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Larvicidal Activity of *Piper arboreum* and Its Synergy Effect with *Melaleuca alternifolia* Essential Oil Against *Spodoptera frugiperda*

Essential oil-based pesticides have been investigated as alternatives to traditional synthetic pesticides, primarily due to their advantages, including low environmental impact and the maintenance of soil health. In Brazil, various natural product-based materials are being studied to control *Spodoptera frugiperda*, a moth that consumes, in larval form, leaves from *Zea* spp., a plant of significant economic importance. On the other hand, the essential oil (EO) of native plants has shown bioactivities that are interesting for agricultural uses, including those of *Piper* spp. species, with approximately 400 species cataloged in Brazil. In this work, the seasonal chemical variability of EOs from *Piper arboreum*, the EO of *Melaleuca alternifolia* leaves, and the synergistic effects among these EOs were evaluated against the larvae of *S. frugiperda.* The EOs were extracted by hydrodistillation for 4 hours, and the larvae were exposed to the EO with the aid of a manual sprayer. Negative and positive controls were performed using pure propanone and Pirate® 0,1%, with mortalities of 0 and 100%, respectively. All tests were conducted in 10 replicates with five larvae, and the EO concentration was maintained at 2% from the synergy evaluation. The EOs from *P. arboreum*, analyzed in triplicate by GC-MS, and were then subjected to Principal Component Analysis (PCA). The *P. arboreum* EOs composition are rich in sesquiterpenoids (Autumn – 74.8%; Winter – 80.7%; Summer – 81.7% and Spring – 87.3%), mainly bicyclogermacrene (17.0±1.70%), germacrene D (9.40±2.07%) and *E*-caryophyllene (9,28±1.03%), the *M. alternifolia* EO is rich in monoterpenoids (93.3%) with predominance of terpinen-4-ol (42.3%). The larvicidal activity of EO from *P. arboreum* (Autumn: 22%; Winter: 28%; Summer: 42% and Spring: 16%) and *M. alternifolia* (24%) were lower than EO mixture (Autumn: 86%; Winter: 92%; Summer: 88% and Spring: 70%), indicating synergy between the EOs. The PCA successfully separated the seasonal samples with PC1 (Variance Explained - VE: 60.28%) and PC2 (VE: 27.66%). The minor compounds were responsible for the separation, corroborating the hypothesis that indicates the synergy between classes of compounds, and not specific compounds.

Keywords: *Agriculture, Biopesticides, Piper* spp.*, Fall armyworm, Seasonality, Synergy*