



UNIVERSITI PUTRA MALAYSIA

**GROWTH HABIT AND PERFORMANCE OF ACACIA MANGIUM AND
ACACIA AURICULIFORMIS GENOTYPES**

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By

AHMED MOHAMED ADAM ELDOMA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
fulfilment of the requirement for the degree of Doctor of Philosophy**

January 2003



This work is dedicated to the resting souls of my late beloved father and mother who showed me the way to life in its best.



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Acacia mangium Willd. and *Acacia auriculiformis* A. Cunn. ex. Benth. are two of the four fast-growing tropical acacias which have received the highest priority for genetic assessment and improvement. Even though *A. mangium* was proposed for timber production in a short rotation but experience has shown that it is impeded by its susceptibility to heart rot, the multiple leaders (ML) formation, and the tendency of growth to break off just short of the target of the desired size for sawn timber production. However, the present work investigated the ML formation, its causes and variation and concurrently assessed growth performance and examined the patterns of shoot growth and some physiological traits of eight selected *A. mangium* and *A. auriculiformis* genotypes through establishment of a field trial and three related glasshouse experiments.

The field trial was a randomized complete block design with four replications utilizing eight genotypes four each of the two species at two sites (burnt and unburned). Results at 23 months showed significant differences ($P < 0.001$) between sites for the number of ML trees/plot, basal diameter, and survival but not for height and between genotypes for ML trees/plot, basal diameter ($P < 0.001$), height ($P < 0.01$) and survival ($P < 0.05$). The site \times genotype interaction was significant ($P < 0.001$) only for ML trees/plot.

At the burnt site the number of ML trees/plot was significantly bigger than the unburned and *A. mangium* provenances were found to be more responsive to burning than *A. auriculiformis*. At the unburned site the variation between them was not significant. Height and basal diameter ranking of the genotypes tend to change drastically with time. Initially *A. auriculiformis* out-performed but with time, *A. mangium* superceded the former for both traits. The study of shoot growth patterns and form further confirmed the effect of site preparation on tree form. There was a significant difference between sites for the number of branches, crown diameter, crown length, stem form and clear bole length. The genotypes also showed significant differences in number of branches, crown length and stem form but not for crown diameter or clear bole length.

ML formation could not be induced using different ash and NPK treatments in combination with drought in the glasshouse. However, the effect of the various treatments varied between the genotypes. NPK resulted in the best growth for all traits examined than ash. *A. auriculiformis* provenances survived well while *A. mangium* failed to survive in the ash. Watering to field capacity (FC) enhanced growth while drought (30-

60%) FC affected growth of all genotypes adversely. The use of different levels of P and K did not induce ML but the genotypes showed considerable variation between them in some of the growth characteristics studied. However, growth increased with increasing level of fertilization.

The use of 6-benzylaminopurine (BAP) as a foliar spray and decapitation could not stimulate ML formation. However, both treatments significantly reduced height, clear bole length, leaf area and total dry weight and increased the number of branches. However basal diameter was significantly reduced by BAP but not affected by decapitation.

The effects of BAP increased consistently with increasing level of application. BAP at 1500 mg/L resulted in mortality of *A. mangium* provenances while *A. auriculiformis* provenances survived and grew normally. Some of the BAP treated plants developed juvenile pinnate leaves while the decapitated and the untreated controls did not. BAP also caused clustering of branches at the middle nodes with mainly narrow angles. Decapitation of the apical bud resulted in the activation of the lateral bud immediately below the point of decapitation that assumed dominance over the rest of the lateral branches by substituting the decapitated apical leader. The results were discussed on the basis of ML formation in relation to apical dominance as affected by site preparation method by burning and its implications on policy formulations and plantation management strategies for these two acacia species.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**TABIAT DAN PERTUMBUHAN DALAM GENOTIP *ACACIA MANGIUM* DAN
*ACACIA AURICULIFORMIS***

Oleh

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Januari 2003

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Acacia mangium Willd. dan *Acacia auriculiformis* A. Cunn. ex. Benth. merupakan dua daripada empat spesis akasia tropika yang cepat tumbesaran dan telah mendapat tumpuan utama dalam kerja pembaikbakaan dan penilaian genetik. Walaupun *A. mangium* telah dicadangkan untuk penghasilan kayu balak dalam jangkamasa tebang yang singkat tetapi pengalaman pengurusan menunjukkan bahawa pembangunan spesis ini terbantut untuk tujuan tersebut. Ini disebabkan oleh jangkitan reput teras, pembentukan pelbagai cabang utama (ML) dan tidak berkeupayaan mencapai saiz sasaran untuk kayu bergergaji. Jesteru itu, penyelidikan ini mengkaji pembentukan, punca dan variasi ML di samping menilai prestasi tumbesaran dan meneliti corak pertumbuhan pucuk serta sifat fisiologi ke atas lapan genotip *A. mangium* dan *A. auriculiformis* melalui penubuhan ujian lapangan dan tiga ujikaji rumah kaca.

