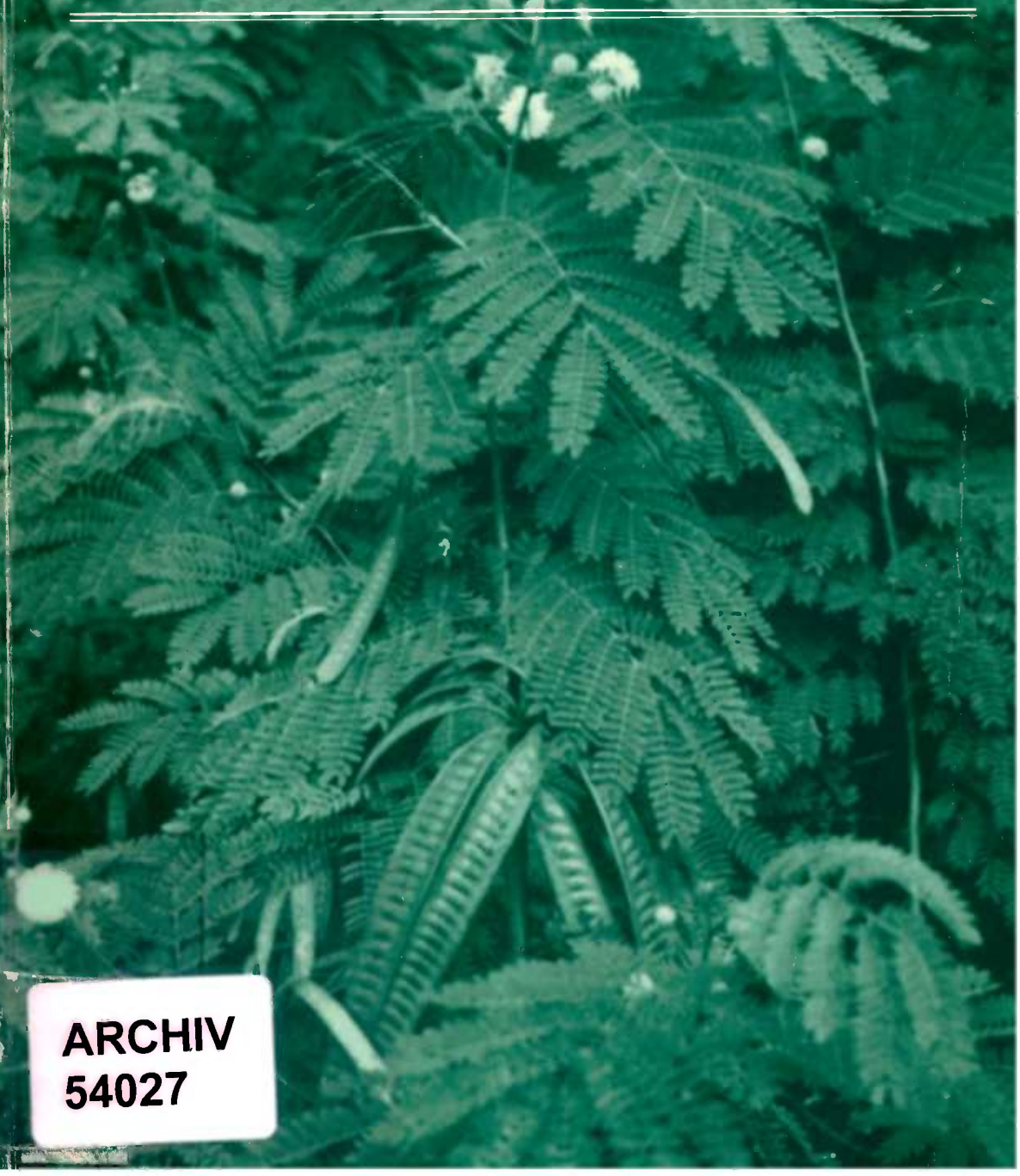
IDRC-21

Leucaena Research in the Asian-Pacific Region

Proceedings of a workshop held in Singapore, 23-26 November 1982



IDRC-211e Leucaena Research in the Asian-Pacific Region

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Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa, Canada

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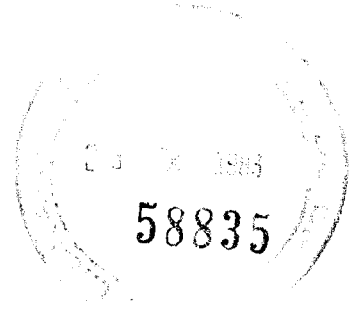

