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SHIFTS IN CARPENTER ANT (HYMENOPTERA: FORMICIDAE) MANAGEMENT STRATEGIES WITH INTRODUCTION OF NEW MANAGEMENT TOOLS AND APPLICATION TECHNIQUES

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Abstract Carpenter ants are major structural pests in the United States, Canada, and Scandinavian countries. With the advent of non-repellent chemicals and more attractive baits, shifts have occurred in management strategies that include either perimeter sprays or baiting as the sole method for control. Four tools or techniques were investigated for efficacy in carpenter ant management. One laboratory study showed the transfer of Termidor® (fipronil) among colony members following exposure to a single ant that had died after exposure to a dry treated surface. Ants from this secondary exposure were transferred to a third colony where mortalities of 41% and 72% were observed. Laboratory colonies also were used to study transfer of fipronil (0.001%) found in Maxforce Carpenter Ant Bait Gel®. Toxic effects were transferred from the initially exposed colony through two successive transfers. After two weeks, 100% mortality occurred in the initial colony, 57% mortality after the first transfer, and 46% mortality after the second transfer. In a field study using perimeter spray applications as the sole method of management, 17 homes with infestations received a perimeter spray of Termidor® (fipronil), TalstarOne® (bifenthrin), or TempoUltra® (cyfluthrin). After treatments, ants were not observed at 100% of the fipronil treated sites, 83% of the bifenthrin treated sites, and 80% of the cyfluthrin treated sites. Another study compared applications of bifenthrin using a power sprayer and a compressed-air hand sprayer for the control of carpenter ants. Infestations were controlled with power spraying at 40% of the sites compared to control at 80% of the sites sprayed with a compressed-air hand sprayer. The latter method allowed more precise placement of a smaller amount of chemical.
Key Words *Camponotus,* bait, insecticide

INTRODUCTION

The nesting habits of carpenter ants cause damage to structures and to other wood products such as utility poles and merchantable timber (Akre and Hansen, 1990). These ants are also considered nuisance pests especially in environments with either coniferous or deciduous trees because of the threat of damage to homes. Carpenter ants are important ecologically in forested areas as predators of insects and as recyclers of dead trees. As urban environments are established in areas without trees, homeowners plant this type of vegetation and carpenter ants are introduced as the trees are established. In the United States and Canada, there are 24 species of *Camponotus* that are structurally damaging or nuisance pests (Hansen and Klotz, 2005). Not all species are found in all areas. Of primary importance is *C. pennsylvanicus* (DeGeer) and *C. noveboracensis* (Fitch) in eastern U.S.; *C. modoc* Wheeler, *C. vicinus* Mayr, and *C. essigi* M. Smith in western U.S.; and *C. floridanus* (Buckley) in the southeast (Smith, 1965). In northern Europe, *C. ligniperda* Latr. is an important pest species. One species, *C. herculeanus* (L.), is an important pest throughout Canada, northern U.S. and northern European countries (Wallin and Schroeder, 1994; Butovitsch, 1976).

The classic methods of carpenter ant control in heavy infestations include wall void injections of dusts or other chemical formulations, perimeter sprays of foundations, and treatments of attic and crawl spaces (Hedges, 1998; Klotz, 2004). Chemical sensitivity and environmental awareness have encouraged less chemical usage inside homes, particularly spray applications. However, homeowners continue to request that these insects be eliminated to prevent structural damage. The use of baits, non-repellent chemicals, and the proper placement of chemicals have been accepted to decrease chemical exposure. In the development of a successful bait, attraction and recruitment of foragers plus the transfer of bait to other colony members are recognized as important parameters (Hansen, 2000).

Several management techniques were investigated to demonstrate efficacy in carpenter ant control. Three pesticides were investigated in the laboratory for chemical transfer among individual ants in a colony after exposure to a treated surface. Another laboratory study investigated the transfer of a toxicant in a bait formulation. A field study of perimeter sprays was made to determine efficacy of this strategy as the sole method of management. In addition, a preliminary study compared efficacy of chemical application with a power sprayer to application with a compressed-air hand sprayer for carpenter ant control.

