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Efficacy of Traps in Ant Management

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ABSTRACT

Background: Ants serve as serious pests of households as well as crop fields. Ants as eusocial insects exhibit complex forms of chemical communication which makes their management difficult. This study evaluates the efficacy of different traps for ant control under laboratory condition.

Methods: An experiment on ant (*Meranoplus bicolor*) mortality was conducted in 2022 at the College of Agriculture, Vellayani, using a completely randomised design with seven traps replicated thrice. Ten ants were used per replication and were exposed to toxicant and attractant mixtures in containers for 24 hours. Ants were then transferred to containers with moist soil and sugar solution and monitored for 20 days to record mortality. Per cent mortality was calculated using Abbott's formula.

Result: The results of the study showed that rapid and absolute mortality was obtained with fipronil 0.3 GR, rava and sugar (0.3:1:1), whereas, boric acid (0.5%) and sugar (25%) and thiamethoxam(0.0001%) and sugar (25%) exhibited delayed mortality of 65.11 and 52.85 per cent respectively on the nineteenth day after the traps were placed.

Key words: *Beauveria bassiana*, Boric acid, Fipronil, Management of ants, *Meranoplus bicolor,* Mortality, Pest sugar solution, Thiamethoxam, Toxicity.

INTRODUCTION

Though the positive roles of ants as critical ecosystem engineers has been much recognized, studies on their damaging roles in agriculture has gained least momentum. Several ant species can harm agricultural crops while foraging and may also pose risks to human activities. They march into houses in search of sugar, flour *etc*., or attack beehives, leading to hive abandonment (Naik, 1984). They have also grown to the status of serious crop pests as well, causing both above ground and below ground damages. They also serve as indirect pests of crop plants through their association with sucking pests. Ants carry away seeds sown in the field, nursery beds and from godowns and dwellings (Reddy and Puttaswamy,1984).

On a wider scale, pest management is generally achieved with insecticide spray (Klotz *et al.,* 2002), however in ant control this approach limits to elimination of foraging workers alone (Knight and Rust, 1990). Use of toxic bait, is generally regarded as the most efficient and successful strategy for controlling multiple colonies of destructive ant species (Williams, 1993). Ants readily gather the bait and carry them back to the nest. The food mixed with insecticide which is consumed by foraging workers is passed on to the other members of the colony *via* trophallaxis (Lee, 2000). Toxic baits are designed to kill the brood and eliminate the queen, ultimately destroying the entire colony.

In this context, a study was conducted to test the efficacy of different traps for the management of pest ants using shield ants, *Meranoplus bicolor* Guerin-Meneville as the test ant under laboratory conditions.

MATERIALS AND METHODS

An experiment on ant mortality was conducted in Department of Entomology, College of Agricultre, Vellayani in 2022. Ants were released into containers with the toxicant and the bait to assess the efficacy of the traps (treatments). The ant species selected for the study was *M. bicolor.* There were seven treatments/ traps, each replicated thrice.

Treatments (Traps) used in the experiment:

T1- Baking soda and sugar (1:1).
T2- Soap and vinegar (1:1).
T3- Boric acid (0.5%) and sugar (25%).
T4- Thiamethoxam 25 WG (0.0001%) and sugar (25%).
T5- Fipronil 0.3 GR, rava and sugar (0.3:1:1).
T6- Talc based formulation of *Beauveria bassiana* (NBAIR Bb5a) and sugar (1:2).
T7- Sugar solution (25%).

Ten shield ants (*M. bicolor*) were introduced into plastic containers housing the traps. The liquid traps were prepared by soaking cotton pads in the solution carrying the toxicant and the attractant. In the case of traps employing solid baits, ten grams of the toxicant: attractant mixture was placed in thin polythene strips in the container. Cotton bolls soaked in water was placed in the containers to maintain the humidity. Ants were exposed to traps for 24 hours and later transferred to a separate container carrying

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moist soil collected from areas free of chemical application. Ants were maintained in the containers carrying moist soil along with cotton bolls soaked in water and sugar solution (25%) respectively for upto 20 days to record the mortality of the ants previously exposed to traps. Counts of live ants were taken on alternate days upto 20 days and percentage mortality was determined as shown in Table 1. Abbots formula was used to find the corrected ant mortality (Nyamukondiwa, 2008).

$$\text{Corrected mortality (\%)} = \frac{\text{1- population after treatment}}{\text{population in control}} \times 100$$

The corrected mortality data recorded was analyzed using the completely randomized design (CRD) in the WASP software.

