UNIVERSIDADE FEDERAL DOS VALES DO JEQUITINHONHA E MUCURI
Programa de Pós-Graduação em Biologia Animal

Jéssika Silva de Lima

EVOLUÇÃO NA RECUPERAÇÃO DE ÁREA DEGRADADA UTILIZANDO-SE PLANTAS DE *Acacia mangium* WILLD (FABALES: FABACEAE): PRODUÇÃO DE MASSA FOLIAR E INSETOS E ARANHAS COMO BIOINDICADORES

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painho, mainha e minhas irmãs

pelo incentivo, amor e carinho.

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“Não importa o que aconteça, continue a nadar”

(WALTERS, GRAHAM - PROCURANDO NEMO, 2003)

RESUMO

Acacia mangium Willd. (Fabaceae) é uma espécie pioneira, de rápido crescimento e rusticidade, além de apresentar potencial nitrificador, sendo utilizadas em programas de recuperação de áreas degradadas. Os objetivos deste trabalho foram estudar a evolução na recuperação de área degradada utilizando-se plantas jovens de *A. mangium*, sua produção de produção de massa foliar e de seus insetos e aranhas como bioindicadores (abundância, diversidade e riqueza de espécies) e as interações entre os grupos de artrópodos, durante 24 meses. O delineamento experimental foi inteiramente casualizado com 24 repetições (plantas jovens), sendo os tratamentos o primeiro e o segundo ano após o plantio. As plantas de *A. mangium*, no segundo ano de desenvolvimento, apresentaram maiores números de folhas/galho, galhos/árvore e de cobertura do solo (serapilheira, plantas herbáceas e gramíneas), abundâncias de Hemiptera *Phenacoccus* sp. (Pseudococcidae) e *Pachycoris torridus* Scopoli (Scutelleridae); Hymenoptera *Tetragonisca angustula* Latreille e *Trigona spinipes* Fabricius (Apidae) e *Brachymyrmex* sp., *Camponotus* sp. e *Cephalotes* sp. (Formicidae); Blattodea *Nasutitermes* sp. (Termitidae) e Neuroptera *Chrysoperla* sp. (Chrysopidae); e maiores abundâncias e riquezas de espécies de insetos polinizadores e de formigas cuidadoras, e abundância de predadores de Sternorrhyncha comparada com o primeiro ano. Maiores abundâncias de Hemiptera *Aethalium reticulatum* L. (Aethalionidae), Hymenoptera *Camponotus* sp., *Cephalotes* sp., *Polybia* sp. (Vespidae), *T. angustula*, *T. spinipes*, e abundâncias de formigas cuidadoras, insetos polinizadores, predadores totais e de Sternorrhyncha e riqueza de espécies de formigas cuidadoras foram observadas em plantas de *A. mangium* com mais folhas ou galhos. As maiores abundâncias de *T. spinipes* e de *Pheidole* sp. se correlacionaram de forma positiva com aqueles de *A. reticulatum*; as de *Tropidacris collaris* Stoll. (Orthoptera: Romaleidae) e de *Parasyphraea* sp. (Coleoptera: Chrysomelidae) com as de Araneidae. As maiores diversidade e riqueza de espécies de Hemiptera fitófagos incrementaram aqueles de predadores de Sternorrhyncha e a abundância de insetos mastigadores a de aranhas. Por outro lado, as maiores abundâncias de insetos mastigadores apresentaram correlação negativa com as de *Bemisia* sp. (Hemiptera: Aleyrodidae); as de formigas cuidadoras com as de *T. spinipes* e as de Dolichopodidae (Diptera); e as de predadores totais com as de *T. spinipes.* A idade das plantas de *Acacia mangium* influenciou no aumento da população de artrópodes e cobertura do solo, indicando ser uma boa alternativa para a recuperação de áreas degradadas.

Palavras-chaves: Bioindicadores. Insetos polinizadores. *Camponotus* sp.

ABSTRACT

Acacia mangium Willd. (Fabaceae) is a pioneer species, with rapid growth and rusticity, in addition to presenting nitrifying potential, being used in programs for the recovery of degraded areas. The objectives of the work were to study the evolution in the recovery of degraded area using *A. mangium* saplings, its production of production of leaf mass and of its insects and spiders as bioindicators (abundance, diversity and specie richness) and as interactions between groups of arthropods for 24 months. The experimental design was completely randomized with 24 replications (saplings), with treatments being the first and second years after planting. The *A. mangium* saplings, in the second year of development, had higher numbers of leaves/branch, branches/saplings and soil cover (litter, herbaceous and grass plants), abundance of Hemiptera *Phenacoccus* sp. (Pseudococcidae) and *Pachycoris torridus* Scopoli (Scutelleridae); Hymenoptera *Tetragonisca angustula* Latreille and *Trigona spinipes* Fabricius (Apidae) and *Brachymyrmex* sp., *Camponotus* sp. and *Cephalotes* sp. (Formicidae); Blattodea *Nasutitermes* sp. (Termitidae) and *Neuroptera Chrysoperla* sp. (Chrysopidae); and greater abundance and specie richness of pollinating insects and tending ants, and an abundance of Sternorrhyncha predators compared to the first year. Greater abundances of Hemiptera *Aethalium reticulatum* L. (Aethalionidae), Hymenoptera *Camponotus* sp., *Cephalotes* sp., *Polybia* sp. (Vespidae), *T. angustula, T. spinipes*, and abundance of tending ants, pollinating insects, total and Sternorrhyncha predators and specie richness of tending ants were observed in *A. mangium* saplings with more leaves or branches. The highest abundances of *T. spinipes* and *Pheidole* sp. correlated positively with those of *A. reticulatum*; and those of *Tropidacris collaris* Stoll. (Orthoptera: Romaleidae) and that of *Parasyphraea* sp. (Coleoptera: Chrysomelidae) with those of Araneidae. Greater diversity and specie richness of Hemiptera phytophages increased those of Sternorrhyncha predators and an abundance of chewing insects to spiders. On the other hand, the highest abundance of chewing insects was negatively correlated with of *Bemisia* sp. (Hemiptera: Aleyrodidae); that of tending ants those of *T. spinipes* and Dolichopodidae (Diptera); and that of total predators with those of *T. spinipes*. The greater age of the *A. mangium* saplings, increased the arthropod populations and soil cover, indicating that it is a good alternative for the recovery of degraded areas.

