LR-3959
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Legume Research,
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.legumeresearch.in

Genetic diversity studies among chickpea (*Cicer arietinum* L.) genotypes under rainfed and irrigated conditions for yield attributing and traits related to mechanical harvesting

B. Vishnu*, V. Jayalakshmi and M. Sudha Rani

Regional Agricultural Research Station,
Nandyal-518 503, Kurnool (Dist.), Andhra Pradesh, India.
Received: 03-11-2017 Accepted: 03-01-2018 DOI: 10.18805/LR-3959

ABSTRACT

Genetic diversity among 30 chickpea genotypes was assessed for yield attributing and traits related to mechanical harvesting during *rabi* 2016-17 under both rainfed and irrigated conditions as separate experiments. The genotypes were grown in randomized block design (RBD) with three replications. Genetic diversity study grouped 30 chickpea genotypes into five different clusters under both the tested environments. Days to 50 per cent flowering followed by days to maturity and 100 seed weight contributed maximum towards diversity under rainfed as well as irrigated conditions. Inter cluster average D^2 values stretched between 7.42 and 20.11 under rain fed condition, while it was slightly higher and varied from 8.64 to 28 under irrigated condition. The most divergent clusters were IV and V under both the situations. The traits that are suitable for mechanical harvesting particularly, height of the first pod and plant height contributed more (8.3 per cent and 8.1 per cent respectively) towards the genetic divergence under irrigated than under rainfed condition (3 per cent and 5.5 per cent respectively). While the angle of the primary branch couldn't show any influence on the divergence under both the tested environments. Promising genotypes with suitable traits for mechanical harvesting besides having yield advantage are'NBeG 780', 'NBeG 857', 'NBeG 47', 'NBeG 863' and 'BG 3061' of cluster I under rainfed and cluster II under irrigated, 'GBM 2' of cluster II in rainfed and cluster I in irrigated, 'ICCL 85213' and 'NBeG 865' of cluster III under rainfed, 'DBGV 3104' of cluster I under rainfed and 'GL 12021' of cluster V under both rainfed and irrigated are suggested for utilization in the crossing programs to breed varieties of chickpea for high yield with amenability to combine harvesting.

Key words: Amenability, Clusters, *Harimanthaja*, Mechanization, Segregants and supplemental irrigation.

INTRODUCTION

Globally chickpea is the second most important pulse crop occupying 14.80 million ha of area with 14.23 million tons of production (FAO STAT, 2016). Chickpea is one of the major pulses cultivated in India. It has high nutritional value and can be a best supplement for meat. Though it is said to have a history of 7500 years during which its remnants were found in Middle East, its Sanskrit name *Harimanthaja* indicates that it is being cultivated in India from the times immemorial. India is the largest producer and consumer of chickpeas in the world with cultivable area of 8.84 million ha and 8.29 million tons of production (http://dpd.dacnet.nic.in/). The scenario of chickpea cultivation in India has drastically changed during last 4-5 decades. There has been impressive growth in area, production and productivity of chickpea in South India. Andhra Pradesh is also an important chickpea growing state with 6 per cent chickpea area of the country and has witnessed chickpea revolution with fast increase in area from 71,000 ha in 1992-93 to 6.3 lakh ha during 2007-08 registering the highest productivity in India (1448 kg ha^{-1}).This is because of the introduction and adaptation of short duration varieties with *Fusarium* wilt resistant such as 'JG 11', 'JAKI 9218' and 'KAK 2'apart from mechanization of most of the farming operations.

Shortage of labour necessitated seed to seed mechanization in chickpea. Farmers are adapting custom hiring of farm machines and implements to cultivate chickpea. But, most of the existing popular chickpea varieties grown in India are short statured with an average plant height 35.0-45.0 cm and semi-spreading growth habit and thus these are not suitable for mechanical harvesting. So, especially in South India, there is a necessity to develop chickpea cultivars with 30 to 40 per cent more height than the existing types and semi-erect to erect growth habit having fruiting zone starting at about 30.0 cm from the ground. During *rabi*, chickpea is grown under receding soil moisture conditions and rarely one or two rains are received during crop growth period. Chickpea is usually subjected to moisture stress due to low rainfall and it responds favourably to supplemental irrigation (Singh, 1980, Raghu and Choubey, 1983). Chickpea is being cultivated under protective irrigation in some areas of Andhra Pradesh even as alternative to commercial crops like cotton and tobacco. The yield

*Corresponding author's e-mail: badabagnivishnu@gmail.com

realisation under protective irrigation is very high yield up to 2.5 to 3.0 t per ha. In this context, the study of chickpea varieties for the traits suitable for mechanical harvesting under irrigated condition (supplemental irrigation) has also gained importance.

