N O T E

Efficacy of Selected Insecticides against *Frankliniella* spp. (Thysanoptera: Thripidae) in Mango Orchards[1]

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Several species of *Frankliniella* (Thysanoptera: Thripidae) are considered to be economic pests of mango (*Mangifera indica* L.), as they feed and reproduce on flowers (Peña et al. 1998, Phytoparasitica 26: 1–20). In the Soconusco region of Chiapas, Mexico, thrips populations increase during mango flowering, where an average of 867 thrips per panicle has been recorded throughout the flowering cycle. The thrips complex in mango orchards of Chiapas consists of seven species in the genus *Frankliniella*, with *F. invasor* Sakimura being the predominant species (Rocha et al. 2012, Florida Entomol. 95: 171–178). Even though several studies have been conducted on mango thrips in Chiapas, the benefits of thrips control with insecticides are unknown. The purpose of this study was to evaluate the efficacy of selected insecticides against *Frankliniella* thrips, trying to elucidate if reduction in the number of thrips has beneficial effects in mango productivity.

The area for the study (N 14°42′04″, W 92°19′05″; 15 m above sea level) was approximately 6 ha (255 × 240 m) with 272 mango trees separated approximately 15 m from each other. Thirty-five trees were selected for the study based on age (5 years old), size (small trees <3 m height), presence of abundant panicles (30–40 cm length) and unopened flowers, and panicles with high numbers of thrips (>100 individuals/panicle). The five treatments (four insecticides and the control) were randomly assigned to the respective trees with seven replications per treatment in a completely random design with covariance. The insecticides tested were commonly used by Mexican growers in mango orchards: imidacloprid (Confidor 350® SC; Bayer CropScience, Mexico), malathion (Malation 1000® EC; Agroquímica

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Tridente, México), spinosad (Spintor 12® SC; Dow AgroSciences, Mexico), and α-cypermethrin (Arrivo 200® EC; FMC Agroquímica de México). Each product was mixed and applied as recommended by the manufacturer using the surfactant Freeway® (Agri Star, Mexico) at a rate of 2 ml/L. The control was water with surfactant.

Flowering of the panicles of the Ataulfo mango extends approximately 15 to 20 d from the opening of the first flower to the opening of last flower; therefore, we applied the treatments three times over that span of time. The first spray was applied before the flowers in the panicles had opened; the second spray was applied 7 d later when approximately 28% of the flowers in the panicles had opened; and the last spray was applied 14 d after the first when approximately 95% of the flowers had opened. Sprays were directed at the mango panicles by using a manually operated 20-L backpack sprayer. Care was taken to insure uniform coverage of all panicles over the entire tree. Mango trees were periodically monitored until harvest, approximately 100 days after initiation of the test.

Thrips numbers per panicle were determined at each sampling interval by removing one panicle from each tree (i.e., experimental unit) for a total of seven panicles per treatment. Thrips from each panicle were collected and preserved for identification and enumeration. Sampling was conducted just prior to and 1 d after each application so that data were analyzed using covariance of population numbers before and after each application. For each application, the number of thrips per panicle prior to spraying was considered as an independent covariate for each treatment. The number of thrips in the samples taken 1 d after spraying represented the dependent variable and the insecticidal effect on the thrips population. The effect of insecticides was assessed using a one-way analysis of covariance with the number of thrips after spraying as a treatment and the number of thrips before spraying as a covariate. Significantly different treatment means were separated using the Tukey's honestly significant difference post hoc test.

