2009 Sunn Hemp Cover Crop Workshop

Date: 25 September, 2009 1:00 pm
Location: Waimanalo Experiment Station, University of Hawaii
Presenter: Koon-Hui Wang, James Leary, Ted Radovich
Organizer: Jari Sugano, Steve Fukuda, Sabina Swift

Updates of Sunn Hemp Superhero Status

Sunn hemp (*Crotalaria juncea*) is an ideal cover crop that can generate great amount of organic biomass within 2.5 months of growth during spring to summer time in Hawaii (Table 1). It is a poor host of several key nematode pests, and releases toxic compounds against many plant-parasitic nematodes. It is important that sunn hemp be incorporated into the soil at its vegetative or early flowering stage so as its tissues will not become too fibrous to till in. Fully bloom sunn hemp crop will result in high carbon content that might eventually tight up soil nutrients for the subsequent crops to uptake. When incorporated into the soil, it enhances beneficial organisms that are natural enemies of nematode pests, and increase free-living nematodes involved in soil nutrient cycling. Currently we are studying different methods to improve sunn hemp cover cropping system.

Conventionally, sunn hemp cover crop is planted for 2 to 3 months, then plowed in as green manure.

Previously Manandhar and Hooks (2007) demonstrated that sunn hemp serves as 'virus sink' and protect zucchini crops from aphid-transmitted viruses and silver leaf symptom associated with whiteflies. Can we integrate the management of plant-parasitic nematodes and insect pest concurrently using cover crops? One approach is to use the **cover crop as living mulch in a strip-till system**. In May 2008, a trial was set up at Poamoho Experiment Station to examine its impact on above and below ground pests and beneficial organisms.

2008 Trial (Cucumber)

- 'Tropic Sun' sunn hemp planted @ 40 lb/acre: planted on 7 May, tilled in 23 July.
- Cover crops were grown for approximately10 weeks.
- Irrigation for cover crop: 10,747 gal/week.
- Alternate rows of cover crops were strip-tilled to create planting rows (Fig 2).
- Alternate rows of cover crops were left as living mulch, 'Sweet Slice' cucumber seedlings were planted Aug 1 (~ 1 week after tilling).
- Urea was applied once at 60 lb/acre on 13 August.
- Sunn hemp living mulch was clipped twice (4 September, 2 October) to open up canopy.
- Sunn hemp (SH) treatment was compared to French marigold (*Tagetes patula*) (MG) and bare ground (BG) control.

	
Cucumber planted into sunn hemp living mulch. Additional sunn hemp clips serve as organic mulch.	Problem of shading as sunn hemp grow taller. Labor intensive to cut back sunn hemp.

Results

Table 1. Biomass and nutrient content from sunn hemp (SH) cover crop.

	23 July 2008	4 September 2008		
	SH	SH (leaves)	SH (stem)	SH (total shoot)
Dry biomass (tons/acre)	4.65	2.57	2.96	5.53
C: N	29.3:1	11.1:1	35.4:1	-
Organic C (lb/acre)	4,764.39	2626.54	3167.2	-
Organic matter (lb/acre)	8,214.22	-	-	-
Total N (lb/acre)	162.75	-	-	-
NH_4-N (lb/acre)	5.11	-	-	-
Organic N (lb/acre)	157.17	-	-	-
P (P_2O_5)	54.87	-	-	-
K (K_2O)	255.75	-	-	-

