CONSIDERATIONS FOR ERADICATION, CONTAINMENT AND LONG-TERM MONITORING OF LITTLE FIRE ANTS IN TAHITI

Report to the Secretariat of the Pacific Regional Environment Programme
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5 July, 2013




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EXECUTIVE SUMMARY

Little Fire Ants (*Wasmannia auropunctata*) were first detected on the island of Tahiti in French Polynesia in 2004. Since that time, this pest has spread across the island, with the majority of infestations located on the north and north-west coastlines. Despite concerted eradication efforts to eradicate by response agencies, Little Fire Ants continue to spread, causing ecological, economic and social impacts.

This report analyses current distribution data and existing knowledge of Little Fire Ant behavior in invaded environments to prioritize treatment and monitoring efforts in order that limited resources are best utilized to reduce the impacts of this pest. Nine recommendations for the strategic response to this species are provided:

1. Eradication efforts should focus on eliminating small (<1 hectare) infestations and if resources permit, infestations sized 1-5 hectares.
2. Containment activities should focus on larger (>5 hectare) infested sites.
3. Further research is needed to quantify the rates of spread for Little Fire Ants on Tahiti.
4. Known pathways and vectors for spread of Little Fire Ants on Tahiti should be monitored and risk minimization efforts should target these pathways.
5. Resources should be allocated to enhanced domestic quarantine inspections for risk items being transported to neighbor islands.
6. Domestic points of departure, especially the sea port and cargo handling facilities should be surveyed frequently to ensure these sites are free of Little Fire Ants
7. International points of departure, especially the sea port, airport and cargo handling facilities should be surveyed frequently to ensure these sites are free of Little Fire Ants
8. Resources should be made available for enhanced international out-bound quarantine activities to monitor and inspect cargo, personal possessions and empty shipping containers bound for international destinations.
9. Resources should be allocated to the development and implementation of a targeted outreach strategy designed to identify new infestations and reduce the risks associated with known Little Fire Ant vectors.

BACKGROUND

Little Fire Ants (Wasmannia auropunctata) are an established and expanding invasive pest on the island of Tahiti. This species poses a serious threat to the economy, ecological health and social well-being of French Polynesia and its inhabitants. Once established, Little Fire Ants form dense three-dimensional supercolonies that cover the ground, vegetation and tree canopies. Ants nesting in trees are easily dislodged by wind and other minor disturbance and often fall from their arboreal homes onto people and animals below, stinging their victims and causing blindness in domestic animals. In natural ecosystems, they prey on, or drive out native fauna, leaving an ecosystem depleted of much of its pre-existing animal life. The mutualisms formed between Little Fire Ants and Homoptera cause crop losses in agriculture and declines in plant health for native ecosystems.

Ten of the 13 municipalities within the administrative sub-division of the Windward Islands are infested with Little Fire Ants. The most recent systematic survey was conducted in 2010, resulting in the documentation of 79 infested sites covering 782.7 hectares. This is despite extensive control efforts undertaken between 2006 and 2010. The municipalities of Mahina (9% of land area) and Arue (4% of land area) are the most heavily infested. This species will spread in future years, most likely infesting a majority of land adjacent to human habitation or disturbance. Eventually it will also invade natural ecosystems.

SCOPE AND PURPOSE

This report is one of a series of reports that focus on the issue of Little Fire Ants in French Polynesia. The specific purpose of this report is to provide recommendations and standard operating procedures for containment or eradication of this species and for the strategic monitoring of their spread within the island of Tahiti.

CURRENT DISTRIBUTION OF LITTLE FIRE ANTS IN TAHITI

Since its discovery in 2004, Little Fire Ants have spread rapidly through the island of Tahiti and onto neighboring Moorea. Over 86 current known infestations exist, covering 758 hectares (Table 1). The most heavily infested municipalities are in the northern and western part of Tahiti island (Figure 1). This distribution is expected to grow as Little Fire Ants are accidentally transported to new locations.

Table 1. current (2012) infested area and number of sites with Little Fire Ants in Tahiti.

Commune	infested area (ha)	number of sites
Mahina	481.9	21
Arue	86.8	9
Punaauia	65.1	14
Faaa	41.3	8
Hitiaa O Te Ra	37.1	13

Papara	23.6	2
Papeete	17.7	11
Pirae	4.0	6
Moorea	0.6	1
Taiarapu Ouest	0.5	1
Paea	0	0
Taiarapu Est	0	0
Teva I Uta	0	0
total	**758.0**	**86**

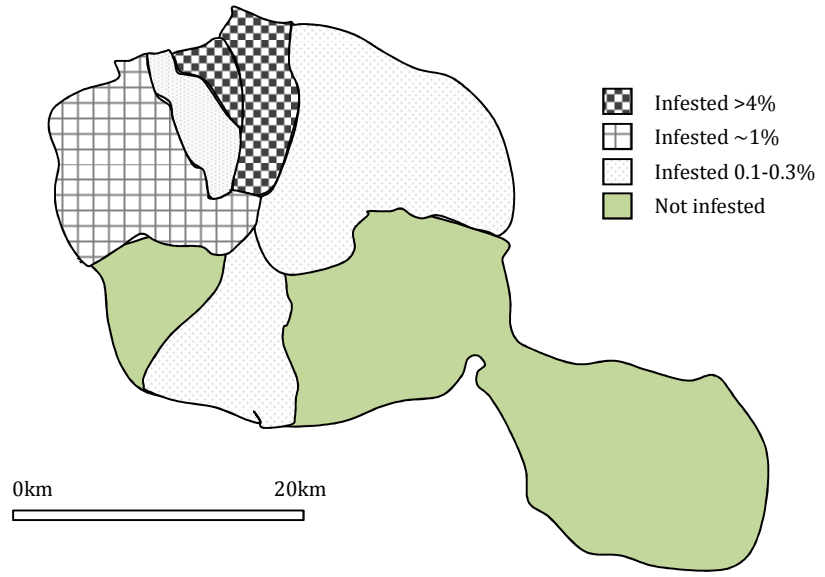


Figure 1. Map of Tahiti showing mean density of infested land (2012).

Little Fire Ants spread through natural expansion (lateral spread or "budding") and "jump dispersal" (spread mediated by human activity). Once a Little Fire Ant colony becomes established in a new location, the colony grows and expands. The main mechanism for natural expansion is via "budding". This occurs when a newly inseminated queen, accompanied by some worker ants, establish a new satellite colony. Usually the new colony is located only a short distance (less than 5 metres) from the parent nest. The colony remains connected to the parent nest and acts as a satellite colony. The rate of natural spread depends on availability of suitable nesting sites, foraging areas and availability of food. It is difficult to predict the exact rate of colony expansion as each site will have different characteristics. However, in suitable sites, spread would be measured in 10s of metres per year. Figure 2 shows the rate of expansion of a single colony with spread rates of 10, 20 and 30 metres per year. If spread of a single colony is within these rates, it is reasonable to assume each separate infestation will grow to cover between 3 and 30 hectares over a ten year period.

Little Fire Ants can also disperse over longer distances when a colony or a colony fragment is transported to a new location. This form of spread is facilitated primarily by human-assisted means, when items harboring Little Fire Ants are moved to new locations. To a lesser extent, jump dispersal can also be caused by natural events such as rafting along flooded waterways, landslides and similar events.

The French Polynesia Ministry of Environment conducted an extensive survey and mapping project in 2010. Using those data, approximately 80% of all recorded infestations were smaller than 5 hectares, and 60% of these were less than 1 hectare in size (Figure 3).

