191

Bay 7660: A Candidate Insect Protectant for Wheat[1,2]

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ABSTRACT

Bay SRA 7660 [phenylghyoxylonitrile oxime(*O*)-*0,0* dimethyl phosphorothioate] was tested on soft winter wheat as a protectant against adult rice weevils, *Sitophilus oryzae* (L.), red flour beetles, *Tribolium castaneum* (Herbst), confused flour beetles, *T. confusum* Jacquelin duVal, and lesser grain borers, *Rhyzopertha dominica* (F.). Results were evaluated at intervals during 12 months by counting dead insects after 21 days' exposure to treated wheat. Bay SRA 7660 at 5 ppm was effective for 9 months against the rice weevil, for 2 months against red and confused flour beetles, and for 6 months against lesser grain borers. Its effectiveness at a dose of 10 ppm against the lesser grain borer equalled the protection afforded by malathion; however, the recommended dosage of ca. 10 ppm malathion gave superior protection from the other 3 species than that given by Bay SRA 7660.

Laboratory evaluations of promising compounds to control insects that attack stored grains are a continuing part of developing acceptable grain protectants. New compounds should be low in mammalian toxicity and possess effective residual activity against a variety of insects that attack stored-grain and grain products. An urgent need for new chemical protectants is indicated by the development of resistance by some insect species to present chemicals and by the natural tolerance shown by others to current chemical protectants.

McDonald and Gillenwater (1976) reported that topical applications of Bay SRA 7660 [phenylghyoxylonitrile oxime(*O*)-*0,0* dimethyl phosphorothioate] in acetone required doses of ca. 13.15 and 12.03 μg/g for LD_{95} readings, respectively, for adults of the cigarette beetle, *Lasioderma serricorne* (F.), and larvae of the black carpet beetle, *Attagenus megatoma* (F.). Malathion required doses of 103 and 285 μg/g, respectively. We, therefore, selected this organophosphorus compound of relatively low mammalian toxicity (LD_{50} to rats of ca. 2500 mg/kg) for evaluation, as a wheat protectant, at doses from 1–10 ppm, for tests with adult rice weevils, *Sitophilus oryzae* (L.), red flour beetles, *Tribolium castaneum* (Herbst), confused flour beetles, *T. confusum* Jacquelin duVal, and lesser grain borers, *Rhyzopertha dominica* (F.).

MATERIALS AND METHODS.—Tests were conducted, in general, as described by LaHue and Dicke (1971). Cleaned, uninfested composite lots of soft winter wheat were tempered to 12.5±0.1% moisture. The source lots were retained in screen-covered 19 liter jars at 26.7±2°C and 60±5% RH for ca. 21 days for the moisture to come to equilibrium; then, 1000-g lots were placed in 3.8 liter large mouth glass jars for treatment. An emulsifiable concentrate containing 25.0% Bay SRA 7660 (wt/vol) was diluted to make emulsions for 1-ml applications to apply the desired dose of AI to wheat. Applications were made with 1-ml volumetric pipettes to the inside wall of the 3.8-liter glass jars above the grain level while the jars were turning on a 33-rpm turntable. Immediately after applications, the jars were placed on a roller for 1 min and then were rotated for 15 min on a mechanical end-over-end tumbler to thoroughly mix the insecticide with the wheat. The jars were covered with lids during storage and were kept in total darkness ca. 75% of the storage time. All treatments were replicated 4 times, and sufficient wheat was treated to provide samples for all toxicity exposures conducted during the 12-month study. Malathion at 10 ppm AI was used as the chemical standard for comparison.

Insects were exposed to treated wheat 1, 2, and 3 weeks and 1, 2, 3, 6, 9, and 12 months after protectant had been applied. After the required aging period, 250-g samples of wheat were removed from each replication and placed in 473-ml glass mason jars for exposure to the different species of insects. The test jars were fitted with rings, 40-mesh screens, and filter paper lids. About 100 adult insects of a species were placed in each sample. Immediately before introduction of the red flour and confused flour beetles, ca. 1.0% by weight of grain from each parent sample was finely ground and added back to the sample. Four replicates of each treatment were exposed to each insect at each exposure for each dosage. All test species were exposed in replicate to untreated (control) lots of wheat at each test period.

RESULTS AND DISCUSSION.—Results were evaluated by counting dead adult insects after 21 days' exposure to treated wheat. LD_{50} or LD_{95} values normally quoted when comparing the effectiveness of the insecticides

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in the laboratory have limited value where insect pests of stored products feed on and come in direct contact with treated grain. The results are presented in tabular form to show the lowest doses required to kill the insects of each test species exposed to treated grain during the 12-month study. Thus, a time interval-effective dose (TIED value) was revealed for each species exposed to soft winter wheat treated with Bay SRA 7660.

Rice Weevils.—In the exposures made 6 months after treatment, rice weevils were effectively controlled in wheat by doses of 2 ppm (Table 1). The 4 ppm dose lost nearly all effectiveness during the 9th month when a gradual loss in effectiveness of the lower dosages occurred. By 12 months only 65.5% of rice weevil adults were killed by the 10 ppm dose compared with 82.2 of those exposed to malathion.

Lesser Grain Borers.—A 6 ppm dose was completely effective for 6 months, but residue effectiveness, in general, gradually decreased the next 6 months (Table 1). Effectiveness of the 10 ppm dose of SRA 7660 was greater than 10 ppm malathion. As the lesser grain borer is one of the most destructive insects in wheat, Bay SRA 7660 appears promising as a protectant against this insect.

