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Assessment of genetic divergence in cucumber (*cucumis sativus* L.) germplasm through clustering and principal component analysis

Chandan Singh Ahirwar, DK Singh and ML Kushwaha

Abstract
The present investigation was conducted with two season during July-October, 2014 and February-June, 2015 at Vegetable Research Centre, Department of Vegetable Science in G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. Pantnagar The genetic divergence among 44 genotypes with two checks Pant Khira-1 and Pointsette of cucumber through cluster analysis. In the first season cluster I and cluster VI had highest mean value for Fruit weight (350.89), during second season, cluster VI had highest mean value for Fruit weight (380.11) and However in pooled data analysis, cluster I had highest mean value for cluster VII Fruit weight (354.98). Days to first male flowers, node number to first male flower, days to first female flowers, node number to first female flower, internodal length, days to first fruit harvest, number of fruits per plant, fruit length, fruit diameter, fruit weight, test weight, seed index, primary branches per plant, plant height and yield contributed towards genetic divergence hence, these characters could respond favorably for phenotypic selection were confirmed by Principal Component Analysis.

Key words: cucumber (*Cucumis sativus* L.), genetic variation, principle component analysis and cluster analysis.

Introduction
Cucurbits (family Cucurbitaceae) are frost-sensitive, predominantly tendril-bearing vines, which are found in subtropical and tropical regions around the globe. India is blessed with a rich diversity of cucurbits and is believed to be the primary and secondary centers of origin of many of the gourds and melons. Gourds, melons, squashes and cucumbers are the main group of crops under the family Cucurbitaceae. Cucurbits (the *Cucurbitaceae* family) are composed of 118 genera and 825 species. Members of this family are distributed primarily in tropical and subtropical regions of the world.
The most economically important cucurbits according to world total creation are watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*) and melon (*Cucumis melo*). The *Cucurbitaceae* includes two subfamilies *Zanonioideae*and the *Cucurbitoideae. Cucurbitoideae* comprises eight tribes one of which is *Melothrieae* which includes the genus *Cucumis*. The genus includes 30 wild and cultivated types that are spread throughout the world and has two major species: cucumber and melon.
Growers, buyers and processors all demand uniformity in plant type, fruit type, and maturity, so it is necessary that cultivars developed for sale to meet commercial standards. The scope of selection in the improvement of cucumber depends upon the genetic diversity available in the germplasm. Since, a considerable amount of variability exists in this crop, a germplasm collection is essential for any rational plant breeding programme. To formulate a sound and successful breeding programme, the importance of the study of genetic variability in the population and the pattern of correlation existing among the traits needs emphasis. To make an improvement in any crop species, the breeder is constantly engaged in effective choice of desireable parents of high genetic variation so that individuals with desirable character combination can be selected. Genetically diverse parents are likely to produce high genetic diversity effects and desirable traits tool in quantifying the degree of divergence among the biological populations.

Materials and Methods
The present investigation was conducted with two season during July-October, 2014 and February-June, 2015 at Vegetable Research Centre, Department of Vegetable Science in G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. Pantnagar is situated

in the foot hills of Himalayan region (Shivalik hills) and falls under humid subtropical climate zone in narrow belt called Tarai. Geographically, Vegetable Research Centre is situated at the latitude of 29.5 ^{0}N, longitude 79.3 ^{0} E and at an altitude of 243.84 meters above the mean sea level. Total 46 genotypes of cucumber (*Cucumis sativus* L.) were used as experimental material in present experiment. The genotypes were diverse with respect to morphological and important economical traits.

The experiment was laid out in randomized block design with three replications. Healthy and uniform sowing of seeds was main field in plots with a spacing of 3 meters × 0.60 cm during the evening hours of during July-October, 2014 and February-June, 2015. The crops were grown with standard package of practices. The observations on various growth, yield and qualitative characters viz. observed highly significant differences for all the traits under study. The observations were recorded on ten randomly selected competitive plants from each treatment for the characters viz. Days to first male flowers, node number to first male flower, days to first female flowers, node number to first female flower, internodal length, days to first fruit harvest, number of fruits per plant, fruit length, fruit diameter, fruit weight, test weight, seed index, primary branches per plant, plant height and yield

Results and Discussion

The cluster mean for all the characters are given Table 1, 2, 3 and 4 for the first season, second and pooled analysis respectively.

