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Research Article

Genetic diversity analysis in sesame (*Sesamum indicum* L.) germplasm based on morphological and quality traits

Ajay Tanwar and Rajani Bisen
Department of Plant Breeding & Genetics
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) 482004
E-mail: rajanitomar20@gmail.com

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Abstract
To study the genetic divergence in sesame (*Sesamum indicum* L.), a set of 97 diverse germplasm, collected from different sources was planted at the Project Coordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *kharif* 2013 in a Randomized Complete Block Design in two replications. With the help of Mahalanobis's D^2 statistics, all the genotypes were clustered in 15 groups. Cluster I was the largest among all clusters comprising 48 germplasm, Cluster IV had 22 germplasm and Cluster V had 15 germplasm. Cluster II, Cluster III, Cluster VI, Cluster VII, Cluster VIII, Cluster IX, Cluster X, Cluster XI, Cluster XII, Cluster XIII, Cluster XIV and Cluster XV had single germplasm each. The trait oil content (34.94%) contributed maximum to genetic divergence followed by days to 50% flowering (28.72%) and number of capsules per plant (23.43%) . Moderate to low contribution was exhibited by plant height, 1000 seed weight, number of secondary branches per plant, capsule length, number of primary branches per plant, seed yield per plant and days to maturity. The highest intra cluster distance was recorded in cluster V (77.42) followed by cluster IV (71.05) and cluster I (62.94). The inter cluster distance was highest between the cluster VI and cluster XV (516.18) followed by cluster VIII and cluster XV (410.70), cluster XI and cluster XIV (363.55) suggesting wide diversity. The lowest inter cluster distance was observed between cluster III and cluster VI (41.10). The highest cluster mean values were found in cluster IX for characters plant height (98.17), number of capsules per plant (74.00) and 1000 seed weight (3.97) and lowest for days to 50% flowering (37.50) and days to maturity (100.00). Cluster XV had highest cluster mean value for days to 50% flowering (43.50), days to maturity (107.50), number of primary branches /plant (5.00), number of secondary branches/plant (2.67), seed yield/plant (9.57) and oil content % (51.06). Thus, selection of germplasm from clusters IX and XV i.e. ES 334962 and RJS-Bo would be effective. Crossing between germplasms lying in clusters VI and XV followed by clusters VIII and XV *i.e.* ES 334962, S-0069 and GRT-83128 may be desirable for getting superior hybrids/recombinants.

Key words
Sesame, D^2 statistics, , genetic divergence, variability

Introduction

Sesame (*Sesamum indicum* L.) is an important oilseed crop of tropical and sub tropical region. India ranks first in the world in sesame cultivation (27.7% area) but its productivity is quite low (368 kg/ha) as compared to the world's average (489 kg/ ha) (www.fao.org). Sesame oil has highest antioxidant content and contains several fatty acids such as oleic acid (43 %), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%). Though variations in climatic and edaphic conditions, according to Muhamman and Gungula (2008), affect sesame yields and performance, the major constraints identified in growing sesame in most countries are instability in yield, lack of wider adaptability, drought, non-synchronous maturity, poor stand establishment, lack of response to fertilizer application, profuse branching, lack of seed retention, low harvest index and susceptibility to insect pests and pathogens. It can set seed and yield well under fairly high temperature and it can grow in stored soil moisture without rainfall and irrigation. But continuous flooding or severe drought adversely affect sesame plants and resulted in low yield (Mensah et al., 2009).

The success of any crop improvement programme essentially depends on the nature and magnitude of genetic variability present in the crop. The knowledge of nature and magnitude of genetic variability is of immense value for planning efficient breeding programme to improve the yield potential of the genotypes. Improvement in yield is normally attained through exploitation of the genetically diverse parents in breeding programmes. Genetic divergence among parents is essential since the crossing programme involving genetically diverse parents is likely to produce high heterotic effects and also more variability could be expected in the segregating generations. Genetic diversity between populations/genotypes indicates the differences in gene frequencies. For identifying such diverse parents for crossing, multivariate analysis using Mahalanobis D^2 statistic (1936) has been used in several crops. This is a valuable tool to study genetic divergence at inter varietal and sub-species level in classifying the crop plants. The present study was, thus, carried out to ascertain the nature and magnitude of genetic divergence among ninety seven sesame genotypes.

