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ÍNDICES E RELAÇÕES ECOLÓGICAS DE ARTRÓPODOS NAS FACES ABAXIAL E ADAXIAL DE FOLHAS DE *Acacia mangium* (FABALES: FABACEAE)

DIAMANTINA - MG

2021

GLEISIANY NUNES GOMES

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Dissertação apresentada ao Curso de Pós-Graduação *Stricto Sensu* em Produção Vegetal da Universidade Federal dos Vales do Jequitinhonha e Mucuri, como parte das exigências do Programa de Pós-Graduação em Produção Vegetal, área de concentração Produção vegetal, para obtenção do título de "Mestra".

Orientador
Prof. Dr. Germano Leão Demolin Leite
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RESUMO

GOMES, Gleisiany Nunes. Diamantina **ÍNDICES E RELAÇÕES ECOLÓGICAS DE ARTRÓPODOS NAS FACES ABAXIAL E ADAXIAL DE FOLHAS DE *ACACIA MANGIUM* (FABALES: FABACEAE)** 2021. 46 p. (Dissertação - Mestrado em Produção Vegetal) - Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, 2021.

Acacia mangium Willd. (Fabaceae) é uma planta exótica, de rápido crescimento e com potencial nitrificador, o que pode favorecer a sucessão vegetal e, assim, auxiliar no processo de recuperação de áreas degradadas. Além disso, essa planta foi indicada como uma estratégia viável para amenizar o efeito estufa global. Os insetos podem ter preferência por atacar diferentes partes da planta ou das folhas (faces adaxial e abaxial). Geralmente, insetos sugadores tendem a preferir a face abaxial das folhas, devido a características como tecido mais macio, epiderme fina, e com nervuras mais espessas, além de servir como proteção contra inimigos naturais e fatores climáticos. Nesse contexto, os objetivos deste trabalho foram avaliar durante 24 meses em uma área degradada, a distribuição espacial (aleatório, agregado ou regular) e os índices ecológicos (abundância, diversidade e riqueza de espécies) em função das faces das folhas (adaxial e abaxial), as interações entre os grupos de artrópodes e a dominância K em plantas de *A. mangium*. O delineamento utilizado foi inteiramente casualizado com dois tratamentos (folhas adaxial e abaxial) e 24 repetições (árvores). Os artrópodos constantes (> 50% nas amostras) foram Araneidae (Araneae), os himenópteros *Camponotus* sp., *Pheidole* sp. e *Pseudomyrmex termitarius* Smith (Formicidae) e *Trigona spinipes* Fabricius (Apidae) e Dolichopodidae (Diptera). O inseto mais frequente (14,54%) foi *Brachymyrmex* sp. (Hymenoptera: Formicidae). As maiores dominâncias-k de insetos fitófagos nas faces adaxial e abaxial foram os hemípteros *Aethalium reticulatum* L. (Aethalionidae) e *Bemisia* sp. (Aleyrodidae), dos inimigos naturais, *Brachymyrmex* sp. e *Camponotus* sp., respectivamente, e de abelhas *T. spinipes*, em ambas as faces foliares. Os insetos fitófagos os hemípteros *A. reticulatum*, *Balclutha hebe* Kirkaldy (Cicadellidae) e Membracidae, *Euxesta* sp. (Diptera: Otittidae), e os ortópteros Tettigoniidae e *Tropidacris collaris* (Stoll) (Romaleidae); as abelhas polinizadoras *Apis mellifera* L., *Tetragonisca angustula* Latreille e *T. spinipes* (Hymenoptera: Apidae); e os inimigos naturais Araneae Araneidae, Oxyopidae e Salticidae, o díptero Dolichopodidae, os himenópteros *Brachymyrmex* sp., *Camponotus* sp., *Cephalotes* sp., *Ectatoma* sp., *Pheidole* sp. e *P. termitarius* (Formicidae) e *Polybia* sp. (Vespidae) foram mais observados ($P < 0,05$) nas faces adaxiais e com comportamento de agregação. *Phenacoccus* sp. (Hemiptera: Pseudococcidae) foi mais observado ($P < 0,05$) na face abaxial e de forma agregada, em folhas de *A. mangium*. As maiores abundâncias, diversidades e riquezas de espécies de insetos fitófagos e polinizadores e inimigos naturais (P <0,05) foram observadas nas faces adaxiais das folhas de *A. mangium*, exceto diversidade de polinizadores que não se detectou diferença estatística (P >0,05). As abundância, diversidade e riqueza de espécies de inimigos naturais foram afetados positivamente com as de fitófagos totais e polinizadores. De forma geral, o aumento em formigas protocooperantes pode reduzir o crescimento desta planta porque estão associadas a insetos sugadores e afugentam inimigos naturais como as aranhas. O conhecimento da face foliar preferida por insetos herbívoros, da diversidade de espécies e o tipo de distribuição espacial, auxilia a realização de planos amostrais e programas de manejo de pragas, além de fornecer informações importantes sobre a ecologia e a relação inseto planta em árvores de *A. mangium*.

Palavras-chave: agregação, distribuição, diversidade, dominância-K, face foliar, insetos.

ABSTRACT

GOMES, Gleisiany Nunes. Diamantina. **ECOLOGICAL INDICES AND RELATIONSHIPS OF ARTHROPODS IN THE ABAXIAL AND ADAXIAL LEAVES ON *ACACIA MANGIUM* TREES (FABALES: FABACEAE)** 2021. 46 p. (Dissertation Masters in Plant Production) - Federal University of the Jequitinhonha and Mucuri Valleys, Diamantina, 2021.

