# EFFICACY of DIFFERENT BAITING MATRICES as TOOLS in the MANAGEMENT of CARPENTER ANTS (HYMENOPTERA: FORMICIDAE)

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**Abstract** Carpenter ants, *Camponotus* spp., are major structural pests as well as nuisance pests in northern areas of the United States, southern Canada, and northern Europe. Management tools have included cultural controls to modify habitats and foraging, dust applications to wall voids, perimeter sprays, baiting, and combinations of these approaches. Comparisons of liquid, gel, and granular formulations were made at 87 field sites with infestations of *C. modoc* or *C. vicinus*. Toxicants in these tests included boric acid, avermectin, hydramethylnon, and fipronil. Foraging sites and trails were utilized during the foraging season for bait placement. Parameters for assessing control included observation of foragers, homeowner observations, and a final inspection the following spring. Efficacy of baits was investigated over five years and found to have 77% to 90% control. Liquids with boric acid required an average of 11.1 weeks for control, and hydramethylnon granules required 10 weeks. Both achieved 100% control. Fipronil granules had a 92% control in an average of 5.9 weeks, but the avermectin granules did not achieve control. Fipronil gel had a 76% control in 6.6 weeks. The results were highly variable because of differences in sites and in competition with natural foods. Granular baits were demonstrated to be effective in controlling carpenter ants in a reduced amount of time when the bait was competitive with natural foraging sources.

**Key Words** *Camponotus* liquid baits gel baits granular baits

## INTRODUCTION

Carpenter ants, *Camponotus* spp., are major structural pests as well as nuisance pests in northern areas of the United States, southern Canada, and northern Europe. A total of 24 species of *Camponotus* has been recorded in North America invading structures. Major pests include *Camponotus modoc* Wheeler, *C. vicinus* Mayr, and *C. essigi* M. R. Smith west of the Great Plains; and *C. pennsylvanicus* (DeGeer), *C. noveboracensis* (Fitch), and *C. nearcticus* Emery east of the Great Plains. In addition *C. floridanus* (Buckley) is a major pest in the southeastern U.S., and *C. herculeanus* (L.) is a pest species throughout the northern states including Alaska and southern Canada and in northern Europe (Hansen and Akre, 1993). Management tools have included cultural controls to modify nesting sites and foraging arenas by removing or correcting conducive conditions for carpenter ant infestations. Chemical applications have included dust formulations injected into wall voids and attic areas plus the application of sprays to sill plates in crawl spaces, in an exterior band around structures, on the foundation, and under the lower edge of siding (Akre and Hansen, 1990; Hansen, 1996; Hedges, 1998; Tripp et al., 2000).

Baiting has become a popular tool in the management of some household insects, and the success of these baiting protocols has been initiated in the management of other groups of insects. Baiting for carpenter ants is a popular approach among homeowners because of the decreased use of chemicals in living space and the specificity for the pest that baiting implies.

Bait development for carpenter ants requires the use of a slow-acting toxicant so that the material can be transported back to the main and satellite nests and spread throughout the colony. The bait matrix must be competitive with established foraging sources. Baiting also requires an

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acceptable delivery system. Granular baits tested against *C. pennsylvanicus* showed that Maxforce bait granules were more effective than Niban or Baygon bait granules (Tripp et al., 2000). Baits are available in liquids, gels, and granular formulations.

The morphology of ants limits their uptake of food in that only liquid can enter the digestive tract. The hypopharynx together with the epipharynx forms a filtering device that prevents particles larger than 100 microns from entering the alimentary canal (Eisner and Happ, 1962). All ants possess a chamber of varying sizes behind the oral cavity that allows food to be stored and partially digested. The infrabuccal chamber or pocket in carpenter ants is relatively large, and food is stored in this area for extended periods of time. In carpenter ants this chamber contains microbial fauna and has several associated digestive glands (Hansen et al., 1999).

This paper compares baits with liquid, gel, or granular matrices used in field trials for management of carpenter ants. The efficacy of the baits and the time required to eliminate the colony at field sites are evaluated.

