CONTROL OF MEAT ANTS (*IRIDOMYRMEX SANGUINEUS* FOREL) IN A WESTERN AUSTRALIAN SANDALWOOD PLANTATION USING BAIT TECHNOLOGY.

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Summary

Meat ants (*Iridomyrmex sanguineus* Forel) showed no significant preference for Distance® Ant Bait (5g/kg pyriproxyfen) or a modified version containing fish oil in choice or no-choice preference tests. However, removal of Distance® + fish oil by meat ants was always higher at each time point for both choice and no-choice tests. Bait efficacy was evaluated following the bait preference trial as well as during a dedicated efficacy trial. Two measures were used to determine the effect of treatments on meat ant mounds – direct ant counts, and presence or absence of ant activity in the mound following physical disturbance. No difference was apparent between the two formulations used in the bait preference trial in terms of mound activity. In the dedicated efficacy trial, no significant difference ($p < 0.05$) in ant counts was found between bait treatments up to 42 days after treatment; but there were obvious trends in terms of mound activity over the full length of the study (47 weeks). Amdro™ (7.3g/kg hydramethylnon) caused an immediate decrease in mound activity within 7 days but this did not persist with these mounds apparently recovering within 15 days and then showing decreased activity out to 47 weeks. For the remaining treatments (pyriproxyfen and s-methoprene based baits) mound activity had decreased by 57 days after treatment in all 3 treatments. Subsequent evaluations at 37 and 47 weeks after treatment showed some increase in mound activity for two of the three insect growth regulator-based baits, but only two of the original 13 mounds treated with Distance® Ant Bait remained active. While the addition of fish oil to Distance® Ant Bait appeared to enhance bait preference, there was no evident value in terms of reducing overall mound activity.

Keywords: Meat ants, *Iridomyrmex*, ant bait, pyriproxyfen, hydramethylnon, methoprene

INTRODUCTION

Meat ants (*Iridomyrmex* spp.) are widespread and ubiquitous throughout Australia and dominate many environments particularly in the arid and semi-arid regions of Australia (Greenslade and Halliday 1983). Meat ants are also a significant nuisance in agriculture either directly through soil disturbance or indirectly through protection of sap-sucking insects (James *et al.* 1996, Stevens *et al.* 2002). Attempts to control meat ant colonies have met with variable success due largely to some key aspects of colony structure. Meat ant colonies are often polydomous forming very large colonies with widely dispersed satellite mounds positioned to exploit food resources (Greaves 1973, Greenslade and Halliday 1983). Hence, treatment of discrete mounds or only portions of the territory of the colony may lead to little more than a temporary localised reduction in abundance. Mounds may be quickly repopulated by ants from nearby untreated portions of the colony or rapidly invaded by adjoining colonies taking advantage of weakness in the treated colony to expand their territory (Greaves 1973). James *et al.* (1996) successfully treated small mounds of *Iridomyrmex purpureus* (F. Smith) in a citrus orchard in southern Australia but a larger mound was unaffected. This was attributed to dilution of the active ingredient in the colony through trophallaxis and hence sublethal dosing. However, it may also be possible that the colony extended beyond just the single large mound and only one portion of the colony was treated.

In this study we firstly investigated the preference of *Iridomyrmex sanguineus* Forel, a close congener of *I. purpureus,* to two bait formulations and then the efficacy of broadcast treatments of four bait formulations. Efficacy data was gleaned also from the follow-up evaluations of mounds used in the bait attractancy trial.

MATERIALS AND METHODS

Trials were conducted in a sandalwood plantation near Kununurra (WA) (15°38'20''S, 128°45'53''E) from September 2002 to August 2003 to evaluate meat ant preference between two different bait formulations and efficacy of various granular bait products for the control of meat ants. The purpose of the attractancy trial was to compare standard Distance® Ant Bait with a formulation containing 1% unrefined fish oil to test the idea that the additional protein might make the bait more attractive to meat ants. Unrefined fish oil (Shakespeare Burley-Up brand, Tuggerah, Australia) is produced from waste products of fish processing and used as a fish attractant for recreational fishing.

