The Andhra Agric. J 58(3): 296-299, 2011

Genetic Diversity in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

One hundred and twenty nine genotypes of chickpea were assessed for genetic diversity utilizing ten physiological and yield attributes through Mahalonobis D^2 statistic. The genotypes were grouped into 11 clusters with D^2 values ranging between 9.69 and 23.56. Cluster I was the largest containing 54 genotypes followed by clusters II (25), VII (18), VI (14), III (12) and the remaining six clusters were one genotype each. The highest inter cluster distance was observed between clusters IX and XI followed by clusters V and VII and clusters V and IX. The maximum per cent contribution towards divergence was made by harvest index (45%) followed by number of pods (37.88%) and 100 seed weight (20.24%). Based on *per se* performance, genetic diversity and cluster means, genotypes ICCV 1083, ICCV 5135, ICCV 15264, ICCV 12028, ICCV 7308, ICCV 12328 and ICCV 5879 may be chosen for crossing programme for chickpea improvement.

Key words : Chickpea, Cluster Distance, Cluster Means, D^2 analysis, Genetic Divergence.

Chickpea is the third largest pulse crop in the world. India, the leading producer of chickpea produces 7.05 mt of chickpea annually from an area of 8.25 m.ha with productivity of 855 kg ha^{-1} (FAO, 2009). In Andhra pradesh, the area, production and productivity are 6.07 lakh ha, 8.57 lakh t and 1413 kg ha^{-1}, respectively. Among abiotic stresses, drought is the major limitation for realizing higher yields in chickpea. In breeding for drought situations, traits which confer yield under water limited conditions can be identified and used as selection criteria (Ludlow and Muchow, 1990). High root biomass, long and deep root system, small leaf lets are attributes showing significant association with drought tolerance whereas high harvest index, large number of pods per unit area and high grain mass along with early maturity are associated with drought escape (Saxena, 1987). Despite the recognition of the importance of the root characteristics, large scale breeding programmes for the root characteristics improvement in chickpea has been limited due to the lack of knowledge on the genetic diversity and genetics of root characteristics (Saxena, 2003). Hence, the present investigation was taken up to study the genetic diversity among parental lines for important traits contributing to superior performance under drought situations.

MATERIAL AND METHODS

A collection of 129 chickpea genotypes maintained at Regional Agricultural Research Station, Nandyal were evaluated in a randomized block design with two replicates during *rabi* 2007-08. Each plot consisted of a single row of each genotype of 4m length with inter and intra row spacing of 0.3m and 0.1m, respectively. Recommended agronomic practices were followed to raise a good crop. Five randomly selected competitive plants from each row were used for recording of data on days to 50% flowering, days to maturity, plant height, number of branches, number of pods, root length, shoot biomass, seed yield, 100 seed weight and harvest index. The genetic diversity was assessed utilizing Tochers method using Mahalanobis D^2 statistic (Rao, 1952).

RESULTS AND DISCUSSION

Analysis of variance revealed significant mean square estimates for all the characters indicating sufficient diversity among 129 genotypes studied. Based on divergence and magnitude of D^2 values, 129 genotypes were grouped into 11 clusters (Table 1). The distribution of different genotypes revealed that cluster I had maximum number of genotypes (54) followed by cluster II (25), VII (18), VI (14), III (12) and remaining clusters were unique with one genotype in each of them.

The maximum inter cluster distance were recorded between clusters IX and XI (D^2 = 23.56) followed by V and VII (D^2=22.16) and V and IX (22.04) and the genotypes from these clusters can be expected to exert desirable segregants when crossed. On the contrary, cluster I and cluster V had shown the lowest degree of divergence indicating

Table1. Clustering of 129 chickpea genotypes by Tocher's method.

Cluster No.	No. of genotypes	Genotype(s)
I	54	ICCV 15567, ICCV 5383, ICCV 15618, ICCV 4872, ICCV 16915, ICCV 6811, ICCV 14831, ICCV 10393, ICCV 8607, ICCV 4948, ICCV 8621, ICCV12824, ICCV 13863, ICCV 12726, ICCV 12307, ICCV 6874, ICCV4495, ICCV 15610, ICCV 15996, ICCV 15612, ICCV 16524, ICCV 15888, ICCV 10945, ICCV 11378, ICCV 7950, ICCV 6816, ICCV 8318, ICCV 867, ICCV 1194, ICCV3362, ICCV 12866, ICCV 1098, ICCV 2263, ICCV 1422, ICCV95, ICCV 5878, ICCV 1398, ICCV 456, ICCV 7441, ICCV 9755, ICCV 1397, ICCV1205, ICCV 14815, ICCV 9942, ICCV 637, ICCV 14799, ICCV67, ICCV 5639, ICCV 15606, ICCV 4567, ICCV 1923, ICCV 3325, ICCV 16903, ICCV 2065.
II	25	ICCV 3512, ICCV 4814, ICCV 5845, ICCV 15802, ICCV 4639, ICCV 1431, ICCV 1510, ICCV 3776, ICCV 9862, ICCV 3761, ICCV 8855, ICCV 1180, ICCV 9895, ICCV 7184, ICCV 4973, ICCV 12155, ICCV 13461, ICCV 4593, ICCV 13524, ICCV 16261, ICCV 16374, ICCV 4182, ICCV 2884, ICCV 12916, ICCV 3631.
III	12	ICCV 14402, ICCV 14669, ICCV 9002, ICCV 4533, ICCV 14098, ICCV 16269, ICCV 13219, ICCV 5434, ICCV 1392, ICCV 1882, ICCV 6802, ICCV 14051.
IV	1	ICCV 11944
V	1	ICCV 1083
VI	14	ICCV 11498, ICCV 10399, ICCV 12851, ICCV 4918, ICCV 283, ICCV 2969, ICCV 1230, ICCV 14595, ICCV 16207, ICCV 4463, ICCV 11124, ICCV 1710, ICCV 506, ICCV 12968.
VII	18	ICCV 15294, ICCV 15333, ICCV 7272, ICCV 7308, ICCV 12328, ICCV 15264, ICCV 13124, ICCV 7255, ICCV 12028, ICCV 7668, ICCV 10755, ICCV 6263, ICCV 7315, ICCV 13523, ICCV 8350, ICCV 15406, ICCV 15435, ICCV 9137.
VIII	1	ICCV 8740
IX	1	ICCV 5135
X	1	ICCV 6571
XI	1	ICCV 5879

