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Genetic Diversity Analysis and Identification of Promising Bell pepper (*Capsicum annuum* var. *grossum* Sendt.) Lines under Protected Conditions

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ABSTRACT

Genetic diversity analysis of germplasm is useful for the conservation of genetic resources, broadening the genetic basis of cultivars, cultivar protection and its use in future breeding programmes. Phenotypic diversity was studied for yield and horticultural traits following multivariate analysis in 29 accessions of bell pepper collected from different regions of India. High genetic diversity was observed amongst the lines and a total of 13 clusters were observed. The inter-cluster D^2 value range from 3.54 to 13.60 indicating that the selected accessions were genetically divergent. No intra-cluster distance values (0.00) were observed in most of the clusters except cluster 1 and 2 revealing homogenous nature of the genotypes within the cluster. The genetically more divergent lines were present in cluster 5 and 8 as indicated by maximum inter-cluster distance value (13.60), which offer promise as a breeding stock in hybridization for the isolation of better transgressive segregants in bell pepper.

1. Introduction

Bell pepper (*Capsicum annuum* L. var. *grossum* Sendt.), a member of family Solanaceae, commonly known as sweet pepper or capsicum or *Shimla mirch* is native of Mexico with secondary centre of origin in Guatemala (Bukasov 1930). It is rich in alkaloids (capsaicin), fatty acids, flavonoids, volatile oil and carotene. It is also a wealthy source of ascorbic acid, vitamin A, rutin (a bioflavonoid), beta-carotene, iron, calcium, zinc and potassium, which are vital for a strong and healthy immune system. It also contains magnesium, phosphorus, sulphur, B-complex vitamins, sodium and selenium (Agarwal *et al.,* 2007). Due to its delicacy, pleasant flavor and good nutritive value, bell pepper has attained a status of high value crop and occupies a place of pride among different vegetables cultivated in India. There is ever increasing demand of bell pepper in urban markets and the fruits are sells at premium price.

Bell pepper is one of the most suitable vegetable crops for cultivation under protected environment. Growing of bell pepper under protected structures ensures higher yield with better quality produce than open environment. Cultivation of bell pepper under protected structures has become popular among the farmers of low and mid hills of Himachal Pradesh. But systematic efforts to identify the promising lines of bell pepper for protected cultivation have not been initiated to develop suitable varieties or hybrids for polyhouse cultivation. For development of new variety or hybrid the presence of genetic divergence is the foremost requirement. The assessment of genetic divergence helps in identification of breeding lines with broad spectrum of genetic variability thus providing better scope to isolate superior recombinants. D^2 statistic developed by Mahalanobis (1936) is effective tool to measure genetic divergence among genotypes in any crop plant. There are many earlier studies on genetic divergence in bell pepper under open conditions but very few systematic research work have been reported under protected conditions. Horticultural traits and to work out the genetic divergence under protected environment.

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The findings of the present study can be further utilized to enhance the yield potential of bell pepper under protected environment.

2. Materials and Methods

The present investigation was conducted during July-December, 2012 under (25 × 10) m modified naturally ventilated polyhouse at the Experimental Farm, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur (1, 290.8 m amsl, with latitude 32^0 6' N; longitude 76^0 3' E).

The experimental material comprised of 29 accessions of bell pepper collected from different geographical regions of India (Table 1). The experiment was laid out in randomized complete block design (RCBD) with three replications. The crop was grown on 20 cm raised bed having 90 cm width. Each bed consisted of two rows of 1.5 m length accommodating ten plants per genotype of each entry. The plants were spaced at (45 × 30) cm inter and intra row spacing. Five randomly selected plants of each entry were used for recording data on yield and horticultural traits *viz.,* days to 50 % flowering, days to first harvest, number of marketable fruits per plant, pericarp thickness (mm), lobes

Table 1. List of bell pepper lines used in genetic divergence analysis

S. No.	Genotypes	S. No.	Genotypes
1	DARL-03	16	HC-201
2	DARL-07	17	LC
3	Kashmir Sel-1	18	ACC-16
4	ARCH-19	19	DARL-01
5	Arka Gaurav	20	PC-2
6	DARL-02	21	Kannual Collection
7	Blocky Pepper	22	Feroz
8	SEL-10-2	23	Kandaghat Sel-9
9	PC-1	24	PRC-1
10	Nauni Collection	25	DARL-09
11	Yolo Wonder	26	Local Collection-1
12	California Wonder	27	DARL-05
13	UHFSP(Y)-11	28	Kashmir Sel-2
14	DARL-10	29	ARCH-9
15	Solan Bharpur		