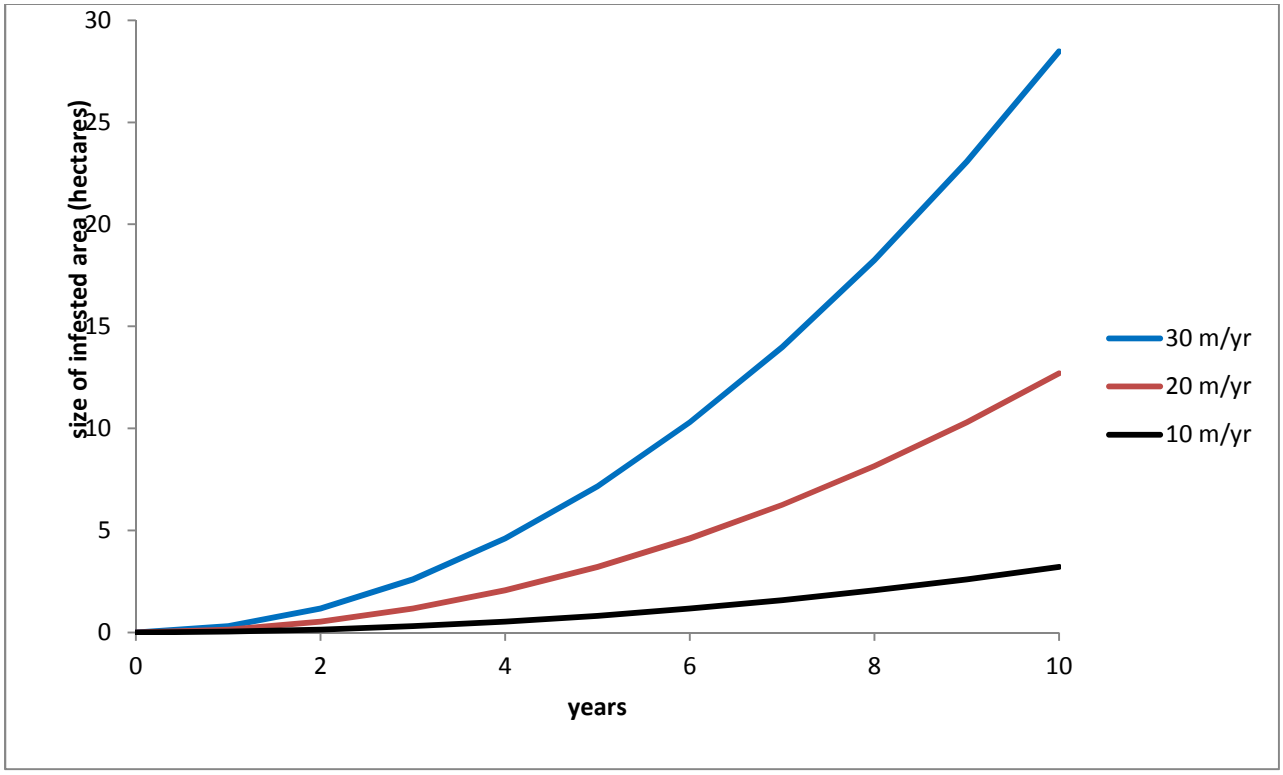


Figure 2. growth of a single Little Fire Ant colony over 10 years with expansion rates of 10, 20 and 30 metres per year. Data calculated assuming circular spread from a single introduction point.

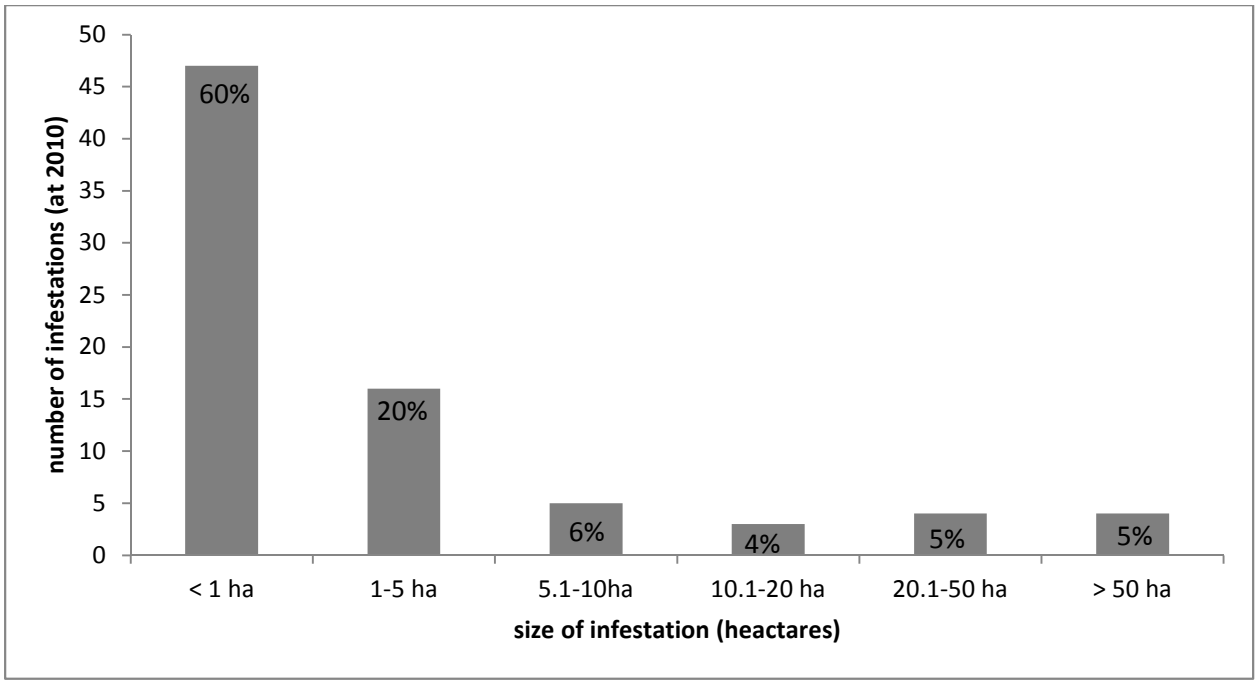


Figure 3. Number of infested sites on Tahiti based on size of infestation (2010 DIREN data).

CONTAINMENT AND ERADICATION METHODS

This species is notoriously difficult to control, much less eradicate. Only two successful eradications have been documented – both less than 25 hectares in size. Little Fire Ants were reportedly eradicated from Marchena island in the Galapagos {Causton, 2005 #571} and the island of Maui in the Hawaiian archipelago {Vanderwoude, 2010 #860}. In both cases, success was achieved using repeated application of baits laced with toxins. On Marchena, the infested zone consisted of low dry forest, and several applications of Amdro® a granular bait containing hydramethylnon (0.739% a.i.) achieved eradication. In Hawai`i, infested areas consisted of lush tropical vegetation and Little Fire Ants were nesting in tree canopies as well as on the ground. In this eradication, a combination of granular baits for the ground layer and a gel bait for vegetation were used. Treatments were applied eleven times over a 12 month period. The climate and vegetation on Tahiti resemble that of Maui more-so than Marchena. Therefore, containment and eradication procedures for Tahiti need to consider colonies nesting in vegetation.

Treatment Priorities

Financial constraints are likely to preclude any attempt at island-wide eradication. Therefore containment and site-eradication activities should target treatment of those sites that will yield the

greatest benefit to Tahiti. The delimiting report for this project (Vanderwoude 2013, unpublished data) recommended treatment of high-value sites and reducing small infestations.

