J. Farm Sci., 35(3): (329-331) 2022

RESEARCH PAPER

Studies on genetic diversity in chilli (*Capsicum annum* L.) for drought tolerance and yield attributing traits

SWARNA GANGOTRI, D. A. PEERJADE, MALLIKARJUN AWATI, H.P. HADIMANI, A. M. NADAF, S. RAGHAVENDRA AND D. SATHISH

Department of Biotechnology and Crop Improvement, College of Horticulture
University of Horticultural Sciences, Bagalkot - 587 104, Karnataka, India
E-mail: gangotriswarna0903@gmail.com

(Received: July,2022 ; Accepted: August, 2022)

Abstract: An investigation was carried out to understand the extent of genetic diversity in thirty-four chilli (*Capsicum annum* L.) genotypes based on sixteen quantitative and qualitative traits. Mahalanobis's D^2 analysis showed the presence of wide genetic diversity among the 34 genotypes by forming 5 clusters irrespective of their geographical diversity, suggesting that there was no relation between geographic and genetic diversity. The cluster II showed a maximum number of genotypes (26), clusters I and III had three genotypes and clusters IV and V had only one genotype each. Intra-cluster distance analysis revealed that the minimum intra-cluster distance was observed in clusters IV and V. The inter-cluster distance (D) was found to be the maximum between clusters II and III and the same was minimum between clusters IV and V. A wider genetic diversity was observed for the different traits studied among the genotypes as evidenced by the formation of five clusters. The results indicated that the maximum contribution towards divergence was by the number of fruits per plant (45.28%) followed by proline content (23.17%), SPAD value (11.23%), fruit length (5.88%) and fruit yield (4.10%).

Key words: Bio-chemical traits, Chilli, D^2 analysis, Drought, Genetic diversity, Phenotypic traits

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important vegetables as well as a spice crop commonly used in the preparation of many Indian delicacies. Chilli belongs to the family Solanaceae with the chromosome number 2n=24 for diploid species and 2n=26 for wild species (Pickersgill, 1991). It is a widely cultivated commercial plant species in India. It has the largest distribution worldwide and can be consumed either as raw or cooked. Chilli is considered to be one of the richest sources of vitamin C (ascorbic acid), vitamin A, vitamin E and vitamin B5. It is also a good source of potassium, magnesium, iron, calcium and phosphorous. Its pungency is attributed to capsaicin, an alkaloid.

Chilli is cultivated in all the seasons in India *viz., kharif, rabi* and summer provided soil moisture is not a limitation. However, there are many constrains for getting good crop yield in chilli like lack of suitable cultivars or hybrids, biotic stresses *viz.,* infection of fungi, bacteria, viruses, nematodes etc. and abiotic stresses *viz.,* moisture, temperature, radiation, nutrition etc. The prolonged dry spells during *kharif* and inadequate irrigations during *rabi* and summer limit the growth and productivity of chilli. Moisture stress is considered to be a major limitation for realizing its full yield potential in many chilli growing areas in India. Drought is recognized as one of the most important abiotic stress conditions especially in chilli as it can affect it in terms of yield and quality parameters. During severe drought conditions, there will be a drastic decrease in plant growth by impairing several physiological and biochemical processes. They include leaf area, leaf respiration, leaf chlorophyll content, plant canopy temperature, leaf water content, proline content etc. Some of the mechanisms through which plants mitigate drought are accumulation of compatible osmolytes, adjusting the osmotic potential, shortening life cycle or keeping stomata open to allow CO^2 assimilation through cell enlargement etc. The effect of moisture stress also varies at various crop growth stages of chilli (Mahmood *et al.,* 2021).

Among the various ways to mitigate the drought effect on chilli productivity is to develop tolerant varieties. Genetic diversity among the germplasms is a pre requisite for a successful breeding program for development of drought tolerant varieties. It helps the breeder to know the extent of genetic divergence among the germplasms which can provide essential and effective information in hybridization and thereby improve the yield.

Material and methods

A field experiment was conducted during *rabi* 2020-21 under controlled irrigation conditions at the Research Farm of the College of Horticulture, University of Horticultural sciences, Bagalkot. Thirty-four chilli genotypes collected from different geographical regions *viz*., Andhra Pradesh, Delhi, Karnataka, Maharashtra *etc.* were evaluated in factorial randomized complete block design (RCBD) with two replications. The seeds were sown in the nursery and 45 days old seedlings were transplanted in the field 60 x 45 cm spacing. The recommended agronomic practices were adopted for raising the crop.

