# Compatible rhizobia and nitrogen requirements for early growth of *Acacia mangium* on Melville Island, northern Australia

**This thesis is submitted for the degree of**

## Master of Philosophy


**By**

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## Declaration

I declare that this thesis is my own original piece of work, does not contain the work of another individual excepting where acknowledged. My research content has not been submitted for a degree at any tertiary education institution.

Contributions including professional advice and help with data collection from others are detailed in the acknowledgments.

DANG Thanh Tan
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# Abstract

*Acacia mangium* is widely planted in tropical parts of SE Asian for reforestation, timber and pulpwood. Plantation has recently been established on Melville Island and early growth and tree form are below commercial expectations. Although *A. mangium* is a N-fixing tree, seedlings are not inoculated with rhizobia and a small amount of inorganic N fertilizer is applied at planting. This thesis explores compatible rhizobia for *A. mangium* and determines the extent to which N may be limiting establishment and early growth of *A. mangium* on Melville Island.

To determine whether there are bacteria in the western soil management (WSM) collection at Murdoch University capable of forming functional nodules on *A. mangium*, a glasshouse trial was undertaken with six isolates. These cultures had been isolated from nodules on roots of *A. acuminate* and were associated with a positive effect on growth. The results showed that strain WSM 2248 also had a positive effected on growth of *A. mangium*, it increased shoot and root dried weight over negative control ones by 524% and 234%, respectively. However, there were a few of chloric seedlings still present. This strain, therefore, might be not the most effective one, and could easily be replaced by indigenous rhizobia in plantations.

The diversity and ability of indigenous rhizobia on Melville Island to colonize and promote growth of *A. mangium* were unknown. Therefore, 20 soil samples were taken from different site types on Melville Island including native forest and *A. crassicarpa*, *A. auriculiformis* and *A. mangium* plantations. A pot trial was undertaken in the glasshouse using *A. mangium* as a baiting plant. 257 isolates were obtained including both fast- and slow-growing rhizobia. They were confirmed by using the *nif*-directed primer RPO1. The fingerprinting PCR of the isolates showed a high diversity of different banding patterns. Surprisingly, root nodule bacteria might be absent in Shark Bay site, while other sites presented variety of rhizobia.

To determine whether inoculation with compatible *Bradyrhizobium* strain was desirable for improving the N status of trees in the field after outplanting, seeds were inoculated in the nursery with two strains *Bradyrhizobium* selected from previous glasshouse trails (from treatments 11 and 18). These seedings were planted in two separate field trials on Melville Island. There was no benefit of inoculation in the nursery and indeed, growth of inoculated seedlings was inferior to that of no-inoculated seedlings supplied with inorganic N. Contamination of the control seedlings bench in the nursery would have seriously comprised the field experiments. Therefore, they were of little use in addressing the question posed in the

introduction. It remains unclear whether inoculation with compatible *Bradyrhizobium* strains in the nursery can benefit the N status of trees in the field after outplanting.

*Acacia mangium* plantations on Melville Island are still in the first rotation and unpublished observations (stunted trees, poor form, and some leaf discolouration) suggest that the trees are not adequately provided with nutrients. Given the sandy texture of the soils it is likely that N is a limiting factor and only a small amount of N is applied in the fertilizer mix at planting. The project compared six nitrogen fertilizer rates at three sites with different soil types: N0, N15 (15g N per tree) N30, N45, N60, and N75 combining basal fertilizer. There were also two controls treatments; nil fertilizer and the current commercial operational fertilizer regime (routine treatment) used on the island. The trials were designed randomised complete block design was used consisting of 3 blocks, each with 8 treatment plots. Each plot contained 48 (6 x 8) seedlings at 4 x 2.5 m spacing. The results confirmed that in first year, trees reach optimal growth at rate of 15 g nitrogen fertilizer per seedlings in combination with mixture of micro- and macro-nutrients (g), 72 K, 218 P and 83.3 micro-nutrient fertilizers. Foliar analysis revealed that it was likely micronutrients, especially B, Cu and Zn, were limiting at some sites and that the micronutrient content of the basal fertilizer reduced these limiting factors.

From this project it is obvious that there are need for further evaluation the operational fertilizer prescriptions for *A. mangium* plantations. Due to the short duration of the trial it is not as yet known if improved micronutrient status would result in improved form of *A. mangium* on Melville Island. Therefore, further studies addressing a range of essential element requirement should be undertaken for *A. Mangium* on Melville Island.

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# Table of Contents