

BIOASSAY FOR EVALUATING TOXICITY AND REPELLENCY OF ESSENTIAL OILS TO THE RED IMPORTED FIRE ANT (HYMENOPTERA: FORMICIDAE)

MARLA J. EVA and ARTHUR G. APPEL

Department of Entomology and Plant Pathology, 301 Funchess Hall,
Auburn University, Alabama 36849-5413, U.S.A.

Abstract The growing concern of consumers about the use of traditional insecticides has increased need for development of safe, effective, and natural insecticides and repellents. Plant extracts containing essential oils have been used for centuries to kill and repel a variety of insect pests including cockroaches, flies, and mosquitoes. Recent laboratory and field experiments have shown that extracts of plants such as citrus and mint that contain mixtures of essential oils are toxic and repellent to a variety of ants, including the red imported fire ant, *Solenopsis invicta* (Burden). Numerous studies, however, report conflicting and inconsistent results. Much of the variation in efficacy results appears to be differences in bioassay methods. We examined several methods to determine the toxicity and repellency of mixtures of essential oils to the red imported fire ant. Toxicity studies included topical application, continuous exposure to a nonporous treated substrate, limited exposure to a treated substrate, and continuous exposure to treated sand. Repellency studies included a Petri dish avoidance assay, a digging assay, and a trail-crossing assay. Laboratory results were compared with the results of application of an essential oil to individual soil mound nests. Topical application methods gave the most accurate and reproducible toxicity results. Bioassay method affected apparent toxicity; topical and continuous exposure results can be affected by how the ants are contained during experiments. If the ants are enclosed in covered containers they are exposed to the essential oils both topically and by vapours (fumigation) confounding topical application and continuous exposure results. Toxicity of an essential oil mixture can be as much as 50% greater if the ants are held in a tightly closed container. Limited exposure methods were most consistent with field toxicity. The substrate digging assay also gave results most similar to those in field tests. Appropriate bioassay procedures are critical for evaluating the potential of essential oils for management of red imported fire ants.