Acacia mangium Willd. (Fabaceae) is an exotic plant, fast growing and with a nitrifying potential, which can favor plant succession and, thus, assist in the recovery process of degraded areas. In addition, this plant was indicated as a viable strategy to mitigate the global greenhouse effect. Insects may prefer to attack different parts of the plant or leaves (adaxial and abaxial faces). Generally, sucking insects tend to prefer the abaxial face of the leaves, due to characteristics such as softer tissue, thin epidermis, and thicker ribs, in addition to serving as protection against natural enemies and climatic factors. In this context, the objectives of this work were evaluated during 24 months in a degraded area, spatial distribution (random, aggregated or regular) and the ecological indexes (abundance, diversity and richness of species) in function of the leaf faces (adaxial and abaxial) the interactions between the arthropod groups and the K-dominance in *A. mangium* plants. The design used was completely randomized with two treatments (adaxial and abaxial leaves) and 24 replications (trees). The constant arthropods (> 50% in the samples) were Araneidae (Araneae), *Camponotus* sp., *Pheidole* sp. and *Pseudomyrmex termitarius* Smith (Hymenoptera: Formicidae) and *Trigona spinipes* Fabricius (Hymenopytera: Apidae) and Dolichopodidae (Diptera). The most frequent insect (14.54%) was *Brachymyrmex* sp. (Hymenoptera: Formicidae). The k-dominances of phytophagous insects on the adaxial and abaxial sides were greater for *Aethalium reticulatum* L. (Hemiptera: Aethalionidae) and *Bemisia* sp. (Hemiptera: Aleyrodidae) and for natural enemies, *Brachymyrmex* sp. and *Camponotus* sp., and for *T. spinipes* bees, on both leaf surfaces. The number of individuals of *A. reticulatum*, *Balclutha hebe* Kirkaldy (Hemipptera: Cicadellidae) and Membracidae, *Euxesta* sp. (Diptera: Otittidae), from Tettigoniidae and *Tropidacris collaris* (Stoll) (Tettigoniidae: Romaleidae); pollinating bees *Apis mellifera* L., *Tetragonisca angustula* Latreille and *T. spinipes* (Hymenoptera: Apidae); and of the natural enemies Araneae Araneidae, Oxyopidae and Salticidae, of the Dolichopodidae diptera, of the *Brachymyrmex* sp., *Camponotus* sp., *Cephalotes* sp., *Ectatoma* sp., *Pheidole* sp. and *P. termitarius* (Formicidae) and *Polybia* sp. (Vespidae) was higher (P <0.05) in adaxial faces and with aggregation behavior. *Phenacoccus* sp. (Hemiptera: Pseudococcidae) was more observed (P <0.05) on the abaxial side and in an aggregated form, in *A. mangium* leaves. The greatest abundance, diversity and richness of species of phytophagous and pollinating insects and natural enemies (P <0.05) were observed on the adaxial faces of *A. mangium* leaves, but the diversity of pollinators was similar between treatments (P> 0.05). The abundance, diversity and species richness of natural enemies were positively affected with those of total phytophages and pollinators. In general, the increase in protocooperating ants can reduce the growth of this plant because they are associated with sucking insects and scare away natural enemies such as spiders. The knowledge of the leaf face preferred by herbivorous insects, the diversity of species and the type of spatial distribution, helps to carry out sampling plans and pest management programs, in addition to providing important information about the ecology and the insect-plant relationship in *A. mangium* trees.

Keywords: aggregation, distribution, diversity, insect, K-dominance, leaf face.

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SUMÁRIO

INTRODUÇÃO GERAL

Acacia mangium Willd. (Fabales: Fabaceae é uma espécie perene, com até 30 m de altura e diâmentro de tronco menor que 50 cm cuja casca é áspera e de cor cinza ou marrom. Suas folhas são grandes, 11-27 cm de comprimento e 3-10 cm de largura, com quatro nervuras longitudinais principais e na base de seus pecíolos há glândulas nectaríferas (MASLIN; MC DONALD, 1996). Suas inflorescências, dispostas em espigas soltas de 5-12 cm de comprimento, são compostas por pequenas flores de cor branca ou creme, unidas ou solitárias nas axilas superiores (HEGDE *et al*., 2013). Seus frutos são vagens lineares, quando maduras são enroladas ou espiraladas, de cores amadeiradas de 7-8 cm de comprimento e 0,3-0,5 cm de largura e suas sementes de cor pretas e brilhantes em formato elipsóide, oblongo ou oval (HEGDE *et al*., 2013). *Acacia mangium* é uma espécie arbórea exótica, de crescimento rápido, com potencial nitrificador, que pode favorecer a sucessão vegetal, auxiliando na recuperação de áreas degradadas (BALIEIRO *et al*., 2004; WANG *et al*., 2013; CALDEIRA *et al*., 2018; PAULA *et al*., 2018). Além disso, pelo Protocolo de Kyoto, essa planta é uma estratégia viável para amenizar o efeito estufa global (LEMMA; OLSSON, 2006). *Acacia mangium* possui maiores valores de taxa fotossintética líquida e eficiência fotossintética do uso do nitrogênio, importantes características para a escolha de espécies adequadas para a reabilitação florestal, comparada às fabáceas *A. auriculiformis* A. Cunn. ex Benth. e *Pterocarpus indicus* Willd, também exóticas e de rápido crescimento (LEE *et al*., 2012).

Contudo, *A. mangium* pode ser atacada por pragas pertencentes às ordens Coleoptera *Costalimaita ferruginea* (Fabricius) (Chrysomelidae), *Oncideres ocularis* Thomson e *O. saga* Dalman (Cerambycidae); Hemiptera *Aethalion reticulatum* (L.) (Aetalionidae) e *Lecanodiaspis dendrobii* (Douglas) (Lecanodiaspididae); Hymenoptera *Atta* spp. e *Acromyrmex* spp. (Formicidae) e *Trigona spinipes* Fabricius (Apidae); Lepidoptera *Periphoba hircia* (Cramer) (Saturniidae) e Orthoptera *Tropidacris collaris* (Stoll) e *T. cristata* L. (Romaleidae), dentre outras (AZEREDO *et al*., 2005; CORDEIRO *et al*., 2010; LEMES *et al*., 2013, 2014; AFONSO *et al*., 2014; PARREIRA *et al*., 2014; SILVA *et al*., 2015, 2020; MARSARO JÚNIOR *et al*., 2016).

O número de insetos coletados e a diversidade de espécies podem ser, significativamente, diferentes até mesmo em plantas próximas entre si. Existem três tipos de distribuições espaciais dos insetos: i) quando os organismos ocorrem de forma inteiramente casualizada, dizemos que esse tipo de distribuição é ao acaso ou aleatória; ii) quando os organismos se reúnem em grupos, é chamada de distribuição agregada ou contagiosa; iii) quando os organismos estão, uniformemente, distribuídos em uma população, temos a distribuição regular ou uniforme (NICKELE *et al*., 2010).

