

## Strip-till cover cropping and vermicompost extracts improve soil and plant health in a short-term vegetable cropping system

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### Introduction

Short-term vegetable crop production often involves frequent tillage and other farm activities that result in disturbed soil food web communities. The warm tropical climate of Hawaiian Islands allows farmers to have year-round production of multiple short-term crops in the same field, which makes the agroecosystem highly vulnerable to this disturbance. A less disturbed soil community would have more structured soil food web which contains soil organisms higher up in the food web pyramid with improved soil nutrient cycling.



*Picture 1. Strip-till cover cropping of sunn-hemp in a zucchini cropping system.*

To conserve soil productivities, soil food web complexity must be restored periodically despite the continuous crop production. Nematodes are good soil health bio-indicators because they have wide range of functional associations and have universal distribution and thus can be used to examine how various land management practices impact soil health (Ferris et al., 2012; Ugarte et al., 2013).

No-till farming is an ideal practice to reduce soil disturbance, but many vegetable growers prefer to cultivate their soil due to high turnover rate of cropping cycles and challenge of weed pressure. Thus, strip-till cover cropping would be a reasonable option. Leguminous cover crops such as sunn hemp (*Crotalaria juncea*) and crimson clover (*Trifolium incarnatum*) can be grown in a strip-till cover cropping system (STCC) between vegetable cropping rows (Wang et al., 2011). Periodic clipping and incorporation of these cover crops as surface mulch (SM) provides the organic materials to the soil food web for a long period of time and continuously enhances abundance of beneficial nematodes that are higher in the soil food web hierarchy. In addition, sunn hemp has also been documented to be suppressive to plant-parasitic nematodes (Wang et al., 2002). Another approach to improve the soil food web structure in short-term agroecosystems is to enrich the soil with compost tea. Compost tea, a water-based extract of compost, can be prepared using a wide range of composts and contains a huge diversity of beneficial microbes or their metabolites, organic acids, plant growth regulator like substances and soluble nutrients (Radovich et al., 2011, Radovich & Arancon, 2011 and Ingham, 2005). This advantage of compost tea may serve as a mean to enhance the soil food web structure.

This article summarizes the effect of strip-till cover cropping and vermicompost water extract on soil food web structure in a short-term agroecosystem. Objectives of this study were to examine if: 1) drenching chicken manure based vermicompost tea could suppress plant-parasitic nematodes; 2) integrating STCC+SM with drenching of vermicompost tea could further improve soil health condition than STCC+SM alone; and 3) nematode community indices are good indicators of zucchini plant health.

## 2. Materials and Methods

Two field trials were conducted in the spring (Trial I) and late summer (Trial II) of 2011 in Wai- alua, HI to evaluate the effect of strip-till planting of sunn hemp or crimson clover cover crops in a zucchini (*Cucurbita pepo*) cropping system. Alternate rows of cover crops were tilled for zucchini planting, the remaining rows of cover crops served as living mulch. A weed-free bare ground (BG) treatment was included as the control (Picture 2 A, B, C). At zucchini planting, each cover crop plot was split to receive four soil treatments: fertilizer (Fert; chicken pellet), compost tea (CT), fertilizer plus compost tea (Fert+CT), and none. Plants that received Fert or Fert + CT treatments were fertilized with 15 g chicken pellets (4-2-2) per plant at planting, equivalent to 66 kg N/ha.

Plants receiving CT treatment were drenched with 120 ml/plant of chicken manure-based vermicompost tea at weekly interval until beginning of fruit harvest (Picture 2 D). Compost water



Picture 2. Zucchini plants grown in strip-till cover cropping system A) sunn hemp, and B) crimson clover; C) a bare ground system and D) Zucchini plants, drenched with chicken manure based vermicompost tea at weekly in-

extract was prepared from chicken manure based vermicompost aerated overnight in water at 1:10 by volume. Due to the poor establishment of crimson clover in summer time, only SH and bare ground (BG) were tested in Trial II. Zucchini fruits were harvested at maturity. Nematode community was analyzed from the soil collected from the experimental plots before and after harvest of zucchini in each trial.

### 3. Summary of Results

- ▶ Drenching compost tea combined with fertilizer suppressed the key plant-parasitic nematodes (*Rotylenchulus reniformis* and *Meloidogyne spp.*) at the initial stage of the zucchini growth and increased percentage of predatory or omnivorous nematodes and structure index (an indicator of improved soil food web structure) at zucchini harvest (Figure 1).

