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Studies on genetic divergence in chilli (*Capsicum* spp.) under sub Himalayan tracts of West Bengal

S. DATTA AND J. C. JANA

Department of Vegetable and Spice Crops
Uttar Banga Krishi Viswavidyalaya,
Pundibari, Cooch Behar - 736165, West Bengal, India

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ABSTRACT

To study the genetic divergence of chilli, 65 genotypes were evaluated in Randomized Block Design with three replications in two consecutive winter seasons of the year 2005-06 and 2006-07 at the experimental field of Uttar Banga Krishi Viswavidyalaya UBKV, Cooch Behar, West Bengal. Results indicated that in the first year 65 genotypes grouped into 12 clusters but 11 clusters in the second year on the basis of D^2 value. Pooled results indicated that 65 genotypes were grouped into the 11 clusters. Cluster I and III comprised 45 and 11 genotypes, respectively. Rest of clusters consisted of one genotype in each case. The clustering pattern revealed that there was no association of species and geographical distribution for the formation of cluster in genetic divergence. The characters namely, primary branches per plant, days to flowering, ascorbic acid content in fruit and extractable fruit colour were contributing maximum divergence and supposed to play important role in the improvement of chilli. On the basis of cluster mean, intra and inter cluster distance and per se cluster V (CA-29) and X (CA-60); cluster VIII (CA-55) and X (CA-60); cluster VIII (CA-55) and XI (CA-58) cluster VIII (CA-55) and IX (CA-59) may be used for their desirable characteristics in breeding programme of chilli improvement for the sub Himalayan terai tracts of West Bengal.

Key words : Chilli, genetic divergence, improvement

Chilli (*Capsicum* spp.) is an important vegetable cum spice crop grown all over the world including India. Though, India used to produce an appreciable quantity of chilli but its productivity is still low. Understanding about the nature and degree of genetic divergence in the available germplasm plays a pivotal role in selection for crop improvement programme. Genetic divergence among the collected genotypes of green chilli may help the breeders in selecting promising genetically diverse parent for the desired improvement. The divergence analysis using Mahalanbis's D^2 statistics, (Mahanalobis, 1936) which measure the forces of differentiation at intra and inter cluster level, is a variable tool for quantitative estimates of divergence Information on genetic divergence of chilli for the sub Himalayan *terai* tracts of West Bengal is scanty. Keeping in view the present investigation was under taken to study the nature and degree of genetic divergence among the chilli genotypes grown in northern part of West Bengal. This information can be exploited in future for varietal improvement programme of chilli.

MATERIALS AND METHODS

To study the divergence of chilli (*Capsicum* spp.) genotypes, sixty five chilli genotypes were transplanted during *rabi* season of two consecutive years 2005-06 and 2006-07. The experiment was laid out in RBD with three replications at the experimental field of UBKV, Cooch Behar, West Bengal. The area lies under the *terai* agro climatic zone of West Bengal, India. The experimental soil was sandy loam in texture (having p^H 5.5, 0.91% organic carbon, 133.81 $kg.ha^{-1}$ available nitrogen, 45.62 $kg.ha^{-1}$ available phosphorus and 59.43 $kg.ha^{-1}$ available potash) with poor water holding capacity. Healthy and uniform seedlings were transplanted in plots of 3.6 m x 3.0 m size with a spacing of 30 cm x 45 cm during middle of November. Organic manure @ 15 t ha^{-1} was applied as basal. Inorganic fertilizers were applied @ 100 : 50 : 50 kg N : P_2O_5 : K_2O ha^{-1} irrespective of year and season. Crop was raised following recommended package of practices. Observations were recorded on different morphological and yield attributing characters from ten randomly selected plants per plot. Ascorbic acid in chilli was determined by colorimetric method and was expressed in mg/100 g of sample (Ranganna, 2001). Capsaicin content (%) of green fruits is measured by spectrophotometric method (Sadasivam and Manickam, 1996). Total extractable colour i.e. capsanthin and capsorubin (in ASTA unit) of red fruits was measured by American Spice Trade Association techniques (Pruthi, 1999). Leaf chlorophyll content was measured by cholorophyll meter (with the unit of SPAD-502) at the time of first harvest. Mahanalobis D^2 statistics was used for assessing the genetic divergence between the groups. The grouping of the population was done by using Tocher's method as described by Rao (1952).