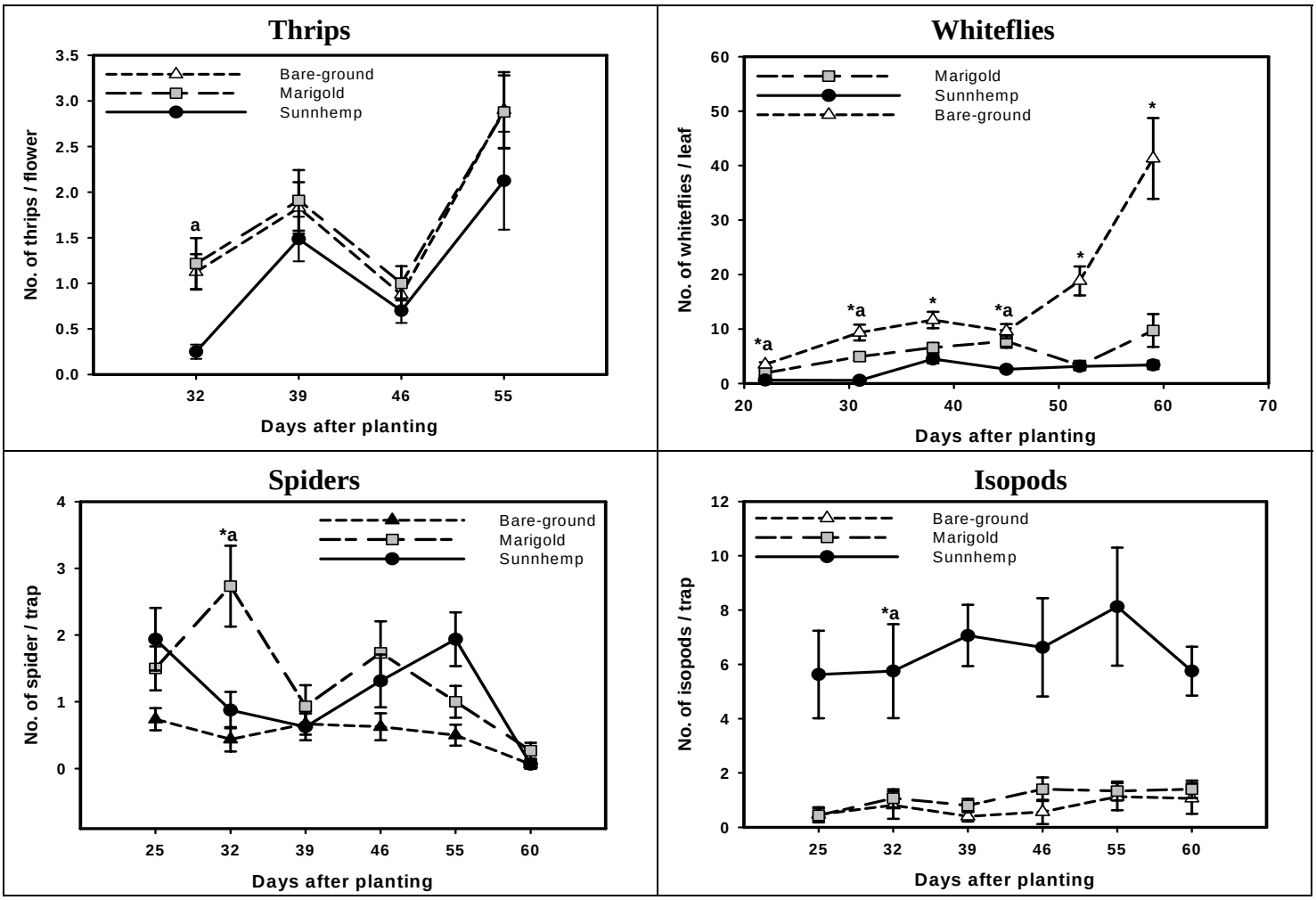
* Nutrient analysis for 4 Sept, 2008 is to be determined.