In the efficacy trial, four products were tested:
Distance® Ant Bait (5 g/kg pyriproxyfen) – 2 kg/ha
Distance® Ant Bait (5 g/kg pyriproxyfen) + 1 % fish oil – 2 kg/ha
Engage® Ant Bait (5 g/kg *s*-methoprene) – 2 kg/ha
Amdro™ Granular Ant Bait (7.3 g/kg hydramethylnon) – 2.5 kg/ha

At the time the trials were conducted, only Amdro™ was registered for use in Australia but not specifically for meat ants. The remaining three products were under development. All four products are based on a re-processed corn granule and soybean oil. Weather conditions during the period of the attractancy trial and during the first few weeks of the efficacy trial were dry with no rain, ca. 32-34 °C daily maxima and relative humidity of 79-85 %. This period was prior to build-up of the wet season. During the ensuing 2 months, temperature rose to as high as 44 °C and humidity to ca. 90 %. Meat ant mounds ranged in size from small (1 entrance hole and minimal mound formation) through to large (3-4 entrance holes with an obvious mound of 40-80 cm in diameter). There were no extremely large mounds or apparently polydomous nests.

Bait preference trial

Twenty-one mounds were selected and three treatments applied to 7 nests each (Distance®, Distance® + fish oil, and both in a choice arrangement). The minimum distance between adjacent mounds was 20 m. Five grams of bait was offered in small open-ended plastic containers which could be retrieved at the end of the trial and the residual bait weighed. Each container was placed 20 cm from the main entrance hole and where both baits were offered the two containers were placed only 2 cm apart. Bait containers were placed between 14.30 and 15.00 hrs approximately 1.5 hrs prior to the commencement of the normal late afternoon activity period for meat ants. Bait removal was estimated at regular intervals (1.5, 4.5, 14.5 and 19.5 hrs after placement) with the last being the morning after. Estimates were based on two visual assessments of bait remaining using 10% increments.

At 37 and 51 days after placement of bait for the preference trial, ant abundance was measured at these mounds using the "sticky bat" method which involved tapping the end of a length of milled timber covered in adhesive tape at the entrance of the main hole, holding it there for 3 seconds and then counting the number of ants adhering to the sticky surface. This method gave an indication of the ability of the mound to respond to a potential threat. Unfortunately just prior to the 51day assessment, eight of the original 21 mounds were destroyed by earthmoving equipment working in the area and so only 13 mounds were assessed at that time.

Efficacy trial

A dedicated efficacy trial involving all four bait products was conducted in an adjoining area of the plantation where nests lined an irrigation ditch. Ten blocks of variable size were assigned each with the four treatments and an untreated control included. Block size was dependent on nest spacing and each block encompassed at least five distinct nests with treatments at least 10 m apart with nominally 10 mounds per treatment. However, in most blocks more than five nests were present and close nests were grouped together, hence total nests treated ranged from 13 to 15 per treatment. Treatments were applied to an area of 2 x 10 m along the irrigation ditch at the nominated rates with the long axis perpendicular to the irrigation ditch to cover the foraging trails into the sandalwood plantation. Bait was applied using a shaker bottle evenly over the area.

Ant abundance was determined using the "sticky bat" method up til land including 42 days after treatment and where no ants were present the nest was considered inactive. From 57 days onwards nest activity was determined by inserting a metal spike into the side of the mound and fracturing the soil. If ants did not appear within one minute the nest was considered inactive.

