DISTRIBUTION OF LIQUID FOOD AND BAIT IN COLONIES OF ARGENTINE ANT (HYMENOPTERA: FORMICIDAE)

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Abstract - The distance and speed that workers of Argentine ant, *Linepithema humile* (Mayr), dispersed food was determined by feeding colonies sucrose + red dye. The maximum distances that the dye was dispersed was 33, 48, and 54 m at 24, 48, and 72 hours, respectively. The addition of 0.001% and 0.0001% fipronil to the sucrose + red dye solution decreased the distance that the dye spread and the percentages of dyed ants. The maximum distance that the dye was recovered was 21 and 27 m at 72 hours with 0.001% and 0.0001% fipronil, respectively. Total consumption of the sucrose + dye decreased from 685 ml in the control to 105 and 103 ml with 0.001% and 0.0001% fipronil, respectively. The effects of fipronil on workers began within 24 hours reducing the amount of bait consumed and the amount of trophallaxis that occurred. The future development of effective ant baits will need to consider the adverse effects of toxicants on trophallaxis and recruitment of workers.
Key words - *Linepithema humile*, trophallaxis, recruitment, pest control

INTRODUCTION

The Argentine ant, *Linepithema humile* (Mayr), is a major pest in urban and agricultural environments throughout the world. Only limited success has been achieved with barrier sprays and granular applications of insecticides (Rust *et al.*, 1996). The possibility of using baits shows promise, but the efficacy of this strategy is linked to understanding the nutritional ecology of the Argentine ant and the distribution of bait throughout the colony (Knight and Rust, 1991; Forschler and Evans, 1994). The pattern of food distribution between adjacent nests of *L. humile* was examined by Markin (1968) by feeding P^{32} in sucrose solutions. In other social insects such as termites, Su *et al.* (1991) evaluated 12 cytological dyes and Miller (1993) tested several fluorescent dyes as markers for foraging population studies.

The objectives of this study were to determine the distance and speed that sucrose was distributed from a centrally located bait station through a *L. humile* colony and the effects of a toxicant such as fipronil on the movement of sucrose.

MATERIALS AND METHODS

A citrus orchard in Quillota, V Region, Chile, was chosen for our study, because of the presence of abundant *L. humile* associated with the long-tailed mealybug, *Pseudococcus longispinus* Targ.-Tozz. The 5-year-old navel orange trees were planted at 6 by 3 meters. The test was initiated on January 6, 1997 and the following treatments were used: 1) 20% sucrose solution + 0.5 % red dye; 2) 20% sucrose solution + 0.5% red dye + 0.001% fipronil; and 3) 20% sucrose solution + 0.5% red dye + 0.0001% fipro-nil. The red dye was a combination of Carmoisin S.I.N. 122 and Yellow Crepuscular S.I.N. 110 dyes.A 2-liter plastic bottle with the neck cut off was buried in the soil up to the margin of the container to facilitate the access of the ants to the bait. A bottle was placed close to a tree in the middle of a 48 by 108 m plot for each treatment. Each bottle was filled with 1,000 ml of bait. Approximately 100 workers were sampled at fixed distances radiating from the center of each plot 24, 48, and 72 hours after baiting. Ants were placed in a cooler in the field and stored at -18°C for 24 hours in the laboratory. The ants were crushed between two pieces of white paper towel using a small roller, and the number of red dots recorded and transformed to percentage of the total number collected in each sample.

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RESULTS AND DISCUSSION

Ants readily accepted the sucrose + red dye after the first scouts found the bait station. The abdomens of those ants that fed on the sucrose + dye solutions immediately turned red. The maximum distance that the sucrose + dye dispersed along the direction of the rows was 33, 48, and 54 m at 24, 48, and 72 hours, respectively (Table 1). The dye dispersed about one-half that distance between rows of trees at each of those times. *L. humile* normally travels in the direction of the rows of the trees in the orchard, probably due to the almost continuous shade and the proximity of the trees along each row. Fewer ant trails are seen in between rows. As the distance from the bait station increased, the red spot on the tissue paper became fainter, suggesting the contents of workers' crops had been diluted by trophallaxis. About 70-90% of the ants sampled near the bait station were dyed (Figures 1-3). At 72 hours, as many as 21% of the ants sampled 54 m away from the feeding station were dyed (Figure 3).

This dispersion is slightly farther and more intense than that reported by Markin (1968), however he used only 2 ml of the radioactive tracer which was consumed in two hours. Markin (1968) indicated that due to the limited size of his plots (48.8 meters) it probably spread beyond the plot limits. Reierson *et al.* (1998) found that each worker was capable of drinking about 0.3 mg of sucrose solution. Therefore, only about 6,700 workers probably contacted the original food source in Markin's (1968) study. In our study, about 2 million ant visits occurred over 72 hours accounting for the 12 to 22% of the ants being dyed even as far away as 52 m.

Table 1. The distribution and consumption of sucrose + fipronil bait by *L. humile* in a citrus orchard.