Insetos podem ter preferência por atacar diferentes partes da planta, inclusive da folha (faces adaxial e abaxial). Em geral, a face abaxial, por ser um tecido mais macio, de fina epiderme, e com nervuras mais espessas, é mais preferida aos insetos sugadores (DAMASCENA *et al*., 2017), além de servir como proteção contra inimigos naturais e fatores climáticos (LEITE *et al*., 2011; SOMAVILLA *et al*., 2012). A presença dos tricomas também pode influenciar na preferência dos insetos a determinada face foliar. Os tricomas tectores podem conferir proteção aos ovos, enquanto os tricomas glandulares podem conter substâncias estimulantes ou desestimulantes (ANTÔNIO *et al*., 2002). O fato de alguns insetos viverem e se alimentarem da face abaxial da folha dificulta o seu controle (NARANJO; FLINT, 1995).

Insetos podem, ainda, relacionar-se uns com outros, tanto da mesma espécie (ex.: relação intraespecífica), quanto de espécies distintas (ex.: relação interespecífica). Essas relações podem ser harmônicas, quando não há prejuízo aos indivíduos envolvidos, ou desarmônicas, quando pelo menos um se prejudica (BEGON *et al*., 2007). A relação interespecífica harmônica inclui a protocooperação, os indivíduos cooperam entre si, mas não dependem uns dos outros para sobreviverem (ex.: formigas e insetos sugadores), no entanto, quando essa relação é desarmônica tem-se a predação, capaz de afetar a distribuição e a abundância das espécies (BEGON *et al*., 2007), ocorre quando um indivíduo mata o outro para alimentar-se (ex.: joaninhas e pulgões) e a competição, com disputa por recursos como alimento, territórios, etc. (LEITE *et al*., 2012). A predação é um importante fator que afeta a distribuição e abundância das espécies, e o comportamento de insetos predadores para com a presa pode afetar tanto direta, quanto indiretamente, a morte do alvo em programas de controle biológico de pragas (RAMOS *et al*., 2018).

Em um determinado local, podem haver diversas espécies presentes, porém poucas espécies podem ser dominantes. A dominância das espécies é influenciada principalmente por índices ecológicos (ex.: diversidade, número de indivíduos e riqueza de espécies) (URAMOTO *et al*., 2005; MONTEIRO *et al*., 2019). Desse modo, valores de dominância-K podem auxiliar na identificação de potenciais pragas por indicarem a distribuição de dominância e a uniformidade dos indivíduos entre as espécies (GEE *et al*., 1985). Todos esses índices permitem a seleção de espécies mais predominantes (SILVEIRA NETO *et al*., 1995), que podem influenciar no controle de outras espécies.

Portanto, conhecer a face foliar preferida por insetos herbívoros, a diversidade de espécies e o tipo de distribuição espacial, permite a realização de planos amostrais e manejo de pragas (NICKELE *et al*., 2010; SOTI *et al*., 2018; FERNANDES *et al*., 2019; GONÇALVES *et al*., 2020). Além de informações importantes sobre a ecologia e a relação inseto planta nessa espécie. Diante do exposto, objetivou-se estudar o comportamento de ataque (aleatório, agregado ou regular), índices ecológicos (abundância, diversidade e riqueza de espécies) em função das faces foliares, as interações entre os grupos de artrópodos (insetos fitófagos, polinizadores e inimigos naturais, incluindo as aranhas) e a dominância-K desses organismos em plantas de *A. mangium*, durante 24 meses, em área degradada.

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ARTIGO CIENTÍFICO

ARTHROPOD FAUNA ON THE ABAXIAL AND ADAXIAL SURFACES OF Acacia mangium (FABACEAE) LEAVES

RESUMO - *Acacia mangium* Willd. (Fabaceae) é uma planta pioneira com rápido crescimento, rusticidade, potencial nitrificador e importante em programas de recuperação de áreas degradadas. O objetivo foi avaliar a distribuição e a diversidade funcional das interações e a dominância-K de grupos de artrópodes em árvores jovens de *A. mangium*. Os números de indivíduos de onze espécies de insetos fitófagos, três de abelhas e quatorze de inimigos naturais foram maiores na superfície adaxial dessa planta. A abundância, diversidade e riqueza de espécies de insetos fitófagos e inimigos naturais, e a abundância e riqueza de espécies de polinizadores foram maiores na face adaxial de *A. mangium*. A distribuição de cinco espécies de hemípteros sugadores de seiva e seis de formigas protocooperantes (Hymenoptera), com interação positiva entre esses grupos, e três de abelhas (Hymenoptera) foi agregada em folhas de plantas jovens de *A. mangium*. *Aethalion reticulatum* (L.) (Hemiptera: Aethalionidae) e *Bemisia* sp. (Hemiptera: Aleyrodidae); *Brachymyrmex* sp. e *Camponotus* sp. (Hymenoptera: Formicidae); e *Trigona spinipes* Fabricius (Hymenoptera: Apidae) foram os insetos fitófagos, inimigos naturais e polinizadores mais dominantes, respectivamente, em folhas de *A. mangium*. A definição da superfície foliar preferida pode auxiliar programas de manejo integrado de pragas.

Palavras-chave: agregação, distribuição, diversidade, dominância-K, superfície foliar, insetos.

ARTHROPOD FAUNA ON THE ABAXIAL AND ADAXIAL SURFACES OF *Acacia mangium* (FABACEAE) LEAVES

ABSTRACT- *Acacia mangium* is a fast growing, rustic, pioneer species, with potential to fix nitrogen, and shows applicability in programs to recover degraded areas. The objective was to evaluate the distribution and the functional diversity of interactions and the K-dominance of arthropod groups on *A. mangium* saplings. The number of individuals of eleven species of phytophagous insects, three bee species, and fourteen natural enemy species were highest on the adaxial leaf surface of this plant. Abundance, diversity and species richness of phytophagous insects and natural enemies, and abundance and species richness of pollinators were highest on the adaxial *A. mangium* leaf surface. The distribution of five species of sap-sucking hemipterans and six of protocooperating ants (Hymenoptera), with positive interaction between these groups, and three bee species (Hymenoptera) were aggregated on leaves of *A. mangium* saplings. *Aethalion reticulatum* (L.) (Hemiptera: Aethalionidae) and *Bemisia* sp. (Hemiptera: Aleyrodidae); *Brachymyrmex* sp. and *Camponotus* sp. (Hymenoptera: Formicidae); and *Trigona spinipes* Fabricius (Hymenoptera: Apidae) were the most dominant phytophagous insects, natural enemies, and pollinators, respectively, on *A. mangium* leaves. Knowledge of preferred leaf surfaces could help integrated pest management programs.

