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Original Article

# Arthropods as possible loss or solution sources on *Acacia mangium* (Fabales: Fabaceae) saplings

## Artrópodes como possíveis fontes de perda ou solução em mudas de *Acacia mangium* (Fabales: Fabaceae)

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### Abstract

*Acacia mangium* (Willd.) (Fabales: Fabaceae) tree shows applicability in programs to recover degraded areas due to its fast-growing, rustic, pioneer species, with the potential to fix nitrogen. However, this plant is attacked by pests. It is important to know, among them, the most important. This study aims to evaluate the herbivorous insects (loss sources) and their natural enemies (solution sources) on 48 *A. mangium* saplings. They were classified according to their ability to damage or reduce the source of damage on these saplings using the percentage of the Importance Index-Production Unknown (*% I.I.-P.U.*). The loss sources *Trigona spinipes* Fabr. (Hymenoptera: Apidae), Aleyrodidae (Hemiptera), *Phenacoccus* sp. (Hemiptera: Pseudococcidae), *Aethalion reticulatum* L. (Hemiptera: Aethalionidae), and *Tropidacris collaris* Stoll. (Orthoptera: Romaleidae), showed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. The solution sources Oxyopidae (Araneae), *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae), and *Brachymyrmex* sp. (Hymenoptera: Formicidae), showed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. The number of *Lordops* sp. (Coleoptera: Curculionidae) was reduced per number of *Brachymyrmex* sp.; that of *T. collaris* those of Oxyopidae and *Brachymyrmex* sp.; and that of Tettigoniidae that of *P. termitarius*, totaling 8.93% of reduction of these herbivorous insects (numbers) on *A. mangium* saplings. These herbivorous insects turn into problems in commercial plantations of this plant since to are related to pests in some crops. These tending ants and Oxyopidae can be important on *A. mangium* commercial crops because they can reduce the number of these herbivorous insects.

**Keywords:** abundance, aggregation, chi-squared test, constancy, frequency.

### Resumo

A *Acacia mangium* (Willd.) (Fabales: Fabaceae) apresenta aplicabilidade em programas de recuperação de áreas degradadas devido ao seu rápido crescimento, espécie rústica, pioneira, com potencial de fixação de nitrogênio. No entanto, esta planta é atacada por pragas. É importante saber, entre eles, o mais importante. Este estudo tem como objetivo avaliar os insetos herbívoros (fontes de perda) e seus inimigos naturais (fontes de solução) em 48 mudas *A. mangium*. Eles foram classificados de acordo com sua capacidade de danificar ou reduzir a fonte de dano nessas mudas usando o percentual do Índice de Importância-Produção Desconhecido (*% I.I.-P.U.*). As fontes de perda *Trigona spinipes* Fabr. (Hymenoptera: Apidae), Aleyrodidae (Hemiptera), *Phenacoccus* sp. (Hemiptera: Pseudococcidae), *Aethalion reticulatum* L. (Hemiptera: Aethalionidae) e *Tropidacris Collaris* Stoll. (Orthoptera: Romaleidae), apresentaram os maiores *% I.I.-P.U.* em folhas de mudas de *A. mangium*. As fontes de solução Oxyopidae (Araneae), *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae) e *Brachymyrmex* sp. (Hymenoptera: Formicidae) apresentaram os maiores *% I.I.-P.U.* nas folhas de mudas de *A. mangium*. O número de *Lordops* sp. (Coleoptera: Curculionidae) foi reduzido pelo número de *Brachymyrmex* sp.; a de *T. collaris* pelos de Oxyopidae e *Brachymyrmex* sp.; e a de Tettigoniidae pelo de *P. termitarius*, totalizando 8,93% de redução destes insetos herbívoros (números) em mudas de *A. mangium*. Esses insetos herbívoros podem se tornar problemas em plantações comerciais desta planta, pois estes estão relacionados como pragas em algumas culturas. Essas formigas e Oxyopidae podem ser importantes em cultivos comerciais de *A. mangium*, pois podem reduzir o número desses insetos herbívoros.

**Palavras-chave:** abundância, agregação, teste do qui-quadrado, constância, frequência.

## 1. Introduction

*Acacia mangium* (Willd.) (Fabales: Fabaceae) tree is a fast-growing, rustic pioneer species with potential for nitrification due to symbiosis with diazotrophic bacteria, resulting in high litter production (Caldeira et al., 2018;

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Eloy et al., 2018; Paula et al., 2018). *Acacia mangium* is adapted to acidic and infertile soils makes this plant important for recovering degraded areas (Balieiro et al., 2004; Wang et al., 2013). Besides, its wood is used, for example, in the construction of furniture (Hegde et al., 2013). However, this plant is attacked by different insect groups: sap-sucking, defoliators, stem apex chewing, and the wood-borer (Lemes et al., 2013; Parreira et al., 2014; Silva et al., 2015, 2020). On the other hand, *A. mangium* is visited and/or colonized by several predators such as ants, neuropteran, spiders, wasps, and others (Silva et al., 2020; Gomes et al., 2023; Lima et al., 2024). These arthropods can be loss and solution sources on *A. mangium* saplings. It is important to know, among them, the most important in each group.

The Importance Indice (*I.I.*) can determine the loss and solution sources on a system in some knowledge areas (e.g., agronomy), when production is known (Demolin-Leite, 2021). Events (e.g., agricultural pest) can present different magnitudes (numerical measurements), frequencies, and distributions (aggregate, random, or regular) of event occurrence, and *I.I.* bases in this triplet (Demolin-Leite, 2021). In general, the higher the magnitude and frequency, with aggregated distribution, the greater the problem or solution (e.g., natural enemies versus pests) for the system (Demolin-Leite, 2021). However, the final production of the system is not always known or is difficult to determine (e.g., degraded area recovery). A derivation of the *I.I.* is the percentage of Importance Index-Production Unknown (*% I.I.-P.U.*) that can detect the loss or solution sources, when production is unknown, for the system (Demolin-Leite, 2024a).

The objective of this study was to determine the loss (e.g., herbivores insects) and solution (e.g., natural enemies) sources, classifying them according to their importance regarding their ability to damage or mitigate the source of damage on 48 *A. mangium* saplings - system with production unknown.

## 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 city 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). According to the Köppen climate classification, the climate of this area is tropical dry, with annual precipitation and temperature between 1,000 and 1,300 mm and ≥ 24ºC, respectively (Alvares et al., 2013). 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 reached 30 cm high with a 2-meter spacing between them. 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 single, 20 L dose of dehydrated sewage sludge with defined biochemical characteristics (Silva et al., 2020) was placed per hole. The young 48 *A. mangium* saplings (young trees in the vegetative period) were irrigated twice a week until the beginning of the rainy season (October).