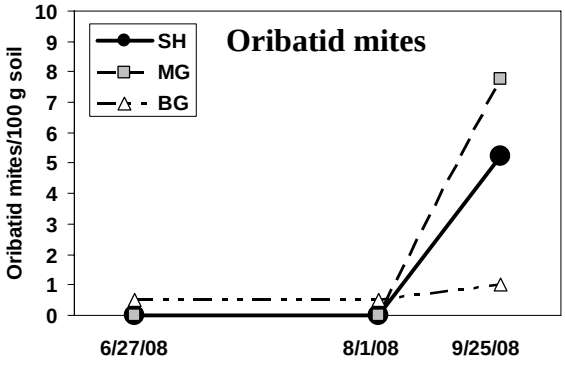
Table 2. Weed coverage at termination of cover crop (23 July 2008).

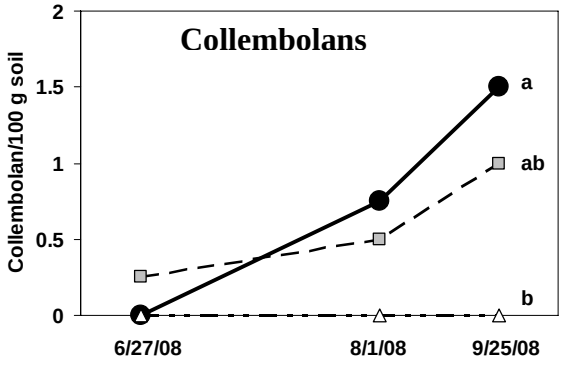
Treatment	Grass	Broad leaf weed	Sedge	Total weed
SH	1.00 b	1.17 c	1.00 a	1.08 b
MG	1.83 a	1.78 b	1.48 a	2.44 a
BG	2.21 a	2.44 a	1.28 a	3.02 a

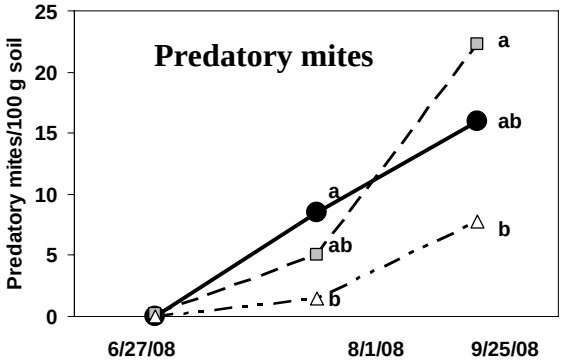
At termination of cover crop (July), sunn hemp generate great amount of biomass with high amount of organic matter and nitrogen. However, majority of the N is in organic form and is not available for the plant to uptake until it is decomposed. Additional sunn hemp clipping generate more amount of organic biomass that can serve as good surface mulch for weed control. Lower C:N of sunn hemp leaves provide an easily available N source whereas high C:N of sunn hemp stems will degrade slowly, thus maintain a source of organic matter over a longer period of time.