Leucaena Research in the Asian–Pacific Region

Proceedings of a Workshop Held in Singapore, 23–26 November 1982

Organized by the Nitrogen Fixing Tree Association and the International Development Research Centre

Abstract

Because of *Leucaena leucocephala*'s multiple uses as forage, fuelwood, poles, green manure, etc., this fast-growing, nitrogen-fixing tree has been the subject of much research in the last decade. The results have clarified the capabilities of the plant as well as its limitations. One main constraint to cultivation in vast areas of Latin America and Southeast Asia has been leucaena's inability to survive on acidic, aluminum-saturated soils. At low pH, the aluminum complexes with calcium, which is essential for good growth. Trials have shown that some varieties of *L. diversifolia* can make use of the calcium from the complexes and that crosses between these varieties and *L. leucocephala* perform well on acidic soils. The main constraint to use of leucaena as a forage derives from the plant's content of mimosine, a toxic, nonprotein amino acid. Although leucaena has proved to be a highly nutritious animal feed, the mimosine and its breakdown product, DHP (3-hydroxy-4[1H]pyridone), have caused toxicity among animals fed high levels of leaf meal. Scientists now have evidence that the mimosine is converted into DHP when brought into contact with an enzyme contained in some of the plant's cells harbouring mimosine. This finding needs follow up; it suggests that simple processing, such as chopping fresh leaves, will convert all the mimosine into the less-toxic DHP. Elsewhere, researchers have found that DHP can be metabolized by anaerobic microorganisms that have been found in the guts of ruminants in countries like Indonesia. They have successfully transferred the microorganisms to animals in Australia where toxicity from DHP has deterred graziers from using leucaena as forage. Other research has defined optimal approaches to breeding and genetic improvement of leucaena; characteristics of rhizobia that effectively provide the plant with nitrogen-fixing ability; biomass production under widely different soil conditions; effects on fish, poultry, cattle, goats, and sheep fed leucaena leaf meal; management and cultural practices for both large-scale and smallholder operations; etc. The results are the subject of this publication, which comprises 30 papers from researchers in the Asian–Pacific Region.

Résumé

Leucaena leucocephala a fait l'objet de nombreuses recherches au cours de la dernière décennie, cet arbre légumineux fixateur d'azote et de croissance rapide ayant de nombreux usages comme fourrage, combustible, poteau, engrais vert, etc. Ces études ont permis d'en délimiter les fonctions. L'un des facteurs limitants de sa culture dans de vastes régions de l'Amérique latine et de l'Asie du Sud-Est est l'incapacité de *Leucaena* de survivre dans des sols acides, saturés d'aluminium. Dans le cas d'un faible pH l'aluminium complexe le calcium, essentiel à une croissance régulière. Des essais ont démontré que certaines variétés de *L. diversifolia* peuvent utiliser le calcium présent dans les complexes et que les croisements entre ces variétés et *L. leucocephala* prospèrent dans des sols acides. Le principal obstacle à l'utilisation de *Leucaena* comme fourrage est sa teneur en mimosine, acide aminé non protéique toxique. Bien que ce fourrage soit hautement nutritif, la mimosine et DHP (3-hydroxy-4[1H]pyridone) ont provoqué des cas de toxicité chez les animaux consommant de grandes quantités de farine de feuilles. Les scientifiques ont découvert que la mimosine se décompose en DHP lorsqu'elle entre en contact avec une enzyme contenue dans certaines cellules où elle est présente. Cette découverte a permis de déterminer des moyens simples de neutraliser cette substance toxique, tel que le hachage des feuilles vertes qui décompose la mimosine en DHP moins toxique. Ailleurs, des chercheurs ont trouvé que le DHP peut être métabolisé par des microorganismes anaérobiques présents dans l'intestin des ruminants dans certains pays comme l'Indonésie. Ils ont réussi à transférer ces microorganismes à des animaux en Australie où les pasteurs refusent l'emploi du fourrage de *Leucaena* à cause de la toxicité de DHP. D'autres recherches préconisent une approche optimale: de la sélection et de l'amélioration génétique de *Leucaena*; des caractères des rhizobiums qui assurent la fonction de la fixation d'azote chez la plante-hôte; de la production de bio-masse dans diverses conditions de sols très variés; des effets des rations de farine de feuilles sur les poissons, les volailles, le bétail, les chèvres et les moutons; de la gestion et des pratiques culturales des

opérations des petites et des grandes exploitations, etc. Tous ces résultats sont détaillés dans la présente brochure qui contient trente communications exposées par des chercheurs de la région du Pacifique asiatique.