### *2.3. Counting the arthropods*

The percentage of defoliation (leaf area loss) on a 0–100% scale with 5% increments for removed leaf area (Kogan and Turnipseed, 1980), and damage score from sap-sucking insects: I = non-damage; II = appearance of yellow chlorotic spots (leaf with 1% to 25% of attack symptoms); III = some yellow chlorotic spots and/or start of black sooty mold (leaf with 26% to 50% of attack symptoms); IV = several yellow chlorotic spots and/or severe blackening of leaves (leaf with 51% to 75% of attack symptoms); and V = yellowing or complete leaf drying (leaf with 76% to 100% of attack symptoms) (Demolin-Leite, 2024a), were assessed visually, and 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 [sampling unit (*n*) – one leaf]. Leaves were randomly assessed on the branch (one leaf per position) in the basal, middle, and apical parts of the canopy – vertical axis - (0 to 33%, 34 to 66%, and 67 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 (age = 12 months) starting six months after transplantation for 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. In these saplings, the number of arthropods on the trunks was also assessed for each evaluation. The evaluator carefully approached, firstly assessing the adaxial leaf surface and, if it was not possible to visualize the abaxial one, with a delicate and slow movement, the leaf was lifted and visualized. The position of leaves of *A. mangium* saplings is generally 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 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 with an aspirator (two hours per week), at the beginning of the study (between transplantation and first evaluation), stored in flasks with 70% alcohol, separated into morph species, 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 each group (e.g., family).

The definition of what is a loss source or solution source was made by field observation (e.g., leaf damage), feed habits, and literature. The same was applied, as example, for prey-predator and sap-sucking insects- tending ant relationships.

### *2.4. Statistical analysis*

Each replication is a sapling with the total individuals collected on 12 leaves (three heights and four sides of the sapling) for 24 months. The distribution type (aggregated, random, or regular) for the lost source (*L.S.*) or solution source (*S.S.*) was defined by the Chi-square test using the R-package 'IIProductionUnknown' (Demolin-Leite and Azevedo, 2022) (Supplementary materials I and II). The data were subjected to simple regression analysis and their parameters were all significant ($P < 0.05$) using the R-package 'IIProductionUnknown' (Demolin-Leite and Azevedo, 2022) (Supplementary material III). Simple equations were selected by observing the criteria: i) data distribution in the figures (linear or quadratic response), ii) the parameters used in these regressions were the most significant ones ($P < 0.05$), iii) $P < 0.05$ and *F* of the Analysis of Variance of these regressions, and iv) the coefficient of determination of these equations ($R^2$). Only *L.S.* and *S.S.* with $P < 0.05$ were shown in Supplementary Materials (I-III). All the data above were used in the Percentage of Importance Index-Production Unknown (*% I.I.-P.U.*).

Percentage of Importance Indice-Production Unknown (*% I.I.-P.U.*) is: *% I.I.-P.U.*= $[(ks_1 \text{ x } c_1 \text{ x } ds_1)/\Sigma(ks_1 \text{ x } c_1 \text{ x } ds_1)+(ks_2 \text{ x } c_2 \text{ x } ds_2)+(ks_n \text{ x } c_n \text{ x } ds_n)]\text{x}100$ (Demolin-Leite, 2024a).

Where:

i) the *key source* (*ks*) is: *ks* = damage (non-percentage) (*Da.*)/total *n* of the *L.S.* on the samples or *ks* = reduction of the total *n.* of *L.S.* (*R.L.S*)/total n. of the *S.S* on the samples (Demolin-Leite, 2024a). Where *Da.* or *R.L.S.* = $R^2 \text{ x } (1 - P)$, when it is of the first degree, or $((R^2 \text{ x } (1 - P))\text{x}(\beta_2/\beta_1)$, when it is of the second degree, where $\mathbf{R^2}$ = determination coefficient and $\boldsymbol{P}$= significance of ANOVA, $\beta_1$ = regression coefficient, and $\beta_2$ = regression coefficient (variable$^2$), of the simple regression equation of the loss source (*L.S.*) or solution source (*S.S.*) (Demolin-Leite, 2024a). When it is not possible to separate the *Da.* between two or more *L.S.*, divide the *Da.* among the *L.S.* as a proportion of their respective "total *n*". *Da.* = 0 when *Da.* was non-significant for damage or non-detected by *L.S.* on the system (Demolin-Leite, 2024a). When an *S.S.* operates in more than one *L.S.*, that caused damage, its *ks* are summed. *R.L.S.* = 0 when *Da.* by *L.S.* or *R.L.S.* was non-significant for damage by *L.S.* or reduced *L.S.* by *S.S.* on the system (Demolin-Leite, 2024a).

ii) *c* (*constancy*) = Σ of occurrence of *L.S.* or *S.S.* on samples, where absence = 0 or presence = 1 (Demolin-Leite, 2021).

iii) *ds* (*distribution source*) = 1 - $\boldsymbol{P}$ of the chi-square test of *L.S.* or *S.S.* on the samples (Demolin-Leite, 2021). Counts (non-frequency) of *L.S.* or *S.S.* are used to perform the chi-square test.

These data, above, are obtained, by R-package 'IIProductionUnknown' (Demolin-Leite and Azevedo, 2022).

Percentage of *R.L.S.* per *S.S.* (*%R.L.S.S.S.*) = (*R.L.S.S.S.*/ total *n* of the *L.S.* – abundance or damage) x 100, where *R.L.S.S.S.* = *R.L.S.* x total *n* of the *S.S.*, with the *R.L.S.* not being summed in this case (Demolin-Leite, 2024a). These data, above, are obtained, by R-package 'IIProductionUnknown' (Demolin-Leite and Azevedo, 2022).

## 3. Results

The loss sources *Trigona spinipes* Fabr. (Hymenoptera: Apidae) (35.33%), Aleyrodidae (Hemiptera) (31.84%) (maximum score damage = II), *Phenacoccus* sp. (Hemiptera: Pseudococcidae) (18.66%) (maximum score damage = II), *Aethalion reticulatum* L. (Hemiptera: Aethalionidae) (9.17%) (maximum score damage = III), and *Tropidacris collaris* Stoll. (Orthoptera: Romaleidae) (1.36%), showed, among 43 herbivorous insects (≈ 0.10%), the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings (Table 1).

The solution sources Oxyopidae (Araneae) (97.32%), *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae) (2.62%), and *Brachymyrmex* sp. (Hymenoptera: Formicidae) (0.06%), among 25 natural enemies (= 0.00%), revealed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. The number of *Lordops* sp. (Coleoptera: Curculionidae) was reduced per number of *Brachymyrmex* sp. (3.99%); that of *T. collaris* those of Oxyopidae (2.14%) and *Brachymyrmex* sp. (0.91%); and that of Tettigoniidae that of *P. termitarius* (1.89%), totaling 8.93% of reduction of these herbivorous insects (numbers) on *A. mangium* sapling (Tables 2-3).

