The Pharma Innovation Journal 2022; 11(8): 625-628

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 625-628

www.thepharmajournal.com
Received: 21-06-2022
Accepted: 29-07-2022

**Moatoshi Jamir**
Department of Genetics & Plant Breeding, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema, Nagaland, India

**Pankaj Kumar Shah**
Department of Genetics & Plant Breeding, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema, Nagaland, India

**HP Chaturvedi**
Department of Genetics & Plant Breeding, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema, Nagaland, India

**Joyashree Baruah**
Agro technology and Rural Development Division, CSIR-North East Institute of Science and Technology (NEIST), Jorhat, Assam, India

**Corresponding Author:**
**Pankaj Kumar Shah**
Department of Genetics & Plant Breeding, School of Agricultural Sciences & Rural Development Nagaland University, Medziphema, Nagaland, India

# Genetic diversity of Naga king Chilli genotypes (*Capsicum chinense* Jacq.) based on yield attributing characters under foothill condition of Nagaland

**Moatoshi Jamir, Pankaj Kumar Shah, HP Chaturvedi and Joyashree Baruah**

**Abstract**
Study on genetic variability and diversity was conducted for two consecutive years with 11Naga King chilli (*Capsicum chinense* Jacq.) genotypes of Nagaland at the research farm of Genetics and Plant Breeding, Nagaland University, SASRD, India during February-October 2018-2019. Sixteen quantitative characters *viz*. days to first flowering, plant height (cm), days to 50 percent fruiting, number of fruits per plant, fresh fruit weight (g), fruit length (cm), fruit width (cm), number of fruits per cluster, number of seeds per fruit, dry fruit weight (g), 1000 seed weight (g), fruit yield per plant (g), beta-carotene (mg per 100g), ascorbic acid (mg per 100g), moisture content (percentage) and capsaicin content (mg per 100g) were taken into consideration. The analysis of variance revealed considerable variability among the genotypes for the character studied. Cluster analysis was used for grouping of 11 chilli genotypes and was grouped into five clusters. Cluster 1 has 7 genotypes and cluster 2, cluster 3, cluster 4 and cluster 5 has one genotype each. High genetic divergence between Cluster I and II were revealed indicating wide genetic diversity between these two clusters. The maximum relative contribution to the total divergence was made by capsaicin content, ascorbic acid and number of fruits per cluster. The present experimental findings will be immensely helpful in *C. chinense* germplasm conservation and in trait specific breeding programmer.

**Keywords:** Ascorbic acid, beta-carotene, capsicum, genetic diversity, king chilli, moisture content and capsaicin

## Introduction
In India the Northeast region is acknowledge as hot-spot for chilli diversity (Mathur *et al*. 2000) [11]. Among many landraces of chilli that are cultivated in the northeast, the Naga King Chilli is the foremost known worldwide. The Naga King Chilli is appraised as India's hottest chilli and was previously regarded as the world's hottest chilli having Scoville heat units (SHU's) rating of 1,001,304 (Bosland and Baral 2007) [2]. The pungent principle of chilli fruit is capsaicinoids, a family of compounds that give them the characteristic pungent taste. In nature, the two major capsaicinoids, capsaicin and dihydrocapsaicin account for 90 percent of the total pungency in chilli fruits (Suzuki *et al*. 1981) [18]. This chilli is grown mainly in the state of Nagaland, Assam and Manipur and to some extent in Mizoram, Arunachal Pradesh and Meghalaya. It is also cultivated in the north eastern region of Bangladesh (Bhuyan*et al*. 2015). Because of its commercial importance, the Nagaland Government obtained the Geographical Indication (GI) of Goods tag for Naga King Chilli in the year (Registration and Protection) Act 1999, to provide some safety net to Naga farmers in the cultivation of the King Chilli. Nagaland Government has obtained the GI rights for this product in 2008.The amount of capsaicinoids in a chili pepper is dependent upon the genetic makeup of the plant and the environment where it is grown Harvell and Bosland (1997) [4] and Zewdie and Bosland (2000) [22]. The capsaicinoids have developed in chilli peppers as a defense mechanism against mammalian predators (Tewksbury and Nabhan, 2001) [19]; nonetheless, this characteristic is an important fruit quality aspect and the reasons chilli peppers are consumed. The information on the nature and degree of genetic divergence is essential for the breeder to choose the right type of parents for purposeful hybridization in heterosis breeding (Patel *et al*., 1989 [14]; Farhad*et al*., 2010; Khodadabi*et al*., 2011). In order to benefit transgressive segregation, the knowledge of genetic distance between parents is mandatory (Joshi *et al*., 2004 [7]; Khodadabi *et al*., 2011). The standardization of variables is also essential towards determining the genetic distance so that all variables are of similar importance in determining the distance.

