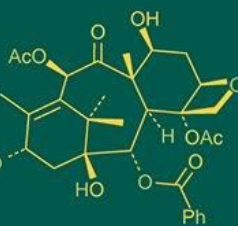
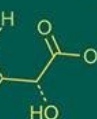


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Genetic diversity of chilli Germplasm for growth, yield and yield attributes

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Abstract

Genetic disparity of germplasm observed in chilli is covered in this review study to comprehend the growth, yield and yield attributes using existing studies. The results of quantitative assessment of genetic divergence among 40 genotypes of chilli for yield and yield contributing characters following Mahalanobis's D^2 statistic are presented. The mean intra and inter cluster D^2 values, the cluster means for each of the 20 traits and Number of times each of 20 traits appeared in first rank and its respective percent contribution towards genetic divergence are presented. Applying secondary sources, this study has incorporated different studies that have given empirical evidence to support the findings, underscoring the potential of chilli agriculture.

Keywords: Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), Principal Component Analysis (PCA), Mahalanobis

Introduction

The breeding process for plants relies on the genetic diversity in crop germplasm that ensures faster growth, yield and crop quality of varying species. Chilli, or *Capsicum annuum*, has a diverse germplasm collection that indicates a varying range of morphological and qualitative traits, supporting selection and hybridisation. For example, Naga Jolokia is the known for being the hottest chilli with high pungency, which grows in India, a country with the highest commercial cultivation capacity (Natarajan, *et al.* 2023). Field components, including the number and weight of fruit, and height and biochemical characteristics of the plant, have been variably reported. These components show the high/low possibility of improving the crop. Vibrant genetic diversity fosters flexibility in response to biotic and abiotic impacts, leading to sustainable production.

Knowledge on breeding genotypes differentiation and trait associations promotes effective breeding and conservation of germplasm.

Results and discussion

An overview of existing literature indicates that it consists of a huge genetic variation within the chilli germplasm with respect to growth, yield and yield-related characteristics.

11 qualitative traits have shown different 40 genotypes in chilli (Figure 1). The ANOVA showed that the differences among the forty chilli genotypes were very significant in all twenty characters measured, which means that there was a great amount of genetic variation. The substantial mean sum of squares of traits, including plant height, the number of primary branches per plant, days to 50% flowering, days to fruit set, and days to first and last harvest. In addition, the length, diameter, average weight, fruit yield per plant, the fruit yield per plot, the percentage of recovery, ascorbic acid, oleoresin content, capsanthin, capsaicin and the content of chlorophyll of the green chilli have also proved that the traits of genotypes varied strongly. This is relative to the growth and yield characteristics. This broad variability provide plenty of selection in making successful choices during chilli improvement programmes.