Keywords: aggregation, distribution, diversity, insect, K-dominance, leaf surface.

1. INTRODUCTION

Acacia mangium Willd. (Fabaceae) is a fast growing, rustic pioneer species with potential for nitrification and high litter production (Caldeira et al., 2018; Eloy et al., 2018). The high nitrogen fixation rate of this plant, in symbiosis with diazotrophic bacteria, increases the production of biomass and nutrients through litter, favoring plant succession (Paula et al., 2018). The high adaptability of *A. mangium* to acidic and infertile soils makes this plant important for recovering degraded areas (Balieiro et al., 2004; Wang et al., 2013). *Acacia mangium* wood is used in the construction of furniture, cabinets, frames, doors and window components, boxes and crates and in the production of coal, coal briquettes and activated carbon (Hegde et al., 2013). The sap-sucking insect *Aethalion reticulatum* (L.) (Hemiptera: Aethalionidae); the defoliating insects *Periphoba hircia* (Cramer) (Lepidoptera: Saturniidae), and *Tropidacris collaris* (Stoll) (Orthoptera: Romaleidae); the stem apex chewing insect *Trigona spinipes* Fabricius (Hymenoptera: Apidae); and the wood-borer insect *Oncideres ocularis* Thomson (Coleoptera: Cerambycidae) were reported damaging *A. mangium* trees (Lemes et al., 2013; Parreira et al., 2014; Silva et al., 2015, 2020).

Herbivorous insects can damage different plant parts, including their leaves (adaxial and abaxial surfaces) (Leite et al., 2008). Sap-sucking insects prefer the abaxial leaf surface due to its softer tissue, thin epidermis and more protuberant veins (Leite et al., 2008; Damascena et al., 2017). In addition, they are better protected against natural enemies and climatic factors (e.g., solar radiation) on this leaf surface (Leite et al., 2008). On the other hand, arthropods, such as defoliating Coleoptera and Orthoptera may prefer the adaxial leaf surface where less effort is required for movement (Salerno et al., 2018). The preference of insect pests for this leaf surface helps in their control (Leite et al., 2008), which becomes more difficult in the case of pests that live and feed on the abaxial leaf surface (Naranjo and Flint, 1995).

The distribution of herbivorous insects and of their natural enemies can be completely randomized (i); in groups, such as aggregated or contagious (ii); or evenly spread with uniform - regular (iii) distributions on the host plants or on the ground (Nickele et al., 2010). Knowledge of insect distribution is important for sampling plans and pest management (Nickele et al., 2010; Soti et al., 2018; Fernandes et al., 2019). The number of insect species per location is usually high with few dominant species (Monteiro et al., 2019). K-dominance indicates the distribution and uniformity of individuals between species and facilitates the identification of potential pests (Gee et al., 1985).

Functional diversity includes different physical, biochemical, behavioral and phenological characteristics, which are measurable (Cadotte et al., 2011). These characteristics are called functional because they are important for understanding how species richness and diversity are related to the ecosystem (Cadotte et al. 2009; Flynn et al. 2011), determining when and where they may exist and their interspecific interactions (e.g., predator and prey) (McGill et al., 2006). For this reason, measuring and understanding species characteristics helps in decision-making in restoration and environmental conservation programs (Cadotte et al., 2011).

The terms "hypotheses" and "predictions" are confused in studies of ecology. The hypothesis is an idea that can be verified by examining the predictions, which result from the assumption that the first is true (Farji-Brener, 2004). Therefore, the objective of this research was to test the following hypotheses: i) the number of phytophagous insects and pollinators and their natural enemies or protocooperating ants will be higher on the adaxial leaf surface due to the lower effort required for movement, therefore resulting in higher ecological indices (abundance, diversity, and species richness) of these groups; ii) the distribution of arthropods will be aggregated in the same host sapling, mainly of sap-sucking and protocooperating insects (e.g., ants, eusocial insects), protecting them against competitors and predators; and iii) the k-dominance of polyphagous insect pests or omnivorous insects (e.g., ants) will be greater in *A. mangium* saplings (young trees).

2. MATERIAL AND METHODS

2.1 *Experimental site*

This study was carried out in a degraded area (≈ 1 ha) of the “Instituto de Ciências Agrárias da Universidade Federal de Minas Gerais (ICA/UFMG)” in the municipality of Montes Claros, Minas Gerais state, Brazil (latitude 16º 51' 38" S, longitude 44º 55' 00" W, altitude 943 m) for 24 months (April 2015 to March 2017). The climate of this area, according to the Köppen climate classification (Alvares et al., 2013), is tropical dry, with annual precipitation and temperature between 1,000 and 1,300 mm and ≥ 18ºC, respectively. The soil is Neosol Litolic with an Alic horizon (Silva et al., 2020).

2.2 *Experimental design*

The *A. mangium* seedlings were prepared, in March 2014, in a nursery in plastic bags (16 x 24 cm) with reactive natural phosphate mixed with the substrate at a dosage of 160g and planted, at the same time, in the final site in September of this year. Each *A. mangium* seedling was planted in a hole (40 x 40 x 40 cm) when they were 30 cm high with a 2-meter spacing between each one. The soil was corrected with dolomitic limestone with the base saturation increased to 50%, natural phosphate, gypsum, FTE (Fried Trace Elements), potassium chloride and micronutrients based on the soil analysis. A total of 20 L of dehydrated sewage sludge with its biochemical characteristics defined (Silva et al. 2020) was placed in a single dose, per hole. The young *A. mangium* trees (saplings in the vegetative period) were irrigated twice a week until the beginning of the rainy season (October). The design was completely randomized with 48 replications (one sapling each) with the adaxial and abaxial leaf surfaces as the treatments.