Data Analysis

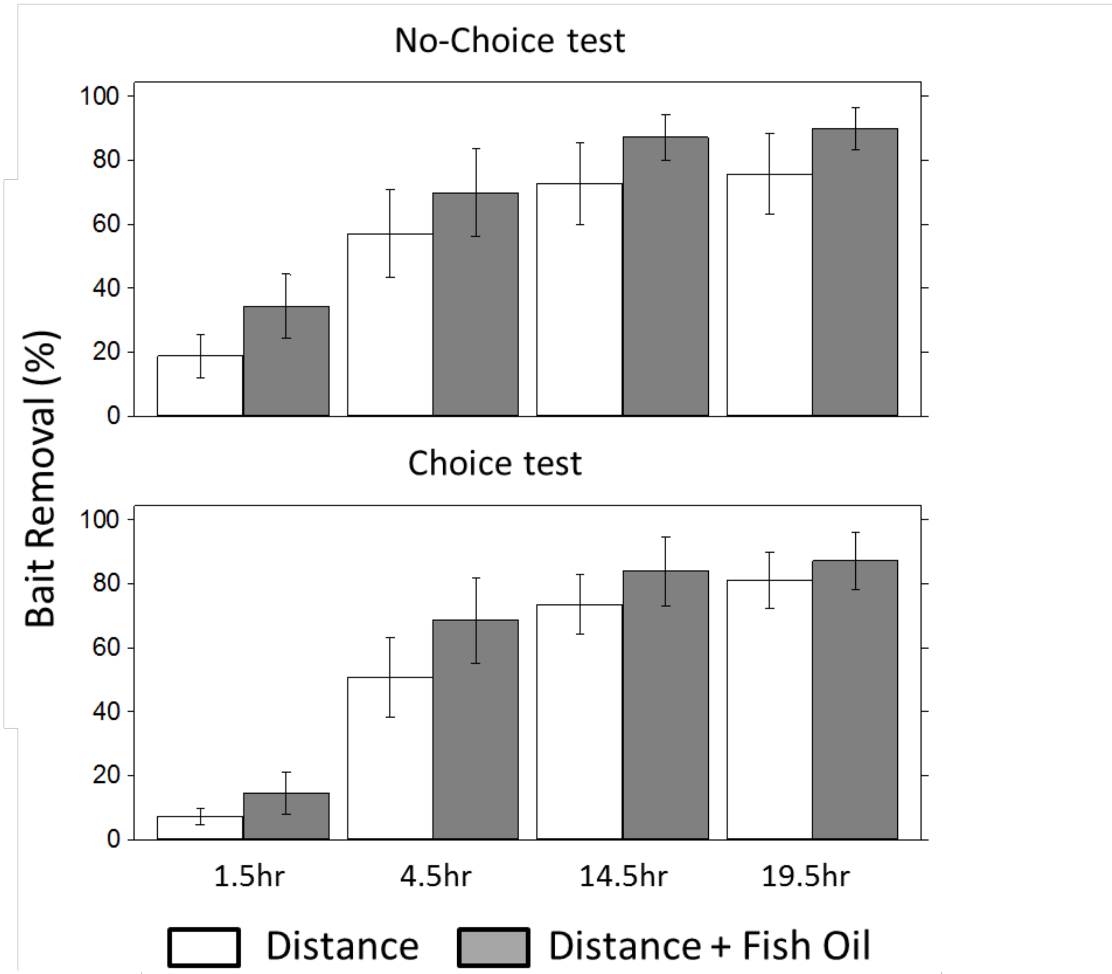
Kruskal-Wallis non-parametric ANOVA (Statistix v.10, Tallahassee, Florida) was used to evaluate the difference in bait removal by meat ants within each time period in the bait preference trial. Ant counts in the efficacy trial up to and including 42 days after treatment were also compared separately for each time period using Kruskal-Wallis ANOVA. As mound activity counts following the bait preference trial and the more comprehensive efficacy trial were single proportional values across all mounds in each treatment, no statistical analysis was justified.

RESULTS

Bait preference trial

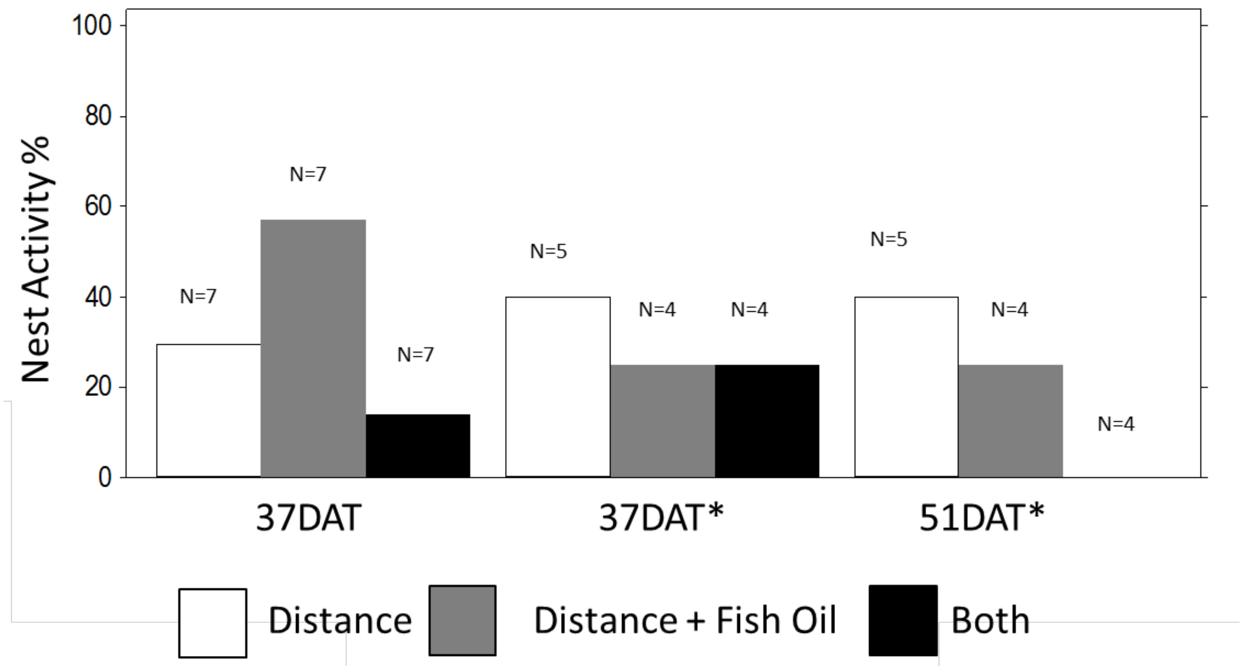
Bait was offered to meat ant nests in a combined choice and no-choice preference test. There was no significant difference in removal rate between Distance® and Distance® + fish oil for either the choice or no-choice components of the preference test (Kruskall-Wallis non-parametric ANOVA, $p > 0.05$ for all time periods). However, there was a consistent trend towards higher removal of Distance® + fish oil in both tests and at all time periods (Figure 1).