High-value sites

High value sites are those areas where Little Fire Ants will have most social, economic or ecological impact as determined by the response agency. It is not possible for these sites to be prioritized in this report as these should be determined by Tahitian stakeholders. However, following are some suggested site types where impacts will be greatest.

Economic impacts

- Hotels, resorts, public use areas (beaches, tourist sites)
- Agriculture, tropical crops, food crops, nurseries, markets
- Commercial establishments that export goods inter-island or internationally

Social impacts

- Homes, hospitals, care facilities

Ecological impacts

- Natural areas (forests, beaches, rivers, cultural heritage sites)

Small developing populations

The future total area for Tahiti will be determined by a number of factors. These include the rate of natural growth of each infestation, the number of "jump-disperal events" and the current number of infested areas. It is beyond the scope of this report to estimate rates of jump-dispersal, however, DIREN conducted extensive survey and mapping of Little Fire Ants on Tahiti Island in 2010. These data will be an under-representation of the true infested area. However, they provide the best available estimate of the distribution of this species as at 2010.

By applying a simple natural growth estimate of 20 metres per year for each infested site, growth in future years can be estimated. Figure 4 shows this growth according to the initial (2010) sizes of each infestation multiplied by the number of known infestations. Due to their larger number and quicker early growth relative to their original size, small developing infestations will be the major contributing factor to future growth. The total infested area of the 45 small (< 1 hectare) sites recorded in 2010 was only 1.9% of the total. However, these are predicted to comprise 28.5% of the total infested area after 10 years (Table 2)[1].

These estimates suggest that more future benefit will be gained by reducing the current number of small infestations. Eradicating all infestations smaller than 1 hectare (15 hectares total) will reduce future growth by 28.5%. In contrast, eradicating all current large (>50 hectare) infestations (526 hectares) will provide a similar future result.

[1] *These data do not include new infestations caused by jump-dispersal events.*

Table 2. current and predicted (10 year) growth of Little Fire Ant infestations on Tahiti by 2010 size classes and assuming a 20 metre annual rate of natural growth.

initial size	current area (ha)	projected area (ha)	current % of total	projected % of total
<1 ha	15.0	794.4	1.9	28.5
1-5 ha	40.5	422.0	5.2	15.1
5.01-10 ha	39.1	201.2	5.0	7.2
10.01-20 ha	36.3	148.1	4.6	5.3
20.01-50 ha	125.5	333.9	16.0	12.0
> 50 ha	526.3	892.1	67.2	32.0
	782.8	2791.6	100.0	100.0

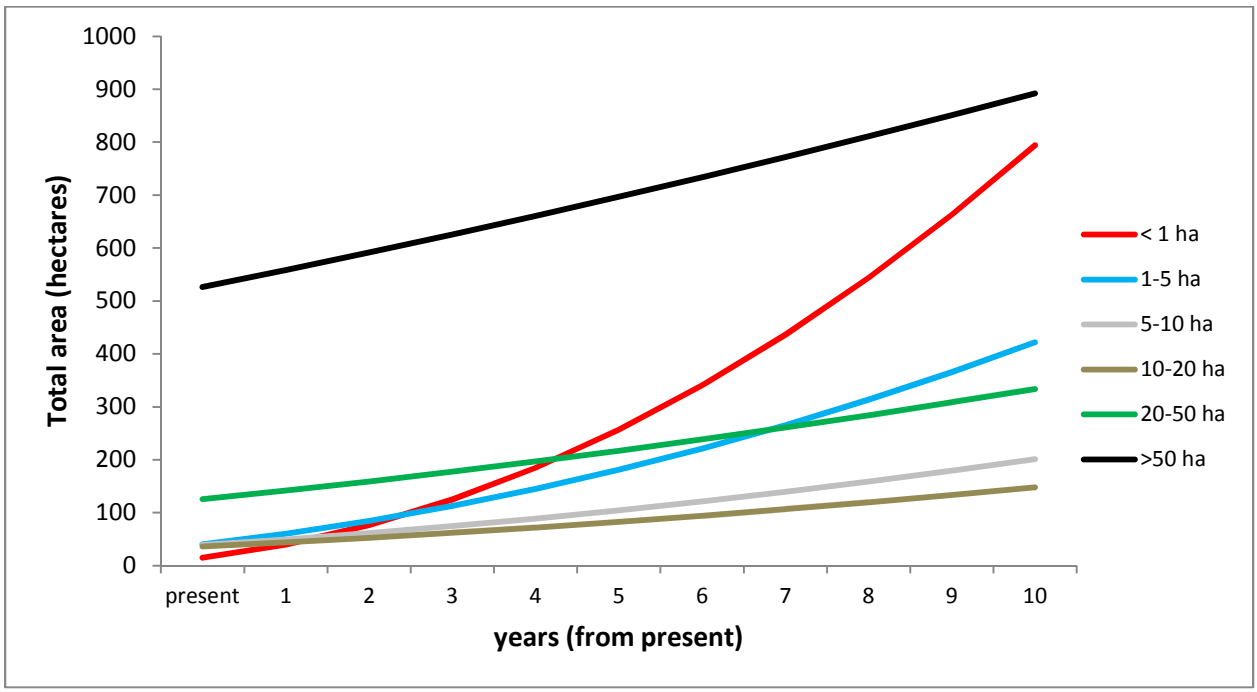


Figure 4. projected growth of infested area (hectares) on Tahiti over ten years classed by 2010 infestation sizes and a 20 metre annual growth rate.

Treatment methods

Spot eradication

The current known Little Fire Ant infestations on Tahiti can be considered as discrete "islands", each with its own independent treatment plan. Treatment and eradication of these islands can proceed independently from each other as resources permit. Although it is preferable for all sites to be treated immediately, this is not absolutely necessary.

On Maui, Vanderwoude et al (2010) demonstrated the use of a combination of treatments as an eradication strategy. The infestation was delimited by lure survey, a 20 metre buffer area was added and this comprised the treatment area. Granular baits were applied to the ground and a gel bait was used for colonies nesting in trees. These were applied monthly over 12 months. Standard operating procedures for both application methods are appended to this report.

Containment

The goal of containment is to limit or prevent further spread of a pest. For containment, only the edge of an infested area needs to be treated as Little Fire Ants do not disperse by flight. Once an infested site has been carefully delimited and a 20 metre buffer applied to the edge of the infestation, the site can be contained through use of a residual pesticide applied in a 2-4 metre band to the ground and vegetation. Alternatively, granular baits can be applied in a band if there is a clear vegetation-free separation between uninfested and infested land. Standard operating procedures for both application methods are appended to this report.

SUGGESTIONS FOR TARGETED MONITORING

When eradication of a new pest is not possible or feasible, targeted mitigation efforts can reduce impacts and spread. Monitoring the spread of a new pest species can greatly assist decision makers in allocating limited resources to this activity by and target priority areas. Monitoring for this species should focus on three key areas: spread pathways and associated vectors, high-value sites and the prevention of spread to neighbor islands and international destinations.

Pathways and vectors

Any item being transported by humans can potentially harbor Little Fire Ants. However, some items are more likely to vector this species than other. Monitoring for Little Fire Ants should focus primarily on pathways for the movement of the following items:

- Potted plants
- Foliage, lays, cut flowers, orchids
- Banana suckers, bamboo cuttings, palms
- Soil, items stored in contact with soil
- Soil, mulch, trash, green waste, plant trimmings
- Agricultural produce – taro, pineapple, papaya, avocado, lychee, yam etc
- Vehicles, especially those with uncleaned truck beds and undersides

High value sites

High value sites are those areas where Little Fire Ants will have most social, economic or ecological impact as determined by the response agency. It is not possible for these sites to be prioritized in this report, however, following are some suggested site types where impacts will be greatest.