MATERIALS AND METHODS

Transfer of Chemicals From Treated Surface in Laboratory Colonies. Paper toweling was sprayed with one of three chemicals following label directions, allowed to dry, and placed in a container with 25 carpenter ant workers. The three chemicals included Termidor® SC 0.06% (fipronil), Phantom® SC 0.5% (chlorfenapyr), and TalstarOne® 0.06% (bifenthrin). The treated substrate covered half of the bottom of each container. Ants died on all treated surfaces with 18 hours; no repellency was observed with any of the chemicals as ants spent an equal amount of time on and off the sprayed substrate. After 18 hours, one dead ant was randomly selected, removed, and added to a container of 50 ants from the same original colony to observe the chemical transfer effect from this exposure. The test was repeated transferring 5 dead ants. All tests were replicated three times. Numbers of dead ants in each colony were counted and recorded daily for 8 days. Because of the high mortality observed in colonies after exposure to the dead ant(s) that died on the fipronil treated surface, on day 3, one ant was randomly selected and transferred from the first transfer containers to containers with another 50 ants from the same colony. This test was also repeated with transfers of five dead ants from colonies previously exposed to five dead ants. These tests were replicated five times. Controls were established for each of the above tests and dead ants were randomly selected and transferred to new containers of ants collected from the original colony. Numbers of dead ants in each colony were counted and recorded daily for 10 days. The daily percent mortalities for each test were averaged.

Transfer of Fipronil in a Bait Formulation to Laboratory Colonies. Colonies of 50 ants were established and offered 0.001% fipronil gel bait (Maxforce). Colonies were also supplied with honey and water. After 5 hours exposure to the bait, five ants were transferred to a new container of 50 ants collected from the same colony. The second set of containers had honey and water, but no bait. After an additional 20 hours, five ants were transferred from the second container to a third container of 50 ants collected from the same colony. This set of containers also had honey and water but no bait. The tests were replicated five times. Controls were established with honey as the only food source and water. Transfers of ants were made as above. Numbers of dead ants were counted and recorded daily for 14 days. The daily percent mortalities for each transfer were averaged.

Perimeter Sprays as the Sole Method of Control. The purpose of this study was to determine if a carpenter ant infestation can be controlled by a single application of one of three chemicals to the exterior perimeter of the structure and to determine the duration of this control through the season. Homeowners in a private fishing club with residences established around a lake in southwestern Washington volunteered their homes for this project. The primary vegetation in this area is Douglas fir and western red cedar. The area has a high incidence of carpenters (*C. modoc, C. vicinus,* and *C. essigi*) and the homes, constructed between 1940 and 1950, have had high carpenter ant infestation rates. Of the 50 homes in the area, 33 volunteered for our project in 2004 and 17 were sprayed between the months of April and September after carpenter ant infestations were identified. The homes had not been treated commercially or privately for carpenter ants since 2003. A perimeter spray (4-8 L) was applied to the lower edges of the siding, around window and doorframes and edges of decks with a compressed-air hand sprayer. Chemicals used included 0.06% bifenthrin, 0.05% cyfluthrin, and 0.06% fipronil. Follow-up inspections were made at 1, 2, 4, 8, and 12 weeks through September. Retreats were made after four weeks if the ant population had not decreased.

Placement of Chemicals in Perimeter Sprays. Ten homes infested with carpenter ants were sprayed with 0.06% bifenthrin. Half of the applications were made with a power sprayer at the application rate of 20 L per 95 m^2 spraying a band 1 m high on the structure and 2 m from the foundation. Half of the applications were made with a compressed-air hand sprayer at 4-8 L per structure and a perimeter band 0.3-0.6 m with spray directed on the foundation and under the lower edge of the siding. Follow-up evaluations were made at 1 day, 1, 2, 4, and 8 weeks following the application.

Table 1. Average daily percentage mortality in small colonies of *Camponotus modoc* following exposure to ants that died after exposure to chemically-treated surfaces.

Chemical	No. ants transferred	Percentage mortality Days following transfer							
		1	2	3	4	5	6	7	8
Chlorfenapyr	1	4.8	5.9	5.9	7.2	8.5	9.8	12.4	13.1
	5	9.7	10.3	10.3	12.7	13.9	15.8	21.2	24.2
Bifenthrin	1	3.3	3.9	3.9	6.5	8.5	10.5	16.3	20.3
	5	10.3	12.7	13.3	18.8	19.4	23	23.6	23.6
Fipronil	1	19	81.7	92.8	100	100	100	100	100
	5	63.6	100	100	100	100	100	100	100
Control	5	0.6	0.6	3	5.5	6.7	10.3	16.4	18.8

Table 2. Mean daily percentage mortality in colonies of *Camponotus modoc* after secondary transfer of ants from a colony exposed to ants from a fipronil-treated surface.

