no genotypes was found to be stable over the four environments.BGM 547, JG 16, DCP-92-3, Subhra and GCP 105 showed high mean value than the population mean and its regression coefficient (bi) was more than unity (bi > 1), showed that it was highly sensitive to environmental conditions. These stability parameters suggested that it was specifically adapted to favourable environments. BG 372, JG 315, GCP 101, JG 322 and JGK 1 were showed high mean value than their population mean and their regression coefficient (bi) was less than unity (bi < 1), suggested that they were least sensitive to environmental conditions, which indicated that they were specifically adapted to poor environments. Twelve genotypes showed low mean value than their population mean with below average in stability (bi < 1), hence they were poorly adapted to all the environments (Table 2).

Mean performance and stability of 100-seed weight (g)

100-seed weight (g) varied from DCP-92-3 (12.02 g) to Subhra (30.07 g). Other genotypes having high mean over environment were JG 11 (24.11g), Rajas (19.69 g), BGM-547 (21.72 g), JAKI 9218 (22.89 g), JG 14 (23.59 g), Vaibhav (23.27 g), Subhra (30.07 g), Indira Chana-1 (22.62 g), JG 130 (23.32 g), JG 218 (22.18 g) and JGK 1 (24.09 g). (Table 3).For this character one genotype has the significant values for regression coefficient and two genotypes have the significant

Table 1 Summary of h^2bs and GA % for all characters in chickpea under all the environments studies.

Characters	Heritability (h^2bs) (%)				Genetic advance as percentage of mean GA (%)			
	E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
Days to 50 % flowering	H	H	H	H	M	M	M	M
Days to maturity	H	H	M	H	L	L	L	L
Plant height (cm)	H	M	H	L	M	M	H	M
Primary branches plant^{-1}	M	H	H	M	H	H	H	H
Pods plant^{-1}	H	H	M	L	H	H	H	M
Biological yield plant^{-1} (g)	M	H	H	H	H	H	H	H
100-seed weight (g)	H	H	H	H	H	H	H	H
Seed yield plant^{-1} (g)	M	M	M	M	H	H	H	H
Harvest index (%)	M	L	M	L	H	L	H	M
Seed volume (ml seed^{-1})	H	H	H	H	H	H	H	H
Hydration capacity seed^{-1} (g)	H	H	H	H	H	H	H	H
Hydration index	H	H	H	H	H	H	H	H
Swelling index	H	H	H	H	H	H	H	H

L = Low M = Moderate H = High

values for deviation from regression. Based on stability parameters of high mean value bi =1 and S^2di =0, Vaibhav, Indira Chana-1 and JGK 1 was found to be stable over the four environments. JG 11, BGM 547, JAKI 9218, JG 14 and JG 130 were showed high mean value than the population mean and its regression coefficient (bi) was more than unity (bi > 1), showed that it was highly sensitive to environmental conditions. These stability parameters suggested that it was specifically adapted to favourable environments. Rajas, Subhra and JG 218 were showed high mean value than their population mean and their regression coefficient (bi) was less than unity (bi < 1), suggested that they were least sensitive to environmental conditions, which indicated that they were specifically adapted to poor environments. JG 16, JG 74, Vijay and JG 315 exhibited low mean value than their population mean with above average in stability (bi > 1). Seven genotypes showed low mean value than their population mean with below average in stability (bi < 1), hence they were poorly adapted to all the environments.

Table 2 Performance of chickpea genotypes for seed yield under different environments

S. No.	Genotypes	E1	E2	E3	E4	Mean ($\bar{X}$)
1.	JG 11	9.12	3.89	9.99	5.86	7.22
2.	Rajas	15.38	3.35	10.61	4.90	8.56
3.	BGM 547	8.18	3.84	9.96	3.85	6.46
4.	JG 16	11.19	5.61	10.99	2.90	7.67
5.	JAKI 9218	9.23	4.42	6.35	4.63	6.16
6.	JG 14	8.38	4.99	6.69	5.36	6.35
7.	BG 372	9.08	3.72	5.39	3.43	5.40
8.	DCP-92-3	6.26	3.09	5.61	2.41	4.34
9.	Pant G 186	3.32	3.82	5.26	6.74	4.78
10.	Vaibhav (Ch)	9.76	5.58	5.67	4.78	6.45
11.	Subhra	14.97	6.53	10.46	6.08	9.51
12.	GCP 105	13.58	3.99	7.02	4.32	7.23
13.	Indira Chana-1(Ch)	8.78	4.95	6.84	4.87	6.36
14.	RG-03-28	7.48	5.09	5.75	5.85	6.04
15.	JG 130	7.14	3.41	7.43	6.07	6.01
16.	JG 74	8.33	3.92	8.80	4.64	6.42
17.	Vijay	3.96	3.27	5.14	3.85	4.06
18.	JG 315	8.10	4.44	6.60	4.70	5.96
19.	GCP 101	9.01	4.36	7.83	4.70	6.48
20.	JG 218	3.41	4.70	3.22	5.14	4.12
21.	JG 322	6.48	3.35	6.93	5.15	5.48
22.	JGK 1	9.07	7.16	10.50	8.49	8.80
	$\bar{X}$	8.65	4.43	7.41	4.94	6.36

