NATIONAL
Fire Ant Eradication
PROGRAM

Red imported fire ants (*Solenopsis invicta*): animal health impacts

Information for veterinarians and animal professionals.

SLR Consulting Australia
National Fire Ant Eradication Program

Overview

Red imported fire ants (*Solenopsis invicta* or fire ants) are aggressive, invasive species that pose a serious risk to the health and welfare of domestic animals, livestock, and wildlife. The National Fire Ant Eradication Program (NFAEP) aims to eradicate them from Australia by 2032.

About fire ants

Fire ants can have severe negative impacts on animals. Research from the United States of America (USA) suggests fire ants most affect mammals, birds, and herpetofauna, with hatching and birthing periods being the most vulnerable for many species.[1,2,3] Fire ants have been implicated in the decline of several species in the USA[1] and, in Australia, are predicted to cause declines in native animal populations and negatively impact many agricultural sectors if not eradicated.[4] Multiple stings from venomous ants have caused death in pets, livestock, and wild animals in the USA, with fire ants considered the most dangerous.[3] They have also been reported invading beehives to feed on stored honey, larvae, and pupae – decimating colonies.[2] The stings are extremely painful and are described as feeling like being burned by fire, hence the common name.[5]

Because nests can be present but go unrecognised, broadscale treatment is necessary to achieve eradication.



Actual size
2–6 mm long

How veterinarians can help

- Identify and report signs of fire ant envenomation.
- Help clients understand the risks and appropriate first-aid responses.
- Encourage clients to report suspect fire ants, nests, and stings at **fireants.org.au/report**
- Stay informed about the NFAEP and fire ants at **fireants.org.au**
- Help clients understand the importance and safety of fire ant control.

Clinical signs of fire ant stings

Fire ants are attracted to mucous membranes, making the eyes, nose, and mouth high-risk targets.[6,7] In animals, stings may cause blindness, dermatitis, and other injuries. Most reports involve dogs, cats, pet birds, poultry, cattle, and horses.[6] Fire ants pose a significant threat to Australian native wildlife by disrupting ecosystems and preying on various species.[4] They are opportunistic omnivores that can impact all levels of the food chain – from invertebrates to vertebrates – and damage plants.[1,2] Their aggressive nature and ability to form large colonies allow them to outcompete native ants and other animals for resources, potentially leading to population declines and local extinctions.[1,2]

Classical clinical signs of fire ant envenomation include pain (described as a severe burning sensation lasting up to 2 hours), localised swelling, inflammation, pruritus, rash, and blistering – followed by the formation of 1 mm to 2 mm diameter sterile pseudo-pustules at undisturbed (i.e. non-scratched) bite sites within 6 to 24 hours.[6,7,8] Pseudo-pustules are caused by the venom's piperidine alkaloids, and their presence is the hallmark clinical sign of fire ant envenomation in humans.[9]

In experimentally envenomated dogs, initial gross lesions appeared at 15 minutes. By 6 hours, they consisted of bright erythematous pruritic papules with full thickness dermal necrosis and inflammation.[6]

Fire ant envenomation has also been associated with Florida spot keratopathy (FSK) and punctate keratopathy in humans (though causality has not been established).[10,11] FSK in dogs and cats is characterised by pinpoint to 5 mm diameter, round, bright white, fluorescein negative, anterior ocular, stromal lesions.[10] Fire ant-associated punctate keratopathy in humans resembles FSK, is persistent (lasting up to 26 months post-envenomation), and is unresponsive to topical antibiotic or corticosteroid treatment.[11]

In humans, fire ant mass arthropod assaults have been associated with acute rhabdomyolysis and secondary acute renal failure.[12] Experimental studies in rodents suggest fire ant venom may also cause seizures, haemolysis, and cardiopulmonary depression and/or arrest, although these outcomes have not yet been definitively recognised outside experimental settings.[13,14]

Neonatal foals may die as a result of fire ant mass arthropod assaults, whereas adult horses are unlikely to die from individual stings.[15] Equine laminitis and abortion are possible secondary complications, with laminitis potentially linked to immunological hyperreactivity or vascular disturbances in affected horses.[15,16]

Anaphylactic reactions have been reported in both humans and animals. Rare cases of eosinophilic fasciitis have also been documented in humans following fire ant envenomation.



