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Genetic variability studies in minicore collection of chickpea (*Cicer arietinum* L.) under different environments*

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Abstract : The present investigation was carried out on chickpea germplasm lines representing minicore collection obtained from ICRISAT, Hyderabad (A.P) for assessing genetic variability under three environments. Considerably high variability was observed for most of the productivity related traits in E_3 (irrigated 2005-06). Over all the environments, genotype ICC 6279 was found to be early flowering. For seed yield per plant, ICC 13124 was the only top yielder in all the three environments. The genotype ICC 13124 was found promising for earliness, large seed size and high yield per plant in all the environments suggesting that this accession is best suited for both rainfed and irrigated condition during the *rabi* season.

Key words: Chickpea, Genetic advance, Genetic variability, Heritability, Minicore

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crop of the semi arid tropics, particularly in the rainfed ecology and resource poor farmers of the Indian subcontinent, the Mediterranean region, the west Asian and North American region, Eastern Africa and Latin America. In the recent past, this crop has experienced an export-driven expansion in new niches such as Australia and Canada. Globally, chickpea is cultivated on about 8.6 million hectare area adding 6.78 million tonnes of grain to the global food basket, with an average productivity of 780 kg/ha (FAO,2009). India grows chickpea on about 6.1 million hectare producing 4.9 million tonnes seed, which represents 27% and 34% of the national pulses acerage and production respectively with an average productivity of 690 kg/ha. In Karnataka, it is grown on an area of 0.29 million hectare with a production of 0.14 million tonnes with an average productivity of only 478 kg/ha (Anon., 2009).

The variability for the characters of economic importance is the basic prerequisite for improvement. Lack of adequate variability has been implicated as one of the major limitation in improving the productivity of chickpea. There have been reports on genetic variability in chickpea but mostly based on limited number of germplasm lines (Sivakumar and Muthaiah, 2001). Upadhyaya and Ortiz (2001) developed chickpea minicore of 211 accessions that represent the core collection 1956 accessions (Upadhyaya *et al.,* 2002) and entire collection of about 17000 accessions at ICRISAT. A set of minicore of chickpea received from ICRISAT, Hyderabad which represents the whole range of variation of cultivated chickpea is an ideal material for assessing the exact nature of diversity, which helps in inferring about the extent of diversity in the entire collection and to determine how far it acts as limiting factors in improving productivity. Hence, the present investigation was carried out to gather information on variability under three different environments in minicore collections of chickpea for eight quantitative characters of economic importance.

Material and methods

The experimental material for the present study comprised of 203 chickpea germplasm lines from the minicore collection obtained from ICRISAT, Hyderabad (A.P). These lines were evaluated for assessing genetic variability under three environments (E_1, E_2 and E_3) for agronomic traits. Three experiments were conducted during rabi 2004-05 and 2005-06 under rainfed and irrigated situation at Genetics and Plant Breeding garden, College of Agriculture, Dharwad (longitude 75^0 07^1 E and latitude of $15^0$$26^1$N) in medium black soils in Augmented Block Design . Each genotype was grown in a single row of 4 m length with 30 cm spacing between rows and 10 cm with in the row. Recommended agronomic practices were followed for proper growth. In irrigated situation, two irrigations were provided one at flowering and other at pod formation stage. The observations were recorded on eight quantitative characters *viz.,* Days to 50 per cent flowering (DFF), Plant height (PLHT), Number of primary branches per plant (PB), Number of secondary branches per plant (SB), Number of tertiary branches per plant (TB), Number of pods per plant (PPP), 100 seed weight (SDWT) (g) and seed yield per plant (YPP) (g). The data collected were subjected for statistical analysis. The analysis of variance for different characters was carried out using the mean data in order to partition variability due to different sources by following Panse and Sukhatme (1961). In order to assess and quantify the genetic variability among the genotypes for the characters under study, estimated the genetic parameters such as genotypic coefficient of variability (GCV%), phenotypic co efficiency of variability (PCV%), heritability (h^2), genetic advance (GA) and genetic advance as per cent mean (GAM). Heritability in the broad sense was derived based on the formula given by Hansan *et al.* (1956). Genetic advance was obtained by the formula prescribed by Johnson *et al.* (1955). The method adopted by Burton and Devane (1953) was used to calculate phenotypic and genotypic co-efficient of variation.