Table 2. Analysis of variance for yield and horticultural traits in bell pepper

Traits	Mean sum of squares			
	Source	Replication	Genotype	Error
	df	2	28	56
Days to 50 % flowering		12.63	24.71*	2.56
Days to first harvest		64.22	30.61*	17.14
Number of marketable fruits per plant		0.47	181.18*	8.46
Pericarp thickness (mm)		0.06	1.07*	0.21
Lobes per fruit		0.09	0.90*	0.11
Fruit length (cm)		2.81	3.50*	0.64
Fruit width (cm)		12.59	1.85*	0.42
Average fruit weight (g)		44.69	152.12*	26.04
Marketable fruit yield per plant (kg)		0.02	0.31*	0.01
Plant height (cm)		249.12	2838.61*	406.50
Harvest duration (days)		499.69	267.52*	125.13
Ascorbic acid content (mg per 100g)		76.45	873.80*	9.37
Capsaicin content (%)		0.0002	0.01*	0.0004
*Significant at P = 0.05				

per fruit, fruit length (cm), fruit width (cm), average fruit weight (g), marketable fruit yield per plant (kg), plant height (cm), harvest duration (days), ascorbic acid content (mg/100g) and capsaicin content (%). The data collected were subjected to multivariate analysis utilizing Mahalanobis D^2 statistics as suggested by Mahalanobis 1936 and Rao 1952. Using 'V' statistics which, in turn, utilizes Wilk's criteria, simultaneous test of difference in mean values of a number of correlated variables/characters was done as suggested by Rao 1952 The grouping of the genotypes into various clusters was done following Tocher's method as suggested by Rao 1952.