Economic impacts

- Hotels, resorts, public use areas (beaches, tourist sites)

- Agriculture, tropical crops, food crops, nurseries, markets
- Commercial establishments that export goods inter-island or internationally

Social impacts

- Homes, hospitals, care facilities

Ecological impacts

- Natural areas (forests, beaches, rivers, cultural heritage sites)

Prevention of inter-island and international spread

French Polynesia is comprised of approximately 130 islands in six island groups. Transportation of people and commodities to neighbor islands is primarily via Tahiti, by boat or ship from the port of Papeete. Few neighbor islands have air strips that are used on a regular basis, and the majority of commodities are transported by boat.

Preventing spread of Little Fire Ants to neighbor islands should be a major focus of any response plan for French Polynesia. Risk items are treated by methyl bromide fumigation at the French Polynesia Ministry of Agriculture facility. However, this practice is voluntary and not mandatory. Regular monitoring for Little Fire Ants should be conducted for the domestic port area, cargo holding facilities, cargo, and personal possessions of travelers.

French Polynesia has few export commodities. The majority of foreign capital is derived from two main sources: the tourist industry and the sale of marine-derived items including seafood and pearls. Tourists are potential vectors for the outward movement of Little Fire Ants, especially via possessions that may have been in contact with soil: tents and other camping equipment, hiking equipment etc, as well as through the purchase of handicrafts at markets and souvenir stores. The major export commodities of seafood and pearls are unlikely to harbor Little Fire Ants. However, a substantial portion of waste products (steel, aluminium etc for recycling) are sold to overseas markets including New Zealand and Asia. These have a greater potential for contamination.

Regular monitoring for Little Fire Ants should be conducted for the international sea port and airport areas, cargo holding facilities, cargo, and personal possessions of travelers. Also, regular monitoring of waste transfer and processing facilities should be conducted.

MONITORING METHODOLOGIES

There are many different monitoring methods for detecting the presence and relative abundance of Little Fire Ants. Each method has advantages and disadvantages, depending on the purpose of the survey. While it is difficult to assign a numeric estimate of confidence in any method, below are descriptions of the main methods in use today. Standard operating procedures for each method are found in the appendices.

Visual searching

Operators trained in visual searching methods and field identification of Little Fire Ants are able to quickly cover relatively large areas in detection surveys. Searchers visually check preferred nesting sites and foraging areas that are present on the site. This method is suitable for detecting well-established colonies of Little Fire Ants however, it requires that searchers have a higher level of training and knowledge than other methods. It is not a method suitable for detecting small or incipient colonies. However, it is a good method for inspecting commodities such as potted plants and produce.

Lure surveys

Although Little Fire Ants are primarily sugar feeders, they are consistently attracted to sources of lipids (fats) and proteins in their environment. An unconfirmed theory for this is that both lipids and proteins are limiting factors in colony development and often not available in sufficient quantities. Peanut butter is an attractive source of both protein and lipid to which Little Fire Ants recruit readily. Placing small amounts on a carrier such as a vial, popsicle stick or similar allows lures to be deployed systematically across a site. After a suitable exposure time these can be retrieved and examined for presence of the target species. Identification can be conducted in the field by trained searchers, or any suspect samples can be returned to a laboratory for further identification by an entomologist.

This method has several clear advantages. Searchers require a minimal level of training, the method is systematic and results are broadly comparable with surveys conducted elsewhere. Results can also be used to provide estimates of the severity of infestation by counting individual ants at each bait.

Intercept surveys

Standard sampling methods for ground-active invertebrates include intercept methods such as pitfall traps and sticky traps. A pitfall trap is comprised of a small vial or container buried in the ground with the top edge level with the soil surface. A small amount of preservative such as ethanol, soapy water or ethylene glycol is added to the vial and the trap is left open for days or even weeks. Crawling invertebrates such as ants accidentally fall into a trap of this type. Once retrieved, any insects can be identified by a trained taxonomist. Sticky traps work in a similar fashion. These are cards with an adhesive surface which are placed in locations where ants are likely to forage. After a suitable exposure time, the cards are retrieved and any insects caught by the adhesive surface can be identified.

Intercept traps usually have a longer exposure time than lures, and therefore will capture more insects. They have the advantage of being less dependent on variables such as time of day, temperature etc and are therefore more likely to detect incipient colonies that have small amounts of foraging workers. However, they are time-consuming to deploy and require at least two visits to the site. While more accurate, they are more costly in terms of time and travel.

Passive detection methods

The methods described previously are "active" methods and require operators to visit a site and conduct a survey. It is not economically possible or feasible to survey every site on Tahiti, so general survey and monitoring activities should target sites with the greatest probability of infestation. Passive methods do not require site visits and rely on the cooperation of the public or selected industries. Engaging the public or selected groups of people is often termed "public outreach". Activities that increase awareness of the Little Fire Ant problem, especially if they encourage residents to contact an appropriate department through a dedicated phone number, often result in detections of previously unknown infestations. Aside from general public awareness activities, several key groups should be targeted:

- Nursery and landscape industries – these industries are primary vectors for spread of this species
- Garden clubs and market vendors – people engaged in these activities are often in close contact with garden plants and other vectors.
- Waste management workers – residential waste can become infested by Little Fire Ants, and informed waste collectors may notice this and report new infestations.
- Tree trimmers and landscaping contractors – operators working in this industry are likely to experience Little Fire Ant stings as they visit sites to conduct their business
- Veterinarians – Little Fire Ants stings can cause tropical keratopathy or "Florida Spots". While this condition is not caused exclusively by Little Fire Ants, follow-up of any new cases may result in discovery of new infestations.

RECOMMENDATIONS

Spot eradication of small infested sites

The survey conducted by DIREN in 2010 identified 86 infested sites with a total area of 780 hectares. Over half of these sites are smaller than 1 hectare and 80% less than 5 hectares. These sites make up 1.9% and 5.2% of total infested land, but will grow disproportionally over the next 10 years to comprise 43.6% of total infested area (excluding new infestations). Eradicating these smaller infestations will require treatment of 55.5 hectares but reduce future infested area by 1,216 hectares (assuming 20 metre annual growth). Treatments should comprise a combination of granular baits applied to the ground and gel baits applied to vegetation.

Recommendation 1.
Eradication efforts should focus on eliminating small (<1 hectare) infestations and if resources permit, infestations sized 1-5 hectares.

Containment of larger infested sites

Larger sites will grow at a relatively slower natural rate than smaller infestations. Containment efforts should focus on these larger >5 hectare infested sites. The goal for containment is to reduce

the rate of natural spread in a cost effective manner. Regular treatment of the edges of these infestations, either with a residual pesticide or granular baits is the most efficient approach.

Recommendation 2:
Containment activities should focus on larger (>5 hectare) infested sites.

Estimating the rate of natural spread

The rate that Little Fire Ant colonies spread, once established, is an unknown factor. Knowledge of this factor will increase the accuracy of any growth estimates, and will greatly assist decicion makers.

Recommendation 3:
Further research is needed to quantify the rates of spread for Little Fire Ants on Tahiti.

Monitoring pathways and vectors

Jump dispersal, or the accidental re-location of Little Fire Ant colonies is a major factor in the local spread of Little Fire Ants, the pathways and vectors are well known from experience in other infested locations in the Pacific region.

Recommendation 4:
Known pathways and vectors for spread of Little Fire Ants on Tahiti should be monitored and risk minimization efforts should target these pathways.

Minimizing transfer to neighbor islands within French Polynesia

Currently only two (Tahiti and Moorea) of the 130 or so islands that make up French Polynesia have Little Fire Ants. Domestic quarantine activities (monitoring and inspection of risk items) will greatly reduce the risk of spread to neighbor islands.