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Results and discussion

Mean, range and environmental index for different quantitative traits in minicore collection of chickpea were depicted in Table 1. the results of the present investigation indicated the prevalence of significant differences among 203 genotypes studied during the three environments for all the eight characters (Table 2). A narrow differences was observed between PCV and GCV for days to 50 per cent flowering. These results are in conformity with the reports of Jeena and Arora (2001). The present finding suggests negligible influence of extraneous factors on this trait.

For the character plant height, narrow difference between PCV and GCV were recorded in all the three environments. Similar observations were made by Lawrence Daniel (2004). Narrow differences for PCV and GCV was recorded for the traits days to 50 % flowering and plant height indicating absence of environmental factor. A high PCV and GCV was estimated for the traits number of primary branches, secondary branches tertiary branches per plant, number of pods per plant and seed yield per plant. These observations are in accordance with the results of Patil (1996) and Jeena and Arora (2001).

The co-efficient of variation indicates only the extent of variability present for different characters and do not indicates the heritable portion. To obtain the heritable portion of variability, it is essential to compute the heritability estimates for different characters. Heritability values considered along with predicted genetic gain increases the reliability of the parameter as a tool in selection programme.

High heritability with moderate GAM was recorded for days to 50 per cent flowering in all the three environments. The results obtained in the present investigation suggest that high heritability with moderate GAM is the indication of presence of both additive and non-additive gene action operating for this character. High heritability with low GAM was recorded for plant height in all the three environments. Similar results were also reported by Chavan *et al.* (1994). High heritability with low GAM recorded for the traits in the present investigation indicated that they are controlled to greater extent by non-additive gene action. Low heritability coupled with low GAM was observed for primary branches per plant and secondary branches per plant in E1. Low GAM reflects higher influence of environment on this trait. High heritability with high GAM was recorded for tertiary branches, pods per plant,100 seed weight and seed yield per plant in all the environments suggesting this trait could be improved through simple selection. These results are in accordance with the findings of Patil (1996) and Sidramappa (2003). High heritability with high GAM is the indication of presence of additive gene action. These traits could be improved through simple selection.

In order to identify the elite lines the mean performance of

Table 1. Mean, range and environmental index for different quantitative traits in minicore collection of chickpea

Characters	Mean			Range			Environmental index		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
DFF	60.26	56.9	56.13	38 to 78	38 to 77	36 to 76	1.27	0.80	0.80
PLHT(cm)	37.19	39.96	48.34	28 to64	26to66	30 to69	2.23	1.51	1.65
PB	2.55	3.71	3.91	2 to 4	2 to 6	2 to 8	0.22	0.32	0.38
SB	14.17	8.81	10.07	8 to 18	5to 17	5 to 19	0.75	0.80	0.60
TB	18.87	17.08	30.23	11to28	6to40	9to34	0.95	1.30	1.38
PPP	91.05	114.35	126.78	21to162	25to182	27to200	4.06	9.54	7.65
SDWT(g)	16.28	17.40	18.58	9to38	11to36	13to39.9	0.53	0.45	0.69
YPP(g)	17.71	18.16	20.85	7to31	8to33	10to49	1.07	0.67	1.53

E_1-04-05 rainfed E_2-05-06 rainfed E_3-05-06 irrigated

Table 2. Genetic variability, heritability and genetic advance for seed yield and its component traits evaluated under rainfed condition during 2004-05, 2005-06 and irrigated condition during 2005-06.