Keywords: Bioindicators. Pollinating insects. *Camponotus* sp.

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SUMÁRIO

INTRODUÇÃO GERAL

As atividades humanas ocasionam a degradação, não somente de ecossistemas naturais, mas também as áreas destinadas à agricultura, com rapidez, principalmente pelos processos inevitáveis do seu crescimento populacional e econômico (GARCÍA-ORTH & MARTÍNEZ-RAMOS, 2011). Em face dos danos ambientais, a recuperação dessas áreas é considerada prioritária, mas que demanda tempo (AMARAL *et al.,* 2013; REIS *et al.*, 2015).

E várias espécies da família Fabaceae tem sido utilizada na recuperação de ambientes degradados destacando-se a *Acacia mangium* Willd espécie originária da Austrália e da Malásia. Por ser uma árvore pioneira, de rápido crescimento e rusticidade, alta adaptabilidade a solos ácidos e inférteis, com alta fixação de nitrogênio (WANG *et al.*, 2013; CALDEIRA *et al.*, 2018; SILVA *et al.*, 2020), devida a simbiose com bactérias diazotróficas, resultando em alta produtividade de biomassa e entrada de nutrientes, via serapilheira, favorecendo a sucessão vegetal (PAULA *et al.*, 2018; SILVA *et al.*, 2020). Além disso, apresenta capacidade adaptativa às condições edafoclimáticas brasileiras (BALIEIRO *et al.*, 2004) e flores com grande produção de néctar, tornando assim bem atrativas para os insetos polinizadores como abelhas com alto potencial para a apicultura e meliponicultura (SILVA *et al.,* 2020).

Em árvores de *A. mangium* foram identificados: Hemiptera *Aethalion reticulatum* L. (Aetalionidae), Hymenoptera *Camponotus* sp. (Formicidae), *Tetragonisca angustula* Latreille e *Trigona spinipes* Fabricius (Apidae) e *Polistes* sp. (Vespidae) e Coleoptera *Oncideres mirim* Martins e Galileo, *O. ocularis* Thomson, *O. saga* Dalman (Cerambycidae), dentre outros (LEMES *et al.*, 2012, 2013, 2015; SILVA *et al.* 2015, 2020). A presença dos artrópodes pode ser utilizada, como bioindicadores, para avaliar as mudanças ambientais com eficiência, por serem sensíveis às mudanças do ambiente e, portanto, podem ser utilizados no monitoramento de distúrbios ambientais (PROSSER *et al.*, 2016; PEREIRA *et al.*, 2018). Por meio de parâmetros populacionais é possível inferir indicadores de saúde e riqueza do ecossistema, qualquer mudança na estrutura ecológica, diminuição do fluxo de matéria e energia e também devido à sua alta mobilidade e ciclo de vida (PEREIRA *et al.*, 2018). A adubação e a idade das plantas afetam a diversidade de insetos fitófagos e seus inimigos naturais, sendo assim, servem como índices de defesa química e nutricional para as plantas (BOWERS & STAMP, 1993). As plantas têm efeito indireto sobre a reprodução, crescimento e sobrevivência de artrópodes (OLIVEIRA *et al.*, 2014).

Competição entre grupos de artrópodes podem ocorrer, sendo elas por interferência direta ou competição exploratória (BHUYAIN *et al.*, 2019). Competição por interferência direta inclui a morte de um dos organismos competidores, o comportamento agressivo e a produção de produtos químicos (ex.: feromônios e cairomônio) (BOULAY *et al*., 2019). Todavia, a concorrência exploratória inclui o esgotamento de recursos, com graves consequências para a maioria ou todos os indivíduos concorrentes, resultando em alta mortalidade dependente da densidade e insuficiência reprodutiva, drásticos acidentes na população e dinâmica populacional instáveis (BOULAY *et al*., 2019). Também existem as relações mutualísticas entre insetos como formigas protocooperantes (ex: *Camponotus* sp.) com os da ordem Hemiptera (ex.: *A. reticulatum*), desempenhando papel de cooperação, protegendo contra inimigos naturais em troca de alimento como o *honeydew*, solução açucarada rica em nutrientes (STADLER & DIXON, 2005; ZANUNCIO *et al*., 2015; ARAUJO *et al*., 2016). Além disso, os insetos podem preferir colonizar plantas com crescimento mais vigoroso – hipótese do vigor da planta – aumentando a abundância e diversidade destes, e dos seus inimigos naturais (PRICE, 1991). Nessas condições, os mesmos processos ecológicos da teoria das ilhas biogeográficas (IBG) se aplicam às plantas, com maior probabilidade de extinção de espécies mais raras em IBG menores (KITAHARA & FUJII, 1997; BURNS, 2016; LEITE *et al.*, 2017).

Deste modo, os objetivos deste trabalho foram estudar a evolução na recuperação de área degradada utilizando-se plantas jovens de *A. mangium*, sua produção de massa foliar e de seus insetos e aranhas como bioindicadores (abundância, diversidade e riqueza de espécies) e as interações (competição, predação e protocooperação) entre os grupos de artrópodes, durante 24 meses. Para tanto, foram testadas cinco hipóteses: i) plantas de *A. mangium* de maior idade tem maior copa (> IBG) (ELOY *et al*., 2018) e produção de serapilheira auxiliando na recuperação da área degradada (AMARAL *et al.,* 2013); ii) maiores abundâncias, diversidades e riqueza de espécies de insetos herbívoros e polinizadores e, consequentemente, as de predadores e formigas cuidadoras, ocorre em plantas de maior idade devido às maiores copas (> IBG) (SCHMITZ, 2008; LEITE *et al.*, 2017; SILVA *et al*., 2020); iii) a abundância de formigas cuidadoras e de predadores é diretamente proporcional aos dos Hemiptera fitófagos e presas, respectivamente (SCHMITZ, 2008; LEITE *et al*., 2012a); iv) maior abundância dessas formigas reduz a de predadores e insetos mastigadores (LEITE *et al.*, 2012b; WÄCKERS *et al.*, 2017); e v) ocorre competição entre insetos (LEITE *et al.*, 2017).

