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Genetic Diversity Studies in Chilli (*Capsicum annuum* L.) Genotypes under Eastern Dry Zone of Karnataka

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ABSTRACT: Genetic divergence among the available germplasm is vital to a plant breeder for an efficient choice of parents for hybridization, hence studies on genetic diversity was conducted with 63 chilli (*Capsicum annuum* L.) genotypes at the Horticultural Research and Extension Centre, Hogalagere, Kolar, Karnataka, India during *kharif* 2020. The Mahalanobis D^2 statistics were used to investigate genetic divergence among 63 genotypes. On the basis of genetic distance, these genotypes were broadly grouped into nine clusters. Cluster I and cluster IV had the maximum genotypes with 16, followed by cluster-II with 13 genotypes, cluster V with 8 genotypes and cluster VI, VII, VIII and IX each had one genotype. Among the different characters studied, green fruit yield per plant (20.00%) contributed the most to the total genetic diversity among the genotypes, followed by average green fruit weight (11.00%), number of fruits per plant (10.81%), dry fruit yield per plant (9.00%) and fruit length (8.00%). The maximum inter-cluster distance was recorded to be 1160116.00 between cluster VIII and cluster IX. Cluster V showed the maximum intra-cluster distance (38452.32). The genotypes belonging to the clusters with the maximum inter-cluster distance are genetically more divergent and these genotypes could be used in hybridization programmes to obtain promising segregants.

Keywords: Chilli, genetic diversity, clusters, green fruit yield, hybridization.

INTRODUCTION

Chilli (*Capsicum annuum* L.), known as the "wonder spice or hot pepper" is one of the most important commercial spice crop used extensively worldwide. It was introduced to India by the Portuguese in the 17th century, and it was quickly incorporated into national cuisines (Bosland and Votava, 2000). Chilli is mostly utilized for its pungent flavour and pungency, taste, appealing colour and has its unique place in the diet as a vegetable cum spice crop. It contains vitamin C (111 mg/100 g), vitamin A (292 I.U/100 g), thiamine (0.19 mg/100 g), a small number of proteins, fats, carbohydrates, and traces of minerals such as molybdenum, manganese, folate, and potassium (Hosamani, 1993).

India is the world's leading producer, consumer, and exporter of chilli. Chilli is grown over 364 thousand hectares in India, with a production of 3851 thousand metric tonnes (Anon., 2019). Haveri, Dharwad, Gadag, Koppal, Belgaum, Bellary, and Raichur are the most prominent chilli-growing districts in Karnataka, Haveri and Dharwad districts accounting for 72 and 60 per cent of total area and production, respectively (Anon., 2019).

Although chilli is grown widely in India but the lack of improved genotypes is the main constraint to low yield. Looking to the market potential of chilli, there is a need to expand area, production and productivity. Hence, there is a prime need for development of varieties or hybrids suited to specific agro-ecological conditions with high quality fruits (Pujar *et al*., 2017).

Genetic diversity is the most important requirement for any successful crop improvement programme because it offers a wide range of variants for effective selection, which can be accomplished through hybridization, recombination, mutation, and selection (Patel *et al*., 1989). As a result, a study was undertaken with the broad goal of evaluating the divergence in the 63 chilli genotypes under eastern dry zone of Karnataka, India.

Long-term selection could be assisted by a better understanding of genetic diversity or genetic similarity (Chowdhury *et al*., 2002) in plants. To determine the source of genes over a certain trait within the available germplasm, a genetic diversity assessment is required. The genetic basis of crop diversity, with the ultimate goal of identifying beneficial allele genes and genomic region variation that can aid in crop modification. The analysis of genetic diversity among genotypes is an important aspect of the breeding process for better genotype selection (Saidaiah *et al.,* 2019).This experiment was undertaken to study genetic diversity and selection of suitable genotypes for future hybridization programme.

MATERIAL AND METHODS

Field experiment was carried out to assess the diversity among 63 diverse chilli genotypes during *kharif* 2020 at HREC, Hogalagere, Kolar of University of Horticultural Sciences, Bagalkot which is located at Zone-5 of Karnataka. The experiment was laid out in Augmented Block Design. Kolar is located in the drought-prone district of region III, Zone -5 (Eastern Dry Zone) of Karnataka and is part of the maidan (plains) region. It spans an area of 3969 km and is located between the north latitudes of 12° 45'54" and 13"35'47" and the east longitudes of 77 50' 29" and 78° 35' 18.The experimental plot was thoroughly ploughed twice and was harrowed twice to bring into a fine tilth. Ridges and furrows are opened at 60 cm apart and the seedlings were planted at 45 cm distance and all the recommended agronomic package of practices were followed as per University of Horticultural Sciences Bagalkot. Observations on plant height at 90 DAT, number of primary branches at 90 DAT, number of secondary branches at 90 DAT, plant spread from E-W at 90 DAT, plant spread from N-S at 90 DAT, days to first flowering, days to fifty per cent flowering, days to first harvest, number of fruits per plant, fruit length, fruit diameter, average green fruit weight, green fruit yield per plant, dry fruit yield per plant, number of seeds per fruit, thousand seed weight, ascorbic acid content and total chlorophyll content were recorded on the five plants chosen at random in each genotype and the mean of five plants were taken for analysis. The genetic divergence was estimated using the D^2 statistic of Mahalanobis and the population was grouped into cluster by following methods suggested by Tocher (Rao, 1952). The intra and inter- cluster distances were calculated formula described by Singh and Choudhary (1977).

