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RESEARCH PAPER

Susceptibility of *Eucalyptus* spp. to an induced infestation of red gum lerp psyllid *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae) in Santiago, Chile

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Abstract

A. Huerta, M. Faúndez, and J. E. Araya. 2010. Susceptibility of *Eucalyptus* spp. to an induced infestation of red gum lerp psyllid *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae) in Santiago, Chile. Cien. Inv. Agr. 37(2): 27-33. To determine the susceptibility of important species of eucalypt trees in Chile to *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae), an insect that was detected on *Eucalyptus camaldulensis* Dehn. in 2002 in Santiago, which causes defoliation of trees affected, and even their death in severe infestations, a field evaluation of an induced infestation was performed in 2004 of one-year-old plants of *E. camaldulensis, E. nitens* Deane & Maiden, and *E. globulus* Labill. Growths of infested plants were compared with uninfested controls, using destructive sampling at 15, 30, 45, and 60 days. Also, observations were made regarding the duration of the development stages of the insect during two generations. The only species that was susceptible to the psyllid was *E. camaldulensis,* while it did not develop on *E. nitens* and *E. globulus*. The plants of *E. camaldulensis* infested with adults of *G. brimblecombei* had small and not significant reductions in plant height, diameter at trunk base, and foliar area, in comparison with control plants after two months. In the Santiago bioclimatic zone, this insect completed the first generation in 30 days (February-March), and the second in 36 days (March-April).

Key words: *Eucalyptus camaldulensis*, *Eucalyptus globulus*, *Eucalyptus nitens*, *Glycaspis brimblecombei*, red gum lerp psyllid.

Introduction

Chile has been invaded in recent years by foreign pests of great impact on eucalypt trees (Poisson and Sandoval, 1998; Beéche, 1999; Meza and Baldini, 2001), among which is the red gum lerp psyllid *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae), a species that was detected in 2001 in the neighbourhood of the International Airport of Santiago, on *Eucalyptus camaldulensis* Dehn (Sandoval and Rothmann, 2002). According to Ide *et al.* (2006), this insect is distributed from the regions of Coquimbo (north-central) through La Araucanía (south-central).

In the US and Mexico, this insect native to Australia (Garrison, 2001) causes high mortality of

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eucalypt trees, affecting severely the forestry sector (Brennan *et al*., 1999; Macias, 2001). The main damage of this pest is the weakening of the trees by suction of sap, which in severe infestations reduces the foliage and causes growth losses, the death of shoots and branches, and in extreme cases, the death of plants. The infestation is detected easily by the presence of lerps, white cones that protect the nymphs, together with honeydew that favors the development of black fungi (sooty mold) on the leaves, reducing photosynthesis (Paine *et al*., 2006). A high density of *G. brimblecombei* causes severe loss of foliage that extremely weakens the affected tree, and favors damage by other insects, like cerambycids *Phoracantha recurva* Newman or *P. semipunctata* Fabr. (Garrison, 2001; Paine *et al*., 2006), both present in Chile (Klein and Waterhouse, 2000). Urban trees are the most vulnerable to *G. brimblecombei*, mainly because they are watered frecuently (Halbert *et al*., 2001).

In the countries where *G. brimblecombei* has been detected, it has been found in diverse species of the genus *Eucalyptus*. In Australia, *E. brassina* Blake, *E. bridgesiana* Baker, *E. camaldulensis*, *E. camphora* Baker, *E. dealbata* Cunn ex Schauer, *E. mannifera* Baker, *E. nitens* Deane & Maiden, and *E. tereticornis* Smith have been mentioned as hosts (Brennan *et al*., 2001; Paine *et al*., 2006). In California, *E. rudis* Endl, *E. tereticornis*, and *E. camaldulensis* have been identified as highly susceptible hosts (Paine *et al*., 2006), and *E. camaldulensis*, *E. blakelyi* Maiden, *E. nitens*, *E. dealbata*, *E. bridgesiana*, *E. brassina*, *E. mannifera*, *E. botryoides* Sm., *E. cladocalix* Muell., *E. cornuta* Labill, *E. globulus*, *E. deglupta* Blume, *E. grandis* Hill, *E. marginata* Donn, *E. punctata DC*., *E. rudis* and *E. robusta* Smith are hosts in Mexico (Macías, 2001). In Brazil, *G. brimblecombei* was found also in a *Eucalyptus x urograndis* hybrid (De Queiroz *et al*., 2003).