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ARTIGO CIENTÍFICO

INSETOS E ARANHAS COMO BIOINDICADORES DA RECUPERAÇÃO DE ÁREAS TROPICAIS DEGRADADAS COM PLANTAS DE *Acacia mangium* (FABACEAE)

RESUMO

Acacia mangium é uma espécie pioneira de rápido crescimento e frequentemente utilizada na recuperação de áreas degradadas. Os objetivos foram avaliar insetos e aranhas, seus índices ecológicos e interações com plantas de *A. mangium* em uma área tropical degradada em processo de recuperação. O delineamento experimental foi inteiramente casualizado com 24 repetições, sendo os tratamentos o primeiro e segundo ano após a implantação das plantas. Número de folhas/galhos, galhos/planta e cobertura do solo por planta de *A. mangium*, Hemiptera *Phenacoccus* sp. e *Pachycoris torridus*; Hymenoptera *Tetragonisca angustula* e *Trigona spinipes*, *Brachymyrmex* sp., *Camponotus* sp. e *Cephalotes* sp.; Blattodea *Nasutitermes* sp. e Neuroptera *Chrysoperla* sp.; abundância, riqueza de espécies de insetos polinizadores, formigas cuidadoras e a abundância de predadores de Sternorrhyncha foram maiores no segundo ano após o transplantio. Números de Hemiptera *Aethalium reticulatum*, Hymenoptera *Camponotus* sp., *Cephalotes* sp., *Polybia* sp., *T. angustula*, *T. spinipes,* formigas cuidadoras, insetos polinizadores, predadores de Sternorrhyncha e riqueza de espécies de formigas cuidadoras foram maiores em plantas de *A. mangium* com maiores números de folhas e galhos. O crescimento da população de artrópodes e da cobertura do solo com a maior idade das plantas de *A. mangium* indicam seu positivo impacto na recuperação de áreas degradadas.

Palavras-chaves: Artrópodes. Diversidade. Formicidae. Insetos polinizadores. *Camponotus* sp.

INSECTS AND SPIDERS AS BIOINDICATORS OF THE RECOVERY OF TROPICAL DEGRADED AREAS USING *Acacia mangium* (FABACEAE) SAPLINGS

ABSTRACT

Acacia mangium is a pioneer species of fast growth and frequently used in the recovery of degraded areas. The objectives were to evaluate insects and spiders, their ecological indices and interactions on *A. mangium* saplings in a tropical degraded area in recovery process. The experimental design was completely randomized with 24 replicates, with treatments in the first and second years after plant implantation. Numbers of leaves/branch, branches/sapling, and ground cover by *A. mangium* saplings, Hemiptera *Phenacoccus* sp. and *Pachycoris torridus*; Hymenoptera *Tetragonisca angustula* and *Trigona spinipes*, *Brachymyrmex* sp., *Camponotus* sp. and *Cephalotes* sp.; Blattodea *Nasutitermes* sp. and Neuroptera *Chrysoperla* sp.; abundance, species richness of pollinating insects, tending ants, and the abundance of Sternorrhyncha predators were greatest in the second year after planting. Numbers of Hemiptera *Aethalium reticulatum*, Hymenoptera *Camponotus* sp., *Cephalotes* sp., *Polybia* sp., *T. angustula*, *T. spinipes*, tending ants, pollinating insects, Sternorrhyncha predators and species richness of tending ants were highest on *A. mangium* saplings with greatest numbers of leaves or branches. The growth in the population of arthropods and ground cover with the *A. mangium* saplings' aging process indicates their positive impact on the recovery of degraded areas.

Keywords: Arthropods. Diversity. Formicidae. Pollinating insects. *Camponotus* sp.

1 INTRODUCTION

Human action usually degrades natural ecosystems, especially with agricultural systems management, for the maintenance of populational and economic growth (GARCÍA-ORTH & MARTÍNEZ-RAMOS, 2011). The recovery of these areas is essential but slow (AMARAL *et al*., 2013; REIS *et al*., 2015).

Species of the Fabaceae family have been used for the recovery of degraded areas worldwide, notably *Acacia mangium* Willd, due to its fast growth, rusticity, high adaptability to acidic and infertile soils and nitrifying potential (WANG *et al*., 2013; CALDEIRA *et al*., 2018; SILVA *et al*., 2020). The high rates of nitrogen fixation by this plant, due to symbiosis with diazotrophic bacteria, increases the production of biomass and nutrient input via litter, favoring plant succession (PAULA *et al*., 2018; SILVA *et al*., 2020). Adaptive capacity to the Brazilian soil and edaphoclimatic conditions (BALIEIRO et al., 2004) and flowers with great nectar production, making them attractive to pollinating insects such as bees, with high potential for beekeeping and meliponiculture (SILVA et al., 2020).

In *A. mangium* trees were identified: Hemiptera *Aethalion reticulatum* L. (Aetalionidae), Hymenoptera *Camponotus* sp. (Formicidae), *Tetragonisca angustula* Latreille and *Trigona spinipes* Fabricius (Apidae) and *Polistes* sp. (Vespidae) and Coleoptera *Oncideres Mirim* Martins and Galileo, *O. Ocularis* Thomson, *O. saga* Dalman (Cerambycidae), among others (LEMES *et al*., 2012, 2013, 2015; SILVA *et al*. 2015, 2020). Arthropods can be bioindicators of environmental changes because of their quick responses (PROSSER *et al*., 2016; PEREIRA *et al*., 2018) and their ecological indices (e.g. diversity) are used to verify modifications in ecological structures (e.g. reduction in the species richness of communities) (PEREIRA *et al*., 2018). The reproduction, growth, and survival of phytophagous insects and their natural enemies vary according to fertilization, plant age, leaf mass, chemical and nutritional defenses (BOWERS & STAMP, 1993; OLIVEIRA *et al*., 2014). Abundance and diversity of phytophagous insects and their natural enemies can be increased in larger plants as they function as biogeographic islands (BGI) preserving endangered species from extinction (KITAHARA & FUJII 1997; BURNS, 2016; LEITE *et al*., 2017).

Still, there may be competition between groups of arthropods by the interference or competition on the exploratory activity (BHUYAIN *et al*., 2019). It involves direct death, aggressive behavior, and the production of chemicals (e.g. pheromones) (BOULAY *et al*., 2019). Competition on the exploratory activity includes resource depletion with high density-dependent mortality rates and reproductive failure (Boulay *et al*., 2019). Tending ants protect Hemiptera insects (e.g. *A. reticulatum*) against natural enemies in exchange for honeydew, a carbohydrate-rich food (STADLER & DIXON, 2005; ZANUNCIO *et al*., 2015; ARAUJO *et al*., 2016).

