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Carbaryl trunk banding for control of elm leaf beetle (Coleoptera: Chrysomelidae) in Victoria

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Abstract

An application of 2% (20 g L^{-1} a.i.) carbaryl solution applied as a bark band just prior to elm leaf beetle larvae descending elm trees produced a greater than 90% mortality of prepupae for five weeks, which declined to 72% seven weeks after insecticide application. A repeat insecticide application was necessary to maintain high mortality levels for the duration of the trial. Mean egg clusters on treated English and golden elms were significantly lower than control trees the following seasons after treatment. Foliage damage on treated trees was reduced in the second and third years of the study on English and golden elms.

Introduction

Elm leaf beetle, *Pyrrhalta luteola* (Muller) (Coleoptera: Chrysomelidae), has rapidly become a pest of elms on the Mornington Peninsula and in many municipalities of Melbourne, Victoria. The elm leaf beetle was first discovered in Australia at Mt Eliza, on the Mornington Peninsula, in February 1989, but may have been present for at least ten years.

In 1990, a research project was initiated to develop an integrated management program for elm leaf beetle in Victoria using biological and chemical control techniques. The first biological control agent *Tetrastichus gallerucae* (Fonscolombe) (Hymenoptera: Eulophidae), an egg parasitoid, was imported and released after host specificity testing in 1990. Biological control of elm leaf beetle has been attempted in the United States for more than 80 years (Dreistadt and Dahlsten 1991), however the establishment of parasitoids against elm leaf beetle in Northern California was severely hampered by insecticides for elm leaf beetle control (Olkowski *et al.* 1986). Insecticidal bark banding on tree trunks was subsequently developed in an effort to protect elms from excessive beetle damage without harming biological agents released for elm leaf beetle (Olkowski *et al.* 1986). This method targets elm leaf beetle larvae as they move from the canopy down the trunk to pupate at the base of the tree (Costello *et al.* 1990). The insecticide, usually carbaryl, is sprayed to the bark in a band around the trunk and the larvae contact the insecticide as they move over the band. By reducing the number of beetles emerging as adults, bark banding may reduce foliage damage by later generations of elm leaf beetle and their progeny (Dreistadt and Dahlsten 1990).

A study on the effectiveness of carbaryl bark banding in reducing beetle populations and foliage damage in Victoria

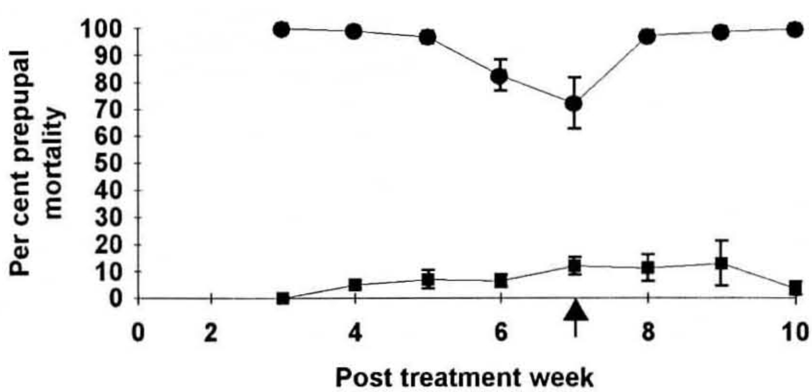

Figure 1. Percentage mortality (mean ± SEM) of elm leaf beetle prepupae collected at insecticide banded (●) and unbanded (■) elms in Mt Eliza 1990–91. Means are significantly different (P=0.001) on all dates. Arrow indicates second banding application. Standard error of means are indicated by the error bars except where obscured by the point.

was commenced in 1990 and was conducted over a four year period.

This paper reports results from the evaluation of carbaryl trunk banding for control of elm leaf beetle on English elm (*Ulmus procera*) and golden elm (*U. glabra* 'Lutescens') in Victoria.

Materials and methods.

In November 1990, nine English and eight golden elms were selected in the Melbourne suburb of Mt Eliza as study sites. The majority of the trees selected were in private residences. Trees were sampled for egg clusters at weekly to fortnightly intervals, beginning in mid November through to early March, to determine the peak of egg laying activity. Foliage samples consisted of 24 to 40, 30 cm branch terminals, (five from the inner canopy and five from the outer canopy in each cardinal direction) per tree and the number of egg clusters per sample was recorded. Samples were taken from the lower half of the canopy using a pole pruner.

In early December 1990, when elm leaf beetle third instar larvae were noticed on trees, the trunks of four English and four golden elms were sprayed with 1.5 L of a 2% (20 g L^{-1} a.i.) carbaryl solution in a half metre wide band, approximately 1.5 m above ground level, using a hand pump sprayer. The trees were resprayed seven week after the initial spray to maintain an effective insecticide barrier. In the second, third and fourth years of the study, trees were sprayed in late December, just prior to elm leaf beetle third instar larvae descending the trees to pupate. The trees were treated only once per year.

In 1990, 100 elm leaf beetle prepupae were randomly collected weekly from the base of each tree and all remaining prepupae were removed. The samples were held in petri dishes at 22°C in the laboratory until pupation. The number of elm leaf beetle pupae were recorded and the per cent mortality determined.