## 4. Discussion

The loss sources *T. spinipes*, Aleyrodidae, *Phenacoccus* sp., *A. reticulatum*, and *T. collaris*, presented the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. The shoots and growth regions by *Leucaena leucocephala* (Lam.) de Wit. (Fabales: Fabaceae) are damaged for *T. spinipes* bees, which remove fibers to construct their nests (Damascena et al., 2017). Besides, this bee species damages flowers such as on *Caryocar brasiliense* Camb. (Malpighiales: Caryocaraceae) trees and *Zantedeschia aethiopica* (L.) Spreng. (Commelinales: Araceae) plants (Carvalho et al., 2018; Demolin-Leite, 2024b). In addition, *T. spinipes* can reduce pollination on *Cucurbita moschata* Dusch (Cucurbitales: Cucurbitaceae) plants owing to insufficient pollen transportation (small body size) and/or chasing other pollinators by flying in flocks and with aggressive behavior (Serra and Campos, 2010). Its control, traditionally, is the location and destruction of its nest (Demolin-Leite, 2024b). *Bemisia tabaci* (Genn., 1889), Aleyrodidae family, is a pest of several plants, including sweet pepper *Capsicum annuum* L. (Solanales: Solanaceae), *Cucumis melo* L. (Cucurbitales: Cucurbitaceae), soybean *Glycine max* (L.) Merrill and common bean *Phaseolus vulgaris* L. (Fabales:

**Table 1.** Total number (*n*), damage (*Da.*), key-source (*ks*), constancy (*c*), distribution source (*ds*), number of Importance Indice (*n. I.I.*), sum of *n. I.I.-P.U.* (Σ *n. I.I.*), and percentage of *I.I.* by loss source (*L.S.*) on 48 *Acacia mangium* (Fabaceae) saplings.

| **Loss source** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***L.S.*** | ***n*** | ***Da.*** | ***ks*** | ***c*** | ***ds*** | ***n.I.I.*** | ***Σn.I.I.*** | ***%I.I.*** |
| *Trigona spinipes* | 143 | 0.8100 | 0.0057 | 26 | 1.00 | 0.1473 | 0.42 | 35.33 |
| Aleyrodidae | 96 | 0.9800 | 0.0102 | 13 | 1.00 | 0.1327 | 0.42 | 31.84 |
| *Phenacoccus* sp. | 63 | 0.9800 | 0.0156 | 5 | 1.00 | 0.0778 | 0.42 | 18.66 |
| *Aethalium reticulatum* | 157 | 1.0000 | 0.0064 | 6 | 1.00 | 0.0382 | 0.42 | 9.17 |
| *Tropidacris collaris* | 56 | 0.0148 | 0.0003 | 32 | 0.67 | 0.0057 | 0.42 | 1.36 |
| Tettigoniidae | 42 | 0.0111 | 0.0003 | 28 | 0.40 | 0.0030 | 0.42 | 0.71 |
| *Parasyphraea* sp. | 17 | 0.0045 | 0.0003 | 11 | 1.00 | 0.0029 | 0.42 | 0.69 |
| Lepidoptera | 13 | 0.0034 | 0.0003 | 10 | 0.85 | 0.0022 | 0.42 | 0.53 |
| *Stereoma anchoralis* | 16 | 0.0042 | 0.0003 | 8 | 1.00 | 0.0021 | 0.42 | 0.51 |
| *Lordops* sp. | 11 | 0.0029 | 0.0003 | 2 | 1.00 | 0.0005 | 0.42 | 0.13 |
| *Diabrotica speciosa* | 8 | 0.0021 | 0.0003 | 8 | 0.24 | 0.0005 | 0.42 | 0.12 |
| *Cerotoma* sp. | 9 | 0.0024 | 0.0003 | 9 | 0.21 | 0.0005 | 0.42 | 0.12 |
| *Eumolpus* sp. | 4 | 0.0011 | 0.0003 | 4 | 0.40 | 0.0004 | 0.42 | 0.10 |
| Curculionidae | 3 | 0.0008 | 0.0003 | 3 | 0.44 | 0.0004 | 0.42 | 0.08 |
| *Cephalocoema* sp. | 3 | 0.0008 | 0.0003 | 3 | 0.44 | 0.0004 | 0.42 | 0.08 |
| Cerambycidae | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| Gryllidae | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Epitragus* sp. | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Disonycha brasiliensis* | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Wanderbiltiana* sp. | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Alagoasa* sp. | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Walterianela* sp. | 2 | 0.0005 | 0.0003 | 2 | 0.49 | 0.0003 | 0.42 | 0.06 |
| *Psiloptera* sp. | 1 | 0.0003 | 0.0003 | 1 | 0.53 | 0.0001 | 0.42 | 0.03 |
| Alleculinae | 1 | 0.0003 | 0.0003 | 1 | 0.53 | 0.0001 | 0.42 | 0.03 |
| *Lamprosoma* sp. | 1 | 0.0003 | 0.0003 | 1 | 0.53 | 0.0001 | 0.42 | 0.03 |
| *Phiblossoma phyllinum* | 1 | 0.0003 | 0.0003 | 1 | 0.53 | 0.0001 | 0.42 | 0.03 |
| *Acrogonia* sp. | 9 | 0.0000 | 0.0000 | 8 | 0.63 | 0.0000 | 0.42 | 0.00 |
| *Anastrepha* sp. | 1 | 0.0000 | 0.0000 | 1 | 0.53 | 0.0000 | 0.42 | 0.00 |
| *Balclutha hebe* | 26 | 0.0000 | 0.0000 | 16 | 1.00 | 0.0000 | 0.42 | 0.00 |
| *Bladina* sp. | 4 | 0.0000 | 0.0000 | 4 | 0.40 | 0.0000 | 0.42 | 0.00 |
| Cicadellinae | 1 | 0.0000 | 0.0000 | 1 | 0.53 | 0.0000 | 0.42 | 0.00 |
| *Dysdercus* sp. | 1 | 0.0000 | 0.0000 | 1 | 0.53 | 0.0000 | 0.42 | 0.00 |
| *Erythrogonia sexguttata* | 8 | 0.0000 | 0.0000 | 4 | 1.00 | 0.0000 | 0.42 | 0.00 |
| *Euxesta* sp. | 20 | 0.0000 | 0.0000 | 16 | 0.48 | 0.0000 | 0.42 | 0.00 |
| *Ferrariana trivittata* | 2 | 0.0000 | 0.0000 | 2 | 0.49 | 0.0000 | 0.42 | 0.00 |
| *Mahanarva fimbriolata* | 1 | 0.0000 | 0.0000 | 1 | 0.53 | 0.0000 | 0.42 | 0.00 |
| Membracidae | 29 | 0.0000 | 0.0000 | 14 | 1.00 | 0.0000 | 0.42 | 0.00 |
| *Membracis* sp. | 6 | 0.0000 | 0.0000 | 6 | 0.32 | 0.0000 | 0.42 | 0.00 |
| *Nasutitermes* sp. | 873 | 0.0000 | 0.0000 | 9 | 1.00 | 0.0000 | 0.42 | 0.00 |
| Nogodinidae | 4 | 0.0000 | 0.0000 | 3 | 0.97 | 0.0000 | 0.42 | 0.00 |
| *Pachycoris torridus* | 6 | 0.0000 | 0.0000 | 4 | 0.99 | 0.0000 | 0.42 | 0.00 |
| Pentatomidae | 27 | 0.0000 | 0.0000 | 21 | 0.31 | 0.0000 | 0.42 | 0.00 |
| *Quesada gigas* | 11 | 0.0000 | 0.0000 | 6 | 1.00 | 0.0000 | 0.42 | 0.00 |