The objectives of this research were to study insects and spiders as bioindicators (abundance, diversity, and species richness) and the interactions (competition, predation, and protocooperation) between arthropod groups, on young *A. mangium* trees (saplings in the vegetative period) in a tropical degraded area.

Five hypotheses were tested: i) oldest *A. mangium* saplings have highest crowns (highest BGI) and greatest litter production, influencing, positively, the recovery of the degraded area; ii) abundance, diversity, species richness of herbivorous and pollinating insects and, consequently, those of predators and tending ants, are biggest in oldest saplings due to their largest crowns (highest BGI); iii) the abundances of tending ants and predators are directly proportional to that of Hemiptera phytophagous and prey, respectively; iv) the greatest abundance of ants reduces that of predators and chewing insects, and v) competition between insects occur.

2 MATERIAL AND METHODS

2.1 Experimental site

The study was carried out in a degraded area (1 ha) at the Universidade Federal de Minas Gerais (UFMG), Montes Claros, Minas Gerais State, Brazil (latitude 16º51'38 S, longitude 44º55'00" W, altitude 943 m) from April 2015 to February 2017. The area was defined as degraded owing to soil losses and changes in soil chemistry or hydrology (MILTON et al., 1994; WHITFORD, 2001). The climate in this area is dry tropical; with annual rainfall between 1,000 – 1,300 mm, dry winter, and average annual temperature of 22.4ºC, according to the Köppen climate classification (ALVARES et al., 2013). The soil is of the Neosol Litolic type with an Alic horizon (SANTANA et al., 2016), and its physical-chemical characteristics are as described by Silva et al. (2020).

2.2 Experimental design

Acacia mangium seedlings were produced from seeds collected on trees on the campus. The seeds were planted in plastic bags (16 x 24 cm) in a nursery with a substrate with 30% organic compost, 30% clay soil, 30% sand, and 10% reactive natural phosphate (160g) in March 2014. In September of the same year, 30 cm tall seedlings were planted, at the same time, in holes (40 x 40 x 40cm), spaced out by two meters each, and fertilized in a single dose, with 20L of dehydrated sewage sludge/hole (Nogueira *et al*. (2007). The saplings were irrigated twice a week until the beginning of the rainy season. The design was completely randomized with 24 repetitions (one sapling each), with treatments in the first and second years after plant implantation.

2.3 Production of vegetal mass and ground cover

Numbers of leaves/branch and branches/sapling and the percentage of ground cover by litter, herbaceous and grassy plants were evaluated visually and monthly per plot (1m^2) in the crown projection of each one of the 24 *A. mangium* saplings.

2.4 Arthropods and their ecological indices and interactions

All 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 - divided into three equal parts and in the north, south, east and west directions - horizontal axis. A total of 12 leaves/sapling/evaluation were observed on 24 *A. mangium* saplings starting six months after transplantation during 24 months, 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 or jump, on approach, were counted as long as they were recognized. 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 registered in previous evaluations, was collected, coded and sent to a taxonomist of its group. We visually observe the interactions between ants and Hemiptera.

2.5 Statistic analysis

Each replication was the total of individuals collected on 12 leaves (three heights and four sides of the sapling). The ecological indices (abundance, diversity and species richness) were calculated per group in the treatments (years 1 and 2) using the BioDiversity Professional, Version 2 software (© 1997 The Natural History Museum) (KREBS, 1989). Abundance and species richness are the total number of individuals and species, respectively, per sampling (BEGON *et al*., 2007). Diversity was calculated using Hill's formula (1st order): N1 = exp (H'), where H' is the Shannon – Weaver diversity indices, that calculates diversity and the current number of species (HILL, 1973).

The data on abundance, diversity, and species richness of phytophagous insects, pollinators insects and natural enemies were analyzed with a non-parametric statistical hypothesis, Wilcoxon signed-rank test (P <0.05) (WILCOXON, 1945) using the statistical software "Sistema para Análises Estatísticas e Genéticas" (SAEG), version 9.1 (SAEG, 2007) (Supplier: "Universidade Federal de Viçosa"). Data were also subjected to second degree or principal component regressions (PCR) (P <0.05), when linear to verify the possible interactions (e.g. protocooperation) between groups of arthropods (e.g. tending ants and Hemiptera phytophagous). 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). PCR uses principal component analysis, based on a covariance matrix to perform regression. It provides a reduction in the size of regression, excluding the dimensions that contribute to collinearity, which are, linear relationships between the independent variables (BAIR *et al*., 2006). The parameters used in these equations were significant (P <0.05) due to variable selection by the ‘‘Stepwise’’ method with the statistical software. The data presented in the text were only significant (P <0.05) and the rest are in supplementary material I.

3 RESULTS

3.1 Production of vegetal mass and ground cover

Numbers of leaves/branch, branches/sapling, and ground cover (litter, herbaceous and grassy plants) were highest on *A. mangium* saplings, in the second year of planting (Table 1).

3.2 Arthropods and their ecological indices

Numbers of Blattodea *Nasutitermes* sp. (Termitidae); Hemiptera *Phenacoccus* sp. (Pseudococcidae) and *Pachycoris torridus* Scopoli (Scutelleridae); Hymenoptera *Tetragonisca angustula* Latreille and *T. spinipes* (Apidae), *Brachymyrmex* sp., *Camponotus* sp., and *Cephalotes* sp. (Formicidae); and Neuroptera: *Chrysoperla* sp. (Chrysopidae) were highest on *A. mangium* saplings in the second year after planting. Abundance and species richness of pollinating insects, tending ants, and abundance of Sternorrhyncha predators were greatest on *A. mangium* saplings in the second year. Numbers of *A. reticulatum*, *Camponotus* sp., *Cephalotes* sp., *Poybia* sp. (Hymenoptera: Vespidae), *T. angustula*, and *T. spinipes* were highest on *A. mangium* saplings with greatest numbers of leaves or branches. Abundances of tending ants, pollinating insects, Sternorrhyncha predators and species richness of tending ants were greatest on *A. mangium* saplings with biggest vegetal mass (e.g. *A. mangium* leaves). However, the numbers of Araneae Araneidae and Oxyopidae; Coleoptera *Cerotoma* sp., *Stereoma anchoralis* Lacordaire (Chrysomelidae), and total Coleoptera; Hemiptera *Bemisia* sp. (Aleyrodidae), Membracidae, and *Bladina* sp. (Nogodinidae); Hymenoptera *Apis mellifera* L. (Apidae), *Ectatoma* sp. and *Pheidole* sp. (Formicidae); and total Orthoptera were highest in saplings in the first year after planting. Also, abundance, species richness of chewing insects (highest defoliation), and spiders were greatest in saplings in this year. The number of *Pheidole* sp., and the abundance and species richness of chewing insects were smallest in leafiest saplings (Tables 2-4).

