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Genetic diversity in indigenous germplasm of ash gourd

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ABSTRACT

Wide range of genetic diversity was observed among twenty three germplasm lines of ash gourd collected from different parts of U.P. and Uttarakhand. Genotypes PAG-50, Pant Petha-1, PAG-64, PAG-12, PAG-14 and PAG-09 were high yielding lines while considering both the seasons summer and *kharif* 2006. Based on Mahalanobis' D^2 analysis all germplasm lines were grouped into 5 clusters. The clustering pattern indicated that geographical distribution need not necessarily be related to the genetic diversity. Cluster I was very large containing 14 genotypes (summer) and 10 genotypes (*kharif)* season. The commercially released cultivar Pant Petha-1 was grouped in cluster II along with other genotypes in both the seasons. The inter-cluster distance was found maximum between cluster III and cluster IV (summer) and cluster II and cluster V in (*kharif)* seasons. The genotypes in these clusters may possibly be utilized in hybrid breeding programme for successful exploitation of hybrid vigour in ash gourd.

Key words: Genetic divergence, ash gourd, D^2 analysis, cluster pattern.

INTRODUCTION

Ash gourd or wax gourd [*Benincasa hispida* (Thunb.) Cogn. 2n = 2x = 24] is a prized cucurbitaceous vegetable because of its high nutritional and medicinal properties, industrial importance for processing, long storability, better transport qualities and higher yield per unit area. It is used mainly for treatment of diabetes and diuresis diseases in Korea and hypertension and inflammation in traditional Chinese medicine (Kalloo and Bergh, 4). Ash gourd juice has potential to improve the weak nervous system (Arora, 1). The abilities of anti oxidation and angiotensin converting enzyme (ACE) activity inhibition may provide protective effects against cardiovascular diseases and cancers (Huang *et al.*, 3). Since the existence of wild populations is unconfirmed, the centre of *Benincasa hispida* is uncertain. Indo-China is the centre of diversity for ash gourd (Rubtzky and Yamaguchi, 12). Rind and seeds of a gourd discovered at the Kana site in Papua New Guinea are identified as remains of *Benincasa hispida*; therefore, it may be possibly domesticated at the Kana site (Matthew, 9). In India, a wide range of variability is available for different component characters in ash gourd (Mandal *et al.* 8) but very sporadic efforts have been made for its genetic improvement. The fact that almost no hybrid is under cultivation reflects the neglectance of crop improvement in ash gourd. A wide range of genetic diversity among parents is essential feature for any hybridization programme. Hence, plant breeders are interested to estimate the extent of genetic diversity among different genotypes which will help them to achieve the set goal through appropriate breeding strategy. Mahalanobis D^2 analysis provides a means for assessment of genetic diversity among crop plants (Mahalanobis, 7) and an attempt was made in the present investigation in ash gourd.

MATERIALS AND METHODS

Twenty three genotypes of ash gourd from three eco-geographic regions were taken for the study (Table 1). The experiment was carried out in Randomized Block Design with three replications at Vegetable Research Center of G.B.P.U.A.&T., Pantnagar during summer and *kharif* 2006. Each genotype was sown in a row of 10m length accommodating 10 plants /row at a spacing of 3x1m. Observations were recorded on 15 quantitative traits on 6 plants from each genotype. The data were subjected to multivariate analysis (Rao, 11). The original mean values were transformed to normalize variables and all D^2 values were calculated. The grouping of genotypes was done by using Tocher's method as described by Rao (11). The criterion used in clustering by this method is that genotypes belonging to the same cluster should show a smaller D^2 value than those belonging to different clusters.

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Table 1. List of genotypes and their respective place of collection.