Left to right: Lesions caused by fire ant sting on a dachshund; fire ant stings to the eyes can result in blindness; 1–2 mm diameter sterile pseudo-pustules can form in undisturbed areas; grazing cattle are at risk of fire ant mass assaults.

Animal welfare and production impacts

Fire ants pose a significant animal welfare risk and a potential cause of production losses. Animal welfare risks include:

- pain, reduced mobility, and feeding difficulties
- injuries to eyes, mucous membranes, limbs, and udders
- death in neonates or small animals in severe cases.

Production losses may include:

- reduced weight gain and milk production
- reproductive issues (e.g. abortion in horses)
- financial loss due to veterinary care, stock loss, and management costs
- industry disruption (e.g. beekeeping, poultry, turf, livestock, and fodder).

Fire ant venom apparatus and envenomation

Worker ants grip with their mandibles while stinging.[2,5,6] Each worker ant delivers approximately 0.66 nL of venom per sting – equivalent to about 3% of its total venom store, which ranges from 20 nL to 40 nL depending on the ant's size.[9,18] Venom is secreted by the venom gland and stored in the poison sac.[9] When used, it is ejected through the main duct of the stinger.[35] The sting of a fire ant is not barbed, meaning individual ants can sting multiple times using their relatively large venom reserve.[9]

Fire ants respond aggressively to threats to their nest or foraging trails, with worker ants releasing an alarm pheromone (2-ethyl-3, 6-dimethylpyrazine) from their mandibular glands.[19] This pheromone triggers swarming behaviour and mass assaults by worker ants.[20,21]

When fire ant mounds are disturbed, worker ants rush to the surface and climb onto any vertical objects, such as grass blades, sticks, or legs of people or animals near the nest.[21] Fire ants can begin stinging within 10 to 20 seconds of climbing onto a victim.[21] Envenomation is common when an ant is caught in clothing or a skin fold.[21] Fire ants are also highly mobile (crawling at approximately 1.6 cm per second), allowing them to leave 'trails' of stings on affected humans and animals.[21]

Fire ant venom

Fire ant venom has been chemically well-characterised. Approximately 95% of the venom components consist of cytotoxic, haemolytic, necrotising, and cardio-depressant piperidine alkaloids.[13,14] These alkaloids are also seizurogenic, can induce respiratory arrest, and affect the vascular system. The venoms also contain around 46 different proteins, 4 of which are well-known and understood to be potent human allergens. Sensitivity to envenomation increases with age and repeated exposure.[6]

Risk factors

Fire ant nests are not always visually obvious, particularly those of young colonies[22,23] and during warmer months when mound-building activity decreases.[65,22] Individual fire ant colonies can contain hundreds of thousands of workers[22,24] and can reach nest densities of thousands of nests per ha.[24] Fire ants prefer disturbed environments and are closely associated with human activity and communities, increasing the likelihood of encounters with companion animals.[20]

Due to the complex subterranean structure of fire ant nests,[25] smaller nests or colonies formed under rocks, wood, or other ground debris can be difficult for animals to avoid, as there may be no obvious mound structure to indicate colony presence. Therefore, in areas with high nest densities, contact with mounds may be unavoidable.

Fire ant colonies may also migrate across the ground surface to relocate to more favourable microhabitats, such as during dry conditions or in response to physical disturbance.[26] Ants in migrating or displaced colonies (e.g. during flood events) are highly defensive and should be avoided.[27] This is especially true during flooding, as fire ant workers have been observed to increase their defensive behaviour and deliver larger venom doses when disturbed during colony rafting.[27]

Data collected from a 1994 survey of veterinarians in Texas confirmed very young, very old, incapacitated, and confined animals – with reduced ability to escape – are at higher risk of mortality.[7]

Diagnosis and diagnostics

Apart from collecting ants for identification and identifying fire ant nests, there are no specific available diagnostic tests or procedures for fire ant envenomation. Diagnosis is more commonly based on the available case history, known fire ant presence, clinical signs, clinical examination findings, and disease progression (e.g. the progression of skin lesions from papule to blister to pseudo-pustule).

