Mole Cricket Sensory Perception of Insecticides

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Objectives:

1. Identify and describe sensory structures that occur on mole cricket antennae and mouthparts.
2. Demonstrate that mole crickets detect and respond to formulated insecticides.
3. Investigate whether responses to insecticides are related to neurotoxicity, or innate or learned behaviors.

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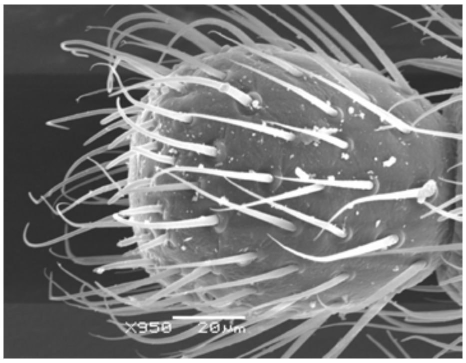
Mole crickets that infest bermudagrass on golf courses where we conduct trials seem to sense and avoid insecticide-treated plots. Greater activity appears to occur in the untreated areas between plots, so plot outlines are obvious. In addition, several Florida superintendents have reported having product failures with key insecticides. Grasshoppers and crickets, which are mole cricket relatives, can learn to associate odors with a reward (e.g., water or food) after only one exposure, so perhaps mole crickets can learn to avoid noxious odors, or perhaps insecticide resistance is beginning.

To identify and describe the sensory structures on mole cricket antennae and mouthparts, we collected adult tawny mole crickets from large linear pitfall traps in spring 2007. We began examining antennae and palps with a scanning electron microscope (SEM). This procedure will be repeated for southern and short-winged mole crickets (native mole crickets were not abundant enough to use in this study).

The number of segments on tawny mole cricket antennae ranged from 67-70 for adult males and 72-75 for females. At least five types of sensilla (sensory structures) were observed on antennae, including sensilla basioconica, s. coeloconica, s. placodea, s. trichodea type I, and s. trichodea type II. Sensilla basioconica and s. placodea may be olfactory (odors). Sensilla coeloconica may sense humidity. Sensilla trichodea (types I and II) may be a mechanoreceptor (sense movement). About 300 sensilla of different types were found per 13,000 µm≈ on the palps, but a transmission electron microscope is needed to see better detail and confirm sensilla function. Only about 5% of sensilla on the maxillary palp of a locust (*Locusta migratoria*, 370 sensillae) and a cricket (*Gryllus bimaculatus*, 5,000 sensillae) are olfactory, so we expect something similar for mole crickets.



Scanning electron microscopy photo of the last (distal) antennal segment of a female tawny mole cricket.

Two-dimensional laboratory assays were conducted to demonstrate whether or not tawny mole crickets could detect insecticides. Autoclaved builder's sand was treated with either bifenthrin (TalstarOne) or fipronil (TopChoice) at the full labeled rate, one-fourth rate, one-sixteenth rate, or no insecticide, and placed in half of a plexiglas arena (30 cm wide, 30 cm high, 1.2 cm deep). The other half contained untreated sand. One adult female was placed in the top middle of the arena (n = 10 mole crickets per treatment). Arenas were positioned vertically and held in random order in the dark. Behavioral observations occurred for the first 90 minutes, and the amount and length of tunneling within 24, 48 and 72 hours was recorded. This test will be repeated later with southern mole crickets.

Tawny mole crickets exhibited four behaviors before and after entering the soil in the arenas: remaining stationary, crawling, attempting to escape, and digging. Before mole crickets dug into the soil in both the bifenthrin and fipronil tests, they spent about 6.5 minutes remaining stationary and antennating the air and sand. Tunneling into the sand occurred faster in the control and 1/4th rate fipronil treatments (4 minutes), compared to the other fipronil treatments. No preferences were detected for tunneling into either the right or left side of the arenas, but product rate did influence where tunneling was initiated. In arenas with the full-rate of fipronil, 80% of mole crickets started tunneling into the untreated area, which indicated a deterrent effect. Tunneling initiation was more random at the two lower rates of fipronil and all rates of bifenthrin.

The total amount of tunneling by 72 hours in the controls was greater than in sand treated with the three rates of fipronil. Most mole crickets that tunneled through fipronil-treated sand and entered untreated sand did not return to the treated sand. After exposure to the full fipronil rate, adults continued to make tunneling leg movements, but they remained stationary, making existing tunnels wider.

During the first 90 minutes of the test, mole crickets in bifenthrin-treated sand made more tunnel branches, closed more tunnels, and had rapid, erratic movements compared to the controls, but by 72 hours, tunneling activity was greater in untreated compared to treated sand. No mortality occurred in the control treatments of either test, but >50% mortality occurred for the full and 1/4th rates after 24 and 36 hours in fipronil and bifenthrin tests, respectively. Mortality was 90% after 48 hours for the full rates of both insecticides.

Summary Points

- Tawny mole crickets appear to sense insecticides at short range or by direct contact in the soil.
- Antennae, maxillary and labial palps have at least 5 types of densely arranged sensilla that may sense movement, humidity, odors, and chemicals.
- Mole crickets that tunneled through fipronil-treated sand had reduced tunneling and movement after exposure, until death.
- Adults that tunneled through bifenthrin-treated sand were overstimulated, made and closed more tunnels, and were more active soon after exposure.