At the end of each elm leaf beetle season (early March), each tree was visually assessed for the per cent damage sustained to the foliage. Average per cent damage to the canopy (missing leaf area caused by adult feeding and skeletonization from larval feeding) was estimated for each tree and rated in an 11 increment scale from 0 to 10, where 0=no damage, 1=1–10%, 2=11–20%, damage etc.

Egg cluster numbers at egg peak for all trees in each treatment were pooled and then analysed using a t-test for variances not assumed to be equal. The same statistical test was used for prepupal mortality.

Results and discussion

Elm leaf beetle prepupal mortality

Significantly greater mortality (P=0.001) occurred among larvae collected at the base of elms treated with carbaryl compared with untreated elms on all dates (Figure 1). The per cent mortality of prepupae remained above 90% five weeks after spraying and declined to 72% seven weeks after spraying. The per cent mortality rose to above 90% shortly after the tree trunks were resprayed, seven weeks after the initial spray, and remained at this level for a further three weeks. Persistence of insecticide in this trial was

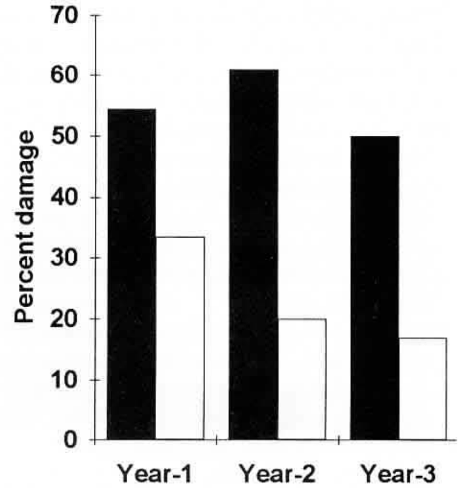

Figure 4. Per cent elm leaf beetle damage to the canopy of carbaryl banded (□) and unbanded (■) English elm.

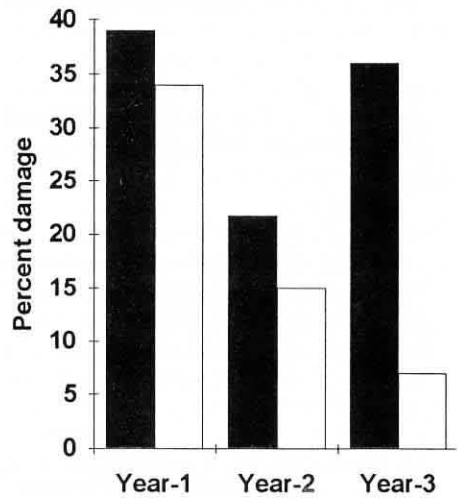

Figure 5. Per cent elm leaf beetle damage to the canopy of carbaryl banded (□) and unbanded (■) golden elm.

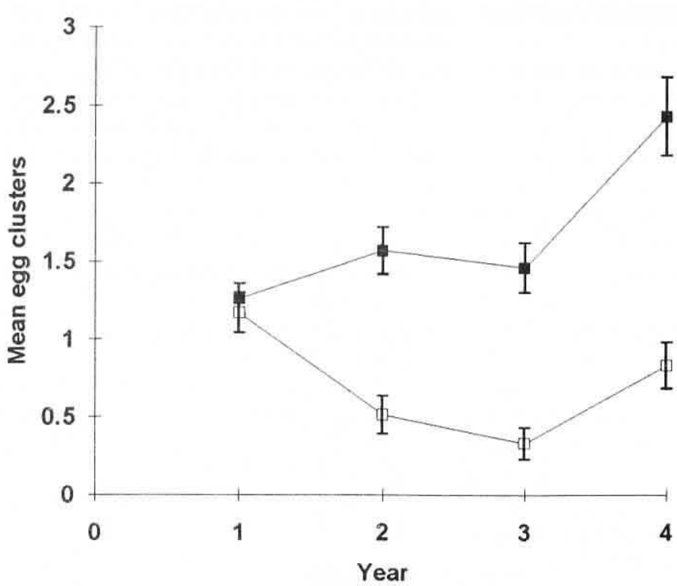

Figure 2. Mean elm leaf beetle egg clusters per 30 cm branch tip on carbaryl banded (□) and unbanded (■) English elm. Significant differences P=(0.05) exist between treatments in years 2–4. Standard error of means are indicated by the error bars.

