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ESTIMATION OF GENETIC DIVERGENCE AMONG THE NIGER GERMPLASM

R. Bisen, A. K. Panday, S. Jain, R. Sahu and M. Malviya

Project Coordinating Unit (Sesame and Niger), JNKVV, Jabalpur (M.P.) India
Corresponding Author Email: rajanitomar20@gmail.com

ABSTRACT

A study was conducted to assess the genetic divergence among the 100 niger germplasm on the basis of morphological and quantitative traits at Project Coordinating Unit (Sesame & Niger), JNKVV, Jabalpur. Genetic distance between clusters was calculated using the generalized Mahalanobis D^2 statistics and grouped the germplasm into seventeen clusters based on divergence analysis. Cluster II was the largest among all clusters comprising 36 germplasm followed by Cluster I having fifteen germplasm, Cluster III having fourteen germplasm, cluster XII having twelve germplasm and cluster IV having eleven germplasm. Clusters V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV, XVI and XVII had single germplasm each. Among the traits studied, seed yield contributed maximum towards genetic divergence (72.53%) followed by days to maturity (12.10%), number of capitula per plant (7.29%) and 1000 seed weight (4.71%). Moderate to low contribution was exhibited by plant height followed by oil content and lowest contribution was given by number of branches per plant. The highest intra cluster distance was recorded in cluster XII followed by cluster III. The inter cluster distance was highest between the cluster XIV and cluster IV followed by cluster VIII and cluster IV. The lowest inter cluster distance was observed between cluster VII and cluster VI. Cluster XVII comprising of germplasm N- 139 exhibited highest mean values for seed yield per plant, number of branches/plant, oil content, plant height, number of capitula per plant and days to maturity. Cluster XVI comprising of germplasm N- 18 exhibited lowest mean values for plant height, number of capitula per plant, 1000 seed weight and oil content. Crossing between germplasms lying in cluster XIV and cluster IV followed by cluster VIII and cluster IV, cluster XVI and cluster IV *i.e*. N- 11, N- 3, N- 580, N- 103, N- 51, N- 13, N- 38, N- 15, N- 33, N- 52, N- 114, N- 140, N- 102, N- 18 may be desirable for getting superior hybrids/recombinants.

Keywords: Niger, divergence, clusters, crossing, hybrids.

INTRODUCTION

Niger [*Guizotia abyssinica (L.f.)* Cass.] belonging to family Asteraceae is minor oilseed crop with its center of diversity and origin in Ethiopia (Baagoe 1974; Murthy *et al*.1993, Hiremath and Murthy, 1988). Niger constitutes about 3% of Indian and 50% of Ethiopian oilseed production in the world. Niger is the only cultivated species of the genus Guizotia with a diploid plant chromosome number of 2n=/2x=/30. It is an annual dicotyledonous herb primarily grown on the denuded soils in hilly and tribal pockets under input starved conditions without chemicals. It is the lifeline of tribal agriculture and economy in India. India ranks first in area, production and export of niger in the world. It is highly cross pollinated and self incompatible crop (Hiremath and Murthy 1986; Adda *et al*. 1994).

Niger is generally planted as a rainfed crop in *kharif* seasons. The niger seed contains about 34 to 36% of quality oil with fatty acid composition of 75-80% linoleic acid, 7-8% palmitic and stearic acids, and 5-8% oleic acid (Getinet and Teklewold 1995). The Indian types contain 25% oleic and 55% linoleic acids (Nasirullah *et al.* 1982). Niger oil has good keeping quality with 70% unsaturated fatty acids free from toxins. It has an advantage of yielding oil and has good degree of tolerance to insect pests, diseases and attack of wild animals. It has good potential for soil conservation, land rehabilitation and as a biofertilizer; consequently the crop following niger is always good.