Resumen

Debido a los múltiples usos de la *Leucaena leucocephala* como forraje, combustible, madera, abono, etc., este árbol, de rápido crecimiento y habilidad para fijar el nitrógeno, ha sido objeto de abundante investigación en la última década. Los resultados han aclarado las capacidades de la planta, así como sus limitaciones. Uno de los problemas para su cultivo en vastas áreas de Latinoamérica y el Sudeste Asiático ha sido su incapacidad para sobrevivir en suelos ácidos, saturados de aluminio. A niveles bajos de pH, el aluminio forma complejos con el calcio que es esencial para un buen crecimiento. Las pruebas han mostrado que algunas variedades de *L. diversifolia* pueden usar el calcio de los complejos y que los cruces entre estas variedades y la *L. leucocephala* se desempeñan bien en suelos ácidos. El principal inconveniente para usar la leucaena como forraje proviene de su contenido de mimosina, un aminoácido tóxico no proteínico. Aunque la leucaena ha probado ser un alimento animal altamente nutritivo, la mimosina y su producto de descomposición, el DHP (3-hydroxy-4[1H]pyridone), han causado toxicidad entre los animales alimentados con altos niveles de harina de follaje. Los científicos tienen ahora evidencia de que la mimosina se convierte en DHP cuando entra en contacto con una enzima que se encuentra en algunas células de la planta que contienen mimosina. Este hallazgo necesita seguimiento, pero sugiere que un simple procesamiento, como picar las hojas frescas, convierte toda la mimosina en el menos tóxico DHP. En otras partes, los investigadores han encontrado que el DHP puede ser metabolizado por microorganismos anaeróbicos que han sido hallados en el intestino de rumiantes en países como Indonesia. Ellos han traspasado con éxito los microorganismos a animales en Australia donde la toxicidad del DHP ha impedido que los ganaderos empleen la leucaena como forraje. Otras investigaciones han definido los enfoques óptimos para el fitomejoramiento de la leucaena, las características de la rizobia que efectivamente dotará a la planta de la habilidad de fijar nitrógeno, la producción de biomasa bajo condiciones edáficas ampliamente distintas, los efectos sobre los peces, las aves, el ganado, las cabras y las ovejas alimentadas con harina de hoja de leucaena, las prácticas culturales y de manejo para las actividades a gran escala o del pequeño agricultor, etc. Los resultados son el tema de esta publicación que abarca 30 trabajos de investigadores en la región Asiopacífica.

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Growth Data from Sabah Softwoods Sdn Bhd Plantations of Some Fast-Growing Leguminous Trees[1]

Tan Kee Chong *Sabah Softwoods Sdn Bhd, Brumas, Sabah, Malaysia*

In 1974, Sabah Softwoods Sdn Bhd was created to manage a 6.0 × 10⁴ ha afforestation program; to date, it has planted 2.3 × 10⁴ ha, some of which include Albizia falcataria, Acacia mangium, *and* Leucaena leucocephala. *Data on height and diameter are being collected, and preliminary indications are that* A. falcataria, *planted at 600–900 stems/ha is sawlog class by age 8 years; that, at the same spacing,* A. mangium *has a mean annual increment in volume equal to 30 m³/ha; and that liming is essential in the soils of Sabah where* L. leucocephala *is grown but is regarded as uneconomic.*

C'est de 1974 que date la fondation de la Sabah Softwoods Sdn Bhd, en vue de mettre en oeuvre un programme de boisement de 6,0 × 10⁴ ha. Jusqu'à présent, on a effectué la plantation de 2,3 × 10⁴ ha, en partie avec Albizia falcataria, Acacia mangium *et* Leucaena leucocephala. *On s'occupe à relever les hauteurs et les diamètres obtenus et les premiers résultats indiquent que* A. falcataria *planté à raison de 600 à 900 pieds/ha atteint les dimensions de sciage dès l'âge de 8 ans ; qu'à la même densité,* A. mangium *produit une augmentation volumétrique annuelle équivalente à 30 m³/ha ; et que le chaulage est essentiel dans les sols du Sabah, où l'on cultive* L. leucocephala, *que l'on considère comme non économique.*