Environments	Characters	Traits							
	under study	DFF	PLHT(cm)	PB	SB	TB	PPP	SDWT(g)	YPP(g)
E_1	GCV(%)	16.29	23.07	12.69	19.05	15.92	18.90	34.65	27.85
	PCV(%)	16.30	27.56	24.04	49.91	25.62	29.47	35.35	29.79
	h^2 (%)	99.87	70.07	27.87	14.57	38.61	41.13	96.07	87.36
	GAM(%)	99.54	39.80	13.73	14.98	20.37	24.97	69.97	53.63
E_2	GCV(%)	18.02	15.06	21.29	25.75	33.34	33.17	26.94	32.30
	PCV(%)	19.42	18.29	25.37	26.78	54.37	41.43	27.70	32.34
	h^2 (%)	86.10	67.83	70.46	99.80	37.62	64.08	94.59	89.75
	GAM(%)	34.44	25.55	36.82	55.06	42.13	54.70	53.99	66.46
E_3	GCV(%)	17.39	14.99	24.70	30.17	23.10	38.68	29.58	31.51
	PCV(%)	17.48	15.95	34.17	58.34	24.08	51.33	38.87	35.17
	h^2 (%)	98.68	88.24	52.26	26.74	92.40	56.78	57.90	80.29
	GAM(%)	35.65	29.00	36.79	32.13	45.66	60.03	46.35	58.18

the test entries for different traits with checks has been compared. Annigeri-1 and KAK-2 were used as check varieties. The genotype performing significantly higher than their checks in all the environments for various characters are presented in Table 3. Since chickpea is mainly grown as a rabi crop, the terminal water stress is gong to affect the yield potentiality of the crop. So one has to identify the genotypes which are early in flowering and maturity and hence they can escape the terminal drought condition. The lines which are early in flowering and maturity have been identified in three different environments (E_1, E_2 and E_3). E_1 had ten genotypes,E_2 had six genotypes and E_3 had nine genotypes which showed significantly early flowering.

Out of 203 genotypes 21, 19 and 17 genotypes expressed significantly higher pods per plant over check Annigeri-1 in E_1, $E_2$and E_3 respectively. ICC 14831 was found to be promising for pods per plant in both rainfed and irrigated condition suggesting that the genotype is fairly tolerant to drought. With regard to 100 seed weight, out of 203 genotypes 22, 21 and 18 genotypes had significantly higher seed weight over check A-1 in E_1, E_2 and E_3 respectively. ICC 8261, ICC 13357, ICC 16903, ICC 10341, ICC 13124, ICC 15406, ICC 2969, ICC 7315 and ICC 1915 are the top bold seeded genotypes ranging fro 23 g to 40 g in all the 3 different environment suggesting that their characteristic feature of bold seededness. In general, kabuli types had higher seed weight in the study.

For seed yield per plant 24, 22 and 17 genotypes showed significantly higher yield over check A-1 in E_1, E_2 and E_3 respectively. Out of these, ICC 13124 (31.25g, 32.85g and 32.95g) was the only top yielder in all the 3 environments. The genotype ICC 13124 is found to be promising for earliness, bold seed and yield per plant in all the environments suggesting that this entry is best suited for both rainfed and irrigated condition during rabi season.

Upadhyaya and Ortiz (2001) evaluated minicore consisting of 216 genotypes at ICRISAT, Hyderabad. The same set of genotypes except 13 have been evaluated in this study during 2004-05 to 2005-06 at Dharwad. It thus provides an opportunity to compare the performance of minicore at Dharwad and Hyderabad with the average of different years and the place in which they are evaluated (Table 4). Of the quantitative traits, a good correspondence was observed for mean, range and coefficient of variation between the studies at Dharwad and Hyderabad. Generally days to 50% flowering, plant height and maturity are environmentally influenced to a greater degree. Even for complex trait like yield per plant had a reasonably high degree of correspondence was observed particularly in respect of mean and coefficient of variation and to some extent in respect