S.No.	Genotype	Source
1.	PAG-05	Local Collection, Lucknow
2.	PAG-09	Local Collection, Pantnagar
3.	PAG-12	Local Collection, Pantnagar
4.	PAG-13	Local Collection, Lalkaun
5.	PAG-14	Local Collection, Lalkaun
6.	PAG-16	Local Collection, Lalkaun
7.	PAG-21	Local Collection, Pantnagar
8.	PAG-23	Local Collection, Kanpur
9.	PAG-30	CSUA&T, Kanpur
10.	PAG-38	Local Collection, Secundrabad, Agra
11.	PAG-41	Local Collection, Vichpuri, Agra
12.	PAG-46	Local Collection, Rambaugh, Agra
13.	PAG-50	Local Collection, Pantnagar
14.	PAG-60	Local Collection, Shivapur, Bahraich
15.	PAG-62	Local Collection, Chatiya, Siddhartha Nagar
16.	PAG-64	Local Collection, Ashidhwan, Basti
17.	PAG-65	Local Collection, Kalawari, Basti
18.	PAG-66	Local Collection, Maskinwa, Gonda
19.	PAG-70	Local Collection, Agra
20.	PAG-71	Local Collection, Agra
21.	PAG-72	Local Collection, Agra
22.	PAG-73	Local Collection, Agra
23.	Pant Petha-1	GBPUA&T, Pantnagar

RESULTS AND DISCUSSION

The analysis of variance revealed that genotypic mean squares were highly significant for all characters consistently over both the seasons. The findings are in agreement with (Puri and Singh, 10). The superior germplasm lines identified for 15 yield contributing traits have been enlisted in Table 2. The genotypes PAG-21, PAG-64, PAG-66, PAG-14 and PAG-12 were observed to be better performing for vegetative traits (main vine length and number of primary branches). The earliness (days to first male and female flower anthesis and node number to first male and female flower) was observed in the genotypes PAG-66, PAG-46, PAG-72, PAG-16, Pant Petha-1, PAG-50 and PAG-71. The genotypes PAG-62, PAG-05, PAG-30, PAG-23 and PAG-66 were found superior for fruit characters like fruit length, fruit diameter, flesh thickness and fruit weight. Smaller seed cavity size was recorded in genotypes PAG-13, PAG-72 and PAG-21. The genotypes PAG-23, PAG-30, PAG-64, and Pant Petha-1 had more number of seeds per fruit. The best performing genotypes for yield (number of fruit per plant and yield per plant) were PAG-09, PAG-12, PAG-64 and PAG-50. These findings are similar to reports of (Puri and Singh, 10) and (Singh *et al.,* 13) in ash gourd.

The D^2 values of each pair of genotypes were estimated after confirming that analysis of variance revealed highly significant differences among 23 genotypes for 15 characters in both the seasons. By the application of clustering technique, 23 genotypes were grouped into 5 different clusters depending on their genetic divergence in both the seasons (Table 3). Cluster I comprised of the highest number of genotypes (14 in summer and 10 in *kharif* season). Of the remaining clusters, cluster II had 6 genotypes in summer and 5 genotypes in *kharif* season including the only commercially released cultivar under study, *i.e.,* Pant Petha-1. Clusters III, IV and V had single genotype each in summer, however, in *kharif* season, cluster III had 4 genotypes and cluster IV and V had two genotypes each. A perusal of the data showed that the genotypes usually did not follow cluster according to their geographical distribution. Average intra-cluster distances (Table 4) ranged from 277.29 (cluster I) to 0.00 (cluster III, IV and V) during summer season and from 232.10 (cluster II) to 156.88 (cluster I) during *kharif* season. The inter-cluster distance was found maximum between cluster III and IV (1238.63) in summer and cluster II and V (1196.28) in *kharif* season. Similar result had also been reported by (Lovely and Devi, 6). The inter-cluster distances were higher than the intra-cluster distance, which indicated the existence of substantial diversity among the genotypes represented in different cluster. The difference in clustering pattern in two seasons indicated the environmental influence in the grouping of genotypes on the basis of diversity analysis. Sureja *et al.* (14) and Verma *et al.* (15) reported significant positive correlations of genetic distance with hybrid performance and heterosis. However, the RAPD based genetic distance measures and use of limited ISSR markers could not effectively predict hybrid performance in this crop.

Genotypes of the cluster III and IV of summer season and genotypes of cluster II and V in *kharif* season will be useful for generating highly diverse recombinant materials through hybridization.