No. of ants transferred	Percentage mortality Days following transfer									
	1	2	3	4	5	6	7	8	9	10
1	9.1	9.5	13.5	21.5	24.4	26.5	32.7	35.3	37.1	41.1
5	9.1	10.5	18.2	24.4	27.6	33.1	44	50.2	52.4	72
Control	0.4	1.1	4.7	5.8	8	10.2	13.1	14.9	16.4	17.5

RESULTS

Transfer of Chemicals From Treated Surface in Laboratory Colonies. After exposure to ants that died from contact with the fipronil treated substrates, colonies had a higher mortality than colonies exposed to ants that had died from contact with bifenthrin and chlorfenapyr treated substrates (Table 1). After exposure to ants that died in the fipronil tests following the first transfer, colonies had an average mortality of 41% and 72% at 10 days after this second transfer (Table 2). The higher mortality occurred with the transfer of five ants compared to transfer of one ant.

Transfer of Fipronil in a Bait Formulation in Laboratory Colonies. The highest mortality occurred in laboratory colonies that fed directly on the fipronil bait (Table 3). When 10% of the ants were transferred from the original feeding colonies to colonies without bait, there was a 57% average mortality. In the second transfer of 10% of the ants from the second containers to the third set of containers of ants without bait, an average mortality of 46% occurred.

Perimeter Sprays as the Sole Method of Control. When inspections discovered infestations of carpenter ants, homes were sprayed throughout the season with the majority of treatments occurring during the months of May and June, which is the peak of carpenter ant activity in the Pacific Northwest (Hansen and Akre, 1985). An equal number of sites was treated with each chemical (Table 4). None of the sites treated with fipronil had a reoccurrence of carpenter ants during the 2004 season. After 4 weeks, one site sprayed with bifenthrin and one site sprayed with cyfluthrin had counts of carpenter ants that were equal to or higher than counts before application. Both sites were retreated with the same chemical as the original treatment. The cyfluthrin site continued to have activity after another four weeks and was retreated a second time.

Table 3. Mean daily percentage mortality in *Camponotus modoc* colonies offered fipronil bait and the primary transfer or secondary transfer of ants from the initially baited colony.

Baiting Sequence	Days						
	2	4	6	8	10	12	14
Initial bait	25.8	77.3	90.7	96.4	99.1	100	100
1st transfer	3.2	7.2	10.4	26.4	37.2	49.2	56.8
2nd transfer	8	9.8	11.6	15.6	18.9	31.3	45.5
Control	4	4	4.4	4.9	5.8	7.1	8

Table 4. Perimeter spray applications for carpenter ant infestations by month at Wauna Lake, WA, 2004

Perimeter Spray	Months					
	April	May	June	July	Sept	Total
Bifenthrin	0	3	2	1	0	6
Cyfluthrin	0	2	2	1	0	5
Fipronil	1	3	1	0	1	6

Placement of Chemicals in Perimeter Sprays. In the comparison of power spray and compressed-air hand spray applications, three of the five (60%) homes that were power sprayed required an additional application of chemical to control the ants. At each of these sites, observations of the numbers of ants were higher after two weeks than the pretreatment counts. In the homes sprayed with the compressed-air hand sprayer, one of the five (20%) sites continued to have ant activity after four weeks and was retreated. The amount of chemical applied by the compressed-air hand sprayer averaged one-fifth that used in power spraying. Increased efficacy is attributed to the placement of chemical under the lower edge of siding where carpenter ants trail or enter structures. This area usually escapes coverage in power spray applications.

DISCUSSION

Transferability of chemicals is instrumental in spreading chemicals to all members of a carpenter ant colony. Development of non-repellent materials with a lower initial toxicity to carpenter ants is effective in both spray applications and in baiting because the ants transfer the chemical to other members of the colony either through feeding or through physical contact. The latter method appeared to be more efficient in transferring fipronil through the colony. Management of carpenter ants is simplified by placement of chemicals outside structures and allowing the social structure of ants to spread the toxicant throughout the colony. Proper placement also contributes to more efficient use of chemicals making these products more accessible to trailing ants.

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