RESULTS AND DISCUSSION

The analysis of variance for different quantitative traits for sixty-three chilli genotypes were highly significant difference among the genotypes for most of the characters studied. Based on the relative magnitude of D^2 estimates (Table 1), 63 genotypes were broadly grouped into nine clusters with variable number of genotypes revealing the presence of considerable amount genetic diversity in the materials. Among the nine clusters, cluster I and cluster IV contained 16 genotypes each, followed by cluster II contained 13 genotypes, cluster V contained 8 genotypes, cluster III contained 6 genotypes and cluster VI, VII, VIII and IX contained one genotype each. The pattern of group revealed that significant variability existed among the genotypes. Similar results were also obtained by Farhad *et al*. (2010); Kumar *et al*. (2010); Srinivas *et al*. (2013); Yatung *et al*. (2014).

Table 1: Clustering pattern of sixty-three chilli genotypes using Tocher's method.

Cluster number	Number of genotypes	Name of the genotype
I	16	COHBC-08, COHBC-33, COHBC-22, COHBC-21, COHBC-31, COHBC-42, COHBC-35, COHBC-58, COHBC-15, COHBC-01, COHBC-60, COHBC-44, COHBC-59, COHBC-02, COHBC-07 and COHBC-53
II	13	COHBC-06, COHBC-30, COHBC-20, COHBC-29, COHBC-56, COHBC-05, ArkaLohit, ArkaSuphal, COHBC-45, COHBC-27, COHBC-03, COHBC-46 and COHBC-18
III	6	COHBC-09, COHBC-16, COHBC-48, COHBC-41, COHBC-34 and COHBC-26
IV	16	COHBC-10, COHBC-25, COHBC-14, COHBC-04, COHBC-24, COHBC-38, ByadagiKaddi, COHBC-28, COHBC-40, COHBC-17, COHBC-55, COHBC-39, COHBC-37, COHBC-51, COHBC-50 and COHBC-49
V	08	COHBC-12, COHBC-57, COHBC-32, COHBC-36, COHBC-11, COHBC-13, COHBC-23 and COHBC-19
VI	01	COHBC-47
VII	01	COHBC-52
VIII	01	COHBC-54
IX	01	COHBC-43

The mean intra and inter cluster D^2 values are given in Table 2. The intra cluster D^2 values varied from 0.00 (Cluster VI, VII, VIII and IX) to 38452.32 (Cluster V).

The cluster V had a maximum D^2 value (38452.32) followed by cluster IV (29625.90), cluster III (19897.36), cluster II (18683.31) and cluster I (15902.22) and no intra cluster distance was observed in cluster VI, VII, VIII and IX. The inter cluster D^2

values of the nine clusters revealed that highest inter cluster distance (1160116.00) was between the cluster VII and cluster IX, similarly the lowest (9196.47) was observed between the cluster VI and VII (Fig. 1 and 2).

Table 2: Average intra and inter cluster distance D^2 for different traits of chilli genotypes.

Cluster distances									
Clusters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**
I	**15902.22**	123010.20	46541.02	408261.00	100172.20	34435.02	69251.88	444461.10	701822.60
II		**18683.31**	234604.80	110865.10	73725.37	239208.80	330939.90	150823.70	271487.20
III			**19897.36**	583887.50	137313.50	45022.54	63347.61	566771.30	912541.90
IV				**29625.90**	224236.10	617364.90	759127.70	57982.05	64340.48
V					**38452.32**	204867.70	279841.30	188284.40	411948.00
VI						**0.00**	9196.47	678232.90	979840.90
VII							**0.00**	825684.10	1160116.00
VIII								**0.00**	71886.15
IX									**0.00**