Cluster I and cluster VI had highest mean value for Fruit weight (350.89), Cluster II days to first female flowers (48.16), cluster VII days to first male flowers (40.42), cluster III days to first fruit harvest (42.44), cluster IV test weight (26.06), cluster III internodal length (7.33), cluster I node number to first female flower (8.22), fruit length (23.39), cluster I number of fruits per plant (6.51), cluster III node number to first male flower (6.33), cluster I and VI primary branches/ plant (5.55), cluster VII fruit diameter (5.18), cluster IV seed index (4.33) and cluster VI plant height (2.34).

During second season, cluster I internodal length (12.27) and cluster VI had highest mean value for Fruit weight (380.11). Test weight (40.63), days to first male flowers (45.03) were calculated in genotypes that belong to cluster VI and cluster IV respectively. Days to first female flowers (48.17), node number to first male flower (6.67), node number to first female flower (9.00) cluster VI, cluster VII and cluster II were calculated in genotype that belong to cluster respectively. cluster IV days to first fruit harvest (55.57) and cluster VII number of fruits per plant (10.23), cluster VI fruit length (21.37), fruit diameter (4.88) VII Yield (202.01), cluster IV Primary branches/ plant (7.66), cluster VII plant height (3.47)cluster VII seed index (4.08).

However in pooled data analysis, cluster I had highest mean value for primary branches/ plant (5.35) and had highest mean value for cluster VII Fruit weight (354.98). Days to first fruit harvest (46.69), internodal length (10.70), node number to first female flower (8.83) were calculated in genotype that belongs to cluster V. Cluster VI days to first male flowers (41.28), cluster III node number to first male flower (6.83), cluster IV days to first female flowers (47.57), cluster VII number of fruits per plant(8.78), cluster V fruit length (23.27), cluster VI fruit diameter (4.47), cluster VII yield (173.24), cluster III test weight (28.26), cluster V seed index (4.91) and plant height (3.00) cluster VII in pooled were recorded to have highest mean for maximum traits under study are used for developing high yielding cucumber varieties.

Maximum inter cluster distance was noticed between cluster I and cluster II during first season. However in second season maximum inter cluster distance was noticed between cluster IV and VII. Pooled analysis of two season data revealed that maximum inter cluster distance was found between cluster III and cluster VII.

During first season, maximum fourteen genotypes were received by cluster II and VI whereas minimum one genotype were received in cluster III and IV each, respectively. In second season, fourteen genotypes were received by cluster II whereas minimum one genotype in cluster IV, VI and VII, respectively. However in pooled analysis, maximum twenty four genotypes were received by cluster II and minimum in cluster III, V, VI and VII (one genotype). Cluster I in first season, cluster VI and cluster VII in pooled analysis were recorded to have highest mean for maximum traits under study. Phenotypic performance would be a good index for selection in cucumber for the characters like node at which first female flower appears, sex ratio, harvest duration,

Table 1: Cluster mean for different economic traits in cucumber germplasm (first season)

S. No.	Characters	Cluster						
		I	II	III	IV	V	VI	VII
1.	Days to first male flowers	38.73	39.06	34.69	39.94	38.09	36.41	40.42
2.	Node number to first male flower	5.33	5.40	6.33	3.67	5.71	5.24	5.47
3.	Days to first female flowers	42.26	48.16	45.66	41.51	42.74	47.19	42.26
4.	Node number to first female flower	8.22	6.55	8.00	6.67	6.33	7.41	7.60
5.	Internodal length (cm)	5.111	5.81	7.33	5.67	6.54	5.81	6.80
6.	Days to first fruit harvest	39.76	36.21	42.44	41.79	37.08	40.28	35.64
7.	No. of fruits per plant	6.51	5.13	4.47	5.54	5.32	6.19	5.38
8.	Fruit length (cm)	23.39	14.63	16.32	12.81	16.05	16.28	17.15
9.	Fruit diameter (cm)	3.55	3.61	2.54	3.45	3.59	4.02	5.18
10.	Fruit weight (g)	350.89	295.43	241.21	322.03	227.23	350.89	295.43
11.	Test weight (gm.)	20.75	19.41	19.87	26.06	23.57	19.72	15.33
12.	Seed Index (gm.)	3.43	3.02	2.44	4.33	2.98	3.39	3.12
13.	Primary branches/ Plant	5.55	5.28	4.33	4.33	5.21	5.55	5.33
14.	Plant height (m.)	1.68	2.23	1.67	1.50	2.11	2.34	1.96
15.	Yield (q/ha)	108.72	84.15	87.08	90.82	71.25	110.03	67.72

