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Estimation of genetic divergence in niger (*Guizitia abyssinica* (L.f) Cass.)

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Abstract
An experiment was undertaken by utilizing forty genotypes of Niger obtained from Project co-ordinator Unit, Jabalpur and AICRP on Niger, Zonal Agriculture Research Station, Igatpuri at ZARS, Igatpuri during *kharif*-2019. The analysis of variance has shown that there was significant variation among the genotypes in all the traits. The multivariate analysis carried out using Mahalanobis D^2-statistics, indicated wider genetic diversity in the genotypes of niger. Out of nine cluster formed, cluster I was largest with eighteen genotypes, followed by cluster II with eight genotypes, The cluster V, VI, VII, VIII, IX were solitary since they had only one genotype, whereas cluster III had six genotypes and cluster IV had three genotypes. The clustering pattern indicated absence of relationship between genetic diversity and geographical origin of the genotypes. The maximum inter cluster distance was observed between cluster IV and VIII (D= 17.68) while, lowest divergence was noticed between cluster V and IX (D=7.48). Maximum intra cluster distance observed within cluster III (D=8.06) while lowest intra cluster distance was observed within cluster I (D=6.12). The variance for cluster means were high for plant height (28.59 per cent), followed by oil content (21.28 per cent), seed yield (17.95 per cent), days to maturity (16.03 per cent) while, number of capitulum per plant was least contributor (0.13 per cent) towards the diversity. Based on inter-cluster distances, cluster mean and *per se* performance *viz;* IGPN-18-1, IGPN-18-12, IGPN-18-13, IGPN-18-14, IGPN-18-18, IGPN-18-19, N-24 and NSKMS-214 were distinct and diverse and can be classified as promising genotypes. These eight genotypes can be used for inter-crossing to obtain heterosis and also wider variability in Niger.

Keywords: Cluster, genetic diversity, mean, niger, seed yield per plant

Introduction
Niger (*Guizotia abyssinica* (L.f.) Cass) is one of the important minor oil seed crops of India. Its cultivation originated in the Ethiopian highlands and has spread to other parts of Ethiopia. Common names include noog/nug, niger, nyger, nyjer, or niger seed, ramtil, ramtilla, inga seed, and blackseed.

It is a highly cross pollinated, annual diploid species 2n=2x=30 belong to family compositae. Sub family Liguliflorae, tribe Heliantheae, subtribe coreopsidiane. Niger though a native of Tropical Africa, is wide spread and extensively cultivated in India since long. It has been reported that this crop is the only cultivated member of the taxon Guizotia. This crop is grown mainly for its oil and seed. The niger seed contains about 35 to 40 percent 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) [4]. The Indian types contain 25% oleic and 55% linoleic acids (Nasirullah *et al*., 1982) [11]. In India the Niger is grown on an area of 2.61 lakh ha mainly during *Kharif*, and average productivity in India is 321 kg/ha with production 0.84 lakh tonnes. India is the largest exporter of Niger in the world to USA, Netherland, Italy, Germany, Belgium, and Spain is the regular buyer. Whereas, USA is the largest buyer in the world. The export of the Niger seed continuously increased. In Maharashtra, it is grown on an area of 0.141 lakh ha with the production of 0.023 lakh MT and productivity is 165 kg/ha (2016-17). India tops in area, production and total export for Niger in the world.

Genetic diversity which is pre-requisite for any successful breeding programme is of paramount importance. Genetic divergence among the parents play a vital role in cultivar improvement because a cross involving genetically diverse parents is likely to generate more variability in segregating generations, and also which can be used for the desired improvement.

Generally, plant breeders select the parents on the basis of phenotypic diversity. Hence the knowledge of genetic diversity among the parents with respect to characters which are to be improved is essential. Therefore it is necessary to collect, conserve and study the genetic diversity among various crops in the form of germplasm for establishing the wide genetic base

for the posterity. Keeping these things in the view, an effort has been made in the present study to evaluate a set of Niger genotypes with the objective to study the nature and magnitude of divergence among the genotypes of Niger.