Table 3. Promising accessions in respect of seed yield and its component traits identified based on the evaluation of chickpea minicore in three different environments

Characters	E_1	E_2	E_3
DFF	(<40 days): ICC 16903, 13357, 6279, 13124, 1882, 14669, 15888, 1164, 8318, JGK 1	(< 38 days): ICC 8058, 6279, 13124, 12824, 1882, 14669	(< 39 days): ICC 6279, 13124, 506, 11879, 15888, 6874, 1164, 1356, JGK 1
PPP	(> 153 pods): ICC 13523, 637, 10341, 1230, 6279, 12824, 3325, 4872, 13863, 15888, 14051, 1397, 3512, 7819, 12155, 3421, 6877, 6537, 3776, 2507, L 550	(>161 pods): ICC 14831, 6816, 2969, 5434, 4918, 14402, 10945, 2277, 13764, 12726, 1205, 9402, A-1, ICC 708, 1164, KAK-2, ICC 12328, 6293, 10399	(>169 pods): ICC 14831, 2969, 13124, 2065, 4182, 2720, 12866, 15264, 2580, 2263, 4463, 6571, 13816, 1710, 1052, 8318, 4567
Bold seeded	(Seed weight>24.0g): ICC 8261, 13357, 10341, 15406, 2969, 2242, 13124, 1923, 15518, 7315, 1915, 16261, 2919, 12947, 3512, 13219, 1164, KAK 2, 5879, 1356, 12492, JGK 1	(Seed weight>25.0g): ICC 16903, 8261, 13357, 10341, 15406, 13124, 1923, 7315, 1915, 16261, 13892, 2072, 456, 12947, 11284, 3512, 11627, 2720, 7272, 6263, 7554	(Seed weight>26.4g): ICC 16903, 8216, 13357, 10341, 15406, 2969, 13124, 7315, 1915, 16261, 2072, 12947, 1397, 3512, 11627, 1164, 7272, JGK 1
High yield	(>24.85g/plant): ICC 1230, 6279, 5504, 13124, 506, 7315, 13892, 15333, 12947, 11284, 3512, 13187, 6877, KAK 2, 12328, 6537, 15606, 2580, 5879, 5383, 1431, 1715, L 550, ICC 7554	(>26.5g/plant): ICC 16903, 15406, 6279, 2242, 13124, 4841, 14402, 15610, 13892, 2072, 2919, 12947, 13077, 13187, 12866, 2990, 9848, 67, 7867, 5135, 10399, 4533	(>30.4g/plant): ICC 637, 13124, 8195, 7308, 6816, 11879, 15888, 16796, 12947, 1510, 13524, 13219, 12866, 6877, 13816, 12928, 4533

Table 4. Mean, range and co efficient of variation for eight quantitative traits in minicore of chickpea

Trait	Mean		Range		Coefficient of variation(%)	
	Present study	Upadhyaya & Ortiz, 2001	Present study	Upadhyaya & Ortiz, 2001	Present study	Upadhyaya & Ortiz, 2001
DFF	60.3	62.2	38-78	33-82	16.30	14.21
PLHT(cm)	37.2	46.7	28-69	12.8-78.6	27.56	18.01
PB (no.)	2.55	2.89	2-4	0-6	24.04	82.96
SB(no.)	14.17	4.07	8-18	1.3-5.3	49.90	39.82
TB(no.)	18.87	2.28	11-28	0-7	25.62	80.69
PPP(no.)	91.1	83.3	21-162	13.3-247.3	29.47	45.34
SDWT(g)	16.28	17.21	9-38	8.3-57.2	35.35	44.54
YPP(g)	17.70	15.0	7-31	5.3-46.0	29.79	36.45

of range also. However for an important traits like yield per plant, pods per plant, seed weight and days to 50% flowering, it may be inferred that the expression of these traits was not very different than at Hyderabad. Thus it may be concluded that the minicore obtained from ICRISAT can be very well used as a source population for genetic and breeding investigation.

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