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Genetic variability, association and divergence studies in twenty superior tree progenies of *Acacia nilotica* (Linn.)

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Abstract
The aim of the study was to determine seed sources variation in *Acacia nilotica*. Seed were collected from twenty superior trees of *Acacia nilotica* from different locations of Uttar Pradesh to study genetic divergence in pod and seed characters. S17(Pukhraya) and S8(SHUATS) exhibited superiority for germination per cent. Maximum Cluster distance was observed highest cluster VI and VII followed by VIII and V. which indicated presence of higher order of divergence among the progeny of superior tress.

Keywords: Seeds, genetic divergence, cluster analysis, *Acacia nilotica*

Introduction
Acacia nilotica Linn. Commonly known as (Babul or Desi babul), is a medium sized, thorny, nearly evergreen tree that can reach up to 20-25 m height but may remain a shrub in poor growing conditions [1, 2]. *Acacia nilotica* belongs to family leguminoceae and is originated from Africa and the India subcontinent. It is now commonly found or cultivated with in almost all tropical and subtropical areas of Africa, Asia, Australia [3]. *Acacia nilotica* is a multipurpose tree; it provides timber, fuel, food, shade, fodder, honey, dye, gum and fences [9]. It also impacts on the environment through soil reclamation, soil enrichment, protection against fire and wind. It is widely used in ethno-medicine [4, 5]. The crown is flattened or rounded, leaves are 5-15 cm long, Alternate with compound.
Acacia nilotica should not be introduced into humid and sub-humid areas, or into dry areas. *Acacia nilotica* is a pioneer species that is relatively fast growing on arid sites. It is an important riverine tree in india, sudan and Senegal, where it is planted for timber.
Acacia nilotica flowers at a relatively young age, around three to fours old in ideal conditions, on current- season growth during the rainy season. Flowering is prolific, and can occur number of times during the year, depending on the availability of soil moisture. Peak flowering appears to occur from October-December and peak fruiting around April-June. Fruiting peaks in January for under condition it June to September and sometimes in December/January, and the ripen fruit from April to June. Seeds are dispersed by mammalian herbivorous. The gum or bark is used for cancers and/ or tumors (or ear, eye or testicles) and treatment of liver and spleen, bark, gum, leaves and pods used medicinally.

Materials and Methods
The present study was conducted at college of Forestry, SHUATS Allahabad to estimate the genetic divergence in pod and seed characters of *Acacia nilotica* collected from different locations of Uttar Pradesh. Trees growing at one location were considered to be one population. Twenty different locations with 5 random trees from each location were selected as superior trees.

Method of Selection of Superior tree and four comparison trees
Superior tree and four comparison trees almost of similar size free from an insect-pest and diseases representing each stand were selected and morphological observations were recorded both for comparison and superior trees. For taking observations on pod and seed character, 10pods /tree were collected randomly from different parts of the tree and average of 10 pods and 10 seeds measurement were recorded for pod and seed length, respectively. Out of these five, the best one were selected as superior tree and marked with sign with yellow paint.

Twenty superior trees were marked and their pods were collected in month of April- June. The latitude and longitude was taken help of GPS for CPTs selected from 20 different locations. The pods were cleaned and stored in muslin relevant information of each selected Superior Tree are presented (Table 1).

A total of three hundred healthy pods were collected and from each lot. The average of 10 pods measurement was recorded for pod length, pod width and pod thickness and expressed in mm. Pod damage was calculated by counting the damaged pods containing in each replication and expressed in percentage.

After taking the observations on pods, seeds were extracted from randomly selected pods in plus tree was kept replication wise for taking observations on seeds. The average of 10 seeds measurements was recorded for seed length, seed width and seed thickness and expressed in mm and 100-seed weight in gram.

All pod and seed characters were measured with the help of digital vernier caliper while, 100-seed weight were recorded with the help of electronic weighing balance. To study the genetic divergence in seed source the observations recorded were subjected to statistical analysis. Cluster analysis was done by using non-hierarchical Euclidian cluster method.