Materials and Methods

The experimental material comprising forty genotypes of Niger were grown in Randomized Block Design with two replications at the research farm of Zonal Agriculture Research Station, Igatpuri Dist. Nashik during *kharif* season of 2019. Each entry was represented by single row of 4.5 m length with spacing of 30 cm between rows. Data were recorded on five randomly and competitive plants of each genotype from each replication for ten quantitative characters *viz*., days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of capitulum per plant, number of seeds per capitulum, diameter of capitulum (cm), 1000 seed weight (g), seed yield per plant (g), oil content (g). Effective method suggested by Mahalanobis (1936) [9] known as "Mahalanobis D^2 statistics" or "D^2 technique" is widely used to know genetic diversity in the germplasm. It was conducted to estimate the intra and inter cluster distances and to group the genotypes into different clusters and a logical grouping of genotypes following Tocher's method (Rao, 1952) [17].

Result and Discussion

The data obtained from ten characters were subjected to statistical analysis of variance revealed highly significant differences among the genotypes for all the characters studied. Table 1. The mean performances of 40 genotypes of Niger for ten characters studied are presented in Table 2. The genotype IGPN-18-18 (94 days) was the earliest for flowering and days to maturity 129 days).

The genotype NSS-5438 (140.8 cm cm) was found tall. The genotype NSKMS-214 was found to be significantly superior for number of branches per plant (11.7) genotype IGPN-18-12 (100.9) produced maximum number of capitulum per plant, genotype IGPN-18-13 (54.0) recorded maximum number of seeds per capitulum, genotype IGPN-18-13 (20.0 mm) recorded maximum diameter of capitulum, genotype IGPN-18-13 (4.35 g) recorded maximum 1000 seed weight, genotype IGPN-18-13 (25.9 g) recorded highest seed yield, genotype IGPN-18-22 (43.50%) recorded significantly high oil content.

On the basis of D^2 values, the forty genotypes evaluated for twelve characters were grouped into nine clusters by using the Tocher's method as described by Rao (1952) [17]. Cluster I was largest with 18 genotypes followed by cluster II (8 genotypes), cluster III (6 genotypes), cluster IV (3 genotypes), while clusters V, VI, VII, VIII and IX were monogenotypic. In the present investigation grouping of genotypes into nine clusters (Table 3) suggested the presence of substantial amount of genetic diversity in the material under investigation. Cluster I was the largest including 18 lines indicates that there was no association between clustering pattern and eco-geographical distribution of the cultures. Murty and Arunachalam (1966) [10] and Somayajulu *et al.*, (1970) [19] while working with different crops, reported that geographical distribution does not necessary reflect genetic divergence.

Cluster II which include 8 lines, cluster III include 6 lines and cluster IV include 3 lines under study had varieties from different eco- geographical regions, thus supporting the view that geographic distribution and genetic divergence do not follow the same trend. Wide range of diversity was reported by many workers while evaluating niger genotypes Sreedhar *et al.*, (2006) [20], Patil (2007) [13], Parmeshwarappa *et al.*, (2011) [12], Pulate *et al.*, (2013) [15], Khuntey and Kumar (2015) [7], Pulate *et al.*, (2015) [16], Bisen *et al.*, (2016) [3] and Goyal and Bisen (2017) [5], Surayanarayana *et al*., (2018) [21] and Patil *et al*., (2019) [14].

The maximum intra cluster distance was observed for cluster III (D=8.06) followed by cluster IV (D=7.26) suggesting that genotypes present in these clusters might have different genetical architecture (Table 4). However, lowest intra cluster distance was observed in cluster I (D=6.12) indicating that genotypes present in these cluster might have genetical similarities with one another and appeared to have evolved from common gene pool. Cluster V, VI, VII, VIII and IX showed no intra cluster distance due to its monogenotypic nature.

Maximum inter cluster distance was observed between cluster IV and VIII (D=17.68) followed by cluster VII and IX (D=16.50), cluster VIII and IX (D= 16.48), cluster II and IV (D=15.75) indicating wide divergence among these clusters. These also suggest that genotype present in one cluster differ entirely from those presenting other clusters. The minimum inter cluster distance was found between cluster VI and VII (D^2 =7.29). The less inter cluster distance between these clusters revealed that genetic constitution of genotypes had close proximity.

Based on mean performance of clusters for 10 characters (Table 5). It was observed that cluster IV exhibited the highest number of capitulum per plant, number of seeds per capitulum, diameter of capitulum, test weight. All these characters appeared to have played important role in determining seed yield per palnt of these cluster.