Note: diagonal values indicate intra cluster distance

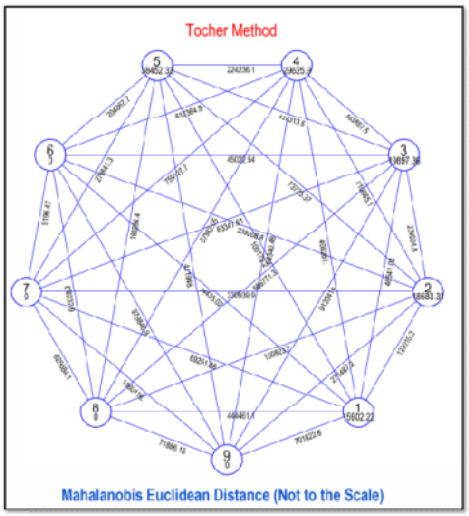

Fig. 1. Distance between inter and intra cluster distances in chilli genotypes.

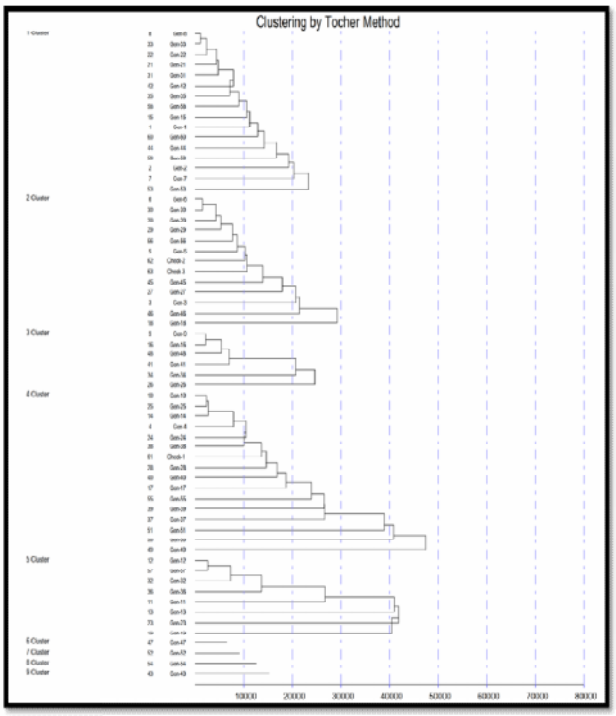

Fig. 2. Dendogram showing the genetic diversity among 63 genotypes of chilli using Tocher's method.

The inter cluster distance was minimum between cluster VI and VII indicating the narrow genetic diversity and maximum between cluster VII and cluster IX, followed by cluster VI and cluster IX indicating wider genetic diversity among the genotypes included in these cluster groups, which could be used in the yield improvement of chilli. A wide range of variability was observed in the cluster means for all the characters studied (Table 3). For characters like plant spread from E-W at 90 DAT (53.60), days to first flowering (23.40), days to fifty per cent flowering (32.40), days to first harvest (52.00), fruit length (13.72), fruit diameter (16.56), average green fruit weight (1.62), green fruit yield per plant (1400.96) and dry fruit yield per plant (61.50) were observed with genotypes in cluster IX. While in cluster VIII recorded higher cluster means for plant height at 90 DAT (85.65), number of primary branches at 90 DAT (7.10), number of secondary branches at 90 DAT (4.00), plant spread from N-S at 90 DAT (52.48), number of fruits per plant (189.00) and ascorbic acid content (415.93). The genotype in cluster VI recorded maximum mean value for thousand seed weight (7.16). The genotype in cluster V recorded higher cluster mean value for number of seeds per fruit (97.35). The genotype in cluster III recorded higher cluster mean value for total chlorophyll content (0.90). The genotypes with maximum mean values are used a parent in future breeding and based on the genetic distance and clustering pattern the most divergent genotypes were from cluster VIII and IX clusters could be used as best parents on crop improvement programme.This is in conformity with the findings of other researchers Hasan *et al.* (2014); Srivastava *et al.* (2016); Abhinaya *et al.* (2016).

The diversity of parents is of the utmost importance for a successful breeding programme, as the crossing made between parents with maximum genetic diversity are more likely to produce desired recombinant in progeny. It is however preferable depending upon information about the genetic diversity found in accessible germplasm, to select appropriate genetically different parents.

Table 3: Mean values of different traits in nine clusters of Chilli.