Results and Discussion

Genetic diversity in plant species is a gift to mankind as it forms the basis for selection and further improvement. Genetic diversity analysis is an efficient method that facilitate the identification of superior germplasm, acceralates the collection, conservation, improvement of germplasm for breeding programmes and tree improvement. Information regarding genetic similarity measures can be used for selection of superior quality planting material for improvement or for use in tree hybridization program [8] In addition to it, the basic premise of the genetic divergence is to cluster the large number of selected phenotypically superior batches into several small homogeneous groups, so as to include representative plants from each group to reduce the total number of entries in provenance/ progeny trial and seed orchard and to find out the magnitude of divergence among groups, so that the groups having wider genetic variance could be hybridized (crossed) to produce greater genetic diversity at a later period for selection. The study of relationships is based on the assumption that the difference in the characters reveals their genetic divergence.

The clustering pattern in the present study showed that 20 Superior trees progenies of *A. nilotica* were grouped into eight clusters, revealing geographical diversity which need not necessarily be related to genetic diversity (Table3). This kind of genetic diversity might be due to differential adaptation, selection criteria, selection pressure and environment [2]. Absence of any relationship between genetic diversity and geographical distribution is in accordance with the findings of [3, 4] in *Jatropha curcas* and [5, 6] in *Madhuca latifolia*. The trees that originated in one region had been distributed into different clusters indicated that trees with same geographic origin could have undergone change for different characters under selection. Cluster analysis showed that superior tree progenies resulted into eight clusters with cluster II comprised with highest number of six superior tree progenies (S_8, S_{11}, S_4, S_5, S_6, S_7,) followed by cluster III and I included three (S_9, S_{10}, S_3) and (S_1, S_2, S_{19}) followed by Cluster IV, V and VI comprehended two superior tree (S_{17}, S_{20}) (S_{13}, S_{16}) and (S_{14}, S_{18}) respectively. However cluster VII and VIII comprised with one superior tree progenies each (S_{12}) and (S_{15}).

The highest inter-cluster distance was found between cluster VII and VI (6.073) followed by cluster VIII and V (5.758) and between cluster VIII and VII (5.443). The maximum intra-cluster distance was found in the cluster VI (3.725). The minimum inter cluster distance was observed between cluster VI and VI (2.82), maximum inter cluster distance VI & VII (6.073). The study indicated that cluster II and I was more divergent and can be utilized for genetic improvement (Table 4). Earlier studies, in crop plant had indicated that inter-mating of divergent groups would lead to greater opportunity for crossing over which would release latent variation by breaking up predominantly repulsion linkage and utilization of diverse parents in breeding was also stressed by [7].

Perusal of Table 5 revealed that germination per cent (67.09), seedling height (41.87), fresh shoot weight(0.29), internodal length (2.73), dry shoot weight (0.20) and shoot/root weight (3.11) was recorded maximum for cluster II whereas, maximum mean value of collar diameter (1.85), dry root weight (0.08) and seedling biomass (0.41) was observed in cluster V, V, IV, respectively, minimum mean value for germination% (58.09), seedling height (39.48), collar diameter (1.81), internodal length (2.47), fresh shoot weight (0.25), fresh root weight (0.11), dry shoot weight (0.17), seedling biomass (0.39) for cluster III, VIII, II, V, whereas, minimum number of dry root weight (0.06) and shoot/root weight (2.12) was observed cluster I and VIII. The study revealed that the maximum mean value was recorded in cluster II, for 5 traits whereas, minimum mean value was observed in cluster VIII with 6 traits. Difference between means of different cluster was significantly different. Wide diversity exists between the cluster: crosses between these clusters may result in substantial segregates and further selection for overall improvement of species.