RESULTS AND DICUSSION

Genetic diversity of the genotypes:

The data on clustering pattern have been presented in Table 1A, 1B and 1C. Analysis of

Email: suchanddatta@rediffmail.com

variance revealed that the genotypes varied significantly for all the characters under study. Based on the D^2 value, 65 genotypes grouped into 12 clusters in the first year, 11 clusters in the second year as well as pooled results. In case of pooled, Cluster I and III comprised of 45 and 11 genotypes, respectively. Rest of clusters consisted of 1 genotype in each case. Variation in clustering pattern irrespective of year is very low. The clustering pattern revealed that there was no association of species and geographical distribution for the formation of cluster in genetic divergence. Similar findings were also reported by Sreelathakumary and Rajmony (2004) and Indra *et al.* (2000).

Table 1A : Cluster wise distribution of 65 chilli genotypes (1st year)

Cluster	Number of genotypes	Genotypes	Species
1	49	CA-21, CA-22, CA-9, CA-51, CA-19, CA-10, CA-11, CA-12, CA-13, CA-14, CA-53, CA-18, CA-8, CA-34, CA-32, G-4, CA-3, CA-15, CA-16, CA-23, CA-24, CA-25, CA-27, CA-52, CA-31, CA-36, CA-7, CA-39, CA-26, CA-1. Pusa Sadabahar, CA-40, CA-49, CA-28, CA-6, CA-41, CA-54, CA-42, CA-43, CA-44, CA-35, CA-45, CA-50, CA-48, Pusa Jwala, CA-47, CA-4, CA-5, CA-33	*Capsicum annuum* (48), *C. frutescens*(1)
2	1	CA-30	*C. annuum* (1)
3	1	CA-2	*C. frutescens*(1)
4	1	CA-29	*C. annuum* (1)
5	5	CA-38, CA-46, PC-1, Utkal Abha, Chilli Philhal	*C. annuum* (5)
6	1	DKC-8	*C. annuum* (1)
7	1	CA-17	*C. annuum* (1)
8	1	CA-37	*C. annuum* (1)
9	1	CA-20	*C. annuum* (1)
10	1	CA-55	*C. annuum* (1)
11	1	CA-58	*C. frutescens*(1)
12	2	CA-59, CA-60	*C. frutescens*(2)

Table 1B : Cluster wise distribution of 65 chilli genotypes (2nd year)

Cluster	Number of genotypes	Genotypes	Species
1	49	CA-33, CA-48, CA-54, Chilli Philhal, CA-39, CA-57, CA-47, CA-30, CA-41, Pusa Sadabahar, CA-44, CA-5, CA-6, CA-26, CA-51, CA-36, CA-40, CA-49, CA-11, CA-28, CA-8, CA-34, CA-19, CA-16, CA-10, CA-7, CA-24, CA-21, CA-53, CA-9, CA-22, CA-12, CA-3, CA-4, CA-31, CA-13, CA-42, CA-1, CA-14, CA-50, CA-27, CA-43, CA-32, CA-2, CA-45, CA-2, CA-45, CA-25, CA-35	*C. annuum* (47), *C. frutescens*(2)
2	4	CA-38, CA-46, Utkal Abha, CA-29	*C. annuum* (4)
3	1	CA-23	*C. annuum* (1)
4	4	CA-15, CA-18, CA-17, G-4	*C. annuum* (4)
5	1	CA-37	*C. annuum* (1)
6	1	Pusa Jwala	*C. annuum* (1)
7	1	CA-20	*C. annuum* (1)
8	1	CA-55	*C. annuum* (1)
9	1	CA-58	*C. frutescens*(1)
10	1	CA-60	*C. frutescens*(1)
11	1	CA-59	*C. frutescens*(1)

Table 1C : Cluster wise distribution of 65 chilli genotypes (Pooled)

