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RESEARCH ARTICLE

Assessment of Genetic Divergence in Chilli Germplasm (*Capsicum annuum* L.)

Chethan Kumar S [1]*, Sahu G S[1], Basavaraj[2] and Chandrakant K[2]

[1*]Department of Vegetable Science, Odisha University of Agriculture & Technology, 751003, India

[2] Department of Vegetable Science, University of Horticultural Sciences, Bagalkot, 587104, India

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ABSTRACT

Chilli or hot pepper (*Capsicum annuum*L.), native to new world tropics, is one of the most essentialvegetable and spice crop worldwide. In India, it is an indispensable spice cum vegetable in every household. In the current experiment, the elite 34 genotypes collected locally and throughout India weresubjected to Mahalnobis D^2 statistics using Tocher'smethod. Results revealed that the genotypes were grouped into 6 clusters based on Mahalanobi's D^2 statistics. Cluster I consisted of 9 genotypes, cluster II had 12 genotypes, cluster IV had 8 genotypes, cluster VI contained 3 genotypes and cluster III & cluster V had single genotype. Maximum inter cluster distance was found between cluster III and VI (217.467), and high cluster mean value for yield per plant was recorded in cluster II(65.92g).Pedicel length trait was found to be prominent contributorto the genetic divergence in present experimental material.

Keywords: *Chilli; Clusters; Mahalnobis D^2Analysis and Genetic Divergence*

INTRODUCTION

Chilli belongs to the family solanaceae of the genus Capsicum with eleven species and the diploid chromosome number of this genus is 2n=2x=24.Chilies were cultivated from 3500BC. Christopher Columbus, who discovered America in 1493 brought chilli to the rest of the world. Though, it was introduced in India late in the 17th century, chillies have become an essential part of Indian cuisine and are valued for their characteristic's pungency, color, aroma and taste it imparts to the food materials. (Mehta,2017). The majority of the Indian chilli belonging to the species *Capsicum annuum* L. is distinguished for its medium pungency and short duration. It is cultivated in almost all the states of the country like Andra Pradesh, Karnataka, West Bengal, Madya Pradesh, Odisha, Rajasthan, Maharashtra, Gujarat, Bihar etc.

India is the world's leader in green and dried chilli production. Green chilli occupies an area of 2.87 lakh ha with production of 34.06 lakh MT followed by china and dry chilli occupies an area of 0.83 lakh ha with production of 18.72 lakh MT and productivity 2.25t/ha. In Odisha dry chilli is cultivated in an area of 65.50 thousand hectares with production 64.50 thousand MT and productivity 0.98 t/ha. (NHB, 2017).

The use of D^2 analysis to group genotypes will aid in selecting potential parental lines for hybridizationprogramme. In this regard the current study was carried out to choose parents from a pool of 34 chilligenotypes in order to start a breeding programme by identifying clusters that are diversified and contain genotypes with good performance.

MATERIAL AND METHODS

The present investigation was carried out at the All India Co-ordinated Research Project on Vegetable Crops, Orissa University of Agriculture and Technology, Bhubaneswar, during 2017-18. The experimental materials comprised of 34 genotypes of chilli including some of the commercially released varieties from different institutes of India as listed in Table 1. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The spacing used in this experiment was 60×40 cm. Five randomly chosen plants in each replication of each entry were labeled and used for recording the observations. The mean of five plants was taken for analysis. Observations were recorded for 15 parameters like plant height (cm), primary branches,

*Corresponding author's e-mail: chethu.kumar.1995@gmail.com

leaf area (cm^2), plant spread EW (cm), plant spread NS (cm), days to initial flowering, days to 50% flowering, fruit length (cm), fruit girth (cm), pedicel length (cm), average fresh fruit weight (g),dry fruit weight (g),number of seeds per fruit, number of fruits per plant, fruit yield per plant (g). The data were subjected to multivariate analysis of genetic divergence using Mahalanobis D^2 statistic and the grouping of entries was done by Tocher's method (Rao, 1952).

Statistical analysis

The mean data of five randomly selected plants were used for statistical analysis. Analysis of variance, cluster analysis based on Tocher's method, and genetic divergence according to Mahalanobis D^2 statistics (Mahalanobis 1936) was performed using the statistical software Indostat Version 9.3.

