Proceedings of the Sixth International Conference on Urban Pests
William H Robinson and Dániel Bajomi (editors), 2008
Printed by OOK-Press Kft., H-8200 Veszprém, Pápai út 37/a, Hungary

INCONSISTENCIES IN THE USE OF BAITS IN FIELD TRIALS AND COMPARISON TO LABORATORY TRIALS WITH CARPENTER ANTS (HYMENOPTERA: FORMICIDAE)

LAUREL D. HANSEN
Biology Department MS 3180, Spokane Falls Community College,
3410 W. Fort Wright Drive, Spokane, WA 99224 USA
e-mail: laurelh@spokanefalls.edu

Abstract Baiting offers an integral tool in the management of ants. Baiting trials with *Camponotus modoc* were successful in 55% of field trials with two granular, three gel, and two containerized baits in 2005-2007. Results with two granular, three gel, and four containerized baits in laboratory trials yielded over 95% mortality. Investigations in laboratory to determine inconsistencies in efficacy between trials using baits in the laboratory and field indicate (1) trials using baits only produce higher mortality than choice tests and (2) baits had varied results in trials conducted in July compared to trials in September. In these trials indoxacarb gel showed a decrease in activity; thiamethoxam gel, fipronil gel, and hydramethylonon granules showed an increase in activity; and no changes were observed with indoxacarb or fipronil containerized baits. Exposure of baits to sun, shade, moist, and dry conditions for 10 days before offering baits to ants demonstrated various results. The age factor produced lower mortality in gel baits and abamectin containerized bait compared to granular baits and containerized fipronil and indoxacarb. Consideration of these factors helps to explain bait failures in the field that may result from a number of conditions; however, the overall efficacy of baiting remains an effective management tool.
Key Words *Camponotus*, liquid baits, granular baits, containerized baits

INTRODUCTION

Carpenter ants are both structurally damaging pests as well as nuisance pests that are of prime importance in urban pest management strategies in forested areas or areas landscaped with trees in North America and Europe. In North America important species include: *Camponotus modoc* Wheeler, *C. pennsylvanicus* (DeGeer), *C. vicinus* Mayr, *C. herculeanus* (L.), *C. noveboracensis* (Fitch), *C. floridanus* (Buckley), *C. essigi* M. R. Smith, and *C. nearcticus* Emery (Smith, 1965; Fowler, 1986; Hedges, 1998; Hansen and Klotz, 2005). In Europe, the most important structural pests include *C. herculeanus* and *C. ligniperdus* (Latr.) (Butovitsch, 1976; Wallin and Schroeder, 1994). Carpenter ants are active during the foraging season, commencing in April in the northern latitudes and extending through summer and early fall. Carpenter ants feed on a variety of arthropods and other organisms. They forage heavily on honey-dew producing Hemiptera, but have been observed feeding on other insects and arachnids. They have also been observed feeding on dead vertebrates, flower nectar, and fruits. Carpenter ants do not commonly feed on food items within structures other than liquids from beverage containers or foods high in sugar content early in the season. Cannon and Fell (2002) reported that 2.3 times more carbohydrate than protein is foraged by *C. pennsylvanicus* and protein collection peaked in June and September. A shift in feeding and activity occurs in August in Washington State when reproductives for the following season emerge from the pupal stage to overwinter in the nest until spring nuptial flights. Although carpenter ants remain active in the late summer and early fall, foraging activity has slowed (Tripp et al., 2000). Counts on trails indicate heaviest foraging activity in the months of June, July, and August for *Camponotus* spp. (Sanders, 1972; Hansen and Klotz, 2005).

The use of baits for the control of carpenter ants was recommended over 70 years ago (Back, 1937; Akre and Hansen, 1990), but development of baits was not actively pursued after the introduction of synthetic organic pesticides. Renewed interest in baits with emphasis on more environmentally friendly strategies has produced the emergence of a number of baiting materials (Klotz et al., 1997). Baits must contain a slow acting toxicant so that the small number of foraging ants has the opportunity to distribute the material to nestmates, queen, and brood. The most difficult aspect of bait development is the problem of attraction (Hansen, 2000). Ants develop a site or resource fidelity that has been observed to occur through repetitive seasons. The introduction of bait must compete with the sites that ants are currently frequenting.

Laboratory screens of baits followed by field tests have shown inconsistencies in their efficacy. This report summarizes differences observed in the efficacy of selected registered baits evaluated in the laboratory and the field for *Camponotus modoc* in 2005-2007.

MATERIALS AND METHODS

Laboratory Tests

Colonies of *C. modoc* were field collected in north Idaho in May and June and maintained in the laboratory with honey, a protein source, and water before baiting trials. Groups of 100 workers were established in plastic dishes with the tops modified by removing the center portion for ventilation. Lids were treated with petroleum jelly to prevent escape. Ants in each container were supplied with honey and water until 24 hours before tests were initiated. Baits included three gel formulations: indoxacarb, fipronil, or thiamethoxam; two granular formulations: hydramethylnon or boric acid (5%); and four containerized baits: indoxacarb, abamectin, fipronil or boric acid (1%). After the initiation of each test, mortality was recorded daily. Five replicates were made for each test 1-3. Four replicates were made for test 4-5.

