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OVIPOSITIONAL RESPONSES OF THE RICE WEEVIL, SITOPHILUS ORYZAE (L.), TREATED WITH SYNERGIZED PYRETHRINS[1]

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ABSTRACT

Rice weevils were exposed to pyrethrins in combination with piperonyl butoxide in cages in which the weevils were in constant contact wth the treated surface. Weevils were exposed for either 1 hr, 2 hr, or 6 hr. Two 6-hr groups were studied—one of insects knocked down, the other of insects not knocked down. Five replications of 20 insects from each exposure group were placed in separate containers of wheat for 3 consecutive 7-day oviposition periods. All parent treatment groups, except the insects exposed for 6 hr with knockdown, exceeded the production of progeny of the untreated controls during all oviposition periods. The increase in the production of progeny by synergized pyrethrins-treated rice weevils over the production of progeny by untreated weevils is the first recorded evidence that production of progeny by rice weevils can be so affected.

Many materials, applied either as a dust or spray, have been investigated for their protective qualities since Wilbur (1952) reported the first use of an insecticidal material as a wheat protectant to prevent damage by grain-infesting insects. Some of these materials have been found effective for long periods of time, but, because of residue problems, have not been approved for use on grains for animal feeds or for human consumption. At present, only malathion, and pyrethrins in combination with piperonyl butoxide, are approved by the Food and

[1] Coleoptera: Curculionidae. Accepted for publication June 2, 1970.
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JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY 44:70–75. January, 1971.

Drug Administration for such use. Thus, until additional materials are developed and accepted by the FDA, work must be continued on these materials to improve their effectiveness and decrease their cost, and to better understand the ways they effect a protective action under normal storage conditions.

This paper presents results from a study to determine the effects of sublethal dosages of pyrethrins in combination with piperonyl butoxide on the reproductive responses of the rice weevil, *Sitophilus oryzae* (L.).

MATERIALS AND METHODS

Test insects.—The standard strain of rice weevil used in the study had been reared for many generations under laboratory conditions and had no history of insecticide exposure. Rearing was done in a room maintained at a constant temperature of 26.7 ± 2° C and 60 ± 5% RH. Hard red winter wheat of the Scout variety was used as the rearing medium. The moisture content of the wheat was 13%.

Cultures of insects 42 ± 7 days old from time of oviposition were screened for emerged adults. Insects used were not sexed.

Exposure cages.—The exposure cages allowed the insects to be in constant contact with the treated surface. Half-pint cylindrical ice-cream cartons were used. The bottom was removed and the sides lined with treated filter paper. The lined carton ring was then slipped down into the carton top, which contained a treated filter disk. The bottom of a petri dish containing another treated filter disk was used to cover the container.

Application rates.—The amount of insecticide to be applied to the test paper was determined by trial tests during which the rapidity and length of the knockdown were recorded. Knockdown of the insects was defined as complete immobilization or immobilization with only slight appendage movement on stimulation with a pencil tip or by gentle blowing. The trial tests showed that a treatment rate of 10 mg per square foot of pyrethrins in combination with piperonyl butoxide at 100 mg per square foot gave the desired degree of knockdown. An exposure of 16 hr gave 100% knockdown with good recovery within a 12- or 24-hr period.

Treatment of test papers.—Acetone solutions of pyrethrins in combination with piperonyl butoxide were prepared so that 1 ml delivered the desired insecticidal level to each 9-cm filter paper disk. This size disk was selected because it would just fit into the top lid of a carton cage. The insecticide was applied to each disk by a 1-ml pipette. The pipette tip was moved over the entire disk surface starting at the center and moving toward the outside in circular manner until the entire amount was delivered. The disks were hung up to dry overnight before use.

Exposure time.—The insects were exposed to synergized pyrethrins-treated filter paper for 1, 2, and 6 hr immediately after their removal from the culture. As 25% of the insects were immobilized (knocked down) after the 6-hr exposure, progeny development was determined on those knocked down as well as those seemingly unaffected. Thus two 6-hr groups were used in the study.

Twenty insects from each group were placed in separate containers with 20 g of wheat at 13% moisture content and held in a rearing room maintained at 26.7 ± 2° C and 60 ± 5% RH. Tests were replicated 5 times. Progeny records were maintained on the weekly basis for 3 weeks. After a 7-day egg-laying period, the adult insects were transferred to another lot of wheat and the infested wheat was returned to the rearing room for progeny development.

In preliminary studies, an oviposition period of 3 days apparently did not provide sufficient time for mating and subsequent egg production even though this time is twice that found by Singh and Soderstrom (1963) to be necessary for rice weevils to become sexually mature for progeny production. Because of this, an oviposition period of 7 days was used with insects from all treatments. For comparison, insects from the 4 groups also were given a 3-day oviposition period.

RESULTS

3-day oviposition periods.—Table 1 shows that the production of progeny by insects exposed to the insecticide for 1 hr, 2 hr, 6 hr without knockdown, and 6 hr with knockdown, was 42, 10, 153, and 91%, respectively, of the production of progeny by the untreated controls. There was no mortality observed among the parent insects.