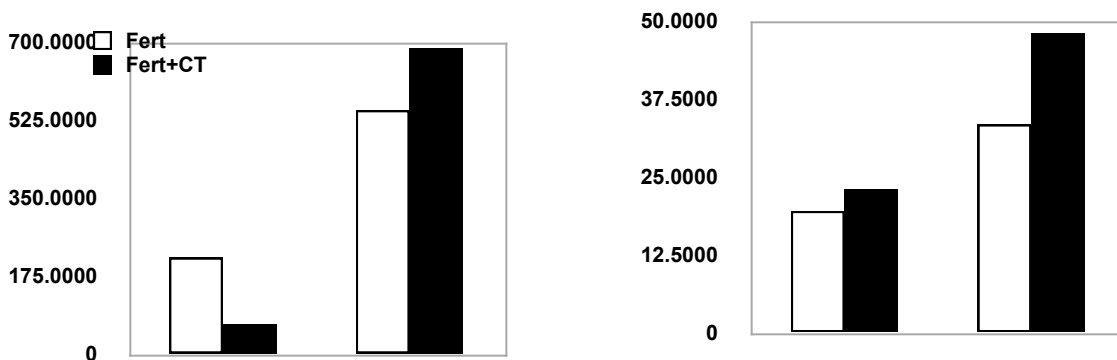


Figure 1. Effect of chicken manure based vermicompost tea (CT) treatment on abundance of key plant parasitic nematodes and structure index as compared to chicken pellet fertilizer (Fert) alone treatment \*\*\* indicates significant difference between Fert and Fert+CT treatments.

- ▶ Planting sunn hemp in a strip-tilled cover cropping system followed by continuous clipping and spreading as surface mulch provided constant inputs of organic matter, suppressed plant-parasitic nematodes and enhanced the abundance of beneficial nematodes throughout the zucchini cropping cycle and resulted in increased zucchini yield (Figure 2). Crimson clover did not enhance beneficial nematodes nor suppressed plant-parasitic nematodes.

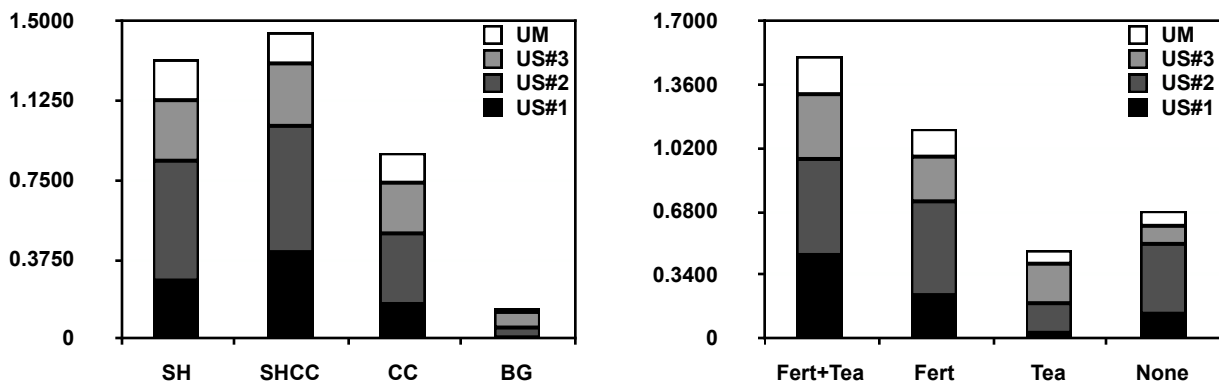


Figure 2. Treatment effects on zucchini fruit weight. US#1 = firm, tender, no damage; US#2 = firm, tender, no major damage; US#3 = off shape, multiple damages; UM = unmarketable, serious damage mainly due to fruit flies, some pickleworms, and viruses. Columns followed by same letters were not different based on Waller-Duncan k-ratio (k=100) t-test.



- ▶ Despite the benefits of compost tea in improving soil food web structure, zucchini yield was not increased by drenching of compost tea alone. On the other hand, drenching compost tea combined with fertilizer increased zucchini yield (Figure 2).
- ▶ In conclusion, growing sunn hemp cover crop with strip tillage and drenching compost tea combined with basic organic fertilizer application are advantageous to enhance the abundance of beneficial nematodes involved in soil nutrient cycling, suppress plant-parasitic nematodes and improve crop yield in short term vegetable cropping system.
- ▶ To maintain soil health, it is important to improve soil food web structure and rejuvenate sunn hemp living mulch through periodic clipping. Future work should examine the effect of higher concentration of compost tea drenching over a longer period of time.

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