3. Results and Discussion

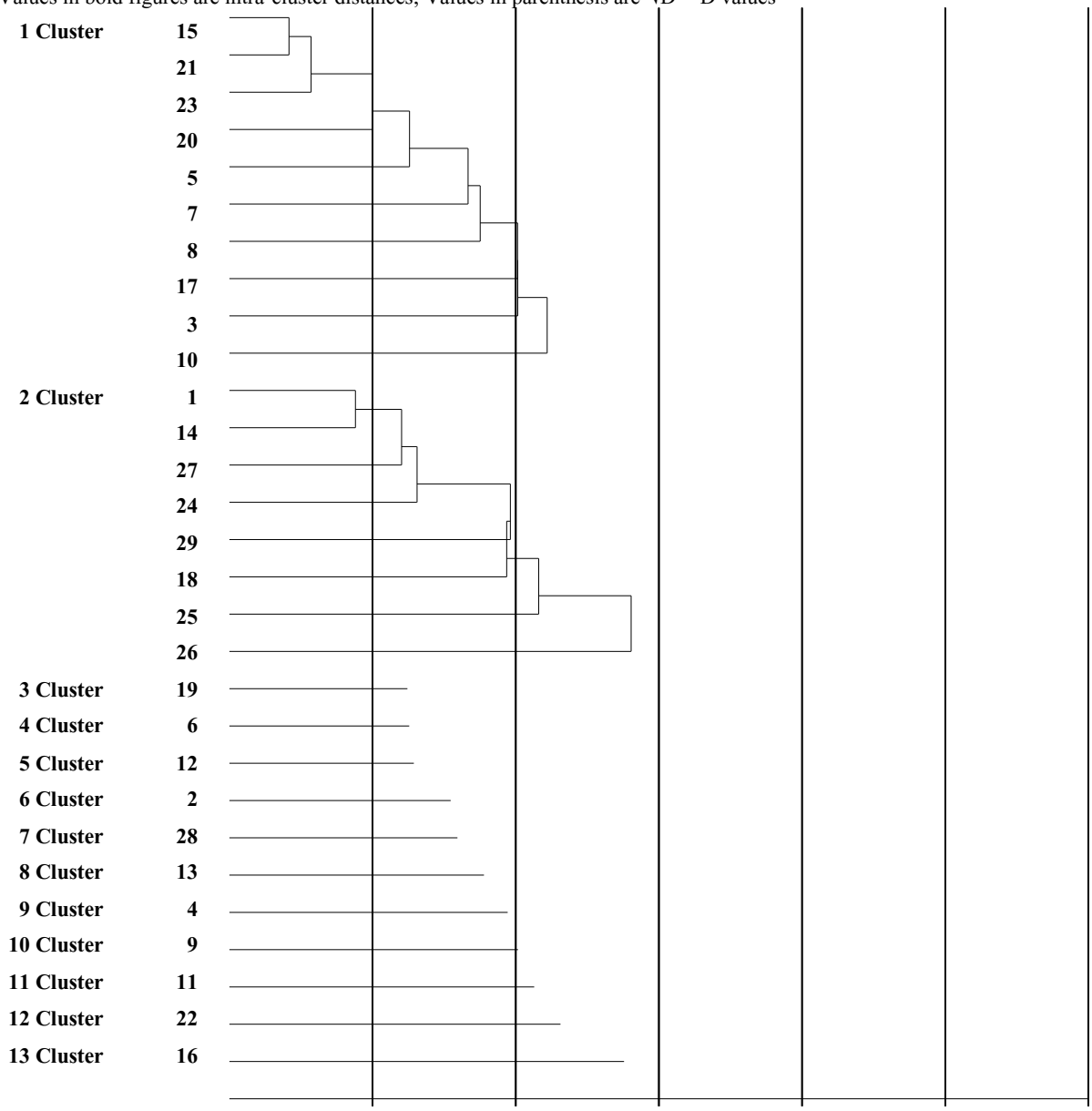
The analysis of variance revealed that significant differences were present for all the traits studied and the experimental materials were genetically divergent from each other (Table 2). The multivariate analysis (D^2) grouped 29 genotypes into 13 clusters following Tocher's method (Figure 1). The pattern of clustering of the genotypes indicated existence of significant amount of variability. The cluster 1 was the largest one comprising of 10 genotypes followed by cluster 2 having 8 genotypes. The remaining clusters (3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13) were monogenotypic, indicating that these genotypes diverged most from others (Dias *et al.,* 2003) and can be used for effective hybridization with lines of other clusters. The inter-cluster D^2 value ranged from 3.54 to 13.60, while there is no intra cluster distance in most of the groups except cluster 1 and 2 (Table 3 and Fig. 1). The absence of intra-cluster distance indicated homogenous nature of the genotypes within the cluster. The maximum inter-cluster D^2 value was observed between cluster 5 and 8 (13.60) followed by cluster 5 and 10 (13.11), cluster 2 and 8 (12.07) and cluster 4 and 5 (12.05), suggesting that the lines belonging to these clusters may be used as parents for hybridization programme to generate heterotic segregants (Lahbib *et al.,* 2012). The crosses involving the diverse genotypes would be expected to manifest maximum heterosis and desirable transgressive segregants (Tasso *et al.,* 2014). Since the intra-cluster distance was either low or absence in most of the clusters, the chances of developing good segregants by hybridization among parents within cluster would be low (Hoque and Rahman 2006).

Table 3. Average intra and inter-cluster distances in 29 lines of bell pepper

Clusters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	**4.50 (2.12)**	8.20 (2.86)	5.28 (2.30)	5.72 (2.39)	10.14 (3.18)	5.57 (2.36)	5.70 (2.39)	6.43 (2.54)	6.39 (5.23)	5.72 (2.39)	7.83 (2.80)	6.81 (2.61)	7.58 (2.75)
2		**4.95 (2.22)**	9.91 (3.15)	11.16 (3.34)	6.64 (2.58)	6.64 (2.58)	9.10 (3.02)	12.07 (3.47)	6.33 (2.52)	10.54 (3.45)	7.02 (2.65)	7.42 (2.72)	11.36 (3.37)
3			**0.00**	3.54 (1.88)	11.51 (3.39)	4.66 (2.16)	5.68 (2.38)	4.22 (2.05)	8.62 (2.94)	6.40 (2.53)	8.44 (2.91)	8.46 (2.91)	5.25 (2.29)
4				**0.00**	12.05 (3.47)	6.38 (2.53)	6.45 (2.54)	4.83 (2.20)	9.74 (3.12)	6.59 (2.57)	9.35 (3.06)	9.49 (3.08)	5.80 (2.41)
5					**0.00**	8.58 (2.93)	12.01 (3.47)	13.60 (3.69)	10.02 (3.17)	13.11 (3.62)	4.62 (2.15)	9.18 (3.03)	11.84 (3.44)
6						**0.00**	5.10 (2.26)	7.77 (2.79)	6.79 (2.61)	7.16 (2.68)	7.04 (2.65)	6.36 (2.52)	6.30 (2.51)
7							**0.00**	6.62 (2.57)	6.51 (2.55)	5.37 (2.32)	10.24 (3.20)	6.66 (2.58)	6.77 (2.60)
8								**0.00**	10.25 (3.20)	6.27 (2.50)	10.26 (3.20)	9.39 (3.06)	5.70 (2.39)
9									**0.00**	8.53 (2.92)	9.01 (3.00)	7.75 (2.78)	11.42 (3.38)
10										**0.00**	10.97 (3.31)	6.65 (2.58)	7.04 (2.65)
11											**0.00**	8.38 (2.89)	9.55 (3.09)
12												**0.00**	7.64 (2.76)
13													**0.00**

