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Variation Studies of Different *Pterocarpus* Species
Recorded in Myanmar

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မြန်မာနိုင်ငံတွင် တွေ့ရှိမှတ်သားသော မျိုးစု *Pterocarpus* တွင်ပါဝင်သည့် ပိတောက်မျိုးစိတ် (၃)မျိုး၏ ကွဲပြားခြားနားမှုကိုလေ့လာခြင်း

ဒေါ်မူမူအောင်၊ M.Sc. (Forest Botany)
သုတေသနလက်ထောက်
သစ်တောသုတေသနဌာန၊ ရေဆင်း

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံတွင် မှတ်သားတွေ့ရှိသော ပိတောက်မျိုးစိတ်(၃)မျိုးရှိရာ စာပေကျမ်းကိုးများ ဖော်ပြချက်အရ နှစ်မျိုးမှာ အခြားနိုင်ငံများမှ တင်သွင်းစိုက်ပျိုးသောမျိုးဖြစ်ပြီး ကျန်တစ်မျိုးမှာမူ မြန်မာနိုင်ငံ၏ မျိုးရင်းဖြစ်ကြောင်း တွေ့ရှိရသည်။ အပင်မျိုးခွဲခြားပညာအရ ကွဲပြားခြားနားချက်များကို သေချာဂဏထွာ လေ့လာထားခြင်းမရှိခဲ့ပေ။ ထို့အတွက်ကြောင့် ဤစာတမ်းသည် မြန်မာနိုင်ငံတွင် တွေ့ရှိရသော ပိတောက်(၃)မျိုးကို ပီပီပြင်ပြင် ခွဲခြားသတ်မှတ်နိုင်ရန် သုတေသနပြုထားသော စာတမ်း ဖြစ်ပါသည်။ မျိုးစိတ်ဖြစ်သော *Pterocarpus macrocarpus* သည် မြန်မာနိုင်ငံတွင် နေရာအနှံ့အပြား ပေါက်ရောက်၍ စီးပွားရေးရတောင့်မှ အရေးကြီးသော သစ်မျိုးဖြစ်ပြီး သိပ္ပံနည်းအရ သေချာစွာလေ့လာရန် လိုအပ်ပေသည်။ အခြားသော ပိတောက်နှစ်မျိုးနှင့်မတူသော အချက်အလက် သာဓကများကို ရှာဖွေတွေ့ရှိ တင်ပြထားပါသည်။ မြန်မာပိတောက်သည် နေရာအနှံ့အပြားတွင် ပေါက်ရောက်သည်ဖြစ်၍ ကွဲပြားသော မျိုးရင်းဒေသများ ဖြစ်ပေါ်နေစရာအကြောင်း ရှိပေသည်။ ထို့အတွက်ကြောင့် မျိုးရင်းဒေသ (၆) မျိုး၏ ကွဲပြားခြားနားချက်များနှင့်ဆိုင်သော အသီး၊ အစေ့ ပေါက်ရောက်နှုန်းနှင့် ပျိုးပင်များကြီးထွားနှုန်းတို့၏ နှိုင်းယှဉ်ချက်များကို လေ့လာပြီးတွေ့ရှိချက်များကို တင်ပြထားပါသည်။ သုတေသန၏ရလဒ်မှာ ပိတောက် စိုက်ခင်းတည်ထောင်မှု၊ လိုင်းအလိုက် ဖြည့်စွက်စိုက်ပျိုးမှု၊ ၎င်းသစ်မျိုး၏ မျိုးရိုးဗီဇထိန်းသိမ်းမှု လုပ်ငန်းတို့တွင် အထောက်အကူ ဖြစ်စေမည် ဖြစ်ပါသည်။

Variation Studies of Different *Pterocarpus* Species Recorded in Myanmar

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Abstract

There are three species of *Pterocarpus* found and recorded in Myanmar. Literature References stated some as introduced species and one as native to Myanmar. Taxonomical as well as dendrological characteristic differences have never been thoroughly studied. So that paper deals with the clarification of the same. The species *Pterocarpus macrocarpus* is distributed widely in Myanmar from South to North, East to West. It is also a commercially important and thus needed thorough investigation. Some significant results were obtained so as to verify Myanmar Padauk from the other two species of *Pterocarpus*. The distribution of *P. macrocarpus* in Myanmar is wide and therefore may develop many provenances, of which six provenances were chosen preliminarily to test their differences. Fruits, seeds germination rate and seedling height growth differences were found out. The result of the research would support in the improvement of Padauk plantation establishment, enrichment planting and thereby enhancing the conservation of the species.

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1. Introduction

The genus *Pterocarpus* which belongs to the family Papilionaceae and to the order Leguminosae has five known species: they are *P. dalbergioides* Roxb. (Andaman Padauk); *P. indicus* Willd. (Malay Padauk also known as Indian Padauk), (Troup, 1921); *P. macrocarpus* Kurz. (Myanmar Padauk); *P. marsupium* Roxb. (Kino tree) and *P. santalinus* Linn. (Red Sanders). Except *P. indicus*, which is a road-side tree and planted for ornamental purpose and the other species are timber trees (Hundley, 1956). The species *P. dalbergioides*, *P. indicus* and *P. macrocarpus* are found in Myanmar, of which *P. macrocarpus* is said to be a wild, native and true padauk (Troup, 1921 and Hundley, 1956) and the other two are recorded as introduced.

The differences among the three species in their taxonomical, dendrological characters, quality of seed and seedlings and nursery practices are the essentials of this research which would eventually support in the plantation establishment techniques and to the conservation of the species.

Therefore the objectives of the research are as follows:

- (i) To identify and verify the Myanmar Padauk (*Pterocarpus macrocarpus*) among the three species found and recorded in Myanmar.
- (ii) To find out the differences concerning fruit and seed characteristics, seed quality and germination and performance of initial seedling growth of six provenances of Myanmar Padauk.
- (iii) To study various aspects such as taxonomy, dendrology, fruits and seeds characteristics, and breeding for effective conservation of the species.

2. Literature Review

The genus *Pterocarpus* belongs to the family Papilionaceae, under the order Leguminosae (Gupta, 1969). The generic name was given by Linnaeus in 1754 as *Pterocarpus*. This was later described by Kurz (1877), Hooker (1879), Brandis (1907), Troup (1921) and Brummitt (1992).

Hutchinson (1964), Willis (1955), Corner (1988) and Allen & Allen (1981) mentioned that the generic name *Pterocarpus* was derived from the Greek 'Pteron' a wing, 'Karpos' – fruit, referring to the winged fruit (pod).

The number of the species of the genus *Pterocarpus* had been variously reported. This genus was known to comprise 60 - 70 species (Allen & Allen, 1981); 15 species (Hooker, 1879; Brandis, 1907); or 35 species (CD-ROM, FRI, Yezin) which were found in the tropics and sub tropics of both hemispheres and 5 species were present in India (Gamble, 1922; Troup, 1921; Pearson and Brown, 1932 and The Wealth of India, 1962). Hundley and Chit Ko Ko (1987) listed 3 species found to be growing in Myanmar.

In Myanmar the vernacular name of *Pterocarpus dalbergioides* Roxb. is "Andaman Padauk" or "Andaman Redwood", because it is found in the Andaman Islands, and it is also known as "Kapali- Padauk" (Troup, 1921 and Hundley and Chit Ko Ko 1987).

P. indicus Willd. is known as "India Padauk" or "Pashu Padauk", "Angsana or Sena" in Malay, "Burma-Rosewood" in English, and Rosewood in Trinidad (Hundley and Chit Ko Ko, 1987; Troup, 1921; Foxworthy, 1927; Corner, 1988 and Jensen, 1995).

P. macrocarpus Kurz. was known as "Burma-Padauk" by the British or "Myanmar-Padauk" in Myanmar; in Thailand as "Pradu", (Kurz, 1877; Hooker, 1879; Hundley and Chit Ko Ko, 1987; Troup, 1921; Gamble, 1922 and Whuangplong, et al., 1994).

P. dalbergioides Roxb. is a native of Andaman Islands. It has been cultivated in Bengal, Southern India and Myanmar (Troup, 1921).

P. indicus Willd. was found in the Malay Peninsula and Archipelago. They were planted along the roadsides and gardens in many towns of the Philippines, India, Indo-China, Myanmar and Singapore (Troup, 1921; Menninger, 1962 and Little and Wadsworth, 1964).

P. macrocarpus is a native of Myanmar and Thailand. In Myanmar it is usually found in the drier parts of the upper mixed deciduous forest (Kurz, 1877; Hooker, 1879; Troup, 1921; Gamble, 1922 and Hundley, 1956).

