Research Article

# Genetic Divergence Study in Chilli (*Capsicum Annuum* L.) Genotypes under Garhwal Hills of Himalaya

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**Abstract**

Genetic divergence among twenty five genotypes of Chilli was assessed using Mahalanobis $D^2$ statistic for fourteen characters at College of Horticulture, Bharsar, Pauri Garhwal, Uttarakhand. The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating considerable diversity in the material. Based on Mahalanobis $D^2$ statistic, the twenty five genotypes were grouped into 7 clusters. The cluster I had the maximum number of genotypes seven while cluster IV contained only one genotype. Among the clusters, maximum number of genotypes were accommodated in the cluster-I (7) followed by cluster-II (5), cluster-VI (5), cluster-III (3), cluster-V (2), cluster-VII (2) and cluster-IV (1). The highest inter-cluster distance was observed between cluster I and IIV (6.978) and the lowest inter-cluster distance was observed between the clusters V and V1 (2.828). Cluster VII (2.768) has exhibited highest intra cluster distance and the lowest was observed in cluster IV (0.001). $D^2$ cluster analysis revealed wide genetic distance (inter cluster) between the genotypes of cluster V (LC-1 (Jodhpur Chilli, Rajasthan), LC-2 (Ajmer, Rajasthan)) and cluster VII (Paprika (IARI- RS, Katrain), Byadgi kaddi (KRCCH, Arabhavi, Karnataka)) and the crossing between genotypes of these two clusters can be exploited for the development of heterotic hybrids in future breeding programmes.

**Keywords:** *Capsicum annuum*, Chilli, $D^2$ statistic, clustering, genetic divergence

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## Introduction

Chilli (*Capsicum annuum* L., 2n = 24) a member of the Solanaceae family has originated from South and Central America. It is an indispensable spice due to its pungency, taste, appealing colour and flavor and has its unique place in the diet as a vegetable cum spice crop. India is the largest producer, consumer and exporter of Chilli in the world with an annual production of 1.492 million tonnes from 1.9 million ha with production [1]. Andhra Pradesh leads the country in its production, productivity and export followed by Karnataka, West Bengal, Madhya Pradesh and Orissa. Capsicinoids and carotenoids are the major chemical constituents of Chilli fruits and add commercial value to the crop. The carotenoids contributing to fruit colour act as dietary precursors of vitamin A and play an important role in the regulation of vision, growth and reproduction. Pungency (heat) is an important quality attribute of hot pepper besides colour. Chilli is a good source of vitamin C (ascorbic acid) used in food and beverage industries. It has also acquired a great importance because of the presence of 'oleoresin', which permits better distribution of color and flavor in foods. Apart from developing traditional varieties through conventional breeding, exploitation of heterosis for yield and yield attributing characters through hybridization is also important in crop improvement. Screening of available germplasm helps in studying the variability and diversity and identification of superior parents for use in hybridization. The knowledge of characters influencing divergence is important for a breeder to plan a successful breeding programme. Thus, the present study was undertaken to assess the genetic diversity in 25 genotypes of Chilli (*Capsicum annuum* L.) and to identify suitable donors for a successful breeding programme in this crop. Mahalanobis's $D^2$ statistic of multivariate analysis is recognized as a powerful tool in quantifying the degree of genetic divergence among the populations and has been utilized in this study [2].

## Materials and Methods

The experiment was carried out with 25 genotypes of Chilli at Vegetable Research and Demonstration Block of the Department of Vegetable Science, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand. The experimental site is located at Bharsar, at an altitude of 1900 m above mean sea level lying between latitude $29^0$ $30.056^0$ north and longitude $78.99^0$ east. It falls under the mid- hill

