

EVALUATION OF INSECT GROWTH REGULATORS AGAINST *PSOROPHORA CONFINNIS* (L-A) IN SOUTHERN CALIFORNIA

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ABSTRACT. The insect growth regulators (IGRs) Dimilin® or TH-6040 {1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl urea)}, HE-24108 {3-butyn-2-yl-N-(p-chlorophenyl carbamate), methoprene or Altosid® {isopropyl (E,E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate}, and R-20458 {(E)-6,7-epoxy-1-(p-ethylphenoxy)-3,7-dimethyl-2-octene} were evaluated against larvae of the floodwater mosquito *Psorophora confinnis* (L-A) in irrigated pastures in the Palo Verde Valley of southern California. TH-6040 WP formulation at the rate of 0.005 lb/A a.i. or higher produced complete control of this mosquito. Most of the mortality occurred in the larval stage. HE-

24108 WP formulation at 0.25 and 0.5 lb/A a.i. produced high mortality in the pupal stage at the lower rate, but most of the mortality occurred in the larval stage at the higher rate. At the higher rate, this material produced complete control of this species, but not at the lower rate.

Altosid SR-10 yielded complete control at both rates (0.025, 0.05 lb/A), most of the mortality occurring in the pupal stage. Two formulations of R-20458 were tested. The EC was inferior to the 2S microencapsulated formulation. This latter formulation gave almost complete control at the higher rate (0.25 lb/A). Most of the mortality was realized in the pupal stage.

During the past few years, studies on the surveillance of arboviral prevalence in the Palo Verde Valley of southern California have shown a high percentage of *Culex tarsalis* Coquillett pools to be positive for WEE and SLE viruses (California State Department of Public Health Reports 1973). To head off a possible outbreak of mosquito-borne diseases in this area, emergency mosquito control programs were initiated by the Coachella Valley Mosquito Abatement District, upon the request of and funding by the Riverside County Board of Supervisors and the city of Blythe and the recommendation of the Vector Control Section of the State Department of Public Health (Stains 1974). During 1974, the Department of Public Works of the city of Blythe continued using the same adulticiding program implemented by the Coachella Valley Mosquito Abatement District in 1973. This program was quite successful in reducing the adult mosquito population.

Due to the large acreage of agricultural land under cultivation, mosquito breeding sources are numerous, and the present mosquito control program is not adequate to insure comfort and safety of residents. During August and September of 1974, many larval breeding locations were observed in irrigation and drainage canals,

river seepage water, sloughs, sumps, cotton and alfalfa fields, irrigated pastures, public parks, and cemetery plots. The predominant species of mosquitoes in these breeding sources was *Psorophora confinnis* (L-A), commonly known as the "3-day" mosquito. Under southern California low desert conditions, this species completes the larval and pupal development in about 3 days in the months of June to September. The adults of this species are highly active during the early and late hours of the day, attacking man and animals readily, inflicting painful bites. Although weekly adulticiding applications provided relief, the duration of relief, however, was short because newly hatched adults reinfested treated areas within 2-3 days. In order to achieve efficient and lasting mosquito control in this area, additional control measures, such as larviciding, source reduction and other measures have to be employed to complement present adulticiding operations. The use of insect growth regulators (IGRs) have shown good potential for the control of flood water and other mosquitoes elsewhere (Mulla et al. 1974, Lewallen and Ramke 1975, Hsieh and Steelman 1974, Mulla and Darwazeh 1975, Schaefer et al. 1974, Steelman and Schilling 1972).

The present studies were initiated to

evaluate several promising insect growth regulators against *P. confinnis* (L-A) in the hot desert region of southern California and to determine their effectiveness as mosquito control agents under field conditions in warm climates.

METHODS AND MATERIALS. Tests were conducted in Shropshire Pasture located on 7th Street, between 10th and 11th Avenues, 1 mile NE of the city of Blythe in the Palo Verde Valley of southern California. The compounds studied are: Methoprene or Altosid® isopropyl (E,E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate, (Zoecon Corp.); Dimilin® or TH-6040: 1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl urea, (Thompson-Hayward Chemical Co.); R-20458: (E)-6,7-epoxy-1-(*p*-ethylphenoxy)-3,7-dimethyl-2-octene, (Stauffer Chem. Co.; and HE-24108: 3-butyn-2-yl-N-(*p*-chlorophenyl carbamate), (Hercules, Inc.).