RESULTS AND DISCUSSION

In the laboratory assessment on efficacy of the traps based on ant mortality, the highest mortality rate was observed in T5 (fipronil 0.3 GR, rava and sugar (0.3:1:1)), followed by T3 (boric acid (0.5%) and sugar (25%) and T4 (Thiamethoxam 25 WG (0.0001%) and sugar (25%), which were statistically comparable. These were followed by T2 (soap and vinegar), T1 (baking soda and sugar (1:1) and T6 (talc based formulation of *B. bassiana* and sugar (1:2). Accordingly, the average number of ants died in each trap on day 19 were 1.38, 1.43, 6.51, 5.29, 10 and 1.95 respectively.

Cent per cent mortality was recorded in [(fipronil, rava and sugar (0.3:1:1)] 24 hours after placement of traps. The insecticide, fipronil which belongs to the group phenyl pyrazoles, exerts its effect on the chloride channels blocking the activation of GABA (Akhtar *et al.,* 2021; IRAC, 2022). It has contact and stomach action and achieves control of a wide range of insect pests, however the environmental and human health implications of fipronil is a matter of concern (Tingle *et al.,* 2003). Though fipronil based trap has recorded the highest ant mortality, its possible threats to human and animal health cannot be neglected. High risk and toxicity of fipronil was studied by scientists in water, soil and food samples. Toxicity to bees also has been reported. Due to high toxicity, countries like USA, France, Uruguay restricted or prohibited the usage of fipronil and it is permitted for seed treatment alone in China (GOMAC, 2008).

Against this backdrop, the use of other traps with least toxicity and greater efficiency would be more advisable in households and homesteads as there are chances of insecticide contamination in foods as ants are pests of nuisance at homes as well.

Following T6, greater ant mortality was recorded in T3 (boric acid 0.5% and sugar 25%) and T4 [thiamethoxam (0.0001%) and sugar (25%)] which were significantly on par on the nineteenth day after placement. The traps T3 and T4 showed a gradual increase in ant mortality indicating delayed toxicity of the active ingredient. To effectively manage ant populations with baits, the toxicant should have delayed action, be easily transferable between

Table 1: Mortality (%) of meranoplus bicolour in various traps under laboratory condition.

Treatments/baits	Mortality (%) DAP									
	1	3	5	7	9	11	13	15	17	19
T1- Sugar +baking soda (1:1)	5.90	6.11	7.92	12.52	12.52	7.92	12.18	12.18	13.78	13.78
	(14.05)^{bc}	(14.31)^{cd}	(16.34)^{cd}	(20.73)^{bc}	(20.73)^{c}	(16.34)^{c}	(20.43)^{c}	(20.43)^{c}	(21.79)^{c}	(21.79)^{c}
T2- Soap +Vinegar	14.64	11.45	11.45	11.45	11.45	10.08	16.35	16.35	14.34	14.34
	(22.5)^{b}	(19.78)^{bc}	(19.78)^{c}	(19.78)^{bc}	(19.78)^{c}	(18.51)^{c}	(23.85)^{c}	(23.85)^{c}	(22.25)^{c}	(22.25)^{c}
T3- Sugar 25% + Boric acid	2.82	24.66	27.99	27.99	32.82	31.20	36.02	40.99	52.85	65.11
	(9.67)^{c}	(29.78)^{b}	(31.94)^{b}	(31.94)^{b}	(34.95)^{b}	(33.96)^{b}	(36.88)^{b}	(39.81)^{b}	(46.63)^{b}	(53.79)^{b}
T4- Sugar 25% + Thiamethoxam	0.03	0.03	0.85	7.05	21.45	33.19	28.51	40.39	46.54	52.85
25 WG (0.0001%)	(0.91)^{d}	(0.91)^{d}	(5.29)^{de}	(15.40)^{c}	(27.59)^{bc}	(35.18)^{b}	(32.27)^{bc}	(39.46)^{b}	(43.02)^{b}	(46.63)^{b}
T5- Sugar + Rava +	99.97	99.97	99.97	99.97	99.97	99.97	99.97	99.97	99.97	99.97
Fipronil 0.3 GR (1:1:0.3)	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}	(89.09)^{a}
T6- Sugar + Beavaria bassiana	0.03	0.03	0.03	0.03	0.03	2.97	0.85	18.37	17.08	19.49
NBAIR Bb5a (2:1)	(0.91)^{d}	(0.91)^{d}	(0.91)^{e}	(0.91)^{d}	(0.91)^{d}	(9.93)^{c}	(5.29)^{d}	(25.38)^{c}	(24.41)^{c}	(26.19)^{c}
CD (0.05)	(8.605)	(10.886)	(12.086)	(13.616)	(11.259)	(13.925)	(12.352)	(12.218)	(11.502)	(10.762)