Fire ant nests look like mounds or flat patches of loose soil and do not have clear entry or exit holes. Worker ants are small, ranging in size from 2 mm to 6 mm within the same nest, and are copper-brown with a darker abdomen.

Call **132 ANT** (13 22 68) to report the suspected stings. In addition, if a nest has been identified, photograph it and submit the images at **fireants.org.au/report**

Differential diagnosis

Important **differential diagnoses** include:[43]

- **Other insect bites and stings** (particularly other Hymenoptera stings). Notably, fire ant stings are unique in that they cause a burning sensation followed by the formation of a pseudo-pustule at the sting site.
- **Cellulitis.** Most fire ant bites will present with local erythema, so differentiating them from cellulitis is important.
- **Folliculitis and pseudo-folliculitis barbae.** These conditions are not typically accompanied by intense pain and pseudo-pustule formation.
- **Urticaria.** May result from reactions to shampoos, medications, toxic plants, or chemicals.

- **Abscesses.** Are usually deeper and more localised than the typical fire ant bite blister.
- **Flea allergy dermatitis (FAD).** Typically, highly pruritic, with evidence of hair loss and self-mutilation in the 'flea triangle' (from the middle of the back to the tail base and down the rear legs). Secondary infection may result in skin pustule and abscess formation.
- **Pyoderma and/or impetigo in puppies.** These conditions can closely resemble fire-ant pseudo pustules. Hallmark lesions include pus-filled blisters, crusts, and scabs on hairless areas of the abdomen and sparsely haired regions such as the axillae and inguinal regions. Lesions may be pruritic, involve hair loss, and typically appear around puberty. They are often caused by coagulase-positive staphylococci and associated with poor hygiene or historical viral infections such as canine distemper. These cases typically lack a history of sudden pain. If in doubt, pustule contents can be cultured for coagulase-positive staphylococci, as fire ant pseudo-pustules are usually sterile (unless interfered with).
- **Demodicosis and early-stage scabies.** These can be tested using a skin scraping and microscopy. These cases typically lack a history of sudden pain.
- **Dermatophytosis.** Diagnosed through fungal culture and skin cytology. These cases typically lack a history of sudden pain.
- **Pemphigus foliaceus.** These cases typically lack a history of sudden pain. If in doubt a skin biopsy can be performed.
- **Lupus-like reactions.** These cases typically lack a history of sudden pain. If in doubt, a skin biopsy can be performed.

Veterinary first aid

The following initial veterinary first aid actions are recommended (in order of priority):

1. First responders should avoid being stung.
2. Use appropriate PPE or take suitable measures to prevent fire ant envenomation. Recommended PPE includes long-sleeved shirts, long pants (tucked into socks), close-toed shoes, and long gloves (thick nitrile or dishwashing gloves).[41] The effectiveness of over-the-counter insect repellents available in Australia is unknown; however, a personal insect repellent product containing DEET is recommended. Persons interacting with live fire ants should periodically check their body – particularly their hands – and remove any visible ants.
3. If the affected animal(s) are able to move, provide an escape route that avoids direct contact between first responders and the ants.
4. Fire ants use their mandibles to anchor themselves before stinging and may attach tightly to skin, clothing, or hair. They cannot be washed off, and attempting to do so may agitate the ants and lead to further stings.
5. The best method of removal is to briskly rub the ants off using a gloved hand, cloth, long-handled soft brush, or fine toothed comb.[40] Any items (e.g. cloths, brushes etc.) used to remove fire ants should be sprayed with a fast acting domestic insecticide (e.g. a pyrethroid-based product) and washed in soapy water to remove any remaining ants.

6. Do not apply household insecticides directly to affected animals or humans.
7. After all ants have been removed, cold packs or compresses may help reduce pain and inflammation. Take care to avoid hypothermia, especially in smaller animals.
8. Minimise licking and/or scratching of the bite sites.
9. Closely observe the animal and initiate further treatment if needed – particularly if multiple bites are present, if significant pain occurs, or if any concerning clinical signs develop.