7-day oviposition periods.—Table 2 shows that increasing the egg-laying to 7 days produced an increase in the production of progeny. All parent groups, except the weevils exposed to the insecticide for 6 hr with knockdown, exceeded the progeny production of the untreated controls from the oviposition that occurred during the first 7-day period.

The production of progeny by the group receiving the 1-hr exposure to insecticide was 35, 49, and 31% greater than the production by the

TABLE 1. The number of progeny from synergized pyrethrins-treated rice weevils that had been confined to wheat kernels for a 3-day oviposition period.

Hours of treatment	Knockdown effect	Total progeny (no.)	Mean	Treated ÷ untreated (%)
1	Negative	43	8.6	42
2	Negative	11	2.2[a]	10
6	Negative	156	31.2	153
6	Positive	93	18.6	91
None	Negative	102	20.4	—

[a] Treatment mean differed significantly from untreated mean at 0.05 level.

TABLE 2. Summary of the number of progeny from synergized pyrethrins-treated rice weevils that had been confined to wheat kernels for three successive 7-day oviposition periods.

Hours of treat-ment	Knockdown effect	Successive weeks	Weekly total progeny (no.)	Mean	Treated ÷ untreated (%)
1	Negative	1	1,041	208.2[a]	135
		2	951	190.2[a]	149
		3	1,063	212.6[a]	131
2	Negative	1	1,147	229.4[a]	149
		2	911	182.2[a]	142
		3	1,005	201.0[a]	123
6	Negative	1	908	181.2[a]	118
		2	748	149.6	117
		3	816	163.2	100
6	Positive	1	415	83.0[a]	54
		2	421	84.2[a]	66
		3	271	43.4[a]	33
None	Negative	1	771	154.2	—
		2	639	127.8	—
		3	814	162.8	—

[a] Treatment mean differed significantly from untreated mean at 0.05 level.

untreated parent controls as a result of the oviposition that occurred during the first, second, and third weeks, respectively. The treatment mean differed significantly from the untreated mean at the 0.05 level in all 3 weeks. The total production of progeny by this group was 37% greater than the total production of progeny by the untreated controls.

The production of progeny by the group exposed to the insecticide for 2 hr was 49, 42, and 23% greater than the number of progeny produced by the untreated controls as a result of the oviposition that occurred during the first, second, and third weeks, respectively. The treatment mean differed significantly from the untreated mean at the 0.05 level in all 3 weeks. The total production of progeny by this group was 38% greater than the production of progeny by the untreated controls.

The production of progeny by the parent group exposed to the insecticide for 6 hr without knockdown was only slightly greater than that of the checks, being 18, 17, and 0% as a result of the oviposition that occurred in the first, second, and third weeks, respectively. Only the treatment mean of the first week was significantly different from the untreated mean at the 0.05 level. By the end of 3 weeks, the total production of progeny by this group was only 11% greater than that of the untreated group.

Insects exposed to insecticides for 6 hr with knockdown produced fewer progeny than the untreated controls for each of the three 7-day oviposition periods. The production of progeny by this group was only 54, 66, and 33% of the progeny production of the untreated controls as a result of the oviposition that occurred during the first, second, and third weeks, respectively. The treatment mean differed significantly from the untreated mean at the 0.05 level in all 3 weeks. The total progeny production resulting from the 3 weeks of oviposition was 50% of that of the untreated controls.

The parent group exposed to insecticide for 6 hr with knockdown showed the greatest mortality at the end of the 3 weeks. Seventeen percent of these insects were dead at the end of the period compared with 12% of the parent insects exposed for 6 hr without knockdown, 7% of the parent group exposed for 2 hr, 10% of the parent group exposed for 1 hr, and 3% of the untreated parent controls.

DISCUSSION AND CONCLUSION

Several tentative conclusions can be drawn from the results of the tests with insects that emerged 36 days after the end of the oviposition period.

First, the 6-hr treatment on a synergized pyrethrins-treated surface stimulated the rice weevil into earlier oviposition than was shown by the untreated controls. The parent group treated for 6 hr produced 53% more insects than did the untreated group after the 3-day oviposition period.

Second, this temporary stimulating effect was lost sometime after the third day. The similarity of the number of progeny produced by the parent group treated for 6 hr and the untreated parent group after a 7-day oviposition period indicated the early loss of the initial stimulating effect of the 6-hr treatment exposure seen in the 3-day oviposition period.

Third, the shorter treatments of 1 and 2 hr had a depressing or delaying effect during the first 3 days of oviposition. This was evidenced by the fact that the production of progeny by the parent groups treated 1 and 2 hr after a 3-day oviposition period was only 42 and 10%, respectively, of the productivity by the untreated parent group, while after a 7-day period of egg-laying it was 35 and 49% greater than the productivity of the untreated checks.

Fourth, treatment sufficient to effect knockdown was necessary to bring about a lasting reduction in the production of progeny. The levels of production of progeny for the group treated for 6 hr without knockdown in all 7-day oviposition periods suggests this. The untreated groups produced more progeny in all cases.

The increase in production of progeny in some treatment groups over those in the untreated controls is the first recorded evidence that production of progeny by the rice weevil is so affected.

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