zone of Uttarakhand [3]. The genotypes studied in a randomized block design were replicated thrice. The nursery was raised during last week of February and the seedlings were transplanted at a spacing of 45 cm x 30 cm during April 25, 2015. Each plot consisted of 12 plants, of which five competitive plants were selected at random for recording the observations. The crop was raised as per the recommended package of practices. Observations were plant height (cm), days to first flowering (days), days to 50% flowering (days), days to first fruit harvesting (days), fruit length (cm), fruit breadth (cm), plant stem girth (cm), pericarp thickness (mm), number of seed per fruit (number), number of primary branches, ascorbic acid content (mg/100g), number of fruits per plant, number of branches, marketable fruit yield per plant (g), per plot (kg) and per hectare (q). The genetic divergence analysis was done using Mahalanobis $D^2$ statistic. The lines were grouped into clusters by the Tocher's method as described by Rao [4].

## Results and Discussion

The computations from distance matrix gave non-hierarchical clustering among 25 Chilli genotypes and grouped them into seven clusters (**Table 1**). Cluster I contained the highest number of chili genotypes (seven), followed by cluster II and VI constituted by five chili genotypes. cluster-III constituted by three chili genotypes, cluster-V and VII constituted by two chili genotypes and cluster-IV constituted by one chili genotypes Averages inter and intra cluster divergence ($D^2$) values have been presented in the **Table 2**. The diagonal figures in the table represent the intra cluster distances. The intra cluster distance was found maximum in cluster VII (2.768) and minimum in cluster IV (0.001). Whereas, highest inter cluster distance (6.978) was recorded between cluster I and VII indicating wide genetic diversity between these two clusters followed by the distance between cluster IV and VII (6.898), cluster II and cluster VII (6.794) and cluster IV and cluster V (6.735) Genotypes from these four clusters if involve in hybridization may occur a wide spectrum of segregating population as genetic diversity is very distinct among the groups.

**Table 1** Clustering pattern of twenty five genotypes of Chilli on the basis of genetic divergence

| Clusters | Number of genotypes | Genotypes along with their sources |
|---|---|---|
| I | 7 | Arka Lohit (IIHR, Karnataka), K-1 (IIVR, Varanasi, UP), DCC-24 (ARS, Chilli, Karnataka), DCC-52 (Karnataka), DCC-27 (Karnataka), Long Chilli (Kerala), Pant C-1 (Pantnagar, Uttarakhand) |
| II | 5 | LC-3(Pali, Rajasthan), LC-5 (Pantnagar, Uttarakhand), LC-7 (Ranichauri, Uttarakhand), 70-F-BR-14 (Local market), G-4 (IIVR, Varanasi, UP) |
| III | 3 | Surya (Local market), Arka Suphal (IIHR, Karnataka), DDC-239 (ARS,Chilli, Karnataka) |
| IV | 1 | DCC-187 (ARS,Chilli, Karnataka) |
| V | 2 | LC-1 (Jodhpur Chilli, Rajasthan), LC-2 (Ajmer, Rajasthan) |
| VI | 5 | LC-4 (Bharatpur, Rajasthan), LC-6 (Nainital, Uttarakhand), LC-8 (Rishikesh, Uttarakhand), LC-9 (Srinagar, Uttarakhand), Byadgi dabbi (KRCCH, Arabhavi, Karnataka) |
| VII | 2 | Paprika (IARI- RS, Katrain), Byadgi kaddi (KRCCH, Arabhavi, Karnataka) |

**Table 2** Average intra and inter cluster distance ($D^2$)

| Clusters | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|
| I | 2.517 | | | | | | |
| II | 3.280 | 2.222 | | | | | |
| III | 3.753 | 3.663 | 2.340 | | | | |
| IV | 4.965 | 6.155 | 5.262 | 0.001 | | | |
| V | 5.885 | 5.672 | 5.825 | 6.735 | 1.117 | | |
| VI | 4.413 | 4.123 | 4.657 | 5.730 | 2.828 | 1.949 | |
| VII | 6.978 | 6.794 | 5.831 | 6.898 | 5.698 | 5.248 | 2.768 |