Conclusion

S_{17}(pukhraya) and S_8(Shuats) exhibited superiority for germination per cent. Maximum Cluster distance was observed highest cluster VI and VII followed by VIII and V. which indicated presence of higher order of divergence among the progeny of superior tress. It could be concluded that the superior trees from different geographical origins can be selected for germplasm maintenance by conventional vegetative propagation method or micro propagation. Inter-specific population genetic variation provides information on various aspects of divergent genotypes. The results of present study revealed that the cluster II comprising six superior trees which means geographic diversity is not necessary for genetic diversity.

Table 1: Details of morphological observations and other relevant information for 20 Superior trees of *Acacia nilotica* Linn.

S. No.	Seed Sources	Altitude (m)	Range of Temp. ºC	Latitude (ºN)	Longitude (ºE)	Rainfall (mm)
S_1	FARRUKHABAD	167	35-45	27º38'N	79 º59'E	896.2
S_2	KANNAUJ	143	30-45	27º05'N	79º91'E	868
S_3	ALLAHABAD	98	32-46	25º45'N	81º84'E	1027
S_4	KANPUR(C.S.A.)	126	25-45	26º49'N	80º30'E	820
S_5	RAWATPUR	126	25-45	26º44'N	80º33'E	820
S_6	BARRA	128	25-45	26º42'N	80º29'E	825
S_7	BAREILLY	268	21-45	28º36'N	79º43'E	1093
S8	SHUATS	98	20-45	25º41'N	81º84'E	1100
S_9	GONDA	111	25-46	27º03'N	81º95'E	1240
S_{10}	BANARAS	76	26-45	25º31'N	82º97'E	998
S_{11}	LUCKNOW	121	24-45	26º84'N	80º94'E	1001
S_{12}	DELHI	215	24-46	28º70'N	77º10'E	693
S_{13}	FATEHPUR	124	25-44	25º85'N	80º89'E	1052
S_{14}	UNNAO	131	24-46	26º53'N	80º48'E	850
S_{15}	MEERUT	226	24-46	28º98'N	77º70'E	933
S_{16}	SITAPUR	141	25-45	27º58'N	80º66'E	1193
S_{17}	PUKHRAYA	130	25-43	26º22'N	79º83'E	1015
S_{18}	HARDOI	147	26-45	27º29'N	79º83'E	1103
S_{19}	FAIZABAD	104	26-45	26º77'N	82º14'E	1143
S_{20}	NURSURY	98	27-44	25º41'N	81º84'E	1027

Table 2: Mean performance of 20 superior trees of *Acacia nilotica* Linn.