According to Ide *et al.* (2006), the most susceptible species of eucalypts would be *E. camaldulensis* and *E. nitens*; while *E. globulus*, *E. grandis* and *E. viminalis* Labill, would have low to medium susceptibility.

The large area planted with species of *Eucalyptus* (over 600 thousand ha; INFOR, 2009) susceptible of being affected by this insect in Chile, stresses the importance to study the susceptibility of one-year-old plants of this species to psyllid. Also, it is interesting to determine the duration of the development stages of the insect to know its biology and to support the integrated management of this pest.

Materials and methods

The study was conducted at the facilities of the "Servicio Agrícola y Ganadero, Región Metropolitana de Chile" (Agriculture and Livestock Service, Metropolitan Region, Chile), Commune of Estación Central, during March and April of 2004. This area has a mild arid Mediterranean Mesothermal Stenothermic climate, typical to the central valley and coast of Chile, with hot and dry summers, and cold winters, with temperature averages ranging from 4.4 °C in July to a maximum of 28.2 °C in January, a period free of freezing of 231 days, an average of 11 freezes per year, an annual mean precipitation of 419 mm, a water deficit of 997 mm and a dry period of eight months (Santibáñez and Uribe, 1993).

The average monthly temperatures in Quinta Normal, obtained at the National Civil Aeronautical Authority, Technical Aeronautical School, Quinta Normal, Santiago, Chile, during the study period in March and April 2004 were 20.73, 20.19, and 15.65 ºC, respectively.

Plants of *E. camaldulensis*, *E. globulus*, and *E. nitens*, species of eucalypts among the most planted in Chile and potential hosts of *G. brimblecombei* were selected for the study. The first two were obtained from the Antumapu tree nursery of the University of Chile located in La Pintana, Santiago, and *E. nitens* from the MonteAguila Forestry and Agriculture Nursery in Los Ángeles (Bío Bío Region). The plants were transplanted from bags to pots containing 400 mL of disinfested plant litter soil.

The psyllids were collected with nets and insect aspirators from an adult stand of *E. camaldulensis* severely infested in La Pirámide, Metropolitan Park of Santiago.

The growth of plants infested with *G. brimblecombei* in the field was studied from February thorugh April 2004, under two treatments by plant species, with and without insects (control), each one with 32 plants. All the plants were covered with a light cloth to avoid insects from escaping and to homogenize light and humidity conditions in all treatments, and also to keep insects out from controls. The infestation was done at two stages, first with 100 adult insects, and seven days later, adding other 60 individuals per plant to infest, to ensure establishment. Four measurements were performed, every 15 days, on random samples of eight plants (four infested and four controls) per species. The homogeneity of the plants was verified 15 days after the first infestation using fixed effect Anova.

The height (cm), diameter at the base of the trunk (mm) and foliar area (mm^2) were measured using a scanner, the LeafArea 1.3 software (University of Sheffield, 2003), and Adobe Photoshop 7.0. The results had a normal distribution and are presented as means ± SD. Fixed effect Anova ($P \leq 0.05$) was used to determine if the presence of the insect influences the decrease of height, diameter at trunk base, and foliar area of the plants at each evaluated period.

To determine the duration of the stages of development, one hundred *G. brimblecombei* adults (males and females) were collected at the Metropolitan Park. These insects were placed on one-year-old *E. camaldulensis* plants, which were covered with a light cloth, surrounded by burned oil and their pots placed on a dish with water to avoid predation by other insects, such as Argentine ants, *Linepithema humile* (Mayr) (Hymenoptera: Formicidae) and European earwigs, *Forficula auricularia* L. (Dermaptera: Forficulidae). Their metamorphosis was observed periodically, from February through April 2004.

Results

Evaluation of growth losses of Eucalyptus plants

Fifteen days after the first infestation, the tests for homogeneity on the three species of eucalypts for the three variables measured, height, diameter at trunk base, and foliar area, did not find significant differences between the treatments with insects and the controls, which allowed continuing the study with the methodology proposed.

As *G. brimblecombei* could only develop on plants of *E. camaldulensis* and not in the other species (*E. nitens* and *E. globulus*), evaluations were performed only on the first species.

The plants infested with adults of *G. brimblecombei* presented numerically, but not statistically inferior means in development of height, diameter at trunk base, and foliar area in comparison with the control plants after two months (Table 1).

Table 1. Changes in height, diameter at trunk base, and foliar area caused by two-month infestation with adults of Glycaspis brimblecombei on one-yr-old plants of Eucalyptus camaldulensis, in Santiago, Chile (2004).

