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Review article

A Review of the Literature of *Dalbergia melanoxylon*

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Abstract

Last review of the literature of *D. melanoxylon* (African Blackwood) or Mpingo was done on the late 1990's under the African Blackwood Conservation Project (ABCP) stationed in Tanzania. Recent investigations on propagation methods of this species has brought new attention of researchers to look forward on how they can rescue the species from being threatened or extinct which can be caused by its low regenerative ability by natural methods in the natural environments. It was now a proper time to add new information to the literature of *D. melanoxylon* from various recent findings covering about thirteen (13) years from the last review of the literature of the species. This literature review was written to organize useful information for researchers who are planning to investigate advanced propagation techniques on this species including tissue culture and mycorrhiza association of the species as recent findings on the species. This review has also exposed the threats of the species, recent status of the species in Tanzania and Africa, recently recommended research to be taken in consideration Ethnobotanical and ecological literatures as previous and early findings were not able to take botanists to the advanced propagation techniques which have been reported recently and finally Biology and silviculture of *Dalbergia melanoxylon.*

Keywords: African Blackwood, *Dalbergia melanoxylon*, Propagation, Mpingo, Ethnobotanical

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Introduction

Increasing harvesting of *Dalbergia melanoxylon* for commercial timber, forest clearing for new settlements and agriculture, frequently occurring bushfires, low regenerative ability of the species by natural methods and lack of the national conservation efforts presents a serious threat to the future availability of *Dalbergia melanoxylon* in Tanzania. This statement is a summation of the problems facing *Dalbergia melanoxylon* today in Tanzania and allover the world and that immediate methods for multiple seedling production for propagation of *D.*

melanoxylon is needed. *Dalbergia melanoxylon* in Tanzania is classified as Lower Risk / near threatened meaning that it is neither endangered nor of least concern. However it may be considered near threatened if propagation efforts are not instituted (Washa *et al*., 2012). *Dalbergia melanoxylon* is also called African Blackwood (in English) or mpingo (in Swahili) as used by Tanzanians (Redhead, and Temu, 1981).

Little research which has been conducted so far on habitat, sivilculture, germination, rooting, propagation, mycorrhizal association and callus induction have shown that it is possible to establish a national large scale plantation of *D. melanoxylon* if a means of multiple productions of seedlings is obtained. Recent findings on mycorrhiza association and rooting indicated high ability of seedling production (Washa *et al*., 2012) but massive harvesting of cuttings for rooting practices is associated with deforestation practices. The remaining possible method for seedling multiple production without deforestation is tissue culture which recently have succeeded to induce callus in *D. melanoxylon.* This literature review therefore is also intended to ask for grants support from organizations, institutions and individuals to enable tissue culture research to be conducted at the University of Dar es Salaam Botany Department for multiple seedling production in *D. melanoxylon*. Success to this research will open a way to sustainable planting and propagation of the *Dalbergia melanoxylon*, mpingo in Tanzania.

Habitant and Distribution of *Dalbergia melanoxylon*

The interest of early researchers as Guillemin & Perrottet 1832 (Guill & Perr) and others in the mid-1960's were based on ethnobotanical research on *Dalbergia melanoxylon* including the habitat, ecology, distribution, economic uses, nomenclature and Synonyms of this species. *Dalbergia melanoxylon* Guill & Perr (Family Leguminosae and subfamily Papilionoidae) (Tack, 1962) 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 (Redhead, and Temu, 1981). The mean minimum temperature in its native range is 18°C and the maximum is 35°C, with no frost. Annual rainfall averages 700 to 1200 mm, often distributed in a bimodal pattern of three to six months. Soils vary from loamy sands to clayey vertisols ("black cotton soils"). The species is water and light demanding; it is common near water and will 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. It is found in 26 sub-Saharan countries (Gillett *et al*., 1971).

Apart from Africa, *Dalbergia melanoxylon* is also found in India around Pune City (Lamrood *et al*., 2001). In Tanzania, *Dalbergia melanoxylon* is abundantly found in T_4, T_5, T_6 and T_8 floristic regions and less abundant in T_1, T_2, T_3 and T_7 floristic regions (Redhead and Temu, 1981. *Dalbergia melanoxylon* inhabit rainforest and open miombo woodlands of Tanzania in which rainfall is often marginal with long drought periods.