3.3 Protocooperation, predation and competition

The numbers of *T. spinipes* and *Pheidole* sp. correlated, positively, with that of *A. reticulatum*; and those of Araneidae with those of *Tropidacris collaris* Stoll. (Orthoptera: Romaleidae) and *Parasyphraea* sp. (Coleoptera: Chrysomelidae). Diversity and species richness of Sternorrhyncha predators correlated, positively, with those of Hemiptera phytophagous, and abundance of spiders with that of chewing insects. However, the number of *Bemisia* sp. correlated, negatively, with that of chewing insects; those of *T. spinipes* and Dolichopodidae (Diptera) with that of tending ants; and that of *T. spinipes* with that of total predators (Table 4).

4 DISCUSSION

A greatest production of vegetal mass with biggest ground cover (eg.: litter), on *A. mangium* saplings (highest BGI), increased abundance of sap-sucking insects and tending ants in the second year after planting. Therefore, numbers of predators, defoliators and, in some situations, were reduced, stirring competition between groups of insects (LEITE *et al*., 2012a, b, 2017; SILVA *et al*., 2020).

Largest canopies of *A. mangium* saplings and ground cover in the second year after planting confirms the first hypothesis that older sapling helps to recover a degraded area, corroborates with greatest biomass production (wood, branch, leaf, and bark) – as with the aging of *Acacia mearnsii* De Wild, *Ateleia glazioviana* Baill and *Mimosa scabrella* Benth (Fabaceae), and *Eucalyptus grandis* (Myrtaceae) W. Hill ex Maiden (ELOY *et al*., 2018). This occurrence expresses the recovery potential of *A. mangium* plants. It presents rapid growth, even in degraded soils, by an efficient nitrogen fixation (CIPRIANI *et al*., 2013; SILVA *et al*., 2020), also, its flowers attract pollinating insects (WANG *et al*., 2013; CALDEIRA *et al*., 2018; SILVA *et al*., 2018; SILVA *et al*., 2020).

Greatest numbers of sap-sucking insects (e.g. *Phenacoccus* sp.) and termite *Nasutitermes* sp., pollinators (e.g. *T. angustula*), tending ants (e.g. *Brachymyrmex* sp.), Sternorrhyncha predators (e.g. *Chrysoperla* sp.) on *A. mangium* saplings, in the second year of planting, are, probably, due to the biggest numbers of leaves (e.g. *Camponotus* sp.) and branches (e.g. *A. reticulatum*) in these saplings (highest BGI). *Acacia mangium* saplings, in the second year of planting, also showed highest abundance and species richness of pollinating insects and tending ants, and abundance Sternorrhyncha predators, probably, due to the biggest vegetal mass. This partially confirms the second hypothesis that with highest BGI has greatest abundance of herbivorous and pollinating insects and, consequently, tending ants and predators (SCHMITZ, 2008; LEITE *et al*., 2017; SILVA *et al*., 2020). Pollinating insects (e.g. *T. spinipes*) and tending ants (e.g. *Camponotus* sp.) showed four to six times highest numbers on *A. mangium* saplings, in the second year after planting, are due to their larger canopies, and, consequently, with biggest numbers of extrafloral nectaries (leaf base), providing greatest amounts of food (HEGDE *et al*., 2013). The elements above validate those of *Brachymyrmex* sp., *Camponotus* sp., and *T. spinipes* on *Leucaena leucocephala* (Lam.) (Fabaceae) plants (DAMASCENA *et al*., 2017) and *Brachymyrmex obscurior* Forel (Hymenoptera: Formicidae) on *Acacia pennatula* (Schltdl. & Cham.) Benth. (Fabaceae) plants (MOYA-RAYGOZA, 2005). Biggest *A. mangium* saplings, in the second year after planting, may have functioned as BGIs, presenting greatest food supplies and shelter for arthropods, what provides a smallest risk of extinction of rarer species (KITAHARA & FUJII, 1997; BURNS, 2016; LEITE *et al*., 2017). Numbers of pollinating insects and *Nasutitermes* sp. were highest on *A. mangium* saplings with largest crowns. A similar fact was observed for galling insects in *Caryocar brasiliense* A. St.-Hil. (Caryocaraceae) and *Macairea radula* (Bonpl.) DC. (Melastomataceae) and *Carpatolechia proximella* Hbn. (Lepidoptera: Gelechiidae) on *Picea abies* (L.) Karst. (Pinaceae) plants with biggest crowns (LARA *et al*., 2008; ZVEREVA *et al*., 2014; LEITE *et al*., 2017). On the other hand, greatest abundance, species richness, and defoliation on *A. mangium* saplings by the chewing insects (e.g. *S. anchoralis, T. collaris*) and, consequently, predatory spiders (e.g. Araneidae), sap-sucking insects (e.g. *Bemisia* sp.) and tending ants (e.g. *Pheidole* sp.), in the first year after planting, occurred, probably, due to rapid growth, softest leaves, highest nitrogen content (e.g. leaf protein and free amino acids in the sap) via fertilization of dehydrated sewage sludge (e.g. rich in nitrogen and other minerals) (TAIZ *et al*., 2017; SILVA *et al*., 2020). *Bemisia* sp. is an initial pest that affects annual crops, with a preference for new leaves of youngest *Glycine max* L. (Fabaceae) - plants with a highest concentration of free amino acids in the sap (most nutritious food) (CRUZ *et al*., 2016).