Table 2. Average intra and inter cluster distances (D^2 values) of 129 chickpea genotypes.

Cluster No.	1	2	3	4	5	6	7	8	9	10	11
I	**7.82**	11.33	10.27	9.81	9.69	10.50	17.63	15.53	15.80	11.83	14.67
II		**8.98**	11.53	11.38	16.52	14.49	15.00	12.39	11.56	14.41	16.60
III			**8.31**	14.64	13.93	14.46	16.48	11.70	14.62	13.20	17.47
IV				**0.00**	12.23	10.61	19.43	18.73	14.64	13.10	14.33
V					**0.00**	10.11	22.16	20.98	22.04	14.22	15.17
VI						**11.19**	20.19	19.41	19.79	13.91	14.03
VII							**11.06**	15.46	18.81	21.75	19.91
VIII								**0.00**	14.75	18.48	19.85
IX									**0.00**	17.40	23.56
X										**0.00**	18.48
XI											**0.00**

Bold and diagonal values indicate intra-cluster distances.

close resemblance between them. In a recent study, large genetic diversity was observed for root characteristics in chickpea minicore germplasm collection (n=211) (Kashiwagi *et al.*, 2005) that represents considerable diversity of the entire chickpea germplasm collection held at ICRISAT (n=16,991) (Upadhyaya and Ortiz, 2001).

As far as the cluster means are concerned, higher mean value for number of pods was recorded in cluster V (40.2) followed by cluster XI (37.1) and cluster III (36.05). Clusters V (10.6 cm), III (9.44 cm) and X (9.25 cm) recorded higher mean values for root length where as clusters XI (22.1 g), VII (13.41 g) and VI (12.43 g) recorded high mean shoot biomass. Higher seed yield was observed in clusters VI, X and VII (6.61, 6.5 and 5.8 g plant^{-1} respectively). For 100 seed weight, higher clusters mean values were observed in clusters VII (29.15 g), V and VIII (16.5 g). Cluster IX recorded higher harvest index (70%) followed by X (65%) and III clusters (58%). The maximum per cent contribution towards divergence was recorded by harvest index (45%) followed by number of pods (37.88%) and 100 seed weight (20.24%). Similar findings were reported by Dwevedi and Gaibriyal (2009) in twenty five genotypes of chickpea where as Lokare *et al.* (2007) reported number of pods per plant, 100 seed weight and seed density as major forces of differentiation in 60 chickpea genotypes. The contribution made by the other characters in the study was comparatively low ranging from root length (1.82%) to shoot biomass (7.8%).

Thus in the present study, chickpea genotypes exhibited a distinct and wide spread clustering pattern there by indicating huge amount of genetic divergence and heterogeneity. The variation observed here may be due to differential adoption of selection criteria, selection pressure and erratic changes in environment and distantly exchange of germplasm by researchers. Based on the genetic distances and clustering pattern and *per se* performance hybridization programme may be initiated involving genotypes of clusters V, VII, IX and XI. The genotypes ICCV 1083, ICCV 5135, ICCV 15264, ICCV 12028, ICCV 7308, ICCV 12328 and ICCV 5879 from these clusters and also the genotypes from clusters comprising only one genotype with specific traits could be used in crop improvement programmes.

Table 3. Cluster means and contribution to total divergence of ten physiological and yield attributes in chickpea.

Cluster No.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branc-hes	No.of pods	Root length (cm)	Shoot biom-ass (g)	Seed yield (g)	100 Seed weight (g)	Harvest Index (%)
I	58.45	96.57	29.24	14.11	29.22	8.72	10.49	5.43	16.06	52
II	65.18	103.30	35.32	13.89	19.63	8.97	11.13	5.17	15.58	48
III	52.17	92.38	28.43	12.33	20.57	9.44	9.54	5.25	16.17	58
IV	71.00	109.50	29.40	14.20	32.10	8.60	12.00	5.55	14.00	50
V	53.50	90.00	27.90	13.85	40.20	10.60	10.40	5.40	16.50	50
VI	59.29	98.50	32.40	17.09	36.05	8.53	12.83	6.61	15.79	52
VII	63.36	100.11	40.77	13.49	15.66	8.74	13.41	5.80	29.15	45
VIII	49.00	101.00	39.90	12.00	10.00	8.35	10.05	2.90	16.50	30
IX	73.50	108.50	26.60	7.40	9.70	7.55	6.30	4.45	11.00	70
X	59.00	100.50	20.60	29.20	29.20	9.25	10.30	6.50	13.50	65
XI	56.00	95.50	37.10	19.60	37.10	8.30	22.10	5.30	17.00	25
Contribution to total divergence (%)	17.67	5.03	3.92	2.29	37.88	1.82	7.80	2.91	20.24	45

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(Received on 02.08.2010 and revised on 06.09.2011)