Elvenia J. Slosson Endowment Fund Project Progress Report
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Title: Interactions of Tactics for Management of Eucalyptus Insect Pests.

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I. INTRODUCTION

Eucalyptus trees have been planted in the California landscape for at least the last 150 years because of their rapid growth, drought resistance, and lack of damaging pests and diseases. The first important insect pest of eucalyptus in California was identified in 1984, and the state has been accumulating new pests at an average rate of one every year since that first discovery. We have been developing pest management solutions for individual pests over the last 15 years. However, it is now clear that this approach requires refinement. The ornamental horticulture community and home gardeners have been placed in a difficult management position because the recommendations they have received for control of one pest may exacerbate problems associated with another pest. For example, recommendations to water and fertilize to enhance tree vigor and resistance to eucalyptus longhorned borers may create trees that are more susceptible to red gum lerp psyllid and eucalyptus tortoise beetle. Systemic insecticide applications for control of the psyllid may disrupt the effectiveness of biological control.

We are examining the interactions among pest management strategies and the impact on the different classes of pests (borers, sap feeders, and defoliators). The results from the study will enable us to develop optimized pest management recommendations aimed at the complex of pests rather than individual pests, to ensure that the complex of pests is controlled below damaging levels. The results will be made available to a variety of home gardener and commercial clientele through presentations, UC Cooperative Extension, and print and Web-based publications.

II. OBJECTIVES

Objective 1. Determine if cultural practices of high levels of irrigation and nitrogen fertilization implemented to improve resistance of eucalyptus trees to borers result in increased suitability and susceptibility of foliage to leaf beetles and psyllids.

Objective 2. Test whether soil-injected systemic insecticides applied to protect trees against red gum lerp psyllid, tortoise beetle, and borers have negative impact on their natural enemies.

Objective 3. Determine if there is an interaction between water and fertilization treatments, systemic insecticide efficacy, and impact on natural enemies.

III. LAY SUMMARY OF ACCOMPLISHMENTS

Under plantation conditions characterized by uniform irrigation, uniform tree age, and uniform tree spacing, treatment of *Eucalyptus rudis* trees by soil injection of imidacloprid was highly significant for reducing red gum lerp populations. Previous studies have demonstrated that bark moisture content of *Eucalyptus* trees is critical for resistance to colonization by the eucalyptus longhorned borer. If bark moisture is maintained above approximately 55%, then the young beetle larvae are incapable of penetrating through the bark tissue. Thus, irrigation of trees to maintain critical levels of bark moisture has been an important cultural management tool. However, moisture and fertilization could make the trees more susceptible to the psyllids. Our results demonstrate that trees under low irrigation treatments had significantly higher densities of psyllids than trees maintained under high levels of irrigation. Trees with high levels of nitrogen fertilization had significantly higher densities of psyllids than trees maintained under low levels of fertilization. Not surprisingly, analysis of the combination of treatments demonstrated that trees maintained under conditions of high irrigation and low fertilization were least colonized by psyllids.

Parasitoids of the herbivores on eucalyptus may be exposed to systemic insecticides if the pesticide is present in floral nectar and if the parasitoids feed in the flowers. We have demonstrated that the egg parasitoid *Avetianella longoi* will feed on sugar solution containing imidacloprid and established the LC_{50} for the parasitoid to the insecticide. The flowers are just beginning to bloom and we are in the process of collecting nectar for pesticide residue analysis and to determine if the nectar is attractive to the wasps. The same procedures will be followed for two other parasitoids.

IV. ACCOMPLISHMENTS FOR CURRENT YEAR

Objective 1. Determine if cultural practices of high levels of irrigation and nitrogen fertilization implemented to improve resistance of eucalyptus trees to borers result in increased suitability and susceptibility of foliage to leaf beetles and psyllids.

The populations of red gum lerp psyllids are significantly reduced under conditions of high irrigation (soil moisture maintained at field capacity) compared to low moisture conditions (soil moisture depleted to 50% of field capacity before irrigation provided) (Table 1). Similarly, the populations of psyllids were reduced under conditions of low nitrogen fertilization. Trees growing under a combination of high moisture and either high or low fertilization conditions had the lowest number of psyllids on the foliage (Table 2). However, there was no difference in psyllid density between high water/ high nitrogen or low water / low nitrogen conditions (Table 3). Psyllid colonization of trees growing under low moisture conditions was not different regardless of which fertilization treatment was included. The results support earlier recommendations of high water/low fertilization to maintain resistance to borers.

