Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 472-476
Received: 19-11-2020
Accepted: 21-12-2020

Prateek Kumar
Ph.D. Scholar, Department of Vegetable Science, ANDUA & T., Kumarganj, Ayodhya, Uttar Pradesh, India

VB Singh
Associate Professor, Department of Vegetable Science, ANDUA & T, Kumarganj, Ayodhya, Uttar Pradesh, India

GC Yadav
Associate Professor, Department of Vegetable Science, ANDUA & T, Kumarganj, Ayodhya, Uttar Pradesh, India

Nishakant Maurya
Ph.D. Scholar, Department of Vegetable Science, ANDUA & T., Kumarganj, Ayodhya, Uttar Pradesh, India

Sharvan Kumar
Ph.D. Scholar, Department of Vegetable Science, ANDUA & T., Kumarganj, Ayodhya, Uttar Pradesh, India

Devesh Tiwari
Ph.D. Scholar, Department of Vegetable Science, ANDUA & T., Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Prateek Kumar
Ph.D. Scholar, Department of Vegetable Science, ANDUA & T., Kumarganj, Ayodhya, Uttar Pradesh, India

Study genetic divergence (D^2) among the parents and their crosses in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

Prateek Kumar, VB Singh, GC Yadav, Nishakant Maurya, Sharvan Kumar and Devesh Tiwari

Abstract
The experiment entitled **"**Diallel cross analysis for growth (earliness), fruit yield and quality traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]**"** was undertaken with the objectives (i) To study the combining ability, variances and their effects (ii) to estimate heterosis over better-parent and standard variety (iii) to find out gene action involved in the inheritance of various characters and (iv) to estimate the heritability (narrow sense) and genetic advance in per cent of mean (v) to examine the genetic divergence (D^2) among the parents and their crosses. The materials of experiment consisted of ten diverse parents Pusa Naveen (P_1), NDBG-601 (P_2), PBOG-3 (P_3), NDBG-517 (P_4)**,** NDBG-603 (P_5), NDBG-624 (P_6), N. Pooja (P_7), NDBG-100 (P_8), Punjab Komal (P_9), and NDBG-11 (P_{10}) were crossed in diallel fashion excluding reciprocal to obtained 45 F_1 and evaluated in randomized block design in three replications having each experimental unit of single row with spacing of 3 m x 0.5 m at MES Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya during *Zaid*, 2017 and 2018. Observations were recorded for 18 metric traits *viz*. days to first staminate and pistillate flower appearance, node number to first staminate and pistillate flower anthesis, days to first fruit harvest, primary branches per plant, vine length (m), fruit length (cm), fruit circumference (cm), T.S.S. (ºB), ascorbic acid (mg per 100 g fresh weight), reducing sugar, non-reducing sugar and total sugars (%),dry matter content, Fruit weight (kg), number of fruits per plant, fruit yield per plant (kg).
The maximum inter-cluster distance was observed between clusters I to VIII (1177.61) and the intra cluster D^2 values ranged from 8.279 (cluster V) to 15.466 (cluster I). The maximum inter-cluster distance was observed between clusters I to VIII (13.225) during pooled. Which suggested that members of these two clusters were genetically very diverse to each other.