Laboratory evaluations included the following. **Test 1.** Bait was added to each dish of ants. Water was supplied as needed. Tests were initiated in June. **Test 2.** Bait and honey were added to each dish of ants, allowing the ants a choice between the bait and honey. Honey and water were supplied as needed. Tests were initiated in July. **Test 3**. Bait and honey were added to each dish of ants, allowing the ants a choice between the bait and honey. Honey and water were supplied as needed. Tests were initiated in September. **Test 4.** Baits were exposed to direct sun or shade for 10 days before adding to each dish of ants. Ants were also supplied with honey and water. To produce the shaded condition, a sunscreen was placed over the bait and light was measured with a CdS (Cadmium sulfide) photo-resistor meter. Light under the sunscreen was reduced by three times compared to the direct sunlight. Ants were monitored after introduction of the baits for 28 days. Baits were exposed and added to dishes of ants in July. **Test 5.** Baits were exposed to moist or dry conditions for 10 days before adding to each dish of ants. Moisture was supplied with a mist sprayer at the rate of 0.1 ml/cm^2 twice daily at 12 hr intervals. After misting, both sets of baits were stored in a greenhouse with relative humidity between 40-55%. Ants were also supplied with honey and water. Ants were monitored after introduction of the baits for 28 days. Baits were exposed and added to dishes of ants in July.

Field Tests

Field sites were selected with structural infestations of *C. modoc* that had not been treated during the current season for carpenter ants. These sites were located in Washington, Oregon, and Idaho. Structures were baited following label directions and monitored weekly for 4-8 weeks. Sites baited in late July were observed for four weeks; sites baited in May and June were observed for 8 weeks. All baits were placed on the exterior of structures on or near foraging trails or ant entrances to the structure. Ants were counted on trails before baits were applied and again at weekly intervals. In addition to inspections on the exterior, homeowners were interviewed initially, at weekly intervals when available, and at the conclusion of the trial to determine level of control within the structure. Additional baits were applied as necessary.

Two granular baits: boric acid or hydramethylnon; three gel baits: thiamethoxam, fipronil or indoxacarb; and two containerized baits: indoxacarb or boric acid (1%) were used in field trials.

RESULTS AND DISCUSSION

Laboratory Tests

Baiting trials with and without a choice of an alternate food source were made in the peak of foraging activity at the end of June and first part of July. Where an alternate food source was available, a lower percent mortality and/or a longer time period was required (Table 1). The time to reach a comparable level of mortality varied from 2.3 to 7 times with an average of 4 times, with the exception of boric acid granule bait where the mortality was reduced by more than half initially but increased after four weeks. In addition, the abamectin container and thiamethoxam gel also showed a lower percent mortality.

Comparing percent mortality in groups of ants baited in July to those baited in September showed a decrease in mortality with indoxacarb gel and a decrease in the time with fipronil gel and hydramethylnon granules. Thiamethoxam gel had an increase in mortality in the September trials. No differences were noted with the indoxacarb or the fipronil containerized baits (Table 1).

An age effect was demonstrated with baits exposed for 10 days to environmental conditions of sun, shade, moisture, or no moisture (Table 2). Gel formulations and the abamectin containerized baits showed a decline in efficacy; boric acid granules showed an increase. In comparing mortality of ants provided with baits exposed to sun or shaded conditions with fresh baits, differences were not observed with hydramethylnon granules or the fipronil and indoxacarb containerized baits. The boric acid granules showed an increase with both baits exposed to sun and shaded conditions. The other baits all showed a decrease in activity with the sun decreasing the activity of fipronil gel and the shaded condition decreasing the activity of the indoxacarb gel. In comparing mortality of ants provided with baits exposed to moist or dry conditions with fresh baits, no differences were observed with the fipronil or indoxacarb containerized baits. Boric acid granules showed an increase in activity and other baits showed a decrease in activity with both conditions. Indoxacarb gel produced lower mortality with the moist condition (Table 2).

Table 1. Time and average percentage mortality of *Camponotus modoc* in laboratory trials with baits offered with a choice or no-choice in three different months

Active Ingredient	Formulation	No Choice June 21		Choice July 12		Choice Sept 10	
		Days	%	Days	%	Days	%
indoxacarb	gel	4	100	28	89	30	26
fipronil	gel	5	100	12	99	6	100
indoxacarb	container	3	100	16	96	13	96
abamectin	container	11	100	28	55	na	na
fipronil	container	2	100	12	100	13	97
hydramethylnon	granule	12	87	28	83	13	78
thiamethoxam	gel	10	100	28	60	30	73
boric acid 5%	granule	12	55	12 28	26 74	na	na
boric acid 1%	container	na	na	24	100	na	na
control		12	2	28	4	30	4

Table 2. Percentage mortality of *Camponotus modoc* after 28 days with fresh bait compared to baits exposed for 10 days to sun, shade, mist, or no mist.

