

CYANTRANILIPROLE: A NOVEL INSECTICIDE FOR CONTROL OF URBAN PESTS

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Abstract. Cyantraniliprole is a novel insecticide that belongs to the anthranilic diamide class of insecticides. The novel mode of action of cyantraniliprole depletes calcium from insect muscle, affecting muscle contraction, causing paralysis and eventually death. We report the results of testing of two formulations of cyantraniliprole, including a sprayable formulation for control of crawling insects and a fly bait formulation for house fly control. Cyantraniliprole was effective as a direct spray (contact activity) and as a residual surface application for control of German cockroaches, crickets and house fly. A proprietary bait comprised of a unique matrix and 0.5% cyantraniliprole, was shown to be highly effective against house fly. Due to the novel mode of action, cyantraniliprole can be a valuable rotational product towards integrated pest management and insecticide resistance management programs.

Key words Cyantraniliprole, house fly, ants, cockroaches, insecticide.

INTRODUCTION

Cyantraniliprole (CYNT) is an anthranilic diamide insecticide discovered by DuPont Crop Protection and more recently, is being developed by Syngenta for uses against selected urban pests. Cyantraniliprole is classified by IRAC as a ryanodine receptor modulator [Group 28] (IRAC, 2012). Cyantraniliprole binds to ryanodine receptors, causing depletion of calcium from muscle cells, leading to muscle contraction, paralysis, and death of the insect (Cordova et al., 2006; Satelle et al., 2008). Cyantraniliprole was categorized as a reduced-risk insecticide (EPA approval granted 2011) with low toxicity to vertebrates. The compound is systemic in plants and has been the subject of development for controlling pests important to agricultural crop production. In the area of urban entomology, Mao et al. (2011) reported results from topical applications and treatment of sand substrates with CYNT against *Reticulitermes flavipes* (Kollar) and *Coptotermes formosanus* Shiraki. Mao's results showed cyantraniliprole to have LC₅₀ and LD₅₀ values similar to those reported for chlorantraniliprole (Altriset), another anthranilic diamide, for both termite species. In recent years, an effort to profile CYNT for activity against certain urban pests was undertaken. This paper reports on the activity of CYNT against important pests in urban settings.

MATERIALS AND METHODS

Laboratory bioassays were conducted beginning in 2009 through 2013 to evaluate the efficacy of cyantraniliprole on urban pests. Tests were conducted at the DuPont Stine-Haskell facility

in Newark, DE, the Syngenta-Vero Beach Research Center, Vero Beach, FL, and the Syngenta Stein, CH, facility, as well as by a contract researcher. Tests of sprayable formulations of CYNT were either by direct spray of target insects or by exposure to residues on treated surfaces. For direct-spray trials, insects were sprayed directly using a spray chamber designed to simulate a contact spray under field conditions, i.e. the spray chamber floor was made of wire mesh so that treated insects would not be subject to spray accumulation. After treatment, insects were transferred to clean containers, provided with food and water and observed for mortality for 2 days. Data were subjected to ANOVA and means were separated with LSD tests. For tests with residues on treated surfaces, non-porous, glazed tiles were sprayed with each treatment with 1 gallon per 1000 ft² volume, and allowed to dry before exposing insects. Insects were exposed to the treated tiles for 30 minutes, transferred to an untreated container with food and water and monitored for mortality for 72 hours. Data were subjected to ANOVA and means were separated with LSD tests.

Trial #PR096161a. Insecticide-susceptible laboratory-reared cockroaches (J Wax strain) were used for testing, with 10 adult males per replication, and 4 replications. A suspension concentrate (SC) formulation of CYNT and indoxacarb 20WG (Arilon®) were used with dilutions of 0.01%, 0.05% and 0.1%.

Trial #USVT0I0472013. Insecticide-susceptible laboratory-reared cockroaches (Orlando strain) were used for testing, 10 adult males per replication, with 4 replications. A 20% SC formulation of CYNT was used at dilutions of 0.05% and 0.1%, and Demand® CS (lambda cyhalothrin) at 0.03% was tested.

Trial #2013.2750.1. Insecticide-susceptible, laboratory-reared cockroaches were used for testing, with 10 adult males per replication, and 4 replications. A 20% SC formulation of CYNT was used at dilutions of 0.05% and 0.1%, and lambda cyhalothrin at 0.03% was used for comparison. Treated tiles were stored up to 60 days and the test repeated on aged tile residues.