The rise in the numbers of predators (e.g. spiders) with that of phytophagous insects (e.g. defoliating insects), that of Araneidae with those of *T. collaris* and *Parasyphraea* sp., that of tending ants *Pheidole* sp. with that of *A. reticulatum*, and diversity and species richness of Sternorrhyncha predators with those of Hemiptera phytophagous on *A. mangium* saplings confirm the third hypothesis that with highest numbers of Hemiptera phytophagous and prey result in greatest numbers of tending ants and predators, respectively (SCHMITZ, 2008; LEITE *et al*., 2012a). The direct correlation between sap-sucking insects and ants of the genera *Camponotus* and *Brachymyrmex* is due to associations between these groups of insects with mutual benefits (NOVGORODOVA, 2015; SANCHEZ *et al*., 2019). This fact accords with the greatest numbers *Dikrella caryocar* (COELHO, LEITE & DA-SILVA) (Hemiptera: Cicadellidae) and *Pseudoccocus* sp. (Hemiptera: Pseudococcidae) with *Crematogaster* sp. (Hymenoptera: Formicidae) on *C. brasiliense* trees (LEITE *et al*., 2012a, 2015). Spiders reduced insect damage, especially defoliators, in agroecosystems in the USA and Italy (LANDIS *et al*., 2000; VENTURINO *et al*., 2008), in 12 agricultural landscapes in the low mountain ranges of Central Hesse (Germany) (ÖBERG *et al*., 2008), and on *C. brasiliense* (LEITE *et al*., 2012b) and *A. mangium* (SILVA *et al*., 2020) trees in the Cerrado and pastures in Brazil. The largest numbers of tending ants, associated with sap-sucking insects (e.g. *Pheidole* sp. with *A. reticulatum*) may also have contributed to the greatest abundance of chewing insects (e.g. *Cerotoma* sp.) and spiders (e.g. Oxyopidae), in the first year after the planting of *A. mangium* saplings. These facts confirm the fourth hypothesis that with highest numbers of tending ants decrease those of chewing insects and predators (LEITE *et al*., 2012b; WÄCKERS *et al*., 2017). Trophobiotic interactions between ants (protection against natural enemies) and Sternorryncha (Hemiptera) (supplier of sugary substance - food) are one of the main mechanisms for the maintenance of ants superabundance in ecosystems (KLIMES *et al*., 2018), which may decrease that of natural enemies, including Sternorrhyncha predators, with a negative impact on the biological control of sap-sucking insects (WÄCKERS *et al*., 2017; KANEKO, 2018; TONG *et al*., 2019). On the other hand, ants can reduce defoliation and fruit-boring insect populations (e.g. Coleoptera and Lepidoptera) (LEITE *et al*., 2012b; GONTHIER *et al*., 2013; FAGUNDES *et al*., 2017; DASSOU *et al*., 2019) besides, they are bioindicators of the recovery of degraded areas (SANCHEZ, 2015).

A greatest abundances of chewing insects and *Bemisia* sp., after the first year, and tending ants and *T. spinipes*, in the second year, after the planting of *A. mangium* saplings, as well as the reduction in the number of these sap-sucking and pollinating insects by largest numbers of chewing insects and ants, confirm the fifth hypothesis that competition between insects occur in those environments (LEITE *et al*., 2017). *Trigona spinipes* directly correlated with *A. reticulatum* in this study, as related by Dos Santos *et al*. (2019) with *Trigona hyalinata* (Lepeletier) on *Clitoria fairchildiana* Howard (Fabaceae) branches (ODA *et al*., 2009). There was probably competition for honeydew, produced by this sap-sucking insect, between *T. spinipes* and tending ants (e.g. *Pheidole* sp.) on *A. mangium* saplings. *Trigona* spp. has strong jaws, is aggressive and can, in addition to attacking, release repellent substances on potential predators or competitors (e.g. ants) for honeydew - insects that suck sap and live in colonies (SCHORKOPF *et al*., 2009). There is also competition, for food and space, between *T. spinipes* x *A. mellifera* and *T. angustula* in cucurbits and *A. mangium* trees (SERRA & CAMPOS, 2010; SILVA *et al*., 2020), and between four-leaf galling insects (Hymenoptera), likewise, between aphids and beetles on *C. brasiliense* trees (LEITE *et al*., 2012b, 2017). Phylogenetic proximity favors the formation and maintenance of groups of mixed species (eussocial or gregarious), probably, due to easier communication between members with similar size, lifespan, and displacement (BOULAY *et al*., 2019).

Differently, close ecological niches sharing reduces the availability of food or reproductive partners through competition between species. The balance between the sharing of these resources and competition is crucial for the understanding of these species' clusters and the disproportionate benefits for one species at the expense of the other (BOULAY *et al*., 2019).

5 CONCLUSIONS

The numbers of *Trigona collaris* (≈1/sapling) and *Bemisia* sp. (≈3/sapling) (first year after planting), *A. reticulatum* (≈3/sapling) (in the second year), and *Nasutitermes* sp. (≈30/sapling) and *T. spinipes* (≈4/sapling) (second year after planting) on *A. mangium* saplings deserve attention since they are pests and harmful for this one and many other plants. The production of vegetal mass (e.g. branches) and ground cover (e.g. leaf litter) and the number of arthropods (e.g. tending ants) increased in sync with the aging process of *A. mangium* saplings. This correspondence indicates that the plant is a valuable alternative for the recovery of degraded areas. Also, the growing numbers of sap-sucking insects made a positive impact in the amounts of tending ants, reducing those of predators, chewing insects, and *T. spinipes*, as the latter competes for food resources (honeydew), from *A. reticulatum*, with the tending ants.

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Table 1 - Number of leaves/branch and branches/sapling, and percentage of ground cover per *Acacia mangium* sapling (Fabaceae) (mean ± SE) and planting year.

Variables	Year		TW*	
	First	Second	*VT*[£]	*P*
Leaves/branch	22.90 ± 0.65	43.92 ± 2.94	5.42	0.00
Branches/sapling	34.40 ± 1.64	49.20 ± 3.32	3.53	0.00
Ground cover	14.66 ± 1.57	37.00 ± 2.99	4.62	0.00

*TW= Test of Wilcoxon. [£]VT= value of test. n= 24 per treatment.

Table 2 - Order, family, and specie of spiders (Class Arachnidae) and insects (Class Insecta), and percentage of defoliation by insects per *Acacia mangium* sapling (Fabaceae) (mean ± SE) and planting year.

