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Susceptibility of Stored Product Insects to Chitin Inhibitors LY-131215 and LY-127063[1]

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ABSTRACT: Two chitin inhibiting compounds were tested against several species of stored product insects. *N*-[((5-(4-Bromophenyl)-6-methyl-2-pyrazinyl)amino)carbonyl]-2-chlorobenzamide (LY-127063) was effective in preventing development of the lesser grain borer *Rhyzopertha dominica* (F.), confused flour beetle, *Tribolium confusum* Jacquelin du Val, sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), Indian meal moth, *Plodia interpunctella* (Hübner), rice weevel, *Sitophilus oryzae* (L.), almond moth, *Ephestia cautella* (Walker), and Angoumois grain moth, *Sitotroga cerealella* (Olivier) at 0.2–13.5 ppm in wheat. 2,6-Dimethoxy-*N*-[5-(4-(2,2,3,3,3,–pentafluorethoxy)phenyl)-1,3,4-thiadiazol-2-yl]benzamide (LY-131215) was only about one-fifth as effective.

Chitin synthesis inhibitors have potential for use as insecticides (Marx, 1977; Vincent, 1978). Most of these are benzamide derivatives. Previously we evaluated 8 such experimental compounds, applied to wheat, against several species of stored product insects (McGregor and Kramer, 1976; Kramer and McGregor, 1979). We report here the results obtained with two other compounds.

Materials and Methods

All insects were obtained from cultures that were maintained at the U.S. Grain Marketing Research Laboratory and had no prior history of exposure to insecticides. The 'Chanute' wheat used in the tests was obtained from a commercial source, and kernels were cleaned and tempered to a moisture of 12.5 ± 0.5% as determined by a Motomco® moisture meter (Motomco Inc., Clark, New Jersey). The chemicals (Fig. 1) evaluated were: I. 2,6-dimethoxy-*N*-[5-(4-(2,2,3,3,3,-pentafluorethoxy)phenyl)-1,3,4-thiadiazol-2-

[1] This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Also, mention of a proprietary product does not constitute endorsement by the USDA.

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Table 1. Activity of LY-131215 (I) and LY-127063 (II) against development of coleopteran and lepidopteran insects exposed from egg stage in wheat.

Species	Compound no.	Average no. F_1 insects in untreated sample[a]	ED_{95} (ppm)[b]
1. Lesser grain borer	I	—	—
	II	250	0.2 (0.1–0.3)
2. Confused flour beetle	I	228	5.0 (3.4–8.1)
	II	164	0.8
3. Sawtoothed grain beetle	I	—	—
	II	189	0.9 (0.7–1.2)
4. Rice weevil	I	232	~100
	II	223	10.6 (4.2–56.3)
5. Indian meal moth	I	44	5.7 (3.4–12.6)
	II	48	2.0 (1.3–4.3)
6. Almond moth	I	—	—
	II	32	13.5 (7.3–38.5)
7. Angoumois grain moth	I	—	—
	II	30	7.5 (4.3–17.0)

[a] Whole kernel wheat diet used for all species except Indian meal moth and almond moth; for these ground wheat medium was used.

[b] 95% confidence limits given in parentheses.

yl]benzamide (LY-131215, AI3-29392, >95%, Lilly Research Laboratory) and II. *N*-[((5-(4-bromophenyl)-6-methyl-2-pyrazinyl)amino)carbonyl]-2-chlorobenzamide (LY-127063), AI3-23939, >95%, Lilly Research Laboratory). Insects, 50 coleopteran adults or 50 lepidopteran eggs, were exposed to 100 g whole wheat or ground wheat moth medium (Kinsinger, 1975) that had been treated with 0.1–100 ppm of the test compound (McGregor and Kramer, 1976; Kramer and McGregor, 1979) by pipetting 5 ml of an acetone solution onto the diet and mixing thoroughly until the acetone had evaporated. The treated diet was allowed to equilibrate for at least 24 hr before testing.