## MATERIALS and METHODS

Field sites were selected where *C. modoc* or *C. vicinus* were infesting structures. These sites had not been treated for carpenter ants during the current foraging season. Sites selected in the Pacific Northwest included 87 infestations in Eastern Washington, Western Washington, and Northwestern Oregon from 1997 to 2001. Trials were started in May and June, the optimum time for foraging, in 68% of the infestations. The remaining 32% were started in July and August.

All of the toxicants and matrices were proven effective in laboratory tests in controlling carpenter ants (*C. modoc)* within two-week periods. Not all baits were tested in each year. Liquid baits containing different concentrations of boric acid, gel bait with fipronil, and granular baits containing either hydramethylnon or avermectin are commercially available. A third granular bait containing fipronil is also included in this paper; however it is not commercially available. Treatments, number of sites, and dates of the initiation of baiting are given in Table 1.

Baits were changed or recharged at weekly intervals. Liquid baits were totally replaced to keep the toxicant concentration at the formulated level. All liquid dispensers had built-in mecha-

Table 1. Treatment and dates at infestation sites: 1997-2001

| Year | Matrix | Toxicant | No. sites | Start date |
|---|---|---|---|---|
| 1997 | Granules | Hydramethylnon | 9 | May(6), June(3) |
| 1998 | Granules | Avermectin | 5 | May(1), June(4) |
| 1999 | Liquid | Boric Acid (1%) | 2 | May(2) |
| | Gel | Fipronil | 9 | June(5), July(4) |
| | Granules | Fipronil | 6 | June(3), August(3) |
| | Granules | Avermectin | 5 | July(5) |
| 2000 | Liquid | Boric Acid (5.6%) | 5 | May (5) |
| | Gel | Fipronil | 8 | June(4), July(4) |
| | Granules | Fipronil | 10 | May(6), June(1), July(2), August(1) |
| | Combination | Boric Acid (1%) Hydramethylnon Nylar | 4 | August(4) |
| 2001 | Liquid | Boric Acid (1%) | 5 | May(4), June(1) |
| | Granules | Fipronil | 9 | May(9) |
| | Combination | Boric Acid (1%) Hydramethylnon Nylar | 10 | May(3), June(2), July(5) |

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nisms to prevent rapid evaporation. Baits were placed in shaded areas under vegetation or rocks near foraging sites or foraging trails. Granular baits were placed in weighing dishes to monitor feeding. These dishes were covered to protect baits from moisture and consumption from other organisms. Some granular baits were also dispensed in the area of the containers to attract foraging ants into the containers. Amounts of bait placed in stations or dispensed were recorded but accurate amounts of consumption were not possible because of the activity of other ants, insects, and slugs in the area. All of the matrices were attractive to slugs.

Evaluation of the success of a baiting protocol was made by weekly observations at the sites and also by interviewing homeowners. Foraging trails were identified before baiting; these trails became sites for evaluation during the season. Trails shifted during the foraging season, and surveillance by homeowners often assisted in determining where these changes in activity occurred. Homeowners were also requested to collect ants if found in new locations to verify that the same species was present.

Management of the infestation was determined successful when neither the technician nor the homeowner observed ants inside or outside the structure for a two- to three-week period. Sites were monitored throughout the season and for years 1997-2000 at the beginning of the following season.

## RESULTS and DISCUSSION

Comparison of field sites with carpenter ant infestations is difficult for a number of reasons. Carpenter ants forage at night and their trails are often concealed or underground (Hansen and Akre, 1985). Ants may enter structures through the crawl space, the attic, under siding, wiring, vegetation, etc. The age and size of a colony is also difficult to determine. In the Pacific Northwest carpenter ant colonies may live for more than 20 years and many satellite colonies may be associated with one parent colony. Carpenter ants may be found on adjacent properties or in woodlands near residences. Some infestations may exist in structures for several years before the homeowner is aware of the infestation.

In the 87 field sites with infestations, 67 were completely controlled by baiting; however, there was a wide range in the number of weeks required (Table 2). Weekly evaluation was required to determine when baiting could be eliminated. At several sites no ants were observed by the technician or by the homeowner for two weeks, a period that was followed by a resurgence of foraging activity, so baiting was continued or resumed. All baiting sites were monitored through the following spring, except for the year 2001, to determine efficacy of the program.