*I.I.-P.U.* = *ks* x *c* x *ds*. *ks* = *Da.*/total *n* of the *L.S.*. *Da.* = $R^2$ x (1 - *P*) when it is of the first degree, or (($R^2$ x (1 - *P*))x($\beta_2/\beta_1$) when it is of the second degree, where $\mathbf{R^2}$ = determination coefficient and ***P*** = significance of ANOVA, $\beta_1$ = regression coefficient, and $\beta_2$ = regression coefficient (variable$^2$), of the simple regression equation, or non-percentage of damage per *L.S.*. *c* = Σ of occurrence of *L.S.* on each sample, 0 = absence or 1 = presence. *ds* = 1 - ***P*** of chi-square test of the *L.S.*. *Da.* = 0 when *Da.* non-significant for damage or non-detected by *L.S.*.

**Table 2.** Total number (*n*), reduction of *L.S.* (*R.L.S.*), key-source (*ks*), constancy (*c*), distribution source (*ds*), number of Importance Indice (*n. I.I.*), sum of *n. I.I.-P.U.* (Σ *n. I.I.*), and percentage of *I.I.* by solution source (*S.S.*) on 48 *Acacia mangium* (Fabaceae) saplings.

| **Solution source** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***S.S.*** | ***n*** | ***R.L.S.*** | ***ks*** | ***c*** | ***ds*** | ***n.I.I.*** | **Σn.I.I.** | ***%I.I.*** |
| Oxyopidae | 30 | 0.0363 | 0.0012 | 21 | 0.90 | 0.02 | 0.02 | 97.32 |
| *Pseudomyrmex termitarius* | 220 | 0.0036 | 0.0000 | 37 | 1.00 | 0.00 | 0.02 | 2.62 |
| *Brachymyrmex* sp. | 1627 | 0.0006 | 0.0000 | 38 | 1.00 | 0.00 | 0.02 | 0.06 |
| *Aphantochilus rogersi* | 2 | 0.0000 | 0.0000 | 2 | 0.49 | 0.00 | 0.02 | 0.00 |
| Araneidae | 49 | 0.0000 | 0.0000 | 30 | 0.64 | 0.00 | 0.02 | 0.00 |
| *Camponotus* sp. | 450 | 0.0000 | 0.0000 | 44 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Cantharis* sp. | 16 | 0.0000 | 0.0000 | 6 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Cephalotes* sp. | 169 | 0.0000 | 0.0000 | 9 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Chrysoperla* sp. | 5 | 0.0000 | 0.0000 | 5 | 0.36 | 0.00 | 0.02 | 0.00 |
| *Cycloneda sanguinea* | 3 | 0.0000 | 0.0000 | 3 | 0.44 | 0.00 | 0.02 | 0.00 |
| Dolichopodidae | 128 | 0.0000 | 0.0000 | 41 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Ectatoma* sp. | 50 | 0.0000 | 0.0000 | 26 | 0.99 | 0.00 | 0.02 | 0.00 |
| *Leucauge* sp. | 2 | 0.0000 | 0.0000 | 1 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Mantis religiosa* | 7 | 0.0000 | 0.0000 | 7 | 0.28 | 0.00 | 0.02 | 0.00 |
| *Oxyopes salticus* | 6 | 0.0000 | 0.0000 | 6 | 0.32 | 0.00 | 0.02 | 0.00 |
| *Pheidole* sp. | 285 | 0.0000 | 0.0000 | 44 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Photinus* sp. | 4 | 0.0000 | 0.0000 | 3 | 0.98 | 0.00 | 0.02 | 0.00 |
| *Podisus* sp. | 4 | 0.0000 | 0.0000 | 4 | 0.40 | 0.00 | 0.02 | 0.00 |
| *Polybia* sp. | 106 | 0.0000 | 0.0000 | 25 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Quemedice* sp. | 2 | 0.0000 | 0.0000 | 2 | 0.49 | 0.00 | 0.02 | 0.00 |
| Salticidae | 39 | 0.0000 | 0.0000 | 24 | 1.00 | 0.00 | 0.02 | 0.00 |
| *Syrphus* sp. | 8 | 0.0000 | 0.0000 | 6 | 0.95 | 0.00 | 0.02 | 0.00 |
| *Teudis* sp. | 1 | 0.0000 | 0.0000 | 1 | 0.53 | 0.00 | 0.02 | 0.00 |
| *Tmarus* sp. | 2 | 0.0000 | 0.0000 | 2 | 0.49 | 0.00 | 0.02 | 0.00 |
| *Uspachus* sp. | 3 | 0.0000 | 0.0000 | 2 | 1.00 | 0.00 | 0.02 | 0.00 |

*I.I.-P.U.* = *ks* x *c* x *ds*. *ks* = *R.L.S.*/total *n.* of the *S.S.*. *R.L.S.*= $R^2$ x (1 - *P*) when it is of the first degree, or (($R^2$ x (1 - *P*))x($\beta_2/\beta_1$) when it is of the second degree, where $\mathbf{R^2}$ = determination coefficient and ***P*** = significance of ANOVA, $\beta_1$ = regression coefficient, and $\beta_2$ = regression coefficient (variable$^2$), of the simple regression equation. *c* = Σ of occurrence of *S.S.* on each sample, 0 = absence or 1 = presence. *ds* = 1 - ***P*** of chi-square test of the *S.S.*. When a *S.S.* operates in more than one *L.S.*, that caused damage, its *ks* are summed. *E.S.*. = 0 when *Da.* by *L.S.* or *E.S.* non-significant for damage by *L.S.* or reduced *L.S.* by *S.S.*.