Table 2: Cluster mean for different economic traits in cucumber germplasm (second season)

S. No.	Characters	Cluster						
		I	II	III	IV	V	VI	VII
1.	Days to first male flowers	40.10	42.34	40.80	45.03	40.69	42.30	34.17
2.	Node number to first male flower	4.96	5.43	5.62	5.33	5.58	5.00	6.67
3.	Days to first female flowers	47.02	46.59	45.14	40.47	47.06	48.17	37.83
4.	Node number to first female flower	6.12	9.00	7.33	7.67	7.29	6.88	8.33
5.	Internodal length (cm)	12.27	9.53	10.59	13.22	9.74	4.28	5.80
6.	Days to first fruit harvest	48.06	47.71	54.08	55.57	47.27	46.68	36.76
7.	No. of fruits per plant	5.66	8.28	4.15	4.70	8.67	8.50	10.23
8.	Fruit length (cm)	15.77	16.56	16.70	14.93	14.97	21.37	16.00
9.	Fruit diameter (cm)	2.78	3.82	3.65	2.38	3.55	4.88	2.36
10.	Fruit weight (g)	274.51	303.19	289.83	221.47	224.41	380.11	355.32
11.	Test weight (gm.)	32.31	30.88	32.91	33.21	31.55	40.63	20.82
12.	Seed Index (gm.)	3.52	3.28	3.32	2.40	3.49	2.52	4.08
13.	Primary branches/ Plant	5.50	4.33	4.82	7.66	4.58	5.00	4.33
14.	Plant height (m.)	2.32	2.05	2.43	2.23	2.62	1.57	3.47
15.	Yield (q/ha)	86.39	139.57	66.99	57.82	108.77	179.49	202.01

Table 3: Cluster mean for different economic traits in cucumber germplasm (pooled)

S. No.	Characters	Cluster						
		I	II	III	IV	V	VI	VII
1.	Days to first male flowers	41.01	39.51	31.45	39.99	39.18	41.28	32.43
2.	Node number to first male flower	5.30	5.36	6.83	5.21	6.00	6.33	6.67
3.	Days to first female flowers	44.42	44.97	39.18	47.57	33.78	39.74	37.82
4.	Node number to first femaleflower	7.15	6.94	8.33	6.71	8.83	6.00	8.67
5.	Internodal length (cm)	9.02	7.64	7.51	8.37	10.70	9.85	5.40
6.	Days to first fruit harvest	43.27	43.83	43.16	44.24	46.69	44.69	37.79
7.	No. of fruits per plant	5.64	6.10	4.00	7.09	4.55	5.85	8.78
8.	Fruit length (cm)	12.34	18.24	12.63	15.94	23.27	6.42	15.65
9.	Fruit diameter (cm)	3.79	3.68	3.03	3.62	4.417	4.47	2.49
10.	Fruit weight (g)	260.08	301.89	341.78	240.70	305.50	319.04	354.98
11.	Test weight	27.49	25.37	28.26	26.08	27.06	24.02	21.72
12.	Seed Index (gm.)	3.22	3.17	3.13	3.48	4.91	2.88	3.29
13.	Primary branches/ Plant	5.35	5.00	5.33	4.98	5.17	4.33	5.00
14.	Plant height (m.)	2.29	2.14	2.32	2.31	2.55	2.50	3.00
15.	Yield (q/ha)	82.22	103.09	76.08	93.94	77.25	103.87	173.24

yield per plant, no. of fruits, fruit weight, fruit length and vine length as reported by Joshi *et al.* (1981) [2]. Kanthaswamy (2006) [3], reported that 74 amaranth genotypes of were grouped into 12 clusters, Oboh (2007) [4] observed four clusters for 16 amaranth (*A. hybridus*), Shukla *et al.* (2010) [8] obtained six clusters for 39 amaranth strains and Akhter *et al*. (2013) discriminated 17 amaranth genotypes into four clusters.

Table 4: Contribution (%) of ten characters towards genetic divergence in cucumber.