Various methods have been used in studying of genetic diversity through cluster analysis of which Tocher's methods is the most popular approach. The cluster analysis is an appropriate method for determining family relationships (Mellingers, 1972) [12]. Euclidean distance can theoretically estimate the genetic distance between parents to maximize the transgressive segregation (Hoque and Rahman, 2006) [5]. The higher genetic distance is revealed between parents, the higher heterosis in progeny can be observed (Lahbib *et al*., 2012). In the present study 11Naga King chilli genotypes from different regions of Nagaland and other parts of India were collected and cultivated at research farm of Genetics and Plant Breeding, School of Agricultural Science and Rural Development, Nagaland University, India during February-October 2018 to February-October 2019 and analyzed for their genetic diversity based on morpho-chemical traits. The main objective of this study is to capture the potential genetic diversity between chilli genotypes grown in India by using cluster analysis and selection of suitable genotypes for future chilli hybridization programmer.

## Material and Methods

The present investigation was conducted for two growing Seasons i.e. 2018 and 2019 under open field condition located in the Experimental Farm of Genetics and Plant Breeding, Nagaland University, SASRD. The experiment was evaluated in Randomized Block Design (RBD) with three replications comprising 12 plants in each plot of (3x2) m2 with a spacing of 75cm between the plants and rows. 11 Naga King Chilli genotypes were procured from different regions growing under Nagaland and the particulars of the landraces are presented in Table 1. The observations were recorded on five randomly selected plants of each genotype on days to first flowering, plant height (cm), days to 50 percent fruiting, number of fruits per plant, fresh fruit weight (g), fruit length (cm), fruit width (cm), number of fruits per cluster, number of seeds per fruit, dry fruit weight (g), 1000 seed weight (g), fruit yield per plant (g), beta-carotene (mg per 100g), ascorbic acid (mg per 100g), moisture content (percentage) and capsaicin content (mg per 100g) were measured.

## Statistical analysis

Analysis of variance, cluster analysis based on Tocher's method using squared Euclidean distance (Kumar *et al*., 2009) was performed using the statistical software Indostat and statistical package for agricultural research (SPAR) version 2.0 programmer. The genetic divergence was calculated according to Mahalanobis$D^2$ statistics (1936).

## Results and Discussion

The analysis of variance in the present investigation revealed significant variation among the 11 genotypes of King chilli for all the characters. The study of $D^2$ (genetic divergence) of 11 genotypes was done through Mahalanobis $D^2$ statistic as described by Rao (1952) [16]. All the genotypes were assembled into 5 different clusters. Cluster I was the largest one comprising of seven genotypes followed by cluster 2, cluster 3, cluster 4 and cluster 5 with 1 genotype each, which indicates heterogeneity among the genotypes. Similar observations have been recorded by Vani *et al*. (2007) [20] evaluated 55 accessions of chilli for genetic divergence, where plant height and yield per plant showed maximum contributions towards diversity $D^2$ analysis grouped all the genotypes into 14 clusters with 10 solitary clusters. Sen *et al*. (2021) [17] study on genetic diversity was conducted with six chilli genotypes with inter-and intra-specific cross varieties of the three most popular chilli species (*Capsicum annuum* L., *Capsicum chinense* Jacq, and *Capsicum frutescens* L.) where Cluster I had the maximum (12) and clusters IV and V had the minimum number (1) of genotypes. The selection of genotypes for hybridization should be based on genetic divergence rather than geographical diversity.

Intra and inter cluster distances (D values) are shown in Table 3. The inter-cluster distances were higher than the intra-cluster distances. The intra cluster divergence was found to be 107.57 in Cluster I, while Cluster 2, cluster 3, cluster 4 and cluster 5 showed zero intra cluster distance due to containing of only one landrace which signifies that the genotypes were similar in their genetic makeup. Similar results were reported by Yatung, *et al*. (2014) and Ozukum and Seyie (2018) [13]. The inter cluster $D^2$ values were found to be maximum between Cluster 3 and 4 (642.67), indicating wide genetic diversity between these two clusters followed by cluster 3 and 5 (595.15), cluster 2 and 5(509.67) and cluster 2 and 4 (466.08). Thus, the genotypes belonging to these clusters form ideal pairs for developing hybrids as suggested by Prabhudeva (2003) [15]. The selection of diverge genotypes from this clusters would produce a broad spectrum of variability for morphological and quality traits studied which may be beneficial for further selection and improvement.

Differences in cluster means exhibited for almost all the characters studied and are presented in Table 4. Cluster 3 had highest mean values for different characters *viz* fruit yield per plant followed by ascorbic acid, moisture content, number of fruits per plant, number of seeds per fruit, fresh fruit weight, fruit length, 1000 seed weight, fruit width, number of fruits per cluster, capsaicin content and dry fruit weight. Therefore, the genotype under cluster 3 has the genetic potential to contribute better for yield maximization of Naga King Chilli genotypes. As for the rest of the genotypes in the remaining clusters the genotype in cluster 2 exhibited highest for plant height and days to 50 percent fruiting, genotype in cluster 4 days to first flowering and genotype in cluster 5 for beta-carotene. The results indicated that selection of genotypes having high values for a particular trait can be utilized in the hybridization programmer for improvement of that particular character. The maximum relative contribution to the total divergence was made by capsaicin content followed by ascorbic acid, number of fruits per cluster, dry fruit weight, fruit yield per plant, beta-carotene and moisture content. Similar results were observed by Yatung *et al*. (2014) [21], Janaki *et al*. (2015) [6] and Manju and Sreelathakumary (2004) [10].