**Table 3.** Percentage of reduction in abundance (*%R.*) of loss source (*L.S.*) per solution source (*S.S.*), sum (Σ), and total of Σ of *R.L.S.* (T.Σ) on 48 *Acacia mangium* (Fabaceae) saplings.

| ***S.S.*** | ***%R.L.S.S.S.*** | | |
|---|---|---|---|
| | ***L.S.*** | | |
| | ***Lordops sp.*** | ***Tropidacris collaris*** | **Tettigoniidae** |
| Oxyopidae | --- | 2.14 | --- |
| *Brachymyrmex* sp. | 3.99 | 0.91 | --- |
| *Pseudomyrmex termitarius* | --- | --- | 1.89 |
| Σ | **3.99** | **3.05** | **1.89** |
| ***T.Σ** | **8.93** | --- | --- |

--- = *L.S.* was not reduced per *S.S.* *%R.L.S.S.S.* = (*R.L.S.S.S.*/total *n* of the *L.S.*) x 100, where *R.L.S.S.S.* = *R.L.S.* x total n of the *S.S.*. *R.L.S.* = $R^2$ x (1 - *P*) when it is of the first degree, or (($R^2$ x (1 - *P*))x($\beta_2/\beta_1$) when it is of the second degree, where $\mathbf{R^2}$ = determination coefficient and ***P*** = significance of ANOVA, $\beta_1$ = regression coefficient, and $\beta_2$ = regression coefficient (variable$^2$), of the simple regression equation. ***T.Σ** = total sum.

Fabaceae), and tomato *Solanum lycopersicon* Mill. (Solanales: Solanaceae). This sap-sucking insect can inject toxins, transmit viruses, and favor the development of fumagine (Zhang et al., 2004; Mansaray and Sundufu, 2009; Kim et al., 2017; Felicio et al., 2019). *Phenacoccus* sp. was the most abundant phytophagous insect on *Platycyamus regnellii* (Benth) (Fabales: Fabaceae) trees fertilized with dehydrated sewage sludge (Souza et al., 2021). Besides, *Phenacoccus* sp. is related as a pest of *Abelmoschus esculentus* (L.) Moench. (Malvales: Malvaceae), *Amaranthus flavus* L. (Caryophyllales: Amaranthaceae), *Bidens pilosa* L. (Asterales: Asteraceae), *Carica papaya* L. (Violales: Caricaceae), *Gossypium hirsutum* L. (Malvales: Malvaceae), *Manihot esculenta* Crantz. (Malpighiales: Euphorbiaceae), *S. lycopersicum*, and *Vitis vinifera* L. (Vitales: Vitaceae). This insect causes necrosis in the apical tissues, reduces the photosynthetic rate, leaf growth (with yellowing and fall of these), negatively affecting the plant production (e.g., *M. esculenta*) (Schulthess et al., 1991; Culik and Gullan, 2005; Culik et al., 2007; Rebolledo-Martínez et al., 2013; Santos and Peronti, 2017). The *A. reticulatum* is 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 "mulungu" *Erythrina speciosa* Andrews (Fabales: Fabaceae) (Araújo et al., 2010; Zanuncio et al., 2015). In addition, this sap-sucking insect damages *A. mangium*, *Triplaris americana* L. (Caryophyllales: Polygonaceae), and *Vernonia condensata* Baker (Asterales: Asteraceae) plants (Menezes et al., 2013; Pires et al., 2014; Silva et al., 2020). Finally, the chewing insect *T. collaris* damages on *A. mangium* saplings confirms its polyphagy, which also attacks plants of *Casuarina glauca* Sieber (Casuarinales: Casuarinaceae), *L. leucocephala*, and *Terminalia argentea* Mart. (Myrtales: Combretaceae) (Poderoso et al., 2013; Damascena et al., 2017; Carvalho et al., 2020).

The solution sources Oxyopidae, *P. termitarius*, and *Brachymyrmex* sp., showed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. The numbers of *Lordops* sp., *T. collaris*, and Tettigoniidae were reduced per numbers of *Brachymyrmex* sp., Oxyopidae, and *P. termitarius*, with a total reduction of these herbivorous insects around 9% on *A. mangium* saplings. Spiders are important predators, as an example, on *C. brasiliense* trees and *T. argentea* (Leite et al., 2012; Carvalho et al., 2020); on pastures and forests (Zografou et al., 2017); in many agroecosystems in the USA (Landis et al., 2000) and Italy (Venturino et al., 2008); and in 12 agricultural landscapes in the low mountain ranges of Central Hesse (Germany) (Öberg et al., 2008). And, finally, ants can reduce defoliation and fruit-boring insect populations (e.g., Coleoptera and Lepidoptera) (Leite et al., 2012; Gonthier et al., 2013; Fagundes et al., 2017; Dassou et al., 2019). Besides, ants are bioindicators of the recovery of degraded areas (Sanchez, 2015). Domatia, which are internal plant structures (e.g., stems and leaves), are adapted for habitation by ants (Janzen, 1966). Many different genera of plants offer these structures like the *Acacia* genus and their stems that are excavated by ants for use as housing structures (Janzen, 1966). Many myrmecophytes are defended from both herbivores and other competing plants by their ant counterparts like *Acacia cornigera* (L.) Willd. (Fabales: Fabaceae) (Rico-Gray and Oliveira, 2007). This plant is thoroughly guarded by its obligate ant partner, *Pseudomyrmex ferruginea* (Smith, 1877), which has more than 30,000 ants on a single colony, tending multiple *Acacia* trees (Rico-Gray and Oliveira, 2007). The soldier ants patrol the trees twenty-four hours a day with incredible aggression, and recruit more works, inside the horn domatia, with any disturbance to the tree (Rico-Gray and Oliveira, 2007). These ants keep the *Acacia* free from other insects and vertebrate herbivores with the bit, sting violently, and prune any trespassers, but also from invading fungi and other plants (Rico-Gray and Oliveira, 2007).

## 5. Conclusions

The loss sources *T. spinipes*, Aleyrodidae, *Phenacoccus* sp., *A. reticulatum*, and *T. collaris*, showed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. These insects turn into problems in commercial plantations of this plant since to are related to pests in some crops. The solution sources Oxyopidae, *P. termitarius*, and *Brachymyrmex* sp., showed the highest *% I.I.-P.U.* on leaves of *A. mangium* saplings. These natural enemies can be important on *A. mangium* due to their capacity to reduce herbivorous damages (e.g., Oxyopidae versus *T. collaris*) reducing 9% of herbivorous insects on *A. mangium* sapling.