Trial USVT0I0482013. House crickets (1 week old, sourced through Carolina Pet Supply) were used for testing, >30 per replication, with 4 replications. The 20% SC formulation of CYNT was used at dilutions of 0.05% and 0.1%, and lambda cyhalothrin at 0.03% was used for comparison.

Trial # PR096162a. Insecticide-susceptible, laboratory-reared house flies (Benzon strain) were used for testing, 10 adult per replication with 4 replications. A 20% SC formulation of CYNT was used with dilutions of 0.01%, 0.05% and 0.1%. Indoxacarb 20WG was tested at the same dilutions. After application, flies were transferred to clean containers, provided with food and water and observed for mortality and knockdown at 4 hours through 7 days.

Trial#PR109105. Laboratory colonies of insecticide-susceptible house flies (Entomology Consultants, LLC, Chaparral, NM) were used in the trial. Choice tests were arranged in cages under laboratory conditions, using one hundred 3-day old adult flies per replicate. Flies were fed a 50:50 mixture of dry instant milk + granulated sugar, along with water, *ad libitum* throughout the study as an alternative choice to each test bait. Pre-weighed quantities of each bait product (based on recommended label rates) were provided in individual cages (along with milk/sugar bait and water) as a series of paired choice tests. Assessments of knock-down (inability of a fly to right itself) and mortality were recorded in each cage/replicate at 5, 15, 30, 60 minutes and 3, 7, and 24 hours. Analysis of variance was performed.

RESULTS AND DISCUSSION

Contact Activity and Residual Spray Tests

For direct sprays of German cockroaches, cyantraniliprole 20 SC provided greater than 97.5% control at dilutions ranging from 0.01 to 0.1%, comparable to levels of mortality observed with indoxacarb (Table 1). Mortality was more rapid with cyantraniliprole compared with indoxacarb, although this observation is expected since indoxacarb is a pro-insecticide, requiring metabolism by insects to be activated. Cyantraniliprole 20SC provided high levels of mortality with German cockroaches as a residual spray application (Table 2). In the two trials, >90% mortality was observed from exposure to treated tiles, although in trial 1, the progression of mortality moved slowly, requiring 72 hours for maximum mortality. The slower action contrasts with the rapid activity observed with lambda cyhalothrin. Although CYNT appears not to be as fast acting as a pyrethroid, this insecticide shows potential when applied as a contact or residual spray for German cockroach control. When surface residues of CYNT were aged indoors to 32 and 60 days, mortality was high with both rates of CYNT, suggesting good residual under indoor conditions. Because of the mode of action, CYNT could be a valuable for managing resistance in German cockroach populations.

Table 1. Percentage mortality and morbidity of *Blattella germanica* sprayed with cyantraniliprole dilutions, DuPont –Stine/Haskell RC, 2009 [PR096161a]. Means with same letter not significantly different ($p < 0.05$).

Treatment and Rate	Mean ¹ % Dead and Moribund		
	1 HAT	4 HAT	24 HAT
Cyantraniliprole 20SC 0.01%	25a	95ab	100a
Cyantraniliprole 20SC 0.05%	32.5a	90abc	100a
Cyantraniliprole 20SC 0.1%	27.5a	87.5abc	97.5ab
Arilon 20WG 0.01%	0b	0d	57.3c
Arilon 20WG 0.05%	0b	2.5d	100a
Arilon 20WG 0.1%	0b	5d	100a
Untreated	0b	0d	0d

The effectiveness of cyantraniliprole of residual sprays on house crickets was determined (Table 3). At rates of 0.05% and 0.1%, mortality of house crickets was 96.5 and 100% at 72 hours exposure. As with German cockroaches, the onset of mortality was slower than with lambda cyhalothrin.

Cyantraniliprole 20SC was also effective against house fly as a direct spray (Table 4). At dilutions as low as 0.01%, >90% of treated flies were dead or moribund within 1 hour and all flies were affected within 24 hours. Efficacy was also achieved with sprays of indoxacarb 20WG at all rates tested but flies were affected more slowly than with CYNT.

Table 2. Mean percentage mortality of German cockroaches (*Blattella germanica*) exposed to glazed tile surfaces treated with cyantraniliprole sprays, Syngenta –VBRC [USVT0I0472013] and Stein, Switzerland [2013.2750.1], 2013.