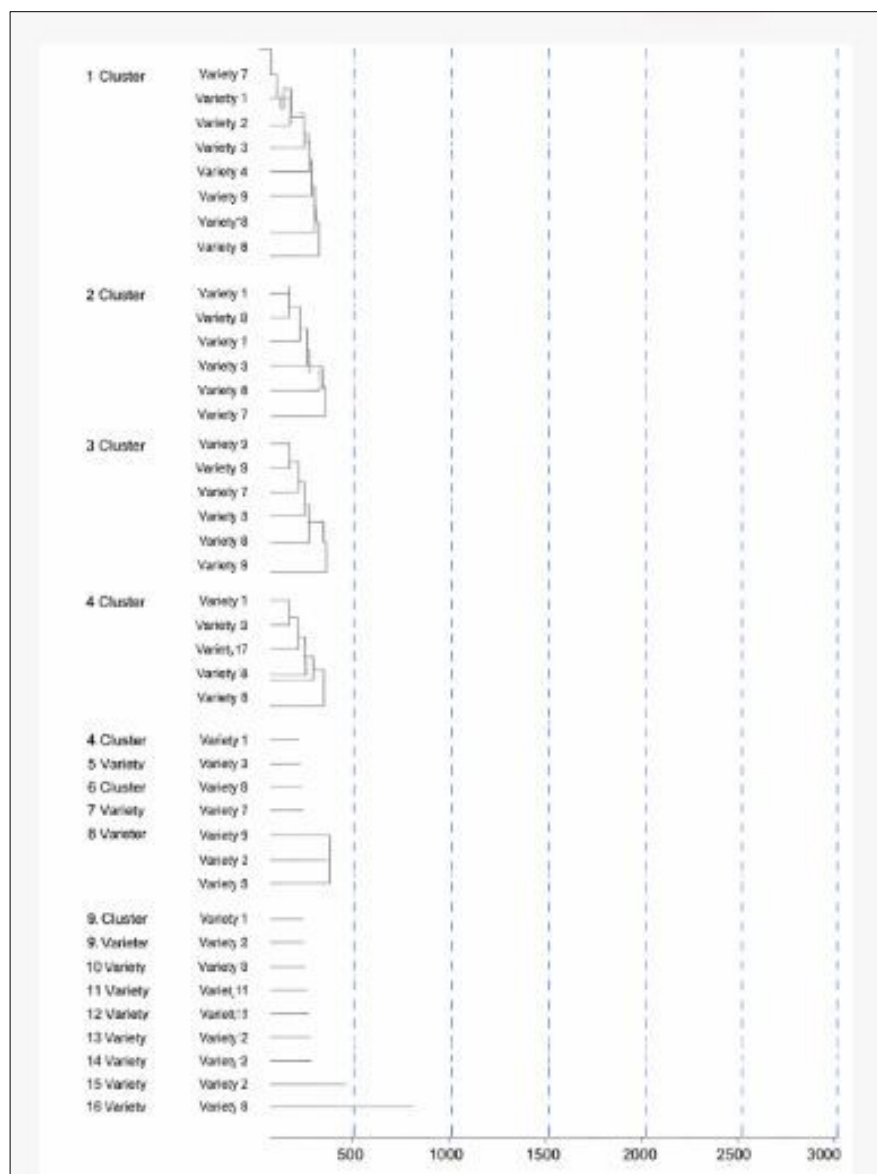


Fig 1: Clustering by tocher's method

The range of genotypes listed in Figure 1 is between 36.84 cm (SD 5335) and 86.30 cm, with the overall mean of 56.82 cm. In this, Warangal chapata (85.03 cm), PSR 7075 (84.13 cm) or IC 572469 (82.25 cm) have a comparatively good performance to the best cheque LCA 625. It means they can be selected where an increase in plant height is needed. Genotypes, SR 6514, EC 399574 and IC 399675 did not exhibit uniform 50% flowering days, as some of them were observed to be early flowering compared to the best cheque like Sindhur (60 days) and showed chances of breeding early. The flowers per axil ranged between 1.00 and 2.83, of which Hirkani recorded the highest (2.83). Many of the genotypes, such as IC 528454, AAT 2, Warangal chapata, IC 13871, and ST 13875, showed much higher values compared to the cheque, indicating that these are superior in giving the yield with respect to this trait. The fruit set period was between 43 and 77 days, with the shortest time belonging to Hirkani and the greatest time belonging to ST 13875, which means that there is a high degree of variation in reproductive behaviour.

Evaluating the genetic bifurcation of the 40 genotypes based on the D^2 statistics of Mahalanobis, which ensures that there is a presence of large genetic diversity by clustering the

genotypes into 15 clusters. Cluster I was the biggest as it had twelve genotypes, and clusters II and III, as well as several monogenotypic clusters, with the reflection of unique genetic composition. Cluster VIII (890.71) was most likely to have as many cluster occurrences of the maximum intra-cluster distance, with cluster number III (738.95) coming afterwards, indicating higher variability was observed within cluster IX.

Cluster mean analysis helped make individual performance patterns by cluster. Cluster VIII had the greatest height of plants (82.99 cm) and the largest fruit maximum diameter (2.08 cm), whereas cluster V had the greatest primary branch per plant (8.18). Its characteristic features included early flowering (41.67 days), early fruit set (45 days), and minimum days to first harvest (87 days) and minimum days to last harvest (126 days), which means that it has the required properties of early and short-term cropping. Cluster VII (0.530 kg) and cluster VIII (0.570 kg) had the highest fruit yield per plant, and the lowest yield (0.140 kg) was recorded in cluster III.