Table:1: List of chilli genotypes with their sources

Genotypes	Name	sources
1	UtkalRashmi	AICRP on Vegetable crop, OUAT
2	BC-7-2-2	AICRP on Vegetable crop, OUAT
3	BC-24-1	AICRP on Vegetable crop, OUAT
4	BC-7-2-1	AICRP on Vegetable crop, OUAT
5	BC-79-1	AICRP on Vegetable crop, OUAT
6	BC-27-2-2	AICRP on Vegetable crop, OUAT
7	BC-25	AICRP on Vegetable crop, OUAT
8	BC-28	AICRP on Vegetable crop, OUAT
9	BC-40-3-1-1	AICRP on Vegetable crop, OUAT
10	BC-40-2-1-1	AICRP on Vegetable crop, OUAT
11	BC-40-2	AICRP on Vegetable crop, OUAT
12	BC-21	AICRP on Vegetable crop, OUAT
13	BC-30	AICRP on Vegetable crop, OUAT
14	BC-7-1-1	AICRP on Vegetable crop, OUAT
15	BC-20	AICRP on Vegetable crop, OUAT
16	BC-70-2	AICRP on Vegetable crop, OUAT
17	BC-406	AICRP on Vegetable crop, OUAT
18	BC-5-1-7	AICRP on Vegetable crop, OUAT
19	BC-78-1	AICRP on Vegetable crop, OUAT
20	BC-78-1-2	AICRP on Vegetable crop, OUAT
21	BC-43	AICRP on Vegetable crop, OUAT
22	MANIPUR LOCAL 1	AICRP on Vegetable crop, OUAT
23	MANIPUR LOCAL 2	AICRP on Vegetable crop, OUAT
24	ARKA ABHIR	IIHR, Bengaluru
25	ARKA LOHIT	IIHR, Bengaluru
26	ARKA SUPHAL	IIHR, Bengaluru
27	BYADAGI KADDI	GKVK, Bengaluru
28	LAM -358	LAM, Guntur, AP
29	LAM-620	LAM, Guntur, AP
30	LAM-625	LAM, Guntur, AP
31	ANURAGHA(KAU)	KAU, Kerala
32	UJWALA(KAU)	KAU, Kerala
33	PUSA SADABAHAR	IARI, New Delhi
34	KUNCHINDA LOCAL	Local collection, AICRP, OUAT

RESULTS AND DISCUSSION

The results from the analysis of variance for 15characters indicated significantly high differences among 34 genotypes of chilli under study except Plant spread EW (cm) and Plant spread NS (cm) (Table. 2). The 34 genotypes of chilli were grouped into 6 cluster on the basis of D^2value (Table 3.). Here cluster II (12) has the highest number of genotypes, followed cluster I (9), cluster IV (8), cluster VI (3) and cluster III and cluster V had one genotype each. Cluster III and VI had the highest inter cluster distance followed by cluster IV and VI. So, promising hybrid derivatives can be obtained by crossing the parents selected from these two divergent groups.

The estimates of intra and inter cluster distance based D^2 values are presented in Table 4 and Figure 1. Intra cluster distance was the highest in cluster VI (107.43) and the lowest in cluster I (27.976). The intra cluster distance III and V was found to be zero as these two cluster contain a single genotype. The spectrum of inter cluster distances ranged from 51.88 (between I and III) to 217.46 (between cluster III and cluster VI). The maximum inter cluster distance was observed between cluster III and VI (217.467) followed by clusters IV and VI (204.108). The minimum inter cluster distance was observed between cluster I and III. Therefore, it is apparent that genetic diversity and geographical diversity do not tally. This is in agreement with the findings of other research by Senapati *et al.* (2003) and Srinivas *et al.* (2013).

Table.2. Analysis of variance for 15 characters of 34 genotypes of chilli.