Table 2. Length of time for complete carpenter ant management

| Matrix | Toxicant | No Sites | Percent Control | Average Weeks* | Range in Weeks* | Sites and dates Ineffective |
|---|---|---|---|---|---|---|
| Liquid | Boric Acid (1-5.6%) | 12 | 100% | 11.1 | 5 to 16 | 0 |
| Gel | Fipronil | 17 | 76 | 6.6 | 2 to 10 | 4 (June-1, July-3) |
| Granules | Fipronil | 25 | 92 | 5.9 | 1 to 12 | 2 (May-1, August-1) |
| Granules | Avermectin | 10 | 0 | – | – | 10(May-2, June-3, July-5) |
| Granules | Hydramethylnon | 9 | 100 | 10 | 5 to 16 | 0 |
| Combination | Boric Acid (1%) Hydramethylnon Nylar | 14 | 71 | 5.7 | 1 to 12 | 4 (June-1, August-3) |

*Average and range in weeks are given for infestations where complete management was achieved.

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Table 3. Sites where baiting was ineffective

| Matrix | Toxicant | No. Sites | Start date | Weeks Baiting | No. Ants | Resolution |
|---|---|---|---|---|---|---|
| Gel | Fipronil | 1 | June | 12 | Decreased | No treatment |
| | | 3 | July | 8 | Decreased | No treatment |
| Granules | Fipronil | 1 | May | 4 | Increased | Alternate treatment |
| | | 1 | Aug. | 4 | Increased | No treatment* |
| Granules | Avermectin | 1 | May | 12 | No change | No treatment |
| | | 1 | June | 4 | Increased | Alternate treatment |
| | | 1 | June | 6 | Increased | Alternate treatment |
| | | 2 | June | 6 | Decreased | Alternate treatment |
| | | 1 | July | 8 | Decreased | No treatment |
| | | 3 | July | 4 | Increased | Alternate treatment |
| | | 1 | July | 8 | Increased | Alternate treatment |
| Combination | Boric Acid (1%) | 3 | Aug. | 4 | Decreased | No treatment ** |
| | Hydramethylnon Nylar | 1 | June | 8 | Increased | Alternate treatment |

*Control was achieved in February (6 months after baiting start).
**Sites were successfully rebaited the following year.

The length of time required for the different matrices varied. The liquid boric acid baits were effective but required the longest average baiting time. The gel was effective in controlling ants at 76% of the sites in an average of 6.6 weeks. This bait was subject to dehydration and may not have been as attractive to foragers in its dried state. The gel was also more difficult to protect from rainfall and consumption by other organisms.

Granular baits showed the greatest diversity. The avermectin granular bait has been effective against carpenter ants in other parts of the country, but does not compete with the natural food sources for ants in the Pacific Northwest. The ants transported the bait but dropped it before reaching the nest or structure. Foragers recruited other ants to the fipronil granular baits and carried it into nests. Results of the fipronil granular bait were often demonstrated within two days when homeowners reported finding piles of dead ants inside the structure or numbers of dead ants outside the structure. The hydramethylnon granular bait was also effective; however the average time for control was increased.

Combination baits containing each of the matrices were also effective when used early in the season. Three of the four combination baits started in August 2000 were not successful at totally eliminating the ants whereas only 10% failed with the earlier start date in 2001.

In the 20 sites where baiting did not completely eliminate the ants (Table 3), 50% had a decrease in the number of ants. At one site large numbers of males, winged females, and workers came out in a finished basement from September through February. This is atypical carpenter ant behavior during these months. The ants died within an hour of emerging, and no ants have emerged since February 2001. Eight of these 20 sites had start dates in May and June; 12 of the sites had a start time in July and August. At the sites using a combination bait started in August 2000, three were successfully rebaited the following summer. Upon requests from the homeowners, half of the sites received an alternate treatment. These included one site with fipronil granules, eight with avermectin granules, and one combination bait. These sites averaged 6.3 weeks in the baiting program, with a range of 4 to 12 weeks.

Though it would appear that liquid baits would have a higher efficacy in management programs because of the limitation of ant morphology for ingesting solids, granular baits have proven to be effective in a reduced time frame in these field trials. Introduction of new chemicals with low toxicity into the insecticide market hold additional promise for use in baiting programs. Some of these have proven effective in laboratory tests and await demonstration in field protocols.

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