Veterinary treatment

Treatment is largely supportive and may involve the use of topical and/or systemic glucocorticoids, non-sedating second-generation antihistamines (including topical antihistamines), and pain relief. Antibiotics may rarely be required if secondary infection develops.

Topical steroids and antihistamines do not alter the course of fire-ant bite pseudo-pustule formation.[11,21] However, their use may reduce pain, discomfort, and the tendency of the animal to exacerbate skin lesions through licking, chewing, and other self-mutilating behaviours.

Importantly, affected animals should be monitored for up to 72 hours following envenomation due to the risk of anaphylaxis.[7] Based on human data, repeated incidents of fire ant envenomation may increase the severity of subsequent reactions and the risk of anaphylaxis.[6]

Prognosis

For simple, uncomplicated, mild cases, the prognosis is generally good, and most cases resolve within a few days with minimal treatment. However, secondary infection and scarring can occur. The occurrence of anaphylaxis or other severe allergic reactions to fire ant venom carries a more guarded prognosis.

Prevention

The most effective method of prevention is to reduce the likelihood of domestic animals coming into contact with fire ants or their nests. This requires early detection. It is important to regularly check animal yards, bedding, and feed for fire ants, and to monitor animals after outdoor activity.

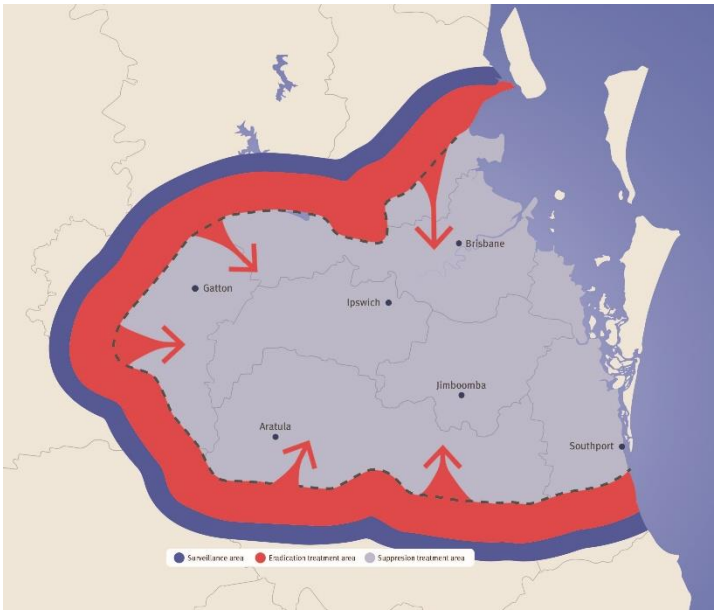
Veterinarians and clients should familiarise themselves with the appearance of fire ants and nests at **fireants.org.au/appearance**

Encourage clients to report suspect ants, nests, or stings at **fireants.org.au/report**

Eradication of fire ants

The NFAEP is delivering the world's largest fire ant eradication effort, using an *outside-in* approach):

- **Surveillance area (dark blue band on map):** for 5 years after an area has been treated, the NFAEP monitors it for any signs of fire ants through on-ground inspections and aerial surveillance.
- **Eradication treatment area (red band on map):** the NFAEP applies multiple rounds of treatments over several years, followed by 5 years of surveillance.
- **Suppression treatment area (light blue area on map):** government agencies, primary producers, property owners, and tenants can self-treat fire ants to reduce populations in high-density areas while awaiting future eradication treatment.



- **Outlier detections:** when fire ants are found outside the NFAEP containment area, an urgent response is activated. Fire ants and nests are destroyed, active surveillance begins, and tracing activities are undertaken, including genetic analysis to determine links to known fire ant populations. Engagement teams also work to raise awareness in the affected area.
- **Human assisted movement** is the greatest risk for fire ant spread. Veterinarians and animal professionals working with livestock producers should be aware of:
  - materials that can carry fire ants (**fireants.org.au/treat/business/materials**)
  - fire ant biosecurity zones (**fireants.org.au/stop/biosecurity-zones**).