MATERIALS AND METHODS

The experiment was conducted at Regional Agricultural Research Station, Nandyal with 30 chickpea genotypes during *rabi* 2016-17 in randomized block design (RBD) with three replications under rainfed and irrigated conditions (two supplemental irrigations were given at 35 and 55 days after sowing). Each genotype was sown in a single row in a plot of 4m row length at a spacing of 30 cm between rows and 10 cm between plants within the row. Observations were recorded on 14 traits *viz*., angle of the primary branch (^{0}), height of the first pod (cm), plant height (cm), days to 50 per cent flowering, days to maturity, number of primary branches, number of secondary branches, SPAD Chlorophyll Meter Reading, number of pods per plant, shoot biomass (g), harvest index (%), seed yield (g), 100 seed weight (g) and protein content (%). Data were subjected to divergence analysis using Mahalanobis D^2 statistic (1936) and the genotypes were grouped into different clusters according to Tocher's method as described by Rao (1952).

RESULTS AND DISCUSSION

Genetic diversity among the parents is a prerequisite for ensuring the chances of selecting improved segregants for various characters (Dwevedi *et al*., 2009). The success of hybridization in highly self-pollinated crops like chickpea mainly depends on the genetic diversity of the parents. Mahalanobis D^2 statistic was found to be a potential tool in quantifying the degree of divergence in germplasm collections of crop plants.

Clustering of thirty chickpea genotypes using Tocher's method (Singh and Chaudhary, 1977) grouped them into five clusters each under both the tested conditions and the distribution of the genotypes into clusters is presented in Tables 1 and 2. Under rainfed condition, cluster I had maximum number of genotypes (15) followed by cluster II and cluster III with seven and six genotypes each respectively, while the clusters IV and V had one genotype each. However, under irrigated condition, cluster II was comprised of more number of genotypes (17) followed by cluster I with 10 genotypes, while, clusters III, IV and V were solitary, with one genotype each. Two genotypes 'JG 11' and 'GL 12021' were commonly distributed under both the conditions in clusters IV and V respectively as these genotypes exhibited similar trend for mean performance under both the tested environments.

Under rainfed condition (Table 3), cluster I recorded higher mean performance for four traits *viz*., angle of the primary branch (74.8^0), shoot biomass (218.58 g), seed yield (111.26 g) and 100 seed weight (32.54 g). The average performance of number of pods per plant (26.86) was high in cluster II, while, for number of primary branches per plant (5.56) high mean value was recorded in cluster III. High mean values for number of secondary branches per plant (8.33), SCMR (60.5) and harvest index (56.77 per cent) were noticed under cluster IV. Height of the first pod (45.0 cm), days to 50 per cent flowering (63 days), days to maturity (102 days), plant height (58.87 cm) and protein content (23.03 per cent) had higher cluster means in cluster V.

Under irrigated conditions (Table 4), high cluster mean for number of secondary branches (9.33) and number of pods per plant (25.47) were recorded in the genotypes of cluster I. The traits angle of the primary branch (75.92^0), shoot biomass (272.81 g), seed yield (143.37 g) and 100 seed weight (30.11 g) had high cluster means in cluster II. Higher SCMR values (62.67) were seen in genotypes of cluster III. Cluster I had genotypes with high cluster means for harvest index (58.17 per cent) and protein content (19.93 per cent). Genotypes of cluster V were noticed to have high cluster means for height of the first pod (43.53 per cent),

Table 1: Distribution of 30 genotypes of chickpea into different clusters under rainfed condition during *rabi* 2016-17