TEST 1 (AUGUST 1974). The larval breeding area was divided into 16 1/32-acre plots. Two plots were utilized per rate, and 2 plots left untreated as checks. The required amount of material from emulsifiable concentrates, microencapsulated concentrates, and wettable powder formulations were mixed in 1000 ml of water and applied with 1/2-gal hand sprayer. Plots were staked and a barrier of mud was constructed between plots to avoid mixing of materials from one plot with the other. Population consisted of 3rd-stage larvae of *P. confinnis*, 2-3 days after flooding. Five dips per plot were taken prior to 24 and 48 hours after treatment, and percent reduction was calculated. In order to determine percent inhibition of emergence (%EI), procedures developed by Mulla et al. (1974) were utilized. In brief, 24 h after treatment, 20 larvae were placed in a 1-qt polystyrene cup provided with four holes around the periphery of the cup—1.5 cm above base, and a 100-mesh brass strainer cloth soldered to cover the holes. The units were attached firmly with a heavy rubber band to a piece of thin bamboo stick, 18 in. in length, which was anchored

in the mud. A screened lid was placed over the cup to prevent predators from entering the unit and to trap the emerging adult mosquitoes for counting. All units, 2 per plot, were placed in the water at the same depth, leaving 2 in. of the cup above water surface. A red surveyor tape was tied to the top of the bamboo stick, as a marker. The isolation units were inspected daily and all living or dead larvae, pupae and adults were counted and removed. Vegetation in treated area was dense and ranged in length from 6-10 in. Water was 3-8 in. deep covering the entire plots. Air temperature prevailing during the test period ranged from 81°-104° F as measured by a weather station.

TEST 2 (SEPTEMBER 1974). The test was divided into 18 1/32-acre plots. Procedure utilized in spraying and evaluation was the same as that in test 1. In addition, pupae were collected from each plot for assessment of emergence. Forty-eight h after treatment, 20 pupae were placed in each of 4-oz. dixie cups containing 100 ml of tap water, 2 cups from each treated plot and checks. The pupal cups were kept outdoors on a picnic table in the shade of a tree for 24 h, the number of dead pupae and adults was recorded and %EI was determined. Larval and field conditions were as in test 1, but air temperature was higher, ranging from 102°-114° F during the test period.

RESULTS AND DISCUSSION. *P. confinnis* larvae were extremely susceptible to the IGR TH-6040 (Dimilin®). At the rate of 0.01 lb/A, complete control of larvae was achieved 2 days after treatment (Table 1). HE-24108 also was highly active against this mosquito, producing 88% reduction in the population at the rate of 0.25 lb/A. At this rate, mortality occurred in the late larval and pupal stages, but at the higher rates, 0.5 lb/A, the bulk of mortality occurred in the larval stage. Altosid SR10 also yielded good reduction of larvae at the rate of 0.025 lb/A, but, as expected, the bulk of the mortality occurred in the pupal stage.

TH-6040, Altosid SR10, and HE-24108

Table 1. Field evaluation of IGRs against larvae of *Psorophora confinnis* in irrigated pasture, (Blythe, Calif. 8/21/1974).^a

Material and formulation	Rate lb/A	Avg. no. of larvae and pupae/dip								
		Pre-treat		Post-treat days						
		L	P	1			2			
		L	P	L	P	(%R)	L	P	(%R)	
TH-6040	0.01	88	0	12	0	86	0	0	100	
25 WP	0.025	47	0	2	0	96	1	0	98	
	0.05	96	0	6	0	94	4	0	96	
HE-24108	0.25	203	0	104	0	49	30	5 ^b	88	
50 WP	0.50	116	0	1	0	99	0	0	100	
Altosid	0.025	110	0	123	0	0	45	7 ^b	53	
SR10	0.05	143	0	128	0	10	16	2 ^b	87	
Check	..	46	0	105	0	0	160	60	0	

^a Air temperature during the experiment was min. 81° F, max. 104° F.

^b Dead pupae observed in the water. The surviving pupae in some of these treatments died prior to emergence and some died in the adult stage (see Table 2).

prevented the emergence of adults completely at the rate of 0.01, 0.025, and 0.5 lb/A, respectively (Table 2). At the rate of 0.25 lb/A, HE-24108 produced only 72% inhibition of emergence from the surviving larvae. The overall level of control is much greater than this as outright mortality of the larvae was 49 and 88% during the two samplings (see Table 1).

The rates of TH-6040 as shown in Tables 1-2 appeared to be too high; therefore, this material was evaluated again at

a lower rate. Irrespective of the high temperature, TH-6040 eliminated the larvae within 2 days after treatment at the rate of 0.005 lb/A (Table 3). In the first test (see Table 1), maximum air temperature did not exceed 104° F, while during the second test, maximum air temperature soared to 114° F. Little or no larval mortality was observed in plots treated with Altosid SR10 and the 2 formulations of R-20458 which was also included in this test. Practically all mortality realized was in the pupal stage.

