Colegio de Postgraduados

Biological control and identification of entomofauna in pecan orchards established in the Guadiana Valley, Durango, Mexico

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ABSTRACT

Objective: To taxonomically identify insect pests associated with pecan cultivation and assess the biological control efficacy of various bioproducts in the Guadiana Valley, Durango, Mexico.

Design/Methodology/Approach: Insect pest quantification was conducted through leaf sampling, which involved the inspection of 100 leaves per orchard. This was achieved by randomly selecting 10 trees per orchard and collecting 10 leaves from each tree. The study was conducted in two phases: (1) fieldwork and (2) laboratory analysis. To evaluate the biological efficacy of entomopathogenic agents against the principal pecan pests, the following treatments were applied: (1) untreated control, (2) *Beauveria bassiana*, (3) *Paecilomyces fumosoroseus*, (4) *Verticillium lecanii*, (5) *Metarhizium anisopliae*, (6) neem extract, and (7) *Bacillus thuringiensis*. A randomized complete block design with three replicates was implemented, with the experimental unit comprising 15 tree rows per 100 meters.

Results: Abundant rainfall during the sampling period resulted in the entomopathogenic treatments showing no statistically significant effect. Nevertheless, the primary insect pests associated with pecan cultivation in the Guadiana Valley were taxonomically identified, with the giant pecan aphid (*Longistigma caryae*) emerging as the most prevalent species.

Limitations/Implications: The study's limitations are influenced by the agroclimatic conditions of the location where the research is replicated.

Findings/Conclusions: The principal insect pest orders and families affecting pecan cultivation in the Guadiana Valley, Durango, were successfully identified.

Keywords: *Carya illinoensis*, biological effectiveness, insect identification.

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INTRODUCTION

Mexico is one of the world's leading producers of pecans, with approximately 167,172.36 hectares (ha) planted with pecan trees (*Carya illinoinensis*), of which 20% correspond to native

and/or creole varieties (SIAP, 2024a). The primary pecan-producing states at the national level are Chihuahua, Sonora, Coahuila, Durango, and Nuevo León (SIAP, 2024b). In the state of Durango, pecan cultivation covers a total area of 10,188.97 ha, distributed across 13 municipalities, with an average yield of 1.43 tons per hectare (SIAP, 2024a). The municipalities of Nazas, Lerdo, Durango, Gómez Palacio, Poanas, San Juan del Río, and Rodeo concentrate 86% of the state's total pecan acreage. Water management is the key factor in pecan production (Godoy & López, 2000); however, one of the major limiting factors is the presence of insect pests (Fu *et al.*, 2012). According to Fu *et al.* (2007) and Franco (1984), a diverse range of insect pests negatively impacts the productivity of pecan orchards. Among the most significant are the pecan shuckworm (PSW) (*Cydia caryana*), the pecan nut casebearer (PNC) (*Acrobasis nuxvorella*), the ambrosia beetle (AB) (*Euplatypus segnis*), and a complex of aphids, including the giant aphid (*Longistigma caryae*), the yellow pecan aphid (*Monelliopsis pecanis*), the black-margined aphid (*Monellia caryella*), the pecan spittlebug (*Clastoptera achatina*), and stink bugs (*Nezara viridula* and *Brochymena* spp.). Given the absence of a specific inventory of insect pests affecting pecan cultivation in the Guadiana Valley region located in central Durango producers often rely on reports from other pecan-growing areas, particularly the Comarca Lagunera. Therefore, a taxonomic identification of the insect pests associated with pecan cultivation in this region is necessary. The objective of the present study was to taxonomically identify the insect pests associated with pecan orchards and evaluate the biological control efficacy of bio-based products in the Guadiana Valley, Durango, Mexico.

MATERIALS AND METHODS

Study area description and location

The study was conducted in pecan orchards belonging to collaborating producers, with two orchards selected within the Guadiana Valley region of Durango (Table 1). Each selected orchard covered an area of approximately 4,800 m^2. Given the logical framework planting layout of 12×12 meters, four rows containing 12 trees each were chosen, resulting in a total of 48 trees per orchard.

Field variable measurement and data recording

To diagnose the insect species associated with pecan cultivation in the Guadiana Valley, biweekly sampling was conducted in a pecan orchard from June 11 to September 11, 2013. The aim was to identify pest population dynamics and determine the action threshold for subsequent entomopathogen applications. Insect counts were carried out using the following methodology: leaf sampling consisted of inspecting 100 compound leaves per

Table 1. Geographical location of the pecan orchards used in the Guadiana Valley.

