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Research Article

Pattern of diversity based on phenological and productivity traits in chickpea (C*icer arietinum* L.)

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Abstract:
One hundred twenty six Recombinant Inbred Lines (RILs) derived from a cross ICCV-2 x JG 62 along with six checks were evaluated to study the genetic divergence. Mahalonobis (1936) D^2 statistic analysis was used for assessing the genetic divergence among the RIL's involving phenological and yield component traits. The 132 genotypes formed 15 clusters and out of which 8 clusters were solitary suggesting the very diverse nature of 8 RILs from rest of the genotypes. But no distinct grouping of *desi* and kabuli types were observed indicating reasonably high degree of recombination between JG 62 and ICCV 2. The two solitary clusters, VIII and X showed their distinctiveness from the other groups as reflected by generally higher magnitude of inter cluster distance values of these two clusters with other clusters and are characterised by mean high pod number, seed yield and ideal duration of reproductive phase. As for degree of contribution of each character to divergence, the pods per plant contributed maximum (76.58%).

Key words:
Chickpea, RILs (Recombinant Inbred Lines), diversity, clusters, Duration of Reproductive Period (DRP), phenological traits, productivity.

Introduction

Among the important grain legumes, chickpea (*Cicer arietinum* L.) is the third most important pulse in the world after dry bean and dry pea. Chickpea holds great promise as a protein and calorie source for people in the developing countries. Chickpea straw has better forage value compared to other straws (Saxena,1987). Because of diversified uses of the crop and its ability to grow better with low inputs under edaphic and arid environments than many other crops, it is an important component of cropping systems of subsistence farming in the Indian sucontinent, Mediterranean region, the middle East and Africa. India has the distinction of being the largest chickpea producer in the world.

Limited or lack of genetic variability is important factor for the limited progress achieved in increasing the productivity of grain legumes including chickpea (Ramanujam, 1975). When the parents utilized in a cross are genetically similar, it is quite likely that the different lines derived reveals low diversity. On the contrary, when diverse parents are used in obtaining a segregating population, the derived lines reveal greater diversity despite sharing a common percentage (Katiyar, 1978). Variation created by hybridization is an important approach.

The extent of variation created however depends on the choice of parents thus making it very crucial. For realizing maximum diversity parents should be diverse. One such cross attempted was ICCV-2 x JG 62. The two parents involved in the cross are highly diverse. The cross was attempted at ICRISAT and RIL population was developed and supplied to Department of Genetics and Plant Breeding, UAS, Dharwad. The 126 RIL's showed very high variability for phenological traits and productivity traits as parents were diverse for these characters. The RIL's were evaluated in their 13^{th} generation and are highly uniform and stable. To achieve further gains it was felt that some of the RIL's in turn can be used as parents in hybridization programme particularly selecting lines showing variation for phenological traits including duration of reproductive period, the character which has been regarded as an important trait for productivity (Sidramappa, 2003). The RIL's were therefore assessed for diversity for phenological and productivity traits. The results obtained from this study are presented in this paper.

Material and methods

Material for the present study consisted of 126 recombinant inbred lines (RIL's) of the cross ICCV 2 x JG-62 in their 13^{th} generation. ICCV-2 is a kabuli

line with bold seeds, early in maturity and with broader leaf size. JG-62 is a *desi* cultivar with small seed size, medium late in maturity and smaller leaf size. The original cross was made at ICRISAT and material was supplied to Department of Genetics and Plant Breeding, Agricultural College, Dharwad. The experiment was conducted on conserved moisture in vertisol field in post rainy season of 2002-03 at University of Agricultural Sciences, Dharwad (15°25'N latitude and 70°26'N longitude at altitude of 678 m above mean sea level) in India. The experiment was laid out in Alfa design with two replications. Each plot consisted of two rows of 4 m length with a spacing of 30 cm between the rows and 10 cm between plants. Observations were recorded on five phenological traits (days to flower initiation, days to 50% flowering, days to pod initiation, days to physiological maturity and duration of reproductive phase) on plot basis. In each plot five competitive plants were selected randomly to record observations on seed yield / plant (g) and four of its component traits *viz.,* plant height, number of branches / plant, number of pods / plant and 100 seed weight (g). The mean values were used for statistical analysis. Mahalonobis (1936) D^2 statistic analysis was used for assessing the genetic divergence among the RIL's involving phenological and yield component traits. D^2 values were clustered using Tocher's method as described by Rao (1952).