Biology and silviculture of *Dalbergia melanoxylon*

Researches which were conducted on *D. melanoxylon* from 1960's to early 2000's were based on 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. *Dalbergia melanoxylon* is a small, heavily branched tree, typically 4.5 to 7.5 m tall but occasionally reaching 15 m. The bole is fluted with high narrow ribs separated by deep indentations. Bole length occasionally reaches up to 3.6 m, but normally ranges from 1.2 to 1.8 m (Bryce, 1967).

Average diameter at breast height (dbh) at maturity is less than 38 cm, although trees have been found with a dbh of more than 60 cm. The bark is pale gray to grayish-brown, papery, fairly smooth, and flaking in long narrow strips (Bryce, 1967). The stems are often crooked. Branchlets are clustered at the nodes. Some grow out, while others are short and spine tipped. They are covered at first with short crisp hairs, and are usually glabrous. Leaves are pinnately and 6 to 22 cm long. The flowers are 6 to 9 cm long, occurring in dense clusters. Pods are elliptic oblong or irregularly oblong, bluntly pointed, flat and thin. They range from 3 to 7 cm long and 0.8 to 1.4 cm wide. They tend to be papery, glabrous, and laxly and rather diffusely veined.

As a member of Papilionoidea species *D. melanoxylon* seeds are usually hard and with a complex hilar valve and enclosed in pods (legumes), plants are shrubs or trees (habits)**,** leaves are usually compound and alternate, flowers are usually bilaterally symmetrical (Zygomorphic), Perfect or hermaphroditic (bisexual), entermophilous (insect pollinated) and white (Nshubemuki, 1993)). *Dalbergia melanoxylon* is a multi-stemmed plant, with irregularly shaped crowns. Its young branchlets are whitish grey with dense white lenticels and its

old barks are pale grey. It has leaf like caducous stipules of about 5mm long with alternate leaves and alternate leaflets (Mugasha, 1978). Flowering occurs in the second part of the dry season, particularly from October to December in Southern Africa. *D. melanoxylon* flowers are about 5mm long with 9 stamens (Bryce, 1967).

Development of fruits from pollination to maturity takes about 6 to 8 months. In southern Africa, the fruits mature between January and March while in Tanzania they mature between July and September (SID, 2004). The fruits are flattened, indehiscent pods and green when unripe, pale green when mature and then turn grayish when dry. Each pod usually contains one to three seeds (Bryce, 1967). The seeds are papery 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 seeds are very fragile and are difficult to separate from the pods when dry. Mature seeds are black and can easily be selected from immature white ones. The seeds have thin seed coats and the embryo is yellowish (TTSA, 1995).

Seeds are about 42,000/kg of pods; generally remain viable for only a few months, although viability could probably be increased by storage in sealed containers. In about 16.000 seeds only 6000 seeds or 35% can germinate (TTSA, 1995). Seed extracted from pods germinates readily without treatment. However, few seedlings attain maturity under natural conditions due to fire and drought (Mugasha. 1978). Seed storage behavior is orthodox; viability can be maintained for several years in hermetic storage at 3^{o}C with 9-12% moisture content. Failure to maintain these recommended storage conditions viability can last for few months from the time of maturity (TTSA, 1995). Field trials are currently exploring suitable spacing for *D. melanoxylon* plantations. An initial spacing of 2 x 2 m results in good branching characteristics, while later thinning improves growth. Stem form is improved by raising the trees under medium shade provided by Pinus caribaea Morelet (Nshubemuki, 1983).

Propagation and conservation efforts of *Dalbergia melanoxylon* in Tanzania

Propagation and conservation ideas and research started in Tanzania in mid-1980's when overharvesting, difficult to germinate and low seedling growth rate of *D. melanoxylon* were found to be big threats for the future availability of the species. These researches include that of Mbuya (1994), Platt *et al.,* (1994), Beale (1995), Fauna and Flora International (1995), Sharman (1995), TTSA (1995) and ABCP or Chuwa Unpublished report (1996)

Initially, Mbuya (1994) wrote on propagation and management of agricultural and pastoral communities including *D. melanoxylon* when investigated useful and shrubs for Tanzania while Platt *et al*., (1994) investigated the State of Knowledge about the Conservation and Cultivation Status of Mpingo (*Dalbergia melanoxylon)* in Tanzania but previously, UNEP, WWF and FFI brought the conservation ideas to Tanzania government in the late 1980's. This is a time when propagation and conservation ideas and research started to emerge among researchers and organizations.