En 1974 se creó Sabah Softwoods Sdn Bhd para administrar un programa de forestación de 6,0 × 10⁴ ha. Hasta hoy día se han plantado 2,3 × 10⁴ ha, algunas de las cuales incluyen Albizia falcataria, Acacia mangium *y* Leucaena leucocephala. *Los datos de la altura y diámetro están siendo recogidos, y las indicaciones preliminares son que la* A. falcataria, *plantada a 600–900 troncos/ha es del tipo aserradero hacia los 8 años, y que al mismo espaciamiento la* A. mangium *tiene un incremento promedio anual en volumen de 30 m³/ha, y que la cal es esencial en los suelos de Sabah donde se siembra* L. leucocephala *pero se la considera no económica.*

Sabah Softwoods Sdn Bhd is a joint venture between Sabah Foundation and North Borneo Timber Company formed in 1974 for a 6.0 × 10^4 ha afforestation program. Up to mid-1982, 2.3 × 10^4 ha had been planted, mainly with fast-growing hardwoods, and there were 2.8 × 10^3 ha planted with agricultural crops (cocoa, oil palm, coffee, etc.).

Permanent sample plots (PSPs) have been established in every 250-ha block. A pair of 0.5-ha plots is measured annually: diameter, breast height (DBH) for all trees and the top height of the largest-diameter 100 trees/ha are recorded. A total 7.3 × 10^3 ha of *Albizia falcataria* have been planted, but only relatively small areas of *Acacia mangium*, on poor sites, and *Leucaena leucocephala* have been planted.

A. falcataria

Data on *A. falcataria* are available from 10 PSPs about 7 years old, and inventory figures

Table 1. Volume growth (MAI) of three *A. falcataria* plantations.

Height class[a] (m)	PSPs	Age (months) 36 (m^3/ha[b])	48 (m^3/ha)	60 (m^3/ha)	72 (m^3/ha)	81 (m^3/ha)
5.5	3	28	41	51	48	49
5.0	4	16	28	37	41	42
4.5	3	15	25	32	36	35

[a] MAI of 100 trees with the largest diameters at 60 months.
[b] MAI = volume to 7 cm diameter.

[1] The data in this paper were assembled by T.J. Wormald, research consultant to the company, as an update to data quoted in Tan and Jones (1982).

Table 2. Proportion and volume of *A. falcataria* height classes per hectare at 5 years (to 7 cm diameter).

Height class (m)	Proportion of crop (%)	MAI (m^3/ha)	Actual volume (m^3/ha)
6.5	6	65	2.7
6.0	11	60	5.0
5.5	22	50	9.9
5.0	31	42	14.0
4.5	27	34	12.1
3.5	3	21	1.3

Table 3. *A. mangium* growth data.

Age (months)	Density (trees/ha)	Mean DBH (cm)	Mean height of 100 largest-diameter trees (m)	Volume (m^3/ha)
28	1330	9.7	11.4	—
34	1040	11.6	13.5	—
42	1020	13.3	17.2	—
48	990	14.4	19.0	110
60	880	16.0	21.6	145

exist for three 5-year-old plantations (Table 1). The stocking of the plantations varies between 600 and 900 stems/ha, and the effect of this spacing has yet to be ascertained. Mean annual increment (MAI) is culminating between 60 and 80 months and will range from 30 m^3/ha to 50 m^3/ha, depending on the site.

Inventories of the 1975–77 plantations cover a range of height classes (Table 2), with MAI volume being 45 m^3/ha at 5 years.

An estimated 30% of the crop will be sawlog class (25 cm DBH) at 8 years — the economic rotation age in unthinned stands. The time could be reduced by early thinning.

A. mangium

The growth data (Table 3) for *A. mangium* have been taken from two PSPs. As individual tree measurements include some forked trees, the number of stems/hectare is greater than for *A. falcataria*, although the original spacing was the same. Sabah Softwoods is anticipating a mean annual increment in volume of 30 m^3/ha.

Table 4. *L. leucocephala* growth data.

Age (months)	Mean DBH (cm)	Mean height for 100 largest-diameter trees (m)
15	4.2	5.8
24	5.5	7.1
36	5.7	8.6

L. leucocephala

K28 is the leucaena cultivar being tested by Sabah Softwoods, but the soils are pH 4.5–5.0 — too acidic to support good growth. Liming has been considered by the company but does not appear to be an economic proposition. Growth data have been collected for 3 years (Table 4).