Cluster VII was characterized by less days to 50 per cent flowering, days to maturity, Cluster

II was characterized by highest plant height, cluster IX was characterized by number of branches per plant, and cluster III was characterized by highest oil percent. On the basis of mean performance of different clusters, it was observed that cluster II, III, VII and IX were performing well for most of the characteristics.

The variance of cluster mean provides information on relative importance of different characters towards seed yield per plant. The present study revealed that plant height was (28.59 per cent) contributed more to genetic diversity followed by oil content (21.18 per cent), seed yield per plant (17.95per cent), days to maturity (16.03 per cent) and diameter of capitulum (9.74 per cent). However, Days to 50% flowering and test weight (2.31 per cent) each) and number of capitulum per plant (0.13per cent) contributed least to the divergence.

Jagdev and Samal (1991) in niger reported that days to flowering, maturity, and seed yield were the characters which contributed to genetic diversity.

Ravanappa and Sheriff (1994) [18] observed more divergence for number of capitulum per plant, oil content and seed yield per plant. Kumar, S. (1999) [8] reported that days to maturity has maximum contribution towards divergence. Sreedhar *et. al.* (2006) [20] and Parmeshwarappa *et. al.* (2009) were also of same opinion.

On the basis of inter cluster distances, cluster mean andperformance observed in the present study, the genotypes *viz.*, IGPN-18-1, IGPN-18-18, IGPN-18-12, IGPN-18-13, IGPN-18-14, IGPN-18-19, N-24 and NSKMS-214 were found to be superior. These genotypes may be used further in hybridization programme for crop improvement.

Table 1: Analysis of variance for different characters in forty genotypes of Niger.

S.N.	Characters	Mean sum of squares		
		Replication (df.1)	Genotype (df.39)	Error (df39)
1	Days to 50% flowering	1.51	17.87**	2.10
2	Days to maturity	1.51	27.17**	1.89
3	Plant height (cm)	0.16	326.09**	8.07
4	No. of branches per plant	0.01	4.05**	1.04
5	Diameter of capitulum (mm)	0.15	41.14**	2.07
6	No. of capitulum per plant	9.52	482.34**	77.59
7	No. of seeds per capitulum	16.2	278.07**	18.66
8	Test weight (g)	0.02	0.47**	0.03
9	Oil content (per cent)	0.27	11.17**	0.59
10	Seed yield per plant (g)	3.96	66.98**	2.32

(*,** Significant at 5 and 1 per cent, respectively.)

Table 2: Mean performance of forty niger genotypes studied for ten characters.

S. N.	Genotype	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of Branches per plant	Diameter of Capitulum (mm)	No. of capitulum per plant	No. of seeds per capitulum	Test weight (g)	Oil content (per cent)	Seed Yield (g)
1	N-24	103.0	141.0	130.2	9.6	10.05	76.4	29.5	3.53	33.35	9.6
2	N-32	101.5	140.0	103.9	6.5	7.05	39.7	15.0	3.28	35.20	6.8
3	IGPN-18-1	106.0	138.0	103.9	6.4	6.55	52.1	16.5	2.93	39.20	6.3
4	IGPN-18-2	102.0	141.0	122.0	8.1	6.65	37.7	21.0	2.93	38.15	7.1
5	N-57	104.0	144.0	106.8	6.8	7.95	51.1	18.0	3.10	36.55	8.1
6	KEC-3	102.5	139.5	109.5	5.9	8.35	38.4	23.5	3.15	35.95	7.9
7	KEC-15	104.0	144.0	100.9	5.1	12.04	77.8	29.0	3.13	34.35	11.8
8	RCR-66	103.5	141.0	121.6	5.3	10.33	66.2	28.5	3.24	34.70	10.6
9	IGPN-18-3	107.0	147.0	103.4	7.0	14.22	77.1	37.0	3.96	36.15	14.7
10	IGPN-18-4	106.0	142.5	127.4	6.2	16.65	65.8	40.0	3.82	35.00	19.4
11	IGPN-18-5	104.0	141.5	125.2	6.0	7.65	45.7	22.5	3.03	38.80	9.4
12	IGPN-18-6	105.0	144.0	105.1	8.0	14.41	80.8	39.0	3.77	34.90	16.2
13	NSS-5390	104.0	140.5	96.3	5.9	10.95	45.9	28.0	2.87	37.25	10.9
14	IGPN-18-7	99.5	136.0	102.7	5.4	9.16	37.0	20.0	2.90	39.55	7.9
15	NSS-5437	104.0	144.0	105.5	6.9	11.55	60.9	28.5	3.32	37.10	11.7
16	NSS-5438	100.5	137.5	140.8	7.2	5.77	48.9	17.0	2.79	39.85	6.7
17	NSS-5440	107.5	145.5	104.3	6.4	16.9	73.8	43.0	3.87	33.25	18.1
18	NSS-5442	102.5	143.0	94.9	5.1	8.48	49.4	26.0	3.55	36.05	9.2
19	IGPN-18-8	105.0	141.0	111.1	7.3	9.19	63.4	21.0	3.04	38.10	7.7
20	IGPN-18-9	108.0	144.0	95.7	7.4	19.10	70.4	52.0	3.97	37.85	21.9
21	IGPN-18-10	108.0	142.0	104.4	6.7	19.60	74.7	48.0	4.13	36.40	24.8
22	IGPN-18-11	108.0	145.0	131.6	8.3	18.95	68.5	53.0	4.24	37.10	23.8