Good and Bad Microarthropods









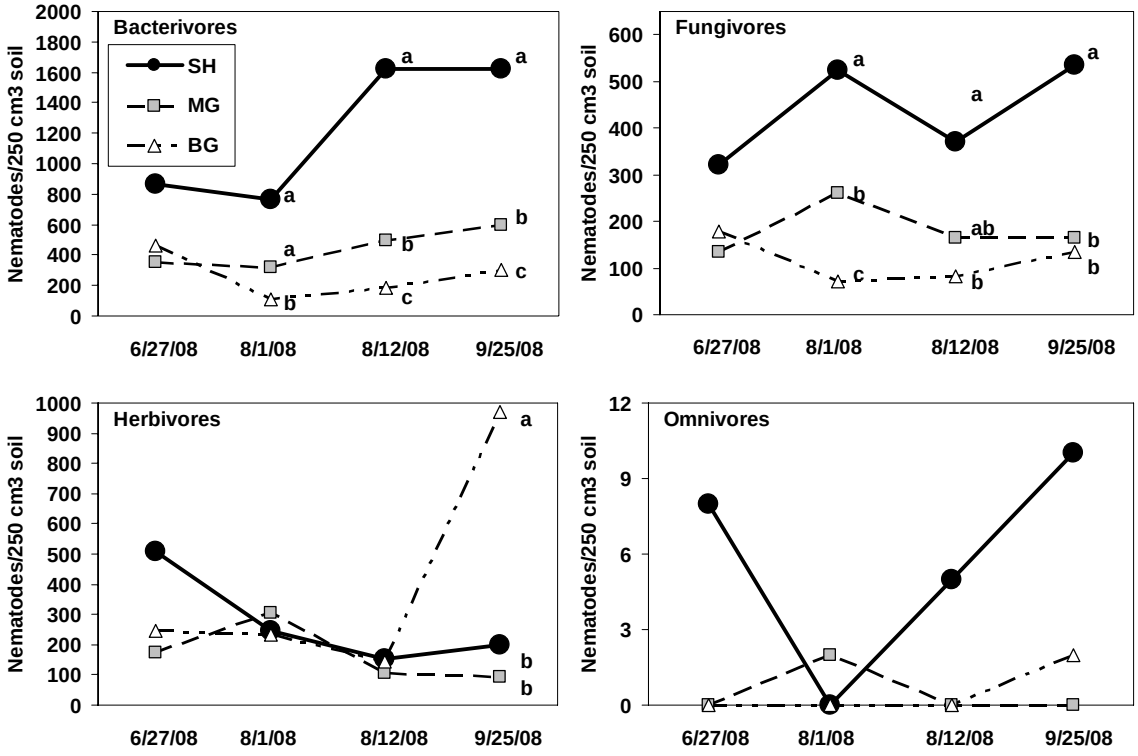
Collembolan, oribatid and predatory mites are soil microarthropods that play important roles in breaking down soil organic matters. Their numbers are lower in the bare ground control plots as compared to cover crop treated plots.

Sunn hemp might have served as a barrier for thrips and whiteflies to locate cucumber crop, thus reduce these insect pests from the crop.

Sunn hemp and marigold living mulch provide a niche for insect predators such as spiders.

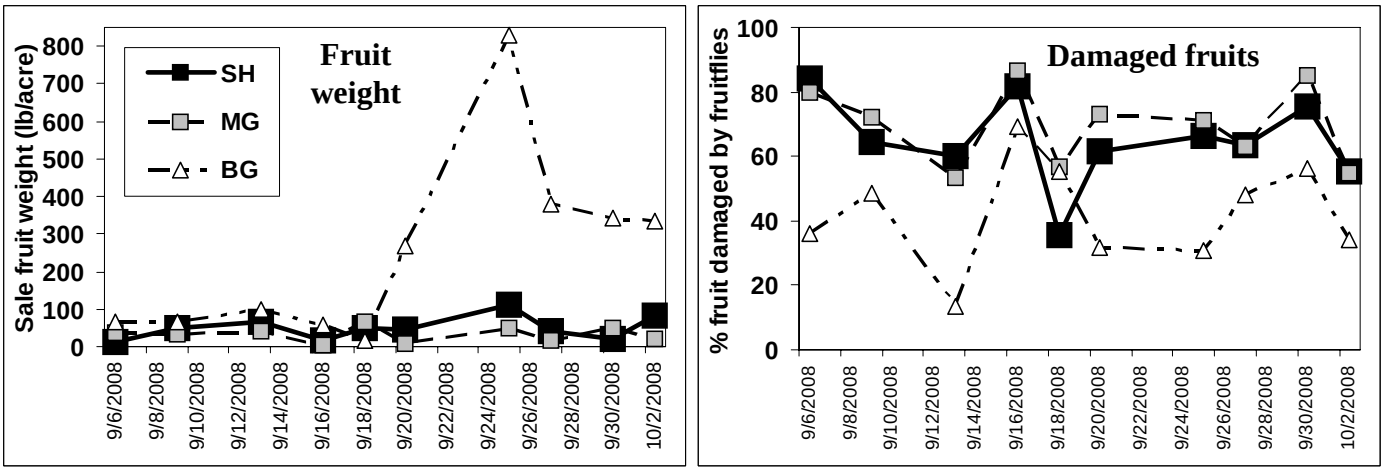
Great amount of organic matters from sunn hemp enhanced deteriovores such as isopods that will enhance decomposition.

