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GERMINATION EFFECTS OF PURPOSIVE BRUCHID SCREENING OF AFRICAN EBONY (*DALBERGIA MELANOXYLON)* SEEDS IN THE ARID AND SEMI-ARID REGION OF SOUTH EASTERN KENYA

Nahashon Musimba[1] --- Josphert N. Kimatu[2†] --- Benard Mweu[3] --- MWK Mburu[4] --- Simon Nguluu[5]

[1]*School of Agriculture and Veterinary Services, South Eastern Kenya University, Kitui, Kenya*

[2]*Biological Department, South Eastern Kenya University, Kitui, Kenya*

[3,4,5]*Department of Dryland Agriculture, South Eastern Kenya University, Kitui, Kenya*

ABSTRACT

The African ebony (Dalbergia melanoxylon) is a tree that is crucial in making of high value wooden traditional artifacts, however its slow growth in the arid and semi-arid lands (ASALs), poor germination and low seedling growth rate, seed pest predation coupled with overharvesting pause a great threat for the future availability of the species. Unscreened natural methods of seed germination might not sustainably solve the problem of low germination. Overharvesting for wood carving, and low natural regenerative ability of the species and lack of the local and national conservation efforts present a serious threat its availability to the future availability of Dalbergia melanoxylon. Availability of viable seed plays a crucial role the establishment of African ebony. There is need for immediate methods for multiple seedling production for propagation of D. melanoxylon. Our studies showed 2% germination without screening but increased to 40% after screening ($p< 0.001$). Careful moisture monitoring of the seedling seemed to increase the growth rate in the ASAL region. Therefore, selected propagation methods of this species can rescue it from the current extinction trend which is caused by its low regenerative ability when natural methods are used and over exploitation. There is need to support on farm cultivation of the tree to sustain the carving industry.

Keywords: Endangered species, Carving, *Dalbergia*, Germination, Predation, African ebony, Borers

1. INTRODUCTION

Dalbergia melanoxylon Guill & Perr (Family Leguminosae and subfamily Papilionoidae) [1] grows under a wide range of conditions including semi-arid, sub-humid and tropical lowland areas. It is often found on dry, rocky sites but is most frequent in mixed deciduous forests and savannahs of the coastal region [2]. Hence, this species is water and light demanding; it is

† Corresponding author

commonly found near water and does not regenerate under heavy cover. Mature trees are fire tolerant. The species is wide spread in tropical Africa from Senegal and Cote d'Ivore in the West, to Kenya and Ethiopia in the East, and extending south to South Africa [3]. The species is highly favoured for carving because it does not crack, it is fungal resistant and is one of the most expensive timbers in the world.

Wood carving industry in Kenya is the largest of its kind in Africa and it generates about US$20 million per year [4]. This has led to over exploitation from its natural habitat and now the tree is now commercially depleted in Kenya. Observations in the ASALs where the species grows in Kenya in the Machakos and Kitui counties, has low arable potential, therefore wood carving became a major income earning option. A survey of 1990 showed an approximately 60,000 to 80,000 wood carvers, supporting over 400,000 households [5]. The locals also engage in charcoal burning of the few woodlots present. However, the unit price of wood carving is two to three orders of magnitude compared to charcoal production of wood and even two to ten times higher than using the tree for timber, firewood or poles. Furthermore, the species is naturally extremely slow growing; trees attain timber size in 70-100 years in some instances. In Kenya, the town of Wamunyu in Machakos County, with 2000 carvers, 100 miles east of Nairobi, where the carving industry began, show that local supplies of the valuable *mpingo* (*Dalbergia melanoxylon*), were exhausted by the 1940s. At this time the tree was the number one choice of the wood carvers and was exported to Europe for the manufacture of clarinets and oboes.

1.1. Recent Approaches in *Dalbergia Melanoxylon* Seed Germination

Recently in the late 2000's to 2012 researchers have directed their research to alternative and advanced techniques and methods for *D. melanoxylon* seedling production and propagation. Amri [6] investigated the effect of timing of seed collections and provenances on seed viability and germination capacity of *Dalbergia melanoxylon*. In this study seed viability varied with different time of seed harvesting, for the seeds harvested between 8-12 weeks from their maturity viability was 57% and germination was 35% but for seeds harvested from 16 weeks and above viability was 37% and germination was 21% which correlate with germination reported by Washa and Nyomora [7] and not far from germination reported as by TTSA [8] as 37%.

1.2. Germination Studies on the *Dalbergia Melanoxylon*

Earlier research conducted on *D. melanoxylon* from 1960's to early 2000's were mainly on the biology and silviculture of the species rather than regenerative methods for propagation and conservation of the species. This is because overharvesting of mpingo from 1960's to early 1990's was not a threat issue [9]. Later studies show that this species has serious reproductive limitations, both asexually and sexually with very low germination capacity [10]. Therefore information on genetic variability is important for successful management and conservation of the species. Preservation of genetic variation and evolutionary processes in viable populations can have ecological role and in conserving the species.

Recent studies by Washa, et al. [11], found that available moisture to *D. melanoxylon* seeds was found to be a factor affecting germination in the natural environment. They found that seeds of the species are vulnerable to high moisture level, they easily get rotten and loss viability at high moisture but also seeds are vulnerable to fungal and insect attack. This is why most seeds of the species produced yearly in the forest do not germinate and loss their viability few months from the time they mature. Hence, there was need to monitor the optimum moisture content for efficient germination of the species seeds.