Fire ant treatment products

Summary for clients

- The NFAEP uses fire ant treatment products and application techniques approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA) under permit. As part of the permit approval process, the APVMA specifically evaluates the safety and use of the active constituents and products used by the NFAEP.
- The risks associated with fire ant treatment are minimal, especially when compared to the significant threats fire ants pose to human and animal health, the environment, economy, and our way of life.
- The treatment products used for fire ant eradication are granular products made of defatted corn grits soaked in soybean oil containing an insect growth regulator (IGR). The NFAEP uses products containing the IGRs pyriproxyfen and S-methoprene, which target the queen and juvenile stages within the fire ant colony. These IGRs are chosen for their proven efficacy and safety.

- The treatment products are formulated to appeal to ants with a preference for oily, protein-rich diets. The soybean oil acts as an attractant, drawing in foraging ants that carry the corn grit granules back to the colony. Once inside, the ants consume the oil, and the active ingredients spread through the colony via trophallaxis – the process where food is passed from ant to ant. The IGRs prevent the queen from producing viable offspring and prevent juvenile life history stages from successfully reaching adulthood. As the adult workers age and die, the colony loses the ability to feed and care for itself, leading to collapse. Because the effects of IGRs wear off over time, repeated treatments are required to ensure colony elimination.
- The corn grit granules are small enough for fire ants to carry and also sink low into grass. Any uncollected granules degrade within days.
- Animals would only become sick if they consumed a large quantity of granules all at once – an unlikely scenario unless they had access to improperly stored bulk treatment product. The NFAEP follows strict storage protocols to prevent this.
- The eradication treatment area is defined based on the risk of natural spread from the outermost known nests. While most new nests form within 500 m to 2 km of a parent colony after a mating flight, in rare cases, nests have been found up to 5 km away. Newly established nests may take up to 6 months to become visually detectable and can be difficult to detect at low density.
- Treating every property within the eradication treatment area is critical to achieving the eradication goal. Broadscale IGR treatment is the only method capable of eliminating all nests – including those without visible mounds. The NFAEP must treat all properties within the eradication treatment area up to 6 times over 2 years, even if fire ants are not immediately visible.
- Due to the timing between applications, the pharmacokinetics of IGRs in animals, and the way these products behave in the environment, effects associated with repeated exposures (including reproductive effects) are unlikely to eventuate.
- Pyriproxyfen and S-methoprene do not biomagnify or bioaccumulate in terrestrial environments.
- Fipronil is only used for direct nest injection (DNI) to treat visible fire ant nests where there is a risk to public or animal safety or when rapid nest destruction is required. It is never used for broadscale treatment. Fipronil is applied at very low concentrations (25 mL to 100 L of water) compared to its use for termite control (typically 600 mL to 100 L of water).
- If you have clients in the suppression treatment area who are self-treating fire ants and nests, please encourage them to report any detections to the NFAEP and to always follow label directions.

Visit **fireants.org.au/treat/treatment-types** for more information.

Eradication treatment product formulation

Fire ant eradication treatment consists of small pieces of corn grit soaked in soybean oil with a small amount of an IGR. The active ingredients used are approved by the APVMA and are safe for humans, animals, and the environment when used as directed.

Eradication treatment active ingredients

Product	Active ingredient	Mode of action	Toxicity
Distance	Pyriproxyfen (5 g/kg)	IGR: Inhibits insect reproduction and development	Very low
Engage	S-methoprene (5 g/kg)	IGR: Inhibits insect reproduction and development	Very low

The NFAEP applies these eradication treatment products to properties within the eradication treatment area. These IGRs are widely used in veterinary medicine (e.g. flea/tick control). S-methoprene is preferred near water due to lower risk to aquatic environments.

Fire ant treatment product application rate

- Insect growth regulators (pyriproxyfen and S-methoprene) are applied at a maximum of 2 kg of pyriproxyfen/ha (0.2 g of pyriproxyfen/m^2).
- Each grain of corn grit (between 1 mm and 3 mm) settles deep in grass, making ingestion by animals unlikely.

