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Genetic Diversity of Chilli (*Capsicum annum* L.) Genotypes a Way Crop Improvement in Uttarakhand Hill Zones of India

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ABSTRACT: Uttarakhand has diverse geography with hilly regions possesses great diversity of vegetation including varieties of Chilli. In this study 19 different chilli genotypes are used for genetic diversity studies and these 19 genotypes was grouped into five clusters for variance analysis. Among the genotypes maximum were placed in cluster III (Nine genotypes) and cluster IV (Five genotypes). The cluster III (580.93) recorded maximum intra-cluster distance and the minimum was detected in cluster IV. The higher inter cluster distance (2384.003) were noted between the II and V cluster and maximum means for most of the valuable traits were noted in the IV and V Cluster. Yield characters showed towards total genetic divergence followed by quality parameters. In conclusion among the genotypes from cluster III, II, V and IV can be useful as a cultivars and also useful for valuable parenting lines in future crop improvement.

Keywords: Capsicum; Diversity; Quality traits; D^2 statistics.

INTRODUCTION

Chilli (*Capsicum annuum* L. var. *accuminatum*) is a vital universal hot spice crop, grown in tropical and subtropical area of the different countries. Chilli is an exceptional and important spice crop due to its biting pungency, colour and unique flavour. India is the chief producer of the red Chilli in the world and exporting majority of the its production. The wide genetic diversity for phenotypic as well as horticultural traits makes red chilli is an important for culinary, cosmetics and medicinal useas (Andrews, 1999; Bosland and Votawa, 2000; Prasath *et al.,* 2007). The indiscriminate use of synthetic colours in the food has several harmful effects on human health (Saleem *et al.*, 2013). This has resulted in huge demand for chilli with high colorant and mild pungency. In north India especially the Kashmir, Uttarakhand, Himachal Pradesh is known for rich coloured chillies with large variability in plant morphology and fruit shape, size and colour (Singh *et al*., 2014). Chilli is either sold as whole or in the processed powder form.

Due to the absence of improved genotypes for high altitude conditions is the key limitation for getting good yields. Evaluation of diverse genotypes helps to find out the good genotypes and cultivars for quick advances in improvement of any crop yields (Ramanujam *et al*., 1974; Gaur *et al*., 1978; Patel *et al*., 1989). The genetic diversity assessment is a significant source and provides information on specific character among the germplasm collections The crop improvement programme and hybridization genetic divergence and variation among the existing and other populations play major role. The maximum diversity within parents and their population facilities good chances of improving the quality and quantity traits under consideration in the offspring (Tomooka, 1991). The present study was undertaken to evaluate the genetic diversity in 19 genotypes of chili and to find the appropriate donors for a fruitful crop improvement in chilli for quality production.

MATERIALS AND METHODS

A. Experimental location and Plant materials

The present investigation was undertaken at College of Horticulture, Bharsar, VCSG UUHF, Uttarakhand during the year 2016-17. Nineteen genotypes (Table 1) were evaluated for plant growth and yield characters. The seedlings were transplanted during third week of

May. All the package of practices and plant protection measures were followed as for university recommendations during the crop period.

B. Observations

Growth parameters such as Plant height (cm), plant spread (cm), stem girth (cm) number of primary branches, secondary branches and tertiary branches, days to first flowering, days to 50% flowering, number of fruits per plant, fruit length (cm), fruit weight (g), fresh fruit yield per hectare (q/ha). The quality parameters such as ascorbic acid content (mg/100g), chlorophyll a, chlorophyll 'b' content (Yashida *et al.* (1971), pericarp thickness (mm), average dry fruit weight (g) and capsaicin content (%) Sadashivam and Manikkam (1996) was estimated (Anonymous, 1975).

C. Statistical analysis

The observation data were analysed and presented as suggested by Panse & Sukhatme (1985) and GCV and PCV were estimated as by Lush (1949; Burton, 1952). Heritability (broad sense) and genetic advance (GA) were estimated as per Johnson *et al.,* (1955) per cent of mean at 5% selection intensity. The genotypes were grouped into a number of clusters using Tocher's method and D^2 statistics method as suggested by Mahalanobis (1936) and Rao (1952).

Table 1: List of chilli genotypes.

