

Control of *Hypsipyla grandella* Zeller in a commercial plantation of *Cedrela odorata* L., in Chiapas, Mexico

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ABSTRACT

Objective: This study aimed to evaluate three control methods for *H. grandella* in a 2.1-year-old commercial forest plantation in Frontera Hidalgo, Chiapas, Mexico.

Design/methodology/approach: Three treatments were established: T1 chemical control with the application of Cypermethrin[®] at a dose of 10 mL L⁻¹ of water, T2 organic control with the application of the organic insecticide Vegex Kuneka[®] at a dose of 10 mL L⁻¹ of water, and T3 silvicultural control with sanitary pruning.

Results: The analysis of variance indicated that a statistical difference was found ($p < 0.01$), where T1 and T3 showing the most favorable outcomes across the variables measured, although in general the three treatments presented low values in percentage of damage (22.22%), high health status (77.78%), vigor of 84.44% and a survival rate of 94.44%.

Limitations on study/implications: The site's environmental conditions influenced the effectiveness of the applied control methods. Additionally, the biological cycle of *H. grandella* can vary depending on ecological conditions, complicating the establishment of a management protocol.

Findings/conclusions: It is concluded that chemical, organic, and silvicultural control methods can reduce borer damage by up to 75%, and the species shows good growth development under these management strategies.

Keywords: Borer, Cedar, Silvicultural management, Control methods, Forest pest.

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INTRODUCTION

Commercial forest plantations are of great importance in Mexico. Red cedar (*Cedrela odorata* L.) is a species from the Meliaceae family, native to tropical America (Pennington & Sarukhán, 2005), and is distributed across Mexico, Central America, the Antilles, and northern South America (Patiño, 1997). It is considered one of the precious wood species in the forest industry (Romo-Lozano *et al.*, 2017). Its high commercial value has led to a decline in natural populations due to intensive logging (Hernández *et al.*, 2018). In Mexico,

it is listed as a protected species under NOM-059-SEMARNAT-2010 (SEMARNAT, 2010) and appears on the Red List of the International Union for Conservation of Nature (Mark & Rivers, 2017).

To promote the recovery and conservation of its natural populations, in recent years *Cedrela odorata* has been included in reforestation programs and commercial forest plantations (CONAFOR, 2020), and more recently in different production systems through the **Sembrando Vida** program (DOF, 2019). To establish plantations with this species, it must be registered as a Wildlife Conservation Management Unit (UMA) subject to intensive management (SEGOB, 2000). However, its growth and development are affected by the presence of *Hypsipyla grandella* (Zeller 1848) (Lepidoptera: Pyralidae), an insect known as the Meliaceae borer, which attacks plants of species such as mahogany (*Swietenia macrophylla* King 1760) and cedar (*Cedrela odorata* L. 1756) (Cibrián *et al.*, 1995; Taveras *et al.*, 2004).

The damage caused by the insect is more severe in young plantations, which hinders the exploitation of their productive potential and creates difficulties in establishing large-scale commercial plantations (Hilje and Cornelius, 2001). The main damage consists of perforations in new shoots, especially the terminal shoot (Taveras *et al.*, 2004). This attack affects apical dominance and results in the branching of the tree (Cibrián *et al.*, 1995), which reduces the commercial value of the wood because it decreases the size of the logs that can be marketed.

Although the pest has not been eradicated, there are various alternatives to reduce its incidence. Some of these are effective (Hilje, 2020; Martínez-Vento *et al.*, 2010; Mero-Jalca *et al.*, 2021), while others are based on silvicultural practices such as mixed plantations, planting densities, and grafting with resistant species, which are more economically and ecologically profitable but have the drawback of being technically less effective. In the state of Chiapas, particularly in the Soconusco region, forest plantations with *C. odorata* have been established. Therefore, the objective of this study was to evaluate three methods for controlling *H. grandella* in a commercial plantation, aiming to explore new alternatives for its management.

MATERIALS AND METHODS

Study Area

The private property El Tesoro covers a total area of 37-75-50 hectares. It is located in the municipality of Frontera Hidalgo, Chiapas, Mexico (92° 14' 52.29" W longitude and 14° 44' 48.43" N latitude), with an altitude of 25 m (Figure 1). The plantation was established in June 2017, covering an area of 7.44 hectares, with a planting density of 722 plants ha⁻¹.