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## References

ALVARES, C.A., STAPE, J.L., SENTELHAS, P.C., GONÇALVES, J.L.M. and SPAROVEK, G., 2013. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift*, vol. 22, no. 6, pp. 711-728. http://dx.doi.org/10.1127/0941-2948/2013/0507.

ARAÚJO, V.A., BÁO, S.N., MOREIRA, J., NEVES, C.A. and LINO-NETO, J., 2010. Ultrastructural characterization of the spermatozoa of *Aethalion reticulatum* Linnaeus 1767 (Hemiptera: Auchenorrhyncha: Aethalionidae). *Micron*, vol. 41, no. 4, pp. 306-311. http://dx.doi.org/10.1016/j.micron.2009.12.001. PMid:20047835.

BALIEIRO, F.C., DIAS, L.E., FRANCO, A.A., CAMPELLO, E.F.C. and FARIA, S.M., 2004. Nutrient accumulation in the aboveground biomass, in the litter layer and phyllodies decomposition of

*Acacia mangium* Willd. *Ciência Florestal*, vol. 14, no. 1, pp. 59-65. http://dx.doi.org/10.5902/198050981781.

CALDEIRA, M.V.W., FAVALESSA, M., DELARMELINA, W.M., GONÇALVES, E.O.G. and MOURA, R.R.S., 2018. Sewage sludge assessment on growth of *Acacia mangium* seedlings by principal components analysis and orthogonal contrasts. *Journal of Plant Nutrition*, vol. 41, no. 10, pp. 1303-1311. http://dx.doi.org/10.1080/01904167.2018.1450421.

CARVALHO, J.C.N., SILVA, F.W.S., LEITE, G.L.D., AZEVEDO, A.M., TEIXEIRA, G.L., SOARES, M.A., ZANUNCIO, J.C. and LEGASPI, J.C., 2020. Does fertilization with dehydrated sewage sludge affect *Terminalia argentea* (Combretaceae) and associated arthropods community in a degraded area? *Scientific Reports*, vol. 10, no. 1, p. 11811. http://dx.doi.org/10.1038/s41598-020-68747-z. PMid:32678241.

CARVALHO, L.M., LADEIRA, V.A., ALMEIDA, E.F.A., SANTA-CECILIA, L.C., BRIGHENTI, D.M. and RESENDE, E., 2018. Bagging to protect calla lily flowers against stingless bee (*Trigona spinipes*). *Ornamental Horticulture*, vol. 24, no. 4, pp. 353-360. http://dx.doi.org/10.14295/oh.v24i4.1193.

CULIK, M.P. and GULLAN, P.J., 2005. A new pest of tomato and other records of mealybugs (Hemiptera: Pseudococcidae) from Espírito Santo, Brazil. *Zootaxa*, vol. 964, no. 1, pp. 1-8. http://dx.doi.org/10.11646/zootaxa.964.1.1.

CULIK, M.P., MARTINS, D.S., VENTURA, J.A., PERONTI, A.L.B.G., GULLAN, P.J. and KONDO, T., 2007. Coccidae, Pseudococcidae, Ortheziidae, and Monophlebidae (Hemiptera: Coccoidea) of Espírito Santo, Brazil. *Biota Neotropica*, vol. 7, no. 3, pp. 61-65. http://dx.doi.org/10.1590/S1676-06032007000300006.

DAMASCENA, J.G., LEITE, G.L.D., SILVA, F.W.S., SOARES, M.A., GUAÑABENS, R.E.M., SAMPAIO, R.A. and ZANUNCIO, J.C., 2017. Spatial distribution of phytophagous insects, natural enemies, and pollinators on *Leucaena leucocephala* (Fabales: Fabaceae) trees in the Cerrado. *The Florida Entomologist*, vol. 100, no. 3, pp. 558-565. http://dx.doi.org/10.1653/024.100.0311.

DASSOU, A.G., VODOUHÉ, S.D., BOKONON-GANTA, A., GOERGEN, G., CHAILLEUX, A., DANSI, A., CARVAL, D. and TIXIER, P., 2019. Associated cultivated plants in tomato cropping systems structure arthropod communities and increase the *Helicoverpa armigera* regulation. *Bulletin of Entomological Research*, vol. 109, no. 6, pp. 733-740. http://dx.doi.org/10.1017/S0007485319000117. PMid:30968787.

DEMOLIN-LEITE, G.L. and AZEVEDO, A.M., 2022 [viewed 14 March 2023]. *IIProductionUnknown: analyzing data through of percentage of importance indice (production unknown) and its derivation* [online]. R Development Core Team. Available from: https://CRAN.R-project.org/package=IIProductionUnknown

DEMOLIN-LEITE, G.L., 2021 [viewed 14 March 2023]. Importance indice: loss estimates and solution effectiveness on production. Technical note. *Cuban Journal of Agricultural Science* [online], vol. 55, no. 2, pp. 1-7. Available from: http://scielo.sld.cu/pdf/cjas/v55n2/2079-3480-cjas-55-02-e10.pdf

DEMOLIN-LEITE, G.L., 2024a. Percentage of importance indice-production unknown: loss and solution sources identification on system. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 84, p. e253218. http://dx.doi.org/10.1590/1519-6984.253218. PMid:35019097.

DEMOLIN-LEITE, G.L., 2024b. Do arthropods and diseases affect the production of fruits on *Caryocar brasiliense* Camb. (Malpighiales: caryocaraceae)? *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 84, p. e253215. http://dx.doi.org/10.1590/1519-6984.253215.

ELOY, E., SILVA, D.A., CARON, B.O., ELLI, E.F. and SCHWERZ, F., 2018. Effect of age and spacing on biomass production in forest plantations. *Revista Árvore*, vol. 42, no. 2, pp. 1-11. http://dx.doi.org/10.1590/1806-90882018000200014.

FAGUNDES, R., DÁTTILO, W., RIBEIRO, S.P., RICO-GRAY, V., JORDANO, P. and DEL-CLARO, K., 2017. Differences among ant species in plant protection are related to production of extrafloral nectar and degree of leaf herbivory. *Biological Journal of the Linnean Society*, vol. 122, no. 1, pp. 71-83. http://dx.doi.org/10.1093/biolinnean/blx059.

FELICIO, T.N.P., COSTA, T.L., SARMENTO, R.A., RAMOS, R.S., PEREIRA, P.S., SILVA, R.S. and PICANÇO, M.C., 2019. Surrounding vegetation, climatic elements, and predators affect the spatial dynamics of *Bemisia tabaci* (Hemiptera: Aleyrodidae) in commercial melon fields. *Journal of Economic Entomology*, vol. 112, no. 6, pp. 2774-2781. http://dx.doi.org/10.1093/jee/toz181. PMid:31265728.