Recommendation 5:
Resources should be allocated to enhanced domestic quarantine inspections for risk items being transported to neighbor islands.

Recommendation 6:
Domestic points of departure, especially the sea port and cargo handling facilities should be surveyed frequently to ensure these sites are free of Little Fire Ants

Minimizing international transfer

Although French Polynesia exports relatively few commodities with risk of infestation, these should be monitored to minimize risks of spread to other countries.

Recommendation 7:
International points of departure, especially the sea port, airport and cargo handling facilities should be surveyed frequently to ensure these sites are free of Little Fire Ants

Recommendation 8:
Resources should be made available for enhanced international out-bound quarantine activities to monitor and inspect cargo, personal possessions and empty shipping containers bound for international destinations.

Outreach as a component of monitoring activities

Outreach is a vital component of any pest management strategy. A good outreach strategy targeting residents, visitors and key industries can greatly assist in identifying new infestations and reduce the risks associated with the movement of known vectors.

Recommendation 9:
Resources should be allocated to the development and implementation of a targeted outreach strategy designed to identify new infestations and reduce the risks associated with known Little Fire Ant vectors.

APPENDIX 1: STANDARD OPERATING PROCEDURE - APPLICATION OF GRANULAR BAITS TO CONTROL LITTLE FIRE ANTS

PURPOSE AND SCOPE

This standard operating procedure describes recommended methods for treating Little Fire Ant (*Wasmannia auropunctata*) nesting on the ground or in vegetation under 1.5 metres in height.

INTRODUCTION

Little Fire Ants nest on the ground, around houses and other structures and in vegetation, including the canopy of mature trees. Treatment for control of colonies nesting on the ground or in low vegetation (less than 1.5 metres) is accomplished most easily with granular baits. For treatment of colonies nesting in trees and vegetation, please refer to the standard operating procedure for gel baits.

MATERIALS

- Granular ant bait (see below)
- Hand held or motorized bait spreader
- Nitrile or latex gloves
- Long pants, long sleeved shirt, shoes and socks (mandatory)[2]
- Dust mask and eye protection (if desired)

METHOD

The intent of treatment with granular baits is to deliver an even distribution of the bait over the soil surface at an approximate rate of 2 kilograms per hectare. Most, but not all, granular baits manufactured for control of Red Imported Fire Ants (*Solenopsis invicta*) are suitable for control of Little Fire Ants.

Granular baits are mostly manufactured using similar ingredients for the bait matrix with the active ingredient differing from brand to brand. The matrix is comprised of corn grits and vegetable oil. The oil is soaked into the grits resulting in light, fine granules 1mm – 3mm diameter. The product is usually a bright yellow color and has a faint odor of vegetable oil. Once the bait container has been opened, the unused product will degrade over approximately 3 months, eventually spoiling. Opened bait containers should be stored in a cool dry location. unopened containers more than two years old are likely to be spoiled also. Bait that is spoiled will have a rancid odor and should not be used.

[2] Some bait products may have additional safety equipment mandated on the product label.

Application

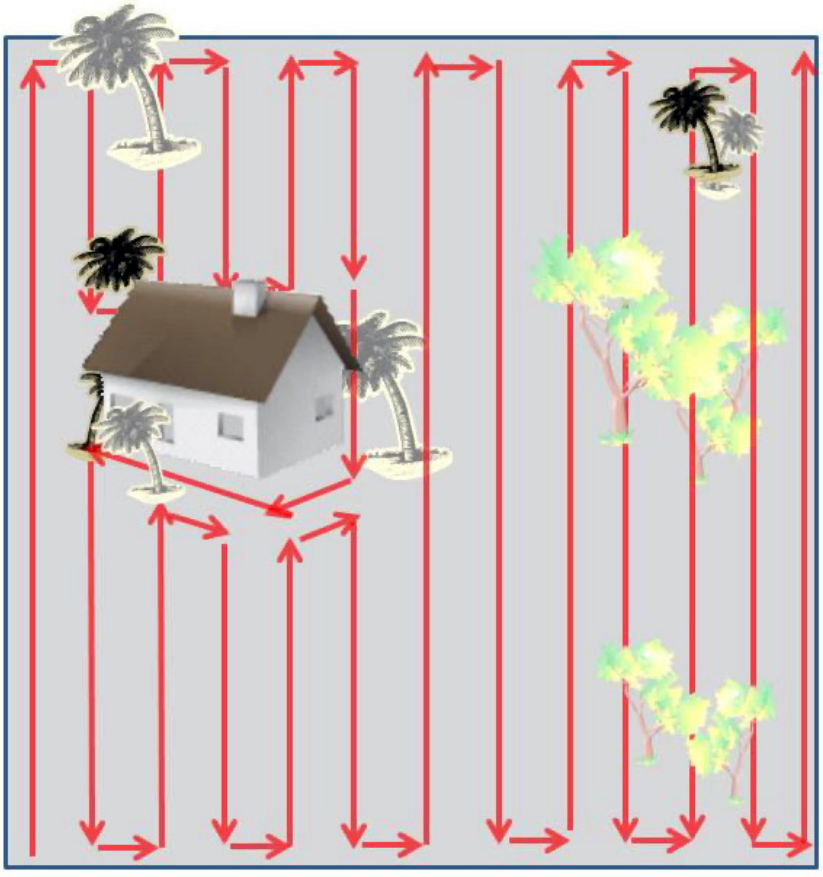
Two main application methods are used: hand-held spreaders and motorized blowers. There are also spreaders that can be attached to tractors or ATV vehicles for treatment of larger areas.

Hand-held spreaders

These are available at low cost from hardware and pesticide stores. They feature a hopper for holding the bait, a winding handle that agitates the bait and scatters it over the ground, and an adjustable aperture that is used to calibrate output. These spreaders are also used to scatter seeds and fertilizer.

Typical hand held bait spreader showing the winding handle (a), the aperture adjustment (b) and correct grip. Set the aperture at "1".

With the aperture set at "1" (see above) the operator winds the spreader handle at approximately 60 rpm while walking at 2-3 mph. The swath width thus created is approximately 4 yards. When applying the bait over the target area, an overlapping series of parallel swathes is recommended. This is accomplished by starting on one boundary of an infested site and proceeding 1 yard inside the boundary. Once the operator reaches the end of the treatment area, he or she takes 2-3 paces towards the untreated area and returns parallel to the original path, working around buildings and other obstacles (see below). Continuing this process, the designated area can be systematically covered. It is important that all ground is treated including spaces between buildings and corners of gardens. An additional sweep around buildings, garden edges and other structures is recommended. Rainfall within 12 hours of treatment will reduce effectiveness so plan to conduct treatment when rain is not expected for 12 hours.



Example of a treatment path taken by an operator treating around an urban structure.

Improving the agitator

Ant bait is light and fluffy. Often it does not feed through spreaders evenly, and two main alterations should be considered: The agitator is the orange plastic "T" shaped device in the bottom of the hopper. This can easily be pulled out. Wrap a small cable tie around the stem and tighten the tie as tightly as possible. Then cut it down so an inch or so is left sticking out. The cable tie should wrap around the stem in an anti-clockwise direction when viewed from above so when it is in the hopper, it is wrapped the way shown in the figures below. Cut the cable tie down to leave a one inch end after placing it onto the stem so it will be easier to tighten. This will assist the bait to flow more evenly.