Keywords: D^2 inter cluster, intra cluster, genetic divergence

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.], (2n =2x= 22) is an important cultivated annual cucurbitaceous crop grown throughout the country. Being warm season vegetable crop it thrives well in warm and humid climate but at present it's off season cultivation has progressively stretched throughout the year in northern Indian plains. In India, the total area covered under bottle gourd is 0.157 million ha with production of 2.683 million tonnes and its productivity is 17.09 tonnes per ha (Anonymous, 2018) [1].
According to De Candolle (1882), bottle gourd has been found in wild form in South Africa and India. However, Cutler and Whitaker (1961) [3] are of the view that probably it is indigenous to tropical Africa on the basis of variability in seeds and fruits.
Out of all the cultivated cucurbits, bottle gourd with its high yield potential and adaptability to diverse climatic conditions holds a great promise to cope up with the per capita per day requirement of vegetables in the balanced diet of the fast growing population pressure and greater dietary awareness, particularly among the literate masses of a country like India. Bottle gourd was one of the first plant species to be domesticated for human use, providing food, medicine and a wide variety of utensils and musical instruments made from the large hard shelled mature fruits. A total of six species have been recognized belonging to the genus *Lagenaria*, of which only *L. siceraria*is the domesticated annual with monoecious sex form while the other five are wild congeners, perennial and dioecious (Bisognin, 2002) [2]. A stable andromonoecious sex form bearing hermaphrodite and male flower in same plant of *L. siceraria*have also been isolated and reported by Singh *et al*., 1996 [10]. The wild forms are native to the northern part of Africa. The *L. siceraria*(Sond.) Naud. and*L. breviflora* (Benth.) G. Roberty are found in South Africa and Zimbabwe, respectively (Jeffrey, 1967) [7].

Thus, the ancestral home of *L. siceraria*is believed to be Africa even though the oldest African archaeological remains date to only about 2000 B.C. in Egypt (Schweinfurth, 1884) [9] and Zambia (Fagan, 1970) [4]. In contrast, archaeological seeds and rind indicate that bottle gourd had reached Asia and the New World by 9,000-10,000 years ago (Cutler and Whitaker, 1961; Gorman, 1969; Mac Neish *et al*., 1970) [3, 5, 8], probably as a wild species whose fruits had floated across the seas (Heiser, 1973) [6]. It travelled to India, where it has evolved into numerous local varieties and from India to China, Indonesia and New Zealand. At present time, the annual running or climbing monoecious vine crop is cultivated throughout the tropical and subtropical regions of the world for food and useful gourds (Whitaker and Davis, 1962) [11].

Material and Methods

The present investigation entitled "Estimate the heritability in narrow sense and genetic advance in per cent of mean for quantitative traits in bottle gourd" [*Lagenaria siceraria* (Mol.) Standl.] was conducted during *Zaid* 2017 (E_1) and 2018 (E_2) to study heritability, genetic advance using diallel mating design at the Main Experiment Station (MES) of the Department of Vegetable Science, A.N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India. Geographically, Kumarganj falls under humid sub-tropical climate and is located in between 24.470 and 26.560 N latitude and 82.120 and 83.980 E longitude at an altitude of 113 m above the mean sea level in the Gangetic Alluvial Plains of Eastern Uttar Pradesh. The soil type of experimental site was sandy loam. This area falls under subtropical climatic zone. This farm received an annual rainfall about 1200 mm. The monsoon starts in the month of June and remains active upto September. Sometimes, continuous cloudy weather with heavy rains for longer period drastically affect the agricultural production. Occasional showers are also very common during winter season. The hot period of Zaid season generally start somewhere from middle of March and continues till the middle of June. The experimental materials for the present study comprised of ten promising and diverse inbred lines/varieties of bottle gourd viz., Pusa Naveen (P1), NDBG-601 (P2), PBOG-3 (P3), NDBG-517 (P4), NDBG-603 (P5), NDBG-624 (P6), N. Pooja (P7), NDBG-100 (P8), Punjab Komal (P9), and NDBG-11 (P10) were crossed in the all possible combinations, excluding reciprocals. The experiments were laid out R.B.D design with three replication during the Zaid season of 2017 and 2018 for the study of heritability (narrow sense) and genetic advance for 18 fruit yield, earliness and quality attributing traits. The observation to recorded Node number to first staminate flower appearance, Node number to first pistillate flower appearance, Days to first staminate flower anthesis, Days to first pistillate flower anthesis, Days to first fruit harvest, Number of primary branches per plant, Vine length (m), Fruit length (cm), Fruit circumference (cm), Total soluble solids (B), Ascorbic acid (mg/100g fresh fruit), Reducing sugars (%), Non-reducing sugars (%),Total Sugar (%), Dry matter content in fruit, Average fruit weight (kg), Number of fruits per plant, Fruit yield per plant (kg).

