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EFFECTS OF A JUVENILE HORMONE MIMIC ON *PSOROPHORA CONFINNIS* (LYNCH-ARRIBÁLZAGA) AND NON-TARGET AQUATIC INSECTS

C. D. STEELMAN AND P. E. SCHILLING[1]

Abstract. Monsanto 0585 (2, 6-di-*t*, butyl-4-(*a*, *a*,-dimethyl benzyl) phenol) caused high levels of larval mortality to *Psorophora confinnis* (Lynch-Arribálzaga) at 24 hr in the laboratory. In rice field tests Mon 0585 caused 100, 82, and 78 percent overall mortality (larvae and pupae) at concentrations of 2.0, 1.0 and 0.5 ppm, respectively, 5 days after treatment when applied to 1st instar larvae at time of flood. Concentrations of 2.0, 1.0 and 0.5 ppm caused 100, 96, and 84 percent overall mortality when applied to 3rd instar larvae 4 days after the rice had been flooded.

The number of Dytiscidae larvae was significantly ($P<.01$) reduced in the treated plots when compared to the untreated control population. Also, a reduction in Hydrophilidae larvae appeared possible.

Laboratory investigations have indicated that synthetic hormone chemicals show promise as mosquito control agents (Spielman and Williams, 1966; Spielman and Skaff, 1966; Jakob and Schoof, 1971). Spielman (1970) and Wheeler and Thebault (1971) conducted outdoor tests in which 100 percent control of *Culex pipiens quinquefasciatus* Say was achieved with 0.02 mg/ml of synthetic hormone. Hormonal action lasted for 72 hours with activity decreasing daily and no effect on 1st, 2nd or 3rd instar larvae was observed.

Sacher (1971) reported that a new chemical with juvenile hormone-type activity gave complete control of mosquito larvae at ca. 1.0 lb/A. He stated that this compound was practically inactive against non-target organisms which included the adult pea aphid, *Acryrthosiphon pisum* (Harris); western corn rootworm larvae, *Diabrotica virgifera* LeConte; Mexican bean beetle larvae, *Epilachna varivestis* Mulsant; house fly larvae and adults, *Musca domestica* Linnaeus; southern armyworm larvae, *Spodoptera* (=*Prodenia*) *eridania* (Cramer); and the strawberry spidermite adult, *Tetranychus atlanticus* McGregor=(*turkestani* U & N).

The present study was conducted to determine the effects of a synthetic hormone on natural populations of *Psorophora confinnis* (Lynch-Arribálzaga) and some non-target aquatic insect species in rice fields.

Materials and Methods. Prior to conducting field tests, 1st instar *P. confinnis* larvae were collected and transported to the laboratory to determine their susceptibility to the synthetic hormone, (2,6-di-*t*, butyl-4- (*a*,*a*- dimethylbenzyl) phenol) tested under the code designation Mon

[1] Associate Professor, Department of Entomology, and Experimental Statistics, respectively, Louisiana State University, Baton Rouge, 70803.

0585 (Sacher, 1971). Fifty 2nd instar larvae were placed in 28 x 17 x 4.5 cm enamel pan which contained 1,000 ml of distilled water treated with Mon 0585 at 1.0, 0.75, 0.5 and 0.25 ppm of the compound. Each concentration and an untreated check were replicated 4 times.

Each pan of larvae was aerated continuously and 0.25 g larval food consisting of finely ground rabbit feed was added daily. The effects of treatment were determined at 24, 48 and 120 hr post treatment. Those larvae and/or pupae killed by the treatments were removed at each observation period.

Field test plots 7.6 x 24.3 m were drill-planted with Saturn rice at a rate of 100 lb/acre and fertilized with 16–8–8 at a rate of 500 lb/acre on May 7, 1971. The plots were flushed with approximately 5 cm of water 14 days after planting to facilitate plant growth and stimulate oviposition by *P. confinnis*. The plots were sprayed topically with propanil at a rate of 3 lb/acre by aircraft 21 days after planting for weed control. Three days after the propanil application, the plots were flooded to a depth of 15 cm.

An emulsifiable concentrate formulation of Mon 0585 was used in these tests. The quantity of Mon 0585 necessary to provide treatment concentrations of 2.0, 1.0 and 0.5 ppm in the total volume of water contained in the plots was mixed with 1 gallon of water in 3 gal hand-pump sprayers and applied to the plots. This allowed a more uniform application of the material over the entire plot. The plots were sprayed at 12 psi with a fan nozzle held ca. 3 ft above the water surface. All treatments including the untreated check were replicated four times. Treatments were assigned to the plots in a randomized design.

Rice in all treatments was observed for possible injury resulting from the spray application of Mon 0585.

TEST 1. Mon 0585 was applied immediately after the plots were flooded. Effectiveness of mosquito control was determined on the fourth and fifth day after treatment. Mosquito counts were made with the aid of an 11.5 cm diameter enamel dipper at 450 ml capacity. Six dips were made diagonally across each plot and the average number of larvae per dip was calculated.