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Materials and Methods

The experiment was conducted under Project Coordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *kharif* 2013. The soil of the experiment is medium black with uniform topography and free from water logged conditions. Jabalpur is situated in 'Kymore plateau and Satpura hills agro-climatic region of Madhya Pradesh at 23.91˚ North latitude, 79.5˚ East longitudes and on an altitude of 411.78 meters above the mean sea level. The region has sub tropical, semi arid climate. The main features are hot and dry summer and cold winter with occasional showers. The average rainfall is about 1200 mm. The minimum and maximum temperatures range between 22 ^{0}C to 35 ^{0}C, respectively during the *kharif* season. The experimental material was comprised of 97 germplasm of sesame laid out in Randomized Complete Block Design (RCBD) in two replications. Gross plots size was with distance between replications 1.0 m, distance between plots 0.50 m and row to row distance 0.30 m. Multivariate analysis was done as per Mahalanobis's D^2 statistics (1928) described by Rao (1952) and the genotypes were grouped into different clusters following Tocher's method. Contribution of each character for genetic divergence was estimated from the number of times each character appeared in first rank.

Results and Discussion

The analysis of variance revealed significant difference among the genotypes for each character, indicating the existence of variability among the genotypes for the character studied.

Grouping of germplasm into clusters using Tocher's method resulted in formation of fifteen clusters (Table 1 and Fig. 1). Clustering of germplasm was not associated with the geographical distribution and mainly grouped due to their morphological differences. Thus, showing evidence that geographical isolation is not the only factor causing genetic diversity in sesame. Clustering pattern was random and independent, and cluster I was largest with 48 germplasm, followed by cluster IV with 22 germplasm in sesame and Cluster V had fifteen germplasm. Cluster II, Cluster III, Cluster VI, Cluster VII, Cluster VIII, Cluster IX, Cluster X, Cluster XI, Cluster XII, Cluster XIII, Cluster XIV and Cluster XV had single germplasm each. Contradictory reports have been given by Anuradha and Reddy (2005) for cluster II being largest with 22 germplasm, followed by cluster I with 17 germplasm; Begum et al. (2011) for cluster IV and III containing the highest and lowest number of genotypes.

The percentage of contribution towards genetic divergence by all the characters is presented in Table 2. In present study, oil content (34.94%) contributed maximum to genetic divergence with 1627 times ranking first followed by days to 50% flowering (28.72%) by 1337 times and number of capsules per plant (23.43%) by 1091 times. Moderate to low contribution was exhibited by plant height, 1000 seed weight, number of secondary branches per plant, capsule length, number of primary branches per plant, seed yield per plant and days to maturity.

The intra and inter cluster D^2 mean values are presented in table 3 and Fig. 2. The highest intra cluster distance was recorded in cluster V (77.42) followed by cluster IV (71.05) and cluster I (62.94). The inter cluster distance was highest between the cluster VI and cluster XV (516.18) followed by cluster VIII and cluster XV (410.70), cluster XI and cluster XIV (363.55), cluster X and cluster XIII (362.71), cluster X and cluster XI (361.83) and cluster VII and cluster XIII (324.68) suggesting wide diversity. Similar results have been obtained by Tripathi et al. (2013) for cluster VI and cluster XI followed by clusters V and XI. Contradictory reports have been given by Parameshwarappa et al. (2012) for cluster II and VI; Rao (2006) for clusters VIII and cluster I and Solanki and Gupta (2004) for cluster I and VII. The lowest inter cluster distance was observed between cluster III and cluster VI (41.10). Contradictory reports have been given by Tripathi et al. (2013) for cluster IV and V.