Figure 1: Bait removal by meat ants in no-choice and choice tests. No significant differences between treatments were detected at any time period ($p > 0.05$). Error bars are standard errors.



Nest activity from the bait acceptance trial was evaluated at 37 and 51 days after bait placement. Nests treated with single applications in the no-choice test received a maximum of 5 g of bait while these offered both baits in the choice test received a maximum of 10 g of bait. For the single applications, this compares with the normal broadcast application rate of 2 or 2.5 kg/ha (or 4-5 g per $20m^2$) used in the dedicated efficacy trial. Bait removed within 20 hrs in the no-choice test was 75-90% of the bait offered or ca. 3.8-4.5 g and in the choice test ca. 80% of bait offered or 8 g bait. In both cases, the bait removed by individual mounds was similar to or greater than the amount of bait that would be applied at the commercial application rate for the plot sized used in the dedicated efficacy trial ($20m^2$). At 37 days after application, between 14 and 57% of mounds were considered still active depending on treatment and by 51 days after treatment (allowing for the loss of eight nests) between zero and 40% of mounds were still considered active (Figure 2). Lower mound activity was evident for those nests treated with 10g of bait during the choice test (0% active) as compared to those treated with 5 g of bait (14%).

Figure 2: Mound activity following treatment with 5 g or 10 g bait during the bait acceptance tests. Five grams of bait were applied in the no choice treatments and 5 g of each bait (10 g in total) applied in the choice treatment. * Mound activity of only those nests not destroyed at 50DAT.



Bait efficacy trial

In the dedicated efficacy trial comparing a number of different baits, the impact of baiting was assessed using measures of both ant abundance and mound activity. Direct ant counts using the sticky bat method revealed no significant difference between treatments for any of the time periods up to and including 42 days after treatment (Kruskall-Wallis non-parametric ANOVA, $p > 0.05$ for all time periods) (Figure 3).