		Distance from the food/bait station (meters)		
Time (hrs)	Direction	20% Sucrose	0.001% Fipronil	0.0001% Fipronil
24	Along rows	33	12	18
	Between rows	18	6	7
48	Along rows 48	21	21	
	Between rows	22	6	
72	Along rows	54	21	27
	Between rows	24	6	
Total consumption		685 ml	105 ml	103 ml

Inspection of the colonies did not show larvae with red colored alimentary canals, supporting observations that larvae are not fed sugars or this dye was rapidly metabolized by the larvae. Similarly, Hooper and Rust (pers. comm.) found that workers did not initially feed larvae ^{14}C- sucrose and usually 24-48 hours passed before slightly detectable amounts appeared in larvae.

The sucrose + dye + fipronil was dispersed only one-third to one-half the distance of the controls in the same time (Table 1). The percentage of ants with red dye significantly decreased with both 0.001% and 0.0001% fipronil (Figures. 4-9). When fed 0.0001% fipronil, the percentage of ants sampled that contained dye ranged from 0 to 38.9% at 72 hours (Figure 9). The total consumption of bait after 72 hours was 105 and 103 ml with 0.001% and 0.0001% fipronil, respectively, compared with 685 ml in the control. This represents a reduction in nearly 1.8 million ant visits to the bait station as determined by calculations based on Reierson *et al.* (1998). There were no differences between both concentrations of the insecticide fipronil concerning the distance at which dyed ants were found, percentage of ants with dye, and consumption of the bait. The reduced distribution of sucrose + fipronil bait suggests that the effects of fipronil are manifested within 24 hours. Trail deposition and recruitment may also be dramatically affected reducing the consumption of the poisoned bait, and thus its effectiveness.

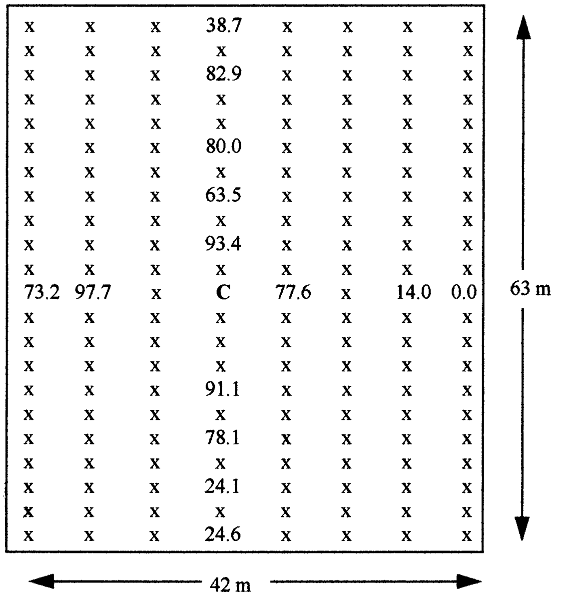

Figure 1. Distribution of sucrose + red dye in *L. humile* colony at 24 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

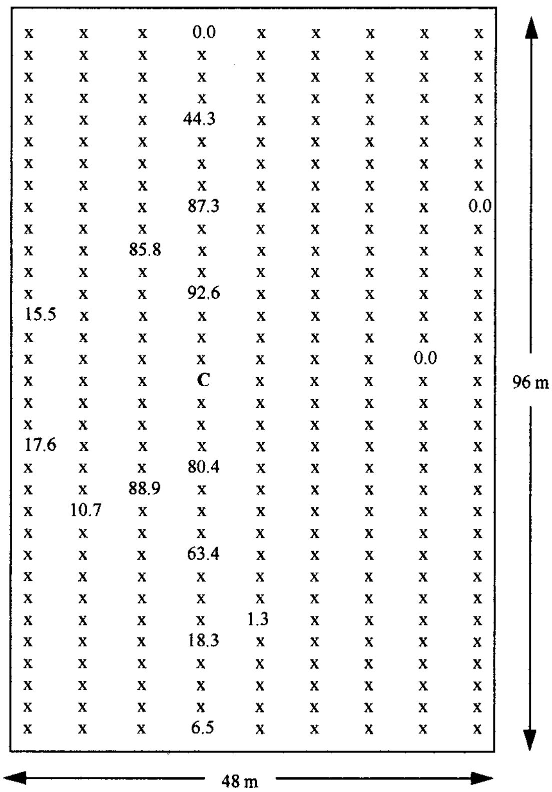

Figure 2. Distribution of sucrose + red dye in *L. humile* colony at 48 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