The cluster mean values of different characters are presented in Table 4. The highest cluster mean values were found in germplasm RJS-Bo of cluster IX for characters plant height (98.17), number of capsules per plant (74.00) and 1000 seed weight (3.97) and lowest for days to 50% flowering (37.50) and days to maturity (100.00). Cluster XV (ES 334962) had highest cluster mean value for days to 50% flowering (43.50), days to maturity (107.50), number of primary branches /plant (5.00), number of secondary branches/plant (2.67), seed yield/plant (9.57) and oil content % (51.06). Contradictory reports have been given by Tripathi et al. (2013) for Cluster VI which exhibited highest means for days to 50 % flowering, plant height, number of primary and secondary branches per plant and days to maturity; Parameshwarappa et al. (2012) for Cluster VII exhibiting highest means for seed yield and number of capsules per plant. Cluster VIII exhibited highest means for plant height and number of branches per plant. Solanki and Gupta (2004) reported that cluster VII recorded the highest values for plant height, number of branches per plant and number of capsules per plant. The lowest cluster mean values were found in cluster XII for number of primary branches/plant, number of secondary branches/plant, capsule length, 1000 seed weight and seed yield/plant. Contradictory reports have been given by Tripathi et al. (2013) for cluster XI which exhibited lowest means for days to

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50 % flowering, plant height, number of primary branches per plant and days to maturity.

Thus, geographic origin cannot be considered as sole criteria for the selection of desirable donors for breeding programmes. Selection of germplasm from clusters IX. Crossing between germplasms lying in clusters VI and

XV followed by clusters VIII and XV *i.e*. ES 334962, S-0069 and GRT-83128 may be desirable for getting superior hybrids/recombinants. Further research on these selected germplasm will save a lot of time for the breeder in future. The study again suggests the vigorous testing of exotic and indigenous germplasm over years and location for identification of stable genetic divergent genotypes in sesame.

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Table 1. Distribution of sesame germplasm in different clusters

Cluster No.	No. of germplasm	Germplasm included in the cluster
1	48	NICC-8282, IS-387, G-13, EC-334955, NCR/82/NO, NIC-8062, G-8,EC-35000, IS-77, ES-110-A, ES-131-1-84, ES-120-1-84-B, IS-99-A, SI-3275, IS-449IS-156-3-84, IS-641-2-84, SI-3315-16, IC-2621694, G-16,Guj Sil-12, IS-289, EC-204704, EC-334995-1, ES-64, IS-350, ES-5503, IC-30884, NIC-8343, IS-90, GRT-8359, IS-686, TMV-12-52, IS-712, NIC-16218, IS-302, NIC-8210, 78-20, ES-560, Coredbose, IC-14142, ES-370, NIC-6059, IS-424, S-0253, BS-10, IC-204997, IS-482-B.
2	1	78-266-1
3	1	ES-173
4	22	IS-436-3-84, IS-199-2-04, EC-334967, IS-387-2, NIC-7982, IS-446-1-84, EC-334992-1, G-19, EC-310455, IS-564, S-0210, I-68,S-0281, EC-335009, ES-312955, GRT-8392, SI-1873, RJS-61, NIC-8260, IS-562,ES-303311, GT-10.
5	15	SI-1925, NIC-9835, GRT-8327, NIC-8055-1, S-0619,IS-132295, S-0627, IC-152485, WLR/92/No/217Shal, G-47, EC-334987, SI-3114, KJS-21, GAD-5, IS-261-2.
6	1	S-0069
7	1	IS-607-2-04
8	1	GRT-83128
9	1	RJS-Bo
10	1	EC334969
11	1	G-40
12	1	IS-205-1
13	1	ES-139-2-84
14	1	EC-334993-1
15	1	ES-334962

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Table 2. Contribution of different characters toward clustering in sesame germplasm

S.No.	Source	Times ranked 1st	Contribution %
1	Days to 50% flowering	1337	28.72
2	Days to maturity	18	0.39
3	Plant height	241	5.18
4	No. of capsules/plant	1091	23.43
5	No. of primary branches/plant	31	0.67
6	No. of secondary branches/plant	53	1.14
7	Capsule length	41	0.88
8	1000 seed weight	198	4.25
9	Oil content (%)	1627	34.94
10	Seed yield/plant	19	0.41