Results and discussion

The 126 RIL's with two parents and four checks showed significantly high variation for all the phenological and productivity traits. The genotypes were subjected to diversity analysis. The 132 genotypes including 126 RIL's formed 15 clusters. Cluster-I accounted for maximum number of genotypes (49), clusters II, III and IV with 19, 16 and 20 genotypes respectively were also the major groups. Eight out of 15 clusters were solitary clusters suggesting the very diverse nature of these 8 RILs from the rest of the material (Table 1). But no distinct grouping of *desi* and kabuli types were observed. This in turn implies, reasonably high degree of recombination between JG 62 and ICCV 2, *desi* and kabuli parental lines involved in generating the RIL material. It also indicates the best possible introgression of *desi* germplasm into Kabuli germplasm and vice-versa.

The within group diversity as indicated by intra cluster distance values of clusters I, II, III, IV, V and VII was comparable though these groups contained different number of genotypes and it was relatively less in cluster XI. ICCV-2 and JG-62 fell in cluster III and V, respectively (Table 2). The *Kabuli* and *Desi* strains formed separate clusters due to the geographic diversity of the strains (Singh, 1973; Adhikari and Pandey, 1983). The intergroup distance of these two clusters was moderately low. However it should be noted that the distinctive nature of these two parents used in generating the RIL population is masked while computing means of the characters. The two checks *viz.,* Annigeri-1 and the local check showed high diversity as indicated by their allocation to two different clusters.

The two solitary clusters, VIII and X showed their distinctiveness from the other groups as reflected by generally higher magnitude of inter cluster distance values of these two clusters with other clusters. These clusters are characterised by mean high pod number, seed yield and ideal duration of reproductive phase (Table 3). The two clusters however differed with reference to seed size, days to pod initiation, days to flower initiation and days to 50 per cent flowering. These two clusters also showed very high distance from their parental clusters, further confirming their distinctiveness from parents. Cluster III which includes ICCV-2 showed very low mean values for different phenological traits viz: days to flower initiation (DF), days to 50% flowering (DFF), days to pod initiation(DP) and days to physiological maturity(DPM). However, cluster XIV was solitary formed by RIL No. 64 and was very late in maturity as evident by very high mean values for all the phenological traits. Chickpea is grown in post rainy season on receding soil moisture condition. Earliness is important for avoiding drought stress and at the same time the Duration of Reproductive Period (DRP) is also important criteria for realising high yields (Sidramappa, 2003). It has been found that DRP of 50-55 days is optimum. Therefore, earliness coupled with optimum DRP is important for realising higher yields. It is probably for this reason that the clusters VIII and X, which have these desirable traits, are high yielding clusters. To select parents for hybridization to achieve further gains in productivity, the genotypes of clusters VIII and X can be crossed with the genotype of cluster IX. RIL No. 23 of cluster VIII and RIL No. 15 of cluster X may be crossed with genotype of cluster IX to improve slightly the high seed size with an ideal combination of other characters. The genotypes of other clusters may be accordingly selected as parents in crossing programme to incorporate genes for characters for which they excelled in performance.

As for degree of contribution of each character to divergence, the pods per plant contributed maximum with some of the contribution from the phenological traits (Table 4). These results are in accordance with

the findings of Narendrakumar (1997). It may be due to the fact that almost all characters contribute to the pod number. It should be pointed out that pods per plant depends on the phenological traits particularly the duration of reproductive period.

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Table1: Clustering pattern of RILs of chickpea

Cluster No.	No. of entries			Entry numbers (RILs no.)
	Desi	Kabuli	Total	
I	30	19	49	1, 2, 4, 5, 6, 10, 11, 12, 13, 25, 34, 35, 36, 39, 40, 41, 43, 46, 47, 48, 49, 50, 51, 59, 61, 67, 69, 70, 78, 79, 85, 86, 88, 94, 97, 98, 101, 102, 104, 106, 108, 109, 111, 115, 118, 121, 124, 126, Local check
II	10	9	19	7, 16, 18, 19, 21, 27, 29, 38, 53, 55, 56, 60, 62, 71, 91, 92, 95, 96, 112
III	11	5	16	3, 9, 42, 45, 99, 105, 113, 114, 116, 117, 119, 120, 122, 123, ICCV 2, ICCV 96029
IV	12	8	20	8, 22, 24, 26, 31, 32, 33, 52, 68, 74, 75, 76, 77, 81, 83 84, 87, 93, 103, 107
V	6	2	8	37, 44, 57, 66, 72, 100, JG 62, Annigeri-1
VI	1	0	1	64
VII	7	3	10	14, 17, 20, 30, 63, 73, 80, 82, 89, 90
VIII	1	0	1	23
IX	0	1	1	65
X	1	0	1	15
XI	1	1	2	28, 130
XII	1	0	1	125
XIII	1	0	1	110
XIV	1	0	1	54
XV	1	0	1	58