	Ratio[1] (mean ± SD)		
Variables	Control plants	Infested plants	% reduction
Height (cm)	1.07±0.26a	1.01±0.21a	5.3
Diameter at trunk base (mm)	1.11±0.17a	1.18±0.27a	0.6
Foliar area (mm^2)	1.39±0.45a	1.36±0.46a	2.3

[1]The ratio is the average quotient of the final and initial measurements. The same letter on each row indicates absence of significant statistical differences ($P \leq 0.05$).

Heigth. Slight numerical differences in average heights of *E. camaldulensis* appear in Figure 1A at day 15 from first infestation. However, these were not significant between plants with and without insects. Similar results were observed at the following evaluations, with height means slightly smaller in the infested plants, but with no statistical differences. Thus, *G. brimblecombei* did not affect height development of plants.

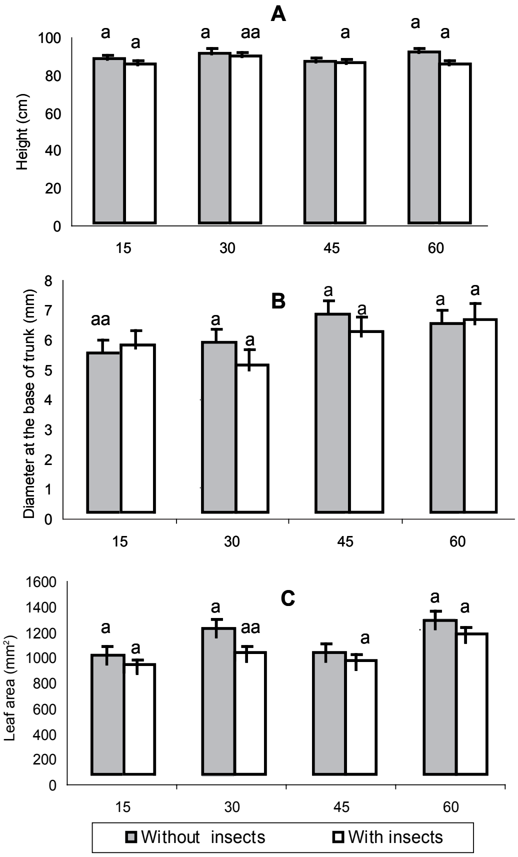

Figure 1. Differences in development (average ± SD) of one-yr-old plants of *Eucalyptus camaldulensis* with and without *Glycaspis brimblecombei*, on days after infestation in Santiago, Chile (2004). A: Heigth (cm). B: Diameter at trunk base (mm). C: Leaf area (mm^2). The same letter on each evaluation indicates absence of significant statistical differences (P≤0.05).

Diameter at trunk base. Although numerical differences were observed between the means of diameter at trunk base of *E. camaldulensis*, no significant statistical differences occurred in the evaluations, thus the plants did not present a change in development of diameter at trunk base attributed to *G. brimblecombei* (Figure 1B).

Foliar area. As with the other parameters in the evaluations, numerical but not statistical differences occurred between the means of foliar area of plants infested by *E. camaldulensis* and those of the control that could be attributed to *G. brimblecombei*.

Duration of the development stages of G. brimblecombei

The observations allowed evaluating two complete generations of *G. brimblecombei* from February through April 2004. The first generation (February-March) completed its cycle, from appearance of the first egg through the death of the last adult in approximately 30 days, while the second (March- April 2004) required near 36 days. The egg, nymph and adult stages of the first and second generations of *G. brimblecombei* lasted nine, eighteen, and five days, and nine, twenty-three, and six days, respectively.

Discussion

The establishment of *G. brimblecombei* only on *E. camaldulensis* could be explained by the greater degree of susceptibility of this eucalypt species to this psyllid. Brennan *et al.* (2001) in California and Ide *et al.* (2006) in Chile identified *E. camaldulensis* among the most vulnerable plant species. In a study with 22 species in Sao Paulo (Brazil), Wilcken *et al.* (2003) classified *E. camaldulensis*, together with *E. tereticornis* and *E. urophylla*, as very susceptible species to *G. brimblecombei*.

On *E. globulus* and *E. nitens*, the psyllid did not get established. According to Floyd *et al.* (1994) and Floyd and Raymond (1998), species with foliar dimorphism like *E. globulus* y *E. nitens* have different chemical composition between the young and mature leaves, having chemicals with some degrees of toxicity. This agrees with Brennan and Weinbaum (2001), who have found a greater resistance to egg laying by *G. brimblecombei* on young leaves of *E. globulus*.