Figure 1. Clustering by Trocher method

Values in bold figures are intra-cluster distances; Values in parenthesis are $\sqrt{D^2}$= D values



*1-29: Genotypes of bell pepper used for genetic divergence analysis

Therefore, it is logical to attempt crosses between genotypes falling in different clusters based on inter-cluster distance. The comparison of cluster means revealed considerable differences amongst the clusters of different traits (Table 4). The most economic traits *viz.* number of marketable fruits per plant (34.93), marketable fruit yield per plant (1.60) and harvest duration (121.00) were represented with highest means by cluster 9. However, cluster 11 and 5 represent maximum means for average fruit weight (64.88) and ascorbic acid content (95.53), respectively, which are also important traits in bell pepper.

Hence, different clusters of genotypes on the basis of cluster means revealed divergence for different traits and can be utilized as indicators for selecting diverse parents for improvement of specific traits in bell pepper. The maximum per cent contribution to genetic divergence was made by ascorbic acid content (61.58) followed by marketable fruit yield per plant (12.56), capsaicin content (10.59) and number of marketable fruits per plant (5.42) as depicted in Figure 2. Therefore, these traits can be used as parameters for selecting diverse parent in capsicum improvement programme.

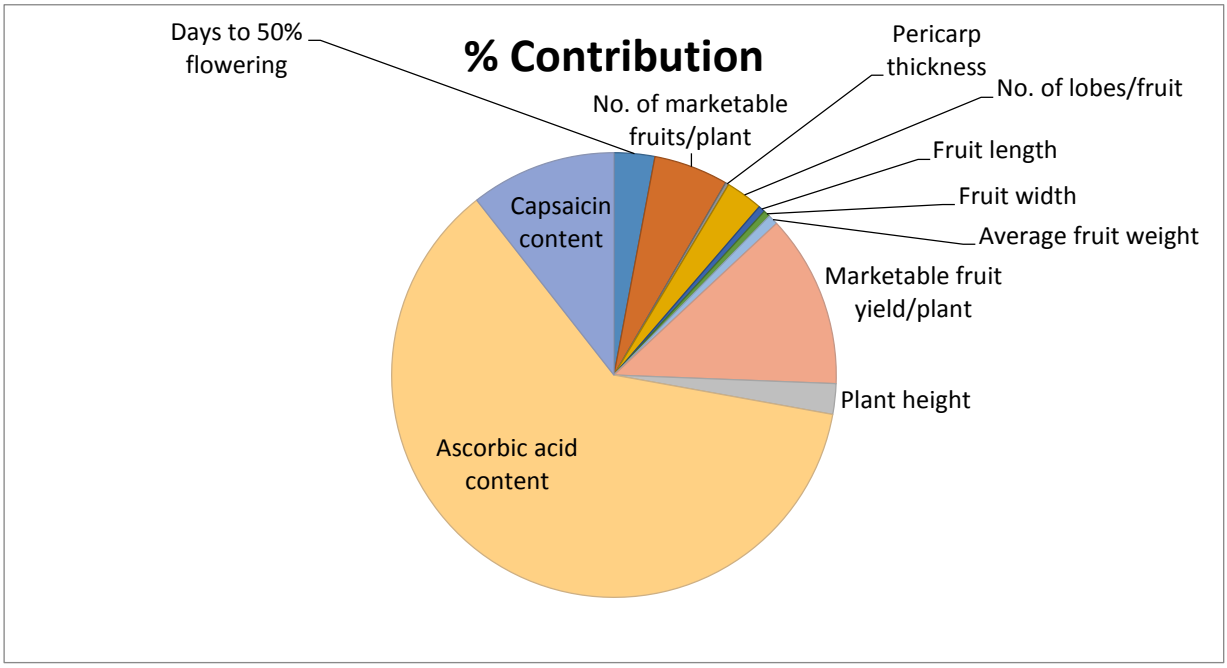
Table 4. Cluster means of yield and horticultural traits in bell pepper