Cluster	Number	Number of genotypes	Genotype(s)
I	15		RVSSG 40, DBGV 3205, NBeG 03105, NBeG 863, DBGV 3104, NBeG 49, NBeG 855, NBeG 47, JAKI 9218, NBeG 857, NBeG 780, ICCV 13114, NBeG 1006, RVSSG 39, BG 3061
II	7		NBeG 1007, RCBM 3, Phule G 08108, RVSSG 8102, ICCV 07112, DBGV 104, GBM 2
III	6		ICCL 85213, H 13-02, NBeG 1009, IPC 2012-30, NBeG 865, NBeG 1005
IV	1		JG 11
V	1		GL 12021

Table 2: Distribution of 30 genotypes of chickpea into different clusters under irrigated condition during *rabi* 2016-17

Cluster	Number	Number of genotypes	Genotype(s)
I	10		NBeG 865, NBeG 1005, NBeG 1007, NBeG 1009, IPC 2012-20, , RVSSG 8102, ICCL 85213, DBGV 104, H 13-02, GBM 2
II	17		DBGV 3205, NBeG 49, DBGV 3104, RVSSG 40, RVSSG 39, NBeG 857, NBeG 03105, NBeG 855, NBeG 1006, NBeG 47, BG 3061, NBeG 780, Phule G 08108, JAKI 9218, NBeG 863, RCBM 3, ICCV 13114
III	1		ICCV 07112
IV	1		JG 11
V	1		GL 12021

Table 3: Cluster means for 14 characters in 30 chickpea genotypes under rainfed condition during *rabi* 2016-17

Cluster Number	APB	HFP	DF	DM	PH	NPB	NSB	SCMR	NPP	SHB	HI	SY	100SW	Protein
I	74.8	32.69	35.58	81.33	52.28	3.16	7.29	60.46	26.62	218.58	51.87	111.26	32.54	21.51
II	73.76	31.23	44.52	87.81	49.73	4.33	5.81	60.23	26.86	166.89	49.72	79.5	25.67	19.72
III	73.67	39.13	56.67	91.22	54.11	5.56	6.06	58.09	25.28	190.21	45.44	86.56	25.5	21.76
IV	73.67	23.13	34	74.67	35.8	2.67	8.33	60.5	22.67	133.67	56.77	75.83	27.83	19.37
V	73.33	45	63	102	58.87	4.67	5	55.8	18.33	106.67	31.4	33.5	17.17	23.03

APB=Angle of primary branch, HFP=Height of the first pod, DF=Days to 50% flowering, DM=Days to maturity, PH=Plant height, NPB=Number of primary branches, NSB=Number of secondary branches, SCMR=SPAD Chlorophyll meter readings, NPP=Number of pods per plant, SHB=Shoot biomass, HI=Harvest Index, 100SW=100Seed weight, Protein=Protein content

Table 4: Cluster means for 14 characters in 30 chickpea genotypes under irrigated condition during *rabi* 201-17

Cluster Number	APB	HFP	DF	DM	PH	NPB	NSB	SCMR	NPP	SHB	HI	SY	100SW	Protein
I	73.97	33.51	52.87	99.27	51.43	3.17	9.33	55.69	25.47	250.42	52.88	131.03	25.05	19.91
II	75.92	30.84	36.8	88.75	51.3	2.29	7.61	59.1	23.51	272.81	53.23	143.37	30.11	19.63
III	74.67	27.8	48.67	102	43.53	2.67	6	62.67	23	227.03	51.93	118.33	22	16.77
IV	75.67	22.53	34	82.67	34.67	2	7	57.67	20.67	202.83	58.17	119.17	28	19.93
V	68.67	43.53	65	112.33	54.93	4.67	6.67	52.57	14.33	137.33	52.17	71.5	19	16.3

APB=Angle of primary branch, HFP=Height of the first pod, DF=Days to 50% flowering, DM=Days to maturity, PH=Plant height, NPB=Number of primary branches, NSB=Number of secondary branches, SCMR=SPAD Chlorophyll meter readings, NPP=Number of pods per plant, SHB=Shoot biomass, HI=Harvest Index, 100SW=100Seed weight, Protein=Protein content

days to 50 per cent flowering (65 days), days to maturity (112.33 days), plant height (54.93 cm) and number of primary branches per plant (4.67). To create variability, inter crossing between the genotypes with high cluster means followed by effective selection is required.