On August 17, 1971, 82 days after treatment, the plots were individually drained through a 4 in. pipe to which a 16 x 18 mesh plastic screen trap was attached to collect the aquatic insects. These specimens were placed in 500 ml jars and transported to the laboratory for identification and counting.

TEST 2. Mon 0585 was applied 4 days after flood by the method previously described. The *P. confinnis* larvae were in the 3rd instar of development at time of treatment. The effectiveness of mosquito control was determined on the 1st and 2nd day after treatment. Mosquito counts and the collection of other aquatic insects were made as previously described. These plots were drained on the same date as those in Test 1. The non-target aquatic insect data were statistically analyzed as 7 treatments in a randomized design. An orthogonal set of comparisons was used to partition the treatment source of variation into components, a component being associated with each of the treatment comparisons.

RESULTS AND DISCUSSION. The susceptibility of *P. confinnis* to selected concentrations of Mon 0585 is shown in Table 1. The high levels of larval mortality achieved by all concentrations at 24 hr in

TABLE 1.—Percent *Psorophora confinnis* larval mortality after treatment in 1st instar with Mon 0585 in laboratory tests.

Concentration (ppm)	% Mortality Hr. post treatment 24	48
1.0	100	..
0.75[a]	95	..
0.5[a]	50	70
0.25[a]	40	50
0.0	0	0

[a] Remaining larvae died at pupation by 120 hr. post treatment.

TABLE 2.—Effect of Mon 0585 applied at flood on natural populations of *Psorophora confinnis* larvae and pupae 4 and 5 days after treatment.

	4 days post treatment			5 days post treatment		
Concentration Mon 0585 (ppm)	Avg. no. larvae/dip	Larval instar	% control	Avg. no. pupae/dip	% control	% Overall control[a]
2.0	0.12	3	98	0	100	100
1.0	1.2	3	77	1.2	84	82
0.5	1.1	3	78	1.8	77	78
0.0	5.1	4	0	7.8	0	0

[a] Numbers of larvae and pupae were combined to calculate the overall treatment effectiveness.

the laboratory were not anticipated since the previously indicated workers did not observe larval mortality in the species utilized in their tests. All *P. confinnis* not killed in the larval stage died at pupation by 120 hr. after treatment.

The effect of Mon 0585 applied at flood (Test 1) on natural populations of *P. confinnis* larvae and pupae is shown in Table 2. The 2.0 ppm concentration caused 98 percent larval mortality 4 days after treatment and the remaining larvae died at pupation. The 1.0 and 0.5 ppm concentrations caused 77 and 78 percent larval mortality 4 days after treatment, respectively. At 5 days after treatment the mosquitoes in the untreated plots had pupated and at that time an 84 and 77 percent mortality had been effected in the plots treated with 1.0 and 0.5 ppm concentrations, respectively.

The numbers of larvae and pupae dipped in each treatment were combined and compared to those dipped in the untreated plots, thus the overall effectiveness of the treatment was calculated. These data indicate that under rice field conditions a 2.0 ppm concentration of Mon 0585 is necessary to achieve an overall 100 percent control since concentrations of 1.0 and 0.5 ppm provided mortalities of only 82 and 78 percent, respectively.

The 2.0, 1.0 and 0.5 ppm concentrations of Mon 0585 caused 95 percent or greater mortality when applied to 3rd instar *P. confinnis* larvae (Test 2) 4 days after the rice had been flooded (Table 3). Mortality at the time of pupation ranged from 100 percent at the 2 ppm concentration to 73 percent at 0.5 ppm. The overall control was calculated as described in Test 1. The 2.0, 1.0 and 0.5 ppm concentrations caused 100, 96 and 84 percent overall mortality, respectively.

The results obtained in Test 1 and Test 2 indicate that at concentrations of 1.0 and 0.5 ppm greater larval and pupal mortality occurred when Mon 0585 was applied 4 days after flood than when applied on the day of the flood.

TABLE 3.—Effect of Mon 0585 applied 4 days after flood on natural populations of *Psorophora confinnis* larvae[a] and pupae 1 and 2 days after treatment.

	1st day post treatment			2nd day post treatment		
Concentration Mon 0585 (ppm)	Avg. no. larvae/dip	Larval instar	% control	Avg. no. pupae/dip	% control	% Overall control[b]
2.0	0.2	4	97	0.0	100	100
1.0	0.2	4	97	0.25	96	96
0.5	0.33	4	95	1.5	73	84
0.0	6.0	4	0	5.54	...	...

[a] Treatment applied to 3rd instar larvae.
[b] Numbers of larvae and pupae were combined to calculate the overall treatment effectiveness.

The aquatic insects collected were adult Hydrophilidae: Berosinae sp., *Berosus striatus* (Say), *Hydrophilus triangularis* (Say) and *Tropisternus lateralis* (F); adult Dytiscidae: *Acilius* sp., *Thermonectes basilaris* (Harris), and *Thermonectes* sp; adult Curculionidae: *Lissorhoptrus oryzophilus* Kuschel; adult Belostomatidae: *Belostoma* 2 sp.; adult Corixidae: *Trichocorixa* sp.; adult Notonectidae: *Notonecta* sp. and Hydrophilidae and Dytiscidae larvae.

