TESTS OF TWO INSECT GROWTH REGULATORS FORMULATED ON SAND AGAINST LARVAE OF SALT-MARSH MOSQUITOES [1]

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ABSTRACT. The insect growth regulators Altosid® and Dimilin® were formulated on sand granules and applied by aircraft against larvae of the salt-marsh mosquito *Aedes taeniorhynchus* (Wied.) in Florida during 1975. In 5 tests of each chemical, control was very effective at dosage rates approximately one-half those suggested or recommended by the manufacturers. Gross application rates of the granular formulation ranged from 5.5 to 8.5 lb./a. for Altosid and 6.1 to 11.7 lb./a. for Dimilin.

The salt marshes of Florida have dense canopies of mangrove trees and pickleweed in the southern portion of the state and thick growth of grasses, mostly *Spartina* spp. and/or rush, dominantly *Juncus roemerianus*, in the northern and panhandle areas. For effective coverage and economy in the application of mosquito larvicides these physical features favor granular formulations by aerial application in these marshes. Accordingly, the insect growth regulators (IGR's) Altosid® and Dimilin® were formulated on sand and tested by aerial application against natural populations of *Aedes taeniorhynchus* (Wied.) in Florida during 1975. Previous trials by Rathburn and Boike (1975) in laboratory and small plot field tests had demonstrated that these IGR's were effective against *Ae. taeniorhynchus* when formulated on sand or vermiculite granules. However, owing to the cheaper cost of sand and lack of a reliable source of a quality grade vermiculite for these formulations, sand was used in the tests reported here.

MATERIALS AND METHODS. All tests were conducted near Vero Beach, Indian River County, in mangrove-pickleweed marshes or in adjacent citrus groves. In this section of Florida, citrus is planted on mounds of soil that are separated by swales having shallow ditches that are used for irrigation. These grass swales and ditches frequently produce large broods of *Ae. taeniorhynchus* when flooded by rain.

Altosid plots ranged in size from 6 to 58 acres, and Dimilin plots were 6 to 27 acres. The granular formulations were applied in all tests by a 300 h.p. Cessna Ag-Truck equipped with a Simpson distributor and Transland gate. Applications were made at 110 mi. per hr on 40-ft flight centers and 40-ft altitude. A known quantity of formulation was placed in the hopper before each test and weighed upon removal to determine the dosage applied.

All formulations were made by the Indian River Mosquito Control District using a 3-cubic yd commercial type rotating concrete mixer. Washed, white sand of 20–45 mesh was used as the base granule. Formulations usually were made in batches of 3,000 lb. For Altosid, the formula was 2,890 lb of sand, 60 lb (7 gallons) of Altosid SR–10, 50±10 pounds of Hi-Sil 233 powder. The Altosid was sprayed on the sand with the mixer rotating until it was evenly distributed. The Hi-Sil was then added and mixed until the formulation was dry and flowed as well as the untreated sand through a test funnel. The actual amount of Hi-Sil for different batches varied slightly depending on the moisture content of the sand. This formulation contained 3 fluid ounces of Altosid SR–10 per 10 lb. of the mix. An application of 10 lb./a. of this formulation

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results in 0.02 lb./a. A.I., the manufacturer's recommended dosage for floodwater mosquitoes.

To make a 3,000 lb. batch of granular Dimilin, 2,950 lb. of sand was placed in the mixer and 10 lb. of an emulsifiable oil containing by volume 97% of Gulf 562 spry oil and 3% N101 surfactant (Rogers and Rathburn, 1960) was poured on the sand. The mixer was rotated for 10 min. and stopped, then 30 lb. of Dimilin 25 W.P. was added and the mixer rotated for 15 min. The mixture was then sampled and if it did not flow as well as the untreated sand through the test funnel, 5 to 10 lb. of Hi-Sil 233 were added and the mixer was again rotated for 10 min., or until the formulation was flowable. Ten lb. of this formulation contains 0.025 lb. A.I. of Dimilin, the manufacturer's suggested dosage.