Animal health risk assessment for fire ant treatment products and their use in fire ant eradication

Pyriproxyfen

Based on studies in laboratory dogs, no deaths occurred following oral dosing of up to 5000 mg/kg body weight. The only adverse effect observed at this dosage was occasional vomiting within the first 24 hours[28] Given the concentration of pyriproxyfen in the corn grit treatment product is 5000 mg/kg, this would be equivalent to a 1 kg dog consuming 1 kg of the treatment product all at once or ingesting the entire amount applied to 0.5 ha in a single instance – an extremely unlikely scenario. This is especially improbable given that the corn grit granules typically settle deep within grass.

In laboratory rodents, deaths were reported following a dose of 2000 mg/kg body weight, preceded by clinical signs such as reduced motor activity, ataxia, and abnormal breathing.[28] This is equivalent to a 1 kg animal consuming 0.4 kg of the treatment product all at once, or ingesting all the product applied to an area of 0.2 ha in a single instance – again, extremely unlikely due to the product's characteristics.

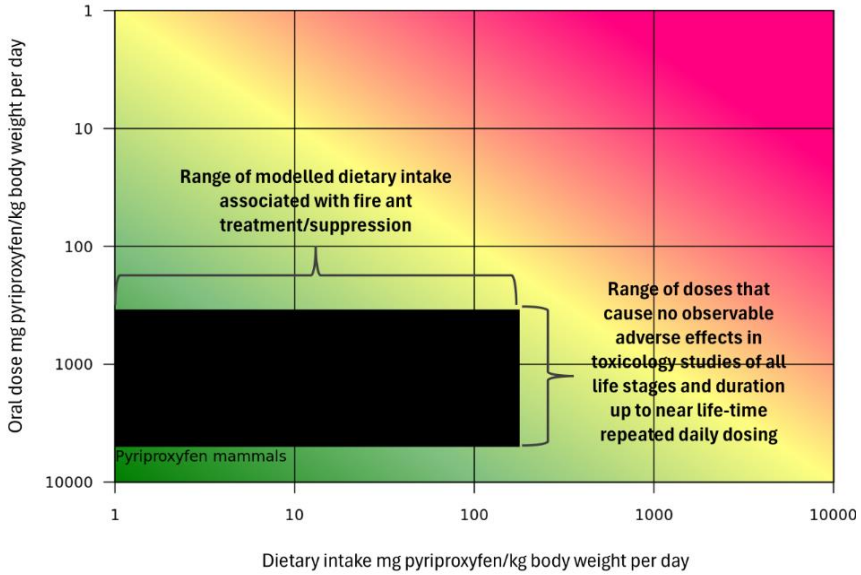
Due to its low toxicity, deaths in birds resulting from the use of pyriproxyfen in eradication treatments are also considered extremely unlikely (see modelling below).

Because of the long intervals between pyriproxyfen applications, its pharmacokinetics in animals, and its environmental behaviour, adverse effects from repeated exposure – including impacts on reproduction and fertility – are unlikely to occur.

Pyriproxyfen does not biomagnify or bioaccumulate in the terrestrial environment.[29,30,31]

Further toxicology studies in mammals: an extensive toxicology database (see list at end of this document) is available for pyriproxyfen, covering all phases of the mammalian life cycle, including multigenerational studies. Exposure modelling demonstrates the risk associated with pyriproxyfen use in fire ant treatments – from acute (single) exposure to near-life time daily exposure, including multigenerational exposure – is low and acceptable (graphically displayed in Figure 2). Even at levels far exceeding those encountered during fire ant treatment, serious adverse effects in wild or domestic mammals are unlikely to occur.