Sl. No	Character	Mean sum of square		
		Replications	Genotypes	Error
1	Plant height(cm)	58.604	292.067**	108.454
2	Number of branches per plant	0.002647	1.213**	0.05008
3	Leaf area(cm^2)	3.688	205.998**	7.050
4	Plant spread EW(cm)	72.842	66.033	41.414
5	Plant spread NS (cm)	30.439	43.781	31.483
6	Days to initial flowering	2.701	92.095**	8.378
7	Days to 50 % flowering	36.425	86.131**	12.482
8	Fruit length(cm)	0.0219	5.789**	0.2000
9	Fruit girth(cm)	0.000056	1.241**	0.0482
10	Pedicel length(cm)	0.000694	0.816**	0.024
11	Number of fruits per plant	385.138	2530.238**	246.599
12	Average fresh fruit weight(g)	0.171	2.360**	0.072
13	Average dry fruit weight(g)	0.001518	0.0865**	0.002215
14	Number of seeds per fruit	28.778	250.99**	10.06
15	Yield per plant(g)	110.911	1080.66**	71.24

**: significant at 1% level

Table: 3: Distribution of different chilli genotypes by Tocher's clustering method.

cluster	No. of genotypes	Name of the genotypes
I	9	BC-70-2,BC-406(17), BC-40-2, BC-7-1-1, Anuragha, ArkaLohit, BC-40-3-1-1, BC-30, ArkaSuphal
II	12	BC-40-2-1-1, BC-78-1, BC-78-1-2, BC-25, BC-28, BC-24-1, BC-7-2-1,Utkal Rashmi, BC-27-2-2, BC-20, BC-43, BC-5-1-7
III	1	Manipur Local 2
IV	8	Ujwala (KAU), PusaSadabahar , LAM-358, Manipur Local 1, Kunchinda Local , LAM-625, LAM-620, ByadagiKaddi
V	1	BC-21
VI	3	BC-7-2-2, BC-79-1, ArkaAbhir

The cluster means in respect of 15 quantitative character is presented in Table 5. Among clusters, cluster 3 and 5 included only a single genotype. Cluster II recorded the highest mean value in respect of number of fruits per plant (120.41) and dry fruit yield per plant (65.92 g). The genotypes included in cluster III was found to be superior in character plant height (100.60cm) and be earlier in days to 50% flowering (47.33 days) In cluster IV recorded the highest mean in respect of pedicel length (3.63 cm) and number of branches (4.51). Cluster V recorded the highest mean value for fruit length (8.6cm), number of seeds per fruit (72.6), leaf area (46.14cm^2) and earliest in days to initial flowering (40.00 days) as well as days to 50 % flowering (47.33 days). Cluster VI was characterized by maximum plant spread both in EW (55.047) and NS (56.82) direction, maximum fruit girth (4.86cm), average fresh fruit weight (3.85g) and average dry fruit weight (0.72). It is found that cluster II had the highest mean value for the trait number of fruits per plant and frit yield per plant, where cluster VI showed the highest mean value for average fresh fruit weight and average dry fruit weight. As per the cluster mean, the cluster having more yield is more desirable than a divergent cluster with less mean yield in the cluster.

Table: 4. Average intra (bold) and inter cluster distance (D^2) for chilli genotypes

Cluster	I	II	III	IV	V	VI
I	**27.9**	62.1	**51.8**	88.60	54.09	136.98
II		50.4	138.6	122.71	96.56	112.78
III			0.0	145.34	60.26	**217.46**
IV				86.65	151.05	204.10
V					0.00	193.91
VI						**107.43**

For D^2 analysis 15 characters including (growth and yield parameter) were considered at a time (Table.6). Among the characters the maximum divergence was contributed by pedicel length (19.96 %) flowed by leaf area (16.40 %), number of branches (13.40 %), and average dry fruit weight (10.70 %) and number of seeds per fruit (9.45 %). So, the selection of parents differing in these traits may be useful for heterosis breeding programme in chilli especially for increase in average dry fruit weight these was also reported by Varalaxmi and Babu (1991) and Senapati *et al.* (2003).

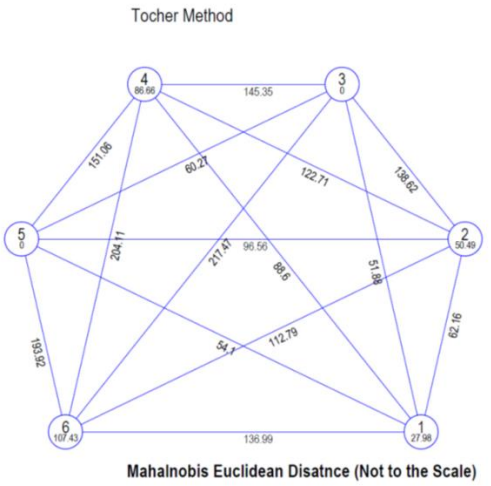

Fig.1. Intra and inter cluster distance between six clusters of chilli genotypes.