Active Ingredient	Formulation	Fresh Bait	10 Days			
			Sun	Shade	Mist	No Mist
hydramethylnon	granule	83	87	85	96	76
boric acid	granule	74	100	99	99	100
fipronil	gel	100	69	86	78	77
thiamethoxam	gel	60	36	39	32	43
indoxacarb	gel	89	79	63	65	77
abamectin	container	55	5	9	6	8
fipronil	container	100	100	100	100	100
indoxacarb	container	100	100	100	100	100

Field Tests

In comparing percent control in field sites (Table 3) with the percent mortality in laboratory tests, lower mortality was observed at the field sites. Control at field sites was extremely variable with 100% control achieved at some sites (no ants observed) while other sites required an alternative treatment.

Table 3. Field sites with infestations of *Camponotus modoc* treated with registered baits: 2005-2007 (= alternative treatment).

No. Sites	Active ingredient	Formulation	Start date	AT	% Control
10	boric acid	granule	May	3	70
10	hydramethylnon	granule	May	4	60
5	thiomethoxam	gel	May	2	60
19	fipronil	gel	May/July	10	47
9	indoxacarb	gel	May/July	3	67
9	indoxacarb	container	May/July	4	55
10	boric acid	container	June	5	50

CONCLUSIONS

Trials to screen for efficacy of baits should offer an alternate food source to achieve a more accurate assessment of bait acceptability and these trials should coincide with the peak foraging activity of carpenter ants. Age of bait and environmental conditions such as exposure to sunlight and moisture are also factors in bait acceptability, particularly with gel formulations.

In laboratory trials, attempts to measure the amounts of bait consumed were not made because carpenter ant workers carry debris and dead nestmates into feeding dishes and bait containers. Ants also scatter granule and dried gel baits. In laboratory tests, bait was not replaced because there was little evidence of direct feeding. Ants were observed inside containerized baits and the attraction may have been shelter rather than feeding. Physical contact with the bait appears to be an important factor and the toxicant may enter the ant through ingestion, adhering to hairs, storage in the infrabuccal pocket, or absorption through the cuticle in grooming or trophallaxis.

Carpenter ant workers forage in vegetation inhabited by insects and have fidelity to these sites. Baits must compete with these resources and this competition remains a major obstacle for acceptance. With baits that do not compete, foraging ants will cover baits placed in their foraging trails.

Baiting as a management strategy does not produce the high efficacy that is demonstrated in laboratory studies, but remains a viable option in strategies for the management of carpenter ants.

REFERENCES CITED

Akre, R.D. and L.D. Hansen. 1990. Management of carpenter ants. In: VanderMeer, R.K., K. Jaffe, and A. Cedno. eds. Applied Myrmecology. Boulder, CO: Westview.

Back, E.A. 1937. House ants. USDA leaflet 147.

Butovitsch, V. 1976. Über Vorkommen und Schadwirkung der Robameisen *Camponotus herculeanus* und *C. ligniperda* in Gebäuden in Schweden. Material Organ. 11: 161-170.

Cannon, C.A. and R.D. Fell. 2002. Patterns of macronutrient collection in the black carpenter ant, *Camponotus pennsylvanicus* (DeGeer) Hymenoptera: Formicidae), Environ. Entomol. 31: 977-981.

Fowler, J.G. 1986. Biology, economics, and control of carpenter ants. Chapt. 10, pp. 272-289. In: Vinson, S.B. ed. Economic Impact and Control of Social Insects. New York: Praeger.

Hansen, L.D. 2000. Successful bait development is more than a matter of taste. Pest Control 68(5): 52, 54, 58.

Hansen, L.D. and J.H. Klotz. 2005. Carpenter ants of the United States and Canada. Ithaca, NY: Cornell Univ.

Hedges, S.A. 1998. Field guide for the management of structure-infesting ants. Cleveland, OH: GIE

Klotz, J.H., L. Greenberg, J.J. Shorey, and D.F. Williams. 1997. Alternative control strategies for ants around homes. J. Agric. Entomol. 14: 249-257.

Sanders, C.J. 1972. Seasonal and daily activity patterns of carpenter ants (*Camponotus* spp.) in northwestern Ontario (Hymenoptera: Formicidae). Can Entomol. 104: 1681-1687.

Smith, M.S. 195. House-infesting ants of the eastern United States: their recognition, biology, and economic importance. Agricultural Research Service, U.S. Dept. Agri. Tech. Bull. 1326.

Tripp, J.M., D.R. Suiter, G.W. Bennett, J.H. Klotz, and B.L. Reid. 2000. Evaluation of control measures for black carpenter ant (Hymenoptera: Formicidae). J. Econ. Entomol. 93: 1493-1497.

Wallin, H. and M. Schroeder. 1994. Hästmyor, deras biologi, skadegörelse i hus och möjligheter till bekämpning av hästmyor i byggnader. Anticimex 90-96-008-9.