Residue Age	Mean % Mortality						
	Trial 1 (VBRC) ¹						Trial 2 (Stein) ²
	1 Day			32 Days		60 Days	7 Days
Treatment	24	48	72	48	72	48	24
Cyantraniliprole SC 0.05%	36.5b	60.8b	86.5a	80.0b	95.0a	97.5a	93.0 (±0.6)
Cyantraniliprole SC 0.1%	23.5bc	76.8b	87.3a	66.3b	95.5a	97.3a	93.0 (±0.6)
lambda cyhalothrin 0.03%	100a	100a	100a	100a	100a	100a	93.0 (±0.6)
Untreated	4.8c	4.8c	4.8b	0.0c	25.0b	10.3b	93.0 (±0.6)

¹On tiles aged 1 day in laboratory; means with same letter not significantly different, LSD p=0.05).²On tiles aged 7 days in laboratory; numbers in parentheses are standard deviations.

Cyantraniliprole Bait for House Fly Control

In a trial using a milk/sugar fly bait with 0.5% CYNT (PR106405b-Harrison & Kudile), >95% mortality was observed within 24 hours, after a 6-hour exposure to the bait, compared with <3% mortality with a blank bait. Based on these results and other rate studies with CYNT, development of a proprietary bait product for house fly control was undertaken. The bait matrix was incorporated with 0.5% CYNT for testing as a house fly bait. In choice tests, the CYNT fly bait, (Zyrox® Fly Granular Bait) was effective in controlling house fly, providing 100% mortality within 24 hours (Table 5).

Table 3. Percentage mortality of house crickets (*Acheta domestica*), exposed to glazed tile surfaces treated with cyantraniliprole sprays, Syngenta VBRC [USVT0I0482013].

Treatment and Rate	Mean % Mortality ¹		
	Hours after exposure		
	24	48	72
Cyantraniliprole 20SC 0.05%	53.8b	95a	96.5a
Cyantraniliprole 20SC 0.1%	42.5b	89.3a	100a
Demand CS 0.03% lambda cyhalothrin	100a	100a	100a
Untreated	0c	0b	0b

¹On tiles aged 1 day in laboratory; means with same letter not significantly different, p<0.05).

Efficacy of CYNT was not significantly different to that observed with Golden Malrin® (1.1% methomyl bait) and Quikstrike® (0.5% dinotefuran) at 7 and 24 hours, although mortality occurred somewhat slower. High levels of knockdown with cyantraniliprole fly bait was observed in 5 min with nearly 100% of flies affected within 30 min. While the mode of action of CYNT would be expected to exhibit delayed action, the activity on house fly was relatively rapid. Compared with Maxforce® fly bait (0.5% imidacloprid), cyantraniliprole bait provided significantly better control. Cyantraniliprole fly bait is a highly attractive novel fly bait product and should be an effective tool in managing house fly populations, particularly with pyrethroid- and imidacloprid-resistant populations.

Table 4. Percentage mortality and morbidity of *Musca domestica* sprayed with cyantraniliprole SC dilutions, DuPont –Stine/Haskell RC, 2009 [PR096162a].

Treatment and Rate	Mean ¹ % Dead and Moribund		
	1 HAT	4 HAT	24 HAT
Cyantraniliprole 0.01%	95.0a	100.0a	100.0a
Cyantraniliprole 0.05%	92.2a	92.2a	100.0a
Cyantraniliprole 0.1%	95.0a	100.0a	100.0a
Arilon 20WG 0.01%	2.5b	12.5c	90.0a
Arilon 20WG 0.05%	2.5b	25.0bc	100.0a
Arilon 20WG 0.1%	0.0b	42.5b	100.0a
Untreated	0.0b	0.0c	7.5b

¹On tiles aged 1 day in laboratory; means with same letter not significantly different, p<0.05).

Table 5. Mean number of dead *Musca domestica* per 100 total after feeding on various bait products; laboratory choice study, Lee (2011) [PR109105].

Treatment	Average number of dead house flies (of 100)			
	1 HAT	3 HAT	7 HAT	24 HAT
Cyantraniliprole Fly Bait	67.8ab	88.5b	97.5a	100.0a
Golden Malrin®	92.5a	100a	100.0a	100.0a
QuikStrike®	79.5a	99a	100.0a	100.0a
Maxforce® Granular Fly Bait	49.3b	76.8c	90.5b	93.0b
Untreated Check	0.0c	0d	0.0c	0.5c

¹On tiles aged 1 day in laboratory; means with same letter are not significantly different, p<0.01).

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