Activity of TH-6041 and TH-6042 Against Stored-Product Insects[1]

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ABSTRACT

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Two experimental insecticides, TH-6041 [*N*, 3-bis(4-chlorophenyl)-4,5-dihydro-1 *H*-pyrazole-1-carboxamide] and TH-6042 [*N*, 3-bis(4-chlorophenyl)-4,5-phenyl-1 *H*-pyrazole-1-carboxamide] were relatively toxic on wheat to the adult stages of the rice weevil, *Sitophilus oryzae* (L.), granary weevil, *S. granarius* (L.), and lesser grain borer, *Rhyzopertha dominica* (F.) ($LD_{95} \leq 6$ ppm). The confused flour beetle, *Tribolium confusum* Jacquelin duVal, sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), Indian meal moth, *Plodia interpunctella* (Hübner), Angoumois grain moth, *Sitotroga cerealella* (Olivier), and almond moth, *Ephestia cautella* (Walker), were more tolerant ($LD_{95} \geq 35$ ppm). TH-6042 was very effective as a progeny suppressant against all Coleoptera ($ID_{95} < 5$ ppm) but only marginally active against Lepidoptera ($ID_{95} < 48$ ppm). TH-6041 had good activity against progeny of the rice weevil, granary weevil, sawtoothed grain beetle, and lesser grain borer ($ID_{95} \leq 26$ ppm).

The formulations, TH-6041 [*N*,3-bis (4-chlorophenyl)-4,5-dihydro-1 *H*-pyrazole-1-carboxamide] and TH-6042 [*N*,3-bis (4-chlorophenyl-4,5-phenyl-1 *H*-pyrazole-1-carboxamide] are representatives of a new group of insecticidal compounds that are stomach poisons and have some contact action (Fig. 1). Because they are active against adults and larvae of numerous species representing various insect orders and have relatively low mammalian toxicity (Mulder et al. 1975, Anon 1976, Wellinga et al. 1977, Grosscurt el al. 1978), we suspected that the pyrazoline derivatives might be useful as protectants of stored products. Therefore, we applied these experimental insecticides on wheat and evaluated their activity against 8 species of Coleoptera and Lepidoptera including the rice weevil, *Sitophilus oryzae* (L.), granary weevil, *S. granarius* (L.), confused flour beetle, *Tribolium confusum* Jacquelin duVal, sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), lesser grain borer, *Rhyzopertha dominica* (F.), Indian meal moth, *Plodia interpunctella* (Hübner), Angoumois grain moth, *Sitotroga cerealella* (Olivier), and almond moth, *Ephestia cautella* (Walker).

Materials and Methods

TH-6041 (A13-29240) and TH-6042 (A13-29241) were obtained from the Thompson-Hayward Chemical Co. (Kansas City, Kans.) as a 25% (wt/wt) WP and 0.12 kg/liter flowable formulation, respectively, and were stored at −10°C until used. All insects were obtained from cultures maintained at the U.S. Grain Marketing Research Laboratory. 'Chanute' wheat was used in all tests and was obtained from a commercial source. Kernels were cleaned and tempered to a moisture of 12.5±0.5% as determined by a Motomco® moisture meter (Motomco, Inc., Electronics Div., Clark, N.J.).

The insects were exposed to insecticide admixed with diet. Appropriate stock solutions of chemicals were prepared in water to provide 1.0–100 ppm dosages of insecticide (wt/wt) when applied to whole wheat or to ground wheat moth medium (Kinsinger 1975). The kernels were treated as described by McGregor and Kramer (1975, 1976). The chemicals were applied to the grain by pipetting uniformly 5 ml of the appropriate stock solution onto the inside surface of a rotating jar containing 100 g of medium. Then the jar was rotated for 20 min on a mechanical tumbler operating at 40 rpm. The treated diet was allowed to equilibrate for at least 24 h before insects were added. The whole wheat or ground wheat moth medium (100 g) was infested with 50 adult Coleoptera or 50 lepidopteran eggs. Activity was evaluated on the basis of the degree of acute toxicity after 21 days of exposure or the inhibition of progeny development after 9 wk. All experiments were conducted at 27°C and 60% RH. The avg number of insects found in 4 replicate samples (minus the number of parent insects when appropriate) was determined. When the numbers of progeny were reduced significantly, the samples were held an additional 6–12 weeks, examined biweekly, and progeny recorded. The LD_{95} or ID_{95} was then expressed as the ppm per weight of grain necessary to obtain 95% mortality or 95% inhibition of progeny development, respectively, when compared to solvent only treated samples. Probit analyses of the data were conducted according to Finney (1952).