Plantation Management

After establishing the plantation, supplemental irrigation was applied weekly during the dry season. Weed control was carried out mechanically at the beginning and end of the rainy season. A dose of 50 g per plant of the 17N-17P-17K fertilizer formula was applied, and preventive applications against the terminal shoot borer caused by *H. grandella* were

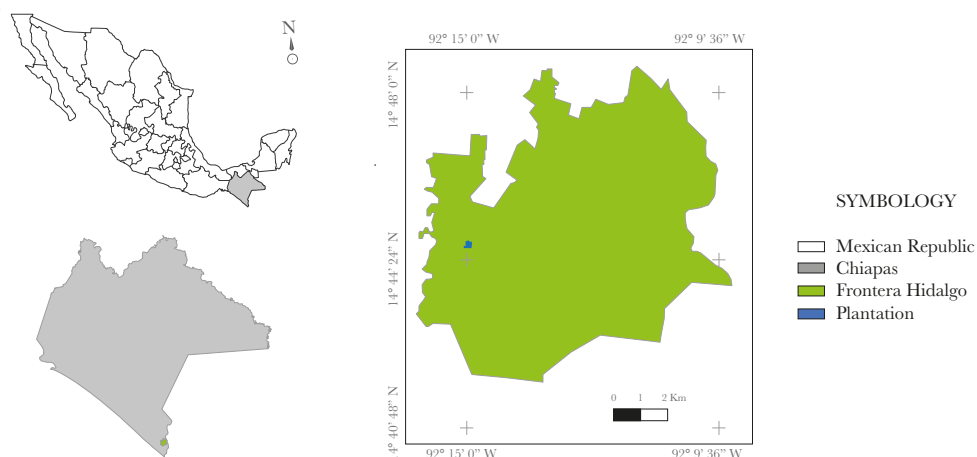


Figure 1. Geographic location of the private property El Tesoro of Frontera Hidalgo, Chiapas, Mexico.

made using Arrivo[®] (Cypermethrin) at a dose of 20 mL 20 L⁻¹ of water, applied every fifteen days during the rainy season. One month before the evaluation, the corresponding actions were carried out for each of the treatments evaluated.

Treatments and Experimental Design

A randomized complete block design was used, consisting of three treatments (Table 1) and four replications, resulting in a total of 12 experimental units. Each unit was distributed over a 100 m² area. Each site included nine trees, covering a total surface area of 1,200 m², with a 12-meter spacing between blocks.

Measured Variables

Four samplings were conducted, the first in August 2019 and the last in May 2020. In each sampling, the following variables were evaluated: health status, measured as the proportion of healthy trees relative to those damaged by the borer; vigor, assessed as the proportion of vigorous individuals per unit area; and survival, measured as the proportion of living trees relative to the number of trees originally planted. Additionally, the percentage of damage was calculated based on the residual from the health status.

Statistical Analysis

The percentage-based variables were transformed using the angular (arcsine) transformation. A Shapiro-Wilk normality test was applied to all variables to verify

Table 1. Description of the treatments for the control of *H. grandella*.

Treatments	Name	Description	Dose
1	Chemical control	Application of Cypermethrin [®]	10 mL·L ⁻¹ of water every 15 days
2	Organic control	Organic insecticide Vegex Kuneka [®]	10 mL·L ⁻¹ of water every 15 days
3	Silvicultural control	Sanitary pruning	Every 30 days

data distribution, and Levene's test was used to assess the homogeneity of variances. Subsequently, an ANOVA was performed, followed by Tukey's mean comparison test ($P \leq 0.05$), using the R Studio statistical software, version 4.4.2 (R Core Team, 2025).

RESULTS AND DISCUSSION

The data for each variable, according to the Shapiro-Wilk test, showed a normal distribution ($W=0.94$, $p \geq 0.67$). Similarly, Levene's test indicated that the variances among treatments were homogeneous ($p \geq 0.69$). Regarding the percentage of damage to the trees, significant differences ($P \leq 0.05$) were recorded between treatments for each sampling period. According to Tukey's test ($\alpha=0.05$), T1 showed the lowest damage caused by the borer across all sampling periods, followed by T3, while T2 was classified as intermediate between T1 and T3, except during the first sampling (Figure 2). These results are similar to those reported in a study conducted in Argentina, where the incidence of the borer in *Cedrela fissilis* was lower with the application of the insecticide Fendona, compared to a silvicultural treatment (Maiocco *et al.*, 2008). However, Hilje and Cornelius (2001) mention that although pruning is not a preventive method, it is effective in mitigating the effects of *H. grandella* attacks. In the present study, the greatest damage was recorded in T2. Nevertheless, Mero-Jalca *et al.* (2021) reported that the use of a bioinsecticide based on *Azadirachta indica*, *Cinnamomum zeylanicum* Blume, and *Allium sativum* was effective in controlling the borer in a *Swietenia macrophylla* King plantation, and they also observed greater growth in the treated trees.

It is important to note that the highest percentage of damage to the trees occurred during the rainy season (August-October), reaching 44%, 55%, and 66%. During this period, the borer tends to increase in activity. However, in the absence of rain, damage is lower up to 11%, 22%, and 44% for T1, T3, and T2, respectively. These findings are consistent with Santos *et al.* (2015), who reported the greatest presence of the borer in *C. odorata* plants during the rainy season.