Sr. No.	Character	Clusters								
		I	II	III	IV	V	VI	VII	VIII	IX
1.	Plant height (cm) at 90 DAT	77.16	73.91	76.34	68.79	70.83	66.18	77.48	85.65	63.00
2.	Number of primary branches at 90 DAT	6.29	6.15	6.10	6.18	6.36	6.70	6.10	7.10	7.00
3.	Number of secondary branches at 90 DAT	3.61	3.59	3.60	3.63	3.35	3.30	3.60	4.00	3.50
4.	Plant spread (cm) from E-W at 90 DAT	45.38	47.47	42.33	46.36	47.18	44.14	46.20	53.20	53.60
5.	Plant spread (cm) from N-S at 90 DAT	44.49	45.99	42.83	45.21	43.98	37.24	44.67	52.48	49.40
6.	Days to first flowering	36.96	36.18	38.02	36.04	37.30	41.40	39.10	37.60	23.40
7.	Days fifty per cent flowering	46.85	44.72	47.25	45.50	47.86	53.00	48.60	47.90	32.40
8.	Days to first harvest	63.92	63.88	64.73	64.09	65.31	66.40	68.80	67.20	52.00
9.	Number of fruits per plant	141.12	179.16	132.67	188.31	145.35	145.20	127.00	189.00	150.80
10.	Fruit length (cm)	12.04	12.27	10.39	12.93	13.67	10.60	7.54	13.34	13.72
11.	Fruit diameter (mm)	11.43	11.27	10.99	13.53	11.72	10.64	11.68	12.46	16.56
12.	Average green fruit weight (g)	0.97	1.03	0.90	1.17	0.96	0.78	0.66	0.97	1.62
13.	Green fruit yield per plant (g)	573.25	897.86	451.98	1192.66	781.79	422.87	338.20	1188.60	1400.96
14.	Dry fruit yield per plant (g)	48.26	53.85	52.18	50.75	45.63	55.60	41.10	31.60	61.50
15.	Number of seeds per fruit	69.15	61.75	74.37	83.22	97.35	49.20	79.80	83.40	46.80
16.	Thousand seed weight (g)	6.64	6.40	6.98	6.15	7.07	7.16	5.37	4.63	4.65
17.	Ascorbic acid content (mg/100g)	180.65	178.51	306.98	207.83	358.23	120.17	102.34	415.93	268.00
18.	Total chlorophyll content (mg/100g)	0.68	0.79	0.90	0.80	0.80	0.87	0.67	0.68	0.44

DAT- Days After Transplanting

The choice of the parents mainly depends upon contribution of characters towards divergence (Table 4). Among the characters, green fruit yield per plant with maximum contribution of 20.00 per cent followed by average green fruit weight (11.00 %), number of fruits per plant (10.81 %), dry fruit yield per plant (9.00 %), fruit length (8.00 %), fruit diameter (6.00 %), thousand seed weight (5.00 %), total chlorophyll content (5.00 %), days to fifty per cent flowering (4.00%), days to first harvest (4.00 %), ascorbic acid content (4.00 %), plant spread (N-S) at 90 days after transplanting (3.00 %), days to first flowering (3.00 %), number of secondary branches at 90 days after transplanting (2.00 %), plant spread (E-W) at 90 days after transplanting (2.00 %), number of seeds per fruit (1.19 %), plant height at 90 days after transplanting (1.00 %) and number of primary branches at 90 days after transplanting (1.00 %). Similar divergence studies were carried by Srivastava *et al.* (2016); Pradhan *et al.* (2017); Nahak *et al.* (2018) ; Ananya *et al.* (2020) in chilli.

Table 4: Per cent contribution from different traits to the total divergence in chilli genotypes.

Sr. No.	Characters	Per cent Contribution (%)
1.	Plant height (cm) at 90 DAT	1.00
2.	Number of primary branches at 90 DAT	1.00
3.	Number of secondary branches at 90 DAT	2.00
4.	Plant spread (cm) from E-W at 90 DAT	2.00
5.	Plant spread (cm) from N-S at 90 DAT	3.00
6.	Days to first flowering	3.00
7.	Days to fifty per cent flowering	4.00
8.	Days to first harvest	4.00
9.	Number of fruits per plant	10.81
10.	Fruit length (cm)	8.00
11.	Fruit diameter (mm)	6.00
12.	Average green fruit weight (g)	11.00
13.	Green fruit yield per plant (g)	20.00
14.	Dry fruit yield per plant (g)	9.00
15.	Number of seeds per fruit	1.19
16.	Thousand seed weight (g)	5.00
17.	Ascorbic acid content (mg/100g)	4.00
18.	Total chlorophyll content (mg/100g)	5.00

DAT-Days After Transplanting

CONCLUSION

The information about the nature and magnitude of genetic divergence is essential for selection of diverse parents, which upon hybridization can result in productive hybrids. At present, there is urgent need to develop high yielding region specific varieties to address local problems and also varieties with wider adoptability. In this study, genetic divergence studies grouped sixty-three genotypes into nine clusters. The hybridization between genotypes of cluster VIII and cluster IX can be utilized for getting superior recombinants or transgressive segregates in segregating population because these clusters were found most divergent.

Conflict of Interest. None.

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