Genetic diversity helps to provide information regarding the amount of genetic variability among the population and serves a platform for specific breeding objectives. The knowledge of genetic diversity among germplasm helps in the selection of diverse parents for hybridization and breeding of high yielding, good quality cultivars that will help in increasing production. Diverse parents are expected to give higher yields alongwith creation of broad spectrum of variability among the various germplasm lines. For identifying such diverse parents, multivariate analysis using Mahalanobis D^2 statistics (1928) has been used in several crops. This is a valuable tool to study genetic divergence at inter varietal and sub-species level in clustering the crops. The present study was, thus, carried out to ascertain the nature and magnitude of genetic divergence among the niger germplasm to provide some information for future research.

MATERIALS AND METHODS

The present experiment was conducted under Project Coordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *Kharif* 2013-14. The soil of the experiment is medium black with uniform topography and free from water logged conditions. Jabalpur has sub tropical, semi arid climate. The main features are hot and dry summer and cold winter with occasional showers. The experiment comprised of 100 niger germplasm laid out in a Randomized Block Design along with check in three replications. The distance between rows was maintained at 0.30 m and plant to plant was 0.10 m. All recommended cultural practices for growing niger were applied equally. The crop was weeded twice manually with continuous scouting to ensure clean field. The observations were recorded on five randomly selected competitive plants in each replication' and quantitative and morphological traits were recorded. The data on yield and quality traits were statistically analyzed on the basis of model described by Cochran and Cox (1957) for randomized complete block design. Data were collected on days to 50% flowering, days to maturity, plant height, diameter of capitulam, number of branches/plant, number of capitula/plant, 1000 seed weight, oil content (%) and seed yield/plant. Genetic distance between clusters was calculated using the generalized Mahalanobis D^2 statistics.

RESULTS AND DISCUSSION

Genetic divergence among 100 germplasm along with check was determined using seed yield and its attributing traits. To estimate D^2 values, correlated means of characters were transformed to standard uncorrelated means using Tocher's method. In the present study, 100 germplasm were grouped into seventeen clusters based on divergence analysis (Table 1). Clustering of germplasm was not associated with the geographical distribution and were mainly grouped due to their morphological differences. Thus, showing evidence that geographical isolation is not the only factor causing genetic diversity in niger. Clustering pattern was random and independent. Cluster II was the largest among all clusters comprising thirty six germplasm followed by Cluster I having fifteen germplasm, Cluster III having fourteen germplasm, cluster XII having twelve germplasm and cluster IV having eleven germplasm. Clusters V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV, XVI and XVII had single germplasm each (Table 1 and Fig. 1).

The percentage of contribution towards genetic divergence by all the characters is presented in Table 2. Among all the traits studied, seed yield (72.53%) contributed maximum towards genetic divergence followed by days to maturity (12.10%), number of capitula per plant (7.29%) and 1000 seed weight (4.71%). Moderate to low contribution was exhibited by plant height (1.70%) followed by oil content (1.05%), diameter of capitulam (0.030%), days to 50% flowering (0.024%) and number of branches per plant (0.08%). Sohanram and Kerketta (1998) reported that traits days to maturity and plant height were the major contributors to the diversity. While, Sreedhar *et al*., 2006 reported that plant height, days to 50% flowering and days to maturity were the major contributors and lowest contribution was made by seed yield/plant. Parameshwarappa *et al*., 2011 also reported that among the seven characters studied, seed yield/plant followed by number of capitula/plant and plant height were the most important characters contributing towards genetic divergence.

Contradictory results were given by Parameshwarappa *et al*., 2009 for seed yield which showed negligible contribution. Pulate *et al*., 2015 reported that number of seeds per capitula contributed highest towards genetic divergence followed by days to 50% flowering, oil content, 1000 seed weight, and lowest by plant height. Patil *et al*., 2007 reported that seeds/capsule contributed towards maximum divergence, followed by seed yield, days to maturity and capitula/plant.