Beale (1995) and Sharman (1995) investigated the sustainable production and conservation of Mpingo where by Beale (1995) investigation was on "An Ecological Economic Approach to Producing a Sustainable Mpingo Trade" while that of Sharman (1995) was on "the Sustainable Management of a Tropical Timber Species Using *Dalbergia melanoxylon*".

Fauna and Flora International (1995) reported on Conservation and Responsible Use of *Dalbergia melanoxylon* while the Tanzania Tree Seed Agency (TTSA, 1995) reported on storage conditions for long period viability of *D. melanoxylon* seeds.

As an effort towards propagation of *D. melanoxylon* in Tanzania which emerged from ideas and researches by UNEP, WWF, FFI, Mbuya (1994), Platt *et al*., (1994), Beale (1995), Sharman (1995), FFI (1995) and TTSA (1995), the African Blackwood Conservation Project (ABCP) was established in 1996 by James Harris, a woodworker from Texas, USA, and Sebastian Chuwa, a botanist from Tanzania. Its purpose was to replenish the population of the mpingo tree, to sensitize the community on economic and ecological importance of the species, to involve the community in seedling production for propagation of the species, to conduct researches on Mpingo and keep records of results. This project used natural methods of soil seed germination which does not solve the problem of low germinability. However this project was abandoned due to lack of support from the government. In the late 1980's the Wildlife Conservation Society of Tanzania started an mpingo replanting effort but it has now ended. Several experimental plots were established in the early 1970's by research

botanists but were abandoned in the early 1980's with no follow up. All these previous research as efforts to propagate and conserve Mpingo was not successful due to either lack of support, lack of follow-up and lack of advanced methods for multiple seedling production in *D. melanoxylon* rather than natural methods which are associated with low germination due to low seed viability.

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 (2008) 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 (2012) and not far from germination reported by TTSA (1995) as 37%.

Washa (2008) investigated "The Dependence of *Dalbergia melanoxylon* Natural Population on Root Suckers Regeneration". In this study, more than 50% of *D. melanoxylon* seedlings and trees in the forest were found to originate from root suckers as a result of adaptation from low seed germinability and environmental harsh conditions. It was suggested that root suckers can be used for propagation of the species but initiating root suckers is also considered as destruction practices to the naturally occurring trees.

Amri (2010) investigated "The Effect of Age of the Donor plant, IBA treatment and Cutting position to the Rooting ability of Stem cuttings in *Dalbergia melanoxylon*". The juvenile stem cuttings or softwood rooted to 72% using IBA hormone compared to 20% rooting of the older stem cuttings under the same treatments. This rooting was defeated by rooting promoted by mycorrhiza inoculums into Washa *et al*., (2012) in which softwood cuttings (juvenile) rooted to 100% while older stem cuttings did not root at all under the same treatments.

Washa and Nyomora (2012) investigated "The Effect of Moisture and Seed treatment on the *In-situ* and *E-situ* Regeneration of *Dalbergia melanoxylon* (African Blackwood) in Pugu Forest reserve". Available moisture to *D. melanoxylon* seeds was found to be main factor affecting germination in the natural environment, 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 attach. 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.

Washa *et al*., (2012) have three investigation studies on *D. melanoxylon*. One is "Identification of the mycorrhizal species associated with *D. melanoxylon*", second is "Their effects to rooting ability of *D. melanoxylon* stem and root cuttings" and third is the unpublished part of the study which still in the process for publication, this succeeded to induce callus in *D. melanoxylon*.

The first investigation published three fungal species being associated with *D. melanoxylon* namely *Inocybe petignosa, Laccaria proxima and Glomus versifornes*. The second investigation tested the effect of these fungal species to rooting of *D. melanoxylon* cuttings. There was significant rooting in the fungal inoculated medium compared to rooting in sterilized medium. Harvesting of cuttings for rooting practices can simply be considered as deforestation practices.

Conclusion

When the Mpingo literature is surveyed from ethnobotanical studies in the mid-1960's by Tack (1962) and Bryce (1967) across the emerging of propagation ideas and research in the mid-1980's and establishment of the ABCP in 1996 to the recent studies based on advanced propagation methods of the species, still one step forward is required. This is a step which will take us into the multiple seedling production for propagation of *D. melanoxylon*. This is a tissue culture step which recently has succeeded to induce callus in *D. melanoxylon*.

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