Traits / Clusters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	42.97	76.93	26.29	3.23	2.94	6.91	5.36	48.50	1.21	167.99	114.97	57.81	0.14
2	41.21	78.71	23.58	3.51	3.03	6.29	5.19	45.00	1.04	153.37	110.88	86.33	0.18
3	39.67	79.33	19.40	2.96	3.85	6.14	5.33	45.53	0.88	127.56	111.67	48.87	0.19
4	38.00	79.00	17.13	3.27	2.78	6.34	5.79	52.06	0.89	166.44	118.33	45.54	0.10
5	42.67	76.00	8.13	4.75	3.00	5.58	6.51	58.95	0.48	175.00	104.33	95.53	0.09
6	37.00	79.00	21.33	3.04	3.00	6.07	5.42	40.48	0.74	139.33	116.00	63.75	0.20
7	37.67	76.00	26.13	2.33	2.28	9.05	4.81	47.13	1.23	203.44	118.00	54.34	0.21
8	44.67	76.00	18.47	2.79	3.15	6.16	5.53	59.70	1.14	153.33	92.33	40.88	0.20
9	39.00	73.00	34.93	3.22	3.40	9.72	5.43	46.10	1.60	160.33	121.00	75.20	0.15
10	45.33	73.00	33.53	2.27	2.20	5.11	5.43	37.56	1.27	232.44	121.00	44.98	0.19
11	45.33	73.00	10.73	3.75	4.00	6.23	6.44	64.88	0.69	130.11	121.00	81.86	0.12
12	49.00	76.00	26.00	3.51	2.00	7.97	3.77	37.42	0.97	217.55	114.00	61.05	0.22
13	42.67	79.00	9.67	2.41	2.27	6.11	5.22	41.68	0.41	187.11	85.67	44.87	0.21

*Traits:

1. Days to 50 per cent flowering
2. Days to first harvest
3. Number of marketable fruits per plant
4. Pericarp thickness
5. Lobes per fruit
6. Fruit length
7. Fruit width
8. Average fruit weight
9. Marketable fruit yield per plant
10. Plant height
11. Harvest duration
12. Ascorbic acid content
13. Capsaicin content

Figure 2. (%) Contribution of yield and horticultural traits towards genetic divergence in bell peppe



Conclusion

It study is concluded that genotypes falling under cluster 9 are genetically diverse on the basis of cluster means for most of the economic traits and possess greater potential as a breeding stock for expecting transgressive segregants in further genetic improvement of bell pepper.

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References

Agarwal A, Gupta S, Z Ahmed (2007). Influence of plant density on productivity of bell pepper (*Capsicum annuum* L.) under green house in high altitude cold desert of Ladakh. *Acta Horticulture* 756: 309-314

Bukasov SM (1930). The cultivated plants of Mexico, Guatemala and Columbia. *Bulletin of Applied Botanical Genetics and Plant Breeding Supplement* 47: 261-273

Dias LAS, Marita J, Cruz CD, Barros EG, TMA Salomao (2003). Genetic distance and its association with heterosis in cacao. Brazilian Archives of Biology and Technology 46: 339-347

Hoque M, L Rahman (2006). Estimation of Euclidian distance for different morpho physilogical characters in some wild and cultivated rice genotypes (Oryza sativa L.). *Pakistan Science* 1: 77-79

Lahbib K, Bnejdi F, M Gazzah (2012). Genetic diversity evaluation of pepper (*Capsicum annuum* L.) in Tunisia based on morphologic characters. *African J Agric Res* 23: 3413-3417.

Mahalanobis PC (1936). On the generalized distance in statistics. *Proceedings of the National Institute of Sciences* 2: 49-55.

Rao CR (1952). Advanced Statistical Methods in Biometrical Research. John Wiley and Sons Inc. New York Edn. 1

Tasso Y, Rakesh D, Singh V, G Upadhyay (2014). Genetic diversity of chilli (*Capsicum annuum* L.) genotypes of India based on morpho-chemical traits. *Australian J Crop Sci* 8: 97-102