Objective 2. Test whether soil-injected systemic insecticides applied to protect trees against red gum lerp psyllid, tortoise beetle, and borers have negative impact on their natural enemies.

The application of soil-injected imidacloprid was effective at protecting the foliage of uniform aged and spaced trees from infestation by the red-gum lerp psyllid. The treatments evaluated are shown in Table 4. The materials were applied at July 2001 and were effective 4 weeks after application (Table 5) through May 2002 (Table 6). The results suggest that the systemic insecticides can protect trees from infestations under the right growing conditions. However, they are potentially limited to the conditions of this specific study and may not be appropriate for less uniform conditions.

Objective 3. Determine if there is an interaction between water and fertilization treatments, systemic insecticide efficacy, and impact on natural enemies.

Systemic insecticides are thought to have less of an impact on natural enemies than contact materials because the routes of exposure for parasitoids and predators may be limited. However, if the insecticide is in nectar produced by the host plant, then parasitoids may poisoned if they feed at floral or extrafloral nectaries. We have demonstrated that *Avetianella longoi* will feed on sugar water containing imidacloprid and the LC_{50} is 164 ppb. The flowers are just beginning to bloom and we are collecting nectar from trees that have been treated with insecticide and from control trees for residue analysis and for feeding trials with this parasite and two other species.

V. RESEARCH SUCCESS STATEMENTS

The research will enable landscape managers to use cultural approaches for limiting susceptibility of eucalyptus trees in the landscape to a range of feeding guilds. The recommendations for scheduling regular irrigation on trees will maintain resistance to both borers and fluid feeding herbivores. Applications of nitrogen fertilizers cannot be recommended. Under the appropriate planting conditions, the systemic insecticide imidacloprid can limit infestations of the red gum lerp psyllid. However, it is not clear yet whether the insecticide treatments are detrimental to natural enemies introduced for biological control.

Table 1. Mean density [mean and (standard error)] of psyllid nymphs on leaves of trees grown under different cultural conditions.

Treatment	**# of nymphs/cm^2**
Low water	0.70 (0.07) A
High water	0.35 (0.05) B
(F=16.66, p<0.001)	
High nitrogen	0.62 (0.07) A
Low nitrogen	0.43 (0.04) B
(F=4.50, p<0.0358)	

Table 2. Numbers [mean and (standard error)] of psyllid nymphs on leaves of trees grown under different combinations of cultural conditions

Treatment	**# of nymphs**
Low water/high nitrogen	16.25 (2.27) A
Low water/low nitrogen	10.66 (1.48) B
High water/high nitrogen	6.38 (1.29) B
High water/low nitrogen	5.91 (1.08) B

F=9.07, p<0.001

Table 3. Mean density [mean and (standard error)] of psyllid nymphs on leaves of trees grown under different combinations of cultural conditions

Treatment	**# of nymphs/cm^2**
Low water/high nitrogen	0.82 (0.11) A
Low water/low nitrogen	0.59 (0.07) AB
High water/high nitrogen	0.43 (0.09) BC
High water/low nitrogen	0.27 (0.04) C

F=9.07, p<0.001

Table 4. Systemic insecticide treatments evaluated. Imidacloprid was active material in all formulations. Materials applied July 2001.

Treatment #	Product	Method	Rate
1	Meridian	drench	6.3oz./100 gal
2	Meridian	drench	8.5oz./100 gal
3	Meridian	soil inj.	2.0g/in. DBH
4	Meridian	soil inj.	4.0g/in. DBH
5	Merit	drench	2.0g/4l
6	Merit	soil inj.	1.5g/in. DBH
7	Control	---------	----------------

Table 5. Numbers of psyllids per leaf of eucalyptus trees treated with systemic insecticides. Trees sampled August 2001.

Treatment	Mean (standard error)
7	0.68 (0.17) A
1	0.00 B
2	0.00 B
3	0.00 B
4	0.00 B
5	0.00 B
6	0.00 B

$F=8.42$, $p<0.0001$

Table 6. Numbers of psyllids per leaf of eucalyptus trees treated with systemic insecticides. Trees sampled May 2002.

Treatment	Mean (standard error)
7	31.61 (3.07) A
3	17.81 (3.29) B
1	8.83 (1.47) C
2	8.81 (1.66) C
4	5.92 (2.12) C
5	2.63 (0.69) C
6	2.19 (0.59) C

$F=23.29$, $p<0.0001$