The means of five different clusters (Table 5) showed that their values varied in magnitude for all the fifteen characters in both the seasons. During summer season, cluster IV showed the highest mean for main vine length, number of primary branches, node number to first male flower, fruit length, fruit diameter, flesh thickness, fruit weight and yield per plant and it is important to note that cluster IV also showed the lowest mean for days to first male and female flower anthesis and node number to first female flower. It indicates that genotypes of cluster IV had desirable attributes for both high yield and earliness. The cluster III showed the lowest mean values for the traits like main vine length, number of primary branches, node number to first male flower, fruit length,

Table 2. Germplasm lines of ash gourd identified for different yield contributing traits.

Character	Season	Range	Mean	Genotypes
Main vine length (m)	Summer	4.87-7.98	6.02	PAG-50 (7.98), PAG-21 (7.13), PAG-70 (6.95)
	Kharif	4.35-9.30	6.83	PAG-64 (9.30), PAG-21 (8.57), PAG-30 (8.57)
	Pooled	4.90-7.85	6.43	PAG-21 (7.85), PAG-64 (7.48), PAG-12 (7.27)
No. of primary branches	Summer	3.92-10.08	7.12	PAG-21 (10.08), PAG-05, PAG-14, PAG-66 (9.50)
	Kharif	5.00-10.25	7.53	PAG-09 (10.25), PAG-64 (9.50), PAG-23, PAG-66, PAG-73 (9.00)
	Pooled	4.96-9.25	7.32	PAG-66 (9.25), PAG-21 (9.04), PAG-09 (8.96)
Days to first male flower anthesis	Summer	49.75-70.40	58.39	PAG-50 (49.75), Pant Petha-1 (52.00), PAG-46 (53.83)
	Kharif	46.00-81.00	62.73	PAG-66 (46.00), Pant Petha-1 (52.75), PAG-38 (55.08)
	Pooled	51.50-74.42	60.56	PAG-66 (51.50), Pant Petha-1 (52.37), PAG-46 (55.54)
Node number to first male flower	Summer	21.08-30.92	26.41	PAG-46 (21.08), PAG-12 (21.65), P:AG-66 (22.67)
	Kharif	18.25-34.00	25.94	PAG-46 (18.25), PAG-14 (20.92), PAG-71 (22.58)
	Pooled	19.67-31.00	26.17	PAG-46 (19.67), PAG-66 (23.83), PAG-38 (23.92)
Days to first female flower anthesis	Summer	58.17-75.66	67.79	Pant Petha-1 (58.17), PAG-50 (58.25), PAG-72 (64.25)
	Kharif	54.00-87.00	71.43	PAG-66 (54.00), Pant Petha-1 (59.11), PAG-13 (64.58)
	Pooled	58.64-81.33	69.61	Pant Petha-1 (58.64), PAG-66 (61.12), PAG-50 (65.37)
Node number to first female flower	Summer	22.11-40.58	32.43	PAG-50 (22.11), PAG-13 (25.22), PAG-09 (26.58)
