THE EFFICACY OF MICRO-INJECTED IMIDACLOPRID AND OXYDEMETON-METHYL ON RED GUM EUCALYPTUS TREES (*EUCALYPTUS CAMALDULENSIS*) INFESTED WITH RED GUM LERP PSYLLID (*GLYCASPIS BRIMBLECOMBEI*)

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Abstract. A stand of red gum eucalyptus trees *(Eucalyptus camaldulensis)* heavily infested with red gum lerp psyllid (RGLP) *(Glycaspis brimblecombei)* was micro-injected at crown level with a single standard treatment of imidacloprid, oxydemeton-methyl, or a combination of both. Psyllid populations were monitored for 15 months following initial treatment. Significant mortality and reduced population levels of immature RGLP occurred within 1 week following an application of all treatment materials. Oxydemeton-methyl was significantly effective, when compared to untreated trees, for approximately 2 months. Imidacloprid-treated trees showed statistically significant reduction of psyllid nymphs, compared to untreated trees, for approximately 8 months. The combination of both materials significantly reduced psyllid nymph populations for approximately 8 months. Many trees continued to show control up to 15 months with imidacloprid. However, nymph population variances among treatment trees were too high to statistically detect significant differences among treatment averages. The longer residual activity in some trees may indicate variability among individual trees sustaining levels of imidacloprid beyond 8 months.

Key Words. Micro-systemic; systemic compounds; imidacloprid; oxydemeton-methyl; red gum lerp psyllid.

The red gum lerp psyllid (RGLP) *(Glycaspis brimblecombei)* is a newly established foliar pest on red gum eucalyptus trees *(Eucalyptus camaldulensis)* in California, U.S. (Gill 1998). Since its initial detection in southern California in 1998, RGLP has quickly spread throughout California and has infested eucalyptus as far north as the San Francisco Bay area and south to San Diego (Brennan et al. 1999). Heavy populations of RGLP have resulted in extensive defoliation that has stressed trees, making them susceptible to nutritional stress, disease, and invasion from other insects (Brennan et al. 1999; Garrison 1999).

The RGLP nymph constructs a protective sugary covering (lerp) that protects it from predators and prevents pesticides from making contact through conventional foliar spraying. Applying systemic materials may be an effective approach in controlling this new pest. Koehler and Campbell (1968) were among the first to implement systemic applications of pesticide to control foliage pests of shade trees. Costonis (1981) and Gardner (1986) have reviewed the efficiency and benefits of pesticide micro-injection, and recently Stanton et al. (1999) reported significantly reduced lace bug damage on green hawthorn *(Crataegus viridis)* via trunk and soil injection of systemic pesticides.

Systemtic pesticide field trials were initiated utilizing the J.J. Mauget method of micro-injection in eucalyptus trees in July 1999. Three treatments were tested: single treatments of oxydemeton-methyl, imidacloprid, and a combination of both. The objective was to determine the efficacy rate of performance and residual activity of micro-injected treatments of oxydemeton-methyl, imidacloprid, and a combination of both materials against RGLP nymphs.

MATERIALS AND METHODS

Study Site

A stand of heavily infested red gum eucalyptus trees lining a golf course at Industry Hills, California, was utilized as a study site beginning July 1999. This site consisted of several hundred densely planted, irrigated trees approximately 20 years old and resembled a natural hillside-forested area. Trees were initially infested with RGLP for less than a year, and at the time of the study, most trees were visually estimated to have been 60% to 80% defoliated. New foliage was under constant attack from egg laying, flying adult pysllids emerging from infested leaves.

Forty trees were selected at random to serve as test subjects. Mean tree diameter measured at breast height averaged 17 cm (6.7 in.), ranged between 10 and 60 cm (3.9 and 23.6 in.), and was used as a criterion to determine standard dosage rates to be micro-injected into the tree trunks at crown level.

Micro-injected doses were applied on July 8, 1999. Each application treatment followed the standard protocol established by the J.J. Mauget Co. A 4.4-mm (11/64-in.) drill bit was used to penetrate the crown bark approximately to a 10-mm (3/8-in.) depth into the xylem tissue. Commercial pre-measured capsules containing prescribed pesticide doses were attached by feeder tubes that were inserted into each treated tree. Imidacloprid-treated trees received a dose of 3 mL of 10% active ingredient per 5 cm (2 in.) of trunk diameter. Oxydemeton-methyl was applied at a rate of 3 mL 50% active ingredient per 5 cm of trunk diameter. A combination of both materials consisting of a dose of 2 mL of 10% imidacloprid and 3 mL of 50% oxydemeton-methyl was applied as a separate combination treatment. Capsules and feeder tubes were removed within 24 hours following treatment. Each treatment and untreated check was replicated 10 times.