The habit of the genus *Pterocarpus* is all erect trees (Kurz, 1877; Hooker, 1879; Brandis, 1907 and Troup, 1921). Troup (1921) mentioned the facts that all the species of the genus *Pterocarpus* were leafless but with flowers in the hot season, except *P. dalbergioides* which flowers in the rainy season. *P. dalbergioides* and *P. macrocarpus* are large trees and *P. indicus* is a medium sized tree (Kurz, 1877; Hooker, 1879; Brandis, 1907 and Troup, 1921). The barks are greyish brown, peeling off in irregular scales, when blazed exudes a bright red gum resin (Troup, 1921; Gamble, 1922 and Hundley, 1956). The branches are ascending with glabrous, unarmed; but *P. indicus* and *P. dalbergioides* have spreading crown at the ends (Troup, 1921 and Jensen, 1995).

Leaves of genus *Pterocarpus* are alternate, pinnately compound leaves with caducous stipules; leaflets 7-9, without stiples (Kurz, 1877; Hooker, 1879; Brandis, 1907 and Cooke, 1956).

Various workers described the different leaf shapes. The leaf of *P. dalbergioides* as ovate to lanceolate (Brandis, 1907) and those of *P. indicus* are ovate to elliptical, ovate to oblong ovate (Kurz, 1877; Brandis, 1907 and Jensen, 1995). In *P. macrocarpus*, they are ovate to oblong (Kurz, 1877; Hooker, 1879; Brandis, 1907; Troup, 1921 and Hundley, 1956). The inflorescences of *P. indicus* are axillary raceme or in copious terminal and axillary panicles (Kurz, 1877 and Hooker, 1879). In *P. macrocarpus*, they are axillary raceme, tawny pubescent in the axile of the leaves (Kurz, 1877 and Hooker, 1879). In *P. dalbergioides*, they are terminal panicles (Troup, 1921).

The flowers of all *Pterocarpus* species studied are small, yellow, fragrant and papilionaceous as described by Kurz, 1877; Hooker, 1879; Brandis, 1907; Troup, 1921 and Hundley, 1956.

The pods of this genus are samara, flat, indehiscent, orbicular, ovate or falcate (Brandis, 1907). The pods of *P. dalbergioides* are 5 cm in diam, nearly glabrous, tapering down to the stalk, often 2 seeded (Brandis, 1907 and Troup, 1921); *P. indicus* they are 2.5-5 cm in diam., orbicular or circular, silky pubescent while young, 1-seeded, beaked (Kurz, 1877; Hooker, 1879; Brandis, 1907; Troup, 1921 and Jensen, 1995). The pods of *P. macrocarpus* are 6 - 7.5 cm in diam., irregularly orbicular, velvety pubescent, with the wing somewhat folded (Kurz, 1877; Hooker, 1879; Brandis, 1907 and Troup, 1921).

Seeds of *Pterocarpus* species studied were 1, rarely 2 or 3, hard and bony, dolabriform in agreement with (Brandis, 1907 and Troup, 1921). In *P. dalbergioides*, they are reddish brown, flattened, smooth, shiny, testa fairly thin and brittle. In *P. indicus*, they are brown, smooth, flattened, brittle when dry. In *P. macrocarpus*, they are brown, with leathery testa (Troup, 1921).

Differentiating the three species (*P. dalbergioides*, *P. indicus* and *P. macrocarpus*) superficially was done by many authors with various objectives. Hundley and Chit Ko Ko, (1987) with references to Brandis, Gamble, Shirley and Troup differentiated Myanmar Padauk to those other so called Padauk. Full description of the three species was given by Troup (1921) in the *Silviculture of Indian Trees*.

According to references in the published literature by Seeber, Weidelt and Banaag, (1979) the dendrological characters of the three species of genus *Pterocarpus* were described.

Plantation of Padauk was not known before the Second World War but natural regeneration was described. Later in the 80's, as the FRI at Yezin was founded, research concerning the species was started. (Htun, 1980 and C.DOO, 1981). Provenances testing for seed size and initial seedling growth was done in Thailand (Whuangplong et al, 1994). Various Research on the genus *Pterocarpus* were done in the Tropics (CD-ROM, FRI).

3. Botanical Studies

3.1 Materials and Methods

3.1.1 Materials

The *Pterocarpus* species (viz. *P. dalbergioides* Roxb., *P. indicus* Willd. and *P. macrocarpus* Kurz.) were the materials of study. The specimens of the three species were collected from Yangon, Mandalay Divisions and Pyinmana Township areas respectively. The flowers were collected during April and July, 1999 and the fruits during January and March of the same year.

3.1.2 Methods

3.1.2.1 Taxonomical Studies

The floral parts were collected, pressed and dried, and are preserved in the FRI Herbarium. Both fresh and preserved specimen were used for taxonomic descriptions and identification.

3.1.2.2 Dendrological Studies

Natural habits of the trees were observed and recorded photographically. Vegetative parts such as leaves, stems, barks and slash for wood were studied. The method applied in dendrological study are adapted from Seeber, Weidelt and Banaag (1979).

3.1.2.3 Fruits and Seeds

Fruits of three species were collected, measured for their sizes and forms (characters) compared. Seeds were extracted from fruits and number per fruit recorded.

3.2 Observations

3.2.1 Taxonomical Studies

3.2.1.1 Specific Description

Key to the species of the genus *Pterocarpus* recorded in Myanmar.

The genus *Pterocarpus* consisted of erect trees with branches having prominent grey lenticels.

- A. Leaves thinly coriaceous, quite glabrous beneath when old; Inflorescence: panicle or almost wholly terminal or panicle almost all axillary, standard of the petals broadly ovate; pods even when young, only sparsely pubescent B
- A. Leaves firmly coriaceous, finely pubescent beneath; inflorescence axillary standard of the petals obovate; pods velvety when young C.
- B. Leaflets 5-9, ovate - lanceolate, narrowed gradually to a point with 5-7 pairs of nerves distinctly raised beneath, edge of pod between stipe and style usually concave *P. dalbergioides*.
- B. Leaflets 7-11, ovate - elliptic, abruptly rounded to a blunt point, nerves hardly more prominent than secondary veins, edge of pod between stipe and stylous acuminate above the basal sinus at a right angle with stalk *P. indicus*.
- C. Leaflets 7-11, ovate oblong, bluntly acuminate, mucronate, axillary flower simple or sparingly branched racemes pedicels considerably longer than the calyx *P. macrocarpus*.

1. *Pterocarpus Dalbergioides* Roxb. Hort. Beng. 53; F1 Ind. iii 236 = *indicus*

A large tree, 30-40 m high. Leaves alternate, unipinnately compound, imparipinnate, 11-15 cm long; leaflets 5-9, alternate, ovate to lanceolate, 4-11 cm long and 2-3.5 cm wide, smooth and subcoriaceous, glabrous on the upper surface and glabrous at the lower surface, the tips acuminate, the bases obtuse, the margins entire; petioles 4-5 cm long glabrous, pulvinate, petiolules very short and 0.4 cm long, glabrous, the rachae 8-10 cm long, terete, glabrous; stipules lanceolate, 0.8 cm long, caducous. Inflorescences terminal panicle, 18 cm long, lateral raceme 9 cm long; bracts minute and caducous; bracteoles 2, minute and caducous. Flower small, pale yellow and fragrant 1 cm long, papilionaceous, pedicels slender, cylindrical and 0.5 cm long, as long as the calyx tube. Calyx turbinate, the tube 0.6 cm long and 0.4 cm wide, lobes five unequal, the two posterior larger, pubescent. Petals 1+2+(2), the standard broadly ovate, 1.2 cm long and 1 cm wide, veins obscure with prominent midrib, the tips retuse, the margins entire, undulate, the bases obtuse, the claw 0.3-0.4 cm long, the wings spathulate, 1 cm long and 0.8 cm wide, veins obscure with prominent midrib, the tips acute, the margins entire, undulate, the bases obliquely obtuse, the claw 0.4 - 0.5 cm long, the keel spathulate, 0.7 cm long and 0.3 cm wide, veins obscure with prominent midrib, the tips acute, the margins entire, the bases auriculate, the claw 0.4 cm long, adhering slightly for a little way near their middle. Stamens 1+(9), diadelphous, staminal tube 0.7-1 cm long and 0.1 cm wide, the filament slender, 0.1- 0.2 cm long; anther oval very minute, ditheous, dorsifixed, introrse, longitudinal dehiscence. Ovaries monocarpellary, fusiformed, about 0.3 cm long and 0.1 cm wide, villous, the stigma simple, the style slender, 0.4 cm long, ovules 2, kidney-shaped, the placentation marginal. Pods dark reddish brown, orbicular, 5 cm

in diameter, tapering down to the stalk; 1-2 seeded sometime 3; seeds reddish brown or brownish, reniform, 1cm long, smooth, shiny, testa fairly thin and brittle.

This species is flowers and fruits from June to September. The tree is found scattered in moist deciduous or semi-evergreen forests near sea level up to 100 m elevation.

Myanmar Name - Kapali Padauk
Locality - Yangon University Campus
Kamayut Township
- Mu Mu Aung

2. *Pterocarpus Indicus* Willd. Sp.P1. 3:904.1802.