Treatments	Genotypes	Source
T_1	Bydagi dabbi	Karnataka
T_2	Bydagi kaddi	Karnataka
T_3	Sankeswar	Uttarakhand
T_4	Hill local	Uttarakhand
T_5	Kandhamullaku chilli (SMALL)	Kerala
T_6	Ranichauri local	Uttarakhand
T_7	Madhya Pradesh local	Madhya Pradesh
T_8	Bharsar local-1	Uttarakhand
T_9	Nainital local	Uttarakhand
T_{10}	Pant nagar local	Uttarakhand
T_{11}	Banvasi local	Karnataka
T_{12}	Arka lohit	IIHR, Bengaluru
T_{13}	Pant C-1*	Uttarakhand
T_{14}	Pusa sadabahar	IARI, New Delhi
T_{15}	Varadha	Uttarakhand
T_{16}	Lakhori	Uttarakhand
T_{17}	Kandhamullaku chilli (Large)	Kerala
T_{18}	Arka suphal	IIHR, Bengaluru
T_{19}	Bharsar local-2	Uttarakhand

RESULTS AND DISCUSSION

In this study we are used 19 genotypes for genetic divergence studies and these were divided into five clusters and it facilitates to easy identification genotypes which are similar features. The genotype collections from diversified places showed autonomous of their origin and according to study the cluster III (9) having maximum genotypes numbers and followed by other clusters such as IV (5 genotypes), I (2), V (2) and II (1).

The analysis of variance discovered the significant differences among the genotypes for all the plant growth and yield characters, it shows the maximum genetic divergence among the 19 genotypes grown in Hill zone of Uttarakhand. The data showed that the intra cluster distance was found maximum in cluster III (580.93), however, the maximum inter cluster distance (2384.00) was recorded between cluster II and cluster V. Whereas, the maximum inter cluster distance was recorded between cluster II and V. The diversified genotypes were characterized by maximum inter cluster distance will vary in phenotypic performance and therefore, chances to obtain favourable transgressive segregates are more on the basis of results obtained.

The existence of diversity among the genotypes was also assessed by the considerable amount of variation in cluster means for different plant characters. The maximum means for fruit length, average fresh fruit weight, fresh fruit weight per hectare, chlorophyll 'a' content, chlorophyll 'b' content and dry fruit yield per plant was observed in Cluster-V. However, cluster-II was noted for days to first flowering, days to 50%flowering, ascorbic acid content and number of seeds per fruit. Crossing between the genotypes of two clusters appeared to be most promising to combine the desirable characters. In the present investigations, cluster V and II were found more divergent and there will be more chances of getting better segregants in F_2 and subsequent. Ajjapplavara (2009); Datta and Das (2013) observed the maximum fruits and fruit yield per plant and powdery mildew disease and leaf curl complex incidence contribute significantly for the genetic diversity. The genotypes such as LCA-206, Pant C-1, KDC-1, Bydagi dabbi and AD-5, Phule Sai, recorded best results than other genotypes, it might be due to heritability along with higher genetic advance was found in number of fruits and yield per plant. These characters may be considered as reliable selection indices as they are possibly governed by

additive gene effect. Similar opinions were also reported by Gogate *et al.* (2006); Jyothi *et al.* (2008); Surya Kumari *et al*. (2010); Hasan *et al.* (2014); Yatung *et al*. (2014); Mishra *et al*. (2016) in Capsicum. Thul *et al.* (2009); Sharma *et al*. (2010). Shrilekhal *et al.* (2011); Rosmaina *et al.* (2016); Belay *et al*. (2020) noted that the high heritability of growth and yield traits were more influenced by genetic factors than environmental factors. The yield characters such as fruit length, fruit diameter, and fruit weight with high genetic variation and heritability should be considered as reliable selection criteria for yield enhancement in chili. Hence, it may be concluded that a widespread range of variability among all economically important traits is available in selected genotypes and its useful further crop improvement programme in chilli.

Table 2: Clustering patterns of nineteen genotypes of chilli on the basis of genetic divergence.

Clusters	Number of genotypes	Genotypes along with their sources
I	2	Sankeswar (Uttarakhand), Hill Local (Uttarakhand)
II	1	Bharsar Local-1(Uttarakhand)
III	9	Bydagi Dabbi (Karnataka), Kandhamullaku Chilli (SMALL) (Kerala), Nainital Local (Uttarakhand), Pant Nagar Local (Uttarakhand), Banvasi Local (Karnataka), Pusa Sadabahar (IARI New Delhi), Varadha (Uttarakhand), Kandhamullaku Chilli (LARGE) (Kerala), Bharsar Local-2(Uttarakhand)
IV	5	Ranichauri Local (Uttarakhand), Arka Lohit (IIHR Bengaluru), Pant C-1(Uttarakhand), Lakhori (Uttarakhand), Arka Suphal (IIHR Bengaluru)
V	2	Bydagi Kaddi (Karnataka), Madhya Pradesh Local (Madhya Pradesh)

Table 3: Average intra and inter cluster distance (D^2).