	Kharif	28.25-45.00	36.20	PAG-71 (28.25), PAG-09 (28.50), PAG-14 (29.33)
	Pooled	27.54-41.29	34.32	PAG-09 (27.54), PAG-46 (29.87), PAG-50 (30.80)
Fruit length (cm)	Summer	18.44-27.89	23.76	PAG-21 (27.89), PAG-50 (27.00), PAG-05 (26.78)
	Kharif	15.00-26.00	21.63	PAG-62 (26.00), PAG-21 (25.08), PAG-12 (24.92)
	Pooled	16.72-26.49	22.70	PAG-21 (26.49), PAG-62 (26.25), PAG-12 (25.57)
Fruit diameter (cm)	Summer	16.00-25.11	19.76	PAG-66 (25.11), PAG-62 (23.44), PAG-16 (22.33)
	Kharif	14.17-24.00	19.10	PAG-62 (24.00), PAG-66 (23.75), PAG-23 (22.17)
	Pooled	15.86-24.43	19.43	PAG-66 (24.43), PAG-62 (23.72), PAG-23 (21.58)
Seed cavity length (cm)	Summer	13.25-21.75	16.79	PAG-09(13.25), PAG-13 (13.42), PAG-64 (13.92)
	Kharif	11.25-19.17	15.45	PAG-73 (11.25), PAG-46 (12.42), PAG-72 (12.67)
	Pooled	13.58-20.17	16.12	PAG-72 (13.58), PAG-09 (13.83), PAG-13 (14.33)
Seed cavity diameter (cm)	Summer	9.56-14.44	11.31	PAG-38 (9.56), PAG-13 (9.86), PAG-21 (10.33)
	Kharif	8.42-15.17	10.60	PAG-13 (8.42), PAG-72 (8.42), PAG-21 (9.08)
	Pooled	9.14-13.12	10.96	PAG-13 (9.14), PAG-72 (9.49), PAG-21 (9.71)
Flesh thickness (cm)	Summer	5.42-10.58	7.63	PAG-05 (10.58), PAG-16 (9.92), PAG-66 (9.33)
	Kharif	4.25-10.17	7.22	PAG-66 (10.17), PAG-65 (9.25), PAG-62 (9.17)
	Pooled	4.87-9.75	7.43	PAG-66 (9.75), PAG-05 (9.29), PAG-65 (8.83)
Number of seeds per fruit	Summer	120-655.50	429.95	PAG-23 (655.50), PAG-30 (651.00), Pant Petha-1 (637.33)
	Kharif	354-1310	830.35	PAG-64 (1310.00), Pant Petha-1 (1160.00), PAG-23 (1157.00)
	Pooled	261.50-906.25	630.15	PAG-23 (906.25), PAG- 64 (904.33), Pant Petha-1 (898.67)
Fruit weight (kg)	Summer	3.25-9.31	6.42	PAG-66 (9.31), PAG-60 (8.06), PAG-05 (7.97)
	Kharif	2.08-7.50	5.21	PAG-23 (7.50), PAG-30 (6.40), PAG-12 (6.39)
	Pooled	2.67-7.70	5.82	PAG-66 (7.70), PAG-23 (7.29), PAG-30 (7.05)
No. of fruits per plant	Summer	1.00-5.45	2.85	PAG-12 (5.45), PAG-09 (5.17), PAG-50 (4.89)
	Kharif	0.20-5.00	1.98	PAG-09 (5.00), PAG-64 (4.20), PAG-14 (3.82)
	Pooled	1.00-5.08	2.41	PAG-09 (5.08), PAG-12 (4.34), PAG-64 (3.72)
Yield per plant (kg)	Summer	4.75-38.31	18.23	PAG-50 (38.31), PAG-09 (31.92), PAG-12 (28.02)
	Kharif	0.70-29.46	10.78	PAG-09 (29.46), PAG-64 (24.28), PAG-14 (23.09)
	Pooled	4.10-30.69	14.50	PAG-09 (30.69), PAG-12 (24.15), PAG-50 (23.58)