Satu ujian lapangan telah ditubuhkan menggunakan rekabentuk blok rawak penuh dengan empat replikasi menggunakan lapan genotip setiap spesis di dua keadaan kawasan (tidak dibakar dan dibakar). Keputusan kajian berumur 23 bulan untuk bilangan

pokok pelbagai cabang utama (ML)/plot, diameter pada dasar dan kemandirian kecuali ketinggian telah menunjukkan perbezaan bererti ($p < 0.001$) di antara keadaan kawasan. Keputusan kajian antara genotip pula menunjukkan perbezaan bererti bagi pokok ML/plot, diameter pada dasar ($p < 0.001$), ketinggian ($p < 0.01$) dan kemandirian ($p < 0.05$). Interaksi di antara kawasan dan genotip juga adalah bererti pada $p < 0.001$ bagi pokok ML/plot sahaja. Perbezaan yang bererti bagi bilangan pokok ML/plot adalah lebih besar di kawasan dibakar berbanding kawasan tidak dibakar dan provenan *A. mangium* didapati lebih cenderung terhadap pembakaran berbanding *A. auriculiformis*. Variasi di antara kedua-dua spesis ini tidak begitu di kawasan yang tidak dibakar. Kedudukan (rank) ketinggian dan diameter pada dasar berubah secara drastik dengan perubahan masa bagi genotip tersebut. Pada awalnya, *A. auriculiformis* menunjukkan prestasi yang lebih baik bagi kedua-dua ciri tersebut tetapi dengan perubahan masa, prestasi yang lebih baik ditunjukkan oleh *A. mangium*. Kesan penyediaan kawasan ke atas bentuk pokok telah dipastikan melalui kajian corak pertumbuhan pucuk dan bentuk batang. Terdapat perbezaan bererti di antara kawasan bagi bilangan dahan, diameter silara, panjang silara, bentuk batang dan panjang batang nyata. Genotip juga menunjukkan variasi yang bermakna dalam bilangan dahan, panjang silara dan bentuk batang tetapi tidak pada diameter silara dan panjang batang nyata.

Rawatan abu, rawatan NPK serta kesan kemarau dalam ujikaji rumah kaca didapati tidak merangsangkan pembentukan ML. Bagaimanapun, pelbagai rawatan didapati memberi kesan yang berbeza-beza di antara genotip. Rawatan NPK menghasilkan keputusan pertumbuhan yang baik bagi semua ciri yang dikaji berbanding rawatan abu. Penyiraman ke tahap kapasiti lapangan (FC) telah dapat meningkatkan tumbesaran manakala kemarau (30 – 60%) FC menunjukkan kesan sebaliknya bagi semua genotip.

Penggunaan kepekatan P dan K yang berbeza tidak menggalakan pembentukan ML tetapi memberi kesan yang berbeza untuk ciri tumbesaran yang dikaji. Walau bagaimanapun, tumbesaran meningkat dengan peningkatan paras pembajaan.

Penggunaan 6-benzylaminopurine (BAP) secara semburan daun dan kaedah pemangkasan juga tidak dapat merangsang pembentukan ML. Juga didapati, kedua-dua rawatan ini telah mengurangkan ketinggian, panjang batang, luas daun dan jumlah berat kering dengan nyata kecuali bilangan dahan. BAP juga memberi kesan penurunan yang bererti kepada diameter dasar tetapi tidak pada pemangkasan. Kesan-kesan rawatan BAP meningkat secara setara dengan peningkatan kepekatan. Pada kepekatan 1500 mg/L BAP telah menyebabkan kematian bagi provenan *A. mangium* manakala provenan *A. auriculiformis* tumbuh secara normal. Beberapa pokok yang dirawat dengan BAP juga menghasilkan daun pinat muda berbanding pokok yang telah dirawat secara pemangkasan dan tanpa rawatan. BAP juga menghasilkan kelompok dahan bersudut kecil di kawasan tengah batang. Pemangkasan kudup apikal menyebabkan rangsangan pembentukan kudup sisi di bahagian bawah poin pemangkasan dengan mengandaikan keunggulan daripada dahan-dahan sisi dan menggantikan batang utama yang dipangkas. Keputusan kajian ini membincangkan asas pembentukan ML yang berkaitan dengan kedominan apikal yang mana dipengaruhi oleh kaedah penyediaan kawasan secara pembakaran serta implikasinya terhadap perumusan polisi dan strategi-strategi pengurusan perladangan bagi kedua-dua spesis akasia ini.

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I certify that an Examination Committee met on 17th January 2003 to conduct the final examination of Ahmed Mohamed Adam Eldoma on his Doctor of Philosophy thesis entitled "Growth Habit and Performance of *Acacia mangium* and *Acacia auriculiformis* Genotypes" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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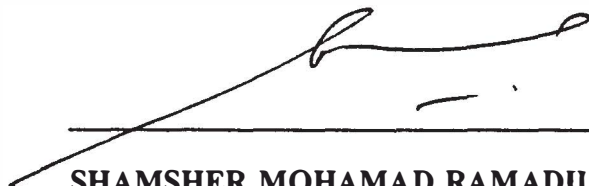
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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been dully acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



AHMED MOHAMED ADAM ELDOMA

Date: *17th Feb. 2003*

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