P. draco Lam. Tabl. Encyc. 3:161.1791.

P. dalbergioides Roxb. Hort. Beng. 53: 1814;F1. Ind. 3: 236.1832.

P. wallichii Wight & Arn. Prod. 267.1834.

P. pallidus Blanco, F1. Filip. ed. 1: 560.1837.

P. santalinus Blanco, F1. Filip. ed.1: 561.1837.

P. zollingeri Miq F1. Ind. Bat. 1:1. 136.1855.

A medium sized tree, 15-20 m tall and 2 m in diameter. Leaves alternate, unipinnately compound, imparipinnate, 16-30 cm long; leaflets 7-11, alternate, ovate to elliptical, lower one ovate and uppermost elliptic, 7-13 cm long and 5-7 cm wide, both surfaces glabrous, smooth and subcoriaceous, the tips slightly acuminate, the bases obtuse to rounded, the margins entire; petioles cylindrical, 2.5-5.0 cm long, glabrous; petiolules, 0.3-0.6 cm long, pubescent, pulvinate, the rachae 14-24 cm long, glabrous; stipule lanceolate, 1-1.2 cm long, caducous. Inflorescences in terminal and axillary raceme, about 15-24 cm long, lateral raceme 9-14 cm long; bracts ovate to lanceolate, about 0.5 cm long, pubescent, caducous; bracteoles lanceolate, about 1.5 cm long, caducous. Flowers numerous, small, golden-yellow, fragrant, 1.5-2.0 cm long, papilionaceous, the pedicels 0.5-1.0 cm long, pubescent. Calyx turbinate, the tubes about 0.4-0.6 cm long and 0.3-0.5 cm wide, lobes five unequal, the posterior connate, puberulose to nearly glabrous. Petals 1+2+(2), free, golden-yellow or bright yellow, the standards broadly obovate, 2 -1.5 cm in diameter, veins obscure, the tips retuse, the margins entire, undulate, the bases attenuate, the claw, 0.4 mm long, the wings oblong to obovate, 1 cm long and 0.7-0.9 cm wide, veins obscure, convergent, the tips acute, the margins entire, undulate, the bases slightly auriculate, the claw 0.5 - 0.6 cm long, the keel spatulate, 0.6 - 0.8 cm long and 0.3 - 0.4 cm wide, veins obscure, the tips acute, the margin entire, the bases auriculate, the claw 0.5 cm long, adhering slightly for a little way near their middle. Stamens 1+(9), diadelphous, staminal tube about 0.5 cm long and 0.2 cm wide, the filaments slender, 0.1-0.2 cm long; anther oval, very minute, ditheous, dorsifixed, introrse, longitudinal dehiscence. Ovaries monocarpellary, fusiformed, about 0.3-0.5 cm long and 0.1-0.2 cm wide, villous, the stigma simple, the style slender about 0.6 cm long, ovules 3, kidney-shaped, the placentation marginal. Pods brownish, circular, 4.5 cm in diameter, glabrous, flat; 1-2 seeded, reddish brown, dolabriformed, flattened, 1-1.3 cm long and 0.5 cm wide, smooth, shining with a leathery testa.

Flowering and fruiting started from March to June. Planted along the road sides. Found growing in sandy areas.

Myanmar name - Pashu Padauk (Pan-Padauk)
Locality - Yangon and Pyinmana Township
Mu Mu Aung

3. *Pterocarpus Macrocarpus* Kurz. in Journ. As. Soc. Beng. 43: 11.187. 1874.

A large tree, 25 - 30 m high. Leaves alternate, unipinnately compound imparipinnate, 11- 20 cm long; leaflets 7-11, alternate, ovate to oblong, 4-10 cm long and 3-5 cm wide, thin coriaceous, the upper surface nearly glabrous and the lower surface pubescent, the tips acuminate with mucro, the base obtuse, the margins entire, the largest leaflets towards the tip of leaf; petiole 3 - 6 cm long, pulvinate; petiolules 0.4 - 0.5 cm long, pubescent, the rachae 8 - 15 cm long, terete, puberulose; stipules lanceolate, 0.8 - 1 cm long, caducous, pubescent. Inflorescences axillary, simple raceme, about 8-15 cm long, lateral raceme 4-8 cm long, tawny pubescent; bracts linear, 0.3 - 0.4 cm long, pubescent, persistent; bracteoles 2, linear; 0.3 - 0.4 cm long, pubescent, persistent. Flowers small, bright yellow, fragrant, about 1-1.2 cm long, papilionaceous, pedicels cylindrical, 0.8 - 1.0 cm long, pubescent, longer than the calyx. Calyx turbinate, the tubes 0.6 cm long and 0.4 cm wide, lobes five unequal, the two posterior larger than others, pubescent, densely rusty to velvety. Petals 1+2+(2), bright yellow, the standard obovate, 0.9 - 1.0 cm in diameter, veins obscure, the tips acute, the margins entire, undulate, the bases attenuate, the claw 0.5 - 0.7 cm long, the wings spatulate, 0.6 - 0.8 cm long and 0.5-0.6 cm wide, veins obscure, the tips acute, the margins entire, undulate, the bases slightly auriculate, the claw 0.5 cm long, the keel obtusely subulate, 0.7 cm long and 0.3 cm wide, veins obscure, the tips acute, the margins entire, the bases cuneate, the claw 0.5 cm long. Stamens 1+(9), diadelphous, staminal tube 0.4-0.5 cm long and 0.1 cm wide, the filament slender, 0.1-0.2 cm long; anther oval, minute, ditheous, dorsifixed, introrse, longitudinal dehiscences. Ovaries monocarpellary, fusiformed, about 0.4 cm long and 0.1cm wide, villous, the stigma simple, the style slender, 0.4 cm long, ovules 2, kidney-shaped, the placentation marginal. Pods brownish, orbicular, 6.5 -7.5 cm in diameter, flat; 1-2 seeded, reddish brown, dolabriform, 1.0 cm long, with a leathery testa.

Flowering and fruiting started from March to June. Found growing in association with deciduous and dry dipterocarp tree species in undulating to hilly region about 800 m.

Myanmar name - Myanmar Padauk (Burma Padauk)
Locality - Moeswe, Sinthaut, Yezin
Pyinmana Township
Mu Mu Aung

3.2.2 Dendrological Studies

3.2.2.1 Dendrological Characteristics of *Pterocarpus dalbergioides* Roxb.

General Appearance

A large evergreen or semi-deciduous tree with ascending branches spreading at the ends, about 30-40 m in height with a clean bole of 7-16 m, the bole is often much buttressed at the base. Branches and inflorescence axes cylindrical, the younger ones puberulose and older ones completely glabrous with prominent grey lenticels.

Habitat

The tree is not gregarious, but is found scattered in mixed deciduous or semi-evergreen forest from near sea-level up to about 100m elevation, grows best on the well-drained lower slopes of the hills and in broader valleys.

Bark Pattern

The bark is yellowish brown, exfoliating in irregular scales. The outer bark is 0.3-0.5 mm thick with brown and the inner bark is 0.8-10 mm thick with pale yellow color. When slashed, drops of gum resin comes out from the tree profusely. The sapwood is grey and small. The heartwood is bright red, streaked with brown and black colour.

Leave

The leaves are pinnate about 11-15 cm long, glabrous. The number of leaflets are 7-9 pairs, alternate, ovate to lanceolate 4-11cm long and 2-3.5cm wide. The texture of leaflets are smooth and subcoriaceous, glabrous. The surface of leaflets are glabrescent on both side. The tips of leaflets are acuminate and the bases of leaflets are obtuse. The margin is entire. The venation is pinnate with 8-12 fine lateral veins interspersed with intermediate veins, tertiary veins reticulate, clearly visible on both side of the leaflet; petioles 4-5 cm long, slightly thicker than midrib.

Flower

The flowers are small about 1.0 cm long, pale yellow and fragrant. The inflorescences are terminal panicle reaching about 18 cm long, lateral racemes about 9 cm long.

Fruit

Samara, pedicelled sub-rounded about 5 cm in diameter, orbicular tapering down to the stalk.

3.2.2.2 Dendrological Characteristics of *Pterocarpus indicus* Willd.

General Appearance

A semi-deciduous tree, attaining to a height of 15-20 m with fluted trunk, usually short bole with steeply ascending branches and more or less pronounced buttresses, wide spreading crown with branches dropping and touching the ground, branches cylindrical with prominent grey lenticels.

Habitat

The trees are found along the roadsides in many towns of Myanmar. The species tolerates longer dry season. The tree appears to thrive best in a tropical climate with a rainfall of not less than 60 inches. It requires a deep well-drained soil and does not thrive on stiff clay soil.

Bark Pattern

The bark is olive-grey or greyish brown, smooth, slightly fissured, fissures 1-2 cm apart, flaking off in small rectangular patches. The outer bark is 2 mm thick with brown color and the inner bark is 4-5 mm thick with orange color. When slashed, exudes blood red sticky sap profusely. The sap wood is creamy and hard. The heart wood is dark brick-red and hard.