The genetic divergence of 45 F_1 and their 10 parents of bottle gourd was worked out using Mahalanobis (1928) D^2 statistics.

Result and Discussion

The study of genetic divergence among the 55 genotypes of bottle gourd was carried out using Mahalanobis D^2 statistics. The 55 genotypes were grouped into eight different non over lapping clusters (Table-1, 2 and 3). Cluster IV had highest number of genotypes (15) followed by cluster V (13), cluster II (11), cluster III (6), cluster VI (4), cluster VII (3), cluster I (2) and cluster VIII (1) in $E_{1,}$ Cluster IV and VI had highest number of genotypes (10) followed by cluster I (9), cluster VII (8), cluster III (7), cluster II and V (5), VIII (1) in $E_2$and Cluster I had highest number of genotypes (12) followed by cluster III and VI (8), cluster IV, V and VII (6*),* cluster VIII (2), in pooled. The distribution pattern of genotypes among different clusters also indicated that there is no geographical parallelism in the grouping of genotypes indicating that genotype of different geographical origin may grouped together or vice-versa.

The estimates of inter and intra-cluster distances represented by D^2 values has been given in Table- 4, 5 and 6. The intra cluster D^2 values ranged from 0 (cluster VI) to 276.293 (cluster VII). The maximum inter-cluster distance was observed between clusters I to VIII (1177.61) and the intra cluster D^2 values ranged from 8.279 (cluster V) to 15.466 (cluster I). The maximum inter-cluster distance was observed between clusters I to VIII (13.225) during pooled, which suggested that members of these two clusters were genetically very diverse to each other.

Table 1: Clustering pattern of 55 bottle gourd genotypes on the basis of Non-hierarchical Euclidean cluster analysis for 8 characters (E_1)

Cluster Number	Number of genotypes	Genotypes
I	2	P_1 x P_{10}, P_2 x P_5
II	11	P_1 x P_5, P_1 x P_7, P_2 x P_3, P_2 x P_6, P_2 x P_7, P_3 x P_6, P_4 x P_7, P_5 x P_7, P_5 x P_{10}, P_6, P_{10}
III	6	P_1 x P_4, P_3 x P_8, P_4 x P_8, P_5 x P_8, P_6 x P_8, P_8
IV	15	P_1 x P_2, P_1 x P_8, P_1 x P_9, P_2 x P_4, P_2 x P_8, P_2 x P_9, P_3 x P_4, P_3 x P_7, P_3 x P_{10}, P_4, P_4 x P_{10}, P_6 x P_{10}, P_7 x P_8, P_8 x P_9, P_8 x P_{10}
V	13	P_1 x P_3, P_1 x P_6, P_2, P_2 x P_{10}, P_3, P_3 x P_9, P_4 x P_6, P_4 x P_9, P_5 x P_9, P_6 x P_7, P_6 x P_9, P_7, P_9 x P_{10}
VI	4	P_3 x P_5, P_4 x P_5, P_5, P_5 x P_6
VII	3	P_1, P_7 x P_9, P_7 x P_{10}
VIII	1	P_9

Table 2: Clustering pattern of 55 bottle gourd genotypes on the basis of Non-hierarchical Euclidean cluster analysis for 8 characters (E_2)

