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OPERATIONAL AND SCIENTIFIC NOTES

EFFICACY OF ALTOSID® PELLETS AND GRANULES AGAINST *AEDES AEGYPTI* IN ORNAMENTAL BROMELIADS

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ABSTRACT. The tank bromeliad *Billbergia pyramidalis* was treated with 2 doses (0.5 and 2 g) of ALTOSID® Granules or Pellets for the control of *Aedes aegypti* L. Emergence inhibition (EI) for all mosquito pupae (including natural populations) in the center wells and leaf axils was >90% for at least 6 and 12 months for both doses of granules and pellets, respectively. No significant difference in %EI was found between center wells and leaf axils.

Aedes aegypti (L.), the urban vector of dengue, is common throughout north Queensland, Australia. It, along with *Aedes notoscriptus* (Skuse), a potential vector of Ross River virus (Ritchie et al., in press), commonly oviposits in tank bromeliads (J. Moloney and S. Ritchie, unpublished data). The central leaves of these plants tightly overlap, forming a cavity that holds water, and the outer axial leaves form 4–6 separate cavities that also hold sufficient water for mosquito larvae to complete development. Although this is not a significant source of mosquitoes for most homeowners, nurseries and enthusiasts who have large stocks of these plants may have serious problems. Traditional methods of control such as flushing (Gettman and Frank 1989), use of oil, or insecticide treatments may not control all mosquitoes and are labor intensive, requiring weekly to biweekly applications.

Slow-release formulations of (*S*)-methoprene have been shown to offer effective control of container-breeding mosquitoes for extended periods (for a review, see Ross et al. 1994). Nasci et al. (1994) found that small bowls (22 × 5 cm) treated with 2 g of ALTOSID® Pellets controlled *Aedes albopictus* (Skuse) for 6 months. The new laminated granule (Kline 1993) also offers long-term control, albeit for somewhat less time than the pellets. The objective of this study was to establish the length of time of control (>90%) of *Ae. aegypti* in the tank bromeliad *Billbergia pyramidalis* (Sims) Lindley treated with 2 doses of ALTOSID® Pellets (4% (*S*)-methoprene) and Granules (1.3% (*S*)-methoprene).

Twenty mature *B. pyramidalis* were prepared by washing each with a hose to remove any existing mosquito eggs, nutrients, or other potential contaminants. Each plant was then planted in a 20-cm-diameter pot containing a mixture of charcoal, bark, quincan gravel, and peat. Bromeliads were filled with water and any that lost water overnight were excluded. The individual bromeliads were then treated at a rate of 0.5 or 2 g of ALTOSID® Granules or Pellets, with 4 replicates for each treatment, and 4 untreated controls. The granules (0.5- and 2-g doses) were distributed evenly over the center well and leaf axils of each plant. For plants treated with 0.5 g of pellets (*ca.* 3 pellets, mean pellet weight was 0.15 g), all 3 pellets were placed in the center well, whereas for the 2-g dose (13 pellets), 3 pellets were placed in the center well, and the remaining pellets were placed in the leaf axil cavities. The bromeliads were then placed in partial shade and were watered with a fine mist on a regular basis. Any new shoots or flowers that developed were removed.

Third-instar *Ae. aegypti* larvae were introduced into each bromeliad as follows: 10 larvae in each central cavity, and 5 larvae into each of 3 leaf axils. The leaf of each axil with larvae was marked by a hole punch for future identification. A few drops of a dilute commercial fish food slurry were added to each plant cavity to enhance larval development. After 2 days, bromeliads were checked daily for pupae by carefully removing the contents from each cavity with a plastic turkey baster. Remaining larvae, along with their water, were replaced back into the original cavity to maintain (*S*)-methoprene levels in the bromeliads. Separate turkey basters were used for each set of control, granule, and pellet doses to prevent contamination. Any dead larvae were removed and recorded. Live pupae were placed into clear 50-ml unlidded plastic jars and these were placed into larger 250-ml clear plastic emergence cups with lids. The adults were then allowed to emerge inside the jars. Trapped live adults, partly emerged dead adults (i.e., still attached to their pupal cases), and dead pupae were counted and used to calculate the percent emergence inhibition (%EI):

$$\%EI = \frac{DP + DA}{DP + DA + AA} \times 100,$$

where DP = dead pupae, DA = dead adults, AA = live adults, and %EI = % control. Fully emerged

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Table 1. Mean (±SE) percent emergence inhibition of *Aedes aegypti* in bromeliads treated with 0.5 or 2 g/plant of ALTOSID® Granules or Pellets.