Order: family, specie	Year		TW*	
	First	Second	*VT*[£]	*P*
Ara.: Araneidae, none identified	0.63±0.17	0.21±0.10	1.95	0.02
Oxyopidae, none identified	0.58±0.17	0.17±0.07	1.98	0.02
Blat.[§]: Termitidae, *Nasutitermes* sp.	6.46±5.30	29.92±14.07	2.31	0.01
Col.: Chrysomelidae, *Cerotoma* sp.	0.21±0.08	0.00±0.00	2.34	0.01
Stereoma anchoralis Lacordaire	0.21±0.13	0.00±0.00	1.77	0.03
Total Coleoptera	1.58±0.53	0.42±0.13	2.22	0.01
Hem.: Aleyrodidae, *Bemisia* sp.	2.71±1.09	0.04±0.04	2.12	0.01
Membracidae, none identified	0.46±0.17	0.33±0.33	2.18	0.01
Nogodinidae, *Bladina* sp.	0.13±0.06	0.00±0.00	1.77	0.03
Pseudococcidae, *Phenacoccus* sp.	0.00±0.00	2.21±1.18	2.06	0.01
Scutelleridae, *Pachycoris torridus*	0.00±0.00	0.17±0.09	1.77	0.03
Hym.: Apidae, *Apis mellifera* L.	0.38±0.15	0.00±0.00	2.59	0.00
Tetragonisca angustula Latreille	0.33±0.13	1.04±0.22	2.63	0.00
Trigona spinipes Fabr.	0.67±0.28	4.00±1.30	2.63	0.00
Formicidae, *Brachymyrmex* sp.	3.04±1.02	37.17±10.56	2.62	0.00
Camponotus sp.	0.63±0.26	8.58±2.04	4.94	0.00
Cephalotes sp.	0.17±0.16	6.88±3.04	2.82	0.00
Ectatoma sp.	0.92±0.26	0.17±0.09	2.59	0.00
Pheidole sp.	4.00±0.74	1.13±0.29	3.06	0.00
Neu.: Chrysopidae, *Chrysoperla* sp.	0.00±0.00	0.13±0.06	1.77	0.03
Total Orthoptera	1.42±0.28	0.75±0.17	1.71	0.04
Defoliation	6.69±0.29	5.87±0.31	2.17	0.01

*TW= Test of Wilcoxon. [£]VT= value of test. n= 24 per treatment. [§]=observed on trunck.

Table 3 - Abundance (Abun.), Diversity (D.) and species richness (S.R) of phytophagous chewing insects (Chew.), Hemiptera phytophagous (Hem.), pollinators (Pol.), tending ants (Ants), Sternorrhyncha predators (Pred.), and spiders (Spid.) per *Acacia mangium* sapling (Fabaceae) (mean ± SE) and planting year.

Variables	Year		TW*	
	First	Second	*VT*[£]	*P*
Abun. Chew.	3.08 ± 0.67	1.29 ± 0.24	2.32	0.01
D. Chew.	2.61 ± 0.53	2.10 ± 0.48	0.56	0.28
S.R. Chew.	1.96 ± 0.30	1.21 ± 0.19	1.80	0.03
Abun. Hem.	8.29 ± 4.14	6.04 ± 2.63	0.99	0.16
D. Hem.	2.10 ± 0.54	1.48 ± 0.31	0.32	0.37
S.R. Hem.	1.67 ± 0.26	1.13 ± 0.19	1.44	0.07
Abun. Pol.	1.38 ± 0.37	5.04 ± 1.31	2.80	0.00
D. Pol.	1.11 ± 0.28	0.99 ± 0.23	0.13	0.44
S.R. Pol.	0.79 ± 0.18	1.25 ± 0.15	2.05	0.02
Abun. Ants	10.63 ± 1.59	56.88 ± 11.24	3.54	0.00
D. Ants	4.71 ± 0.70	3.55 ± 0.47	1.15	0.12
S.R. Ants	2.63 ± 0.25	3.21 ± 0.30	1.68	0.04
Abun. Pred.	1.13 ± 0.24	2.38 ± 0.53	2.06	0.01
D. Pred.	1.23 ± 0.31	1.50 ± 0.35	0.49	0.30
S.R. Pred.	0.83 ± 0.15	1.04 ± 0.16	0.98	0.16
Abun. Spid.	1.79 ± 0.30	0.71 ± 0.16	2.56	0.00
D. Spid.	1.57 ± 0.58	0.85 ± 0.27	0.28	0.38
S.R. Spid.	1.33 ± 0.22	0.67 ± 0.15	2.21	0.01

*TW= Test of Wilcoxon. [£]VT= value of test. n= 24 per treatment.

Table 4 - Relationships between abundance (Abun.) of chewing insects (Chew.), tending ants (Ants), spiders (Spid.), pollinating insects (Pol.), Hemiptera phytophagous (Hem.), Sternorrhyncha predators (Pred.) and total predators (Tot.Pred.), diversities (D.) of Hem. and Pred., species richness (S.R) of Chew., Hem., Ants and Pred., numbers of *Aethalium reticulatum* (Aret.), *Bemisia* sp. (Bem.), Araneidae (Aran.), *Camponotus* sp. (Camp.), *Cephalotes* sp. (Ceph.), Dolichopodidae (Doli.), *Parasyphraea* sp. (Para.), *Pheidole* sp. (Phei.), *Polybia* sp. (Poly.), *Tetragonista angustula* (Tangu), *Trigona spinipes* (Tspi.), *Tropidacris collaris* (Tcoll.), branches/sapling (Branches) and leaves/branch (Leaves) per *Acacia mangium* sapling (Fabaceae).

Principal component regressions	R^2	*F*	*P*
Aret.= -11.87+1.98xPheid.+1.12xTspi.+0.18xBranches	0.26	5.24	0.00
Aran.= 0.18+0.34xPara.+0.24xTcoll.	0.22	6.15	0.00
Pheid.= 4.76+0.05xAret.-0.07xLeaves	0.19	5.18	0.01
Tspi.= -2.80+0.13xBranches+0.10xAret.-0.13xAbun. Tot.Pred.	0.25	4.76	0.01
Simple regressions			
Abun. Chew.= 4.42-0.07xLeaves	0.14	7.58	0.01
Abun. Ants= -22.00+1.67xLeaves	0.30	19.38	0.00
Abun. Spid.= 0.85+0.18xAbun. Chew.	0.14	7.21	0.01
Abun. Pol.=- 1.40+0.11xBranches	0.10	5.36	0.03
Abun. Pred.= 0.24+0.05xLeaves	0.10	5.25	0.03
D. Pred.= 0.91+0.26xD. Hem.	0.12	5.96	0.02
S.R. Chew.= 2.66-0.03xLeaves	0.14	7.20	0.01
S.R. Ants= 1.67+0.04xLeaves	0.16	8.76	0.00
S.R. Pred.= 0.65+0.21xS.R. Hem.	0.10	4.83	0.03
Camp.= -3.60+0.25xLeaves	0.20	11.52	0.00
Ceph.= -13.10+0.50xLeaves	0.45	37.67	0.00
Tangu.= -0.20+0.03xLeaves	0.16	8.96	0.00
Bem.= -0.65+1.43xAbun. Chew.-0.10xAbun. $Chew.^2$	0.16	4.22	0.02
Tspi.=-0.17+0.15xAbun. Ants-0.001xAbun. $Ants^2$	0.19	5.13	0.01
Doli.= 0.64+0.03xAbun. Ants-0.0002xAbun. $Ants^2$	0.14	3.77	0.03

n=48

Supplementary material I - Order, family, and specie of spiders (Class Arachnidae) and insects (Class Insecta) per *Acacia mangium* sapling (Fabales: Fabaceae) (mean ± SE) and planting year.