Characters	Germination %	Seedling height (cm)	Collar diameter (mm)	Internodal length (cm)	Fresh shoot weight (g)	Fresh root weight (g)	Dry shoot weight (g)	Dry root weight (g)	Shoot/root ratio	Seedling biomass (g)
S_1	60.00	40.51	1.83	2.19	0.29	0.13	0.19	0.08	2.48	0.42
S_2	61.67	40.19	1.83	2.71	0.28	0.15	0.20	0.06	3.11	0.41
S_3	60.12	40.36	1.82	2.53	0.30	0.13	0.20	0.06	3.21	0.42
S_4	61.83	40.61	1.82	2.52	0.32	0.13	0.21	0.06	3.39	0.45
S_5	56.52	41.20	1.83	2.56	0.29	0.13	0.21	0.06	3.49	0.43
S_6	61.17	40.41	1.82	2.56	0.30	0.11	0.22	0.07	3.38	0.41
S_7	59.83	41.83	1.83	2.56	0.26	0.12	0.16	0.06	2.58	0.39
S_8	68.02	41.69	1.80	2.74	0.29	0.13	0.21	0.07	3.08	0.40
S_9	64.65	40.31	1.84	2.66	0.26	0.13	0.18	0.07	2.52	0.42
S_{10}	57.55	42.32	1.83	2.52	0.27	0.12	0.17	0.07	2.54	0.39
S_{11}	66.17	42.07	1.82	2.72	0.29	0.12	0.21	0.07	3.14	0.40
S_{12}	63.92	40.44	1.85	2.67	0.29	0.12	0.21	0.07	3.18	0.40
S_{13}	63.70	41.46	1.86	2.68	0.29	0.13	0.20	0.08	2.62	0.41
S_{14}	62.25	42.68	1.83	2.67	0.28	0.13	0.21	0.07	2.99	0.41
S_{15}	64.33	39.48	1.81	2.47	0.25	0.13	0.18	0.06	3.06	0.39
S_{16}	64.83	40.86	1.84	2.48	0.25	0.11	0.18	0.08	2.31	0.36
S_{17}	70.00	40.36	1.82	2.57	0.29	0.12	0.17	0.07	2.91	0.41
S_{18}	59.85	42.73	1.80	2.46	0.25	0.13	0.17	0.08	2.77	0.38
S_{19}	52.00	42.01	1.84	2.43	0.27	0.13	0.18	0.07	2.56	0.39
S_{20}	64.15	40.34	1.82	2.39	0.29	0.14	0.19	0.07	2.60	0.42
Mean	62.13	41.09	1.83	2.55	0.28	0.13	0.19	0.07	2.90	0.41
CD5%	7.99	1.51	0.03	0.21	0.03	0.02	0.03	0.01	0.47	0.03
CV	7.87	2.24	0.85	5.04	6.98	7.96	10.55	6.25	9.82	5.25
Max.	70.00	42.73	1.86	2.74	0.32	0.15	0.22	0.08	3.49	0.45
Min.	52.00	39.48	1.80	2.19	0.25	0.11	0.16	0.06	2.31	0.36

Table 3: Distribution of 20 superior tress into different clusters

Cluster	Total number of plus tree in each cluster	Notation of plus tree
I	3	S_1, S_2, S_3
II	6	S_8, S_{11}, S_4, S_5, S_6, S_7
III	3	S_9, S_{10}, S_{19}
IV	2	S_{17}, S_{20}
V	2	S_{13}, S_{16}
VI	2	S_{14}, S_{18}
VII	1	S_{12}
VIII	1	S_{15}

Table 4: Intra and inter cluster distance of 20 superior trees of *Acacia nilotica*

Clusters	I	II	III	IV	V	VI	VII	VIII
I	3.239	3.896	3.501	3.125	4.422	4.733	4.662	3.536
II		1.671	4.297	3.388	4.212	3.699	4.838	4.552
III			3.237	3.516	3.508	4.171	4.598	4.308
IV				2.827	3.999	4.516	4.857	3.784
V					3.100	4.524	4.193	5.758
VI						3.725	6.073	5.127
VII							0.000	5.443
VIII								0.000

Table 5: Mean value for various traits in different cluster refer twenty superior tree progeny of *Acacia nilotica* Linn.

Cluster	Germination %	Seedling height	Collar diameter	Inter nodal length	Fresh shoot weight	Fresh root weight	Dry shoot weight	Dry root weight	Shoot/ Root ratio	Seedling biomass
I	60.16	40.73	1.82	2.51	0.29	0.12	0.19	0.06	3.09	0.41
II	67.09	41.87	1.81	2.73	0.29	0.12	0.20	0.07	3.11	0.40
III	58.06	41.54	1.83	2.53	0.26	0.12	0.17	0.07	2.54	0.39
IV	67.07	40.35	1.82	2.48	0.28	0.13	0.18	0.07	2.75	0.41
V	64.26	41.16	1.85	2.57	0.26	0.11	0.18	0.08	2.46	0.38
VI	61.05	42.70	1.81	2.56	0.26	0.12	0.19	0.07	2.88	0.39
VII	63.91	40.44	1.85	2.66	0.29	0.12	0.21	0.07	2.12	0.40
VIII	64.33	39.48	1.81	2.47	0.25	0.13	0.18	0.06	3.06	0.39

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