The prespray sampling of thrips revealed the presence of large numbers of individuals in all treatments. At the first application, thrips numbers ranged from 246 to 751 individuals/panicle prior to the application (Fig. 1A). After this first spray, significantly fewer numbers of thrips were observed on panicles treated with malathion and spinosad ($F = 4.53$; df $= 4$, 29; $P = 0.006$) than on the control panicles. For the second application, the prespray numbers ranged from 340 to 1694 thrips per panicle (Fig. 1B). Significant differences in the number of thrips before and after this application were observed. The α-cypermethrin and spinosad treatments significantly reduced thrips populations by 68% and 43%, respectively, with population numbers significantly lower than that of the control ($F = 9.61$; df $= 4$, 29; $P < 0.001$). For the third application, numbers of thrips in the prespray sample ranged from 474 to 1,109 individuals/panicle (Fig. 1C). No significant differences in the number of individuals before and after spraying were detected ($F = 1.04$; df $= 4$, 29; $P = 0.41$).

A total of 293,206 thrips was collected in the pre- and postspray samples in the course of this study. Of these, 196,933 were larvae (67%) and 96,273 adults (33%). Of the adults collected, approximately 99% represented the genus *Frankliniella*, with *F. invasor* as the predominant species (>95%). Although the larvae could not be identified to the species level, it is reasonable to assume that they were also predominantly *Frankliniella*. Other species of thrips collected from mango panicles