Following treatment, ten leaves were randomly sampled weekly from each tree. After 3 months of weekly sampling, leaves were sampled on a monthly basis for 1 year. Collected leaves were immediately bagged and placed in a cooler and kept refrigerated prior to microscopic examination. Population levels of RGLP nymphs on leaves were determined by microscopically examining both sides of leaves. Lerps were carefully removed and live nymphs were counted. A pre-treatment census of RGLP nymph populations was taken on July 1, 1999 (Table 1). Post-treatment levels of pesticide efficacy were determined by comparing the mean population levels of live RGLP nymphs found under lerps on sampled leaves. Dead or living nymphs found outside lerps were not counted.

The total average percentage reduction of RGLP nymphs due to treatments, compared to untreated trees, was calculated using the following formula:

$$\% \text{ reduction} = (\text{untreated average} - \text{treatment average}/\text{untreated average}) \times 100$$

RESULTS AND DISCUSSION

Efficacy results were based on comparisons of population levels of live RGLP found under lerps among leaves sampled over this 15-month study. Direct RGLP nymph mortality following treatment was too difficult to measure because newly killed early instar nymphs often failed to establish a protective lerp and fell off the leaves undetected. Tables 1 and 2 summarize the monthly RGLP nymph densities among treatment and untreated trees. A statistical analysis (5% error rate) was performed among treatments using Stateview® ANOVA and Fisher's PLSD.

Significant reduction in RGLP nymph populations occurred among most treatments when compared to untreated trees on a weekly basis (Table 1). However, significant differences between various materials, at the 5% error rate, could not be detected until the third month following application. During the first month following treatment, oxydemeton-methyl showed early efficacy when compared to untreated trees. However, after the first month following treatment, population levels of RGLP nymphs began to rise and no significant difference was detected between the population levels of this material and untreated trees after two months (Table 1). Therefore, residual effectiveness in reducing RGLP nymph populations, under the conditions of this study, seems to be limited to approximately 2 months. The overall percentage reduction of RGLP nymphs compared to untreated trees for 3 months was 52.9%.

Imidacloprid-treated trees had significantly lower RGLP populations than untreated trees for 8 months (Tables 1 and 2). Averaged reduction of RGLP nymphs, when compared to untreated trees, was 81.4% over 3 months, 73.2% over 8 months, and 40.7% over 15 months.

Table 1. Pre- and post-treatment monthly means[z] (4-week intervals) of numbers of live red gum lerp psyllid nymphs per leaf in trees treated with insecticides[y].

	Pretreatment	Post-treatment		
Treatment	7/1/99	7/16 – 8/6	8/13 – 9/3	9/10 – 10/2
Imidacloprid[x]	5.42 a	2.28 a	0.49 a	0.43 a
Combination[w]	5.36 a	1.77 a	1.16 a	1.55 a
Oxydemeton-methyl[v]	5.26 a	0.87 a	2.51 a	4.77 b
Untreated	5.62 a	4.70 b	8.32 b	4.22 b

[z]Means followed by the same letter are not significantly different at the 5% level (Fisher's PLSD).
[y]Treatments applied July 8, 1999.
[x]Imicide® 3 mL 10% active ingredient per 5-cm trunk diameter.
[w]Imicide® 2 mL 10% active ingredient and Injecticide® 3mL 50% active ingredient per 5-cm trunk diameter.
[v]Injecticide® applied 3 mL of 50% active ingredient per 5-cm of trunk diameter.

Table 2. Post-treatment monthly means[z] of numbers of RGLP nymphs/leaf between November 1999 and September 2000.

Treatment	11/99	12/99	1/00	2/00	3/00	4/00	5/00	6/00	7/00	8/00	9/00
Imidacloprid[y]	7.13 a	3.93 a	5.35 a	0.91 a	4.64 a	2.38 a	1.32 a	2.70 a	17.4 a	0.58 a	1.63 a
Combination[x]	4.99 a	6.30 a	8.67 ab	3.38 bc	4.55 a	3.25 a	4.04 a	9.37 a	21.4 a	3.13 a	3.84 ab
Oxydemeton-methyl[w]	15.6 b	11.22 b	10.3 bc	3.27 bc	6.70 a	5.37 b	8.10 b	19.9 b	21.2 a	0.49 a	7.71 b
Untreated	22.1 b	15.55 b	15.82 c	4.44 c	4.69 a	2.64 a	4.36 a	9.75 a	20.3 a	2.60 a	7.41 b

[z]Means followed by the same letter are not significantly different at the 5% level (Fisher's PLSD).
[y]Imicide® 3 mL 10% active ingredient per 5-cm trunk diameter.
[x]Imicide® 2mL 10% active ingredient and Injecticide® 3 mL 50% active ingredient per 5-cm trunk diameter.
[w]Injecticide® 3mL 50% active ingredient per 5-cm trunk diameter.

The combination of both materials showed significant lower population levels than the untreated trees over 8 months (Tables 1 and 2). Overall reduction of RGLP nymphs, when compared to untreated trees, was 74% over 3 months, 64.1% over 8 months, and 4.1% over 15 months. The lower overall difference of the combination treatment may be due to the reduced amount (2 mL instead of 3 mL of 10% active ingredient) of imidacloprid applied in combination with oxydemeton-methyl.

Nymphal population variances among treatment trees were too high to consistently detect significant differences between treatment averages on several dates after 8 months.