Cable tie ready for placement (left) with agitator re-attached (right)

Holding the aperture adjuster open for long periods can cause discomfort and fatigue for operators. The trigger can be locked in place simply by inserting a self-tapping screw through the assembly while holding the aperture open at the desired setting. Usually #1 is sufficient, but a better position is half way between #1 and #2. Drill a small pilot hole and drive a self tapping screw through the assembly so the trigger remains open.

Screw holding the trigger permanently open.

Motorized blowers

Motorized blower-misters can be used to cover large areas quickly and offer several advantages:

- Blowers can project granular baits more than six metres
- An operator can cover much greater area in the same time, and
- Granules can be blown into areas that are not easily accessible

Their disadvantages include high purchase costs, a requirement for gasoline and specialized maintenance, additional weight and difficulty calibrating output. Several manufacturers produce these machines, with a common one being made by Maruyama.

A Maruyama MD155DX blower-mister

Choosing baits for control of Little Fire Ants

Many baits manufactured for control of Red Imported Fire Ants are effective against Little Fire Ants. However, some are not attractive to Little Fire Ants and these should not be used. Both the Hawai'i Ant Lab and Dr Arnold Hara of the University College of Tropical Agriculture and Human Resources have tested many baits available in USA. Together, their research shows that baits containing methoprene or pyriproxifen as the active ingredient are NOT effective against Little Fire Ants, while those containing hydramethylnon, indoxacarb and fipronil work best. Below is a table of ant bait formulations that are attractive to Little Fire Ants and therefore recommended. There may be other bait products available from other countries, however, use this as a guide for baits sourced from the United States.

Some product formulations suitable for control of Little Fire Ants.

Product brand	Manufacturer	Active ingredient	Concentration	EPA registration number
Amdro Block® Amdro Fire Ant Bait®	BASF	Hydramethylnon hydramethylnon	0.880%	73342-2
Probait®	Zoecon	hydramethylnon	0.730%	73342 -1-2724
Maxforce Complete® Maxforce Fire Ant Killer	Bayer	Hydramethylnon hydramethylnon	1.000% 1.000%	432-1265 432-1265
Advion fire ant bait®	Dupont	indoxacarb	0.045%	352-627
Maxforce FC Fire Ant Killer®[3]	Bayer	fipronil	0.00045%	71106-GA-001

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[3] This has not been tested against Little Fire Ants but should work very well.

APPENDIX 2: STANDARD OPERATING PROCEDURE - TREATMENT OF LITTLE FIRE ANTS WITH GEL BAITS

PURPOSE AND SCOPE

This standard operating procedure describes recommended methods for treating vegetation and structures within a designated outbreak of Little Fire Ant (*Wasmannia auropunctata*). Little Fire Ants nest on the ground and in vegetation. This means all vegetation needs to be treated in addition to ground treatment

MATERIALS

- Gel baits (see mixing instructions in separate operating procedure)
- ZEP brand spray bottle or good quality 2 gallon pump-up sprayer
- Nitrile or latex gloves
- Long pants, long sleeved shirt, shoes and socks
- Hat and eye protection

METHOD

The intent of treatment with gel baits is to ensure areas not adequately covered by granular baits are also treated. Little Fire Ants are like to nest in trees, vegetation and even the crowns of coconuts. Worker ants from these colonies do not forage great distances and may not always reach the ground-applied bait granules.

The gel bait is made mostly from water and vegetable oil. It is the texture of ketchup and sticks to vegetation when sprayed. The bait is easily applied to cracks, crevices, branches, vertical surfaces etc and it is therefore very suitable for use on trees, shrubs and buildings. The recommended application rate is 10kg per hectare depending on how much vegetation cover is present. Rainfall within 12 hours of treatment could reduce effectiveness, however, most of the gel baits will remain unless rainfall is very heavy.

Aim to produce spatters – small drops of bait between 5-10 mm in diameter, with at least one drop of bait every 30 centimetres.

Bait applied to a banana leaf. Some of the droplets are highlighted with arrows, and ants can be seen feeding on the bait.

Every tree, shrub, structure building within the treated area will need to be treated as follows:

Trees

Vegetation under 6 metres in height can be treated from the ground. Shoot 1-2 squirts onto every limb, branch junctions, hollows, areas with dead wood, areas where debris has collected and along branches. Large trees like coconuts may need to be climbed. Go as high as it is safe to do so and apply several shots into the crown of each coconut, in foot holds and hollows of the trunk. If Little Fire Ants are seen, place additional amounts of bait along foraging trails. The bait should be placed at approximately 1 meter intervals.

Bananas

Banana clumps are perfect habitat for Little Fire Ants. In infested areas, almost all the spaces between leaf axils and the stem will house a small colony. Spray bait in the areas of the stem where green or dying leaves are attached. Also spray the trash around the banana clump and place some bait along fallen or cut trunks.

Shrubs and small trees

Flowering plants, fruit bearing trees and small shrubs are often used by Little Fire Ants for food gathering. These are generally too fragile to climb but spray across these with an even coverage of "splatters". If a foraging trail is seen, follow it to the ground and/or to the nest and place some bait there also.

Buildings and structures

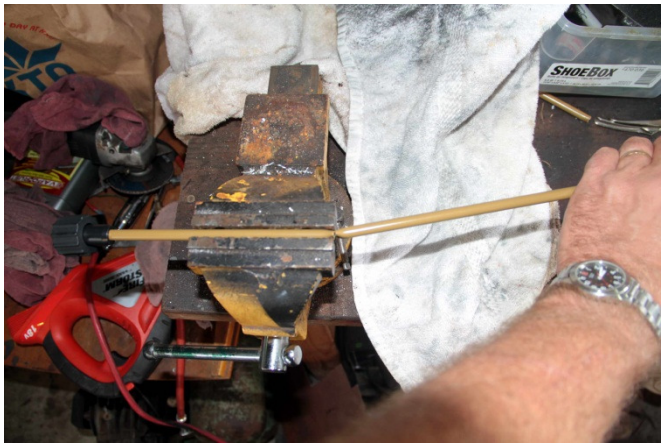
The bases of buildings and other structures are places where Little Fire Ants will be found. Work around each building, placing splatters of bait every 30 centimetres or so. The best spots to place baits are cracks crevices, hollows and places where foraging trails can be seen. If ants are seen foraging up walls or posts, place additional bait as high as can be safely reached. Always choose the shady side of posts to place bait as Little Fire Ants prefer to forage in shady locations.

Spray tools

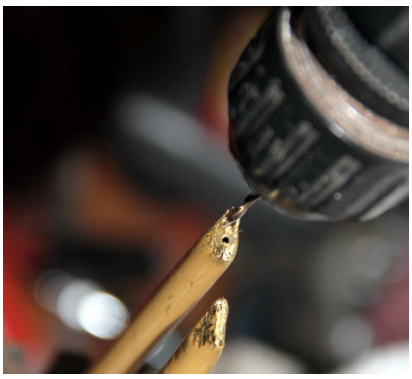
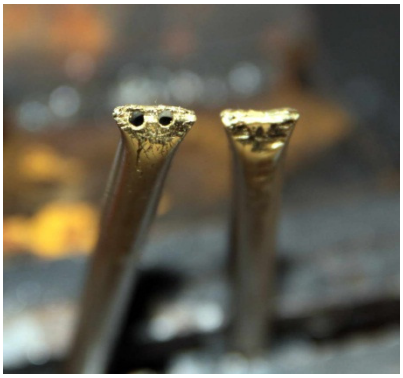
Gel baits can be sprayed with good quality squirt bottles (not the cheap kind). With these sprayer types, it is possible to shoot a thin stream of gel 6-6 metres. This is very handy for spraying vegetation or covering larger areas. As you depress the trigger, wave the wand or bottle in the air to form a shower of smaller droplets. ZEP brand spray bottles work very well, however, different brands may also be available. Often these sprayers have a small filter at the bottom of the inlet tube. This needs to be removed prior to use.