Table 2. Field evaluation of IGRs against larvae of *Psorophora confinnis* in irrigated pasture, (Blythe, Calif. 8/21/1974).^a

Material and formulation	Rate lb/A	Avg. % cumulative mortality after treat (days) ^b						
		2			3			(%) EI
		L	P	A	L	P	A	
TH-6040	0.01	100	..	..	..	..	..	100
25 WP	0.025	100	..	..	..	..	..	100
	0.05	61	26	0	63	36	1	100
HE-24108	0.25	5	38	4	5	51	16	72
50 WP	0.50	100	..	..	..	..	..	100
Altosid	0.025	9	39	0	10	79	11	100
SR10	0.05	63	21	0	64	31	5	100
Check	..	0	3	2	0	3	5	8

^a Air temperature as in Table 1.

^b In isolation units in the field.

Table 3. Field evaluation of IGRs against larvae of *Psorophora confinnis* in irrigated pasture. (Blythe, Calif. 9/6/1974).^a

Material and formulation	Rate lb/A	Avg. no. larvae and pupae/dip							
		Pre-treat		Post-treat days					
		L	P	1			2		
				L	P	(%R)	L	P	(%R)
TH-6040	0.005	13	0	14	0 ^b	0	0	0	100
25 WP	0.010	9	0	10	0 ^b	0	0	0	100
R-20458	0.10	7	0	11	0	0	0	6	14
2 S	0.25	55	0	3	0 ^c	95	1	3	93
R-20458	0.10	13	0	7	0	46	1	6	46
EC 4	0.25	7	0	16	0	0	1	8	0
Altosid	0.025	11	0	27	0	0	0	12	0
SR10	0.05	27	0	18	0	34	0	7	74
Check	..	12	0	25	0	0	0	15	0

^a Air temperature during experiment: min. 102° F, max. 114° F. Larvae and pupae in exposed areas in checks during the high temperature were in distress.

^b Dead larvae recovered.

^c Dead pupae recovered.

At the rate of 0.005 and 0.01 lb/A, TH-6040 inhibited adult emergence completely (Table 4). Altosid SR10 also yielded complete inhibition of emergence in this test and results were similar to those obtained in the first test (see Table 2). R-20458, however, performed poorly

at the rates of 0.1 and 0.25 lb/A. At the higher rate, R-20458 the microencapsulated 2S formulation produced 64% inhibition of adults, while the EC formulation results were more inferior (see Table 4). The larval isolation units in the field and the pupal isolate units in the motel from

Table 4. Field evaluation of IGRs against larvae of *Psorophora confinnis* in irrigated pasture. (Blythe, Calif. 9/6/1974).

Material and formulation	Rate lb/A	Avg. % cumulative mort. and inhibition of emergence (%)						
		Larval isolates ^a				Pupal isolates ^b		
		L	P	A	(%) EI	P	A	(%) EI
TH-6040	0.005	67	33	0	100	NP	..	100
25 WP	0.01	90	10	0	100	NP	..	100
R-20458	0.10	9	63	10	82	28	29	57
2 S	0.25	1	71	15	87	36	11	47
R-20458	0.10	0	29	6	35	3	5	8
EC 4	0.25	3	56	5	64	8	5	13
Altosid	0.025	3	97	0	100	100	0	100
SR10	0.05	0	100	0	100	100	0	100
Check	..	50	50	0	100 ^c	100	0	100 ^c

NP: No pupae or larvae in plots. Air temperature as in Table 3.

^a Field isolation units.

^b Pupa collected from field plots and isolated in the motel.

^c Due to very hot weather, handling of larvae and pupae resulted in complete mortality.

check plots suffered complete mortality. However, relatively low levels of mortality occurred in isolates from plots treated with both formulations of R-20458. Although the level of inhibition of emergence in R-20458 treatments was low, a good deal of mortality also occurred in the larvae and pupae treated under field conditions. Larvae and pupae were found weak or dead in exposed shallow water in the treated areas when air temperature reached 114° F. In protected areas, where vegetation was dense and high, larvae and pupae were active and healthy. From the information gathered here and the data reported elsewhere (Steelman and Schilling 1972, Hsieh and Steelman 1974), it is apparent that TH-6040, Altosid®[®], and HE-24108 possess high level of activity against *P. confinnis*, and good potential for the control of this species in a variety of breeding sources.

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