Table 3 Mean performance and stability for seed yield and its components in chickpea under all the environments.

Genotypes	Pods plant^{-1}			100-seed weight (g)			Seed yield plant^{-1} (g)		
	($\bar{X}$)	bi	S^2 di	($\bar{X}$)	bi	S^2 di	($\bar{X}$)	bi	S^2 di
JG 11	26.28	0.45	1.00	24.11	3.03*	1.51	7.22	1.37**	1.70
Rajas	29.04	1.11**	0.17	19.69	-1.78	17.14**	8.56	2.73**	-0.52
BGM 547	30.91	1.52**	-9.41	21.72	1.65	-0.30	6.46	1.33**	2.80
JG 16	44.78	1.83**	110.61**	16.35	1.61	3.50	7.68	1.77**	2.08
JAKI 9218	30.45	1.26**	77.77*	22.89	2.38	-0.67	6.16	1.07**	-0.42
JG 14	25.68	0.46	-5.12	23.59	1.92	-0.28	6.36	0.73*	-0.47
BG 372	37.56	1.40**	7.07	15.23	0.85	0.78	5.41	1.20**	0.55
DCP-92-3	32.61	1.53**	-3.21	12.02	0.56	-0.22	4.35	0.89*	-0.38
Pant G 186	23.19	0.31	20.89	12.98	-0.15	1.30	4.79	-0.22	2.99
Vaibhav (Ch.)	26.93	1.16**	26.99	23.27	0.86	-0.39	6.45	0.88*	1.79
Subhra	37.88	2.03**	14.46	30.07	-0.87	6.92**	9.51	1.99**	0.73
GCP 105	36.51	1.94**	78.42*	14.99	0.73	-0.05	7.23	2.05**	3.25
Indira Chana-1(Ch.)	23.60	0.36	7.78	22.62	1.15	0.10	6.36	0.81*	-0.31
RG-03-28	27.05	0.75	30.44	19.14	1.07	0.45	6.05	0.51	-0.32
JG 130	24.10	0.53	22.61	23.32	2.01	1.95	6.02	0.75*	0.77
JG 74	27.68	1.23**	-10.43	18.96	2.70	1.53	6.43	1.16**	0.25
Vijay	27.60	0.51	11.63	15.80	1.92	-0.56	4.06	0.22	-0.23
JG 315	34.96	1.10**	4.08	13.94	1.69	-0.52	5.96	0.85*	-0.80
GCP 101	33.36	1.22**	14.28	16.67	0.23	-0.06	6.48	1.14**	-0.79
JG 218	25.33	-0.02	399.78**	22.18	-1.14	1.05	4.12	-0.42	-0.57
JG 322	31.90	0.67	1.28	14.10	0.57	0.52	5.48	0.69	0.09
JGK 1	40.44	0.62	61.56*	24.09	0.65	-0.45	8.81	0.49	0.55
Population mean	**30.81**			**19.44**			**6.36**		

* Significant at 5 % level; ** Significant at 1 % level

Mean performance and stability of seed yield plant^{-1} (g)