Good quality spray bottles

Another way to spray larger areas is with a pump-up sprayer. The cheaper types do not work very well. Search for a sturdy model with a wide (13mm) outlet hose that connects to the bottom of the sprayer. The pump assembly must also be good quality as high pressure is needed. The Redmax brand sprayers work well. Make sure the one you purchase has a metal wand or purchase a metal wand separately because it will need to be modified as follows:





First, hold the wand in a vice and bend until it snaps. This should leave it almost closed at the tip. Squeeze the tip almost closed with a pair of pliers or vice grips. You can drill two very narrow holes in the tip or leave it as it is. Either way, it will need more crimping to get the spray pattern right. Experiment with a batch of blank gel bait. You will need to adjust the tip until the bait squirts out in a nice thin stream. After carefully adjusting it, this should be able to spray around 5-6 metres, or even further.

Cleaning and maintenance

The gel baits used in this standard operating procedure is viscous and oily. Equipment must be thoroughly cleaned with an industrial degreaser to remove all residues inside the bottles, plungers and wands. If equipment is not carefully cleaned on a daily basis, any remaining oil will harden and block the wand, nozzles and other pump components. It is recommended to use a heavy-duty degreaser to thoroughly rinse the tank and spray through the nozzle until only clear soapy liquid emerges. Then rinse out old cleaner, re-fill with new detergent and allow some to be sprayed through the wand. Leave the degreaser standing in the hoses, tank and wand, and thoroughly rinse immediately before the next time the sprayer is used.

APPENDIX 3: STANDARD OPERATING PROCEDURE - MIXING GEL BAITS FOR CONTROL OF LITTLE FIRE ANTS

PURPOSE AND SCOPE

This standard operating procedure describes recommended methods for mixing a Gel bait for control of Little Fire Ant (*Wasmannia auropunctata*). Gel baits are easier to apply to vegetation where ants frequently nest and are less affected by rain than conventional baits

INTRODUCTION

The Little Fire Ant (*Wasmannia auropunctata*) is very difficult to control. They have many small colonies, each with many queens, and will have nests on the ground as well as in trees and other vegetation. All these small colonies are inter-connected and if some die out, they are re-populated by neighboring colonies. One management problem is that virtually all commercial baits consist of small granules. These are easy to spread on the ground, but can not be applied to vegetation. If only the colonies on the ground are treated, neighboring ants living in trees will quickly spread back to the ground. The bait granules are also inactivated by rainfall. Once the granules become soggy, they are no longer attractive to ants. Tahiti experiences regular and frequent rain. In some locations it is difficult to predict if it will rain on any given day.

Contrary to popular belief, ants do not eat solids - they only consume liquids. Granular baits are made from corn granules soaked with vegetable oil, and when a worker ant finds a bait granule, she sucks the oil out of the granule and leaves the rest behind. Ants can consume a gel bait far more easily than a granular product, so in theory, gels should be more effective than granules.

Baits in liquid or gel form do not have the same limitations as granular products. They can be applied to vegetation where they will stick to the leaves and branches and are not affected as quickly by rainfall. They are, however, a bit more difficult to apply compared with granular baits. Also, gel baits suitable for control of Little Fire Ants are not available commercially and need to be prepared before treatment can begin.

METHOD

Ingredients

1. Toxicant
2. Corn, safflower or similar vegetable oil
3. Water
4. Xanthan gum
5. Peanut butter (creamy)
6. Dye or coloring agent if desired

Mixing equipment

1. 20 litre plastic bucket with tight fitting lid
2. Electric or battery drill
3. Whisk or paint mixer
4. Measuring jugs
5. Scales
6. Chemical resistant apron or similar
7. Rubber gloves
8. Eye protection

Choice of toxicant

The following pesticides have been used experimentally in gel baits against Little Fire Ants[4]

Product name	Manufacturer	Active ingredient	Concentration in product	Amount **product** needed per kg bait
Provaunt® Avaunt®	Dupont	indoxacarb	300 g/kg (wettable powder)	6.0 grams
Termidor®	BASF	fipronil	100 g/kg (suspension concentrate)	0.5 grams
Tango®	Wellmark International	S-methoprene	49 g/kg (suspension concentrate)	51 grams
various	various	Boric acid	99.9 g/kg powder	20 grams

Vegetable oil

Most edible vegetable oils used in cooking appear to be suitable. It is easy to compare palatability of various oil options be presenting foraging Little Fire Ants with a choice of several types and recording which type attracts more ants.

Xanthan gum

Xanthan is an emulsifier and thickener used in cooking. Addition of this product is necessary to mix the oil and water in a way that does not cause the ingredients to separate before use. It also mixes the toxicant with the oil. Normal xanthan gum is a powder and can be difficult to mix with water. Hot (60-70° C) water will mix a little more readily. Bulk "rapid dispersal" xanthan gum is preferred and is much easier to mix. It is available from Philoutlet, email philoutlet@gmail.com or phone +1 312 733 0000. Normal xanthan is available elsewhere through health food stores and pharmacies.

Peanut butter

Any creamy or smooth variety is acceptable. The cheaper brands are best as they are already homogenized making them easier to mix.

Coloring

[4] Mixing and use of gel baits with these active ingredients may require approval from pesticide regulators in French Polynesia

It may be desirable to add food coloring or other edible dye to make it easier to observe where treatment has taken place. However, colorings may also stain structures, concrete and plants.

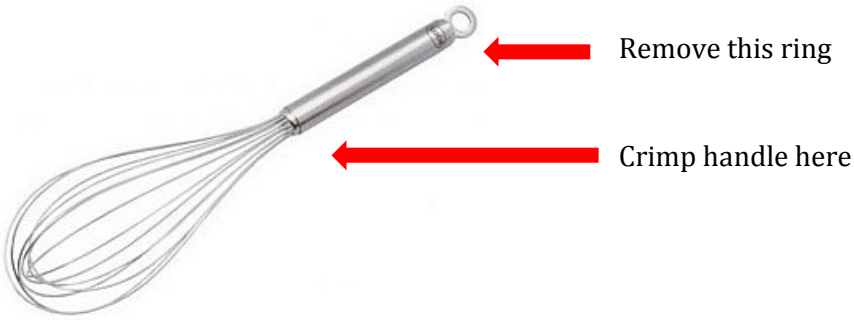
MIXING PROCEDURE

This method uses quantities sufficient to make 8 kilograms of gel bait. Make the bait mixture the afternoon before it is needed. The mixture will not keep fresh for more than 2-3 days.

- Add 4.8 litres of water and toxicant to the bucket.
- Mix with drill and whisk until thoroughly incorporated.
- Slowly add 64 grams of xanthan gum to the water while mixing. Make certain to add the xanthan powder slowly so that it does not form lumps. Continue to mix until a uniform jelly-like consistency is achieved.
- Add 2.8 kg oil and 240g peanut butter. Continue to mix until all the oil is combined with the water and a consistent color and texture is achieved.
- Sometimes small lumps form in the mixture despite best efforts to avoid them. In this case, leave the mixture overnight and mix again in the morning just prior to use.

Mixing devices

A battery or electric drill with a kitchen whisk or a paint mixer works best for mixing. The best type of drill is one with higher speed (RPM). Standard type paint mixers work well. Others prefer a kitchen whisk modified to fit into the drill chuck.