Furthermore, it has been proven from a study on 95 capsicum genotypes that phenotypic traits and biochemical composition are linked, which enhances the agronomic

performance of chilli (Khan *et al.* 2025). All these findings imply the abundance of genetic resources available in chilli germplasm that can be capitalised to come up with high-yielding cultivars.

Genetic distance was measured among 40 chilli genotypes using Mahalanobis' generalised distance 'D²' on a combination of 20 traits related to yields. Analysis of 'D²' revealed a great distance among the genotypes, thus emphasising large genetic variability. The 40 genotypes were partitioned into fifteen clusters using Tocher's approach on estimates of 'D²' (Alekhya and Namboodiri, 2024). Among these, cluster I had 12 chillies, while others had 7 each, such as II and III. The rest were multi-genotypic: IV, V, VI, VII, IX, X, XI, XII, XIII, and XV. The rest were monogenotypic: VIII and XIV. The range of intra-cluster distance was from 0.00 to 890.71. This value was highest among chillies grouped into VIII with a distance measure of 890.71, followed by chillies grouped into III with 738.95, followed by chillies grouped into II with 607.86. Several chillies grouped into different clusters registered zero distance, implying homogeneity. The inter-cluster distances were also quite variable, ranging from a maximum distance of 4919.75 units between clusters XIV and XV to a minimum of 369.21 units between clusters VII and V. The divergence of clusters II and III was narrow, while the wide divergence occurred between IV and VII and between IV and VI hybridisations.

The result of the relative contribution of 20 traits also indicated that ascorbic acid accounted for the maximum contribution to total genetic divergence (2551.28%) and accounted for 199 first-rank positions. This was followed by capsaicin (2397.44%) and accounted for 187 first-rank positions, while capsanthin (1807.61%) and fruit length (1705.10%) accounted for 141 and 133 first-rank positions, respectively. The oleoresin content accounted for 717.95% and contributed 56 first-rank positions, while fruit yield per plant accounted for 576.92% and contributed 45 first-rank positions. Chlorophyll content accounted for 179.49% and contributed 14 first-rank positions, while days to first fruiting, number of primary branches per plant, and days to fruit set accounted for 25.64%. Recovery percentage accounted for 12.82% and contributed only 1 first-rank position.

Table 1: Cluster Analysis of Nearest and Farthest Clusters with D² Values

Cluster No.	Nearest Cluster with D ² values	Farthest Cluster with D ² values
I	V (705.18)	XV (2865.63)
II	I (856)	XV (2807.95)
III	IX (910.41)	XV (2933.66)
IV	IX (484.40)	XV (3057.05)
V	VII (369.21)	XV (3310.04)
VI	VI (376.79)	XV (2771.68)
VII	V (369.21)	XV (3479.44)
VIII	IX (694.35)	XV (3479.44)
IX	VI (376.79)	XV (4600.06)
X	V (388.70)	XV (2118.40)
XI	IV (637.93)	XIV (3021.58)
XII	I (900.68)	XV (3393.35)
XIII	IV (751.18)	XV (3468.00)
XIV	II (884.62)	XV (4919.75)
XV	XI (1698.96)	XIV (4919.75)

Conclusion and recommendation

A genetic study based on the germplasm of chilli shows multiple differences in growth parameters and yield parameters. These parameters have justified the usefulness of germplasm collections in breeding. It can be stipulated that the greater the heritability and genetic progress of major qualities, the more important phenotypic selection is in the breeding of cultivars. Multivariate analysis is used to increase the acts of discrimination between genotypes, thereby providing a means of age-selective breeding. The analysis of molecular markers should also be integrated with the phenotypic assessment in the future so that the genetic architecture can be studied and help trade off markers-assisted selection. Germplasm panel and multi-environment tests should be expanded to make desirable traits stable in dissimilar agroecological conditions.

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