GOMES, G.N., LEITE, G.L.D., SOARES, M.A., GUANÃBENS, R.E.M., LEMES, P.G. and ZANUNCIO, J.C., 2023. Arthropod fauna on the abaxial and adaxial surfaces of *Acacia mangium* (Fabaceae) leaves. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 83, p. e245536. http://dx.doi.org/10.1590/1519-6984.245536. PMid:34669792.

GONTHIER, D.J., ENNIS, K.K., PHILPOTT, S.M., VANDERMEER, J. and PERFECTO, I., 2013. Ants defend coffee from berry borer colonization. *BioControl*, vol. 58, no. 6, pp. 815-820. http://dx.doi.org/10.1007/s10526-013-9541-z.

HEGDE, M., PALANISAMY, K. and YI, J.S., 2013. *Acacia mangium* Willd. - a fast growing tree for tropical plantation. *Journal of Forest and Environmental Science*, vol. 29, no. 1, pp. 1-14. http://dx.doi.org/10.7747/JFS.2013.29.1.1.

JANZEN, D.H., 1966. Coevolution of mutualism between ants and acacias in Central America. *Evolution*, vol. 20, no. 3, pp. 249-275. http://dx.doi.org/10.2307/2406628. PMid:28562970.

KIM, S., JUNG, M., SONG, Y.J., KANG, C., KIM, B.Y., CHOI, I.J., KIM, H.G. and LEE, D.H., 2017. Evaluating the potential of the extract of *Perilla* sp. as a natural insecticide for *Bemisia tabaci* (Hemiptera: Aleyrodidae) on sweet peppers. *Entomological Research*, vol. 47, no. 3, pp. 208-216. http://dx.doi.org/10.1111/1748-5967.12211.

KOGAN, M. and TURNIPSEED, S.G., 1980. Soybean growth and assessment of damage by arthropods. In: M. Kogan and D.C. Herzog, eds. *Sampling methods in soybean entomology*. New York: Springer, pp. 3-29. http://dx.doi.org/10.1007/978-1-4612-9998-1_1.

LANDIS, D.A., WRATTEN, S.D. and GURR, G.M., 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology*, vol. 45, no. 1, pp. 175-201. http://dx.doi.org/10.1146/annurev.ento.45.1.175. PMid:10761575.

LEITE, G.L.D., VELOSO, R.V.S., ZANUNCIO, J.C., ALMEIDA, C.I.M., FERREIRA, P.S.F., FERNANDES, G.W. and SOARES, M.A., 2012. Habitat complexity and *Caryocar brasiliense* herbivores (Insecta; Arachnida; Araneae). *The Florida Entomologist*, vol. 95, no. 4, pp. 819-830. http://dx.doi.org/10.1653/024.095.0402.

LEMES, P.G., ANJOS, N. and JORGE, I.R., 2013. Bioecology of *Oncideres ocularis* Thomson (Coleoptera. Cerambycidae) on *Acacia mangium* Willd. (Fabaceae). *Journal of the Kansas Entomological Society*, vol. 86, no. 4, pp. 307-317. http://dx.doi.org/10.2317/JKES121121.1.

LIMA, J.S., LEITE, G.L.D., GUANABENS, P.F.S., SOARES, M.A., SILVA, J.L., MOTA, M.V.S., LEMES, P.G. and ZANUNCIO, J.C., 2024. Insects and spiders on *Acacia mangium* (Fabaceae) saplings as bioindicators for the recovery of tropical degraded areas. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 84, no. 4, p. e252088. http://dx.doi.org/10.1590/1519-6984.252088. PMid:34755814.

MANSARAY, A. and SUNDUFU, A.J., 2009. Oviposition, development and survivorship of the sweetpotato whitefly *Bemisia tabaci* on soybean, *Glycine max*, and the garden bean, *Phaseolus vulgaris. Journal of Insect Science*, vol. 9, no. 1, p. 1. http://dx.doi.org/10.1673/031.009.0101. PMid:19611218.

MENEZES, C.W.G., BERTOLUCCI, S.K.V., PINTO, J.E.B.P., CARVALHO, G.A. and SOARES, M.A., 2013. First record of *Aethalion reticulatum* (Hemiptera: Aethalionidae) in *Vernonia condensata* (Asteraceae), a medicinal plant from Brazil. *Phytoparasitica*, vol. 41, no. 5, pp. 611-613. http://dx.doi.org/10.1007/s12600-013-0322-0.

ÖBERG, S., MAYR, S. and DAUBER, J., 2008. Landscape effects on recolonisation patterns of spiders in arable fields. *Agriculture, Ecosystems & Environment*, vol. 123, no. 1-3, pp. 211-218. http://dx.doi.org/10.1016/j.agee.2007.06.005.

PARREIRA, D.S., ZANUNCIO, J.C., MIELKE, O.H.H., WILCKEN, C.F., SERRÃO, J.E. and ZANUNCIO, T.V., 2014. *Periphoba hircia* (Lepidoptera: Saturniidae) defoliating plants of *Acacia mangium* in the State of Roraima, Brazil. *The Florida Entomologist*, vol. 97, no. 1, pp. 325-328. http://dx.doi.org/10.1653/024.097.0153.

PAULA, R.R., BOUILLET,, J.-P., GONÇALVES, J.L.M., TRIVELIN, P.C.O., BALIEIRO, F.C., NOUVELLON, Y., OLIVEIRA, J.C., DEUS JÚNIOR, J.C., BORDRON, B. and LACLAU, J.-P., 2018. Nitrogen fixation rate of *Acacia mangium* Wild at mid rotation in Brazil is higher in mixed plantations with *Eucalyptus grandis* Hill ex Maiden than in monocultures. *Annals of Forest Science*, vol. 75, no. 14, pp. 1-14. http://dx.doi.org/10.1007/s13595-018-0695-9.

PIRES, E.M., SILVA, L.C., BATIROLA, L.D., NOGUEIRA, R.M., BARRETO, M.R. and CORASSA, J.N., 2014. *Triplaris americana* L. (Polygonaceae), a new host plant for *Aethalion reticulatum* (Linnaeus, 1767) (Hemiptera: aethalionidae). *Brazilian Archives of Biology and Technology*, vol. 58, no. 1, pp. 31-33. http://dx.doi.org/10.1590/S1516-8913201400039.