The intra and inter cluster D^2 mean values are presented in Table 3. The highest intra cluster distance was recorded in cluster XII (14.43) followed by cluster III (11.18), cluster IV (11.09), cluster II (8.74) and cluster I (5.23). The inter cluster distance was recorded highest between the clusters XIV and IV (230.75) followed by clusters VIII and IV (210.01), clusters XVI and IV (184.92), clusters XV and IV (178.22), clusters IV and II (169.06), and clusters XVII and XIV (164.16). The lowest inter cluster distance was observed between clusters VII and VI (2.31).

The cluster mean values of different characters are presented in Table 4. The highest cluster mean values were exhibited by cluster XVII comprising of germplasm N- 139 for characters seed yield per plant (56.11), number of branches/plant (11.67), oil content (40.86), plant height (127.33), number of capitula per plant (94.67) and days to maturity (118). The lowest cluster mean values were recorded in cluster XVI comprising of germplasm N- 18 for plant height (85.33), number of capitula per plant (45.33), 1000 seed weight (3.33) and oil content (34.12). On the contrary, Parameshwarappa *et al*., 2011 reported that Cluster IV and V exhibited highest means for seed yield per plant, number of capitula per plant, number of seeds per capitula, days to maturity and plant height and suggested that the genotypes from cluster IV and V which have high cluster means for the majority characters can be used as parents for hybridization programme to achieve novel recombinants.

Thus, geographic origin cannot be considered as sole criteria for the selection of desirable donors for breeding programmes. Crossing between germplasms lying in clusters XIV and IV followed by clusters VIII and IV, clusters XVI and IV *i.e*. between the germplasm lines *viz*., N- 11, N- 3, N- 580, N- 103, N- 51, N- 13, N- 38, N- 15, N- 33, N- 52, N- 114, N- 140, N- 102, N- 18 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 vital testing of exotic and indigenous germplasm over years and location for identification of stable genetic divergent genotypes in niger. The pattern of clustering was highly influenced by environment and therefore, experimental conditions should be taken into consideration.

Table 1. Distribution of niger germplasm in different clusters

Cluster No.	No. of germplasm	Germplasm included in the cluster
1	15	N- 12, N- 18, N- 27, N- 32, N- 50, N- 47, N- 36, N- 35, N- 29, N- 133, N- 109, N- 120, N- 28, N- 48, N- 96
2	36	N- 9, N- 16, N- 17, N- 7, N- 121, N- 8 N- 20, N- 25, N- 128, N- 125, N- 71, N- 70, N- 129, N-107, N- 79, N- 95, N- 99, N- 106, N- 75, N- 136, N- 117, N- 101, N- 126, N- 132, N- 37, N-137, N- 115 N- 80, N- 93, N- 46, N- 14, N- 124, N- 88, N- 21, N- 127, N- 22
3	14	N- 76, N- 86, N- 108, N- 87, N- 134, N- 5, N- 135, N- 100, N- 138, N- 49, N- 24, N- 84, N- 92
4	11	N- 3, N- 580, N- 103, N- 51, N- 13, N- 38, N- 15, N- 33, N- 52, N- 114, N- 140
5	1	N- 85
6	1	N- 123
7	1	N- 83
8	1	N- 102
9	1	N- 116
10	1	N- 17
11	1	N- 31
12	12	N- 114, N- 113, N- 34, N- 57, N- 110 N- 111, N- 23, N- 141, N- 98, N- 26, N- 81, N- 4
13	1	N- 10
14	1	N- 11
15	1	N- 90
16	1	N- 18
17	1	N- 139

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

S.No.	Source	Times ranked 1st	Contribution %
1	**Days to 50% flowering**	12	0.24%
2	**Plant height**	84	1.70%
3	**Diameter of capitulam (cm)**	15	0.30%
4	**No. of branches/plant**	4	0.08%
5	**No. of capitula/plant**	361	7.29%
6	**Days to maturity**	599	12.10%
7	**1000 seed weight**	233	4.71%
8	**Oil content (%)**	52	1.05%
9	**Seed yield/ plant**	3590	72.53%