Cluster	Number of genotypes	Genotypes	Species
1	45	CA-5, CA-6, CA-10, CA-11, CA-12, CA-13, CA-34, CA-25, CA-54, CA-24, CA-19, CA-39, CA-49, CA-33, CA-48, CA-36, CA-7, CA-43, CA-14, CA-42, CA-27, CA-3, CA-37, CA-32, CA-41,CA-52,CA-27, CA-35,CA-38, CA-8,CA-15, CA-44,CA-53,CA-21, CA-22, CA-23, CA-16, CA-47, CA-18, CA-50, CA-51, CA-28, PC-1, G-4, CA-46	*C. annuum* (45)
2	1	CA-30	*C. annuum* (1)
3	11	CA-1, CA-2, CA-17, CA-26, Utkal Abha, Pusa Sadabahar, CA-4, CA-28, Chilli Philhal, DKC-8, Pusa Jwala	*C. annuum* (9), *C. frutescens*(2)
4	1	CA-31	*C. annuum* (1)
5	1	CA-29	*C. annuum* (1)
6	1	CA-45	*C. annuum* (1)
7	1	CA-20	*C. annuum* (1)
8	1	CA-55	*C. annuum* (1)
9	1	CA-59	*C. frutescens*(1)
10	1	CA-60	*C. frutescens*(1)
11	1	CA-58	*C. frutescens*(1)

Table 2 : Cluster mean and percentage of contributing characters toward divergence in chilli (Pooled)

Cluster Number	Plant height (cm)	Primary branch	Secondary branch	Days to flowering (days)	Days to 1st harvest (days)	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (g)
I	75.37	6.20	17.68	61.85	108.66	5.95	1.10	2.94
II	62.36	8.23	22.32	41.00	82.17	6.03	1.16	2.02
III	62.43	6.17	17.01	71.58	121.64	5.63	1.11	2.48
IV	75.67	7.90	17.17	52.00	89.83	5.34	1.13	3.10
V	50.96	8.72	25.43	38.17	72.17	6.02	1.12	2.90
VI	74.26	6.40	20.27	49.50	88.50	4.45	1.49	3.10
VII	85.05	6.90	16.43	70.00	128.17	8.41	1.16	4.55
VIII	47.69	5.98	19.83	50.17	87.00	12.79	1.82	5.00
IX	101.58	7.13	18.17	74.83	130.17	1.87	0.56	0.71
X	105.93	8.97	26.52	97.50	145.00	1.31	0.42	0.30
XI	97.82	5.73	15.10	106.00	147.17	1.76	1.79	3.65
% of contribution toward divergence (1st year)	2.69	5.05	2.20	7.15	8.46	5.72	1.49	18.83
% of contribution toward divergence (2nd year)	2.74	5.20	2.10	0.10	6.59	3.37	0.72	21.76
% of contribution toward divergence (Pooled)	5.38	10.90	6.88	4.93	10.66	3.99	4.42	9.65

Intra and Inter cluster divergence

The maximum intracluster distance was recorded in cluster III (11.49). In case of pooled result, the maximum inter cluster distance (23.33) was observed between cluster VII (CA-20) and X (CA-60) followed by 21.50 in cluster VIII (CA-55) and XI (CA-58), 21.41 in cluster VII (CA-20) and X (CA-60), 21.37 in cluster V (CA-29) and X (CA-60) and 21.17 in cluster VIII (CA-55) and IX (CA-59). Similar inter and intra cluster distance of chilli was also observed by Indra *et al.* (2000). So, the genotypes included in these cluster have the greater divergence and hence the crossing between the genotypes in these clusters were expected to give desirable recombinants. Hence, intermating between the genotypes in these clusters (V, VIII, IX, X and XI) were expected to give more transgressive segregates in the advance generations. Roy and Sharma (1996) suggested that genotypes with outstanding mean performance should be intercrossed for genetic improvement of chilli.

