Hot Water Treatment as Potential Control of Mites and Scales on Tea Plants

Megan Manley* and Koon-Hui Wang. Department of Plant and Environmental Protection Sciences

CRATE

Abstract

Two field trials were conducted to determine if hot water treatment by foliar spray could be an effective non-chemical approach to mitigate spider mites (*Tetranychus urticae*), red mites (*Dermanyssus gallinae*) and scale insect (Coccoidea) infestation on tea plants (*Camellia sinensis*). A portable water heater was used to deliver hot water, averaging 47°C, on 3-year old 'Yutaka Midori', 'Yabukita', and 'Bohea' tea plants naturally infested with mites and scales. Plants were sprayed weekly over a 9-weeks period. Hot water spray reduced mites and scales several times during the first 5 weeks in Trial I ($P < 0.10$), but not thereafter. In Trial II, hot water treatment only reduced scales on week 4 and 5 ($P < 0.01$) but not mites. Despite non-persistent effect, hot water treatment could be integrated into a non-chemical IPM program to mitigate foliar arthropod pests for tea production in tropical climates.

Introduction

Hot water treatment has been shown by previous CTAHR researchers to be effective to free various plant materials including potted plants, plant suckers, tropical cut flowers from arthropods and other invertebrate or even vertebrate pests (Hara, 2011). Effective hot water bath and hot water shower treatments have been developed to treat export materials against quarantine pests. Most recently, some research has been initiated on the use of hot water foliar spray as pest management tool in field crop production (Hara, 2011). Tea production has gained some popularity among new farmers in Hawaii, however pest problem on tea would be a challenge if tea is to be produced in lower elevation. Although insecticide are available, tea producers prefer not to leave pesticide residues on the tea. Thus, non-chemical pest management approaches for tea are needed. The objective of this research is to examine if hot water spray on tea foliage could offer an effective control measure against mites and scale insects on tea plants.

Materials and Methods

Two small-scale field trials were conducted at a 3-year established tea plot at the University of Hawaii Manoa Poamoho Experiment Station. The field was naturally infested with red, broad and 2-spotted spider mites, and scale insects (Fig. 1A and 1B) . Trial I was conducted on a 18-m tea planting row of 'Yabukita' where half of the row was sprayed with hot water and the other half was sprayed with cold water once a week over 9 weeks between Jan. 15 and March 23, 2015. Hot water was generated from a portable gas powered tankless water heater (L5, Eccotemp Systems, LLC, Summerville, SC, Fig. 2A) delivered through a shower cap spray nozzle calibrated for 227-gal/acre at a pace of 0.5 m/sec targeting at 47±1°C (117±1.5°F). The temperature was monitored using an infrared thermometer (Fig. 2B). The same amount of cold water was delivered to the control plots. The experiment was conducted with 4 replications, each with 4 plants/replication.

Fig. 1: Tea plants naturally infested with A) mites and B) scale insects, and C) the Wrist Motion Shaker used to agitate the mites and scales off leaf samples.

Ten fully mature leaves (3rd leaves from the tip) were collected from each experimental unit before and after the water treatment on each week, stored in individual plastic bags, and brought back to the laboratory to extract arthropod pests from the leaves using leaf wash method.

Materials and Methods (continue)

Leaves were soaked in 70% ethyl alcohol in Nalgene flasks and agitated for 1 minute using a Wrist Motion Shaker (Fig. 1C, Fisher Scientific, Feasterville, PA). Leaves were then discarded and mites, scales and other insects collected on 100-mesh screen were counted under a dissecting microscope (Leica M125, Leica Microsystems, Wetzlar, Germany).

Trial II: A second field trial was conducted at the same established tea plot but on two other tea varieties, 'Yutaka' Midori' and 'Bohea', from Feb. 19 to March 23, 2015. Similar plot dimension to Trial I were imposed for each varieties, however, the treatments were randomized.

Figure 2: A) The portable gas powered tankless water heater, B) infrared thermometer is used to measure the hot water temperature in a measuring cup, and C) tea plants were sprayed with a portable water heater and spray nozzle.

Results

- In Trial I, hot water spray reduced mites on tea on week 2 ($P < 0.01$) and 3 ($P < 0.10$) (Fig. 3B), and reduced scale insects on week 1 ($P < 0.01$) and 5 ($P < 0.05$) (Fig. 3D). Repeated measures over the first 5 weeks showed that hot water treatment suppressed mites ($P < 0.05$). Hot water treatment did not reduce these arthropod pest beyond 6 weeks after the initiation of the experiment.
- Reduction in mites on week 4 ($P < 0.05$) and scales on weeks 4 and 5 ($P < 0.10$) before the hot water treatment (Fig. 3A, C) indicating suppression of arthropod pests by hot water treatment occasionally lasted for one week, possibly due to suppression of hatching.
- In Trial II, hot water treatment did not suppressed mites before or after the spray (Fig. 4A, B), but did reduce scales on weeks 4 and 5 ($P < 0.05$) during the "before" counting (Fig. 4C).

Discussion and Implication

- Lack of consistent arthropod suppressive effects from hot water spray in this experiment suggests that possibly more frequent spraying is needed. Spider mites required 7 days (Goff, 1986) and scales required 2 months (CTAHR Knowledge Master, http://www.ctahr.hawaii.edu/fb/coffee/coffee_insect.html) to mature in Hawaii. Hara (2011) foliar sprayed eggplant with hot water every day and found less whiteflies infestation. Future studies should look into spraying hot water twice a week on scale and mites infested tea plants.
- Hot water spray treatment could be a viable tool to be integrated with other non-chemical pest management approaches for tea plantation in the warmer climate. For example, drenching tea roots with uncured vermicompost tea has been shown to reduce mite damage on tea consistently (Mishra et al., 2014).

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Results (continue)

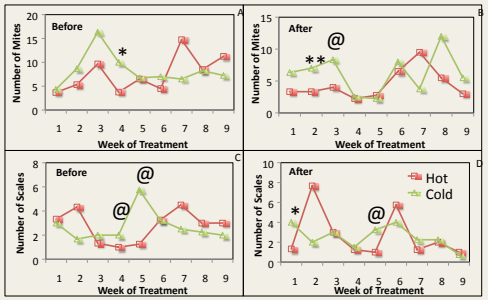

Figure 3: Number of mites and scales before and after hot or cold water spray in Trial I. Means (n = 4) on each date followed by * (= P < 0.05), ** (= P < 0.01), or @ =(P < 0.10) indicated significant difference based on analysis of variance.

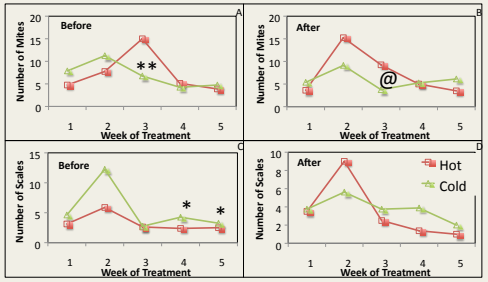

Figure 4. Numbers of mites and scales before and after hot or cold water spray in Trial II. Means (n = 8) on each date followed by * (= $P < 0.05$), ** (= $P < 0.01$), or @ (= $P < 0.10$) indicated significant difference based on analysis of variance.

Conclusion

Hot water spray treatment offered some significant effects to reduce foliar arthropod pest pressure on tea plant and could be integrated with other integrated pest management tools to develop non-chemical pest management program for tea production in the tropics.

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College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Western IPM Center