Order: family, specie	Year		TW*	
	First	Second	*VT*[£]	*P*
Ara.: Oxyopidae, *Oxyopes salticus* (Hentz)	0.04±0.04	0.04±0.04	0.00	0.50
Salticidae, none identified	0.38±0.11	0.17±0.07	1.37	0.08
Uspachus sp.	0.04±0.04	0.04±0.04	0.00	0.50
Sparassidae, *Quemedice* sp.	0.04±0.04	0.00±0.00	1.00	0.15
Tetragnathidae, *Leucauge* sp.	0.04±0.04	0.04±0.04	0.00	0.50
Thomisidae, *Aphantochilus rogersi* O. Pic.-Camb.	0.04±0.04	0.00±0.00	1.00	0.15
Tmarus sp.	0.00±0.00	0.04±0.04	1.00	0.15
Col.: Cantharidae, *Cantharis* sp.	0.04±0.04	0.46±0.45	0.02	0.48
Chrysomelidae, *Alagoasa* sp.	0.04±0.04	0.00±0.00	1.00	0.15
Diabrotica speciosa Germar	0.08±0.05	0.17±0.07	0.86	0.19
Disonycha brasiliensis Costa Lima	0.04±0.04	0.00±0.00	1.00	0.15
Eumolpus sp.	0.08±0.05	0.04±0.04	0.59	0.27
Parasyphraea sp.	0.38±0.15	0.08±0.05	1.59	0.06
Walterianela sp.	0.00±0.00	0.04±0.04	1.00	0.15
Wanderbiltiana sp.	0.04±0.04	0.00±0.00	1.00	0.15
Curculionidae, *Lordops* sp.	0.42±0.41	0.04±0.04	0.03	0.49
None identified	0.04±0.04	0.04±0.04	0.00	0.50
Lampyridae, *Photinus* sp.	0.08±0.08	0.04±0.04	0.02	0.48
Tenebrionidae, *Epitragus* sp.	0.04±0.04	0.00±0.00	1.00	0.15
Dip.: Dolichopodidae, none identified	0.88±0.18	1.58±0.32	1.49	0.06
Syrphidae, *Syrphus* sp.	0.13±0.06	0.17±0.09	0.05	0.47
Hem.: Aethalionidae, *Aethalium reticulatum* L.	3.96±3.74	2.54±2.49	0.48	0.31
Cercopidae, *Mahanarva fimbriolata* Stal	0.04±0.04	0.00±0.00	1.00	0.15
Cicadellidae, *Acrogonia* sp.	0.04±0.04	0.00±0.00	1.00	0.15
Balclutha hebe Kirkaldy	0.25±0.10	0.08±0.05	1.25	0.10
Cicadellinae	0.00±0.00	0.04±0.04	1.00	0.15
Erythrogonia sexguttata Fabr.	0.08±0.05	0.00±0.00	1.42	0.07
Ferrariana trivittata (Signoret)	0.00±0.00	0.04±0.04	1.00	0.15
Cicadidae, *Quesada gigas* Oliver	0.17±0.13	0.25±0.13	0.83	0.20
Membracidae, *Membracis* sp.	0.04±0.04	0.13±0.06	1.03	0.15
Nogodinidae, none identified	0.04±0.04	0.00±0.00	1.00	0.15
Pentatomidae, none identified	0.33±0.11	0.21±0.08	0.72	0.23
Podisus sp.	0.04±0.04	0.08±0.05	0.59	0.27
Pyrrhocoridae, *Dysdercus* sp.	0.04±0.04	0.00±0.00	1.00	0.15
Hym.: Formicidae, *Pseudomyrmex termitarius*	1.88±0.79	2.96±2.06	0.49	0.30
Vespidae, *Polybia* sp.	0.42±0.10	3.33±2.68	0.58	0.27
Lep.: none identified	0.08±0.05	0.13±0.06	0.46	0.32
Man.: Mantidae, *Mantis religiosa* L.	0.00±0.00	0.04±0.04	1.00	0.15
Ort.: Gryllidae, none identified	0.00±0.00	0.04±0.04	1.00	0.15
Romaleidae, *Tropidacris collaris* Stoll.	0.92±0.23	0.42±0.13	1.53	0.06
Tettigoniidae, none identified	0.50±0.14	0.25±0.09	1.14	0.12
Pha.: Phasmatidae, *Phibalossoma phyllinum* Gray	0.00±0.00	0.04±0.04	1.00	0.15

*TW=Test of Wilcoxon. [£]VT= value of test. n= 24 per treatment.

CONCLUSÕES GERAIS

Atenção especial deve ser dada para *T. collaris* (≈1/árvore) e *Bemisia* sp. (≈3/árvore) (primeiro ano de cultivo), *A. reticulatum* (≈3/árvore) (nos dois anos de cultivo) e *Nasutitermes* sp (≈30/árvore) e *T. spinipes* (≈4/árvore) (segundo ano de cultivo) em plantações de *A. mangium* mediante os seus históricos como pragas nesta e em outras plantas. Com a idade das plantas de *Acacia mangium* aumentou a produção de massa verde (ex.: galhos) e de cobertura do solo (ex.: serapilheira) e de artrópodos (ex.: formigas cuidadoras), indicando ser uma boa alternativa para recuperação de áreas degradadas. Além disso, com o aumento de insetos sugadores resultou em maior quantidade de formigas cuidadoras o que reduziu as de predadores, insetos mastigadores e de *T. spinipes,* esta última competindo por recursos alimentares (*honeydew*), oriundo de *A. reticulatum*, com estas formigas.

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