1.3. Fruits, Seeds, and Flowers of *Dalbergia Melanoxylon*

Studies on the seed showed that *D. melanoxylon* seeds are hard and enclosed in pods. The flowers are perfect or bisexual, insect pollinated and white flowers about 5 mm long with 9 stamens [9, 12]. The seeds are kidney-shaped, laterally compressed, smooth, about 7.5 to 9.5mm long and 0.5 to 0.7mm wide giving an average fresh seed mass of between 0.06 and 0.17g. The mature seeds are black and can easily be selected from immature white ones. The seeds have thin seed coats and the embryo is yellowish [8]. The seeds generally remain viable for only a few months, although viability could probably be increased by storage in sealed containers after collection. In about 16000 seeds only 6000 seeds or 35% can germinate [8], although we found this to be not attainable in our preliminary studies. But some seeds extracted from pods germinated readily on sand beds. However, we observed that most seedlings could not attain maturity if moisture content was not monitored properly. This could be the case of seedling death during droughts as observed by Mugasha [13]. Previous studies show that seed storage behavior is orthodox and viability can be maintained for several years in hermetic storage at 3°C with 9-12% moisture content, otherwise viability can be lost in a few months from the time of maturity [8]. The fruits usually green when young and pale green when mature. They contains one to three seeds and are flattened. They are not able to dehisce and are grayish when completely dry and could be observed to be infested with fungal growths [9].

2. MATERIALS AND METHODS

The study was carried on at the South Eastern Kenya University which is near Wamunyu, a town which is the epicenter of wood carving in Kenya. It has arid and semi-arid climate. It receives quite erratic rain fall. However, it the times when adequate rain is present, the plant life thrives excellently. The pods were collected by hand from trees. Collected seed were kept in labeled khaki envelopes. The pods and seeds were used as study samples.

The collected seeds were sown in beakers filled with moist sand at a germination room temperature of between 23-32°C. The seeds were kept as a uniform depth of 0.5-1.0 cm. The seeds were moistened every alternate day. The number of germinated seeds were counted and the total numbers of germinated seeds evaluated using the formula; total number of germinated seeds X 100 total number of sowing.

We used a Grain moisture meter; model GMK-303RS (Korea). Most meters and probes rely on an inbuilt calibration between moisture and either electrical capacitance or resistance. They are calibrated against oven-based moisture determinations. We used whole bean grains and obtained averages of the percent grain moisture contents. The GMK-303RS is calibrated to measure bean grain of moisture content 12.5 - 19.7%. It had an accuracy of $\pm$ 0.5%. It has an operation which is by the electrical resistance method; it also has a microprocessor control and automatic temperature compensation capable of obtaining average data by just a tap of a button.

3. RESULTS

3.1. Examination of Seeds

The seeds were found to be fairly fragile. It required one to be careful when extracting the seeds from the pods when dry. We examined the seed physical characteristics, damage and germination rate (Figure 1). Majorly, the study revealed that more than 70% of *D. melanoxylon* seeds were abortive or damaged by insects at the time of collection and if the monitoring of the days after seed maturation is beyond two months.

Figure-1. Seed of *Dalbergia melanoxylon* from the arid and semi-arid land of south eastern Kenya region, A, show a partially opened seed, B shows a fully opened seed, C shows the separated seed while D shows seeds from various pods which have different dimensions and levels of fungal infestations.

3.2. Germination Rate and Moisture Content of *Dalbergia Melanoxylon*

The seed showed between 35-40% germination. The continuous watering so that the seeds are not water stressed seemed to increase the germination rate. Furthermore, when the seeds were crowded they yellowed and did not show vigour as when they were transferred to loam red soil singly. This increased their growth rate (Figure 2).

Figure-2. Laboratory grown, three week old, germinated seedlings of *Dalbergia melanoxylon*, which took 10 days for the first emergence to be observed.

3.3. Moisture Content Test

The good seeds where pooled and after several measurements, using a Grain moisture meter; model GMK-303RS (Korea). We found the average moisture content (n=10) of the *D. melanoxylon* seeds to be 12.4%.

D. Melanoxylon Seed Predation by Insect Borers (Bruchids)

During seed collection from tree crown in the forest, it was noticed that the pods and seeds were damaged by insect borers and could not germinate. By using hand and hand lens the pods were opened into two halves. It seemed that the insects could also be causing damage to flowers, fruits and seeds before descending on the mature pods. Our, observations showed that the good seeds were not more than 40% and further delay in collecting the seeds made more seeds to be damaged by insects' borers and fungal infestation increased (Figure 3).

Figure-3. The black round spots are pores made by insect borers (Bruchids) on *Dalbergia melanoxylon* seeds, which make them not to germinate. Notice also the black colour due to fungal infestation.

4. DISCUSSION AND RECOMMENDATIONS

The study shows that collection of seeds should be done in the first two months in the ASALs so as to increase the number of seeds not damaged by insects and are able to germinate. Furthermore the ASALs also present the most suitable environmental condition for the fast growth of the tree, if moisture conditions are improved [7] and the species is cultivated to reduce predation pressure from insects which could be overwhelming the trees from the time it gives the first leaves to the time it has mature pods. The ASALs high temperature have been reported to have a higher number of predatory insects which suck moisture from plants at all stages of plant growth and development.

Therefore to curb the near extinction of the very few remaining natural populations of *D. melanoxylon*, and improving its germination rate so as to attain sustainable exploitation for the carving industry; moisture content of germinating seedlings, reduction of predatory insects and timely collection and screening of seeds are crucial factors to be considered in the future plans of domesticating the plant and in the studies on genetic and epigenetic variations of the *D. melanoxylon*.

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