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Genetic diversity of symbiotic *Bradyrhizobium elkanii* populations recovered from inoculated and non-inoculated *Acacia mangium* field trials in Brazil

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ABSTRACT

Acacia mangium is a legume tree native to Australasia. Since the eighties, it has been introduced into many tropical countries, especially in a context of industrial plantations. Many field trials have been set up to test the effects of controlled inoculation with selected symbiotic bacteria versus natural colonization with indigenous strains. In the introduction areas, *A. mangium* trees spontaneously nodulate with local and often ineffective bacteria. When inoculated, the persistence of inoculants and possible genetic recombination with local strains remain to be explored. The aim of this study was to describe the genetic diversity of bacteria spontaneously nodulating *A. mangium* in Brazil and to evaluate the persistence of selected strains used as inoculants. Three different sites, several hundred kilometers apart, were studied, with inoculated and non-inoculated plots in two of them. Seventy-nine strains were isolated from nodules and sequenced on three housekeeping genes (*glnII*, *dnaK* and *recA*) and one symbiotic gene (*nodA*). All but one of the strains belonged to the *Bradyrhizobium elkanii* species. A single case of housekeeping gene transfer was detected among the 79 strains, suggesting an extremely low rate of recombination within *B. elkanii*, whereas the nodulation gene *nodA* was found to be frequently transferred. The fate of the inoculant strains varied depending on the site, with a complete disappearance in one case, and persistence in another. We compared our results with the sister species *Bradyrhizobium japonicum*, both in terms of population genetics and inoculant strain destiny.

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1. Introduction

Acacia mangium is a leguminous tree native to northern Australia, Papua New Guinea and Indonesia. It is naturally found in tropical rainforests with a mean rainfall ranging from 1500 to 3000 mm per year. *A. mangium* has been planted widely in the tropics since the early 1980s, first in Indonesia and Malaysia for pulp production, but also for revegetation and rehabilitation purposes. Its main qualities are rapid early growth, good wood quality and its tolerance to different soil pH and composition. In 1998, Turnbull et al. [60] estimated the area planted to *A. mangium* in Asia at 600,000 ha. *A. mangium* belongs to the Mimosoideae tribe, and has the ability to form nitrogen fixing symbiosis with soil bacte-

ria collectively known as rhizobia. It has been found associated with various *Bradyrhizobium* strains in different countries and continents [23,50,55,66], and recently Le Roux et al. [22] suggested that *A. mangium* is preferentially nodulated by *Bradyrhizobium elkanii* species. It has also been found associated, albeit much less frequently, with other species, such as *Rhizobium* sp. [14,65], *Mesorhizobium* sp. [11], and *Ochrobactrum* sp. [39]. In South America, *A. mangium* has been introduced in several countries (Brazil, Colombia, Costa Rica, etc.), and two previous studies identified some isolates nodulating *A. mangium* in Brazil, such as *Bradyrhizobium* sp. [35,36].

Inoculating plants with efficient nitrogen-fixing bacteria is an environment-friendly way of improving the economic and natural growth of legumes, especially in poor or degraded soils. In *A. mangium*, regardless of the symbiotic rhizobial selected, inoculation improves survival in the field by 10% [28]. Galiana et al. [15] reviewed several inoculation field trials in different countries. They showed that inoculation had a positive effect on *A. mangium*

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