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Evaluation of two methods for monitoring the blackmargined pecan aphid and its predators

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Abstract. The present study aimed to evaluate, qualitatively and quantitatively, yellow sticky traps and entomological net in the monitoring of *Monellia caryella* (Fitch, 1855) (Hemiptera: Aphididae) and its predators in a pecan plantation in Santa Maria, Rio Grande do Sul, Brazil. This plantation was implemented on 1.2 ha in February 2012 with the Barton and Shawnee varieties at a spacing of 7 m x 7 m. Twenty pecan plants were randomly selected to sample the blackmargined pecan aphid and its predators. From November 2014 to May 2015, 13 collections were carried out with yellow sticky traps and an entomological net. A total of 898 arthropod specimens were collected, 50.9% of which were from yellow sticky traps and 49.1% from the entomological net. Regarding the yellow sticky traps, only *M. caryella* was identified at the species level, with the predators identified at the taxonomic levels of order (Araneae) and family (Coccinellidae; Coleoptera). In terms of the entomological net, all the insects of interest at the species level were identified. There was a significant difference only between the averages in the number of Araneae specimens, with the highest density found in the yellow sticky traps. Both methods provided the correct identification of *M. caryella* and efficiently recorded its population peak. It is concluded that yellow sticky traps are effective for monitoring *M. caryella*, while the entomological net is suitable for monitoring and correctly identifying species of natural enemies of the insect pest in pecan plantations.

Keywords: *Carya illinoinensis*; entomological net; *Monellia caryella*; pecan nut; sticky trap.

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The pecan tree [*Carya illinoinensis* (Wangenh.) K. Koch, Juglandaceae] originated in Mexico and the United States (McWilliams 2013). Pecan nuts have nutraceutical properties that benefit human health, increasing consumer demand for the product (Fronza *et al*. 2018). The pecan tree crop has expanded in South Africa, Australia, Argentina, Uruguay, and Brazil (Bilharva *et al.* 2018). In the latter country, this species has adapted to edaphoclimatic conditions, especially in the southern region, a fact that, combined with the profitability of the crop, has encouraged its cultivation (De Marco *et al*. 2018).

In Brazil, the management of pecan trees presents some challenges, including identifying phytosanitary problems and implementing ecologically appropriate strategies for controlling insect pests and pathogens (Bilharva *et al.* 2018). Among the insect pests considered harmful to pecan cultivation in the country (Nava *et al*. 2021), the following stand out: Ambrosia beetles, belonging to the genera *Corthylus* Erichson, 1836 and *Xyleborinus* Reitter, 1913 and the species *Xyleborus ferrugineus* Fabricius, 1801 and *Xyleborus retusus* (Eichhoff, 1868) (Coleoptera: Curculionidae: Scolytinae) (Boscardin & Costa 2020; Poletto *et al*. 2020); the twig girdlers *Aegomorphus jaspideus* (Germar, 1823), *Megacyllene acuta* (Germar, 1821), and *Oncideres dejeani* Thomson, 1868 (Coleoptera: Cerambycidae) (Nava *et al.* 2021); and the blackmargined pecan aphid *Monellia caryella* (Fronza *et al*. 2015).

The blackmargined pecan aphid is among the main pests in pecan trees (Thompson & Conner 2012), causing damage to plant leaves (Boscardin & Costa 2018). *Monellia caryella* was introduced in Brazil and is distributed in the state of Rio Grande do Sul. Like the other pests mentioned above for the crop, studies on its bioecology, influence of environmental factors, and monitoring and control techniques are necessary to implement more efficient integrated pest management (IPM) systems (Nava *et al*. 2021).

Yellow sticky traps are the main method of monitoring sucking insect pests in forest crops (Zanetti & Silva 2021). For some of them, in addition to monitoring, such traps are used to control these pests (Shimoda & Honda 2013).

The use of yellow sticky traps favors the quantification of the target species. However, the sticky present in the traps can damage other specimens of interest (*e.g.*, natural enemies), thus hampering their identification and quantification. In this sense, using complementary capture methods that favor the maintenance of morphological characteristics is important for properly identifying species of interest. The present study aimed to evaluate, qualitatively and quantitatively, the use of yellow sticky traps and entomological net in monitoring winged adults *of M.* caryella and its predators in a pecan plantation.

MATERIAL AND METHODS

The study was conducted in a pecan plantation of about 1.2 hectares, located in the experimental area of the Department of Agricultural Diagnosis and Research (DDPA), Santa Maria (-29.67527778; -53.91250000). The climate of the region is humid subtropical, without

droughts (Alvares *et al*. 2013). The soil of the study region is classified as Arsenic Dystrophic Red Argisol, well-drained, with a reddish Bt horizon (textural B type) and a sandy loam surface texture, acidic, and poor in organic matter (Streck *et al*. 2008).