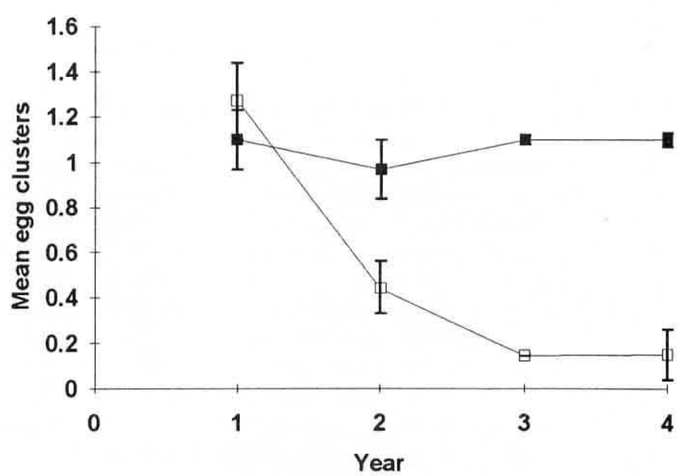

Figure 3. Mean elm leaf beetle egg clusters per 30 cm branch tip on carbaryl banded (□) and unbanded (■) golden elm. Significant differences P=(0.05) exist between treatments in years 2–4. Standard error of means are indicated by the error bars except where obscured by the point.

considerably less compared with a similar trial conducted by Dreistadt and Dahlsten (1990) in California. They found that a single spring application persisted for at least fifteen weeks and affected two generations of prepupae. Hall *et al.* (1988) reported that a one metre wide band of 2% carbaryl produced 100% mortality for two weeks after application but was ineffective at six and eight weeks after application (36.8% and 52.7% mortality respectively). Dreistadt and Dahlsten (1990) suggested that substantial spring and summer rains at the study sites of Hall *et al.* may have contributed to the reduction in persistence. Similarly, heavy rains (152.2 mm in 19 rain days) may have reduced the persistence of insecticide in Mt Eliza. Also, trees in this study were sprayed three weeks prior to larvae descending trees reducing the period of effective insecticide control.

Egg clusters

In the first year of the trial, no significant differences (P=0.05) in mean egg cluster numbers at egg peak were found between control and treated trees prior to the application of insecticide (Figures 2 and 3).

On English elms treated with insecticide, egg clusters were significantly reduced (P=0.05) in the second and third years of the trial, while egg clusters increased on the control trees (Figure 2). In the fourth year, egg cluster numbers increased on both the control and treated trees but the treatment effect remained significant.

On golden elms, egg clusters on treated trees were reduced in years two, three and four, while egg clusters remained relatively constant on control trees. (Figure 3). Egg cluster numbers during these years were significantly (P=0.05) lower on treated trees compared to controls.

Foliage damage

In the first year, the damage sustained to the canopy of both control and treated English elms (Figure 4) was considerable (54 and 35% damage respectively). Foliage damage in the second year increased on control trees to 60% while it decreased on treated trees to 20%. Foliage damage was further reduced in the third year on both control and treated trees.

On golden elms, foliage damage in the first year on control and treated trees was 39% and 34% respectively and declined in the second year to 22 and 15% (Figure 5). The per cent damage to the canopy in the third year increased on control trees to 36% while the damage on treated trees decreased to 7%.

The degree of damage sustained to elms in the second and third years, on both elm species, appear to be correlated to the mean egg cluster numbers during these years. As mean egg cluster numbers on trees increase from one year to the next, so does the per cent damage to the foliage. This can be seen on control trees of golden elms (Figures 3 and 5) where an increase in mean egg cluster number from years two and three resulted in a large increase in damage to the foliage. Similarly, a decrease in mean egg cluster density has, in all cases, resulted in a decrease in foliage damage, particularly on treated trees.

This study supports the findings of Costello *et al.* (1990), who observed a reduction in foliage damage on carbaryl banded Scotch elms (*U. glabra*) during a five year study. Dreistadt and Dahlsten (1990) observed, in a two year study, significantly less foliage damage on treated English elms by late in the season compared with untreated trees. However, both treated and untreated elms were severely defoliated and thus concluded that banding did not satisfactorily control damage on English elm. Our study found that foliage damage on treated English elms could be reduced from 34% to 17% after two years of treatment. The observations made by Dreistadt and Dahlsten (1990) and by us support the conclusions of Olkowski *et al.* (1986) that insecticide bands appear capable of providing adequate foliage protection when beetle populations are low to moderate.

At Mt Eliza, the period of larval descent lasts for approximately six to eight weeks, beginning in late December through to mid February. A single application of carbaryl applied to trunks just prior to larvae descending trees may provide effective control if frequent rains do not occur during December and January. Otherwise, a second banding application is recommended if pupal survival rises above 10 % before the end of January.

Bark banding on trees, where only one elm leaf beetle generation is completed per year, will not significantly reduce foliage damage in the first year of treatment but will reduce the number of hibernating adult beetles for the following year. This study supports the findings made by Costello *et al.* (1990) that bark banding over several years is required to reduce insect density and subsequently, foliage damage.

Dreistadt and Dahlsten (1990) report that approximately 30 to 40% defoliation of trees is the maximum tolerated aesthetically by many persons. If these injury levels are acceptable, then this study indicated that carbaryl bark banding of golden and English elms in Victoria can reduce foliage damage by elm leaf beetles to a tolerable level over a number of years of treatment. Carbaryl bark banding has been shown to reduce treatment costs and environmental contamination compared to the use of broad-spectrum foliar applied insecticides (Dreistadt *et al.* 1991), and would have no impact on egg parasitoids currently being released for control of elm leaf beetle in Victoria.

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