Good and Bad Nematodes



Numbers of free-living and plant-parasitic nematodes in soil collected from sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots.

Bacterivorous, fungivorous and omnivorous nematodes are free-living nematodes feed on bacteria, fungi or other soil microorganisms. They play important roles in soil nutrient cycling. Herbivorous nematodes parasitize plants and are very damaging to many crops especially the cucurbits.



Cucumber fruit weight and percent fruit damaged by fruitflies in sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots.

Despite suppression of multiple insect pests and plant-parasitic nematodes while enhancing multiple beneficial microarthropods and nematodes involve in soil nutrient cycling, cucumber yield was lower in sunn hemp plots vs the control partly due to more severe fruitflies damage and shading effect of the cover crops.

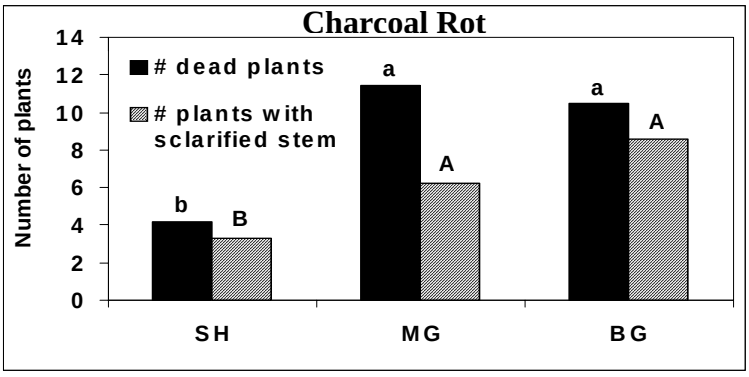
2009 Trial (Winter Gourd)

Winter gourd intercropped with sunn hemp.

Winter gourd planted in bareground (25 Jun, 2009).

The effect of sunn hemp living mulch in a strip-till system was continued to be evaluated in 2009. Winter gourd seedlings were transplanted into same planting rows of cucumber in the 2008 trial. Winter gourd is selected because it is more tolerant to shading and is less damaged by fruitflies or pickle worms as compared to cucumber. Alternate rows of sunn hemp living mulch in the 2008 trial were till in along with old cucumber residues. This is to further reduce the shading effect of sunn hemp. Sunn hemp was seeded at a lower rate (30 lb/acre) one week after transplanting of winter gourd seedlings (transplanted on April 2009). Crop was maintained similar to the 2008 cucumber crop. Unfortunately the winter gourd seedlings were infected by a seed-borne fungal disease, charcoal rot caused by *Microphominia*. Incidence of charcoal rot was recorded, and plants that survived the charcoal rot were continued to be evaluated.

Results



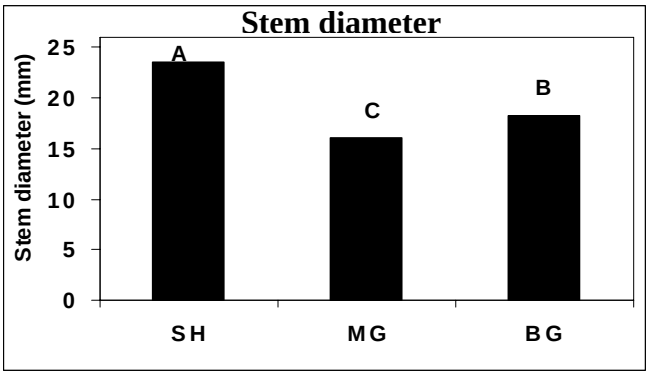


Fig. Numbers of plant die or with sclarified stem caused by charcoal rot, and stem diameter of winter gourd measured on 29 July 2009.