S. N.	Genotype	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of Branches per plant	Diameter of Capitulum (mm)	No. of capitulum per plant	No. of seeds per capitulum	Test weight (g)	Oil content (per cent)	Seed Yield (g)
1	N-24	103.0	141.0	130.2	9.6	10.05	76.4	29.5	3.53	33.35	9.6
2	N-32	101.5	140.0	103.9	6.5	7.05	39.7	15.0	3.28	35.20	6.8
3	IGPN-18-1	106.0	138.0	103.9	6.4	6.55	52.1	16.5	2.93	39.20	6.3
4	IGPN-18-2	102.0	141.0	122.0	8.1	6.65	37.7	21.0	2.93	38.15	7.1
5	N-57	104.0	144.0	106.8	6.8	7.95	51.1	18.0	3.10	36.55	8.1
6	KEC-3	102.5	139.5	109.5	5.9	8.35	38.4	23.5	3.15	35.95	7.9
7	KEC-15	104.0	144.0	100.9	5.1	12.04	77.8	29.0	3.13	34.35	11.8
8	RCR-66	103.5	141.0	121.6	5.3	10.33	66.2	28.5	3.24	34.70	10.6
9	IGPN-18-3	107.0	147.0	103.4	7.0	14.22	77.1	37.0	3.96	36.15	14.7
10	IGPN-18-4	106.0	142.5	127.4	6.2	16.65	65.8	40.0	3.82	35.00	19.4
11	IGPN-18-5	104.0	141.5	125.2	6.0	7.65	45.7	22.5	3.03	38.80	9.4
12	IGPN-18-6	105.0	144.0	105.1	8.0	14.41	80.8	39.0	3.77	34.90	16.2
13	NSS-5390	104.0	140.5	96.3	5.9	10.95	45.9	28.0	2.87	37.25	10.9
14	IGPN-18-7	99.5	136.0	102.7	5.4	9.16	37.0	20.0	2.90	39.55	7.9
15	NSS-5437	104.0	144.0	105.5	6.9	11.55	60.9	28.5	3.32	37.10	11.7
16	NSS-5438	100.5	137.5	140.8	7.2	5.77	48.9	17.0	2.79	39.85	6.7
17	NSS-5440	107.5	145.5	104.3	6.4	16.9	73.8	43.0	3.87	33.25	18.1
18	NSS-5442	102.5	143.0	94.9	5.1	8.48	49.4	26.0	3.55	36.05	9.2
19	IGPN-18-8	105.0	141.0	111.1	7.3	9.19	63.4	21.0	3.04	38.10	7.7
20	IGPN-18-9	108.0	144.0	95.7	7.4	19.10	70.4	52.0	3.97	37.85	21.9
21	IGPN-18-10	108.0	142.0	104.4	6.7	19.60	74.7	48.0	4.13	36.40	24.8
22	IGPN-18-11	108.0	145.0	131.6	8.3	18.95	68.5	53.0	4.24	37.10	23.8