This situation has not been studied for *E. nitens*, but the foliar dimorphism in this species would explain in part the absence of the insect. The chemical composition of young leaves of these plant species would inhibit the establishment and ensuing reproduction of the psyllid.

According to Brennan *et al.* (1999, 2001), Garrison (2001), and Paine *et al.* (2006), among others, the development of natural populations of *G. brimblecombei* is explosive, and causes in a short time defoliation and even death of the plants affected. However, under an induced infestation in our study, the damage was not at the level expected. In this way, although lesser means in height, diameter at trunk base, and foliar area in the plants of *Eucalyptus* infested with the psyllid occurred, compared to plants not infested, these differences were not significant, due in part probably to the low establishment achieved by the insect.

Brennan *et al.* (1999), Nagamine and Heu (2001), Macías (2001), Garrison (2001), Paine *et al.* (2006), and De Queiroz *et al.* (2003) coincide in stating that *G. brimblecombei* causes losses in growth of diverse species of eucalypts, and even death. However, no such losses were detected that could be attributed to the insect in any of the species evaluated. It is worth mentioning that our results come from one-year-old plants, and not adult specimens strongly infested, on which infestation levels are very high. Probably, a larger exposure time to the pest may cause greater effects on growth and survival of plants, as indicated by Floyd and Foley (2001).

The small rates of reduction of foliar area in the species studied may be related to the need of the adults to feed and develop only on the tree where they emerged. Specifically, the adults may have not adapted completely to the foliage of *E. globulus* and *E. nitens* due to their particular chemical composition, as implied by Floyd and Foley (2001).

We recommend making a more detailed and longer duration study in the field, where the effects of the psyllid on growth may be observed both on young and adult plants.

With respect to the duration of the stages of development of *G. brimblecombei*, the slower one of the second generation is expected to occur under less favorable conditions, as those taking place in Chile at the end of summer. During the evaluation period, the temperature records, one of the most relevant variables for insect development, revealed a downward trend.

In Australia, its native ground, *G. brimblecombei* presents two to four generations. Lifespan from egg stage to adulthood varies from several weeks with warm weather to several months when temperatures are colder (Garrison, 2001).

Only *E. camaldulensis* was susceptible to an induced infestation by *G. brimblecombei* on one-year-old plants, while *E. nitens* and *E. globulus* did not present susceptibility to the insect, as no specimens of the insect at any stage of development were found on them. Possibly, the foliar dimorphism of these plant species, together with their different chemical composition, deters establishment on young leaves. Plants of *E. camaldulensis* infested with adults of *G. brimblecombei* had small and not significant reductions in growth, diameter at trunk base, and foliar area compared with the control plants after two months. At the Santiago bioclimatic area, *G. brimblecombei* presented two generations, lasting 30 and 36 days, from February through April.

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Resumen

A. Huerta, M. Faúndez y J. E. Araya. 2010. Susceptibilidad de *Eucalyptus* spp. a una infestación inducida del psílido de los eucaliptos rojos *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae) en Santiago, Chile. Cien. Inv. Agr. 37(2):27-33. Con el fin de conocer la susceptibilidad de especies de eucalipto importantes en Chile a *Glycaspis brimblecombei* Moore (Hemiptera: Psyllidae), insecto que se detectó sobre *Eucalyptus camaldulensis* Dehn. en 2002 en Santiago, y que causa defoliación en los árboles afectados, y su muerte en infestaciones severas, en 2004 se evaluó en el campo una infestación inducida sobre plantas de un año de *E. camaldulensis, E. nitens* Deane & Maiden y *E. globulus* Labill. Las pérdidas de desarrollo de las plantas infestadas se compararon con testigos no infestados, mediante muestreos destructivos a los 15, 30, 45 y 60 días. Se hicieron también observaciones de la duración de los estados de desarrollo del insecto durante dos generaciones. La única especie susceptible al psílido fue *E. camaldulensis,* mientras que en *E. nitens* y *E. globulus* el insecto no se desarrolló. Las plantas de *E. camaldulensis* infestadas con adultos de *G. brimblecombei* tuvieron reducciones leves, pero no significativas, en el desarrollo en altura, diámetro a la altura del cuello y área foliar en comparación con las plantas testigo después de dos meses. En la zona bioclimática de Santiago, este insecto completó la primera generación en 30 días (febrero-marzo) y la segunda en 36 días (marzo-abril).

Palabras clave: *Eucalyptus camaldulensis*, *Eucalyptus globulus*, *Eucalyptus nitens*, *Glycaspis brimblecombei,* psílido de los eucaliptos rojos.

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