**Table 1:** Specification of genotypes

| Code | Place of Collection | District |
|---|---|---|
| T1 | Azailong | Peren |
| T2 | Pongkong | Mon |
| T3 | Medziphema | Dimapur |
| T4 | Tenyiphe | Dimapur |
| T5 | Deukoram | Peren |
| T6 | Peren | Peren |
| T7 | ChÜmoukedima | Dimapur |
| T8 | Jalukie | Peren |
| T9 | Sochunoma | Dimapur |
| T10 | Athibung | Peren |
| T11 | Thekrejuma | Kohima |

**Table 2:** Clustering pattern of 11 genotypes of Naga King Chilli based on the basis of genetic divergence

| Cluster Number | Number of Genotypes | Genotype Member |
|---|---|---|
| Cluster 1 | 7 | T2, T3, T4, T5, T6, T8, T10 |
| Cluster 2 | 1 | T11 |
| Cluster 3 | 1 | T7 |
| Cluster 4 | 1 | T9 |
| Cluster 5 | 1 | T1 |

**Table 3:** Average of inter and intra cluster distance of 11 genotypes of Naga King Chilli

| Cluster Number | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 | Cluster 5 |
|---|---|---|---|---|---|
| Cluster 1 | 107.57 | 177.39 | 274.16 | 296.81 | 224.03 |
| Cluster 2 | 177.39 | 0.00 | 98.57 | 466.08 | 509.67 |
| Cluster 3 | 274.16 | 98.57 | 0.00 | 642.67 | 595.15 |
| Cluster 4 | 296.81 | 466.08 | 642.67 | 0.00 | 357.53 |
| Cluster 5 | 224.03 | 509.67 | 595.15 | 357.53 | 0.00 |

**Table 4:** Cluster wise mean value of 16 characters in Naga King Chilli genotypes

| Characters | CR 1 | CR 2 | CR 3 | CR 4 | CR 5 | CR 6 | CR 7 | CR 8 | CR 9 | CR 10 | CR 11 | CR 12 | CR 13 | CR 14 | CR 15 | CR 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster 1 | 155.67 | 51.52 | 195.19 | 46.14 | 4.85 | 4.98 | 2.61 | 2.50 | 34.83 | 0.80 | 4.51 | 230.51 | 2.10 | 180.95 | 83.19 | 1.29 |
| Cluster 2 | 156.00 | 54.27 | 195.33 | 56.33 | 5.25 | 5.39 | 2.61 | 2.54 | 39.17 | 0.77 | 4.48 | 194.00 | 1.35 | 193.00 | 83.60 | 1.74 |
| Cluster 3 | 153.00 | 51.80 | 194.33 | 72.75 | 5.86 | 5.66 | 2.78 | 2.73 | 42.23 | 0.90 | 4.95 | 327.94 | 2.48 | 196.00 | 85.20 | 1.96 |
| Cluster 4 | 157.00 | 52.19 | 195.00 | 46.40 | 5.25 | 4.95 | 2.53 | 2.46 | 35.42 | 0.85 | 4.33 | 193.46 | 4.17 | 154.67 | 84.40 | 1.34 |
| Cluster 5 | 151.33 | 51.86 | 188.00 | 48.90 | 5.22 | 5.13 | 2.53 | 2.65 | 36.07 | 0.80 | 4.32 | 279.63 | 4.89 | 182.33 | 83.60 | 0.87 |

**Table 5:** Contribution of each character towards divergence

| Sl. No. | Characters | Contribution (%) |
|---|---|---|
| 1 | Days to first flowering | 0.00 |
| 2 | Plant height (cm) | 0.00 |
| 3 | Days to 50% fruiting | 0.00 |
| 4 | Number of fruits per plant | 0.00 |
| 5 | Fresh fruit weight (g) | 0.00 |
| 6 | Fruit length (cm) | 0.00 |
| 7 | Fruit width (cm) | 0.00 |
| 8 | Number of fruits per cluster | 7.27 |
| 9 | Number of seeds per fruit | 0.00 |
| 10 | Dry fruit weight (g) | 1.82 |
| 11 | 1000 seed weight (g) | 0.00 |
| 12 | Fruit yield per plant (g) | 1.82 |
| 13 | Beta-carotene (mg/100g) | 1.82 |
| 14 | Ascorbic acid (mg/100g) | 40 |
| 15 | Moisture content (%) | 1.82 |
| 16 | Capsaicin (%) | 45.45 |
| Total | | 100.00 |

## Conclusion

At present due to the occurrence of genetic erosion caused by interchanging of local cultivars of Naga King chilli with improved ones, it has become immensely important to conserve genetic diversity. There is every chance of losing some useful genetic resources if efforts are not been made from time to time for evaluation, collection and maintenance of locally adapted landraces materials. In Naga King chilli, a wide diversity of plant and fruit characters is quite apparent which holds eminent potential for developing high yielding varieties with desirable characters through appropriate breeding methods.

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