Available online at www.sciencedirect.com

SciVerse ScienceDirect

http://www.elsevier.com/locate/biombioe

Genetic divergence studies in niger (*Guizotia abyssinica*) germplasm

Sangita Yadav [a,*], *Zakir Hussain* [a], *Poonam Suneja* [a], *M.A. Nizar* [a], *Shiv K. Yadav* [b], *M. Dutta* [a]

[a] *National Bureau of Plant Genetic Resources, New Delhi 110012, India*
[b] *Division of Seed Science & Technology, IARI, New Delhi 110 012, India*

ARTICLE INFO

Article history:
Received 21 November 2011
Received in revised form
4 April 2012
Accepted 10 April 2012
Available online 18 May 2012

Keywords:
Niger
Guizotia abyssinica
Oil
Oil quality
Genetic diversity
Test weight

ABSTRACT

Variability in 35 accessions of niger (*Guizotia abyssinica*) was assessed for test weight and oil quality parameters. Analysis of variance showed significant differences for test weight and oil parameters. The test weight varied from 260 to 440 mg. Total oil content ranged from 35.16% to 40.47%. The oleic acid ranged from 23.52 to 53.3% of the total fatty acids while linoleic acid ranged from 32.03 to 58.28%. High heritability (>90%) was recorded for all the oil parameters except for linoleic acid and test weight. The range of Manhattan distance coefficient values was 0.23–3.46 with a mean of 1.84. Cluster I included three accessions with highest linoleic acid (>53%), highest stearic acid (>8%), highest palmitic acid (>9%) and least oleic acid (<29%). These accessions were collected from Orissa state. Cluster II included two accessions with least oil content collected from Andhra Pradesh. The cluster III included 30 accessions and was divided into two sub-cluster i.e. IIIA; with low linoleic acid (<43%) and high oleic acid (>40%); and IIIB; with high linoleic acid (>44%) and low oleic acid (<37%). The cluster III contained the accessions representing Maharashtra and Madhya Pradesh. Thus, on the basis of present findings it is evident that a lot of variability exists for the oil quality parameters among the niger accessions grown in different states of the country. Hybridization between accessions of different clusters will result in creation of wide spectrum of variability in subsequent segregating generations for further use in breeding programmes.

1. Introduction

Guizotia abyssinica commonly known as niger, is the only cultivated member of the taxon, *Guizotia*. Niger is diploid, with a chromosome number of 2n = 30 [1–5]. Its origin has been reported in Ethiopia and it was introduced in India before the Christian era [6] via trader route. It is completely self incompatible and highly cross-pollinated oil seed crop. It is used for human consumption as well as for industrial uses [7,8].

In Ethiopia, 50–60% of the edible oil requirement for domestic consumption is obtained from niger seed [9]. In India, it provides only about 3% of the edible oil requirement of the country and is cultivated in Andhra Pradesh, Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka, West Bengal and union territory of Nagar Haveli. Madhya Pradesh has the largest area under the crop [10]. In addition to its use as an edible crop, its oil is used for industrial and pharmaceutical purposes also [11]. The oil content of niger is reported to be in the range of 30–50% of the seed weight and the oil has four

* *Corresponding author*. Tel.: +91 9868273681; fax: +91 11 25849459.
E-mail addresses: sangitayadav@nbpgr.ernet.in, sangitaydv@gmail.com (S. Yadav).
0961-9534/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biombioe.2012.04.011

major fatty acids which include two main unsaturated fatty acids viz., linoleic acid (18:2) and oleic acid (18:1); and two major saturated fatty acids viz., palmitic acid (16:0) and stearic acid (18:0) [12]. The abundance of these major fatty acids as well as some minor fatty acids reported to be present in small or trace quantity varies greatly from one accession to the other [13,14]. Niger accessions from India are reported to be high yielding [15]. There are some studies on genetic divergence for seed oil quality parameters but no report is available from India on the genetic divergence of biochemical parameters in germplasm of this crop. Keeping these points in view, present investigation was undertaken and 35 accessions of niger representing various states were assessed for test weight and five biochemical parameters, namely, total oil content, palmitic acid, stearic acid, oleic acid and linoleic acid.