Leave

The leaves are pinnate with 7-11 alternate leaflets, rachis 16-30 cm long. The leaf is dark green shining foliage. Leaflets are ovate to elliptic, sometimes almost circular, 6-14 cm long and 4-7.5 cm wide, the tips acuminate and the bases are rounded. The texture is papery thin, both faces glabrous. The venation is pinnate with 6-8 fine lateral veins interspersed with intermediate veins, tertiary veins reticulate, clearly visible on both side of the leaflet; petiole 4-7 mm long, slightly thicker than midrib with a small groove on the upper side.

Flower

The flowers are numerous about 1.5-2.0 cm long, deeply yellowish with orange tinge, borne in axillary racemes, fragrant, on slender pedicels longer than calyx, in panicles at the end of branchlets.

Fruit

The fruit is circular, glabrous, indehiscent pod, surrounded by a broad, unequally sinuate notched at the base and shortly stalked, the stylous acuminate above the basal sinus, the style distance above the base, pointing outwards, at a right angle with the stalk, silky pubescent while young.

3.2.2.3 Dendrological Characteristics of *Pterocarpus macrocarpus* Kurz.

General Appearance

A large deciduous trees and light demanding in nature which usually grows to 25-30 m in height with a clean bole of 6-10 m; ascending branches with prominent grey lenticles. Young shoots are tawny pubescent.

Habitat

It usually occurs in dry upper deciduous and dry dipterocarp forests and undulating to hilly region up to an elevation of about 800 m. It prefers a well-drained soil and grows best on sandy loam. On lateritic soil, it is stunted.

Bark Pattern

The bark is greyish brown, peeling off in irregular scales. The outer bark is 3 mm thick with greyish brown colour and the inner bark is 8 mm thick with pale yellow color. When slashed, a blaze the tree exudes bright red astringent gum resin. The sapwood is light

yellowish brown and small. The heart wood is bright yellowish red to brick red or sometimes streaked with brown color and hard.

Leave

The leaves are alternate, pinnate with 7-11 leaflets, rachis 14-24 cm long. The leaf is light green shining foliage. Leaflets are ovate to oblong in shape 4-10 cm long and 3-5 cm wide. The tips of leaflets are acuminate with mucro and the base is obtuse. The texture is thin coriaceous. The margins are entire and the largest leaflets towards the tip of leaf. The upper surface is nearly glabrous and the lower surface is pubescent. The venation is pinnate with 6-8 lateral vein, tertiary veins reticulate clearly visible on both side of the leaflet. The petiole is about 4-5 mm long.

Flower

The flowers are small, 1.0 cm long, yellow, fragrant, simple raceme, axillary, panicle about 12-18 cm long, lateral raceme 4-8 cm long, tawny pubescent.

Fruit

The pods are irregularly orbicular, about 4-6 cm in diam., while young greyish or tawny velvety pubescent and less so when fully ripe with the wing somewhat folded, unequally sinuate, rounded at the base, the minute stylous point above the basal sinus.

3.2.3 Fruits and Seeds

For Comparison, the type, color, shape, size of the fruits (seeds) were measured and observed. (See Table 6)

3.3 Results and Discussion

Padauk, one of the most popular and commercially important timber trees (Rodger, 1963) has controversies concerning the species taxonomic identification. The name *Padauk* encompasses species like *Pterocarpus dalbergioides*, *P.indicus* and *P.macrocarpus*. Myanmars especially those living in Yangon, the capital of Myanmar, and other towns know and acquainted with *P.indicus*, the trees which have conspicuous, golden yellow and clustered flowers borne on drooping branches with glossy leaves as Padauk. Many accepted them as “Padauk” without knowing “Myanmar Padauk”, the *Pterocarpus macrocarpus*, (Bor,1953 and Kurz, 1877) which is a tall tree sometimes reaching the height of over 35 m (over 100 ft.) with a clean bole up to 6 m. The flowers are smaller and not so obvious although quite fragrant, bright yellow and found widely distributed in the mixed deciduous drier parts and Dipterocarp forests of Myanmar. The other two were introduced into Myanmar (Troup, 1921; Gamble, 1922; Hooker, 1879; Brandis, 1907, Kurz, 1877 and Hundley and Chit Ko Ko, 1987) and are found mostly in towns and not in the natural forest. According to the literature *P. dalbergioides* is a large tree and has good timber and therefore should be introduced and tested as exotic in plantation establishment in Myanmar. *P. macrocarpus* is also found sparsely in neighbouring countries like Combodia and Thailand

but abundantly in Myanmar. The other two are found mostly in towns supporting the fact that they are planted species. The following facts are found according to the research:

- (1) There are differences in habits of the three species: *P. dalbergioides* and *P. macrocarpus* are large trees and *P. indicus* a medium size trees. The branches of *P. macrocarpus* are unarmed while there of *P. dalbergioides* with ascending branches spreading at the ends. There of *P. indicus* with wide spreading crown with lower branches drooping and touching the ground.(See Table 1)
- (2) Bark colors are different in that *P. macrocarpus* is greyish brown, that of *P. dalbergioides* has yellowish brown and *P. indicus* with olive-grey or greyish brown. The bark of the *P. dalbergioides* is found to be thickest where the thicken of barks of *P. macrocarpus* is medium and *P. indicus* thin. (See Table 2)
- (3) The color of sapwood of *P. dalbergioides* was found to be grey, that of *P. indicus* was creamy and the *P. macrocarpus* was yellowish brown. The sizes of sapwood for *P. dalbergioides* and *P. macrocarpus* were small but *P. indicus* was a little larger.
- (4) The heartwood of *P. dalbergioides* was found to be bright red, streaked with brown and black color, whereas *P. indicus*, dark brick-red color, and that of *P. macrocarpus* bright yellowish red to brick red or sometime streaked with brown color.
- (5) When slashed the *P. dalbergioides* exudes drops of gum resin, the *P. indicus* exudes blood red sticky sap and the *P. macrocarpus* exudes bright red astringent gum resin.
- (6) There were differences also in the leaves among the three species. For examples, the color of the leaves of *P. dalbergioides* were green, of *P. indicus*, dark green and of *P. macrocarpus* light green; the shape of all the three species are ovate at times but that of *P. dalbergioides* sometimes lanceolate, that of *P. indicus* elliptic and that of *P. macrocarpus* oblong; the size of the leaves of *P. indicus* is large (16-30 cm long), that of the *P. macrocarpus* medium (14-24 cm long) and that of the *P.dalbergioides* are the smallest (11-15 cm long); texture showed differences: the *P.dalbergioides* has smooth and subcoriaceous, glabrous, the *indicus*, papery thin with both faces glabrous, the *P. macrocarpus*, with thin coriaceous, upper surface glabrous and lower surface pubescent, the base of the leaves, the *P.dalbergioides* and the *P. macrocarpus* had obtuse base and the *P. indicus* with rounded base; in number of leaflets, the *P. dalbergioides* had 5-9, the *P. indicus* and the *P. macrocarpus* had 7-11, the type of venation were the same for all the three species.(See Table 3)
- (7) The most important part for identification of the species was the inflorescence. The types of inflorescences were different among the three species. The *P. dalbergioides* had the terminal panicle position of the inflorescence, the *P. indicus* had terminal and axillary racemes and the *P. macrocarpus* axillary panicle in position. The sizes are also different in that the *P. indicus* had the largest with 15-24 cm, the *P. dalbergioides* had 18 cm long and the *P.macrocarpus* the smaller size of 8-15 cm long.. (See Table 4 and also figures 1 to 3)
- (8) The sizes of the fruits were also different. The *P. macrocarpus* had larger fruits where as *P. dalbergioides* and *P. indicus* had smaller fruit sizes. The types are all samara and brownish in color (See Table 5). As the specific name implied the fruits of *P. macrocarpus* are large.
- (9) The comparison on seeds between the three species showed only slight differences. The seed sizes of all the three species had no difference: the *P. macrocarpus* is almost one seeded and the other two being 1 or 2 seeded, *P. dalbergioides* sometimes having 3 seeds. (See Table 6)

Table 1. Comparison of habits of the three species of the genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Habits	a large tree	a medium sized tree	a large tree
2.	Size	30-40 m in height with a clear bole of 7-16 m.	15-20 m in height with fluted trunk, short bole.	25-30 m in height with a clear bole of 6-10 m.
3.	Branch	ascending branches spreading at the ends. prominent with grey lenticels.	wide spreading crown with lower branches drooping and touching the ground. prominent with grey lenticels.	unarmed branches. prominent with grey lenticels.