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Table 3. Inter and intra cluster D^2 values for different clusters

clusters	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VII	Cluster IX	Cluster X	Cluster XI	Cluster XII	Cluster XII	Cluster XIV	Cluster XV
Cluster I	62.94	83.03	81.22	127.74	139.12	124.73	99.97	81.88	137.9	246.56	94.91	114.30	163.39	172.35	323.84
Cluster II		0.00	73.50	100.50	59.44	111.56	76.92	134.75	118.76	127.16	103.26	146.73	176.25	238.69	210.67
Cluster III			0.00	57.30	138.93	**41.10**	129.54	126.95	87.20	167.17	177.32	70.21	128.84	74.08	160.31
Cluster IV				71.05	165.95	115.64	116.88	123.80	169.89	133.05	217.44	115.19	257.89	159.19	186.80
Cluster V					77.42	164.72	130.17	208.59	141.44	135.11	168.61	166.16	206.37	282.87	211.76
Cluster VI						0.00	215.82	216.92	42.33	187.71	286.28	51.66	58.67	64.28	142.78
Cluster VII							0.00	73.28	266.26	153.63	113.74	172.95	324.68	261.01	323.02
Cluster VII								0.00	252.15	272.61	95.14	150.09	320.60	224.35	410.70
Cluster IX									0.00	217.95	263.54	67.22	48.63	133.80	178.69
Cluster X										0.00	361.83	162.50	362.71	297.18	92.60
Cluster XI											0.00	261.00	298.61	363.55	**516.18**
Cluster XII												0.00	126.04	58.25	166.72
Cluster XII													0.00	129.22	280.82
Cluster XIV														0.00	210.12
Cluster XV															0.00

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Table 4. Cluster mean for yield and yield contributing traits of sesame germplasm

S.N.	Characters	Cluste I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII	Cluster IX	Cluster X	Cluster XI	Cluster XII	Cluster XIII	Cluster XIV	Cluster XV
1	**Days to 50% flowering**	37.85	41.00	39.00	40.18	41.57	38.50	40.50	38.50	37.50	44.00	38.00	38.00	37.00	37.00	43.50
2	**Days to maturity**	**104.88**	**102.50**	**104.50**	**104.48**	**106.57**	**101.00**	**112.00**	**105.00**	**100.00**	**100.50**	**103.50**	**102.50**	**107.50**	**99.50**	**107.50**
3	**Plant height**	81.05	88.00	85.00	82.86	81.88	93.84	64.34	76.17	98.17	79.00	78.67	80.34	94.34	76.17	84.84
4	**No. of Capsules**	44.18	41.33	49.50	41.19	48.76	63.17	33.00	29.50	74.00	47.50	28.83	60.83	67.17	64.84	65.17
5	**No. of primary branches/plant**	3.97	3.67	4.83	3.95	4.29	3.34	2.33	3.67	4.67	3.00	5.67	4.17	4.00	4.50	5.00
6	**No. of secondary branches/plant**	**2.24**	**1.17**	**2.67**	**2.37**	**1.99**	**1.17**	**1.50**	**2.50**	**1.67**	**1.17**	**2.50**	**0.67**	**1.67**	**1.34**	**2.67**
7	**Capsule length**	2.50	2.44	2.70	2.57	2.58	2.78	2.44	2.07	2.64	2.80	2.45	2.63	2.75	2.60	2.45
8	**1000 seed weight**	3.65	3.82	3.96	3.62	3.51	3.76	3.66	3.22	3.97	3.11	3.75	3.11	3.49	3.76	3.47
9	**Oil content (%)**	43.91	43.65	48.12	48.63	42.85	47.96	44.10	45.18	50.23	48.00	40.09	47.59	44.17	45.47	51.06
10	**Seed yieldper plant**	8.40	8.63	8.49	8.37	8.38	8.97	7.81	8.98	7.38	7.51	7.82	7.54	9.26	9.57	9.57