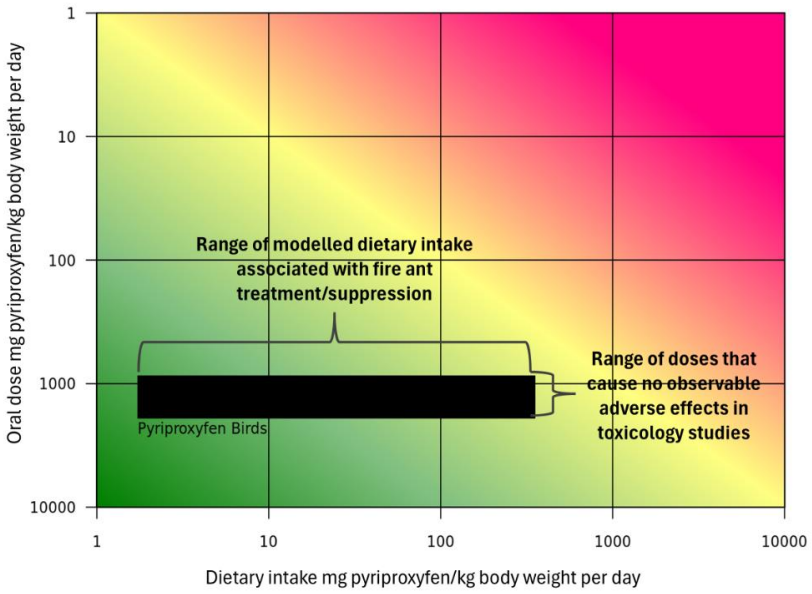
Figure 2: Risks associated with pyriproxyfen used for fire ant treatment/suppression to mammals



The rectangle formed by the range of doses that cause no observable adverse effects in the toxicology database (Y axis) and the range of estimated exposures associated with pyriproxyfen used for fire ant treatment/suppression (X axis) lies in the green (acceptable) zone of the plot indicating a low (acceptable) risk.

Toxicology studies in birds: a sufficient avian toxicology database is available for pyriproxyfen. Exposure modelling demonstrates the risk associated with pyriproxyfen use for fire ant treatment or suppression is low and acceptable (graphically displayed in Figure 3). The risk to birds, including wild and domestic birds, is low and acceptable. Serious adverse effects in birds are unlikely to occur following the application of pyriproxyfen to treat fire ants.

Figure 3: Risks associated with pyriproxyfen used for fire ant treatment/suppression to birds



The rectangle formed by the range of doses that cause no observable adverse effects in the toxicology database (Y axis) and the range of estimated exposures associated with pyriproxyfen used for fire ant treatment / suppression (X axis) lies in the green (acceptable) zone of the plot indicating a low (acceptable) risk.

S-methoprene

Based on studies in laboratory dogs, no deaths or adverse clinical signs occurred following oral dosing at 5000 mg/kg body weight.[32] Given the concentration of S-methoprene in the corn grit treatment product is 5000 mg/kg product, this would be equivalent to a 1 kg dog consuming 1 kg of the treatment product all at once or ingesting the entire amount applied to 0.5 hectares at a single instance – an extremely unlikely scenario. This is especially improbable given that the corn grit granules typically settle deep within grass. In the unlikely event this did occur, no clinical signs would be expected.

In laboratory rodents, no deaths occurred following oral dosing at an extremely high dose of 24000 mg/kg body weight.[32]

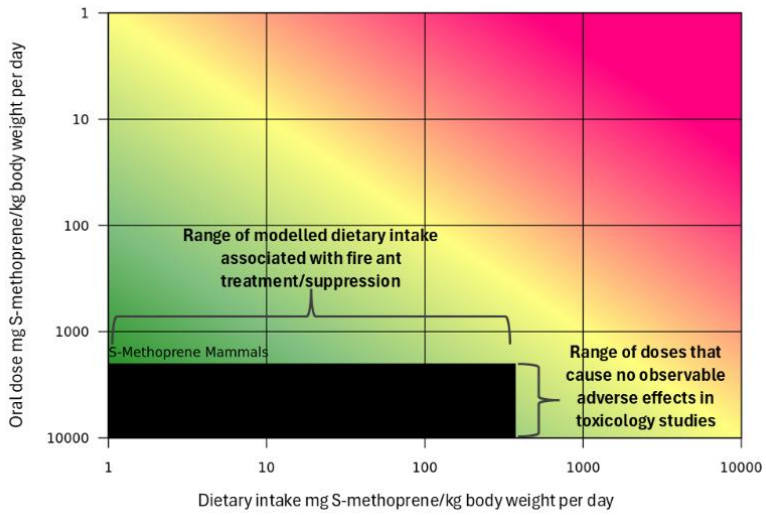
Due to its low toxicity, deaths in birds resulting from the use of S-methoprene in eradication treatments are also considered extremely unlikely (see modelling below).