Cluster Number	Number of genotypes	Genotypes
I	9	P_1 x P_4, P_1 x P_6, P_1 x P_{10}, P_3 x P_4, P_5 x P_7, P_5 x P_{10}, P_6, P_6 x P_7, P_7
II	5	P_1 x P_5, P_1 x P_7, P_2 x P_6, P_4 x P_5, P_5
III	7	P_2 x P_9, P_2 x P_{10}, P_3 x P_8, P_3 x P_{10}, P_4 x P_8, P_6 x P_{10}, P_8 x P_9
IV	10	P_1 x P_2, P_1 x P_8, P_3 x P_6, P_4 x P_{10}, P_5 x P_9, P_6 x P_8, P_7 x P_8, P_7 x P_{10}, P_8, P_9 x P_{10}
V	5	P_1 x P_3, P_2, P_2 x P_5, P_3, P_4

VI	10	P_1 x P_9, P_2 x P_3, P_2 x P_4, P_2 x P_7, P_3 x P_5, P_3 x P_7, P_4 x P_7, P_5 x P_6, P_5 x P_8, P_{10}
VII	8	P_1, P_2 x P_8, P_3 x P_9, P_4 x P_6, P_4 x P_9, P_6 x P_9, P_7 x P_9, P_8 x P_{10}
VIII	1	P_9

Table 3: Clustering pattern of 55 bottle gourd genotypes on the basis of Non-hierarchical Euclidean cluster analysis for 8 characters (Pooled)

Cluster Number	Number of genotypes	Genotypes
I	12	P_1xP_2, P_1xP_4, P_1xP_5, P_1xP_6, P_1xP_7, P_1xP_8, P_1xP_9, P_1xP_{10}, P_2, P_7xP_9, P_9, P_{10}
II	7	P_2xP_3, P_2xP_5, P_2xP_7, P_2xP_9, P_5x, P_5xP_7, P_5xP_9
III	8	P_2xP_6, P_2xP_8, P_2xP_{10}, P_3, P_3xP_5, P_4xP_7, P_4xP_9, P_9xP_{10}
IV	6	P_3xP_6, P_3xP_7, P_4xP_5, P_4xP_6, P_5xP_{10}, P_8xP_{10}
V	6	P_3xP_9, P_4, P_6xP_{10}, P_7xP_8, P_7xP_{10}, P_8xP_9
VI	8	P_3xP_8, P_3xP_{10}, P_4xP_8, P_4xP_{10}, P_5xP_6, P_5xP_8, P_6xP_8, P_8
VII	6	P_2xP_4, P_3xP_4, P_6, P_6xP_7, P_6xP_9, P_7
VIII	2	P_1, P_1xP_3

Table 4: Estimates of average intra and inter-cluster distances for 8 clusters in bottle gourd (E_1)

Cluster	I	II	III	IV	V	VI	VII	VIII
I	168.398	242.578	212.277	246.432	482.623	761.181	540.195	427.353
II		163.937	202.117	308.094	486.886	933.301	540.610	386.990
III			103.756	213.913	522.838	804.050	342.728	267.349
IV				155.001	344.237	528.077	423.386	249.310
V					257.429	398.932	637.905	489.135
VI						0.000	963.823	867.756
VII							276.293	311.551
VIII								141.876

Table 5: Estimates of average intra and inter-cluster distances for 8 clusters in bottle gourd (E_2)

Cluster	I	II	III	IV	V	VI	VII	VIII
I	3.27.172	336.637	386.934	777.173	1177.061	484.822	435.999	394.398
II		167.141	263.785	508.501	1076.154	344.834	278.641	354.310
III			133.266	417.358	645.465	482.839	301.931	266.823
IV				269.556	500.109	779.653	700.186	696.698
V					0.000	1583.804	1250.227	1100.319
VI						77.642	204.402	249.018
VII							135.232	213.626
VIII								162.441

Table 6: Estimates of average intra and inter-cluster distances for 8 clusters in bottle gourd (Pooled)

Cluster	I	II	III	IV	V	VI	VII	VIII
I	15.466	42.017	39.784	44.088	73.225	61.901	53.104	60.110
II		11.908	20.885	24.373	25.115	21.564	19.715	30.765
III			12.288	24.897	30.290	21.794	27.430	21.915
IV				14.003	34.933	24.569	23.670	30.540
V					8.279	17.983	22.537	37.111
VI						12.493	19.663	20.589
VII							15.051	28.345
VIII								13.793