The various growth, quality and yield observations *viz*., plant height (cm), number of primary branches, number of secondary branches, number of internodes, leaf area (cm^2) specific leaf area (cm^2/g), specific leaf weight (g/cm^2), relative water content (%), days to 50 per cent flowering, number of fruits/plant, fruit length (cm), fresh fruit weight (g), SPAD value at harvest, stomatal conductance ($mmol/m^2/s$), proline content

Table 1. Clustering pattern of chilli genotypes based on D² analysis

Cluster no.	No. of genotypes	Genotypes name
I	3	DB variety, Dappa, Arka Lohit
II	26	ST-7, ST-14, ST-17, ST-19, ST-22, ST-24, GPM-40, GPM-33, GPM-120-3-1, PSB-UC- 1, PSB-EC, PSB Selection-2DC, KCA-33A-USF, KCA-33B-ULF, KCA-19-3-PC-3, Byadgi Kaddi, Byadgi Dabbi, Sygenta-555-1, Sitara, SRS, Pusa Sadabahar, Arka Meghana, Arka Haritha, Arka Shweta, Sitara Gold, Guntur
III	3	ST-10, ST-15, ST-21
IV	1	ST-16
V	1	ST-11

Table 2. Average intra and inter cluster distance (D^2) values of clusters in chilli genotypes

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V
Cluster I	13.86	54.04	88.36	70.25	73.68
Cluster II		25.92	44.76	32.62	41.61
Cluster III			22.74	34.59	42.27
Cluster IV				0.00	31.41
Cluster V					0.00

Table 3. Cluster mean analysis for growth, quality and yield characters in chilli genotypes

Characters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V
Plant height (cm) at harvest	61.38	44.81	33.43	46.11	37.99
No. of primary branches at harvest	4.77	3.82	3.06	4.00	3.83
No. of secondary branches at harvest	7.94	5.87	5.00	6.16	5.66
No. of internodes at harvest	8.66	6.17	4.99	7.32	4.32
Leaf area (cm^2) at harvest	13.96	12.10	5.04	11.64	6.23
Specific leaf area (cm^2/g) at harvest	0.10	0.08	0.05	0.08	0.08
Specific leaf weight (g/ cm^2) at harvest	10.02	12.96	22.18	12.11	12.37
Relative water content (%) at harvest	74.72	53.47	44.56	54.27	55.35
Days to 50 per cent flowering	62.00	56.40	48.67	49.00	63.00
No. of fruits/plant	25.05	17.89	12.33	11.83	11.83
Fruit length (cm)	11.66	11.46	11.94	10.66	12.27
Fresh fruit weight (g)	3.02	1.63	0.87	1.63	1.70
SPAD value at harvest	37.42	41.30	44.82	41.55	40.20
Stomatal conductance (mmol/m^2/s) at harvest	0.44	0.47	0.54	0.51	0.46
Proline content (mg/g f w)	13.06	10.19	9.26	9.4	11.04
Fruit yield (g/plant)	201.82	166.21	74.92	187.41	101.08

(mg/g) in fresh biomass and fruit yield (g/plant) were recorded in all the genotypes from three randomly selected plants in each replication and their average was worked out and used for statistical analysis. Mahalanobis (1936) D^2 statistics was used for computing the genetic divergence among all the genotypes and they were grouped in different clusters based on the genetic distance (Rao, 1952).

Results and discussion

The Mahalanobis D^2 analysis revealed that the 34 chilli genotypes were distributed into 5 clusters (Table 1). Cluster II was the largest comprising 26 genotypes followed by clusters I and III having 3 genotypes each and clusters IV and V were solitary in nature. Cluster I consisted of genotypes that had traits showing drought tolerance and cluster III consisted of genotypes that showed traits showing drought susceptibility. Hence it was seen that genotypes having resistance and susceptible characters were grouped under different genotypes and the geographic distribution of these genotypes was not related to their genetic diversity. Similar findings have also been reported by Yatung *et al.* (2014) and Kumari *et al.* (2018).

The inter and intra-cluster D^2 values among five clusters are presented in Table 2. Inter-cluster average D^2 values ranged from a distance of 31.41 to 88.36 units. The maximum inter-cluster distance was observed between clusters I and III (88.36) followed by clusters I and V (73.68) indicating that the maximum diversity was observed between the genotypes grouped under these clusters. These genotypes could be used for a hybridization program which would result in high heterotic combinations for yield. The minimum inter-cluster distance was observed in cluster IV and V which indicated that most of the characters had similar values in these clusters. Maximum intra-cluster distance was observed in the cluster II followed by cluster III which indicated that the genotypes in these clusters were closely related and had less divergence among them.