PODEROSO, J.C.M., COSTA, M.K.M., CORREIA-OLIVEIRA, M.E., DANTAS, P.C., ZANUNCIO, J.C. and RIBEIRO, G.T., 2013. Occurrence of *Tropidacris collaris* (Orthoptera; Acridoidea; Romaleidae) damaging *Casuarina glauca* (Casuarinaceae) plants in the municipality of Central Bahia, Brazil. *The Florida Entomologist*, vol. 96, no. 1, pp. 268-269. http://dx.doi.org/10.1653/024.096.0143.

REBOLLEDO-MARTÍNEZ, A., ANGEL-PÉREZ, A.L., PERALTA-ANTONIO, N. and DÍAZ-PADILLA, G., 2013 [viewed 14 March 2023]. Control de fumagina (Capnodium mangiferae Cooke & Brown) con biofungicidas en hojas y frutos de mango "manila". *Tropical and Subtropical Agroecosystems* [online], vol. 16, no. 3, pp. 355-362. Available from: https://www.redalyc.org/articulo.oa?id=93929595007

RICO-GRAY, V. and OLIVEIRA, P.S., 2007. *The ecology and evolution of ant-plant interactions*. Chicago: University of Chicago Press, 320 p. http://dx.doi.org/10.7208/chicago/9780226713540.001.0001.

SANCHEZ, A., 2015. Fidelity and promiscuity in an ant-plant mutualism: a case study of *Triplaris* and *Pseudomyrmex. PLoS One*, vol. 10, no. 12, p. e0143535. http://dx.doi.org/10.1371/journal.pone.0143535. PMid:26630384.

SANTOS, R.S. and PERONTI, A.L.B.G., 2017. Occurrence of *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in okra in Acre state, Brazil. *EntomoBrasilis*, vol. 10, no. 2, pp. 135-138. http://dx.doi.org/10.12741/ebrasilis.v10i2.684.

SCHULTHESS, F., BAUMGÄRTNER, J.U., DELUCCHI, V. and GUTIERREZ, A.P., 1991. The influence of the cassava mealybug, *Phenacoccus manihoti* Mat.-Ferr. (Horn., Pseudococcidae) on yield formation of cassava, *Manihot esculenta* Crantz. *Journal of Applied Entomology*, vol. 111, no. 1-5, pp. 155-165. http://dx.doi.org/10.1111/j.1439-0418.1991.tb00306.x.

SERRA, B.D.V. and CAMPOS, L.A.O., 2010. Entomophilic pollination of squash, *Cucurbita moschata* (Cucurbitaceae). *Neotropical Entomology*, vol. 39, no. 2, pp. 153-159. http://dx.doi.org/10.1590/S1519-566X2010000200002. PMid:20498949.

SILVA, F.W.S., LEITE, G.L.D., GUANABENS, R.E.M., SAMPAIO, R.A., GUSMÃO, C.A.G., SERRÃO, J.E. and ZANUNCIO, J.C., 2015. Seasonal abundance and diversity of arthropods on *Acacia mangium* (Fabales: Fabaceae) trees as windbreaks in the Cerrado. *The Florida Entomologist*, vol. 98, no. 1, pp. 170-174. http://dx.doi.org/10.1653/024.098.0129.

SILVA, J.L., DEMOLIN-LEITE, G.L., TAVARES, W.S., SILVA, F.W.S., SAMPAIO, R.A., AZEVEDO, A.M., SERRÃO, J.E. and ZANUNCIO, J.C., 2020. Diversity of arthropods on *Acacia mangium* (Fabaceae) and production of this plant with dehydrated sewage sludge in degraded area. *Royal Society Open Science*, vol. 7, no. 2, p. 191196. http://dx.doi.org/10.1098/rsos.191196. PMid:32257306.

SOUZA, G.F., LEITE, G.L.D., SILVA, F.W.S., SILVA, J.L., SAMPAIO, R.A., TEIXEIRA, G.L., SOARES, M.A. and ZANUNCIO, J.C., 2021. Bottom-up effects on arthropod communities in *Platycyamus regnellii* (Fabaceae) fertilized with dehydrated sewage sludge. *Revista Colombiana de Entomología*, vol. 47, no. 1, p. e8943. http://dx.doi.org/10.25100/socolen.v47i1.8943.

VENTURINO, E., ISAIA, M., BONA, F., CHATTERJEE, S. and BADINO, G., 2008. Biological controls of intensive agroecosystems: wanderer spiders in the *Langa astigiana. Ecological Complexity*, vol. 5, no. 2, pp. 157-164. http://dx.doi.org/10.1016/j.ecocom.2007.10.003.

WANG, F., ZHU, W., ZOU, B., NEHER, D.A., FU, S., XIA, H. and LI, Z., 2013. Seedling growth and soil nutrient availability in exotic and native tree species: implications for afforestation in southern China. *Plant and Soil*, vol. 364, no. 1-2, pp. 207-218. http://dx.doi.org/10.1007/s11104-012-1353-x.

ZANUNCIO, A.J.V., SERRÃO, J.E., PEREIRA, A.I.A., SOARES, M.A., WILCKEN, C.F., LEITE, G.L.D. and ZANUNCIO, J.C., 2015. *Aethalion reticulatum* (Hemiptera: Aethalionidae) feeding on *Erythrina speciosa* (Fabales: Fabaceae): first record of its host plant and damage characteristics. *The Florida Entomologist*, vol. 98, no. 1, pp. 175-177. http://dx.doi.org/10.1653/024.098.0130.

ZHANG, W., MCAUSLANE, H.J. and SCHUSTER, D.J., 2004. Repellency of ginger oil to *Bemisia argentifolii* (Homoptera: Aleyrodidae) on tomato. *Journal of Economic Entomology*, vol. 97, no. 4, pp. 1310-1318. http://dx.doi.org/10.1093/jee/97.4.1310. PMid:15384342.

ZOGRAFOU, K., ADAMIDIS, G.C., KOMNENOV, M., KATI, V., SOTIRAKOPOULOS, P., PITTA, E. and CHATZAKI, M., 2017. Diversity of spiders and orthopterans respond to intra-seasonal and spatial environmental changes. *Journal of Insect Conservation*, vol. 21, no. 3, pp. 531-543. http://dx.doi.org/10.1007/s10841-017-9993-z.

## Supplementary Material

Supplementary material accompanies this paper.

**Supplementary material I.** Aggregated (Agg.), regular (Reg.), or random (Ran.) distribution (Dist.) of the loss sources on 48 Acacia mangium (Fabaceae) saplings.

**Supplementary material II.** Aggregated (Agg.), regular (Reg.), or random (Ran.) distribution (Dist.) of the solution sources on 48 Acacia mangium (Fabaceae) saplings.

**Supplementary material III.** Simple regression equations of damage per loss source (L.S.) and reduction or increase of L.S. (abundance or damage) per solution source (S.S.) on 48 Acacia mangium (Fabaceae) saplings.

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