Red Flour Beetles.—Residue effectiveness of Bay SRA 7660 was relatively short-lived in tests with the red flour beetle (Table 2). Mortalities were 93.9, 82.7, and 60.0% at 1, 2, and 3 weeks, respectively, after treatment with a dose of 1 ppm. Residues gradually lost effectiveness during the 3rd month of storage as a dose of 9 ppm was necessary for 100% mortality.

Confused Flour Beetles.—This species was more tolerant than the red flour beetle to residues on wheat (Table 2). Doses of 6 ppm or more were completely effective for 2 months; however, the residual life was short with a rapid loss in effectiveness the 3rd month.

Malathion was superior as a protectant to Bay SRA 7660 at a dose of 10 ppm against rice weevils and red and confused flour beetles; however, lesser grain borers were more tolerant to malathion than to Bay SRA 7660 residue. This concurs with the findings of McDonald and Gillenwater (1976) who reported that malathion was more toxic than Bay SRA 7660 in topical applications to red and confused flour beetles. They also reported that the slopes of regression lines for Bay SRA 7660 were larger than corresponding slopes for malathion and concluded that the larger slopes indicate greater homogeneity (in 5 of 6 species tested) for susceptibility to Bay SRA 7660 than to

Table 1.—Average mortality percentages of adult rice weevils and lesser grain borers in soft winter wheat during 12 months' storage after treatment with Bay SRA 7660.

Insecticide and dose (ppm)	Posttreatment period Months				
	2	3	6	9	12
Bay SRA 7660			*Rice weevils*		
1	85.2	23.7	23.5	21.0	0
2	100.0	98.4	96.0	21.0	0
3	100.0	100.0	100.0	37.0	0
4	100.0	100.0	100.0	59.0	0
5	100.0	100.0	100.0	91.0	4.0
6	100.0	100.0	100.0	99.5	11.0
7	100.0	100.0	100.0	100.0	15.0
8	100.0	100.0	100.0	100.0	29.5
9	100.0	100.0	100.0	100.0	38.5
10	100.0	100.0	100.0	100.0	65.5
Malathion					
10	100.0	100.0	100.0	100.0	82.2
Control	0.2	0.3	0	0	0
Bay SRA 7660			*Lesser grain borers*		
1	67.9	70.0	12.0	8.0	0
2	97.4	89.8	22.0	14.5	0
3	100.0	100.0	73.5	20.5	8.5
4	100.0	100.0	93.5	37.5	12.0
5	100.0	100.0	96.0	41.0	17.0
6	100.0	100.0	100.0	53.5	42.5
7	100.0	100.0	100.0	55.5	42.5
8	100.0	100.0	100.0	68.5	52.5
9	100.0	100.0	100.0	84.5	63.4
10	100.0	100.0	100.0	89.0	65.5
Malathion					
10	100.0	99.6	90.6	76.2	62.9
Control	0	0.2	0.2	0	0

Table 2.—Average mortality percentages of adult red and confused flour beetles in soft winter wheat during 12 months' storage after treatment with Bay SRA 7660.

Insecticide and dose (ppm)	Posttreatment period Months					
	1	2	3	6	9	12
			Red flour beetles			
SRA 7660						
1	25.0	1.6	0	0	0	0
2	94.6	20.4	0	0	0	0
3	100.0	63.2	14.6	0	0	0
4	100.0	86.9	47.8	0	0	0
5	100.0	96.2	57.9	0	0	0
6	100.0	100.0	60.1	0	0	0
7	100.0	100.0	83.2	0	0	0
8	100.0	100.0	94.5	8.0	3.7	0
9	100.0	100.0	100.0	14.0	3.5	1.0
10	100.0	100.0	100.0	33.5	3.6	1.1
Malathion						
10	100.0	100.0	100.0	67.9	33.3	20.2
Control	0	0	0	0.2	0	0
			Confused flour beetles			
SRA 7660						
1	15.0	2.5	0	0	0	0
2	64.0	17.3	0	0	0	0
3	98.3	49.1	2.2	0	0	0
4	98.4	74.7	9.8	0	0	0
5	100.0	87.7	11.5	0	0	0
6	100.0	100.0	23.0	0	0	0
7	100.0	100.0	42.5	0	0	0
8	100.0	100.0	46.4	2.0	2.0	0
9	100.0	100.0	52.2	2.0	2.0	0
10	100.0	100.0	58.0	6.0	4.0	2.5
Malathion						
10	100.0	100.0	96.4	41.6	20.0	8.0
Control	0	0	0	1.2	0	0.2

malathion. Consequently, resistance to Bay SRA 7660 is not likely to develop rapidly. The development of new insecticides suitable to replace malathion is imperative because of the increasing incidence of resistance to malathion by many stored-product insects.

Time interval-effective dose values as shown in the Tables were revealed to be different for each species of the insects used in the test.

REFERENCES CITED

LaHue, D. W., and E. B. Dicke. 1971. Phoxim as an insect protectant for stored grains. J. Econ. Entomol. 64: 1530–3.

McDonald, L. L., and H. B. Gillenwater. 1976. Toxicity of pirimiphos methyl and Bay SRA 7660 to six species of stored-product insects. J. Ga. Entomol. Soc. 11: 110–4.