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OPERATIONAL NOTE

EFFICACY OF A GRANULE FORMULATION OF THE INSECT GROWTH REGULATOR, S-METHOPRENE, AGAINST SALT-MARSH MOSQUITOES IN FLORIDA

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ABSTRACT. Three field trials were conducted at Guana River State Park, Florida to evaluate the effectiveness of the granule formulation of methoprene, Altosid® XR-G, against salt-marsh mosquitoes. Three applications of Altosid XR-G (1.5% s-methoprene) were made at application rates of 9.0, 4.5, and 2.3 kg/ha. Pupae were collected from control and treated sites after inundation. Under field conditions, Altosid XR-G gave 44.6% control at 67 days posttreatment at Site 1 (9.0 kg/ha), 43.7% control at 67 days posttreatment at Site 2 (4.5 kg/ha), and 38% control at 53 days posttreatment at Site 3 (2.3 kg/ha). All treatments taken together achieved an adjusted 10-wk cumulative mosquito emergence inhibition of 69%. Collections were composed of *Ochlerotatus sollicitans* 68%, *Oc. taeniorhynchus* 27%, and *Psorophora columbiae* 5%.

KEY WORDS Methoprene, Altosid® XR-G, salt marsh, *Ochlerotatus sollicitans*, *Oc. taeniorhynchus*

In St. Johns County, FL, salt marshes account for approximately 150 km^2 (58 mi^2) of the 1,577 km^2 (609 mi^2) in the county. Seasonal indicators such as rainfall, tide, and temperature have been used to determine when treatment is needed. *Bacillus thuringensis israelensis* (*Bti*) is regularly used to control larval populations of salt-marsh mosquitoes. However, as St. Johns County continues to develop rapidly, applying *Bti* within an appropriate time frame for control is more difficult because of a lack of personnel. Therefore, treating salt marshes with a sustained-release methoprene formulation has the potential to be a viable alternative to treating with *Bti*.

Floodwater mosquitoes in irrigated pastures (Kramer and Beesley 1991), experimental brackish ponds (Floore et al. 1990), and grassland depressions in Kenya (Linthicum et al. 1989, Logan et al. 1990) have been controlled by treating these areas with methoprene. Altosid® XR-G, an s-methoprene, sustained-release insect growth regulator, is one product that could be useful in controlling salt-marsh mosquitoes in St. Johns County.

Three field trials were conducted at Guana River State Park, Florida, to evaluate the effectiveness of the granule formulation of s-methoprene, Altosid XR-G, against salt-marsh mosquitoes. Guana River State Park, a popular tourist spot known for its large hatches of salt-marsh mosquitoes, encompasses over 971 ha (2,400 acres) of salt marsh and mangrove tidal wetlands, oyster bars, estuarine lagoon, upland habitats, and offshore seas in northeast Florida. The vegetation is primarily cordgrass (*Spartina alterniflora* Loisel and *S. patens* (Ait.) (Muhl)) and black needle rush (*Juncus roemerianus* Scheele). Treating this wetland preserve has proven difficult in the past because Guana Lake is not easily accessible by land and Anastasia Mosquito Control District can only target the larval stages with *Bti* and methoprene products, as adulticiding is not allowed.

Three sites were located, 1 for each application rate: maximum, 9.0 kg/ha (20 lb/acre); medium, 4.5 kg/ha (10 lb/acre); and low 2.3 kg/ha (5 lb/acre). Altosid XR-G label recommends a lower application rate for *Aedes* species, but a higher rate for areas with heavy vegetation. Thus, we wanted to evaluate and determine the optimum application rate providing control of mosquitoes in heavily vegetative areas within the salt marsh.

Each site was treated with the use of a Solo 450 backpack blower with a 15-m swath. The speed maintained by the applicator for all 3 sites was 34 m/18 sec (110 ft)—the time it takes the Solo 450 to release 0.5 kg (1 lb) of chemical. All applications were made by treating the perimeter and then walking the length of the site up and down and spraying from side to side. The control sites were located adjacent to the treatment sites with a heavy mangrove barrier separating the 2 sites.

Site 1 was approximately 1.6 ha (1 acre). Thirty-six kilograms (20 lb) of Altosid XR-G was used to treat this site. Site 2 was approximately 0.4 ha (0.5 acre). Altosid XR-G was applied at the medium application rate of 4.5 kg/ha (10 lb/acre) prior to flooding of the treatment area. Site 3 was approximately 0.4 ha (0.5 acre). Two and a third kilograms (5 lb) of Altosid XR-G was used to treat this site.