Table 7: Clusters means for 18 characters in bottle gourd (E_1)

Cluster	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Days to first fruit harvest	Number of primary branches per plant	Vine length (m)	Fruit length (cm)	Fruit circumference (cm)	T.S.S. (%)	Ascorbic acid (mg/100g)
I	11.602	13.250	40.703	43.725	57.233	14.163	7.400	36.000	20.933	3.467	7.322
II	12.390	12.958	43.266	46.558	60.061	13.113	6.945	36.028	22.851	3.715	7.062
III	10.845	11.355	42.072	46.828	59.360	13.491	6.199	38.647	21.848	4.883	6.613
IV	10.635	11.847	41.439	46.805	59.578	12.676	6.006	37.129	23.021	4.062	7.020
V	11.272	12.559	41.242	46.155	58.197	11.964	5.904	34.575	23.695	3.823	6.963
VI	12.975	13.793	43.058	48.208	60.858	13.360	7.433	35.775	21.815	4.300	6.775
VII	9.120	10.557	39.957	46.056	59.332	9.714	4.681	34.703	24.477	3.100	6.867
VIII	9.710	11.400	40.670	43.000	56.000	11.670	6.000	23.433	32.767	3.500	9.810

Cluster	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Dry matter content fruit	Fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)
I	4.930	0.760	5.690	2.785	0.858	5.295	5.345
II	2.851	0.748	3.598	3.027	0.898	5.678	5.411
III	2.537	0.687	3.233	2.538	1.126	5.389	5.878

IV	2.666	0.663	3.333	2.787	0.935	5.868	5.699
V	3.421	0.619	4.033	2.740	0.904	5.979	5.588
VI	2.425	0.652	3.077	2.525	1.120	5.025	5.643
VII	2.943	0.467	3.418	2.823	0.954	6.440	5.880
VIII	5.930	0.370	6.300	1.930	1.177	5.480	6.340

Table 8: Clusters means for 18 characters in bottle gourd (E_2)

Cluster	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Days to first fruit harvest	Number of primary branches per plant	Vine length (m)	Fruit length (cm)	Fruit circumference (cm)	T.S.S. (%)	Ascorbic acid (mg/100g)
I	12.295	13.079	42.360	47.795	60.873	12.562	6.614	37.537	24.194	3.899	7.088
II	13.720	14.089	44.798	47.874	62.919	13.996	7.450	36.268	23.085	3.855	6.979
III	11.193	12.008	43.562	48.550	63.502	15.230	6.292	36.568	23.586	4.026	6.446
IV	11.109	12.135	43.151	48.307	61.459	13.998	6.168	38.463	25.506	4.345	7.046
V	11.249	13.584	44.817	47.775	62.078	10.126	6.659	40.892	23.750	4.427	8.121
VI	11.952	13.005	43.965	48.768	63.335	13.503	7.048	37.583	22.876	3.917	6.848
VII	10.617	11.668	43.069	49.010	62.237	12.587	5.791	36.509	24.907	3.940	7.250
VIII	10.000	11.740	42.300	44.720	58.803	12.250	6.240	24.373	34.407	3.537	10.010

Cluster	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Dry matter content fruit	Fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)
I	3.389	0.706	4.097	3.021	1.018	5.736	5.547
II	2.387	0.745	3.133	3.206	0.997	5.569	5.102
III	2.404	0.749	3.149	2.798	1.009	6.951	6.655
IV	2.727	0.579	3.307	2.491	1.083	6.221	6.427
V	4.319	0.621	4.935	3.035	1.009	5.930	5.142
VI	2.530	0.674	3.203	2.956	1.018	5.855	5.970
VII	3.633	0.700	4.318	2.600	0.962	6.706	6.669
VIII	6.047	0.380	6.427	1.970	1.260	5.863	6.783