2. Materials and methods

Thirty five accessions of niger germplasm collected from four different states of India and grown at NBPGR regional station at Akola, Maharastra, India, for two consecutive years (2009 and 2010) were used for the study. The station is situated at 23°43′ latitude and 77°64′ E longitude and receives an average rainfall varying from 750 mm to 900 mm from southwest monsoons during July to September. Mature plants were harvested by cutting plants at 15–20 cm above ground level and placing them in plastic bags before taking them to the laboratory [15]. Seeds were manually separated of the rest of the plant and cleaned of impurities. The seeds samples were oven dried at 60 °C, and then they were stored in dessicator until analysis. Oil content was determined by wide line nuclear magnetic resonance (NMR) spectroscopy. The oven-dried seed samples were analysed by NMR (Newport analyser 4000) and fatty acid analysis was done using Gas Liquid Chromatograph (GLC, Model-HP6890) [16] with reference to a standard of extracted niger oil.

The analysis of variance, heritability in broad sense, phenotypic and genotypic variance were calculated using software PBSTAT 1.2 [17]. Manhattan distance coefficient was calculated in pair wise combinations. The dissimilarity matrix was used to construct dendrogram by unweighted pair group method for arithmetic mean (UPGMA) based Sequential Agglomerative Hierarchical and Nested (SAHN) clustering. The Principal Component Analysis (PCA) based on the Euclidean coefficients of dissimilarity was done. All these calculations were done using NTSYS-pc version 2.11 (USA) [18].

3. Results and discussion

3.1. *Estimation of genetic variability*

Analysis of variance (ANOVA) indicated significant variation among the different accessions with regards to most of the characters investigated which indicate the presence of sufficient variability in the material studied.

Maximum test weight (440 mg) was recorded in accessions IC372618, IC372580, IC372584 and IC372586 and the minimum weight (260 mg) was recorded in IC211356 and IC211078. Among all the accessions, the genotype IC211078 was found to have minimum test weight with maximum total oil content (40.47%), stearic acid (8.90%) and linoleic acid (58.28%).

Systematic efforts were initiated only after 1994 to analyze variability among different landraces and germplasm existing in India for traits viz. days to 50% flowering, days to 50% maturity, plant height, number of capitulae per plant, number of branches per plant, seed yield, oil content and protein content. However, the variability for these traits is not discrete since niger is a highly cross-pollinated species and this behaviour poses major problems in maintenance of genetic purity and breeding. Moreover, the diverse agro-climatic conditions of India, further influence the variability [10].

Results for oil content obtained in this study revealed that it ranged from 35.2% in IC211356 to 40.5% in IC211078, which corresponds to the earlier reported range of 27–47% for this trait [14,19]. However recent report [12] revealed the oil content in niger seed ranged from 30 to 50%, where only 7% of the population had more than 50% oil content while the oil content in 47% of the population was less than 40%. The increase in the quantity of oil per unit area of land is the most important objective in niger improvement program which can be achieved either through increasing the seed yield by breeding for high yielding varieties or through developing varieties with high oil content. As the maximum oil content in indigenous germplasm of niger is only up to 47%, it is recommended that high oil content genes from exotic germplasm should be incorporated into indigenous breeding materials and populations for enhanced oil content. Variation in the oil content of the Indian niger is an encouraging reality as the presence of variability by itself is indicative of the potential prospect of improving the oil content of this crop. The genetic variability available in the germplasm accessions will be of great help in achieving these objectives [5,14,20,21].

Oil quality and its further utility are determined solely by its fatty acid composition. Study of fatty acid composition of niger oil has shown that it has four major fatty acids, namely, palmitic acid, stearic acid, oleic acid and linoleic acid. The results showed that the niger oil has two saturated fatty acids (SFA) namely, palmitic and stearic ranging from 14.79 to 18.33%, one mono unsaturated fatty acid (MUFA) viz. oleic acid, ranging from 23.52 to 53.03% and one poly unsaturated fatty acid (PUFA) i.e. linoleic acid ranging from 32.03 to 58.28%. These observations clearly indicate the presence of considerable variability for fatty acid profile among the different accessions in the study.

Amount of major as well as some minor fatty acids varies greatly from one accession to the other [13,14]. Though, the variation in the oil content of niger cannot be accounted for by the location or the climatic condition of the area [20], variation in the fatty acid profile, however, can be attributed to several factors such as the area of origin of the material, the climatic condition of the area and more importantly genetic variation present in the material. Higher temperatures during the reproductive phase of the plant would influence the oleic/linoleic ratio by enhancing the production of higher levels of oleic acid in the seed and increase in the oleic acid content of the seed is compensated by relatively reduced level of linoleic acid. In general, cooler temperatures favour the production of