APPENDIX 4: STANDARD OPERATING PROCEDURE - SURVEILLANCE AND MONITORING METHODS FOR LITTLE FIRE ANTS

PURPOSE AND SCOPE

This standard operating procedure outlines procedures and specifications for detection, delimitation and quarantine inspection of commodities for *Wasmannia auropunctata* (Little Fire Ants).

INTRODUCTION

There are three main survey types: detection surveys, delimiting surveys and inspection for quarantine purposes. (The standard operating procedure for quarantine inspection can be found in a separate document). Each survey type has a different aim and the type of information that needs to be gathered is also different. In a detection survey, the objective is to determine if a site does, or does not, have an invasive ant. This is the easiest type of survey to conduct because all that is needed to confirm presence of the ant is a single specimen. In delimiting surveys, the purpose is to map the extent of an infestation. For quarantine detections, the goal is to determine if a commodity is infested with the target species.

Detection of ants can be accomplished by several means including visual searches, placement of long term trapping devices like pitfall traps or by placing lures of attractive food items within the survey area. The use of lures has several advantages for most survey types including low cost, ease of deployment and systematic nature. Briefly, lures that are attractive to the target species are deployed in a grid pattern over the search area, left exposed for sufficient time to be discovered by the target species, then collected and the specimens identified by a trained taxonomist.

Little Fire Ants are consistently attracted to peanut butter, so this makes a good lure. Depending on the nature of the survey, there are two recommended lure designs: a bait stick, or a vial. Preparation of these two lure types are detailed below.

Planning the survey

When planning the survey, work out the area to be covered and obtain a map or aerial image of the site. Google Earth is a good source of maps but most ports have port plans which can also be used. Contact site management at least a day before the survey to make sure you have permission to enter and arrange any passes etc that might be needed. In the case of an airport or sea port, try to pick a time when no planes are expected or ships are being loaded/unloaded. Also, plan to conduct the survey during clear weather when rain is not expected.

Lure preparation (bait stick method)

When field identification is possible, or only a few specimens are anticipated, surveys can be conducted with the bait stick method. This is the most rapid survey method but is least accurate if detailed information such as ant density is needed.

Materials

1. Disposable chopsticks (cut in half), disposable coffee stirrers or popsicle sticks
2. Bright-coloured spray paint
3. Smooth peanut butter
4. Zip-lock bags
5. Marking pen
6. GPS unit

Preparation and deployment

Paint both sides of the chopsticks or coffee stirrers with bright-coloured spray paint (this makes locating deployed sticks much easier). Once the paint has dried, grab a handful of sticks and dip them into the jar of peanut butter. Withdraw the sticks and place them into a zip-lock or other plastic bag with the peanut butter end inside the bag. Pull the sticks out one by one as needed, making sure to leave only a thin smear of peanut butter on each stick. Place the sticks in specified locations and at a spacing determined by the type of survey to be conducted.

Collection

Leave the lures in the field for 45-90 minutes and then retrieve them. If the collector can identify Little Fire Ants in the field, take a GPS waypoint at every location where Little Fire Ants are detected. If the samples are to be returned to the laboratory for identification, place the sticks individually into a zip-lock bag. Seal the bag, take a waypoint and write the waypoint number onto the bag. This way, positive samples can be mapped after they have been identified. Place samples in a freezer at -18^{o}C until ready for identification.

Lure preparation (vial method)

When all samples need to be returned to a laboratory for identification, the vial method may be the best alternative.

Materials

1. Clear plastic vials (30-60 CC) with lids.
2. Smooth peanut butter
3. Marking pen
4. GPS unit

Preparation and deployment

Its best to make only enough baits for a day's work. This way the baits will be fresh and attractive to ants (ants are not as interested in old baits). If possible, make them up the day before and store them in a refrigerator overnight.

Smear a thin layer of peanut butter onto the inside of each vial. Replace the caps and store prepared samples in a carry bag ready to take into the field. Place the vials in specified locations and at a spacing determined by the type of survey to be conducted.

Collection

Leave the vials in the field for 45-90 minutes and then retrieve them. Take a GPS waypoint at every location where a vial has been placed and write the waypoint number onto the vial. Make certain to keep one collector's vials separate from other collector's vials and ensure a record of waypoint numbers and GPS coordinates accompany the vials to the laboratory. This way, positive samples can be mapped after they have been identified. Place samples in a freezer at -18^{o}C until ready for identification.

Conducting the survey

The aim of the survey is to thoroughly sample the ants at the site. This is done by placing baits in a grid pattern over the entire area, placing protein baits and sugar baits alternately. The spacing between baits should be around 10 paces for general detection surveys. It is not important to have the grids at **exactly** this spacing as long as they are approximately correct. See Table 3 for survey specifications for different types of survey. Sections of the survey site that are all concrete or asphalt do not need to be sampled because few ants nest in these locations. Common ant habitats are listed in Table 4 and it is important that these are all sampled.

Bait vials should be collected 45-90 minutes after placement. It takes much less time to retrieve vials than it does to deploy them. As a guide, teams should place vials for one hour, then stop and retrieve the vials they have deployed in the order they were deployed. This way, the vials placed at the beginning will have been out for 60 minutes and the ones deployed last will have been exposed for about 45 minutes depending on ant species. Try to plan out a route that will take you back to the point where you started – it saves extra walking.

Surveillance should not occur during or after rain when the ground surface is still wet, or on windy days. Also no rain should fall between placement of bait traps and their retrieval. If rain is imminent, it is a good idea to stop deploying baits and retrieve the ones already out. If this is not possible, collect the baits one hour after the rain has stopped. If not many ants are at the baits, it might be necessary to re-survey the rain-affected section.

Bait vials should be placed in the shade where possible. Remember the sun might have moved by the time you collect the vials so place them carefully to avoid this. As a hint place your vials with the opening away from prevailing wind and angle the entrance slightly to the ground. This helps prevent vials filling with water and debris if you encounter a sudden down pour.

Any unusual ants (that look different from common established species) sighted while conducting surveillance should also be collected.

Table 3. specifications for surveys

	Detection survey	Delimiting Surveys	Commodity inspection
Methods	Vials	Vials or bait sticks	Bait sticks or visual
lure spacing	200-400/ha, 1 vial every 5-7m depending on available resources	100/ha, 1 vial every 10m. Once no ants detected, switch to 1 vial every 5 m at least 20m beyond the limits of detection	Visual inspection of 1% of commodity or bait sticks in 1-10% of pots for potted plants
Frequency/ length of program	Six monthly annually (2 rounds per year)	Immediately, if results negative follow up every six months for 2 years If results positive, treat and monitor out to delimiting boundary	As needed
Buffer zone	50m	20m	
Visual Surveillance	Very efficient in high density areas especially if surveyors are familiar with the ant. Habitat is 3 dimensional- in soil, intermediate canopy, vegetation, target bananas and coconut trees first. A good visual method is to use a smear of peanut butter on a bait stick.		

Table 4. list of common ant habitats

1.	Tree trunks (visual inspection and bait at base if appropriate)
2.	Flowers and trunks of trees
3.	Shrubs and poles
4.	Building edges and foundations
5.	Concrete slab edges
6.	Cracked concrete
7.	Disturbed sites
8.	Drains and culverts
9.	Electrical generators and fittings
10.	Exposed rocks
11.	Fence palings
12.	Grass areas

13.	Verges
14.	Hot water pipes and heaters
15.	Isolated weeds
16.	Logs
17.	Loose gravel
18.	Low vegetation (including grass)
19.	Plant pot bases
20.	Road margins
21.	Rubbish piles
22.	Soil
23.	Tree crotches and hollows
24.	Vertical surfaces
25.	Weed and plant re-growth
26.	Wooden structures
27.	Underneath stones or concrete rubble