S. No.	Source	Contribution %
1.	Days to First Male Flower	2.13
2.	Node to First Male Flower	1.06
3.	Days to First Female Flow	4.64
4.	Node to First Female Flow	6.47
5.	Internodal Lenth (cm)	1.35
6.	Days to First harvesting	1.06
7.	Fruits Per Plant	2.03
8.	Fruit Length (cm)	26.96
9.	Fruit Diameter (cm)	3.77
10.	Fruit Weight (g)	41.93
11.	Test Weight (g) 1000 Seed	2.61
12.	Seed Weight (g) 100 Seeds	1.84
13.	Primary Branches/ Plant	0.68
14.	Plant Height (m.)	2.03
15.	Yield (Q/ha)	1.45

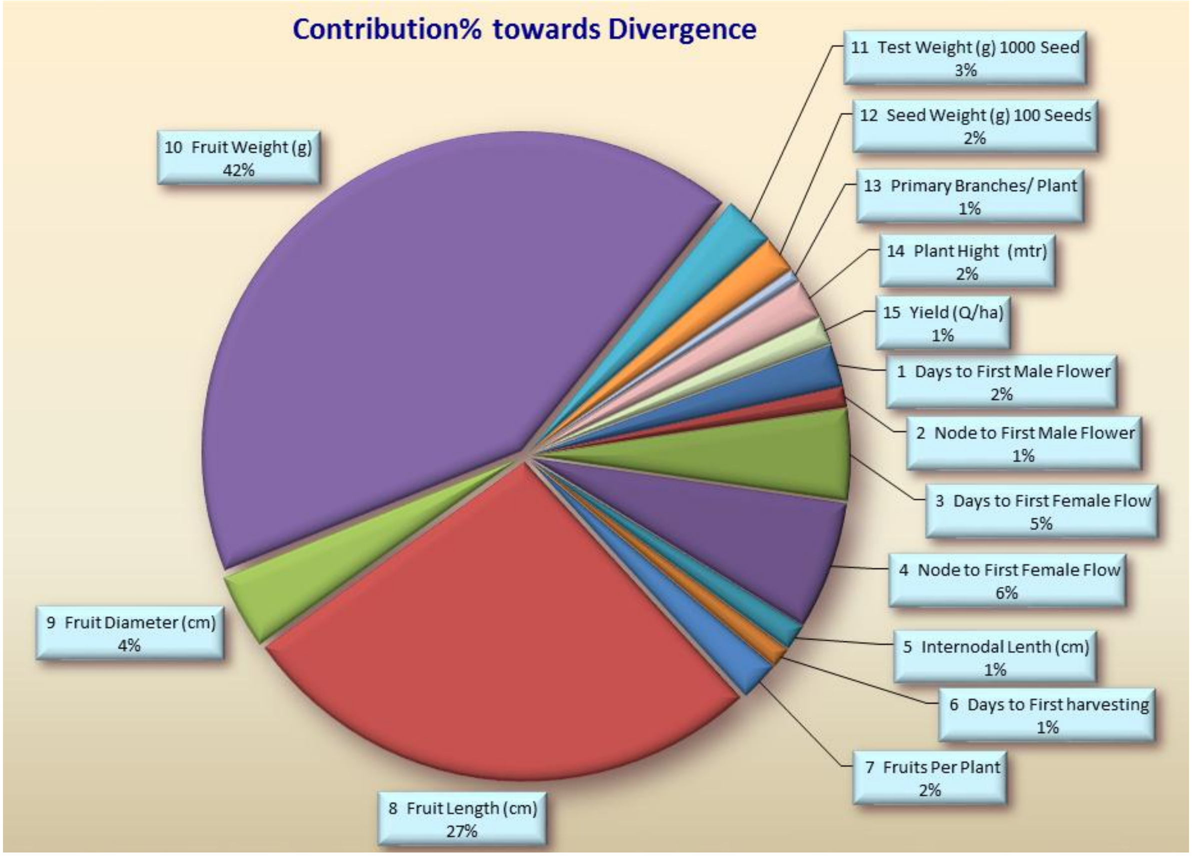

Fig 1: Contribution (%) of ten characters towards genetic divergence in cucumber.

Conclusion

In the first season cluster I and cluster VI had highest mean value for Fruit weight (350.89), during second season, cluster VI had highest mean value for Fruit weight (380.11) and However in pooled data analysis, cluster I had highest mean value for cluster VII Fruit weight (354.98). Therefore, Selection of superior genotypes in view point of desirable morphologic traits, with high genetic distance could be selected for hybridization programs and recognition of best genotypes for different traits to produce new elite hybrids in cucumber.

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