Table 2: Inter and intra cluster distance values for fifteen clusters formed with ten quantitative characters in chickpea

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
I	**22.63**	40.83	40.50	39.96	32.84	27.47	67.92	87.91	32.89	91.45	47.82	46.36	64.54	45.99	50.92
II		**19.94**	71.19	32.24	48.97	54.79	40.05	64.31	38.51	63.13	64.30	73.53	90.54	40.05	78.68
III			**19.57**	68.16	41.89	27.94	100.55	118.72	54.03	123.92	46.54	27.51	42.33	66.44	33.34
IV				**19.74**	58.87	51.92	41.10	54.74	48.00	6.37	76.75	78.24	96.83	59.20	75.07
V					**22.82**	32.96	81.75	106.14	30.86	106.85	28.78	34.18	49.71	38.55	50.64
VI						**0.00**	83.47	102.12	35.38	107.32	46.94	35.42	55.55	57.89	31.57
VII							**21.21**	33.97	67.70	31.05	98.09	106.69	124.19	69.03	106.88
VIII								**0.00**	91.43	18.30	123.93	129.02	147.40	95.80	124.41
IX									**0.00**	93.32	49.43	53.00	71.44	48.02	62.04
X										**0.00**	122.89	131.52	148.84	91.17	129.20
XI											**14.27**	27.57	37.71	38.76	53.60
XII												**0.00**	21.08	57.92	36.14
XIII													**0.00**	68.55	48.66
XIV														**0.00**	**73.56**
XV															**0.00**

Note : Diagonal values indicate intra cluster distances ;Above diagonal values indicate inter cluster distances

Table 3: Cluster mean values for 10 different characters in chickpea

Chracters/ Clusters	PH	NB	DF	DFF	DP	DPM	NP	SW	SY	DRP
I	41.62	2.18	38.84	42.43	49.20	90.54	77.80	20.90	16.86	49.90
II	42.46	2.35	46.50	53.18	58.86	95.68	107.23	21.56	21.08	49.15
III	34.08	2.23	33.56	36.84	42.81	82.25	46.28	20.79	10.44	48.00
IV	38.48	2.21	31.87	37.20	45.15	87.70	110.10	19.40	21.52	54.05
V	44.69	2.12	46.81	53.06	61.06	95.75	63.31	23.28	14.90	48.93
VI	40.90	2.00	34.50	37.50	43.50	95.00	62.00	24.90	13.20	60.50
VII	44.30	2.32	43.05	46.75	53.95	94.50	140.55	20.39	27.77	51.45
VIII	40.20	2.20	33.00	36.00	40.50	88.00	162.50	21.13	28.08	55.00
IX	57.25	2.00	39.50	49.50	62.50	98.00	78.50	33.84	22.64	58.50
X	40.00	3.00	41.50	44.00	51.00	93.00	167.00	15.88	26.47	51.50
XI	36.75	2.20	55.75	60.75	66.75	97.25	48.75	17.17	12.11	41.50
XII	33.40	2.20	44.50	47.00	56.00	90.50	37.50	25.08	8.62	46.00
XIII	30.12	1.45	49.00	52.00	61.00	88.50	21.50	18.58	4.32	39.50
XIV	35.00	2.75	62.50	65.00	67.00	100.00	85.50	14.43	10.37	37.50
XV	22.00	2.20	30.00	33.00	47.00	98.00	43.00	14.57	5.86	68.00

PH - Plant height
NB - No. of branches per plant
DF - Days to initiation of flowering
DFF - Days for 50 per cent flowering
DP - Days to pod initiation
NP - Number of pods
DPM - Days to physiological maturity
DRP - Duration of reproductive period
SW - 100 seed weight
SY - Seed yield

Table 4: Degree of contribution of each character to divergence in chickpea

Character	Per cent contribution	Rank
Plant height	3.40	4
No.of branches / plant	0.00	10
Days to first flowering	2.72	5
Days to 50% flowering	3.59	3
Days to pod initiation	7.36	2
Days to physiological maturity	1.26	9
No. of pods/plant	76.58	1
100 seed weight	1.63	7
Seed yield / plant	1.90	6
Duration of reproductive phase	1.57	8