2.3 *Counting the arthropods*

The number of leaves/branch, branches/sapling and height (m) of *A. mangium* were ≈ 23, 34, and 34 and 59, 1,6, and 2,8 in the first and second years, respectively (unpublished data). All insects (e.g., Formicidae - eusocial insects) and spiders were counted, between 7:00 A.M. and 11:00 A.M., by visual observation, every two weeks on the adaxial and abaxial surfaces of the first 12 leaves expanded, per sapling. These leaves were assessed, randomly, on branches (one leaf per position) in the basal, middle and apical parts of the canopy – vertical axis - (0 to 33%, 33 to 66% and 66 to 100% of total sapling height, respectively) and in the north, south, east and west directions - horizontal axis. A total of 12 leaves/sapling/evaluation were observed on 48 *A. mangium* saplings starting six months after transplantion during 24 months (27,648 total leaves), covering the entire sapling (vertical and horizontal axis), capturing the highest possible number of arthropods (insects and spiders), especially the rarest ones. The evaluator approached, carefully, firstly assessing the adaxial leaf surface and, if it was not possible to visualize the abaxial one, with a delicate and slow movement, lifting the leaf to visualize it. The position of leaves of *A. mangium* saplings is, in general, tilted upwards, facilitating the visual assessment of arthropods on their leaf surfaces. Insects with greater mobility (e.g., Orthoptera), that flew, on approach, were counted as long as they were recognized (e.g., Order). The arthropods (insects and spiders) were not removed from the saplings during the evaluation.

A few arthropod specimens (up to 3 individuals) per species were collected using an aspirator (two hours per week), at the beginning of the study (between transplantation and first evaluation, six months after), stored in flasks with 70% alcohol, separated into morphospecies, and sent to specialists for identification (see acknowledgments). Any visible arthropod, not yet computed in previous evaluations, was collected, coded and sent to a taxonomist of its group.

2.4 *Statistical ecological indices*

Each replication is the total of individuals collected on 12 leaves (three heights and four sides of the sapling). The distribution of arthropods was defined by the Chi-square test using the BioDiversity© Professional software, Version 2 (Krebs, 1989). The ecological indices (abundance, diversity and species richness) were calculated per group (phytophagous insects, pollinators, and natural enemies) and treatments (adaxial and abaxial surfaces) using the aforementioned program. Abundance and species richness were the total number of individuals and species (Begon et al., 2007), respectively, per sapling. The diversity was calculated using Hill´s formula per sapling (Hill, 1973).

The data for abundance, diversity and species richness of phytophagous insects, pollinators and natural enemies were subjected to a non-parametric statistical hypothesis, the Wilcoxon signed rank test (p-value < 0.05) (Wilcoxon, 1945) using the Statistics and Genetics Analysis (SAEG) program, version 9.1 (Saeg, 2007) (Supplier: "Universidade Federal de Viçosa", Brazil). The data were subjected to second degree regression or principal component regression (PCR), when linear (p-value < 0.05) to verify the possible interactions (e.g. protocooperation) between groups of arthropods (phytophagous insects, pollinators and natural enemies, including spiders). Simple equations were selected based on the criteria: i) distribution of the data in the figures (linear or quadratic response), ii) the parameters used in these regressions were the most significant ones (p-value < 0.05), iii) p-value < 0.05 and *F* of the Analysis of Variance of these regressions, and iv) the determination coefficient of these equations (R^2). The PCR model uses principal component analysis, based on a covariance matrix, to obtain the regression. These reduce the dimensions of the regression, excluding those that contribute to collinearity, that is, linear relations between the independent variables (Bair et al., 2006). The parameters used in these equations were all significant (p-value <0.05) according to the selection of the variables by the ‘‘Stepwise” method using the statistical program mentioned. The data presented are the significant data (p-value < 0.05).

K-dominance was calculated by plotting the cumulative percentage of abundance according to the logarithmic classification of the species (Lambshead et al., 1983), using the aforementioned BioDiversity program. The K-dominance values indicate the distribution of dominance and the uniformity of the number of individuals between species (Gee et al., 1985). The data presented in the text were the significant data (p-value < 0.05) and the remaining are in the supplementary material I (used to calculate the ecological indexes).

3. RESULTS

Phytophagous insects Hemiptera *Aethalium reticulatum* L. (Aethalionidae), *Balclutha hebe* Kirkaldy (Cicadellidae) and Membracidae, Diptera *Euxesta* sp. (Otittidae), Orthoptera Tettigoniidae and *Tropidacris collaris* (Stoll) (Romaleidae); Hymenoptera pollinating bees *Apis mellifera* L., *Tetragonisca angustula* Latreille and *Trigona spinipes* Fabricius (Apidae); and natural enemies Araneae Araneidae, Oxyopidae and Salticidae, Diptera Dolichopodidae, Hymenoptera *Brachymyrmex* sp., *Camponotus* sp., *Cephalotes* sp., *Ectatoma* sp., *Pheidole* sp., and *Pseudomyrmex termitarius* (Smith) (Formicidae) and *Polybia* sp. (Vespidae) were more numerous (P <0.05) on the adaxial face and in aggregate form. On the other hand, Hemiptera *Phenacoccus* sp. (Pseudococcidae) (aggregation behavior) was more numerous on the abaxial *A. mangium* leaf face. Hemiptera *Bemisia* sp. (Aleyrodidae) (Chi-sq= 613.89; P= 0.00) presented aggregation behavior (P<0.05), but this was not significant for *B. hebe* and *Euxesta* sp. (P> 0.05). Abundance, diversity and species richness of phytophagous insects, pollinators and natural enemies (P<0.05) were higher on the adaxial *A. mangium* leaf face, but the diversity of pollinators was similar on both leaf faces (P> 0. 05) (Tables 1-2).

Abundance, diversity and species richness of natural enemies correlated, positively, with those of total phytophagous and pollinator insects; those of total spiders correlated, positively and negatively, respectively, with those of phytophagous Orthoptera and Hemiptera; that of *Mantis religiosa* L. (Mantodea: Mantidae), positively, with those of *T. angustula* and Salticidae; Dolichopodidae with Membracidae and *B. hebe*; Araneidae with Coleoptera *Cerotoma* sp. (Chrysomelidae), *T. collaris* and *T. spinipes*; Oxyopidae with *T. angustula*; Sternorrhyncha predators with Membracidae; *Pheidole* sp. with *A. reticulatum* and this sucking insect with *P. termitarius*; and *P. termitarius* with *B. hebe* and *A. reticulatum*. On the other hand, greater number of protocooperating ants on the leaves of *A. mangium* reduced those of Sternorrhyncha predators, Dolichopodidae and *T. collaris*, Tettigoniidae, *T. spinipes* and *T. angustula*; and that of *Cephalotes* sp. reduced that of *Parasyphraea* sp. (Coleoptera: Chrysomelidae). The high number of Tettigoniidae and *T. spinipes* on the *A. mangium* leaves reduced that of *T. collaris,* and that of *T. spinipes* reduced that of *T. angustula* (Table 3).