The data in Table 4 show the average number by treatments of non-target aquatic insects collected in sufficient numbers for statistical analysis from both treatment and control plots. The number of Dytiscidae larvae was significantly ($P < .01$) reduced in the treated plots when compared to the untreated control population. No statistically significant difference in the populations of adult *Thermonectes* sp., *L. oryzophilus, B. striatus, Trichocorixa* sp., *Notonecta* sp., *T. lateralis* and Hydrophilidae larvae was found between the treated and untreated plots. Although a reduction in Hydrophilidae larvae may have occurred, its statistical significance was doubtful because of the lack of uniform population dispersal over the field test area, which caused too much variation between replications.

Leech and Chandler (1968) reported that the adults of many species of Hydrophilidae and Dytiscidae made dispersal flights during April and May. Although some species oviposited throughout the summer, most species deposited eggs during the spring. The life cycle was completed during the summer and the adults commonly emerged and dispersed in August and September. In this study the difference in numbers of Hydrophilidae and Dytiscidae larvae collected from the untreated compared to the treated plots indicates that the reduction was due to the chemical treatment rather than to pupation. Had the collections been made later in the summer, pupation could have obscured the effects of this chemical on the larval stage of development.

No rice plant injury was observed during this study.

These data indicate that while providing effective control of *P. confinnis* under field conditions, synthetic hormone chemicals may not be as specific to mosquitoes as laboratory work has indicated.

TABLE 4.—Average numbers of non-target aquatic insects collected from rice plots treated with Mon 0585.

Aquatic Insects	Average numbers collected/treatment — Treatment—concentration (ppm) — Applied at flood 2.0	1.0	0.5	Applied 4 days after flood 2.0	1.0	0.5	Check
ADULTS							
Thermonectes sp.	24.5	8.0	29.5	13.3	33.5	18.3	33.0
Lissorhoptrus oryzophilus	11.3	2.5	4.3	6.3	6.3	9.5	4.0
Berosus striatus	2.5	0.5	5.5	2.5	1.5	4.3	2.0
Trichocorixa sp.	38.3	10.5	94.0	90.3	99.5	53.5	31.8
Notonecta sp.	3.0	1.5	1.5	1.8	0.5	1.8	10.8
Tropisternus lateralis	14.3	6.3	18.8	20.3	7.8	18.0	12.5
LARVAE							
Hydrophilidae	71.0	62.3	24.3	21.8	1.0	64.5	132.3
Dytiscidae	2.5[a]	3.3[a]	5.5[a]	1.3[a]	0.5[a]	4.3[a]	37.8

[a] All treatment-concentrations caused statistically significant ($P < .01$) reductions when compared to control population.

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ADULT MOSQUITO KILL AND DROPLET SIZE OF ULTRALOW VOLUME GROUND AEROSOLS OF INSECTICIDES[1]

G. A. MOUNT and N. W. PIERCE

Entomology Research Division, Agr. Res. Serv., USDA, Gainesville, Fla. 32601

Abstract. Ground applications of ultralow volume insecticide aerosols against caged adult female *Aedes taeniorhynchus* (Wiedemann) showed that Pennwalt TD-8550 (methyl (mercaptoacetyl)methlycarbamate *S-ester* with *O*-methyl methylphosphonodithioate), synergized pyrethrins, Dowco® 214 (*O,O*-dimethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate), chlorpyrifos, Plant Protection PP-511 (*O*-[2-diethylamino)-6-methyl-4-pyrimidinyl] *O,O*-dimethyl phosphorothioate), naled, and resmethrin were the most effective of 13 chemicals tested. Correlation of droplet size with adult mosquito kill indicated an optimum size range of 11 to 20 μ for naled, chlorpyrifos, and Plant Protection PP-511 with mass medium diameters (mmd's) from 8 to 17 μ.

We have continued to evaluate promising insecticides for adult mosquito control with the ultralow volume (ULV) ground aerosol method. This report gives the results obtained with an additional 13 chemicals tested during 1971.

Tests with Caged Mosquitoes. These tests were conducted in an open field near Gainesville, Florida, in April, May and June. The tests were performed between 6 and 9 pm when climatic conditions were favorable. Temperatures 5 feet above the ground ranged from 74° to 84° F and averaged about 79° F. Wind velocities ranged from <2 to 10 miles per hour (mph) and averaged about 4 mph.

The insecticides tested were as follows:

Chevron RE-11775 (58 percent *m-sec*-butylphenyl methyl(phenylthio)-carbamate mixture with 29 percent and 5 percent *O*-isomers)
Chlorphoxim
Chlorpyrifos
Dichlorvos
Dowco® 214 (*O,O*-dimethyl *O*-(3,5,6-trichloro-2-pyridyl)phosphorothioate)
Lethane® 348 (2-(2-butoxyethoxy) ethyl thiocyanate)
Malathion
Naled

[1] This paper reflects the results of research only. Mention of a pesticide or a commercial or proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the U.S. Department of Agriculture.