Table 3: Composition of forty Niger genotypes into different clusters by Tocher's method

Cluster number	No. of genotypes	Name of genotype includedin cluster	Origin
I	18	IGPN-18-3, IGPN-18-6, IGPN-18-8, IGPN-18-15, IGPN-18-17, IGPN-18-20, IGPN-18-21, IGPN-18-23 NSS-5390, NSS-5437, NSS-5440, NSS-5442, N-32, N-57, KEC-3, KEC-15, RCR-66 and JN-46.	ZARS, Igatpuri and Project co-ordinator Unit, Jabalpur
II	8	IGPN-18-2, IGPN-18-5, IGPN-18-7, IGPN-18-16, PhuleKarala, PhuleVaitarna NSS-5438, NSKMS-227,	ZARS, Igatpuri and Project co-ordinator Unit, Jabalpur
III	6	IGPN-18-4, IGPN-18-9, IGPN-18-10, IGPN-18-11, IGPN-18-22 and JN-1	ZARS, Igatpuri and Project co-ordinator Unit, Jabalpur
IV	3	IGPN-18-12, IGPN-18-13 and IGPN-18-14	ZARS, Igatpuri
V	1	N-24	Project co-ordinator Unit, Jabalpur
VI	1	IGPN-18-19	ZARS, Igatpuri
VII	1	IGPN-18-18	ZARS, Igatpuri
VIII	1	IGPN-18-1	ZARS, Igatpuri
IX	1	NSKMS-214	Project co-ordinator Unit, Jabalpur

Table 4: Average intra and inter-cluster D values of Niger genotypes.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX
I	6.12	9.36	10.40	11.18	9.31	8.18	11.03	11.55	9.64
II		6.88	11.06	15.75	9.31	11.67	11.46	10.31	10.41
III			8.06	10.95	13.90	11.33	11.33	12.46	12.08
IV				7.26	15.23	11.64	14.78	17.68	12.27
V					0.00	10.71	14.06	13.33	7.48
VI						0.00	7.19	9.95	13.65
VII							0.00	8.17	16.50
VIII								0.00	16.48
IX									0.00

Table 5: Cluster means performance for ten characters studied in Niger.

Cluster No.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of Branches per plant	Diameter of capitulum (mm)	No. of capitulum per plant	No. of seed per capitulum	Test Weight (g)	Oil content (Per cent)	Seed yield per plant (g)
I	103.36	142.11	104.85	6.39	10.50	60.57	26.75	3.31	36.09	10.71
II	101.81	138.94	122.61	6.84	9.49	47.28	23.81	3.22	39.08	9.22
III	105.50	141.25	112.40	6.83	17.28	65.88	45.08	4.00	37.16	20.28
IV	104.50	143.00	101.30	8.97	19.45	89.87	51.33	4.18	32.57	23.20
V	103.00	141.00	130.20	9.60	10.05	76.40	29.50	3.54	33.35	9.60
VI	99.00	135.00	97.70	6.00	6.70	46.60	23.00	3.17	32.95	7.60
VII	94.00	129.00	95.70	6.60	6.00	51.80	20.00	2.97	39.15	6.50
VIII	106.00	138.00	103.90	6.40	6.55	52.10	16.50	2.93	39.20	6.30
IX	106.00	145.50	133.40	11.70	18.20	90.60	44.50	3.96	34.30	18.90
Population mean	102.60	139.31	111.34	7.70	11.58	64.56	31.16	3.47	35.98	12.47

Table 6: Per cent contribution of ten characters towards genetic divergence in forty germplasm lines of Niger.

Sr No.	Characters	No. of times appearing first in ranking	Contribution per cent
1	Days to 50% flowering	18.0	2.31
2	Days to maturity	125.0	16.03
3	Plant height (cm)	223.0	28.59
4	No. of branches per plant	3.0	0.38
5	Diameter of capitulum	76.0	9.74
6	No. of capitulum per plant	1.0	0.13
7	No. of seeds per capitulum	10.0	1.28
8	Test weight (g)	18.0	2.31
9	Oil content (per cent)	166.0	21.28
10	Seed yield per plant (g)	140.0	17.95
	Total		100.0

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