Results and Discussion

Table 1 summarizes the activity of TH-6041 and TH-6042 against the various species of insects. In terms of both

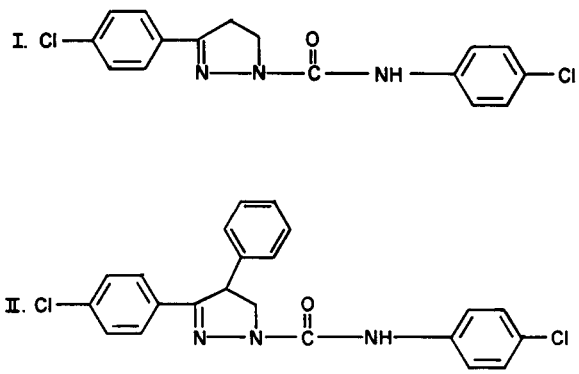

FIG. 1.—3-Aryl-2-pyrazoline insecticides. I. TH-6041, *N*, 3-bis (4-chlorophenyl)-4,5-dihydro-1 *H*-pryazole-1-carboxamide. II. TH-6042, *N*, 3-bis (4-chlorophenyl)-4,5-phenyl-1 *H*-pyrazole-1-carboxamide.

[1] Mention of a pesticide or a proprietary product does not constitute a recommendation or an endorsement by the USDA. Received for publication May 1, 1978.

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Table 1.—Activity of TH-6041 and TH-6042 against species of insects in wheat[a].

Species	TH-6041[b]		TH-6042	
	LD_{95}	ID_{95}	LD_{95}	ID_{95}
		Coleoptera		
Rice weevil	<1	<1	<1	4.4 (0.7–11.4)
Granary weevil	6.1 (0.9–10.3)	<1	<1	≈1
Confused flour beetle	>100	>100	>100	≈1
Sawtoothed grain beetle	>100	25.8 (22.4–31.6)	35.6 (27.7–51.5)	2.5 (1.6–4.2)
Lesser grain borer	<1	<1	<1	<1
		Lepidoptera		
Indian meal moth	—	>100	—	31.6 (22.1–51.6)
Angoumois grain moth	—	61.2 (43.9–92.5)	—	48.2 (33.8–78.3)
Almond moth	—	>100	—	11.1 (8.9–14.8)

[a] Whole kernel wheat diet used for all species except Indian meal moth and almond moth for which ground wheat medium was used.
[b] 95% confidence limits given in parentheses.

adult mortality and inhibition of progeny, TH-6042 was more active than TH-6041. Both compounds were generally more effective against beetles than against moths.

The rice weevil, granary weevil, and lesser grain borer were the most susceptible species with LD_{95} values for TH-6042 of < 1 ppm. The sawtoothed grain beetle and confused flour beetle were at least 35 times more tolerant. However, after 21 days of exposure to diets treated with sublethal doses of insecticides, the insects that survived displayed uncoordinated and sluggish movements. Some laid upside down and moved their legs continuously.

In terms of inhibition of progeny, both compounds were generally effective, especially against beetle populations. Numbers of beetle progeny in control samples averaged ca. 600 insects/replication and ranged from a low of 113 for the confused flour beetle to 1565 for the rice weevil. TH-6041 and TH-6042 prevented 95% of the beetle progeny development at ≤ 5 ppm doses except when TH-6041 was tested against the confused flour beetle (ID_{95} > 100 ppm) and sawtoothed grain beetle (ID_{95} = 26 ppm). TH-6042 was more effective than TH-6041 in suppression of lepidopteran development with ID_{95} values ≤ 48 ppm. Numbers of moths produced from 50 eggs in check samples ranged from 36 for the almond moth to 42 for the Indian meal moth.

The results of our feeding tests indicate that TH-6041 and TH-6042 might protect stored commodities against 3 beetle species but not against the confused flour beetle and sawtoothed grain beetle. TH-6042 also might be used to prevent the development of large populations of all beetles and moths tested in the study. With most insects, there was a difference in efficacy between the 2 compounds. However, the rice weevil, lesser grain borer, and Angoumois grain moth showed relatively similar susceptibilities to both compounds.

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