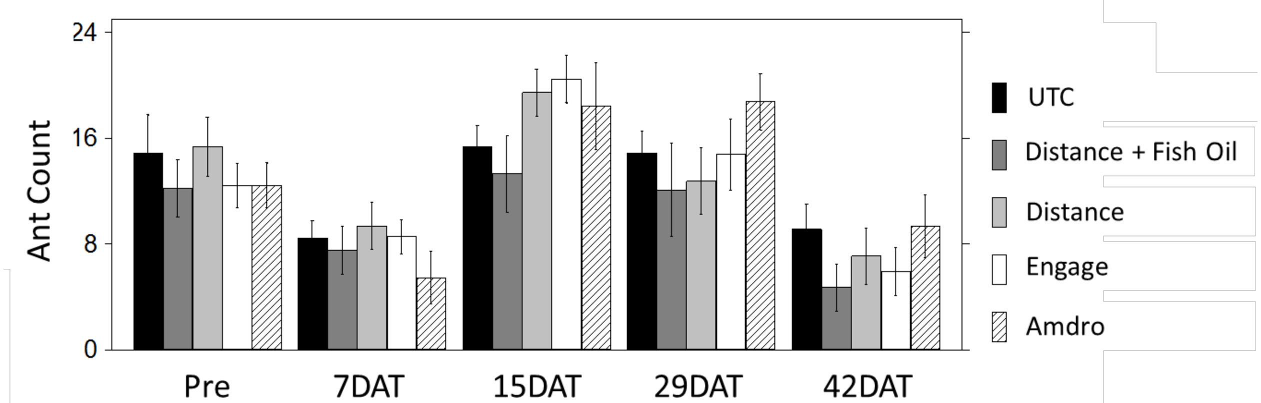
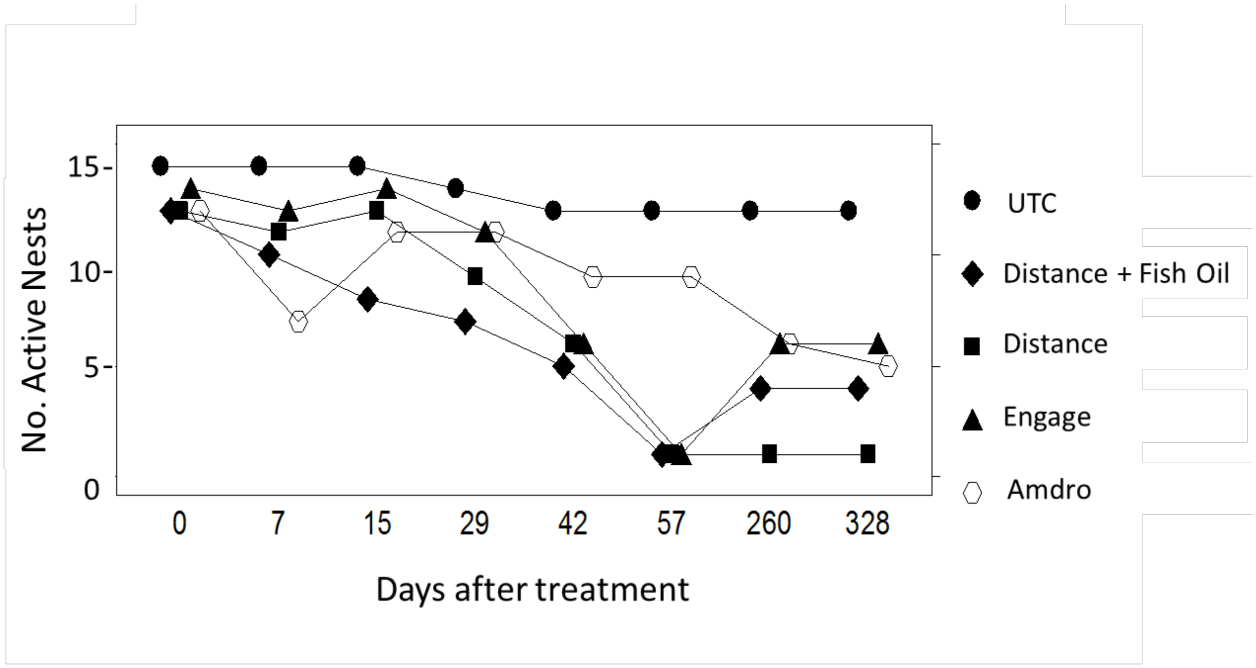


Figure 3: Ant counts following treatment with various ant baits. No significant differences between treatments were detected at any time period ($p > 0.05$). Error bars are standard errors.

Mound activity data is more instructive because it shows a clear pattern in decline between 29 and 57 days after treatment for the IGR-based baits – Distance®, Distance® + fish oil and Engage® (Figure 4). Conversely, the effect of Amdro™ was evident within the first week with active mounds declining from 13 to 8 but then returning to higher levels. Assessments were conducted at 260 and 328 days after treatment and the number of active mounds in all treatments remained well below that in the untreated control with only two active mounds remaining for the Distance® treatment.

Figure 4: Mound activity following treatment with various ant baits. The "sticky bat" method was used tup o and including 42 days and thereafter mound activity was assessed by observing activity after physical damage to the mound.



DISCUSSION

Meat ants showed no significant preference for Distance® + fish oil over standard Distance® although there was a trend towards faster uptake of the fish oil supplemented bait. The standard formulation appears to be attractive enough to meat ants although the addition of food supplements does significantly influence attractiveness for some species (Webb 2014 in press).