Table 2. Comparison of barks of the stems from the three species of genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Color	yellowish brown	olive-grey of greyish brown	greyish brown
2.	Shape	exfoliating in irregular scales	flaking off in small rectangular patches	peeling off in irregular scales
3.	Outer bark	3-5 mm in thick with brown	2 mm in thick with brown	3 mm in thick with greyish brown
4.	Inner bark	8-10 mm in thick with pale yellow	4-5 mm in thick with orange	8 mm in thick with pale yellow
5.	Sapwood	grey and small	creamy and hard	light yellowish brown and small
6.	Heartwood	bright red, streaked with brown and black	dark brick-red and hard	bright yellowish red to brick red or streaked with brown and hard
7.	Slash	drops of gum resin	exudes blood red sticky sap	exudes bright red astringent gum resin

Table 3. Comparison of leaves of the three species of the genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Color	green	dark green	light green
2.	Shape	ovate to lanceolate	ovate to elliptic	ovate to oblong
3.	Size	11-15 cm long	16-30 cm long	14-24 cm long
4.	Texture	smooth and subcoriaceous, glabrous	papery thin, both faces glabrous	thin coriaceous, upper surface glabrous and lower surface pubescent
5.	Tip	acuminate	acuminate	acuminate with mucro
6.	Base	obtuse	rounded	obtuse
7.	Number of leaflets	5-9	7-11 or 14	7-11
8.	Venation	pinnate with 5-7 fine veins tertiary veins reticulate, visible on both side.	pinnate with 6-8 fine veins tertiary veins reticulate, visible on both side.	pinnate with 6-8 fine veins tertiary veins reticulate, visible on both side.

Table 4. Comparison of inflorescences of the three species of the genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Position	terminal panicle	terminal and axillary racemes	axillary panicle
2.	Size	18 cm long, lateral raceme 9 cm long	15-24 cm long, lateral raceme 9-14 cm long	12-18 cm long, lateral raceme 4-8 cm long
3.	Color	yellow	bright yellow or golden yellow	bright yellow or yellow

Table 5. Comparison of fruits of the three species of the genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Type	samara	samara	samara
2.	Color	dark reddish brown	brownish	brownish
3.	Shape	orbicular	circular	irregularly orbicular
4.	Size	5 cm in diameter	4.5 cm in diameter	6.5-7.5 cm in diameter
5.	Pedicel	subrounded, tapering down to the stalk	shortly stalked	1.5 cm long
6.	Style	0.2 cm long, very short stylous above the basal sinus	0.5-0.7 cm long, the stylous acuminate above the basal sinus, at a right angle with the stalk	0.3-0.5 cm long the minute stylous point above the basal sinus

Table 6. Seed characteristics of the three species of the genus *Pterocarpus*

No.	Characters	<i>P. dalbergioides</i>	<i>P. indicus</i>	<i>P. macrocarpus</i>
1.	Color	reddish brown or brownish	reddish brownish	reddish brown
2.	Shape	reniform	dolabriform	dolabriform
3.	Size	1 cm long and 0.2 cm wide	1-1.3 cm long and 0.5 cm wide	1 cm long and 0.3 cm wide

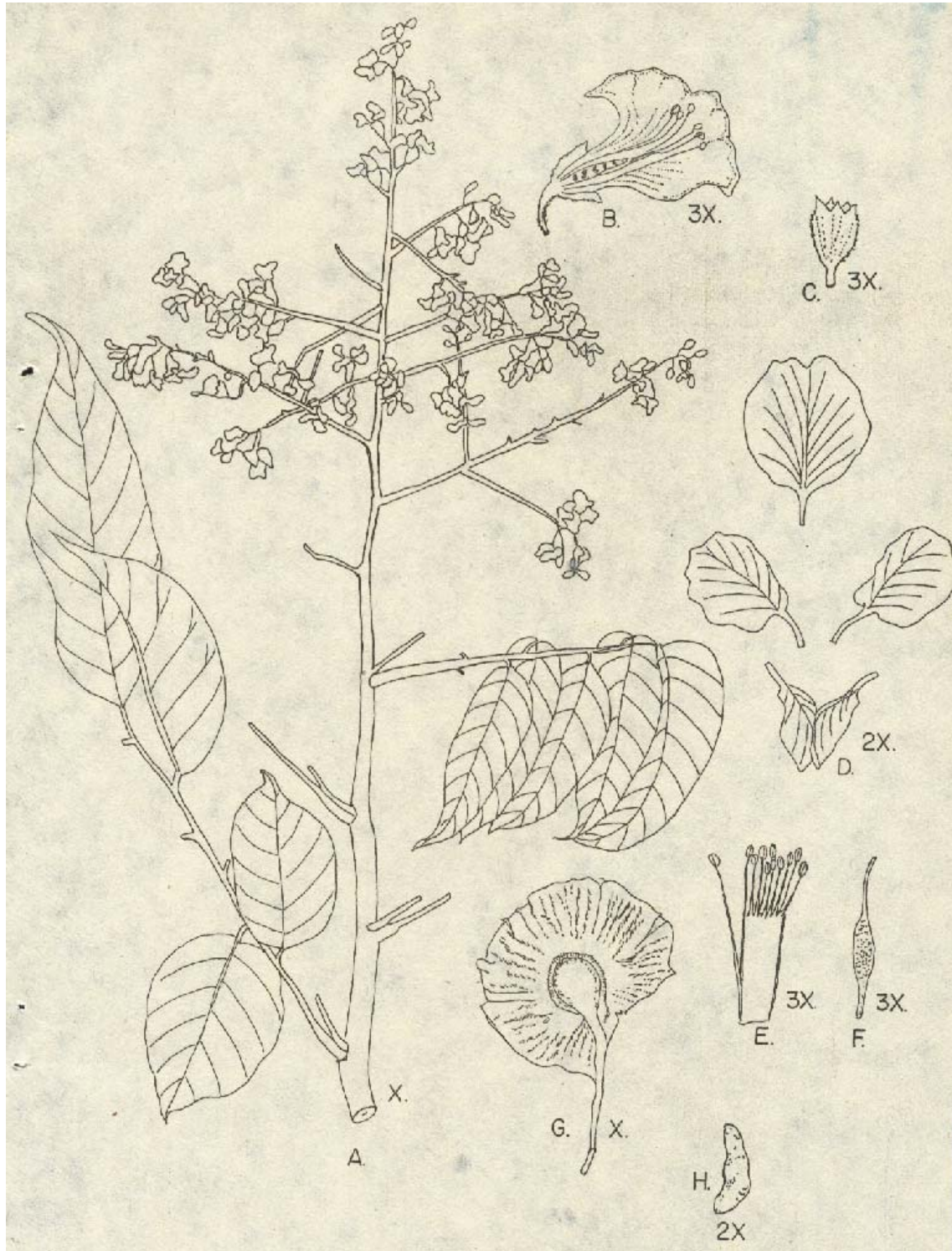


Figure (1) *Pterocarpus dalbergioides* Roxb.

- | | | | |
|----|--------------------------|----|---------|
| A. | Habit | E. | Stamens |
| B. | L.S. of flower | F. | Pistil |
| C. | Calyx | G. | Pod |
| D. | Standard, wings and keel | H. | Seed |



Figure (2) *Pterocarpus iondicus* Willd.

- | | |
|-----------------------------|------------|
| A. Habit | E. Stamens |
| B. L.S. of flower | F. Pistil |
| C. Calyx | G. Pod |
| D. Standard, wings and keel | H. Seed |



Figure (3) *Pterocarpus macrocarpus* Kurz.

- | | | | |
|----|--------------------------|----|---------|
| A. | Habit | E. | Stamens |
| B. | L.S. of flower | F. | Pistil |
| C. | Calyx | G. | Pod |
| D. | Standard, wings and keel | H. | Seed |

4. Variation Study of Six Provenances of Myanmar (*Pterocarpus macrocarpus* Kurz.)

4.1 Materials and Methods

Materials

Fruits (seeds) from six provenances; viz. Gangaw, Minbyin, Moeswe, Sinthawt, Taungdwingyi and Yamethin were used as materials for research. The location of the provenances were shown in Map (Figure 4) corresponding to the States and Divisions in Myanmar.

Methods

Collection of Fruits (seeds)

Fruits (seeds) from the above mentioned provenances and population of 5 to 10 trees from each were collected. Total number of trees collected was 50 as shown in Table (7).

Seed Testing

Collected fruits (seeds) were tested according to the international seed testing procedure. Firstly the fruits (seeds) were cleaned and dried before testing. (i) The fruits (seeds) were weighed for per unit weight in gram and volume measurement was also taken. (See Table 8).

(ii) Germination

The seeds were tested for germination giving three treatments namely: (a) Partial Scarification; (b) Presoaking in Water and (c) Control.

(a) Partial Scarification

Seeds were clipped open slightly with secateurs on opposite side of the micropylar end. The seeds were then sown in germination boxes containing only sand. The results of germination were recorded.

