Suppression of Mites by Vermicompost Tea on Tea plant (*Camellia sinensis*)

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Introduction

Tea (*Camellia sinensis*) production in Hawaii was first commercialized by only one company in 1892, and the industry was slightly expanded by 1960s (Nakamoto et al., 2011). Due to high labor and production costs and low global tea prices, tea production has not shown to be a lucrative crop for Hawaii, but did show great potential as a specialty product (Nakamoto et al, 2011). If qualified for "100% Hawai'i-Grown Tea", loose-leaf brewing tea marketed in Hawaii currently carries prices from under $100 to $4800 per pound, depending on the harvest, types of tea, and marketing channels (Nakamoto et al, 2011). Clearly the industry has potential for growth in Hawaii. One key recommendation to guide the growth and development for tea production in Hawaii is to ensure quality. Prevention and suppression of insect and disease on tea would be part of the effort to ensure the tea quality. A thorough description and management guide to insect and mite pests of tea in Hawaii was published by Hamasaki et al. (2008). This article will focus on examining a non-pesticide approach to mitigate mite damage on tea plants.

Mite damage on Tea

Several species of phytophagous mites are a threat to tea plant. These include red and black flat mites (B*revipalpus phoenicis*, Geijskes: Tenuipalpidae), spider mites (Tetranychidae), broad mites and yellow tea mites (*Polyphagotarsonemus latus* Banks: Tarsonemidae). All of these mites cause similar damage on tea plants. They feed on plant sap and cause scarring, distortion, bronzing and or browning of the leaves (Fig. 1A). While broad mites generally prefer the younger growth, both flat mites and spider mites prefer the upper surface of mature leaves, and the damage progresses from older leaves upward to the younger growth. Young plants are more susceptible to flat mites and broad mites, whereas old established tea plants are more susceptible to spider mites. Among these

Fig 1. A) Scarring and bronzing of tea leaf caused by mites; B) Defoliation of tea leaves caused by mites.

mites, spider mite appeared to be causing the most damage (Hamasaki et al., 2008; Elmoghazy, 2011). Severe infestation of spider mites will result in massive defoliation (Fig. 1B).

Common control measure against mites relies on insecticidal spraying resulting in several negative effects such as suppression of natural enemies, potential development of pesticide resistant populations, and increase in production costs (Elmoghazy, 2011). Sulfur is an effective OMRI certified insecticide against mites, however organic tea producers prefer not to leave pesticide residues on the tea leaves to be harvested as the original flavor of the tea might be compromised affecting the quality of tea. Many farmers are looking towards non-chemical approaches for managing mites on tea.

Vermicompost tea

Spider mite resistant tea varieties are currently not available. Adding compost to soil has been known to enhance soil and plant health, and protecting plant against stress from pests and pathogens. However, the use of compost requires hauling in large amounts of solid compost from a distance followed by soil incorporation of compost through tillage. In addition, tea is a perennial crop, thus post-plant pest and disease management is more important than adding compost at pre-plant. While preparing conventional (thermophilic) compost is time consuming and requires frequent turning, turning of vermicompost is done by earthworms and other associated microorganisms. Vermicompost is produced by mesophilic decomposition and stabilization of organic matter by certain earthworms and microorganisms. One noteworthy benefit of using vermicompost is that it contains a significant amount of beneficial microbes that can promote plant growth, reduce plant stress and suppress various plant pathogens and arthropod pests (Arancon et al., 2008). It is assumed that microbial biomass and plant nutrients can be transferred from vermicompost into aqueous extracts, otherwise known as vermicompost tea (VCT), making the application of vermicompost more feasible (Ingham, 2005; Pant et al., 2009). Aracon et al. (2008) reported that VCT prepared by aerated methods support higher microbial biomass possibly due to dissolved oxygen supporting more beneficial microbial activities.

Fig 2. Brewing vermicompost tea overnight with air pumps (2.5W).

A working hypothesis for this project is that drenching plant roots with VCT offers a non-chemical based pest management strategy against mite damage. Drenching plants with VCT has been shown to increase plant available nutrients and plant growth promoting organic acids, and promote high microbial activities in the soil that could eventually increase plant tolerance to stress (Arancon et al., 2004). Vermicompost tea can be prepared by two methods:

aerated and non-aerated. Aerated VCT is usually prepared by filling vermicompost into a porous container, then suspended in a water containing vessel, typically 1 part vermicompost to 10-50 parts water. Constant agitation is used to provide aeration either by air injection directly into the water or by circulation of the water typically for 12-24 hours. Non-aerated compost tea is prepared by mixing 1 part compost with 3-10 parts water in an open container, where it remains with or without daily stirring, for at least several days (often for 1 to 3 weeks) (NOSB, 2004).