All 3 sites were treated dry on April 24, 2006. After the first inundation on May 1, 2006, Site 3

Table 1. Percent emergence inhibition (% EI) of salt-marsh mosquitoes from Altosid® XR-G–treated and untreated field sites at Guana River State Park, Florida, April–July, 2006.

	Treatment site			Control site	
Days posttreatment	Treatment (kg/ha)	No. pupae collected	% EI	No. pupae collected	% EI
12	4.5	50	100.0	100	25.0
18	4.5	150	88.1	69	17.4
50	9.0	1,762	92.2	180	7.0
50	4.5	1,189	84.0	200	8.1
36	2.3	863	61.5	182	7.2
67	9.0	507	44.6	25	2.2
67	4.5	421	43.7	54	3.3
53	2.3	215	39.0	21	4.5

was re-evaluated because the site had merged with the lake. On May 15, 2006, a new Site 3 was treated with the same kg/ha as mentioned previously.

Sites 1 and 3 flooded and dried 2 times throughout the study. The first inundation of Site 1 came 50 days posttreatment, and Site 3 36 days posttreatment, on June 19, 2006. The 2nd rain event occurred on July 6, 2006. There were approximately 17 days between rain events. During this time the sites were completely dry. Site 1 remained wet for a total of 9 days (13%) throughout this study, 1 day following a high-tide event in June and 4 days following rain events on June 19 and July 6, 2006. Site 3 remained wet for a total of 10 days (19%), 1 day following each of the high-tide events in May and June and 4 days following rain events on June 19 and July 6, 2006.

Site 2 flooded and dried 4 times during the study. Inundation occurred on May 6, May 12, June 19, and July 6, 2006. The first inundation occurred 6 days posttreatment. The site immediately dried and was flooded again 6 days later, on May 12, 2006. After this rain event, the site was dry for 36 days before the next rain event, and was dry for 17 days before the last rain event on July 6, 2006. Site 2 remained wet for a total of 15 days (22%), 1 day after the initial rain event on May 6, 1 day following each high-tide event in May and June and 4 days following each rain event on May 12, June 19, and July 6, 2006.

Mosquito larvae and pupae were sampled using a handheld dipper following initial flooding and were sampled biweekly until the water had evaporated. Pupae were brought back in 3.78-liter (1-gal) jugs to the lab and reared to determine percent survival to adulthood. Numbers of dead pupae in each container were counted until no live pupae remained in the sample.

Percent emergence inhibition (% EI) of salt-marsh mosquitoes from s-methoprene–treated sites and untreated controls can be seen in Table 1. Percent mortality was calculated as the number of pupae not completely emerging/number of pupae in the sample ($n = 100$) $\times$ 100. Emergence inhibitions between treatment and control areas were compared with the use of the z-test for proportions (Dixon and Massey 1969).

For all 3 field sites, the majority of the pupae collected did not complete ecdysis. However, those pupae that did complete ecdysis in the initial stages of the study only partially emerged, with their tarsi still attached to the exuvia. These collections were composed of *Ochlerotatus sollicitans* (Walker) (68%), *Oc. taeniorhynchus* (Wiedemann) (27%), and *Psorophora columbiae* (Dyar and Knab) (5%).

The emergence inhibition was significantly greater for mosquitoes from treated areas compared with controls throughout this study ($z = 19.1$, $P < 0.01$). Although emergence inhibition varied throughout the field trials, an adjusted 10-wk cumulative inhibition (69%) of adult emergence was achieved (Table 1). Data in Table 1 show fewer pupae collected from the control sites. This may account for the variation in mortality observed in the control sites as opposed to the field sites. However, pupal exuviae were observed on the water surface at the control sites, suggesting that a good portion of the control site had already emerged prior to collection. Very few if any exuviae were observed at the treated sites. This observation may be attributed to the physiological affects of methoprene on time of larval development.

Although the manufacture's stated efficacy period is 21 days posttreatment for a flooded site, Sites 1 and 2 were still averaging approximately 40% control 67 days posttreatment, providing 3 times the manufacturer's stated efficacy period. At Site 3, 39% control was obtained 53 days posttreatment. There was no rain event at the 21-days posttreatment mark; however, Site 1 was averaging 92% control, 50 days posttreatment. The results reported here suggest that Altosid XR-G provides some control after being exposed to the environment for up to 2 months. By applying this chemical to salt marshes before the first high tide or rainfall of the mosquito season, big hatches of nuisance salt-marsh mosquitoes can be reduced and almost eliminated for the first flooding event. In addition, this chemical can persist and remain viable, as seen in this study, for up to 2 months postapplication. This allows the district to save money and focus manpower on inland areas.

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