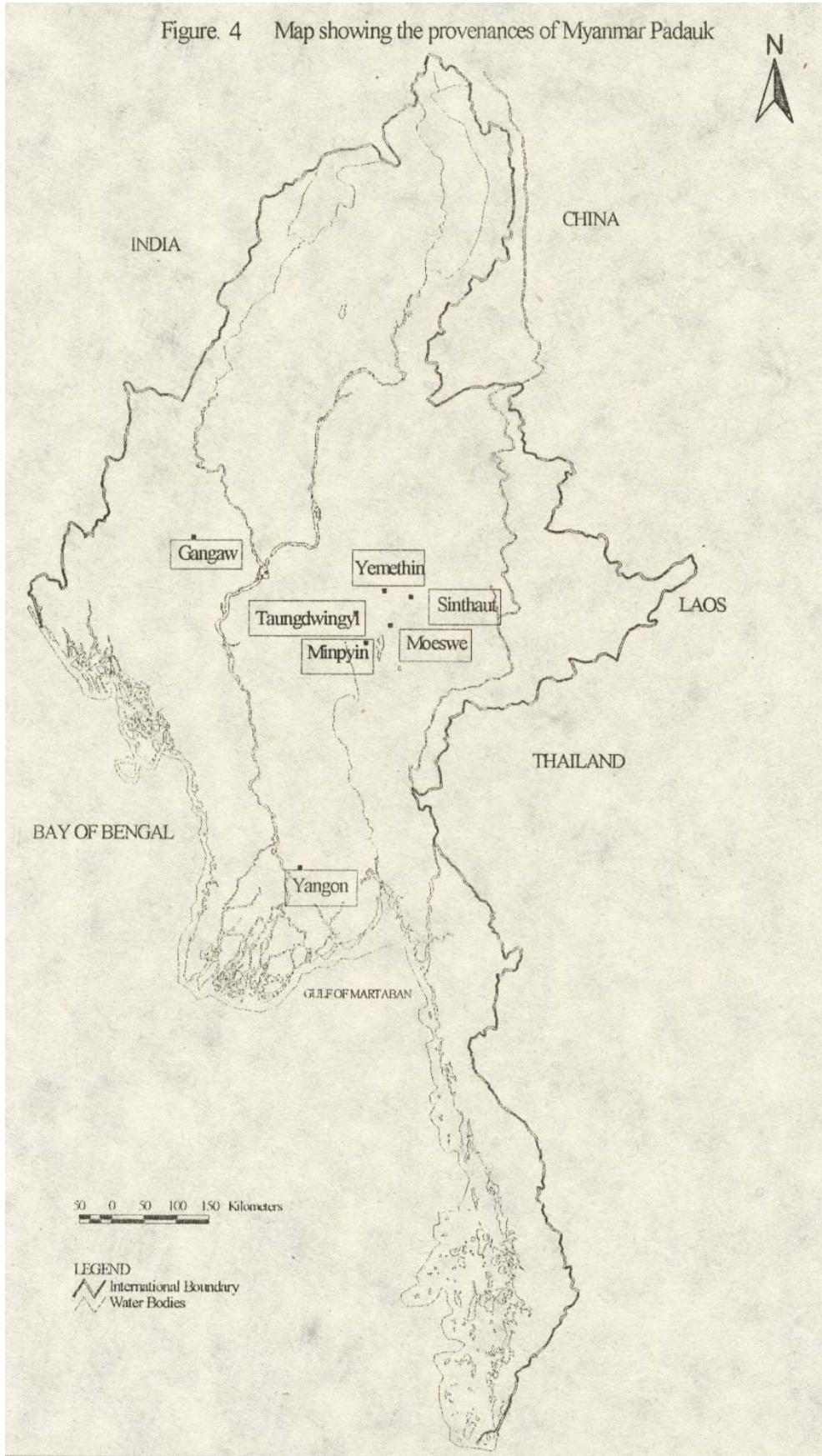
(b) Presoaking in Water

Seeds were presoaked in water for 24 hours and then sown in seed boxes containing sand. The results of germination were recorded.

(c) Control

The controlled seeds are sown in germination boxes containing sand only. The results were recorded.

Figure. 4 Map showing the provenances of Myanmar Padauk



(3) Transplanting of Seedlings

The germinated seedlings are transplanted into plastic bags of 18.5 cm x 7.5cm in size containing a mixture of sand, manure and compost in the ratio of 1: 2 : 6 respectively. The seedlings are transplanted at the stage when they have one pair of leaves.

Seedlings are placed in the nursery yard in a Randomized Complete Block Design (RCBD) and 4 times replicated with 25 seedlings in each replications.

(4) Height Growth Measurement

The height growth measurement was done after six months time for the performance of initial growth. The results are recorded and analysed using Duncan's New Multiple Range Test (DMRT).

4.2 Results and Discussion

The size and weights of seeds from all the six provenances were not much different from each other (See Table 8) except Sinthawt provenance which was slightly smaller in size.

The germination test results have shown some differences on observed values and through analysis of variance (See Table 10, 12 and 14 and Figure 5, 7 and 9). Moeswe provenance has had the highest germination rate in the partial scarification treatment followed by Gangaw, Minbyin, Taungdwingyi, Sinthawt and Yamethin provenances. The presoaked seeds from Moeswe and Sinthawt have had the highest rate of germination followed by Gangaw and others. Controlled seeds have shown almost the same rate as presoaked seeds. The higher rate of germination have shown by Moeswe and Sinthawt in presoaking and controlled might due to the range of distribution of the provenances. The presoaked treatment had produced slightly higher germination rate than the other two treatments. The lower rate of germination by partial scarification by clipping with secateur was found to be due to the fungus infection during experiment.

The controlled and scarified seeds continued to germinated until 30 days from the date of sowing, when the presoaked seeds went on to germinate a few days more. (See Table 9)

Minbyin provenance had the highest initial height growth under the partial scarification treatment, followed by Moeswe, Taungdwingyi and others; in presoaked treatment, Moeswe provenance had shown the highest height growth followed by Sinthawt, Gangaw and others; while in the control experiment, Moeswe provenance had led the Yamethin, Sinthawt and other provenances (See Table 11, 13 and 15 and Figure 6, 8 and 10). The best initial growth of seedling from Moeswe provenance might be due to distribution range of the species (i.e geographical, rainfall, temperature, etc.). Of all the provenances sampled Moeswe and Sinthawt lies in the eastern drier aspect of Bago Yoma and Gangaw, Taungdwingyi and Minbyin lies in the mid-western aspect. The Yamethin lies in north-eastern aspect and is much drier than the others. The differences in germination rate and seedling growth might be due to environmental factors such as rainfall, site, temperature, etc. The range of distribution of *Pterocarpus macrocarpus* in Myanmar is very wide because of that the other provenances around Myanmar need further tests.

The rate and quality of germination, and seedling growth can be used as helpful indicators in establishment of plantations. The seeds requirement for sowing to obtain seedling for an acre can be calculated. (See Table 16)

The timing to outplant the seedlings against the possible growth of up coming weeds in the field, and a better initial height growth of seedlings are vital requirements to achieve optimum result.

According to the research, Moeswe and Sinthawt can be taken as good provenances which can be used for plantation establishment and enrichment planting in their own geographical locations.

Further provenance study on Padauk will be beneficial for tree improvement and conservation of the species. The seedlings from the six provenances will be field tested and the survival rate will be determined later this year.

Table 7. Provenances of *P. macrocarpus* sampled in the study.

Provenances	°N Lat.	°E Long	No. of Trees	Forest Type	Annual Rainfall (mm)
Gangaw	22° 10'	94° 08'	10	DDF Dry	1196
Minbyin	NA	NA	10	MDF Dry	NA
Moeswe	19° 43'	96° 13'	10	MDF Dry	1401
Sinthawt	NA	NA	5	MDF Moist	NA
Taungdwingyi	NA	NA	10	MDF Dry	NA
Yamethin	20° 25'	96° 09'	5	MDF Dry	969

DDF = Dry dipterocarp forest; MDF = Mixed deciduous forest

NA = Information not available

Table 8. Number of seeds per unit weight (gm)

No.	Provenance	No. of seeds	No. of seeds per unit weight (gm)
1	Gangaw	100 x 4	4.9
2	Min byin	100 x 4	4.5
3	Moeswe	100 x 4	4.3
4	Sinthawt	100 x 4	6.2
5	Taungdwingyi	100 x 4	5.1
6	Yamethin	100 x 4	4.6

Table 9. Germination response of Padauk seeds from six provenances.

No.	Provenance	Treatment	No. of seed sown	No. of germinated 5 days after sowing	Total (Cumulative) germination							Total Germination percent
					Days							
					5	10	15	20	25	30	35	
1.	Gangaw	Partial scarification (Nursery)	100	4	12	26	32	30	36	41	-	41
	Minbyin		100	8	24	31	34	34	38	-	-	38
	Moeswe		100	7	12	24	32	42	42	49	-	49
	Sinthawt		100	5	14	20	21	23	23	25	-	25
	Taungdwingyi		100	8	13	22	27	30	35	-	-	35
	Yamethin		100	1	5	7	10	12	15	-	-	15
2.	Gangaw	Control (Nursery)	100	7	13	18	37	48	56	60	-	60
	Minbyin		100	8	15	26	31	31	34	47	-	47
	Moeswe		100	13	32	40	44	53	60	69	-	69
	Sinthawt		100	2	12	20	34	55	65	65	70	70
	Taungdwingyi		100	5	19	16	27	32	39	40	46	46
	Yamethin		100	3	15	24	36	36	43	58	-	58
3.	Gangaw	Soaking in water for 24 hours	100	9	17	30	48	55	58	61	73	73
	Minbyin		100	10	29	34	40	47	52	55	58	58
	Moeswe		100	28	37	54	70	82	84	90	95	95
	Sinthawt		100	9	29	46	58	77	85	85	95	95
	Taungdwingyi		100	5	16	24	34	42	45	50	56	56
	Yamethin		100	3	18	25	37	48	48	65	67	67

Table 10. Germination percent of presoaked *Pterocarpus macrocarpus* seeds from six provenances.