The pecan plantation, comprised of the Barton and Shawnee varieties, was implemented in February 2012, with a spacing of 7 m x 7 m, totaling 240 plants. To sample the winged adults of *M. caryella* and their predators, 20 pecan plants were randomly selected and collected with yellow sticky traps and an entomological net.

From November 2014 to May 2015, 13 samples were collected every 15 and/or 20 days, totaling 260 samples for each collection method. Such a period corresponds to the vegetative growth of pecan plants, in which there is, therefore, the presence of leaves in the crown. In March 2015, the plants sampled had an average height of 2.9 ± 0.6 m and an average diameter of 39.1 ± 9.3 mm.

Yellow sticky traps were installed at the crown bottom of each selected plant and fixed with a wire. They measured 23 x 11 cm and were made of special paper containing sticky glue, with both sides checkered (2 x 2 cm) (Promip®). The traps remained for 48 hours at the site and, at the time of collection, were wrapped in plastic film and taken to the laboratory for screening, identification, and counting of arthropods of interest [*Monellia* caryella, order Araneae, and family Coccinellidae (Coleoptera)].

The entomological net, consisted of a rim approximately 40 cm in diameter and a bag made of cotton cloth, 80 cm long, tapering, with a rounded end, containing a cable. After selecting the plants, the entomological net bag was wrapped in the branches of the plants; five shakes in each branch were performed, using a ladder to reach the height of the crown. The collections were carried out in such a way as to cover the entire crown in the morning, between 9 am and 12 pm. The collected material was deposited in sealed and identified plastic bags. Subsequently, the samples were taken to the laboratory and kept refrigerated (approximately at -6ºC) until the time of screening, identification, and counting of arthropods.

For the yellow sticky traps, it was possible to identify *M. caryella* and only quantify the specimens of Araneae and Coccinellidae. The adults of *M. caryella* measured about 2 mm and had a yellow body with part of the head, chest, and some abdominal segments in black; at rest, the wings were arranged along the body; along the front edge of the anterior wings, there was a black band (Nava *et al*. 2021). Such morphological characteristics assisted in their identification in both collection methods. For the entomological net, all specimens were identified at the species level.

Monellia caryella specimens were sent to Dr. Regina Célia Zonta de Carvalho (ADAPAR) to confirm species identification. The Araneae specimens were sent to Dr. Antonio Domingos Brescovit (Instituto Butantan), and the specimens of Coccinellidae (Coleoptera) were sent to Dr. Lúcia Massutti de Almeida (UFPR) to identify the species.

Data were analyzed using the statistical program Past 4.02 (Hammer *et al.* 2001). The variation between the averages in the number of specimens of predators (Araneae and Coccinellidae) and *M. caryella* collected with the two methods were analyzed using Student's t-test (α=5%). Data were expressed as average and standard deviation, and those that did not demonstrate normality by the Shapiro-Wilk test were transformed into $x = log (x+1)$.

RESULTS AND DISCUSSION

During the period, 898 arthropod specimens were collected; of these, 50.9% were collected with yellow sticky traps and 49.1% with the entomological net. *Monellia caryella* showed the highest frequency in both collection methods (Table 1).

Among the species of predatory arachnids collected with the entomological net (Table 1), jumping spiders (Araneae: Salticidae) and crab spiders (Araneae: Thomisidae) stand out for feeding on different types of insects, including aphids harmful to pecan nuts (Ree & Knutson 1997). Moreover, the ladybug species *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) has already been shown to be efficient in controlling *M. caryella* (Abbas *et al.* 2013). Thus, the entomological net proved to be efficient in monitoring and correctly identifying species of natural enemies of the blackmargined pecan aphid.

There was a significant difference between the averages in the number of specimens collected only for Araneae, with the highest average in the number of specimens verified for the yellow sticky traps (Figure 1). The population peak of *M. caryella* was verified in the summer, on February 23, 2015, for both collection methods (Figure 2). This is a hemimetabolous species, with a biological cycle completed in up to seven days under conditions of high temperatures, especially in the summer (Nava *et al*. 2021), a fact that may explain the registration date of the pest insect population peak.

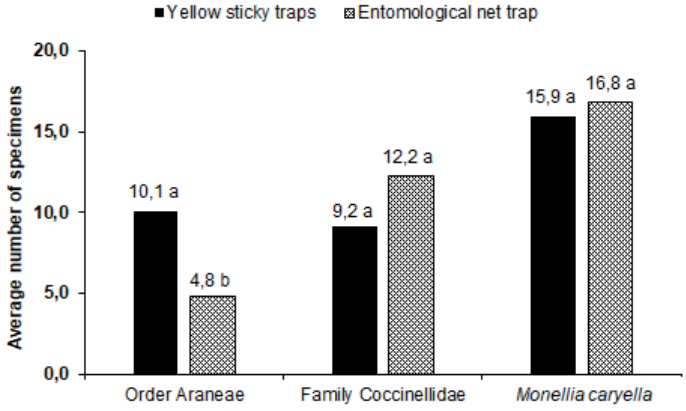

Figure 1. Average number of individuals belonging to the taxonomic groups of arthropods collected with yellow sticky traps and an entomological net in pecan planting in Santa Maria, Rio Grande do Sul, Brazil, between November 2014 and May 2015. *Means followed by the same letter for each taxonomic group do not differ significantly by the t-test at the 5% level.