Table.6. Relative contribution of different characters to genetic divergence

Sl. No	Source	Contribution %	Times Ranked 1st
1	Fruit Length (cm)	6.95	39.000
2	Fruit Girth (cm)	3.74	21.000
3	Pedicel Length (cm)	19.96	112.000
4	number of Seeds per Fruit	9.45	53.000
5	Average Fresh Fruit Weight (g	0.53	3.000
6	Average Dry Fruit Weight (g)	10.70	60.000
7	Number of fruits Per Plant	0.00	0.000
8	Fruit yield Per Plant (g)	0.89	5.000
9	Days to initial Flowering	2.85	16.000
10	Days to 50% Flowering	0.36	2.000
11	Leaf Area (cm^2)	16.40	92.000
12	Plant Height (cm)	0.53	3.000
13	Number of Branches	13.90	78.000
14	Plant Spread EW (cm)	3.03	17.000
15	Plant Spread NS (cm)	0.71	4.000

Conclusion

Genetic divergence has been considered a significant component in separating genetically distinct parents for a successful and effective hybridization programme in order to obtain viable transgressive segregants as well as new gene recombination in the gene pool. Maximum inter cluster distance observed between cluster III and cluster VI followed by cluster IV and cluster VI and cluster V and VI. This indicates the genotypes belonging to cluster III (Manipur Local 2), cluster IV (Ujwala (KAU), Pusa Sadabahar, LAM-358, Manipur Local 1, Kunchinda Local, LAM-625, LAM-620, ByadagiKaddi) and cluster VI (BC-7-2-2, BC-79-1, Arka Abhir) are more diverse and hence, hybridization between genotypes of respective cluster may improve the yield of chilli.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

Authors should ensure that they have written and submit only entirely original works, and if they have used the work and/or words of others, that this has been appropriately cited. Plagiarism in all its forms constitutes unethical publishing behavior and is unacceptable.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There was no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS. No separate external data source is required. If anything is required from the MS, certainly, this will be extended by communicating with the corresponding author through corresponding official mail; chethu.kumar.1995@gmail.com

Author contributions

Idea conceptualization-CKS and SGS, Experiments-CKS and SGS, Guidance –SGS, Writing original draft – CKS, B, CK, Writing- reviewing &editing –SGS, CK and B.

Table. 5: cluster mean values of 34 genotypes of chilli for 15 quantitative character

clusters	Plant Height (cm)	Primary Branches	Leaf Area (cm^2)	Plant Spread EW (cm)	Plant Spread NS (cm)	Days to initial flowering	Days to 50% Flowering	Fruit Length (cm)	Fruit Girth (cm)	Pedicel Length (cm)	Avg Fresh Fruit Weight (g)	Dry Fruit Weight (g)	Number of Seeds per Fruit	Number of fruits per plant	Fruit Yield Per Plant (g)
I	90.392	3.654	39.838	51.234	53.332	42.149	49.184	6.397	3.389	3.209	2.450	0.451	49.433	90.660	40.789
II	99.319	3.779	31.958	51.090	53.706	41.138	48.196	6.937	3.807	3.164	3.048	0.559	45.388	**120.417**	**65.920**
III	**100.600**	3.230	36.320	49.000	54.560	41.330	**47.330**	5.940	2.900	3.000	2.000	0.360	64.070	38.000	13.677
IV	90.816	**4.510**	39.545	50.650	51.121	50.830	56.037	5.870	2.979	**3.639**	2.092	0.428	42.086	81.520	34.325
V	92.670	4.000	**46.140**	48.670	49.780	**40.000**	**47.330**	**8.600**	3.430	3.000	2.820	0.510	**72.600**	98.200	50.083
VI	87.667	4.150	29.373	**55.047**	56.823	42.890	48.777	6.167	**4.860**	2.760	**3.850**	**0.720**	40.030	98.933	62.733

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