Provenance	Germination %
Gangaw	25.23 b
Minbyin	22.00 bc
Moeswe	29.16 a
Sinthawt	29.16 a
Taungdwingyi	21.82 bc
Yamethin	24.03 b
CV	12.15 %

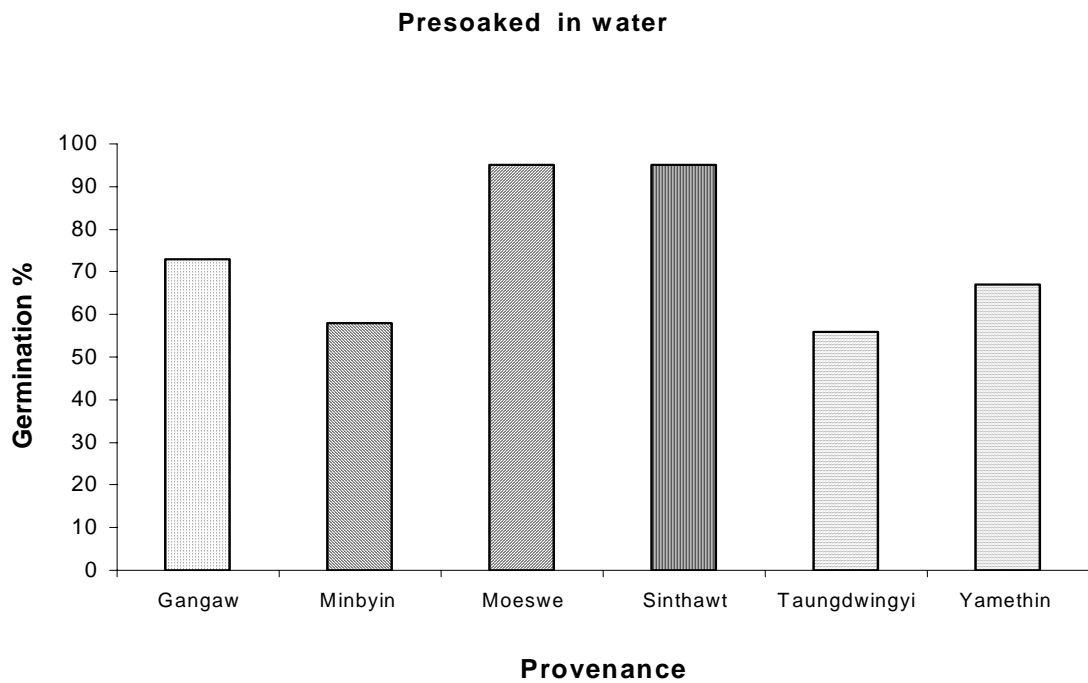


Figure 5. Germination percent of *Pterocarpus macrocarpus* from six provenances.

Table 11. Comparison of heights of seedlings germinated from presoaked seeds of *P. macrocarpus* from six provenances.

Provenance	Height in cm
Gangaw	30.41 ab
Minbyin	26.51 bc
Moeswe	37.51 a
Sinthawt	34.53 a
Taungdwingyi	26.87 bc
Yamethin	22.79 d
CV	9.09 %

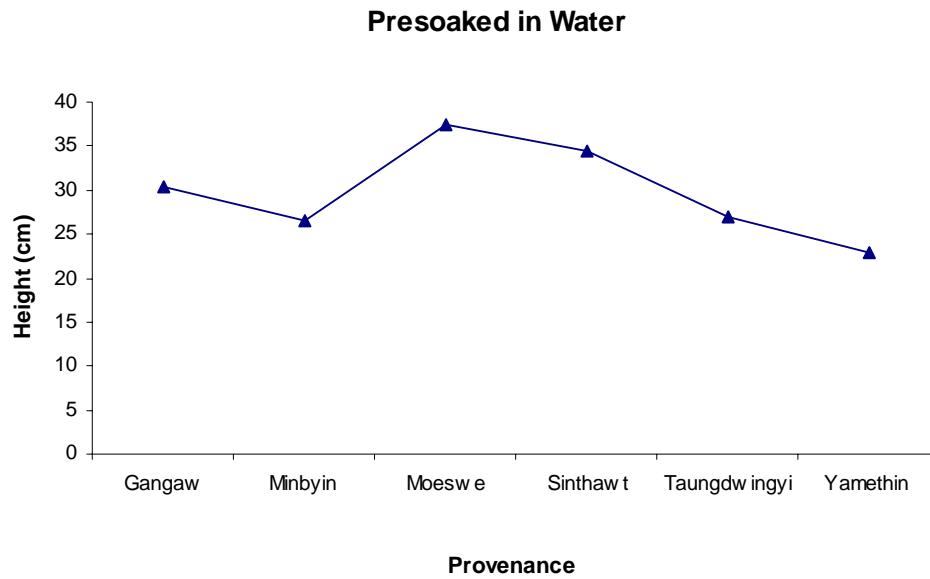


Figure 6. Comparison of seedling height of *Pterocarpus macrocarpus* from six provenances.

Table 12. Germination percent of the control of *Pterocarpus macrocarpus* from the six provenances.

Provenance	Germination %
Gangaw	22.67 ab
Minbyin	19.80 bc
Moeswe	24.23 a
Sinthawt	24.71 a
Taungdwingyi	19.71 bc
Yamethin	21.17 ab
CV	15.74 %

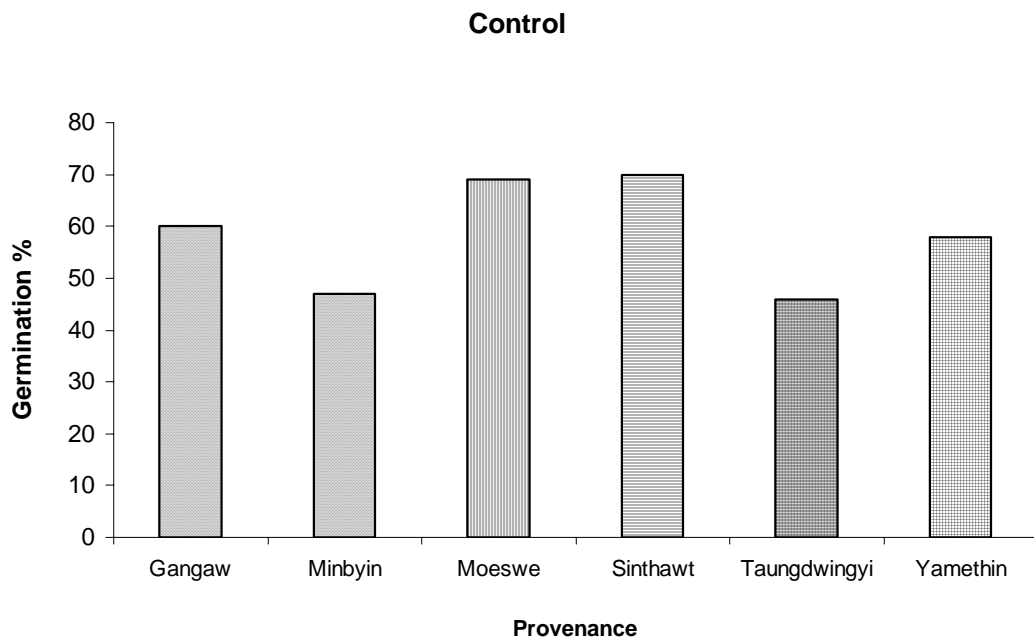


Figure 7. Germination percent of *Pterocarpus macrocarpus* from six provenances.