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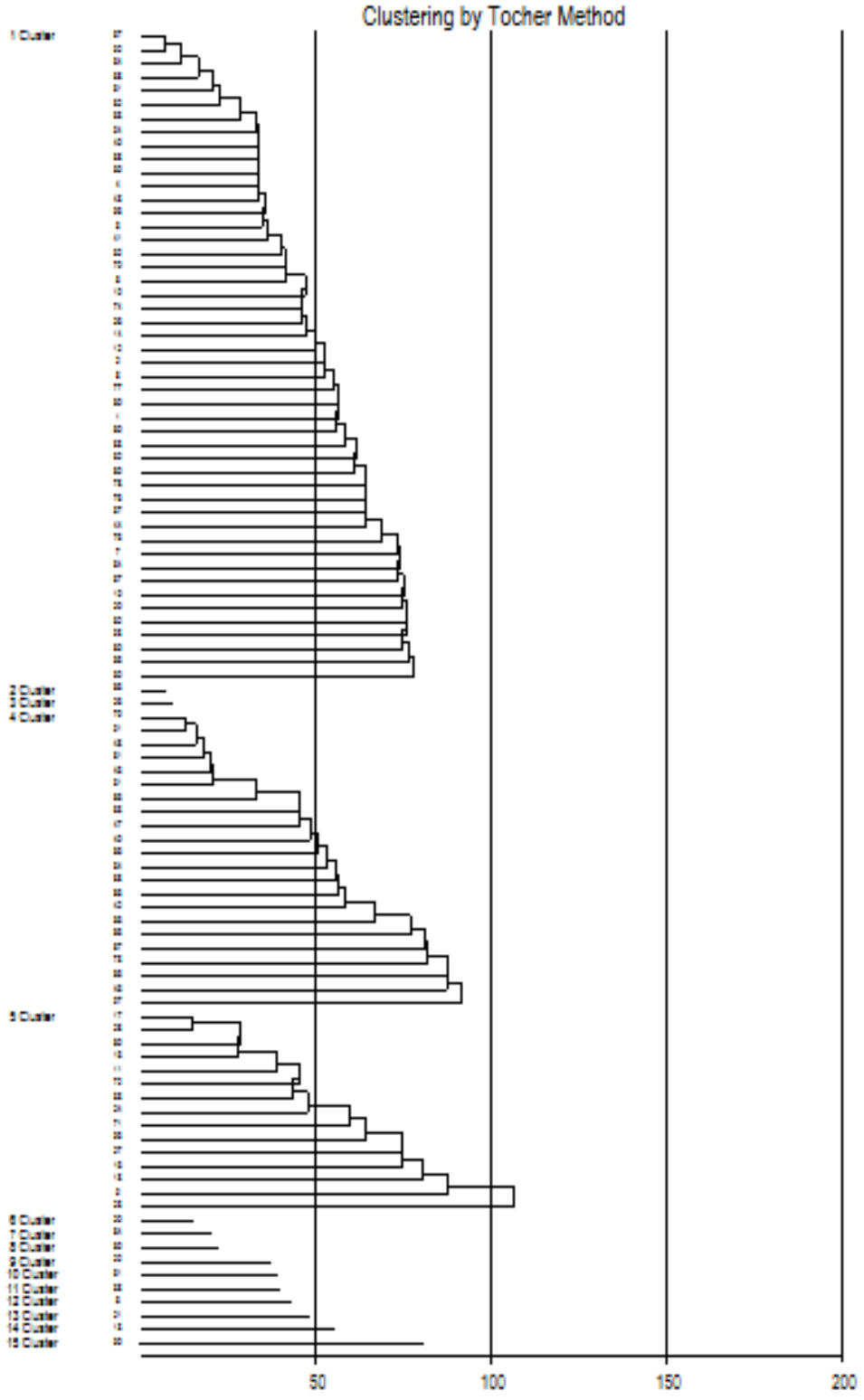