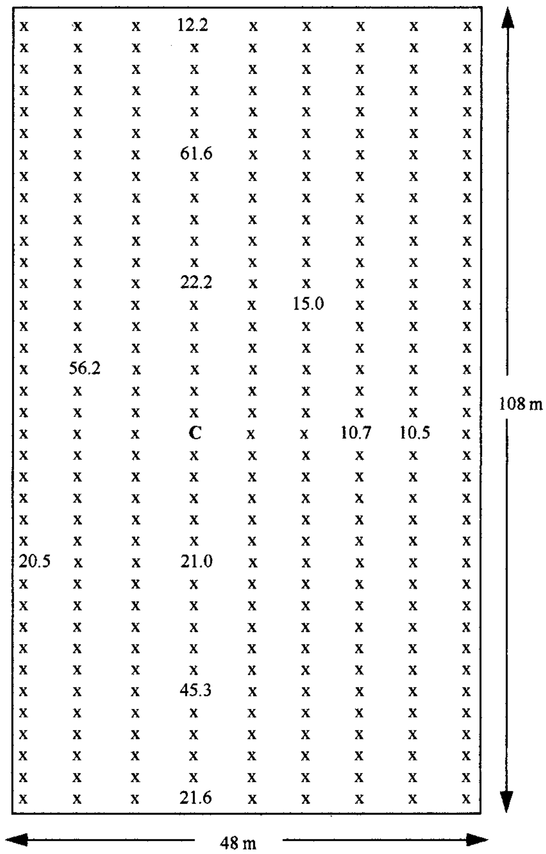

Figure 3. Distribution of sucrose + red dye in *L. humile* colony at 72 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

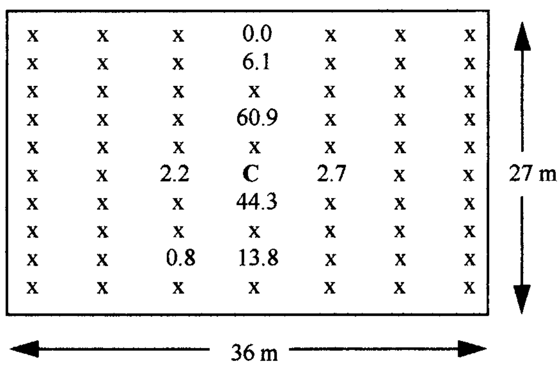

Figure 4. Distribution of sucrose + red dye + 0.001% fipronil in *L. humile* colony at 24 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

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x	x	x	9.9	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	21.0	x	x	x
x	x	x	64.6	x	x	x
x	0.0	x	x	x	0.0	x
x	x	x	C	x	x	x
0.0	x	x	x	x	x	x
x	x	2.1	22.2	0.8	x	x
x	x	x	x	x	x	x
x	x	x	2.9	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	0.7	x	x	x

39 m

36 m

Figure 5. Distribution of sucrose + red dye + 0.001% fipronil in *L. humile* colony at 48 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

x	x	x	7.8	x	x	x
x	x	x	13.1	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	39.6	x	x	x
x	x	0.9	x	x	x	x
x	x	x	x	x	x	x
x	0.0	x	C	4.3	x	0.0
x	x	1.1	x	x	x	x
x	x	x	1.1	x	x	x
x	x	0.0	x	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	0.0	x	x	x

39 m

36 m

Figure 6. Distribution of sucrose + red dye + 0.001% fipronil in *L. humile* colony at 72 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

x	x	x	1.3	x	x	x
x	x	x	x	x	x	x
x	x	x	4.3	x	x	x
x	x	x	x	x	x	x
x	0.0	x	45.3	x	x	x
x	x	x	x	x	x	x
x	0.0	11.4	C	x	x	x
x	x	x	28.9	11.1	x	x
x	x	x	x	x	0.0	x
x	x	x	0.0	x	x	x
x	x	x	x	x	x	x
x	x	x	4.0	x	x	x

33 m

36 m

Figure 7. Distribution of sucrose + red dye + 0.0001% fipronil in *L. humile* colony at 24 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

x	x	x	0.0	x	x	x
x	x	x	x	x	x	x
x	x	x	12.5	x	x	x
x	x	x	x	0.0	x	x
x	x	0.0	16.9	x	x	x
x	x	x	x	x	x	x
x	0.0	x	C	0.0	x	x
x	x	x	68.8	x	x	x
x	x	0.0	x	x	x	x
x	x	x	37.1	x	x	x
x	x	x	x	x	x	x
x	x	x	7.5	x	x	x
x	x	x	x	x	x	x
x	x	x	4.0	x	x	x

39 m

36 m

Figure 8. Distribution of sucrose + red dye + 0.0001% fipronil in *L. humile* colony at 48 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

x	x	x	0.0	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	38.4	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	C	x	0.0	x
x	x	x	x	x	x	x
x	0.0	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	x	x	x	x
x	x	x	32.3	x	x	x
x	x	x	x	x	x	x
x	x	x	10.2	x	x	x
x	x	x	13.4	x	x	x
x	x	x	1.1	x	x	x

45 m

36 m

Figure 9. Distribution of sucrose + red dye + 0.0001% fipronil in *L. humile* colony at 72 hours. The values are expressed as percentages of ants collected containing dye. Each "x" represents a tree. C, bait station.

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