The K-dominance and total number (n) of *A. reticulatum* were higher on the adaxial face (k= 34.9 and n= 156, respectively), while those of *Bemisia* sp. were higher on the abaxial (k= 41.5 and n= 71, respectively). *Brachymyrmex* sp. was the most dominant natural enemy on the adaxial face (k= 20.8 and n= 363, respectively), and *Camponotus* sp. was the most dominant on the abaxial face (k= 21.0 and n= 29, respectively) of the *A. mangium* leaves. *Trigona spinipes* was the dominant pollinating insect on both the adaxial (k= 64.1 and n= 134) and abaxial (k= 64.3 and n= 9) faces of the *A. mangium* leaves.

4. DISCUSSION

The greater number, in aggregate pattern, especially of sap-sucking hemipterans (i.e., *A. reticulatum*) and their protocooperating ants (i.e., *P. termitarius*), and the three bee species (i.e., *T. spinipes*) on the adaxial leaf surface of *A. mangium* saplings increased the values of the ecological indices (abundance, diversity and species richness) of these groups (i.e. phytophagous insects) on this leaf surface of *A. mangium* saplings. This, probably, is due to the lower effort required by these arthropods to hold onto this surface compared with the abaxial one, confirming the first hypothesis (preference for the adaxial leaf surface). The wax content, hairiness, roughness, regular shape or not and the type and number of veins in the leaves of host plants affect arthropod walking and they prefer the leaf surface (adaxial or abaxial) that requirs less effort for movement (Peeters, 2002; Gorb et al., 2008; Gorb and Gorb, 2009; Prüm et al., 2012; Salerno et al., 2018). *Acacia mangium* leaves are large (11-27 cm long x 3-10 cm wide), hairless, smooth and present four main longitudinal ribs (Hegde et al., 2013) and probably have a surface that provides restricted contact for arthropods to hold onto, which may have affected the number of these organisms on the adaxial leaf surface.

The aggregate distribution of five species of sap-sucking hemipterans, six protocooperating ant species (Hymenoptera) and three bee species (Hymenoptera) on *A. mangium* sapling leaves confirms the second hypothesis (distribution will be aggregated) as found for *A. reticulatum* and *Camponotus* sp. on *Bauhinia forficata* Link (Fabaceae), Acrididae

(Orthoptera) on several plants, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) on *Capsicum annuum* L. (Solanaceae), *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae) on pine and *T. spinipes* on cucurbits (Bashir and Hassanali, 2010; Serra and Campos, 2010; Barônio et al., 2012; Goodsman et al., 2016; Kim et al., 2017). This behavior can increase the local population density of these arthropods (Rivault et al., 1998; Goff et al., 2009), thus facilitating feeding and mating, attraction of mutualistic species, and protection against predators; however, it can also result in conflicts (e.g., competition) between them (Goff et al., 2009; Boulay et al., 2019). The positive correlation between spiders and phytophagous insects on *A. mangium* saplings is, probably, due to the predators following their prey, as observed on *Caryocar brasiliense* Camb. (Caryocaraceae), *L. leucocephala* and *Pistacia lentiscus* L. (Anacardiaceae) (Auslander et al., 2003; Damascena et al., 2017; Leite et al., 2017). The increase in the number of phytophagous insects (e.g., *Cerotoma* sp.) and pollinators (e.g., *T. spinipes*) allows higher numbers of spiders (e.g., Araneidae) on *A. mangium* saplings because the latter prey on insects in natural and agricultural systems (Venturino et al., 2008; Leite et al., 2012, 2016). On the other hand, the reduction in the number of spider individuals with the increase in that of sap-sucking insects is, possibly, due to interactions between protocooperating ants (e.g., *P. termitarius*) with these Hemiptera (e.g., *A. reticulatum*) on *A. mangium* saplings. Trophobiotic interactions between ants (offering protection against natural enemies) and Sternorryncha (supplying sugary food substances) are one of the main mechanisms that maintain the overabundance of ants in ecosystems (Kaminski et al., 2010; Silva and Fernandes, 2016; Klimes et al., 2018), which may decrease that of natural enemies, including spiders (Venturino et al., 2008; Leite et al., 2012, 2016). The reduction in populations of Sternorrhyncha predators (e.g., Dolichopodidae) on *A. mangium* saplings by protocooperating ants shows the negative impact of the latter on the biological control of sap-sucking hemipterans (Karami-Jamour, 2018; Tong et al., 2019). The reduction in the number of *T. angustula* by *T. spinipes* indicates possible competition for food and space as observed for sap-sucking insects (e.g., aphids) with chewing insects (e.g., beetles), *Eurytoma* sp. (Hymenoptera: Eurytomidae) with three other galling hymenopterans on leaves of *C. brasiliense* (Leite et al., 2012, 2017) and *T. spinipes* with *A. mellifera* and *T. angustula* on cucurbits and *A. mangium* (Serra and Campos, 2010; Silva et al., 2020). Phylogenetic proximity tends to favor the formation and maintenance of groups of mixed species (eusocial or gregarious), possibly, due to similar size, life cycle and movement with easier communication between them (Boulay et al., 2019). However, it can increase competition between species that share similar ecological niches

(Boulay et al., 2019). The balance between resource sharing and competition is important to understand species clusters, as well as for those occupying the same ecological niche presenting lower food availability or productive partners (Boulay et al., 2019). Interspecific competition can disproportionately benefit one species at the expense of another when arthropods use mixtures of chemical compounds, such as hydrocarbons, to communicate between them (Boulay et al., 2019).