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

	Cluster 1	Cluste r 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Clust er 9	Cluste r 10	Clust er 11	Clust er 12	Cluster 13	Cluste r 14	Cluste r 15	Cluster 16	Cluster 17
Cluster 1	**5.23**	77.89	43.55	25.46	58.11	9.57	13.33	**106.40**	16.73	46.53	15.96	20.34	9.66	122.67	83.77	90.37	14.32
Cluster 2		**8.74**	17.56	**169.06**	12.32	39.44	40.43	15.01	32.16	13.28	32.89	38.21	72.43	19.53	13.40	13.77	**107.18**
Cluster 3			**11.18**	**113.39**	15.25	19.39	20.16	31.65	17.44	15.34	17.43	20.46	37.16	31.21	25.87	21.84	67.78
Cluster 4				**11.09**	**137.48**	51.65	56.56	**210.01**	66.96	**119.37**	63.45	68.65	34.05	**230.75**	**178.22**	**184.92**	27.15
Cluster 5					0.00	24.39	20.27	10.08	20.04	11.23	17.97	26.80	60.41	35.16	11.47	13.74	79.73
Cluster 6						0.00	**2.31**	58.96	2.59	18.00	2.85	8.34	13.33	77.05	42.11	48.28	24.50
Cluster 7							0.00	54.28	6.27	21.17	3.71	10.81	17.02	75.70	43.09	44.27	28.17
Cluster 8								0.00	48.12	27.05	49.10	55.61	**109.10**	28.56	7.37	17.28	**125.35**
Cluster 9									0.00	12.60	3.13	9.37	23.47	68.47	31.81	44.94	31.44
Cluster 10										0.00	12.41	22.69	46.52	42.16	18.68	24.48	75.06
Cluster 11											0.00	9.77	20.44	69.45	38.90	44.97	33.17
Cluster 12												**14.43**	23.49	70.18	40.94	49.68	32.87
Cluster 13													0.00	102.27	90.53	75.85	32.05
Cluster 14														0.00	35.21	14.87	**164.16**
Cluster 15															0.00	20.92	98.49
Cluster 16																0.00	128.87
Cluster 17																	0.00

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

Cluster	Days to 50% flowering	Plant height (cm)	Diameter of capitulam (cm)	No. of branches/plant	No. of capitula/plant	Days to maturity	Oil content (%)	1000 seed weight (g)	Seed yield/ plant (g)
Cluster 1	42	112.31	1.34	9.62	48.40	115	40.55	3.51	42.25
Cluster 2	42	108.88	1.32	9.85	43.77	113	39.59	3.51	14.87
Cluster 3	42	112.86	1.34	9.71	46.90	110	39.09	3.59	23.46
Cluster 4	42	110.00	1.34	10.79	49.00	115	41.70	3.58	45.27
Cluster 5	42	103.67	1.47	11.33	60.00	118	36.42	3.73	18.33
Cluster 6	43	106.00	1.33	10.00	49.33	116	39.08	3.45	33.30
Cluster 7	41	101.67	1.40	9.33	50.33	117	36.40	3.61	32.70
Cluster 8	41	118.00	1.43	10.67	76.33	118	35.32	3.59	9.23
Cluster 9	45	120.00	1.23	10.00	47.33	118	38.56	3.43	30.03
Cluster 10	42	113.67	1.37	8.67	21.67	119	40.89	3.35	22.27
Cluster 11	41	116.67	1.30	11.33	43.00	118	39.46	3.68	31.50
Cluster 12	42	113.69	1.28	9.69	57.36	114	40.02	3.56	31.40
Cluster 13	41	106.00	1.43	11.33	34.33	107	40.70	3.39	41.40
Cluster 14	42	110.33	1.23	9.00	32.00	102	36.93	3.66	8.97
Cluster 15	44	107.67	1.30	7.67	73.67	119	37.30	3.26	12.50
Cluster 16	42	85.33	1.53	8.67	45.33	109	34.12	3.33	12.33
Cluster 17	42	127.33	1.27	11.67	94.67	118	40.86	3.54	56.11