Suppression of insect pests by vermicompost tea

Vermicompost teas have considerable potential for pest suppression. An experiment done by Arancon et al. (2007) showed that drenching of VCT suppress spider mite damage. Through the application of the VCT, the soluble phenolic compound commonly found in vermicompost enters the plant and causes the plant tissue to be unpalatable, thereby affecting the rate of reproduction and survival of the pests (Pathma and Sakthivel 2012). Edwards et al. (2007) reported that earthworm uptake soil particles, absorb humic acids through their guts, and excrete monomeric phenols and polychlorinated phenols into the vermicompost. Diverse and active microbial activities in VCT resulted in release of nutrients in a slow but balance pattern that decreases nitrogen inputs, increases phenol contents in plants, thus resulting in plant resistance to pest attacks (Pathma and Sakthivel 2012). The objective of this research is to evaluate the potential of drenching tea plants with VCT to reduce mite damage.

Fig 3. Tea plants used for the drenching of vermicompost tea at the Poamoho Experiment Station.

Materials and Methods

Two small-scale field trials were conducted in a 2-year old tea plot at the Poamoho Experiment Station of University of Hawaii at Manoa, Waialua, Oahu. The field was naturally infested with broad mites and 2-spotted spider mites. Vermicompost tea was prepared by brewing food-based uncured vermicompost for 12-24 hours using an air pump (2.5W). In Trial I, a total of 15 mite damaged 'Yabukita' tea plants from one planting row was selected. The first seven plants were drenched with VCT and the last seven plants were drenched with water as control (C). One plant in between VCT and C served as a buffer between the treatments. For Trial II, 20 'Yutaka Midori' tea plants were selected from another planting row. The first 5 plants were treated with VCT followed by 5 plants treated as controls. The subsequent

10 plants were treated in the same manner. Plants that received VCT were drenched with 250 ml of aerated VCT per plant while the controls were drenched with 250 ml of tap water. Plants were drenched biweekly. Ten new leaves from each plants were examined for mite damage subsequent to each drenching. Leaves with scaring and bronzing on the lower or upper sides of the leaves were categorized as damaged (Fig. 1A), while those without the symptom were recorded as healthy. Trial I and Trial II were terminated at 2.5 and 2 months after first drenching, respectively.

Statistical analysis

All data collected were converted to percent leaves with mite damage. These data were then subjected to repeated measure analysis over time using PROC MIXED in SAS 9.2 (SAS Inc, Cary, NC). Least square means were calculated and subjected to Tukey t-test.