Table 3. Classification of 23 ash gourd genotypes based on D^2 analysis.

Cluster	Genotype	
	Summer	*Kharif*
I	PAG-05, PAG-09, PAG-13, PAG-14, PAG-16, PAG-21, PAG-38, PAG-41, PAG-62, PAG-64, PAG-65, PAG-66, PAG-70, PAG-71 (14)	PAG-05, PAG-13, PAG-16, PAG-21, PAG-30, PAG-46, PAG-50, PAG-60, PAG-62, PAG-70 (10)
II	PAG-23, PAG-30, PAG-60, PAG-72, PAG-73, Pant Petha-1(6)	PAG-09, PAG-12, PAG-14, PAG-64, Pant Petha-1 (5)
III	PAG-46 (1)	PAG-23, PAG-38, PAG-41, PAG-71(4)
IV	PAG-50 (1)	PAG-65, PAG-66 (2)
V	PAG-12 (1)	PAG-72, PAG-73 (2)

*Values in parenthesis are number of genotypes in particular cluster.

Table 4. Average intra (bold) and inter-cluster D^2 values among clusters in ash gourd.

Cluster	I	II	III	IV	V
I	277.29(156.88)	439.72(476.21)	416.81(284.22)	621.33(307.84)	835.95(489.27)
II		226.42(232.10)	565.76(772.72)	575.93(864.94)	549.10(1196.28)
III			0.00(173.08)	1238.63(433.61)	1198.01(313.26)
IV				0.00(203.06)	602.76(622.13)
V					0.00(192.37)

Values without parenthesis, based on summer data; Values in parenthesis, based on *kharif* data.

fruit diameter, flesh thickness, number of seeds per fruit, fruit weight, number of fruits per plant and yield per plant. The cluster V showed highest mean values for days to first male flower anthesis, node number to first female flower, seed cavity length, number of seeds per fruit and number of fruit per plant and it also followed cluster IV for the yield per plant. The seed cavity diameter was found maximum in cluster III and minimum in cluster V. The cluster I showed the highest value for days to first female flower anthesis and lowest value for seed cavity length which indicated that late maturing genotypes had more flesh and smaller seed cavity. During *kharif* season, cluster II showed highest mean values for main vine length, number of primary branches, fruit length, number of seeds per fruit, fruit weight, number of fruits per plant and yield per plant. The cluster IV showed highest value for fruit diameter and flesh thickness, while lowest values for main vine length, number of primary branches, days to first male and female flower anthesis, node number to first male and female flower and number of seeds per fruit.

Heterosis is of direct relevance for developing hybrids in both cross and self-pollinated crops. It is increasingly realized that crosses between divergent parent usually produced greater heterotic effect than those between closely related ones (Dey *et al.*, 2) and (Kumar *et al.*, 5). But, when divergent parents crossed, heterosis is not found to occur always. It is, therefore, essential to explore the possible limits to parental divergence for occurrence of heterosis. In this study, it was found that genotypes which were grouped in cluster IV and III in summer season and cluster II and V in *kharif* season may be selected in hybridization programme for possible exploitation of heterosis by devising a suitable breeding programme.

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Table 5. Cluster means of ash gourd genotypes for 15 characters based on D^2 analysis.

Character	I	II	III	IV	V
Character	I	II	III	IV	V
Main vine length (m)	6.042 (6.799)	5.780 (7.863)	4.873 (6.518)	7.983 (5.783)	6.440 (6.625)
No, of primary branches	7.494 (7.167)	6.583 (8.350)	5.000 (7.738)	7.833 (6.667)	6.500 (8.000)
Days to first male flower anthesis	59.272 (65.955)	56.552 (62.400)	53.833 (58.533)	49.750 (56.583)	70.400 (66.708)
Node number to first male flower	26.775 (26.951)	27.053 (26.610)	21.083 (25.417)	27.500 (23.417)	21.650 (24.542)
Days to first female flower anthesis	69.493 (73.213)	65.748 (70.355)	66.833 (70.688)	58.250 (67.667)	66.750 (73.250)
Node number to first female flower	33.205 (37.704)	32.528 (35.728)	29.500 (35.938)	22.110 (33.750)	34.167 (34.875)
Fruit length (cm)	23.577 (23.120)	23.495 (33.950)	22.333 (21.667)	27.000 (21.278)	26.220 (15.333)
Fruit diameter (cm)	19.902 (18.944)	19.634 (19.833)	18.500 (19.604)	21.000 (20.333)	18.667 (15.167)
Seed cavity length (cm)	16.250 (16.518)	17.139 (16.283)	17.000 (15.417)	18.583 (13.222)	20.167 (11.958)
Seed cavity diameter (cm)	11.375 (10.306)	11.278 (11.183)	11.500 (12.333)	11.083 (9.695)	10.583 (8.417)
Flesh thickness (cm)	7.871 (7.426)	7.264 (6.917)	5.750 (6.688)	8.917 (9.167)	7.167 (5.250)
No. of seeds per fruit	355.440 (760.185)	581.222 (987.350)	256.000 (929.500)	542.000 (587.889)	627.330 (919.000)
Fruit weight (kg)	6.543 (5.097)	6.390 (6.079)	4.750 (5.854)	7.833 (4.889)	5.153 (2.792)
No. of fruits per plant	2.865 (1.838)	2.341 (3.929)	1.000 (1.179)	4.890 (1.333)	5.450 (0.350)
Yield per plant (kg)	18.666 (9.130)	14.470 (23.542)	4.750 (6.785)	38.307 (6.389)	28.057 (0.870)

Values without parenthesis, based on summer data; Values in parenthesis, based on *kharif* data.

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