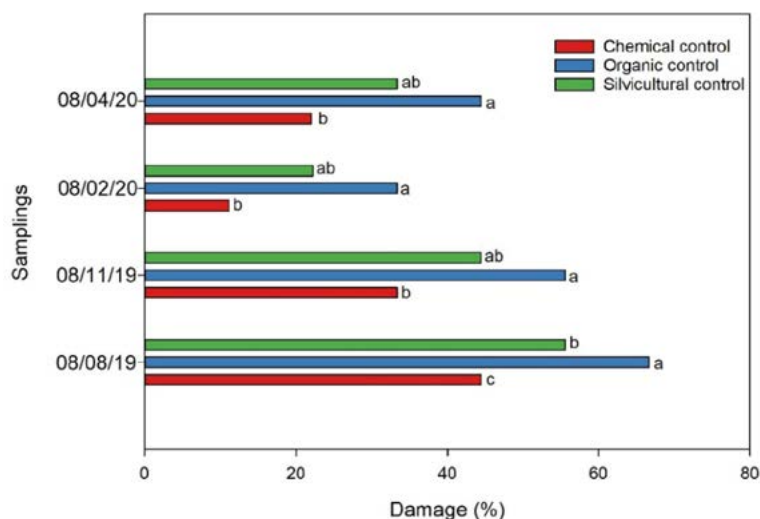


Figure 2. Percentage of damage caused by *H. grandella* on *C. odorata* trees. Different letters among treatments within each sampling period indicate statistically significant differences (Tukey, $P \leq 0.05$).

The analysis of variance indicated statistically significant differences ($p < 0.01$) among the treatments for each of the evaluated variables, except for vigor and survival in the last sampling (Table 2). Plant health showed an increasing trend, as the incidence of borer attacks decreased with the application of treatments, leading to a higher percentage of healthy trees. Treatments T1 and T3 recorded the highest percentages of healthy trees compared to the other treatments. Throughout the evaluation period, trees exhibited good vigor in response to the treatments, maintaining high percentages since the first sampling date. Finally, regarding survival, all treatments showed rates above 90% across the four sampling events. T1 and T3 maintained high survival percentages from the first sampling, whereas the other plots showed some variation, which was due to the replacement of dead plants in order to maintain the initial planting density of 722 trees ha^{-1} .

In general terms, the sampling sites showed a health status of 66.67%, vigor of 84.44%, and survival of 94.44%. These results are favorable when compared to those reported by Muñoz *et al.* (2011) at the El Belem property in the municipality of Múgica, Michoacán, who recorded a survival of 82.7%, vigor of 84.36%, and health status of 80.5% at 2.5 years of age. Similarly, Ramírez-García *et al.* (2008) reported a survival of 93%, vigor of 84.36%, and health status of 90.3% at 3.0 years in the Doroteo Arango ejido, municipality of González, Tamaulipas. According to Maiocco *et al.* (2008), in a *C. fissilis* plantation affected by borer incidence, survival was 74% in treated individuals, indicating the effectiveness of chemical and silvicultural treatments.

Although the borer *H. grandella* does not cause the death of the plant, it generates significant damage that leads to deformation of lateral branches, causing the tree to develop forks and lose its commercial value (Gómez *et al.*, 2017; Mero-Jalca *et al.*, 2021). Briseño (1997) states that the most susceptible phase to borer attack is between three and six years of age. If the trees are not attacked during this period, it is possible that the pest will no longer pose a problem for the plantation. Therefore, the implementation of mainly chemical and silvicultural treatments is important to mitigate borer damage (Ruíz *et al.*, 2016), as well as to guarantee the quality of the stem structure through nutritional

Table 2. Results of plant health status, vigor, and survival.

Variable	Treatment	Samplings			
		08/08/19	08/11/19	08/02/20	08/04/20
Health status (%)	1	55.56±1.43 a	66.67±1.57 a	88.89±0.91 a	77.78±1.90 a
	2	33.33±1.40 c	44.44±1.06 b	66.67±0.56 b	55.56±1.67 b
	3	44.44±1.57 b	55.56±0.56 ab	77.78±0.56 ab	66.67±0.64 ab
Vigor (%)	1	78.89±4.54 b	78.89±7.86 b	81.67±5.32 ab	84.44±5.56 a
	2	78.89±4.54 b	84.44±3.21 ab	81.67±2.78 ab	84.44±3.21 a
	3	87.22±2.78 a	87.22±2.78 a	87.22±2.78 a	84.44±3.21 a
Survival (%)	1	97.22±2.78 a	94.44±2.78 a	97.22±2.78 a	94.44±3.21 a
	2	88.89±4.54 b	91.67±5.32 b	91.67±5.32 b	94.44±5.56 a
	3	91.67±2.78 ab	94.44±3.21 a	94.44±3.21 ab	94.44±3.21 a

Letters that are not the same between columns indicate statistical difference (Tukey $P \leq 0.05$).

management (Calixto *et al.*, 2015), maximize economic yield, and ensure the ecological sustainability of commercial plantations.

CONCLUSIONS

Chemical and silvicultural control methods are the most effective for reducing the damage caused by the borer (*H. grandella*) in *Cedrela odorata*. Although organic control can achieve good results in infested trees by reducing damage. Despite the fact that the borer does not cause tree mortality, the application of these treatments is highly relevant because it ensures better stem straightness and, consequently, the wood attains a higher economic value.

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