Two methods were used for evaluating treatments: dipping of live larvae and pupae and use of covered 5-gallon size plastic buckets containing late instar larvae or pupae. One or two buckets were

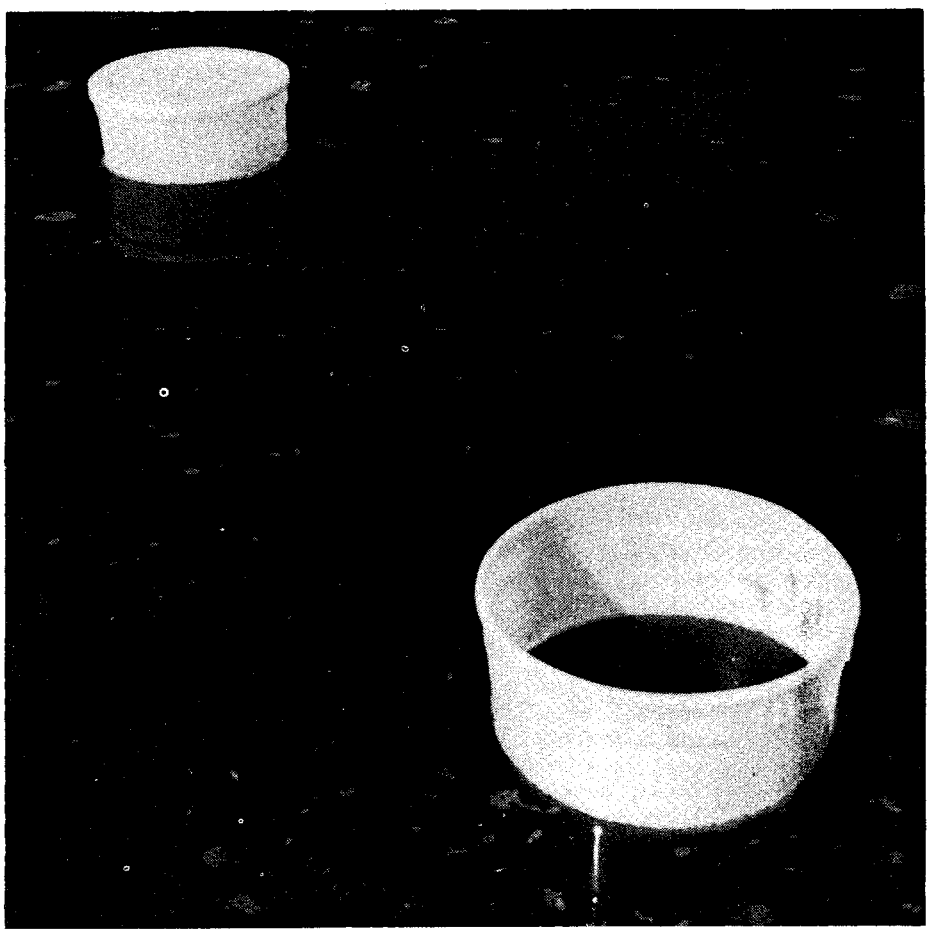
Fig. 1. — a. Pool in mangrove salt marsh showing plastic buckets used in evaluating granular IGR larvicides. b. Close-up of check bucket, covered during application, and open bucket containing treated larvae.

placed at each of two dipping stations in each plot. Approximately 3 in. of soil from the plot were placed in the buckets for ballast, then water and several hundred larvae were dipped from the station and placed in each bucket, with the water level in the bucket being approximately the same as in the plot. Buckets were covered with tightly fitted lids during treatment which were carefully removed immediately after treatment, care being taken to blow or brush all granules from the lid before it was removed. (See Fig. 1.)

Late instar larvae and/or pupae were taken from the untreated buckets and from the treated water at the station and held at the laboratory in paper cups for emergence. The cups were fitted above with lightweight cages to retain emerging adults. Owing to accidents with some of the buckets, this method was not used successfully in 3 of the 5 Dimilin plots and 1 Altosid plot.

Small fishes were present in some plots in sufficient numbers for testing. These were dipped and placed in covered and open buckets during treatment.

Plans were to apply either 5 or 10 lbs./a. of each formulation in all tests, but due to difficulty in maintaining accurate calibration of the hopper gate, the quantity of formulation applied was quite variable.