Site	Huerta	Geographic Coordinates		
		NL†	WL¶	Altitude (m)
1	Agrícola REMAGA	23° 57' 53.3"	−104° 36' 37.2"	1881
2	Tobías Morales Lara	23° 57' 22.3"	−104° 35' 31.7"	1879

† North Latitude, ¶ West Longitude.

orchard, selecting 10 trees at random and sampling 10 leaves from each tree. Accordingly, the work was divided into two phases: (1) fieldwork and (2) laboratory analysis. Fieldwork: Biweekly sampling was conducted by randomly selecting 10 out of the 48 trees designated for treatment in each orchard. Direct sampling included 10 leaves and 10 nut clusters per tree. Additionally, an entomological sweep net was used on each tree, with 10 sweeps per tree. Captured insects were preserved in sterilized plastic containers filled with 70% ethanol. Laboratory Analysis: In this phase, all insects collected during fieldwork were taxonomically identified using a stereomicroscope at the Valle del Guadiana Experimental Station (Durango) and the La Laguna Experimental Station (Coahuila). Identification was based on specialized entomological keys, including those by Borror and White (1970), Bland and Jacques (1978), Arnett *et al.* (1980), Leahy and White (1987), Milne and Milne (1992), Triplehorn and Johnson (2005), and Eaton and Kaufman (2007). As a result, an entomological inventory of species associated with pecan cultivation in the Guadiana Valley was established.

Distribution of biological effectiveness treatments

To evaluate the biological effectiveness of entomopathogenic agents in controlling major pecan pests, the following treatments were tested: untreated control, *Beauveria bassiana*, *Paecilomyces fumosoroseus*, *Verticillium lecanii*, *Metarhizium anisopliae*, neem extract, and *Bacillus thuringiensis*.

A randomized complete block design with three replicates was employed. Each experimental unit consisted of 15 rows of trees, each 100 meters long. Rows 2, 4, 6, 8, 10, 12, and 14 were used to minimize edge effects during application. Insect sampling was conducted on the central row of each experimental unit. The variables evaluated included population densities of yellow aphids and spittlebugs. For this, the number of individuals was recorded on 10 leaves from trees 3, 6, and 9 in each experimental unit. Applications were carried out using a John Deere tractor towing a 1,000-liter "Savage" brand tank equipped with a cannon-type sprayer (Figure 1) for the dispersion of entomopathogens.

Statistical analysis

The data obtained were analyzed using SAS® software version 9.4 (SAS Institute Inc., 2013) to assess variability. An analysis of variance (ANOVA) was conducted under a randomized complete block design, and mean comparisons were performed using Tukey's test at a significance level of $P \leq 0.05$.

RESULTS AND DISCUSSION

During the sampling intervals corresponding to the application of the different entomopathogenic treatments, no statistically significant differences were observed among treatments, as the results exceeded the 0.05 confidence threshold. Notably, heavy rainfall occurred throughout the sampling period, especially from late June to early September. This rainfall had a marked impact on the pest action threshold, as terrestrial insect populations tend to decline significantly under wet conditions. Consequently, the reduced number of individuals likely limited the effectiveness of the entomopathogenic

Figure 1. Cannon-type sprayer for the dispersion of entomopathogens.

products, resulting in no statistically significant control. Based on the data collected from both field and laboratory work, the principal insect pests associated with pecan cultivation in the Guadiana Valley, Durango, were taxonomically identified (Table 2). Compared to the nearest pecan-producing region, the Comarca Lagunera, the catkin borer was not detected; however, the giant aphid (*Longistigma caryae*) was present. This species has not previously been reported under the conditions specific to that neighboring region.

Figures 2, 3, and 4 schematically illustrate some of the identified pests, including the yellow pecan aphid (*Monelliopsis pecanis*), the black-margined aphid (*Monellia caryella*), and the pecan spittlebug (*Clastoptera achatina*).

Table 2. Taxonomic identification of insect pests associated with pecan (*Carya illinoensis*) cultivation in the Guadiana Valley.

Order	Family	Order	Family
Coleoptera	Elateridae	Hemiptera	Aphididae
	Cicindellidae		Coreidae
	Chrysomelidae		Pyrrhocoridae
	Coccinellidae		Cicadidae
	Tenebrionidae		Lygeidae
	Lampiridae		Miridae
	Anthicidae		Braconidae
	Scarabeidae		Pentatomidae
Diptera	Agromycidae		Cercopidae
	Asilidae		Membracidae
	Muscidae	Himenoptera	Aphididae
	Tephritidae		Braconidae
	Dolichopodidae		Tiphidae
	Syrphidae		Formicidae
	Culicidae		Vespidae
Lepidoptera	Pieridae		
Neuroptera	Crisopidae		

Figure 2. Yellow pecan aphid (*Monelliopsis pecanis*).

Figure 3. Black-margined aphid (*Monellia caryella*).

Figure 4. Pecan spittlebug (*Clastoptera achatina*).

In northern Coahuila, staining or stink bugs (*Nezara viridula*) have been reported to cause significant damage, with yield losses ranging from 5% to 40%. Another important pest in that region is the bud moth (*Gretchena bolliana*), which primarily affects young and actively growing trees by feeding on apical shoots and foliage (Aguilar, 2007). In contrast, in the Guadiana Valley, neither stink bugs nor the bud moth are present at levels considered alarming for pecan crop management.

CONCLUSIONS

The orders and families of the principal insect pests associated with pecan cultivation in the Guadiana Valley, Durango, were taxonomically identified. This serves as a foundational reference for future research, as no entomological inventory had previously been reported for pecan pests in this region, particularly in the central part of the state. Additionally, some pest species found in the neighboring Comarca Lagunera region (Torreón, Coahuila; Gómez Palacio and Lerdo, Durango), such as the catkin borer, were not observed in the Guadiana Valley.

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