Month	Mean percent emergence inhibition[1] ALTOSID® Granules 0.5 g/plant	ALTOSID® Granules 2 g/plant	ALTOSID® Pellets 0.5 g/plant	ALTOSID® Pellets 2 g/plant	Control
0–4	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	9.7 ± 3.2 B
5	95.0 ± 5.0 A	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	7.3 ± 3.2 B
6	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	9.1 ± 3.7 B
8	85.2 ± 9.5 AB	85.2 ± 14.8 AB	96.7 ± 3.3 AB	100.0 ± 0 A	29.2 ± 15.0 B
10	71.2 ± 17.2 A	95.2 ± 2.5 A	97.2 ± 2.8 A	100.0 ± 0 A	10.8 ± 2.0 B
12	93.5 ± 4.72 A	100.0 ± 0 A	100.0 ± 0 A	100.0 ± 0 A	11.1 ± 4.8 B

[1] Means ($n = 4$) in the same row followed by a different letter are significantly different ($P < 0.05$) by Tukey's HSD test.

adults too weak to fly from the surface of the water were included with the live adults.

Percent emergence inhibition was monitored monthly for the first 6 months, then every other month until month 12 (May 1996). Treatment and control mean proportion EI was arcsine transformed and compared by analysis of variance (ANOVA) using SYSTAT® (Evanston, IL, USA). The Tukey–Kramer test was used to separate means. The %EI in plant center wells and leaf axils was compared for each dose using a paired *t*-test.

Both doses of pellets and granules provided nearly 100% control of *Ae. aegypti* for 6 months (Table 1). A significant difference was found between all (*S*)-methoprene treatments and respective controls for all months except month 8, where unusually high temperatures 2 days following removal of pupae (36.2°C and 35.6°C) may have resulted in high control mortality. Tun-Lin (1992[2]) found that 67% of a Townsville strain of *Ae. aegypti* failed to complete development at 35°C. Efficacy was relatively constant, with time not significantly affecting %EI over the last 5 months ($F = 0.947$, $P = 0.536$). The greatest emergence from a treatment group (%EI = 71.2%) occurred in the 0.5-g granules at 10 months. Heavy rains during the exposure period (117 and 118 mm over 2 days) may have diluted the concentration of (*S*)-methoprene in the bromeliads. Nonetheless, only one of the emerged adults completely eclosed and flew from the water surface. During a dry period 2 months later, control rose to 100% in all but the 0.5-g granule treatment.

Overall, no significant difference was found between proportion EI (arcsine transformed) for mosquitoes located in the center well or leaf axils. Emergence did occur in the leaf axils (88.1% EI in month 5) before emergence in the center well (87.5% EI in month 8).

[2] Tun-Lin, W. 1992. Studies on the ecology and biology of *Aedes* (*Stegomyia*) *aegypti* (Linnaeus) (Diptera: Culicidae) immatures in Queensland, with special reference to improved surveillance. Ph.D. dissertation. University of Queensland, Brisbane, Queensland, Australia.

All doses of the granules and pellets provided >90% control for 6 months, with both doses of pellets providing >90% control for 1 year. Methoprene placed in the center well only (as for 0.5-g pellets) can still affect larvae in the lateral leaf axils. Periods of heavy rainfall appear to have a diluting effect and temporarily reduce control. Thus, substantial watering of treated bromeliads should be limited. In conclusion, ALTOSID® Granules or Pellets would provide an effective and economical way to control *Ae. aegypti*, and potentially other mosquitoes, in tank bromeliads for urban and nursery growers of these plants.

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