The data on the mean values of characters studied are presented in the Table 3. The highest cluster mean values for plant height (cm), number of primary branches, number of secondary branches, number of internodes, leaf area (cm^2), specific leaf area (cm^2/g), number of fruits/plant, fresh fruit weight (g), proline content (mg/g) and fruit yield (g/plant) in

Table 4. Per cent contribution of each character towards genetic divergence in chilli genotypes

Characters	Contribution %
Plant height (cm) at harvest	0.00
No. of primary branches at harvest	0.00
No. of secondary branches at harvest	0.00
No. of internodes at harvest	0.18
Leaf area (cm^2) at harvest	0.36
Specific leaf area (cm^2/g) at harvest	3.03
Specific leaf weight (g/ cm^2) at harvest	0.00
Relative water content (%) at harvest	0.00
Days to 50 per cent flowering	2.85
No. of fruits/plant	45.28
Fruit length (cm)	5.88
Fresh fruit weight (g)	2.85
SPAD value at harvest	11.23
Stomatal conductance(mmol/m^2/s) at harvest	1.07
Proline content (mg/g f w)	23.17
Fruit yield (g/plant)	4.10

cluster I whereas specific leaf weight (g/cm^2), SPAD values and stomatal conductance (mmol/m^2/s) were highest in cluster III. Rajeswari *et al.* (2020) and Almuwayhi (2021) also reported that physiological traits had marked influence on the drought tolerance and productivity of chill.

Among the 16 characters studied, the maximum contribution towards fruit yield was observed with number of fruits per plant and proline content under drought condition (Table 4). The contribution mainly depended on the genotypes included in the study and the environmental influence over the characters. Similar results were also reported by Lahbib *et al.* (2013), Nagaraju *et al*. (2018) and Parveen *et al.* (2019).

Conclusion

On the basis of Mahalanobis D^2 diversity analysis among the chilli genotypes, the ST-10, ST-15 and ST-21 were grouped under one cluster and DB variety, Dappa and Arka lohit were grouped under another cluster suggesting that these genotypes are susceptible and tolerant, respectively for drought.

References

Almuwayhi M A, 2021, Impact of water deficit on correlations and changes of some physiological traits of sweet pepper (*Capsicum annuum* L.), *African Journal of Agricultural Research,* 17(2): 247-254.

Kumari V, Singh J, Mishra S and Gayen R, 2018, Studies on genetic divergence in chilli genotypes (*Capsicum annuum* L.). *Journal of Pharmacognacy and Phytochemistry,* 7(6): 55-58.

Lahbib K, Bnejdi F and El Gazzah M, 2013, Selection of pepper parent from a collection of *Capsicum annuum* landraces based on genetic diversity. *Journal of Plant Breeding and Crop Sciences,* 5(5): 68-72

Mahalanobis P C 1936, On the generalised distances in statistics. *Proceeding of the National Institute of Science of India*, 11(2): 49-55.

Mahmood T, Rana R M, Ahmar S, Saeed S, Gulzar A, Khan M A, Wattoo F M, Wang X, Branca F, Mora Poblete F, Mafra G S and Du X, 2021, Effect of drought stress on capsaicin and antioxidant contents in pepper genotypes at reproductive stage, *Plants*, 10: 1286.

Nagaraju M M, Reddy R V S K, Reddy K M, Naram L, Naidu A and Krishna K U, 2018, Assessment of genetic diversity in different chilli (*Capsicum annuum* L.) genotypes. *Journal of Pharmocognacy and Phytochemistry*, 7(6): 1473-1478.

Parveen A, Rai, G K, Mushtaq M, Singh M, Rai P K, Rai S K and Kumdoo A A, 2019, Deciphering the morphological, physiological and biochemical mechanism associated with drought stress tolerance in tomato genotypes. *International Journal of Current Microbiology and Applied Science,* 8(5): 227-255.

Pickersgill B, 1991, Genetic resources and breeding of *Capsicum* spp. *Euphytica*, 96: 129-133.

Rajeswari V, Vijayalakshmi D, Srinivasan S, Swarnapriya R, Varanavasiappan S and Jeyakumar P, 2020,Morpho-physiolological changes in chilli under drought and heat stress. *Current Journal of Applied Science and Technology,* 39(47): 68-77.

Rao C R, 1952, Advanced Statistical Methods in Biometrical Research, John Willey and Sons, New York.

Yatung, T, Dubey R K, Singh V and Upadhyay G, 2014, Genetic diversity of chill (*Capsicum annuum* L.) genotypes of India based on morpho-chemical traits. *Australian Journal of Crop Science,* 8(1): 97-104.