The distribution equipment used probably was designed for application of granular fertilizers or insecticidal dusts at much higher rates, therefore was not consistent in applying 5 to 10 lbs./a. A device is being designed for the hopper gate for metering smaller quantities with the hope that this problem can be solved before additional tests are made.

RESULTS. Owing to the variability of the dosages applied, data of individual tests are presented rather than averages of replications; however, results were good with both IGR's at all dosage levels used (Tables 1 and 2). The results do show a need for further testing of the granular formulations to determine minimum effective dosage, and this is planned during 1976.

Table 1. Tests of Altosid® on sand granules applied by aircraft against salt-marsh mosquito larvae, 1975.

Test No.	Dosage-lb./a. Volume	A.I.	Average number larvae or pupae/dip (days) Pre-treat	1	2	3	4	5	6	7	% Emergence of pupal sample check	treated
1	5.5	0.011	43	58	69	27	6	—	—	—	40.0	0
2	5.5	0.011	32	76	73	80	69	9	<1	0	....	3.5
3	8.1	0.0162	13	10	19	18	25	19	17	<1	75.5	0
4	8.2	0.0164	13	19	26	22	26	14	8	<1	71.7	0
5	8.5	0.0169	22	8	13	12	13	9	5	<1	73.4	0

— No dipping.

From the limited experience gained from these tests, there was no indication of sufficient residual activity by either of the IGR's to control a second brood of floodwater *Aedes*. During one test of Dimilin, a second brood did hatch about 2 to 3 days after treatment, and this brood was not controlled by the original treatment.

In one Altosid plot that received 4.2 lbs. of granules (0.008 lb.A.I.) per a., not included in Tables 1 and 2, 20 *Gambusia affinis*[4] fry were placed in a covered bucket and an open bucket respectively. Four days after treatment 17 live fishes were recovered from the treated bucket and 13 from the check bucket. No dead fishes were found in either bucket, and the other fishes of the original 20 were not accounted for.

In a plot treated with Dimilin, 30 fishes were dipped from the plot and placed in each of 2 buckets as described above. This plot also was discarded for mosquito bioassay because the pilot could not see one flag, and this resulted in overtreatment of the dipping stations, as well as the buckets containing fish. The total volume applied was 14.6 lbs./a. or 0.037 lb.A.I. The fish station was also overtreated with this same dosage. Four days after treatment, 17 live fishes were collected from the check bucket and 18 from the treated bucket. One adult molly, *Poecilia latipenna*, was taken from each bucket and all other fishes were adult *Gambusia affinis*. Unfortunately, no effort was made to recover all of the fishes from either bucket; therefore, as in the Altosid plot, the other fishes of the original 30 were not accounted for. It should be noted, however, that live fishes were observed in almost all plots treated with both IGR's at pretreatment time and on each posttreatmnt date, and no dead fishes were ever observed in any plot.

DISCUSSION. While dosage rates were quite variable due to mechanical problems with the distribution equipment, the results of these tests indicate that effective coverage and larval mosquito control was obtained in Florida salt-marshes at ap-

[4] All fishes were identified by the late Dr. Robert W. Harrington, Jr. of the Florida Medical Entomology Laboratory, Vero Beach, Florida.

Table 2. Tests of Dimilin® on sand granules applied by aircraft against salt-marsh mosquito larvae, 1975.

Test No.	Dosage-lb./a.		Average number of live larvae or pupae/dip (days)						Percent reduction	
	Volume	A.I.	Pre-treat	1	2	3	4	5	dipping[1]	bucket
1	7.9	0.010	39	51	27	26	13	2	96	
2	6.1	0.014	48	62	—	5	2	—	96	93
3	6.1	0.014	10	19	0	—	—	—	100	
4	6.9	0.016	37	5	0	—	—	—	100	
5	11.7	0.029	82	114	130	53	8	<1	99	99

[1] Based on last day of dipping.
— No dipping

proximately one-half the recommended dosages of Altosid and Dimilin when applied by aircraft as granular formulations on sand. Additional testing is planned to refine dosage rates and support firm recommendations for operational use under Florida conditions.

Literature Cited

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