Some trees were observed to have longer residual activity than others, which may indicate possible differences among individual trees sustaining levels of imidacloprid beyond 8 months. Differences may be due to several factors that may interfere with material uptake. Such factors may include tree health, age, root and crown structure, crowding, and the degree of nutrient or water stress. Tattar et al. (1998) also found the translocation of trunk micro-injected imidacloprid varied considerably among and between three tree species. These factors need to be the subject of further investigation to improve the implementation of micro-systemic methods used in tree care.

CONCLUSION

All materials showed significant reduction of RGLP nymph populations when compared to untreated trees. Oxydemeton-methyl showed effective control for the first month following treatment, but showed less effectiveness thereafter. Imidacloprid and imidacloprid combined with oxydemeton-methyl showed statistically significant reduction of nymph population levels up to 8 months. Given the ability of RGLP to quickly reinfest trees, longer residual materials, such as imidacloprid, have a distinctive advantage over short residual materials for controlling RGLP infestations.

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Résumé. Un peuplement d'Eucalyptus camaldulensis infesté lourdement par le *Glycaspis brimblecombei* (insecte) a été micro-injecté au niveau de la cime avec un traitement standard d'imidacloprid, d'oxydemeton-méthyle ou une combinaison des deux. Les populations de Glycaspis ont été suivies durant 15 mois après le traitement initial. Une mortalité significative et une réduction des niveaux de populations au stade immature du Glycaspis se sont produites dans la semaine suivant l'application de ces traitements. L'oxydemethon-méthyle était significativement effectif durant deux mois environs comparativement à des arbres non traités. Comparativement aux arbres non traités, les arbres traités à l'imidacloprid ont montré des réductions statistiquement significatives des nymphes de Glycaspis durant huit mois environs. La combinaison des deux produits réduisait significativement les populations de Glycaspis nymphes pour une durée approximative de huit mois. Plusieurs arbres continuaient à démontrer des indices d'efficacité de l'imidacloprid jusqu'à 15 mois. Cependant, les variances de populations de nymphes entre les traitements d'arbres étaient trop importantes pour statistiquement détecter des différences significatives entre les moyennes de traitements. L'activité résiduelle plus longue chez certains arbres pourrait indiquer une variabilité chez les arbres individuels maintenant des niveaux d'imidacloprid au-delà de huit mois.

Zusammenfassung. Eine Gruppe von heftig mit RGLP infizierten Eucalyptusbäumen *(Eucalyptus camaldulensis)* wurde durch Mikro-injektion auf der Höhe der Kronen von einer Standartbehandlung mit Imidacloprid, Oxydemeton-methyl oder einer Kombination aus beidem behandelt. Die Psyllid-Populationen wurden über die folgenden 15 Monate überwacht. Bei allen drei Behandlungen trat eine Woche nach der Applikation eine deutliche Sterberate und eine reduzierte Population von unreifen RGLPs auf. Oxydmeton-methyl war sehr effektiv im Vergleich zu unbehandelten Bäumen für einen Zeitraum von 2 Monaten. Die mit Imidacloprid behandelten Bäume zeigten über 8 Monate statistisch deutliche Reduktionen der Nymphen. Die Kombination beider Mittel reduzierte die Psyllidnymphen-Populationen für 8 Monate. Viele Bäume zeigten über die genannten Zeiträume hinaus bis zu 15 Monate noch Kontrollwirkung. Dennoch sind die Populationsvarianzen zwischen den Behandlungen zu hoch um signifikante Unterschiede zwischen den durchschnittlichen Behandlungen zu identifizieren. Die längere Aktivität von Imidacloprid über 8 Monate hinaus in einigen Bäumen könnte eine Variabilität zwischen individuellen Bäumen anzeigen.

Resumen. Un rodal de árboles de eucalipto *(Eucalyptus camaldulensis)* fuertemente infestado con el sílido *(Glycaspis brimblecombei)* fue microinyectado al nivel de la corona con un solo tratamiento estándar de imidacloprid, oxydemeton-methyl, o una combinación de ambos. Las poblaciones del sílido fueron monitoreadas durante 15 meses después del tratamiento inicial. Se presentó significativa mortalidad y reducción de los niveles de la población de sílidos inmaduros en la primera semana después de la aplicación de los tratamientos. Oxydemeton-methyl fue efectivo significativamente, comparado con los árboles no tratados, por aproximadamente dos meses. Los árboles tratados con Imidacloprid mostraron reducción estadísticamente significativa de las ninfas del sílido, comparados con los árboles no tratados, por aproximadamente 8 meses. La combinación de ambos materiales redujo las poblaciones del sílido por aproximadamente 8 meses. Muchos árboles con imidacloprid mostraron control hasta 15 meses. Sin embargo, las varianzas de la población de las ninfas entre los tratamientos fueron demasiado altas para detectar estadísticamente diferencias entre las medias de los tratamientos. La prolongada actividad residual en algunos árboles puede indicar la variabilidad entre árboles individuales para sostener niveles de imidacloprid arriba de los 8 meses.