Table 13. Comparison of heights of seedlings germinated from control of *P. macrocarpus* from the six provenances

Provenance	Height in cm
Gangaw	17.31 d
Minbyin	18.83 bc
Moeswe	29.18 a
Sinthawt	24.07 ab
Taungdwingyi	18.72 bc
Yamethin	24.77 ab
CV	10.7 %

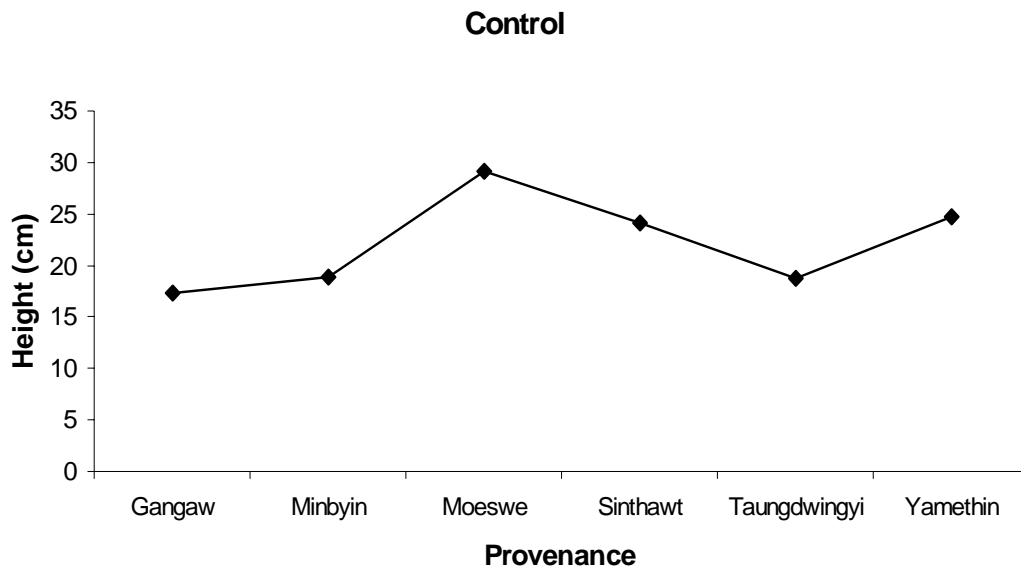


Figure 8. Comparison of seedling height of *Pterocarpus macrocarpus* from six provenances.

Table 14. Germination percent of seeds of *Pterocarpus macrocarpus* with partial scarification of six provenances.

Provenance	Germination %
Gangaw	18.58 b
Minbyin	17.85 bc
Moeswe	20.42 a
Sinthawt	14.45 c
Taungdwingyi	17.19 bc
Yamethin	11.11 d
CV	11.08 %

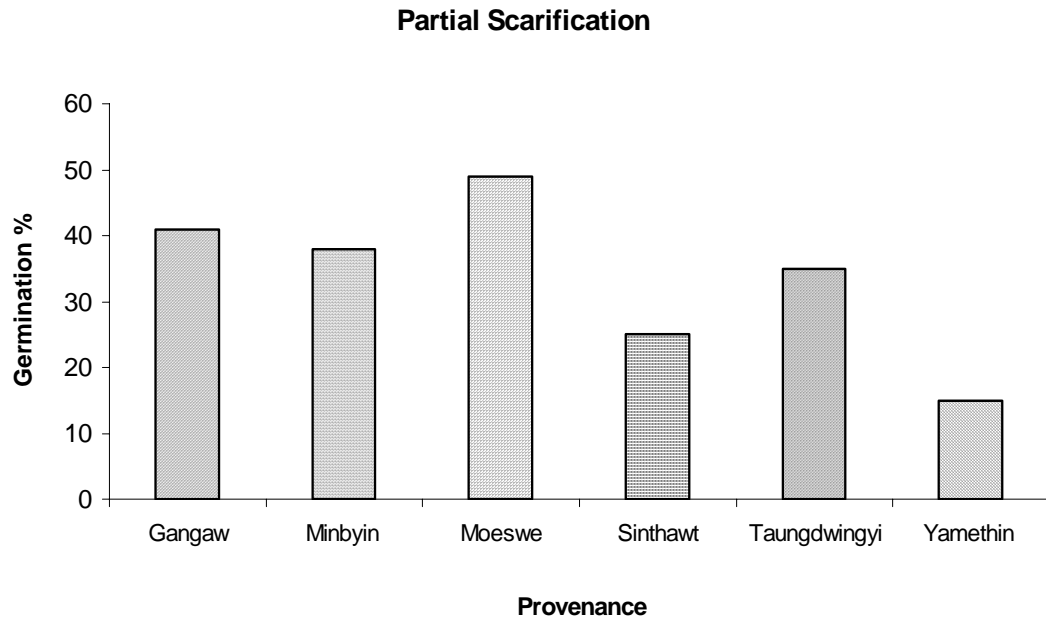


Figure 9. Germination percent of *Pterocarpus macrocarpus* from six provenances.

Table 15. Comparison of heights of seedlings germinated from pretreatment of Partial scarification from six provenances.

Provenance	Height in cm
Gangaw	18.31 bc
Minbyin	27.38 a
Moeswe	21.19 b
Sinthawt	11.73 d
Taungdwingyi	20.29 bc
Yamethin	13.52 cd
CV	16.8 %

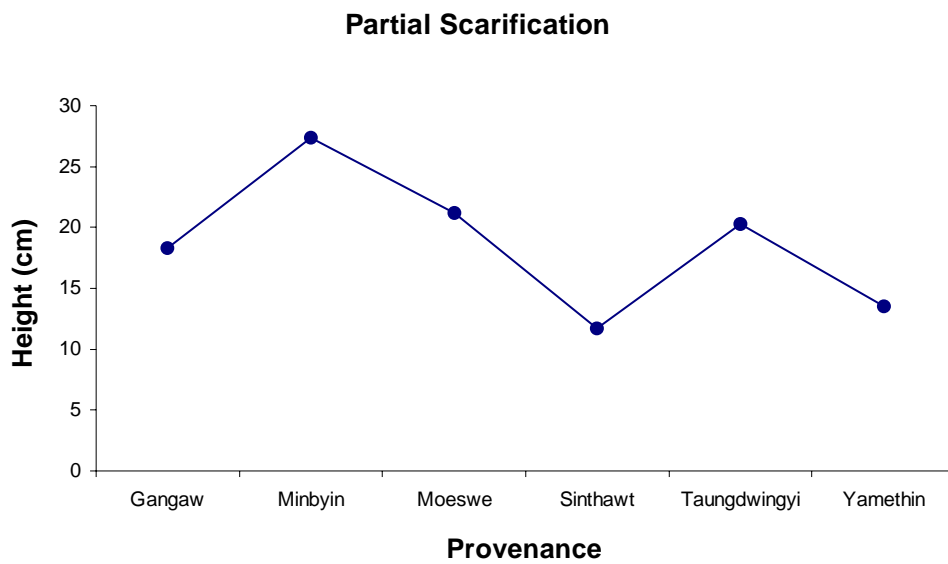


Figure 10. Comparison of seedling height of *Pterocarpus macrocarpus* from six provenances.

Table 16. The seed requirement for planting one acre at various spacing.

No.	Acre with spacing	Seedlings required	Seeds required to be sown with 50 % germination rate and including 10 % damage
1.	6' x 6'	1210	3000
2.	8 ½' x 8 ½'	600	1500
3.	9' x 9'	540	1350
4.	12' x 12'	300	750
5.	15' x 15'	200	500

Others Units (Myanmar)

1 tin contains 4400 seeds

8 tins= 1 pyi

Price of 1 tin of seeds = 600 Kyats

1 pyi contains ----- 213. 87 fruits

Extraction seeds from fruits mostly 1 seed from one fruit obtained.

1. The tin in Myanmar is a volume measurement of one condensed milk tin.
2. The pyi is original Myanmar volume measurement.

5. Conclusion

The research may be concluded as follows;

The first part of the research was carried out in order to find out the differences between the three species of the genus *Pterocarpus* recorded and found in Myanmar. The conclusion:

- (1) Due to the nature of distribution and occurrence, *P. macrocarpus* can be confirmed as the Myanmar Padauk, because the other two species are not found in the natural forest throughout Myanmar.
- (2) There are differences in taxonomical and dendrological characteristics between the three species of genus *Pterocarpus* found and recorded in Myanmar. I have develop a taxonoimical key to the species based on their differences.
- (3) Phenological characters such as time of flowering, size of leaves and leaf-shedding are also different. It is noted that the *P. indicus* shed leaves earliest in the year sometime around March and flowering started around April; the *P. macrocarpus* shed leaves around April when the leaf-buds started to form together with the flower buds. It is also observed that the flowering of *P. macrocarpus* prolonged late into September in the natural forest; the *P. dalbergioides* shed leaves in late May and flowered during June - September. The comparison was made in the same locality. The sizes of leaves were also different in that the *P. dalbergioides* leaves had smallest, the *P. indicus* had the biggest leaves and the *P. macrocarpus* had the medium sized leaves.

- (4) The branches of all three species had lenticel, which could be taken as one of the characteristics of the genus.
- (5) The *P. macrocarpus* had irregular bark pattern whereas the other two species had thin column-like sheets.

In the second part, six provenances of *P. macrocarpus* were tested for their initial growth performances. The results would be applied establishing plantations or in enrichment planting for species conservation. The conclusion:

- (1) The seeds of the six provenances sampled had shown not much differences in size with the exception of Sinthawt provenance which is slightly smaller.
- (2) The germination percent of Moeswe and Sinthawt provenances was higher than the others.
- (3) Moeswe and Sinthawt provenances had excelled in the rate of seedling growth.

Moeswe and Sinthawt provenances seedling growth were found the best among the six provenances.

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