DAP- Days after placement.

ants through trophallaxis and kill the recipient without repelling foraging ants (Nyamukondiwa, 2008). Hence, an ideal toxicant is one that does not start killing ants for several hours, allowing it to spread completely within the entire colony (Davis and Van Schagen, 1993).

In T3 (boric acid 0.5% and sugar 25%) 65.11 per cent mortality of *M. bicolor* was recorded on the nineteenth day after treatment. Boric acid acts as a stomach poison and has been used for ant control over the past several decades. It interferes with water regulation in ants, leading to greater consumption of bait to offset dehydration (Klotz *et al.,* 1996). At minimal concentrations, it is highly effective in eliminating laboratory colonies of *Tapinoma melanocephalum, M. pharaonis, Solenopsis invicta* and *L. humile* (Ulloa-Chacon and Jaramillo, 2003).

In treatment, thiamethoxam (0.0001%) and sugar (25%), 52.85 per cent mortality was recorded on the nineteenth day. New generation insecticides with unique modes of action are highly effective at lower doses against target pests while remaining safe for natural enemies (Seetharamu *et al.,* 2020). Thiamethoxam, which falls under the novel neonicotinoid class of insecticides commonly used for controlling sucking pests, has gained traction over the past few years in the insecticide industry (Giri *et al.,* 2018). They have specific toxicity on insect nervous system over mammalian system chiefly exerting its effect by interfering with the nicotinic acetylcholine receptor. This distinct mechanism of action makes them effective for controlling insects that have developed resistance to conventional insecticides such as the carbamates, organophosphates and pyrethroids. It has minimal impact on beneficial insects, low toxicity towards mammals and are not reported to be associated with any developmental malformations or unprecedented mutations (Shobhana and Farid, 2008).

Thiamethoxam was selected as the active ingredient for baiting due to its relatively high water solubility of 4.10 g L-1 at 25°C. High water solubility is considered an essential property for developing an effective aqueous bait (Rust *et al.,* 1997). Alginate hydrogel beads soaked in a sucrose solution containing 1 mg L-1 thiamethoxam resulted in complete control of all castes of Argentine ants, *Linepithema humile* (Mayr), within 14 days in the laboratory. Additionally, the field trial showed a 79 percent reduction in ant activity after 8 weeks (Tay *et al.,* 2017). However, in the present study only 52.85 per cent mortality was recorded in thiamethoxam based trap, this could be probably due to difference in ant species tested. The ant species tested (*M. bicolor*) was found to have greater hardiness and hence greater longevity under artificial conditions owing to the presence of a thicker cuticle. Peeters and Ito (2015) reported that various formicoids have a thick cuticle as an adaptation for specific lifestyles *viz*., *Calyptomyrmex*, *Cataulacus*, *Cephalotes*, *Meranoplus* (Myrmicinae), *Echinopla* and *Polyrhachis* (Formicinae). Cuticle is an expensive resource at colony-level. As against thinner cuticle, thicker cuticle offers protection, helps reduce desiccation losses etc. This indicated the need for administering greater dose of the toxicant for increased mortality of the test ant species.

CONCLISION

Among the traps tested, T5- fipronil 0.3 GR, rava and sugar (0.3:1:1) showed cent per cent mortality of ants by the first day of inoculation, while T3-boric acid (0.5%) and sugar 25% and T4-thiamethoxam(0.0001%) and sugar 25% exhibited delayed mortality of 65.11 and 52.85 per cent respectively on the nineteenth day after the traps were placed. However, toxicants with delayed toxicity is considered ideal for ant management such that they aid in the spread of the toxicant *via* trophallaxis in the entire colony. This will ultimately enable to lower the population of ant species identified as damaging. In addition, Fipronil being a highly toxic insecticide raises many environmental and human health concerns. Hence traps based on boric acid and thiamethoxam which are relatively safe, at slightly higher doses can be used to achieve greater mortality of the colony, particularly for management of destructive ants in the house holds.

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Conflict of interest

All authors declare that they have no conflict of interest.

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