Cluster mean

On the basis of pooled value (Table 2), it was observed that cluster V had the highest fruit yield per plant (258.5 g) and leaf chlorophyll content (65.85 SPAD-502) and second highest secondary branches (25.43). In this experiment cluster mean with respect to yield per plant varied from 119.0 g to 258.5 g this was close proximity with the findings of Sreelathakumary and Rajmony (2004). Cluster VII having the highest ascorbic content (165.10 mg per 100 g fresh) and pericarp thickness (0.21mm) and the second highest fruit length (8.41 cm), individual fruit weight (4.55 g).

Table 2 Continued

Cluster Number	Fruit number	Yield per plant (g)	Pericarp thickness (mm)	Chlorophyll content (SPAD-502)	Ascorbic acid content (mg per 100g)	Capsaicin content in green fruit (%)	Extractable fruit colour (ASTA)
I	103.31	154.0	0.18	59.60	123.28	0.61	104.73
II	153.17	232.0	0.17	64.95	131.58	0.36	81.88
III	105.13	154.0	0.18	61.19	126.05	0.63	109.74
IV	120.34	177.5	0.17	58.34	115.94	0.64	128.50
V	174.44	258.5	0.17	65.85	144.57	0.51	114.26
VI	135.70	199.0	0.19	60.95	122.16	0.66	39.79
VII	70.23	128.0	0.21	60.10	165.10	0.26	53.62
VIII	141.14	201.0	0.18	65.18	154.68	0.19	185.34
IX	292.80	146.0	0.19	54.23	104.77	1.69	75.60
X	468.54	119.0	0.19	58.37	84.50	2.08	89.87
XI	80.04	123.5	0.20	57.34	112.33	1.52	126.53
% of contribution toward divergence (1st year)	5.63	2.24	0.14	0.15	5.40	26.53	4.47
% of contribution toward divergence (2nd year)	18.94	0.53	1.05	1.00	5.65	23.54	6.83
% of contribution toward divergence (Pooled)	4.90	6.44	5.77	2.98	8.54	6.32	8.22

Cluster VIII had the highest fruit length and diameter (12.79 and 1.82 cm respectively), individual fruit weight (5.00 g) and extractable fruit colour (185.34 ASTA). Cluster IX had the second highest plant height (101.58 cm), number of fruits (292.80), capsaicin content in green fruit (1.69%) but having second lowest individual fruit weight (0.71 g) and third lowest fruit yield per plant (146.0). Cluster X had the highest plant height (105.93 cm), secondary branches (26.52) and number of fruits (468.54) and capsaicin content in green fruit (2.08%) but lowest individual fruit weight (0.30 g) and yield per plant (119.00). Cluster XI took the maximum days to flowering (106.00 days) and duration to first harvest (147.17 days) and third highest plant height (97.82 cm), individual fruit weight (3.65 g) and capsaicin content in green fruit (1.52%).

Contribution of the character toward divergence

The contribution of the individual characters (Table 2) revealed that the characters namely, primary branches per plant, days to first fruit harvest, ascorbic acid content in fruit, individual fruit weight and extractable fruit colour were contributing maximum divergence and supposed to play important role in the improvement of chilli for this region. Therefore, selection of divergent parent based on these characters will be very useful for heterosis breeding in chilli (Senapati *et al.*, 2003). The higher contribution towards genetic divergence was also recorded in fruits per plant and fruit length by Sreelathakumari and Rajamony (2004), individual fruit weight by Senapati *et al.* (2003) which was also similar with the findings of the present experiment. Contribution of the character toward divergence varied from year to year this might be due to complex interaction of different characters with respect to edaphological factors and their expression.

Selection of the parents for crop improvement

Yield is an important character which varied from year to year. So, for selection of genotypes, pooled performance was taken into account. Selection of the parents per genotypes based on mean performance, intra and inter cluster distance should be taken into account (Gogate *et al.* 2006). On the basis of cluster mean, intra and inter cluster distance and *per se* performance of the genotype existed in between the cluster V (CA-29) and X (CA-60), cluster VIII (CA-55) and X (CA-60), cluster VIII (CA-55) and XI (CA-58), cluster VIII (CA-55) and IX (CA-59) and cluster VII (CA-20) and X (CA-60) may be used for their desirable characteristics in breeding programme of chilli improvement.

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