The average intra and inter cluster D^2 values of various characters are furnished in Tables 5 and 6.The inter cluster average D^2 values stretched between 7.42 and 20.11 under rainfed condition(Table 5). The maximum inter cluster and intra-cluster distance under rainfed condition were observed between cluster IV and V (20.11) and cluster III (6.24) respectively. Under irrigated condition, the range of inter cluster average D^2 values was 8.64 to 28.58. The maximum inter cluster and intra-cluster distances was observed between cluster IV and V (28.58) and cluster I (7.19) respectively stating that the genotypes of these clusters are more divergent. Hybridization between the genotypes of the clusters (IV and V, I and V, III and IV and I and III under rainfed, IV and V, II and V, I and IV, III and V and I and II under irrigated) having maximum inter cluster distances would result in high heterotic expression for yield components. Superior recombinants can be obtained by using the genotypes from these clusters under respective conditions as parents in hybridization program. Maximum intra cluster distance indicated the presence of greater diversity among the genotypes allocated in those respective clusters. Greater intra-cluster distance was recorded under irrigated condition indicating better expression of the genotypes.

The number of times that each of the 14 characters appeared in first rank and its respective per cent contribution towards the diversity under rainfed and irrigated conditions was studied(Table 6).Days to 50 per cent flowering contributed maximum towards diversity (44.4 per cent in rainfed situation and 46 per cent in irrigated situation) by ranking 193 and 200 times under rainfed and irrigated conditions respectively followed by days to maturity (rainfed: 18.9 per cent by first rank 82 times; irrigated: 11.3 per cent by ranking first for 49 times) and 100 seed weight (rainfed: 9.7 per cent ranked first for 42 times; irrigated: 9.2 per cent by ranking first for 40 times). The greater contribution of days to 50 per cent flowering for divergence is also reported by Jayalakshmi and Ronald (2011), Pandey *et al.* (2013), Jayalakshmi *et al.* (2014), Sachin *et al.* (2014), Anita *et al.* (2015) and Jayalakshmi *et al.* (2016).

The contribution of height of the first pod and plant height contribution was (8.3 per cent and 8.1 per cent respectively) more under irrigated than under rainfed condition (3 per cent and 5.5 per cent respectively) towards the total divergence. While the angle of the primary branch didn't show any influence on divergence in either situation.

Improvement of traits related to mechanical harvest: The genotypes from cluster I ('NBeG 1006' and 'NBeG 47') under rainfed condition and the genotypes of cluster II ('NBeG 1006', 'NBeG 47', 'NBeG 780' and 'NBeG 855') under irrigated condition for angle of the primary branch, genotype 'GL 12021' of cluster V under under both the conditions for height of the first pod as well as for plant height might be selected for a breeding programme which is aimed at the development of genotypes suitable for mechanical harvesting.

Improvement of traits related to seed yield: For improvement of seed yield under rainfed condition, genotypes of clusters III ('NBeG 865', 'IPC 2012-30' and 'ICCL 85213') with high mean values for number of primary branches per plant and genotype 'JG 11' of cluster IV with high mean values for number of secondary branches per plant, SCMR and harvest index might be chosen. The genotypes *viz.*, 'NBeG 857', 'NBeG 863', 'NBeG 03105', 'BG 3061', 'RVSSG 40' and 'ICCV 13114'from cluster I with high *per se* performance for seed yield could also be involved in hybridization programme.

Similarly, under irrigated condition, the genotype 'GL 12021' of cluster V with more number of primary branches, genotypes of cluster I ('IPC 2012-30', 'GBM 2', 'NBeG 865' and 'DBGV 104') with high mean values for number of secondary branches and number of pods per plant, genotypes of cluster II ('BG 3061', 'NBeG 863', 'NBeG 03105', 'RVSSG 39', 'DBGV 3104', 'ICCV 13114', 'NBeG 49', 'JAKI 9218' and 'NBeG 47') with high mean values for shoot biomass and 100 seed weight and genotype 'JG 11' of cluster IV with high harvest index and genotypes of cluster II ('RVSSG 39') can be useful in breeding for higher seed yield.