Table 9: Clusters means for 18 characters in bottle gourd (Pooled)

Cluster	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Days to first fruit harvest	Number of primary branches per plant	Vine length (m)	Fruit length (cm)	Fruit circumference (cm)	T.S.S. (%)	Ascorbic acid (mg/100g)
I	11.257	12.653	42.014	46.996	60.376	12.486	6.254	36.013	23.564	3.849	7.067
II	11.623	12.884	43.896	48.853	61.940	12.774	6.435	38.263	22.731	4.250	7.194
III	11.422	11.990	42.042	47.397	60.003	13.586	6.523	35.556	23.612	4.178	6.860
IV	10.910	12.417	42.461	47.161	59.973	11.878	5.933	35.608	24.840	3.691	7.232
V	11.055	12.068	43.016	47.971	61.201	13.237	6.471	36.343	24.046	4.016	7.186
VI	11.684	12.815	42.659	46.446	61.087	13.457	6.633	36.994	24.346	4.039	7.292
VII	11.926	12.091	43.612	48.219	60.973	13.034	6.357	37.381	23.485	4.106	6.810
VIII	11.075	11.960	39.638	42.825	55.990	10.703	6.198	36.177	23.118	3.292	7.053

Cluster	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Dry matter content fruit	Fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)
I	3.161	0.668	3.825	2.697	0.935	5.779	5.604
II	2.882	0.681	3.565	2.712	1.031	5.675	5.879
III	2.916	0.693	3.611	2.680	1.004	5.572	5.768
IV	3.253	0.560	3.811	2.660	1.082	5.906	5.976
V	3.096	0.744	3.839	2.990	1.005	6.200	6.238
VI	3.236	0.650	3.879	2.886	0.968	6.283	5.764
VII	2.964	0.640	3.608	2.816	0.998	6.240	6.141
VIII	2.678	0.630	3.313	3.253	0.919	6.028	4.965

Reference

1. Anonymous. Horticulture Data Base, National Horticulture Board, Gurgaon, Ministry of Agriculture and Farmers Welfare, India 2018.
2. Bisognin DA. Origin and evolution of cultivated cucurbits. Ciencia Rural 2002, 32(4).
3. Santa Maria-RS, Brazil. Cutler HC, Whitaker TW. History and distribution of the cultivated cucurbits in the Americas. American Antiquity 1961;26:469-485.
4. Fagan B. Hunter-gatherers at Gwisho. In: B. Fagan (eds.), Introductory readings in archaeology. Little, Brown and Company, Boston 1970, 168-174.
5. Gorman CF. Hoabinhian: A pebble-tool complex with early plant association in Southeast Asia. Science 1969;163:671-673.
6. Heiser CB. Variation in the bottle gourd. In: B.J. Meggers, E.S. Ayensu and W.D. Duckworth (eds.), Tropical forest ecosystems in Africa and South America: A comparative review. Smithsonian Institution Press, Washington, DC 1973, 121-128.
7. Jeffrey C. Cucurbitaceae. In: E. milne-Redhead and R.M. Polhill (eds.), Flora of tropical East Africa. Crown Agents for Oversea Governments and Administrations, London 1967, 1-157.

8. MacNeish RS, Nelkin-Terner AN, Cook AG. The second annual report of the Ayacucho archeological-botanical project. R.S. Peabody Foundation for Archeology, Andover, M.A 1970.
9. Schweinfurth G. Further discoveries in the flora of ancient Egypt. Nature 1884;29:312-315.
10. Singh KP, Chaudhary DN, Singh VK, Mandal G. Combining ability analysis in bottle guard. J. Res. Birsa. Agri. Univ 1996;8(1):39-43.
11. Whitaker TW, Davis GN. Cucurbits. Interscience Publishers, Inc., New York 1962.