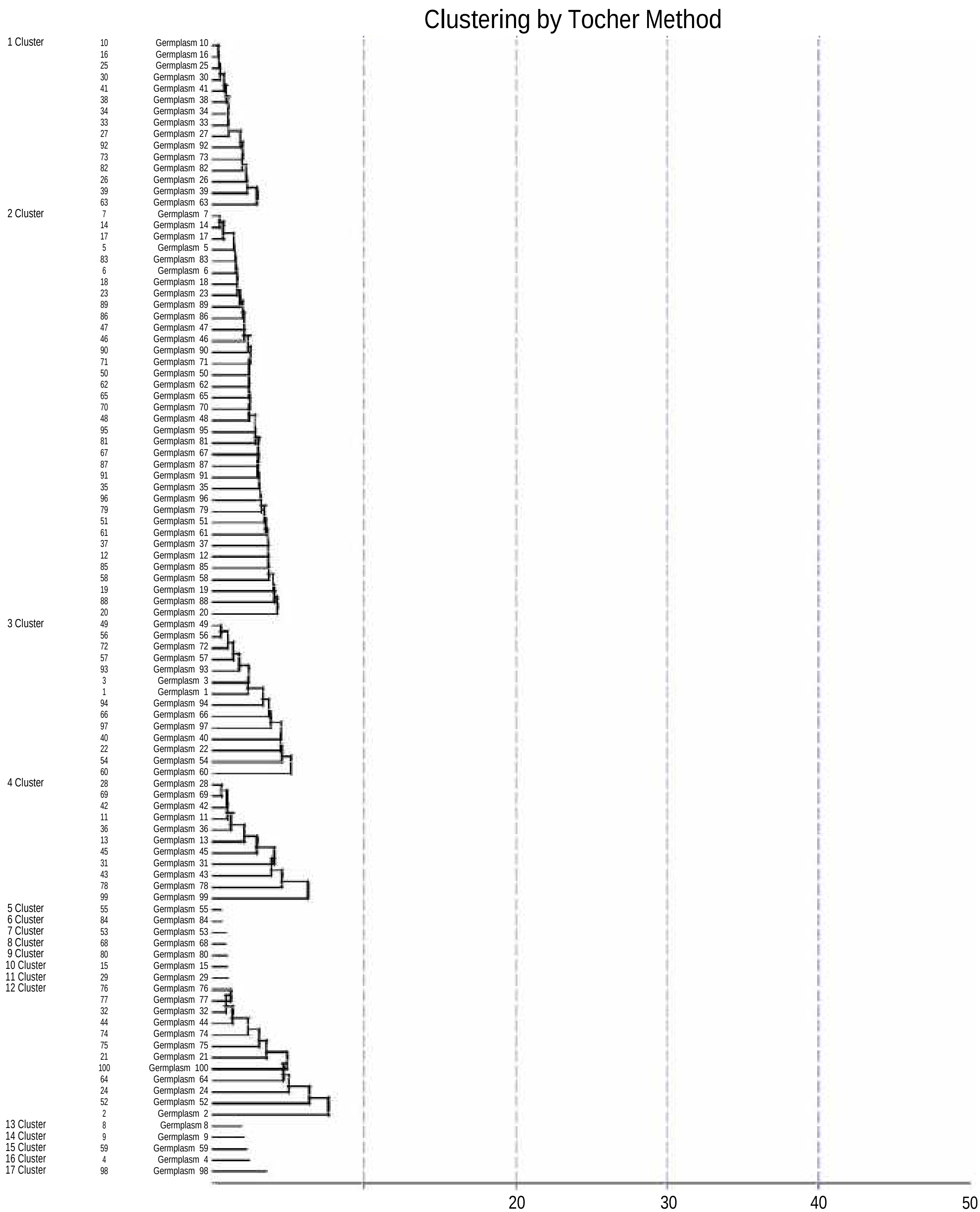

Fig 1. The dendrogram showing the spatial position of niger germplasm

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