Traits related to mechanical harvest and seed yield: Promising genotypes with high yield and traits suitable for mechanical harvesting from divergent clusters are 'NBeG 780', 'NBeG 857', 'NBeG 47', 'NBeG 863' and 'BG 3061'from cluster I in rainfed and cluster II in irrigated, 'GBM 2' of cluster II in rainfed and cluster I in irrigated, 'ICCL 85213' and 'NBeG 865' of cluster III in rainfed,

Table 5: Average inter and intra cluster distances in 30 chickpea genotypes under rainfed condition during *rabi* 2016-17

Cluster	I	II	III	IV	V
I	4.63	7.42	12.12	7.75	17.52
II		5.4	9.02	9.06	13.45
III			6.24	15.43	8.57
IV				0	20.11
V					0

Table 6: Average inter and intra cluster distances in 30 chickpea genotypes under irrigated condition during *rabi* 2016-17

Cluster	I	II	III	IV	V
I	7.19	13.75	8.64	18.51	12.79
II		6.62	11.01	9.86	23.56
III			0	13.03	16.24
IV				0	28.58
V					0

'DBGV 3104' of cluster I under rainfed and 'GL 12021' of cluster V under both rainfed and irrigated are suggested to be utilized in crossing programs to breed for high yield with amenability to combine harvesting.

REFERENCES

Anita, B. Suneeta, P. and Rachana, S. (2015). Genetic studies on chickpea genotypes grown in late sown under rice fallow conditions of Madhya Pradesh. *Electronic Journal of Plant Breeding*. **6**: 738-748.

Dwevedi, K.K. and Gaibriyal, M.L. (2009). Assessment of genetic diversity of cultivated chickpea (*Cicer arietinum* L.). *Asian Journal of Agricultural Sciences*. **1**:7-8.

FAO, Stat. (2016). *FAO Statistical Year book*. Food and Agriculture Organization of the United Nations. Available from: http://www. faostat.fao.org.

Jayalakshmi, V. and Ronald, G.R. (2011). Assessment of genetic diversity for quantitative traits in chickpea (*Cicer arietinum* L.). *Journal of Research ANGRAU*. **39**: 58-61.

Jayalakshmi, V., Ronald, R.G. and Lakshmanna, K. (2014). Diversity analysis of chickpea germplasm in scarce rainfall zone of Andhra Pradesh, India. *Journal of Legume Research*. **37** : 682-684.

Jayalakshmi, V., Kiran Kumar Reddy, C., Jyothirmayi, G. and Trivikram Reddy, A. (2016). Studies on genetic diversity in chickpea utilizing morphological and total protein markers. *Journal of Legume Research*. **39**: 323-325.

Mahalanobis, P.C. (1936). On the generalized distance in statistics. *Proceedings of National Academy of Sciences in India*. **2**: 49-55.

Pandey, A., Gupta, S., Kumar, A., Thongbam, P.D. and Pattanayak, A. (2013). Genetic divergence, path coefficient and cluster analysis of chickpea (*Cicer arietinum* L.) cultivars, in the mid-altitudes of Meghalaya. *Indian Journal of Agricultural Sciences*. **83** : 1300-1304.

Raghu, J.S. and Choubey, S.D. (1983). Response of gram to irrigation and fertilization. *Indian Journal of Agronomy*. **28**: 239–42.

Rao, C.R. (1952). *Advanced Statistical Methods in Biometrical Research*. John Wiley and sons Inc. New York, pp. 236-272.

Sachin, D., Parh,e P.N., Harer. sand Nagawade, D.R. (2014). Investigation of genetic divergence in chickpea (*Cicer arietinum* L.) genotypes. *The Bioscan*. **9**: 879-882.

Singh, R.K. and Chaudhary, B.D. (1977). *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers, New Delhi, p.252.

Singh, R.C., Faroda, A.S. and Sharma. (1980). Response of gram to irrigation and fertilization. *Indian Journal of Agronomy*. **25**: 239–243.