Mound activity assessments following the bait acceptance tests also showed no clear difference between Distance® and Distance® + fish oil. The application rate of ca. 5 g/mound (single treatment) was broadly analogous to the standard broadcast application rate (2 kg/ha or ca. 4 g/20 m^2) and achieved ca. 85% reduction in mound activity by 51 days after treatment. However, the bait offering of 10 g/mound in the choice test ultimately resulted in zero mound activity by the same time. While these results are somewhat anecdotal due to the loss of 8 of 21 nests just prior to the 51DAT assessment, they do suggest that Distance® (either alone or enhanced with fish oil) provided acceptable levels of nest elimination and that 10 g per nest provided better nest elimination than 5 g.

Ant counts using the "sticky bat" method did not show any significant difference between treatments during the first 6 weeks following application in the dedicated efficacy trial. We suspect that while this method of assessment provided an easy and safe way to count meat ants, it was relatively insensitive particularly when used on IGR treated colonies which may not show substantial declines in activity until several months after application. There was some reduction in the mean ant count at 7 days after treatment for Amdro™ although this was not significantly different from the control. For assessment of colony activity, the dedicated efficacy trial utilised the sticky bat method of assessment up until 42 days after treatment and thereafter colony response was assessed following damage using a steel bar. As this was essentially a presence/absence assessment the data is somewhat more robust than actual ant counts. Within 7 days there was a decline in nest activity for Amdro™ but this did not persist. The three IGR-based baits ultimately caused a decline in nest viability from 29 days onwards leading to a ca. 85% decline in nest viability by 57 days after treatment. Only Distance® maintained this low level of mound activity through to the later assessments (260 and 328 days after treatment). Some mounds in the Distance® + fish oil (3 mounds) and Engage® (5 mounds) treatments appeared to recover. Whether this represents true colony recovery or mound accession by adjoining colonies or new colony establishment is uncertain.

The plot configuration in the dedicated efficacy trial was designed to intersect foraging trails leading into the sandalwood plantation where meat ants actively foraged in the canopies, presumably harvesting honeydew from sap-sucking insects, although the specific source of honeydew was not noted at the time of the trial. This is a common feature of meat ant biology with well-worn trails leading from mounds to nearby trees and a high dependence on honeydew for both nutrition and moisture (Greaves and Hughes 1974).

Meat ant colonies are known to grow very large, sometimes being polygynous and sometimes having multiple satellite mounds up to 100 m away (Greaves 1973, Greaves and Hughes 1974, Greenslade and Halliday 1983, McIver 1991, Mobbs *et al*. 1978). In one extreme case a colony occupied an area of 10 ha with 85 separate mounds and 1600 entrance holes (Greenslade and Halliday 1983). Meat ant colonies are also highly aggressive and rapidly take over any weakened colonies or vacant territory (Greaves 1973). It is therefore possible that attempts at nest eradication may appear to fail simply because the physical mound has been overtaken by an adjoining untreated colony or the mound has been re-invigorated by the ants from satellite mounds of the same colony (Greaves 1973). Establishment of incipient colonies is rare because of natural mortality of newly mated queens and available territories are usually occupied and aggressively defended. Budding may be a more common mechanism for new colony establishment along with isolation and subsequent independence of satellite mounds (Greaves and Hughes 1974).

Greaves (1973) attempted eradication of *I. purpureus* nests using dust and liquid treatments of various organochlorines and organophosphates. While most colonies succumbed to treatment, physical mounds were quickly occupied by ants from either adjoining colonies or untreated satellite mounds of the treated mound. Aside from the work of Greaves and co-workers, there is almost no published information on attempts to control meat ants, and particularly with bait technology. James *et al.* (1996) and Stevens *et al*. (2002) studied the effects of granular baits on *I. purpureus* in citrus orchards in southern Australia. Baits containing hydramethylnon and fipronil were effective in reducing the number of foraging workers when 10 g of bait was placed at the base of citrus trees or directly onto meat ant mounds. No such reduction was evident in this study with Amdro™, and while there was an early reduction in active mounds, the effect did not persist. Each colony only had access to ca. 5 g of bait which may have been insufficient to achieve higher levels of nest elimination. Had we applied bait over a wider area encompassing a larger portion of the foraging range of each colony, there may have been a more dramatic effect. Despite this it seemed that the IGR based baits had a much more persistent effect on colony activity than Amdro™ even with a similar application rate. It has been suggested that IGRs, because they are not acutely toxic, may be more persistent in ant colonies and shared around within and between colonies more effectively (Drees *et al.* 1992, Oi *et al.* 2000).
Clearly meat ants are susceptible to baiting but colony size and the presence of satellite mounds may influence the amount of bait required and speed of control and ultimately whether the entire colony succumbs.

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