The higher K-dominance and number of the phytophagous Hemiptera *A. reticulatum* and *Bemisia* sp., of the natural enemies *Brachymyrmex* sp. and *Camponotus* sp. and of the pollinator *T. spinipes* can be explained by the first two being pests in different cultures (polyphages) which may be feeding and reproducing on *A. mangium* saplings, confirming the third hypothesis (k-dominance of polyphagous pest insects or omnivorous insects will be greatest). The other insects are protocooperating sap-sucking ones, such as *A. reticulatum*, a pest that reduces the development of fruits and sprouts, leading to hypertrophy and cracks in the apex of seedlings and possibly killing plants of *Erythrina speciosa* Andrews (Fabaceae) (Araújo et al., 2010; Zanuncio et al., 2015) in addition to damaging those of *A. mangium*, *Triplaris americana* L. (Polygonaceae) and *Vernonia condensata* Baker (Asteraceae) (De Menezes et al., 2013; Pires et al., 2015; Silva et al., 2020). The whitefly *B. tabaci* transmits viruses to agricultural plants such as *Cucumis melo* L. (Cucurbitaceae) (Felicio et al., 2019). Sap-sucking insects, especially at high densities, can be associated with ants of the genera *Camponotus* and *Brachymyrmex* with mutual benefit with direct correlation between these groups (Novgorodova, 2015; Sanchez et al., 2019) because they collectively and aggressively defend their resources (e.g., sap-sucking insects) (Novgorodova, 2015). The greater numbers of *Brachymyrmex* sp., *Camponotus* sp., and *T. spinipes* agrees with reports for these insects on *L. leucocephala* trees, which may be due to attraction by extrafloral nectaries in the leaf petioles of this plant (Damascena et al., 2017), and on *A. mangium*, with an extrafloral nectary on the leaf base (Hegde et al., 2013). The high numbers of *T. spinipes* is a common feature because this insect was reported in this condition on *A. mangium*, *Brassica oleracea* L. var. italica (Brassicaceae), *L. leucocephala* and *Vaccinum* sp. (Ericaceae) (Silveira et al., 2010; Dos Santos et al., 2012; Damascena et al., 2017; Silva et al., 2020). This insect removes fiber from buds and growth parts to build its nests and reduces pollination (e.g., Cucurbitaceae) because it does not carry pollen and frequently dislodges it from the plant (Serra and Campos, 2010). Bees associated with flowers obtain most of their food resources (e.g., nectar and pollen), but some of their interactions (e.g., *T. spinipes*) with sap-sucking insects (e.g., *A. reticulatum*) are an alternative to obtain honeydew as food (Dos Santos et al., 2019).

5. CONCLUSIONS

The higher values of ecological indices (e.g., abundance) of arthropods (e.g., phytophagous) on the adaxial *A. mangium* leaf surface is probably due to the reduced effort (e.g., easier walking) for insect on this surface compared to the abaxial one. Protocooperating ants, the most dominant natural enemies on *A. mangium* leaves, can reduce the growth of this plant because they are associated with sap-sucking insects and chase away natural enemies like spiders. The greater K-dominance of *A. reticulatum* and *T. spinipes* on *A. mangium* leaves may be a problem, because these insects can damage leaves and sprouts of this plant. The aggregation behavior of arthropods on the adaxial leaf surface of *A. mangium* favors the control of potential pests of this plant.

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Table 1 Number of arthropods and their aggregated (Aggr.) or random (Ran.) distributions (Dist.) on the adaxial and abaxial leaf surfaces of *Acacia mangium* (Fabales: Fabaceae)/sapling (mean ± SE)

Arthropods	Leaf surface*		QT
	Adaxial	Abaxial	Dist
Araneae: Araneidae	1.63±0.2	0.38±0.1	Agg
Oxyopidae	1.00±0.1	0.25±0.0	Agg
Salticidae	1.08±0.2	0.54±0.2	Agg
Coleoptera: Chrysomelidae, *Stereoma anchoralis* Lacord.	0.58±0.2	0.08±0.0	---
Curculionidae	0.13±0.0	0.00±0.0	---
Lampyridae, *Photinus* sp.	0.17±0.0	0.00±0.0	Ran
Diptera: Dolichopodidae	5.17±0.5	0.17±0.0	Agg
Syrphidae, *Syrphus* sp.	0.33±0.1	0.00±0.0	---
Otittidae, *Euxesta* sp.	0.75±0.1	0.00±0.0	---
Hemiptera: Aethalionidae, *Aethalium reticulatum* L.	6.50±4.4	0.04±0.0	Agg
Cicadellidae, *Balclutha hebe* Kirkaldy	0.92±0.1	0.17±0.0	---
Erythrogonia sexguttata Fabricius	0.33±0.1	0.00±0.0	---
Membracidae	1.13±0.3	0.08±0.0	Agg
Nogodinidae	0.17±0.0	0.00±0.0	Ran
Bladina sp.	0.17±0.0	0.00±0.0	---
Pseudococcidae, *Phenacoccus* sp.	0.00±0.0	2.63±1.2	Agg
Hymenoptera: Apidae, *Apis mellifera* L.	0.71±0.2	0.17±0.1	Agg
Tetragonisca angustula Latreille	2.42±0.3	0.04±0.0	Agg
Trigona spinipes Fabricius	5.58±1.3	0.38±0.1	Agg
Formicidae, *Brachymyrmex* sp.	15.13±6.	0.00±0.0	Agg
Camponotus sp.	13.08±1.	1.21±0.3	Agg
Cephalotes sp.	4.00±1.9	0.08±0.0	Agg
Ectatoma sp.	1.83±0.3	0.04±0.0	Agg
Pheidole sp.	9.50±1.0	0.71±0.2	Agg
Pseudomyrmex termitarius Smith	5.63±0.8	0.54±0.2	Agg
Vespidae, *Polybia* sp.	4.33±2.7	0.08±0.0	Agg
Mantodea: Mantidae, *Mantis religiosa* L.	0.21±0.0	0.04±0.0	---
Orthoptera:Romaleidae, *Tropidacris collaris* Stoll.	2.13±0.2	0.08±0.0	Agg
Tettigoniidae	1.67±0.2	0.08±0.0	Agg

*WT= Wilcoxon test. **QT= Chi-square test, n= 48 per treatment. --- p-value > 0.05, and the remaining are significant

Table 2 Abundance , diversity and species richness of phytophagous insects, pollinators , and natural enemies on the adaxial and abaxial leaf surfaces of *Acacia mangium* (Fabales: Fabaceae)/sapling (mean ± SE)

	Leaf surface		WT*	
	Adaxial	Abaxial	*TV*	*P*
Abundance of Phytopagous	24.21 ± 5.18	7.58 ± 2.21	4.2	0.00
Diversity of Phytopagous	17.02 ± 2.14	4.18 ± 0.81	3.8	0.00
Species Richness of of Phytopagous	8.25 ± 0.55	2.29 ± 0.33	5.4	0.00
Abundance of Polinators	8.71 ± 1.38	0.58 ± 0.21	5.2	0.00
Diversity of Polinators	1.44 ± 0.44	0.58 ± 0.19	0.7	0.25
Species Richness of Polinators	2.08 ± 0.16	0.38 ± 0.11	5.3	0.00
Abundance of Natural Enemies	63.88 ± 7.33	5.17 ± 0.70	5.7	0.00
Diversity of Natural Enemies	18.36 ± 1.43	6.85 ± 0.84	4.9	0.00
Species Richness of Natural Enemies	9.71 ± 0.49	3.13 ± 0.30	5.6	0.00