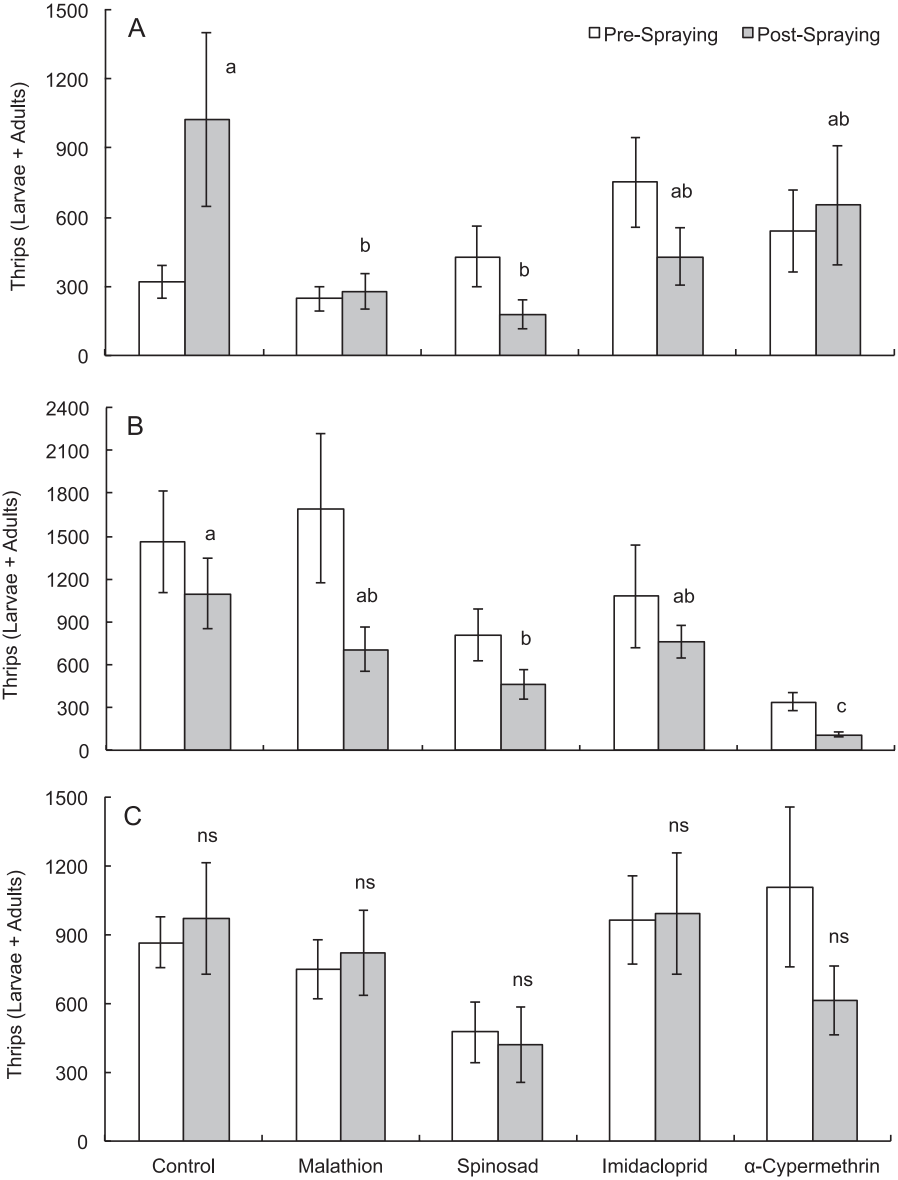

Fig. 1. Mean (± standard error) number of thrips in Ataulfo mango panicles before and after the first (A), second (B), and third (C) insecticidal spray. Tukey's honestly significant difference test was used to detect differences among postapplication treatment means.

were *F. borinquen* (Hood), *F. cephalica* (Crawford), *F. insularis* (Franklin), *F. zeteki* Hood, *Bregmatothrips venustus* (Hood), *Scirtothrips citri* (Moulton), *Haplothrips gowdeyi* (Franklin), *Leptothrips* sp., and *Karnyothrips texensis* (Hood).

Even though the insecticides applied in this study reduced thrips in most treatments, yield responses of treated trees were not significantly higher than the control ($\chi^2 = 4.82$; df $= 4$; $P = 0.31$). Consequently, based on these preliminary results, the use of insecticides to control *Frankliniella* spp. in mango orchards appears to be unwarranted at the thrips levels present during this study.

Dead thrips on mango panicles was evidence that the insecticides were killing thrips targeted by the sprays. Perhaps the relative lack of difference in numbers of thrips between the pre- and the postapplications was due to reinfestation from untreated nearby plants, by the emergence of adults from pupation in the soil, or eclosion of thrips larvae in the same experimental trees. In fact, *Frankliniella* thrips lay eggs inside the panicle tissues (Ortiz et al. 2016, Entomol. Mex. 3: 420–424) and are protected from insecticide sprays. Kay and Herron (2010, Australian J. Entomol. 49: 175–181) also reported problems with thrips reinfestation in Australia when testing insecticides against *F. occidentalis* on peppers.

Species in the genus *Frankliniella* associated with mango flowers are clearly phytophagous and, undoubtedly, cause detrimental effects in mango panicles where they feed and reproduce. However, because we did not find significant effects of the insecticides in terms of mango yields, we infer that the economic threshold of damage should be higher than the population densities of thrips observed throughout this study. These results and assumptions are in agreement with two studies that reached similar conclusions. Damián-Aragón (2000, B.S. Thesis, Universidad Autónoma de Chiapas, México, 85 p.) found that methamidophos, dimethoate, and fluvalinate were effective in controlling the flower thrips complex in Ataulfo mango; however, no increases in yields in response to treatments were obtained. Ordaz-Morales (2001, B.S. Thesis, Universidad Autónoma de Chiapas, México, 61 p.) conducted a cost-benefit analysis of controlling thrips in Ataulfo mango flowers and determined that the costs of using methamidophos, dimethoate, and fluvalinate were not recovered with the slight increases in yields obtained. Although neither of these studies included information on thrips densities or species identity, their conclusions align with the results we obtained in this present study despite testing different kinds of insecticides.

In summary, this work has provided preliminary evidence that the use of insecticides to control *Frankliniella* spp. in mango panicles will likely not increase mango yields with thrips densities we observed (e.g., 246 to 751 per panicle at the beginning of flowering, 340 to 1,694 per panicle with 28% flowers open, and 474 to 1109 per panicle with 95% flowers open). We postulate that the economic threshold for damage should be higher than these observed densities of thrips, and we recommend that growers avoid the use of insecticides when thrips densities are at or below the number per panicle we report herein. Additional research should be directed to determine the action or economic threshold of these thrips pests.

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