Clusters	I	II	III	IV	V
I	198.67				
II	642.61	294.08			
III	776.97	1172.27	580.90		
IV	1593.68	637.02	1920.41	0.00	
V	2067.33	2384.00	1094.40	2174.53	0.00

Table 4: Cluster means for different traits in nineteen genotypes of chilli.

Sr. No.	Traits	Clusters				
		I	II	III	IV	V
1.	Plant Height (cm)	56.17	56.13	44.48	47.80	49.17
2.	Plant Spread (cm^2)	39.53	37.47	30.13	29.55	41.37
3.	Stem Girth cm)	2.83	2.84	2.78	2.49	2.70
4.	Primary Branches/ plant	3.50	4.20	3.23	3.67	3.17
5.	Secondary Branches/ plant	2.87	4.73	3.30	3.43	2.97
6.	Tertiary Branches/ plant	12.71	14.40	8.27	10.24	13.83
7.	Total Branches/ plant	18.47	21.33	14.80	16.23	18.03
8.	Days to 1st Flowering	36.43	31.07	33.62	33.92	32.23
9.	Days to 50% flowering	48.73	45.40	47.06	46.65	46.47
10.	No of fruits /plant	41.33	37.07	25.88	27.09	38.67
11.	Fruit length (mm)	120.57	112.33	80.32	72.79	120.99
12.	Average fresh fruit weight (g)	4.26	3.70	2.61	2.72	3.87
13.	Fresh fruit yield /plant (g)	152.57	113.33	86.69	76.32	202.04
14.	Fresh fruit yield per plot (Kg)	1.83	1.36	1.03	0.92	2.42
15.	Fresh fruit yield per hectare (Q)	112.75	83.74	62.62	56.58	149.48
16.	Ascorbic acid (mg)	20.70	179.20	37.16	110.48	75.20
17.	Chlorophyll ‘a’	0.21	0.05	0.15	0.14	0.13
18.	Chlorophyll ‘b’	0.29	0.05	0.17	0.16	0.13
19.	Pericarp thickness (mm)	0.57	2.40	1.29	2.08	1.62
20.	Average dry fruit yield per plant	2.52	1.80	1.38	1.57	1.90
21.	Dry fruit yield per plant (g)	72.59	59.16	43.95	38.68	69.22
22.	No of seeds per fruit	68.83	99.33	65.56	61.33	91.50
23.	Seed weight per fruit	2.49	1.68	1.90	1.73	2.10
24.	Capsaicin (%)	0.10	0.09	0.10	0.10	0.10

Table 5: Genetic divergence contribution of Characters.

Sr. No.	Source	Ranked 1st	Contribution %
1.	Plant Height (cm)	0.01	0.00 %
2.	Plant Spread (cm^2)	0.58	0.58 %
3.	Stem Girth cm)	0.01	0.00 %
4.	Number of Primary Branches	0.01	0.00 %
5.	Number of Secondary Branches	0.01	0.00 %
6.	Number of Tertiary Branches	0.01	0.00 %
7.	Total Number Branches	0.01	0.00 %
8.	Days to first Flowering	0.01	0.00 %
9.	Days to 50% flowering	0.01	0.00 %
10.	Number of fruits	0.01	0.00 %
11.	Fruit length (mm)	1.17	1.17 %
12.	Average fresh fruit weight (g)	0.01	0.00 %
13.	Fresh fruit yield per plant (g)	0.01	0.00 %
14.	Fresh fruit yield per plot (Kg)	0.01	0.00 %
15.	Fresh fruit yield per hectare (q/ha)	32.16	32.16 %
16.	Ascorbic acid (mg)	23.39	23.39 %
17.	Chlorophyll 'a' content	0.01	0.00 %
18.	Chlorophyll 'b' content	18.71	18.71 %
19.	Pericarp thickness (mm)	0.01	0.00 %
20.	Average dry fruit yield per plant	1.17	1.17 %
21.	Dry fruit yield per plant (g)	12.87	12.87 %
22.	Number of seeds per fruit	7.02	7.02 %
23.	Seed weight per fruit (g)	0.01	0.00 %
24.	Capsaicin (%)	2.92	2.92 %

CONCLUSION

The study shows that significant amount of genetic variability was observed among the nineteen genotypes for plant growth, yield and quality attributing characters of chilli germplasms. Highest intra-cluster distance was observed in cluster III (580.93) and the minimum was observed in cluster IV followed by cluster V. Genotypes from cluster V, IV, III and II can offer potential for their direct and indirect use as varieties and as potential parenting materials for crop improvement programme in chilli.

Conflict of Interest. Nil.

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