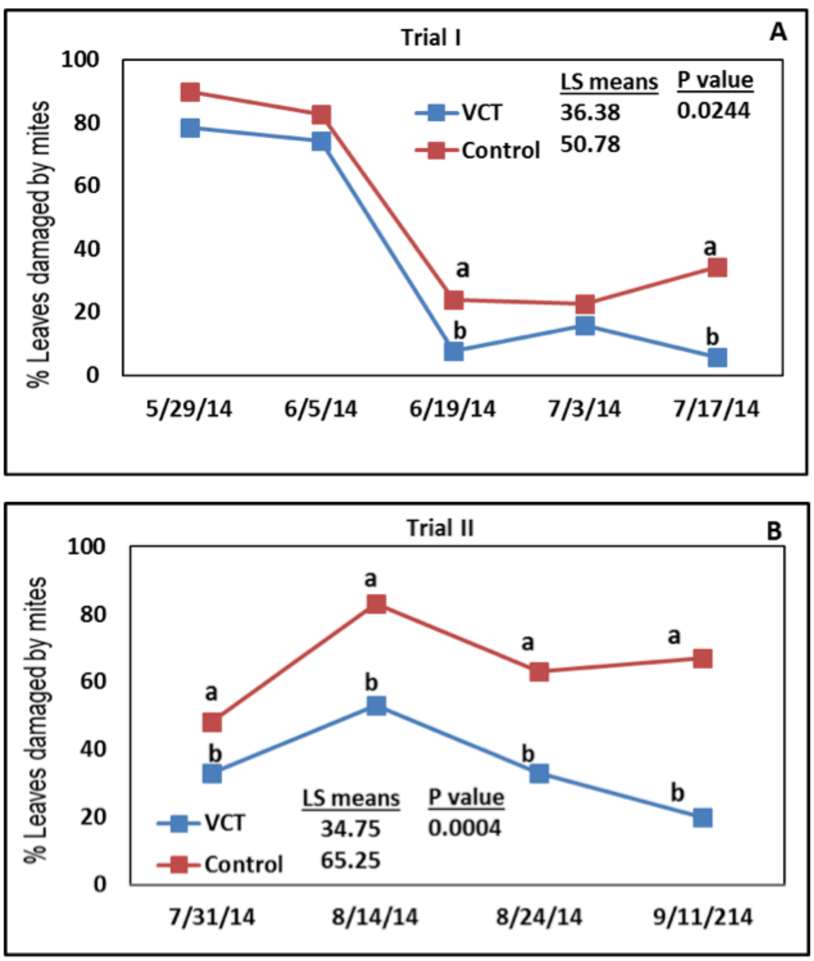

Fig 4. Effect of vermicompost tea (VCT) on % mite damage on tea plant in A) Trial I and B) Trial II. Means are average of 7 and 10 plants in Trial I and Trial II, respectively. Means on each sampling date followed by same letter are not different based on Waller-Duncan k ratio (k=100) t-test. LS means = least square means. P value is based on adjusted Tukey t-test after repeated measure analysis.

Results and Discussion

Drenching tea plants with VCT significantly reduced percent of new tea leaves damaged by mites in both trials ($P < 0.05$; Fig. 4). However the effect was more significant in Trial II than in Trial I. Based on least square means repeated over time, VCT reduced 28.36% of mite damage compared to the control in Trial I, whereas it reduced 46.74% in Trial II. Percent of mite damage in Trial I was more severe at the beginning of the trial than that in Trial II which might have caused the level of difference in the control between these trials. Results showed that VCT reduced 50% of mite damage by 3rd drenching on both trials. Weather patterns and fertilization schedule might have caused the fluctuations in mite populations and its damage. Although VCT drenching is not a curative treatment for mite damage, it serves as a preventative measure to combat against mite damage on tea. It is important to drench VCT at least at biweekly interval continuously to achieve a preventative measure. More research should examine integrating this induce host plant response from VCT drenching with other control measure to further protect tea plants from mite damage especially if tea were to be planted in warmer climates and lower elevation in Hawaii.

References

Arancon, N.Q., Edwards, C.A., Atiyeh, R., and Metzger, J.D. 2004. Effects of vermicompost produced from food waste on the growth and yields of greenhouse peppers. Bioresources Technology 93: 139-144.

Arancon, N.Q., Edwards, C.A., Oliver, T.J., and Byrne, R.J. 2008. Suppression of two-spotted spider mite (*Tetranychus urticae*), mealybugs (*Pseudococcus*) and aphid (*Myzus persicae*) populations and damage by vermicompost. Crop Protection 26: 26-39.

Edwards, C.A., Arancon, N. Q., Emerson, E., and Pulliman, R. 2007. Suppression of plant-parasitic nematodes and arthropod pests with vermicompost tea. Biocycle December 2007: 38-39.

Elmoghazy, M.M.E., El-Saiedy, E.M.A., and Romeih, H.M.A. 2011. Integrated control of the two spotted spider mite *Tetranychus Urticae* Koch (Acari: Tetranychidae) on faba bean, *Vici faba* (L.) in an open field at Behaira Governorate, Egypt. IJESE 2: 93-100.

Hamasaki, R.T., Shimabuku, R., and Nakamoto, S.T. 2008. Guide to insect and mite pests of tea (*Camellia sinensis*) in Hawai'i. CTAHR Cooperative Extension Service IP-28, 15 pp.

Ingham, E.R. 2005. The Compost Tea Brewing Manual: Latest Methods and Research. Soil Food Web Inc., Corvallis, OR.

Pant, A., Radovich, T.J.K., Hue, N.V., Talcott, S.T. and Krenek, K.A. 2009. Vermicompost extracts influence growth, mineral nutrients, phytonutrients and antioxidant activity in pak choi (*Brassica rapa* cv. Bonsai, Chinensis group) grown under vermicompost and chemical fertilizer. J. Sci. Food Agr. 89:2383–2392.

Pathma, J. and Sakthivel, N. 2013. Molecular and functional characterization of bacteria isolated from straw and goat manure based vermicompost. Applied Soil Ecology 70: 33-47.

Nakamoto, S. T., Gonsowski, J., Hamasaki, Petersen, R. E., and Seguritan, A. 2011. Hawai'i-Grown Tea: A Market Feasibility Study. Honolulu, HI: University of Hawai'i, College of Tropical Agriculture and Human Resources (CTAHR) and Pacific Asian Center for Entrepreneurship and E-Business (PACE), Shidler College of Business. 16 pp.

NOSB, 2004. Compost Tea Task Force Report. National Organic Standards Board. http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5058470

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