The selection of diverge genotype from cluster would produce a broad spectrum of variability for morphological and quality traits studied which may enable further selection and improvement. The minimum inter-cluster distance was observed between cluster V and cluster VI (2.828) followed by cluster I and cluster II (3.280) and cluster II and

cluster III (3.663) indicating that the genotypes of these clusters were genetically close. Cluster mean value of 14 different characters shown in **Table 3**. Difference in cluster means existed for almost all the characters studied. Highest mean value for fruit length, days taken for first flowering, days to first harvest, fruit yield per plant was observed in cluster V that means the genotype fallen in cluster V having the genetic potentiality to contribute better for yield maximization of chili genotypes. Cluster VII possessed genotypes with maximum fruit breadth coupled with days for 50% flowering and Pericarp thickness indicating selection of genotypes from these cluster for future Chilli breeding program have positive impact for fruit breadth, days for 50% flowering and Pericarp thickness. Cluster III had the genotypes that showed lowest mean value for all the characters studied indicating selection of genotypes from these cluster for future Chilli breeding program have no positive impact. For those traits, where selection is not responsive and non-additive gene effects are playing major role in the expressions, hybridization between diverse parents on the basis of their mean performance to get superior hybrids or transgressive segregates or partitioning of additive genetic variation and non-additive genetic variation in segregating generations will be useful.

**Table 3** Cluster means for different trait in twenty five genotypes of Chilli

| Sr. No. | Traits | Clusters | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | V1 | VII |
| 1. | Plant height (cm) | 73.74 | 88.95 | 68.80 | 72.33 | 84.13 | 83.13 | 79.27 |
| 2. | Fruit breadth (cm) | 1.60 | 1.18 | 1.45 | 1.96 | 1.25 | 1.25 | 2.39 |
| 3. | Fruit length (cm) | 7.51 | 7.08 | 7.00 | 8.85 | 12.92 | 11.83 | 12.22 |
| 4. | Days taken for first flowering | 39.86 | 41.13 | 38.11 | 39.67 | 36.67 | 37.73 | 37.50 |
| 5. | Days for 50 per cent flowering | 54.38 | 52.60 | 51.78 | 59.67 | 51.83 | 53.80 | 49.50 |
| 6. | Days to first harvest | 70.71 | 67.53 | 65.44 | 72.67 | 64.83 | 69.00 | 65.00 |
| 7. | Plant stem girth (cm) | 2.86 | 3.03 | 2.62 | 2.32 | 3.20 | 3.26 | 2.92 |
| 8. | Fruit pericarp thickness (mm) | 1.01 | 0.80 | 1.06 | 1.15 | 1.35 | 1.35 | 2.07 |
| 9. | Number of seeds per fruit | 68.94 | 51.54 | 57.84 | 106.73 | 97.47 | 67.87 | 45.23 |
| 10. | Number of primary branches | 6.87 | 5.15 | 4.02 | 3.47 | 3.70 | 4.69 | 3.77 |
| 11. | Ascorbic acid content (mg/100g) | 104.35 | 89.99 | 101.81 | 87.90 | 89.30 | 88.61 | 68.93 |
| 12. | Number of fruits per plant | 90.71 | 111.56 | 99.42 | 65.71 | 71.30 | 90.30 | 46.72 |
| 13. | Number of branches per plant | 11.91 | 11.00 | 7.65 | 7.53 | 11.81 | 9.38 | 6.47 |
| 14. | Yield per plant | 148.15 | 150.11 | 141.20 | 144.60 | 232.76 | 215.77 | 179.95 |

Studies on genetic divergence will be helpful in identification of better parents. Here in this case, genetic divergence studies grouped twenty five genotypes into seven clusters. The hybridization between genotypes of cluster V and cluster VII can be utilized for getting superior recombinants or transgressive segregates in segregating population because these clusters were found most divergent. Earlier workers like [5-9], have also indicated the significance of genetic divergence in Chilli.

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