Fig. 1. Clustering by Tocher's Method

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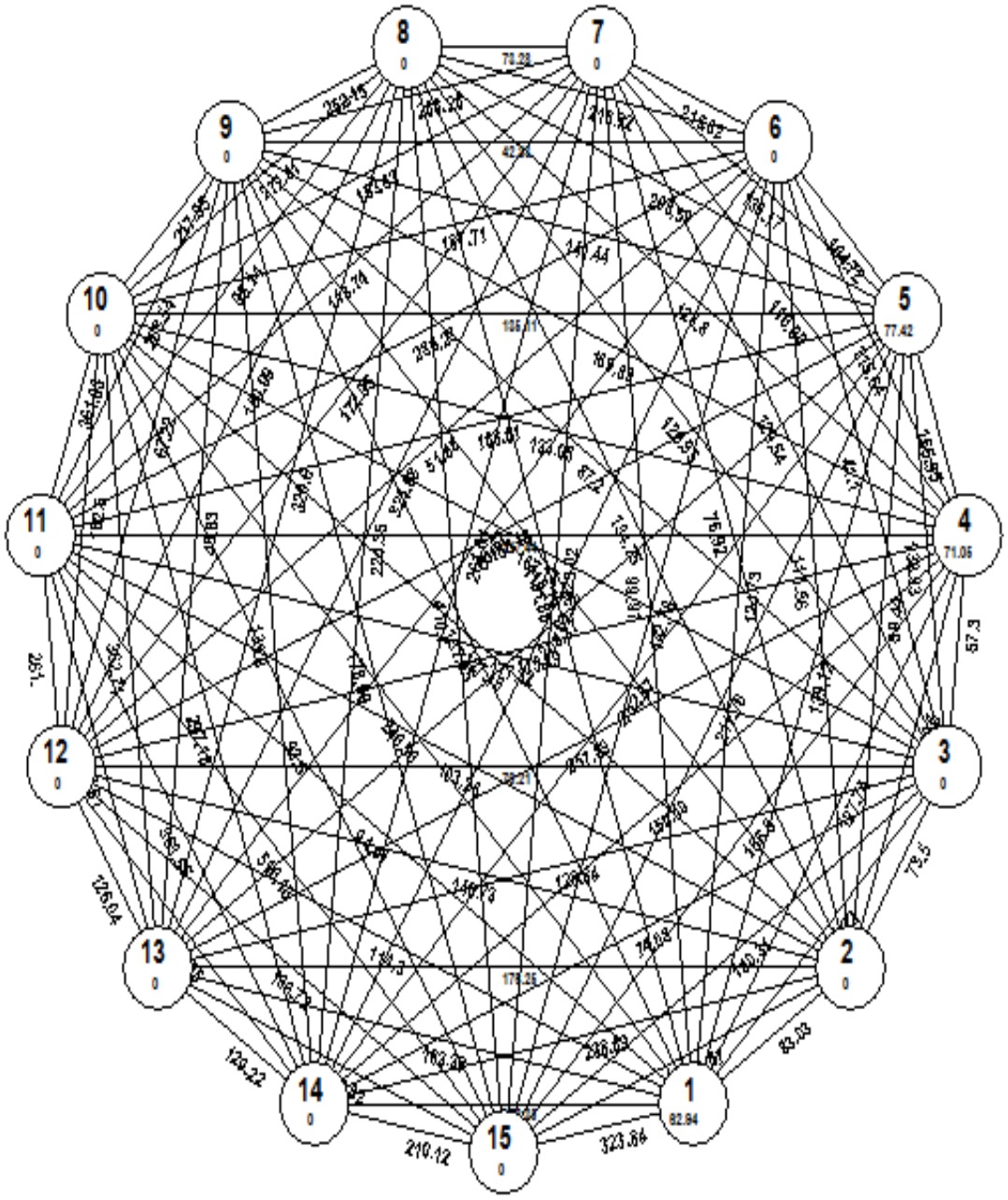

Fig. 2. Diagram showing intra and inter cluster distances among XV clusters