All experiments were conducted at 27 ± 2°C and 60 ± 5% RH. Four replications were conducted at each dose. Toxicity to test coleoptera was determined after 21 days of exposure; for Lepidoptera, percentage mortality was calculated from the differences between the number of eggs added and the number of adults that emerged. For Coleoptera, the number of original parent insects was subtracted from the total dead and live insects after 9 weeks. When the progeny was reduced >10–20%, the samples were reexamined after nine more weeks. Values were corrected for mortality in untreated samples and the correct mortality values were then used to establish

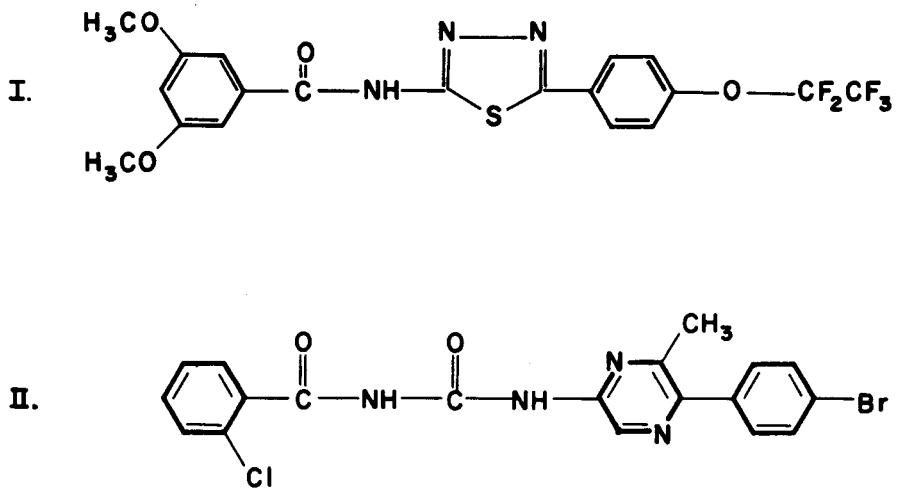

Fig. 1. The structures of chitin inhibitors LY-131215 (I) and LY-127063 (II). See Materials and Methods for nomenclature.

the ppm in the diet required to suppress 95% of the control population (ED_{95}) as determined by probit analysis (Finney, 1952).

Results and Discussion

Although neither of the two benzamide compounds tested for insect growth regulating activity in this study was acutely toxic at 100 ppm to either stored product beetles or moths, both suppressed development of progeny when applied to whole wheat or ground wheat media. The activity against seven species of insects (calculated ED_{95} values) is reported in Table 1 and the number of progeny in untreated samples is given for comparison. The pyrazinyl derivative (LY-127063) was 3–10 times as effective as the thiadiazole compound (LY-313215). Three of the four beetle species (lesser grain borer, *Rhyzopertha dominica* [F.], confused flour beetle, *Tribolium confusum* Jacquelin du Val, and sawtoothed grain beetle, *Oryzaephilus surinamensis* [L.]) were highly susceptible to the pyrazinyl derivative (ED_{95} values of <1 ppm). The rice weevil, *Sitophilus oryzae* (L.), and the three moth species studied (Indian meal moth, *Plodia interpunctella* (Hübner), almond moth, *Ephestia cautella* (Walker), and Angoumois grain moth, *Sitotroga cerealella* (Olivier) were more tolerant of the compound (ED_{95} 2–14 ppm).

We have previously evaluated the insecticidal activity of several compounds similar to the two derivatives reported in this study (Kramer and McGregor, 1979). The monochloro pyrazinyl analog (LY-127063) was 2–30

times as effective as the dichloro derivative against all species except the almond moth; against the latter species it was only one-half as active as the dichloro derivative. Among the thiadiazolyl derivatives, the pentafluoroethoxy compound (LY-131215) had about the same activity toward the confused flour beetle and rice weevil as the 3- or 4-(trifluoromethyl),3,5-bis(trifluoromethyl), and 4-chloro- analogs, but it was at least 15 times more effective than the latter compounds against the Indian meal moth.

The two compounds evaluated here are generally the most active of the thiadiazolyl or pyrazinyl derivatives so far known to inhibit chitin deposition in stored product insects (Kramer and McGregor, 1979). At doses near the ED_{95} value, treated grain showed no appreciable damage from the infestations, and it is likely that the insects died in the ovum, embryonic, or early larval stage.

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