*WT= Wilcoxon test, n= 48 per treatment, [£]TV= Teste value

Table 3 Relationships between the numbers of *Aethalium reticulatum*, Araneidae, *Balclutha hebe*, *Cerotoma* sp. (Cer.), Dolichopodidae, Orthoptera, Oxyopidae, phytophagous Hemiptera (Hemiptera), protocooperating ants (Ants), *Pseudomyrmex termitarius* (Pter.), spiders, Sternorrhyncha predators, *Tetragonisca angustula* (Tangu.), *Trigona spinipes* (T.spi.), and *Tropidacris collaris* (T.collaris) on *Acacia mangium* (Fabales: Fabaceae)/sapling

	ANOVA		
Principal component regression equations	R^2	*F*	*P*
Spiders= 1.74 + 0.66 x Orthoptera -0.04 x Hemiptera	0.38	13.50	0.00
Araneidae= 0.33 + 0.95 x Cer. + 0.28 x T.collaris + 0.07 x T.spi.	0.44	11.63	0.00
Oxyopidae= 0.27 + 0.29 x *Tetragonisca angusta*	0.34	23.42	0.00
Aethalium reticulatum= -2.50 + 1.87 x *Pseudomyrmex termitarius*	0.22	13.02	0.00
Pter.= 1.76 + 1.80 x *Balclutha hebe* + 0.11 x *Aethalium reticulatum*	0.30	9.69	0.00
Second degree regression equations			
Sternorrhyncha predators = 0.49 + 0.19 x Ants -0.001 x Ants^2	0.60	33.74	0.00
Dolichopodidae = -0.03 + 0.17 x Ants -0.001 x Ants^2	0.73	62.09	0.00
Tropidacris collaris = -0.01 + 0.06 x Ants -0.0003 x Ants^2	0.60	33.37	0.00
Tetragonisca angustula = -0.09 + 0.07 x Ants -0.003 x Ants^2	0.63	37.97	0.00
Tetragonisca angustula = 0.56 + 0.37 x Tspi. -0.01 x Tspi.^{2}	0.28	8.78	0.00

n= 96

Supplementary material I. Number of arthropod species per leaf (mean ± SE) collected on *Acacia mangium* (Fabales: Fabaceae) sapling used to calculate the ecological indexes which were non-significant (p-value > 0.05)

Arthropods	Mean± SE
Araneae: Anyphaenidae, *Teudis* sp.	0.02 ± 0.02
Oxyopidae, *Oxyopes salticus* Hentz	0.13 ± 0.13
Salticidae, *Uspachus* sp.	0.07 ± 0.05
Sparassidae, *Quemedice* sp.	0.04 ± 0.03
Tetragnathidae, *Leucauge* sp.	0.04 ± 0.04
Thomisidae, *Aphantochilus rogersi* O. Pickard-Cambridge	0.04 ± 0.04
Tmarus sp.	0.04 ± 0.03
Coleoptera: Buprestidae, *Psiloptera* sp.	0.02 ± 0.02
Cantharidae, *Cantharis* sp.	0.32 ± 0.27
Unknown Cerambycidae species	0.02 ± 0.02
Chrysomelidae, *Alagoasa* sp.	0.04 ± 0.03
Diabrotica speciosa Germar	0.17 ± 0.07
Disonycha brasiliensis Costa Lima	0.04 ± 0.03
Eumolpus sp.	0.08 ± 0.05
Lamprosoma sp.	0.02 ± 0.02
Parasyphraea sp.	0.36 ± 0.15
Walterianella sp.	0.04 ± 0.03
Wanderbiltiana sp.	0.04 ± 0.03
Coccinelidae, *Cycloneda sanguinea* (L.)	0.06 ± 0.05
Curculionidae, *Lordops* sp.	0.23 ± 0.21
Tenebrionidae, Alleculinae	0.02 ± 0.02
Epitragus sp.	0.04 ± 0.03
Diptera: Tephritidae, *Anastrepha* sp.	0.02 ± 0.02
Hemiptera: Cercopidae, *Mahanarva fimbriolata* Stal	0.02 ± 0.02
Cicadellidae, *Acrogonia* sp.	0.19 ± 0.08
Cicadellinae	0.04 ± 0.04
Ferrariana trivittata (Signoret)	0.04 ± 0.03
Cicadidae, *Quesada gigas* Oliver	0.04 ± 0.04
Pentatomidae, *Podisus* sp.	0.08 ± 0.05
Pyrrhocoridae, *Dysdercus* sp.	0.02 ± 0.02
Scutelleridae, *Pachycoris torridus* (Scopoli)	0.13 ± 0.09
Neuroptera: Chrysopidae, *Chrysoperla* sp.	0.11 ± 0.06
Orthoptera: unknown Gryllidae species	0.04 ± 0.04
Proscopiidae, *Cephalocoema* sp.	0.06 ± 0.05
Phasmatodea: Phasmatidae, *Phibalossoma phyllinum* Gray	0.02 ± 0.02

CONCLUSÃO GERAL

O provavelmente menor esforço (ex.: caminhar) exercido pelos artrópodos (ex.: fitófagos) na face adaxial comparada à abaxial resultou nos maiores índices ecológicos (ex.: abundância) dos artrópodos (ex.: fitófagos) e de forma agregada (comportamento de ataque) em *A. mangium*, o que favorece o controle dos potencialmente pragas e auxilia na realização de planos amostrais. Tais iformações são úteis para se entender a relação inseto planta em árvores de *A. mangium*. Os insetos sugadores atraíram, provavelmente, mais formigas protocooperantes, dos inimigos naturais os mais dominantes, nas folhas de *A. mangium*. Mas isso pode ser um problema, pois essas formigas podem reduzir o crescimento da *A. mangium* por serem associadas com insetos sugadores e afugentarem inimigos naturais como as aranhas. O inseto sugador *A. reticulatum* e a abelha *T. spinipes* apresentaram maiores dominâncias-K entre os fitófagos e polinizadores, respectivamente, em folhas de *A. mangium*, além de poder estar associados, *T.spinipes* se alimentando de honeydew. Mas isso é preocupante, pois esses insetos podem danificar frutos e brotações dessa planta.