Seed yield plant^{-1} varied from Vijay (4.06 g) to Subhra (9.51 g). Other genotypes having high mean over environment were JG 11 (7.22 g), Rajas (8.56 g), BGM 547 (6.46 g), JG 16 (7.68 g), JG 14 (6.36 g), Vaibhav (6.45 g), Subhra (9.51 g), GCP 105 (7.23 g), Indira Chana-1 (6.36 g), JG 74 (6.43 g), GCP 101 (6.48 g) and JGK 1 (8.81 g). (Table 3).For this character sixteen genotypes have the significant values for regression coefficient and no genotypes have the significant values for deviation from regression. Based on stability parameters of high mean value bi =1 and S^2 di =0, JG 14, Indira Chana-1, JG 74 and GCP 101 were found to be stable over the four environments. Rajas, JG 16, Subhra and GCP 105 showed high mean value than the populations mean and its regression coefficient (bi) was more than unity (bi > 1), showed that it was highly sensitive to environmental conditions. These stability parameters suggested that it was specifically adapted to favorable environments. JG 11, BGM 547, Vaibhav and JGK 1 were showed high mean value than their population mean and their regression coefficient (bi) was less than unity (bi < 1), suggested that they were least sensitive to environmental conditions, which indicated that they were specifically adapted to poor environments. Ten genotypes showed low mean value than their population mean with below average in stability (bi < 1), hence they were poorly adapted to all the environments. Similar finding were also reported earlier by Bakhsh *et al.*(2011), Rozina *et al.* (2011), Choudhary and Haque (2010), Tomar *et al.* (2010).

CONCLUSIONS

The genotype JG 11 was stable for primary branches plant^{-1} over all environments. GCP 101 was stable for biological yield plant^{-1}. Vaibhav, Indira Chana-1 and JGK 1 were stable for 100-seed weight. JG 14, Indira Chana-1, JG 74 and GCP 101were stable for seed yield plant^{-1} and JG 14 and JG 74 were stable for harvest index over all the environments.

ACKNOWLEDGEMENT

The authors are grateful to the All India Coordinated Research Project on Chickpea, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India for authentic guideline and valuable suggestion.

REFERENCES

Akhtar, L. H., Muhammad, A. and Muhammad, N. 2011. Genetic divergence and inter-relationship studies in chickpea (*Cicer arietinum* L.). Pakistan Journal of Agricultural Sciences 48(1): 35-39.

Anonymous, 2011. Project coordinator's report, All India Coordinated Research Project on chickpea. Indian Institute of Pulses Research, Kanpur, p-34.

Bakhsh,A., Malik, S. R., Masood, A., Iqbal, S. M., Akhtar, L. H. and Qureshi, R. 2011. Grain yield stability in chickpea (*Cicer arietinum* L.) across environments. Pakistan Journal of Botany 43(5): 2947-2951.

Burton, G. W. 1952. Quantitative inheritance in grass. *In:* Proc. 6th Inter. Grassland Cong. 1: 277- 283.

Choudhary, R. N., and Haque, M. F. 2010. Stability of yield and its components in chickpea (*Cicer arietinum* L.) for Chhotanagpur region. Legume Research 33(3): 164-170.

Eberhart, S. A. and Russell, W. A. 1966. Stability parameters for comparing varieties. Crop Science 6: 36-40.

Jayalakshmi, V., Jyothirmai, J., Reddy, A. T. and Reddy, C. K. K. 2011. Genetic variability for drought tolerant and yield traits in chickpea. Journal of Food Legumes 24(1): 33-35.

Johnson, P. L., Sharma, R. N., Nair, S. K. and Pandey, R. L. 2010. Contribution of important traits of rainfed chickpea (*Cicer arietinum* L.) for improving seed yield. Current Advances in Agricultural Sciences 2(2): 104-106.

Malik, S. R., Saleem, M., Iqbal, U., Zahid, M. A., Bakhsh, A. and Iqbal, S. M. 2011. Genetic analysis of physiochemical traits in chickpea (*Cicer arietinum* L.) seeds. International Journal of Agricultural Biology 13: 1033–1036.

Parameshwarappa, S. G., Salimath, P. M., Upadhyaya, U. D., Patil, S. S. and Kajjidoni, S. T. 2011. Genetic divergence under three environments in a minicore collection of chickpea (*Cicer arietinum* L). Indian Journal of Plant Genetics Resources 24(2): 177-185.

Rozina, H., Khan, H., Shahenshah, L. N., Munir, I., Arif, M., Khalil, I. A. and Khan, A. Z. 2011. Performance of chickpea genotypes under two different environmental conditions. African Journal of Biotechnology 10(9): 1534-1544.

Sharmaand L. K. and Saini, D. P. 2010. Variability and association studies for seed yield and yield components in chickpea (*Cicer arietinum* L.). Research Journal of Agricultural Sciences 1(3): 209-211.

Tomar, O. K., Singh, D. and Singh, D. 2010. Phenotypic stability for yield and its component in chickpea. Journal of Food Legumes 23(1): 79-81.