Because of the long intervals between S-methoprene applications, its pharmacokinetics in animals, and its environmental behaviour, adverse effects from repeated exposures – including impacts on reproduction and fertility – are unlikely to occur.

S-methoprene does not biomagnify or bioaccumulate in the terrestrial environment.[33,34,35]

Further toxicology studies in mammals: an extensive toxicology database (see list at end of this document) is available for S-methoprene, covering all phases of the mammalian life cycle, including multigenerational studies. Exposure modelling demonstrates the risk associated with S-methoprene use in fire ant treatments – from acute (single) exposure to near-life time daily exposure, including multigenerational exposure – is low and acceptable (graphically displayed in Figure 4). Even at levels far exceeding those encountered during fire ant treatment, serious adverse effects in wild or domestic mammals are unlikely to occur.

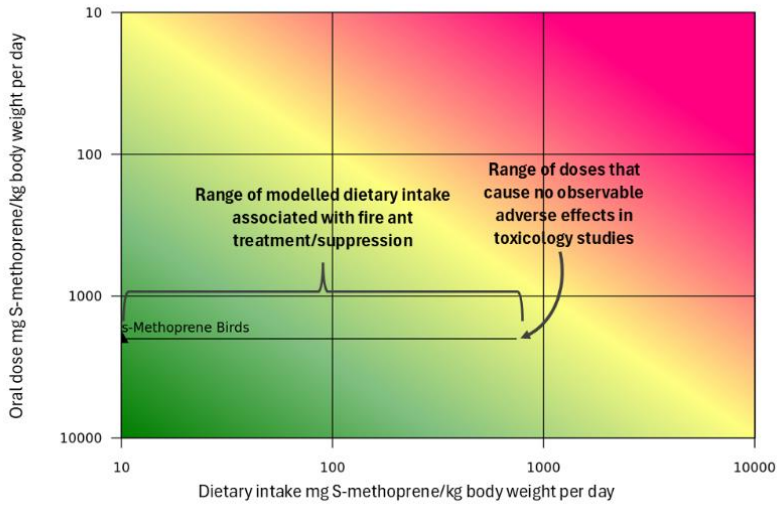
Figure 4: Risks associated with S-methoprene used for fire ant treatment/suppression to mammals



The rectangle formed by the range of doses that cause no observable adverse effects in the toxicology database (Y axis) and the range of estimated exposures associated with S-methoprene use for fire ant treatment / suppression (X axis) lies in the green (acceptable) zone of the plot indicating a low (acceptable) risk.

Toxicology studies in birds: a sufficient avian toxicology database is available (see the end of this document) for S-methoprene. Exposure modelling demonstrates the risk associated with S-methoprene use for fire ant treatment or suppression is low and acceptable (graphically displayed in Figure 5). The risk to birds, including wild and domestic birds, is considered low and acceptable. Serious adverse effects in birds are unlikely to occur following the application of S-methoprene to treat fire ants.

Figure 5: Risks associated with S-methoprene used for fire ant treatment/suppression to birds



The thin rectangle formed by the range of doses that cause no observable adverse effects in the toxicology database (Y axis) and the range of estimated exposures associated with S-methoprene used for fire ant treatment/suppression (X axis) lies in the green (acceptable) zone of the plot indicating a low (acceptable) risk.

The NFAEP is committed to human, animal, and environmental safety and adheres to all requirements of the APVMA.

Database records accessed for toxicological modelling

The underlying data for no observed adverse effect levels can be obtained from the publicly available WHO/FAO JMPR monographs.

The modelling used to derive the predicted exposure levels are publicly available from US EPA.

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