The two methods provided the correct identification of *M. caryella* and efficiently recorded the population peak of this pest insect. Yellow sticky traps stand out in the sense that they are a passive collection method; that is, they do not require the constant presence of the operator, which can result in reduced costs of monitoring the insect pest, a parameter not evaluated in the present study and which should be considered when choosing the monitoring method to be used. Allied with this, concerning these traps, the quantification of *M. caryella* results in a faster and easier process than the entomological net. The availability of data collected through agile collection methods results in faster decision-making, which can be decisive for successful IPM applications.

The entomological net collection stood out for preserving the morphological characteristics of the specimens of arthropods collected, which is fundamental for species-level identification. The correct identification of the natural enemies of *M. caryella* in pecan trees is the starting point for adopting an effective biological control, which, alone or combined with other control methods, can serve as a basis for implementing IPM in the crop.

Table 1. Abundance and frequency (%) of individuals belonging to the taxonomic groups of arthropods collected with yellow sticky traps and entomological net in a pecan planting in Santa Maria, Rio Grande do Sul, Brazil, between November 2014 and May 2015.

Taxonomic groups		Yellow sticky traps	Entomological net
CLASS ARACHNIDA			
Order Araneae			
Family Anyphaenidae			
Arachosia honesta Eugen von Keyserling, 1891			6
Xiruana hirsuta (Mello-Leitão, 1938)			1
Anyphaenidae 1			3
Family Araneidae			
Araneus corporosus (Eugen von Keyserling, 1892)			1
Family Eutichuridae		NI*	
Cheiracanthium inclusum (Hentz, 1847)			15
Family Salticidae			
Salticidae 1			30
Family Sparassidae			
Sparassidae 1			5
Family Thomisidae			
Misumenops sp.			2
	∑	**131 (28.7%)**	**63 (14.3%)**
CLASS INSECTA			
Order Coleoptera			
Family Coccinellidae			
Cycloneda sanguinea (Linnaeus, 1763)			29
Harmonia axyridis (Pallas, 1773)		NI*	95
Harmonia sp.			32
Hyperaspis sp.			1
Scymnus sp.			2
	∑	**119 (26.0%)**	**159 (36.1%)**
Order Hemiptera			
Family Aphididae			
Monellia caryella (Fitch, 1855)		207	219
	∑	**207 (45.3%)**	**219 (49.7%)**
	∑ total	**457 (100.0%)**	**441 (100.0%)**

*NI - Identification at the family and/or species level was not possible.

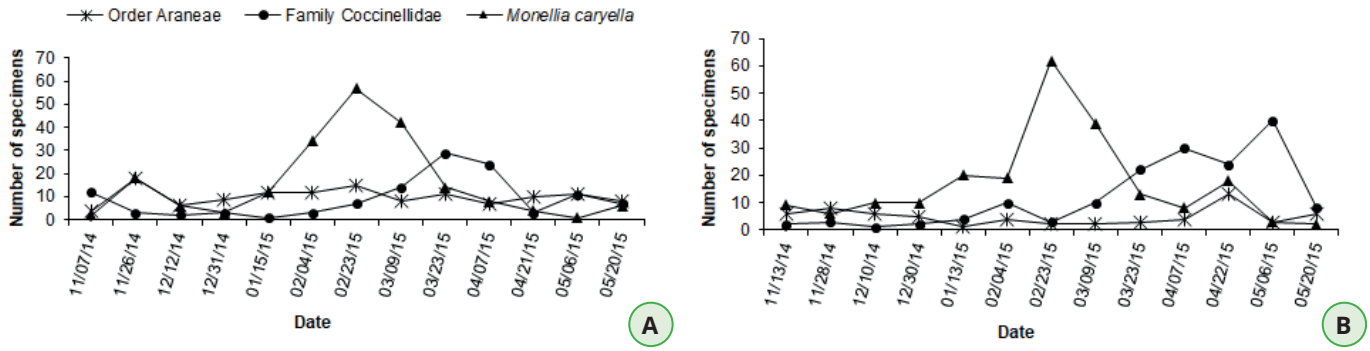

Figure 2. Population fluctuation of individuals belonging to the taxonomic groups of arthropods collected with yellow sticky traps (A) and entomological net (B) in a pecan plantation in Rio Grande do Sul, Brazil, between November 2014 and May 2015.

Therefore, yellow sticky traps are effective in the field collection and laboratory screening phases, effectively monitoring *M. caryella* in pecan plantations. Meanwhile, the use of an entomological net is suitable for arthropod collections in the crowns of pecan trees, allowing not only the monitoring but also the correct identification of species of natural enemies of *M. caryella*.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

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