More seedlings survived from charcoal rot disease in SH plots than the other treatments. Plants in SH plots were more vigorous as indicated by bigger stem diameter.

Good and Bad Nematodes and Soil Health Bioindicators

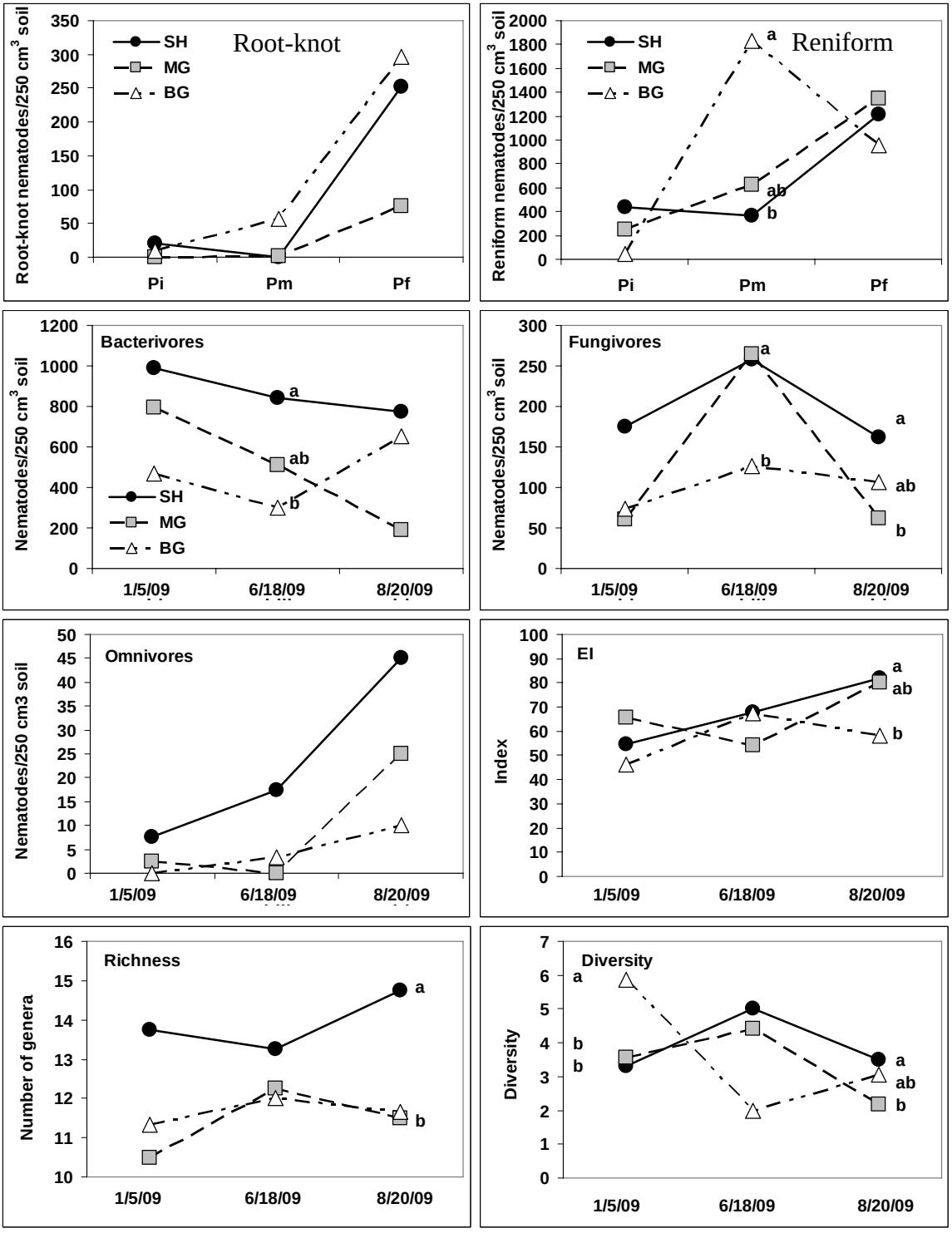


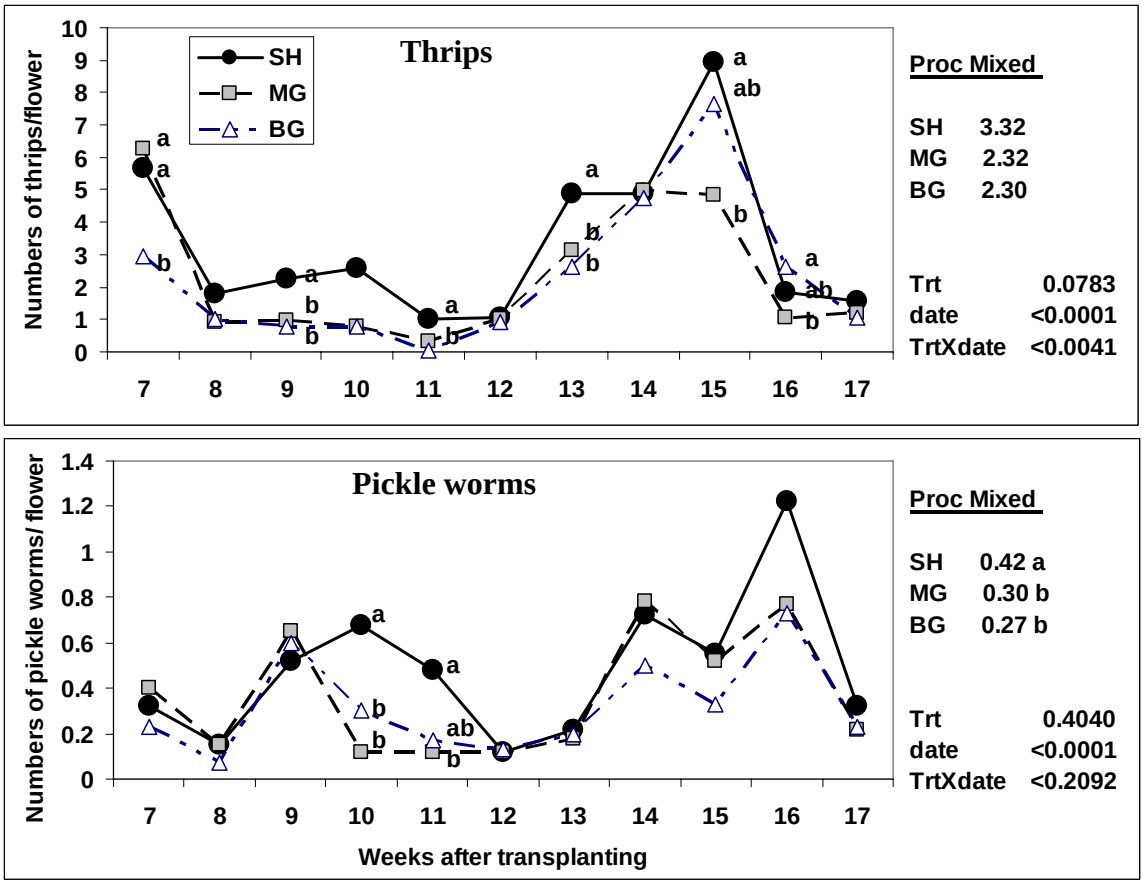
Fig. Numbers of plant-parasitic nematodes (root-knot nematodes and reniform nematodes) and free-living nematodes (including bacterivores, fungibovores, and omnivores) in soil collected from sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots. Higher enrichment index (EI) indicates soil is enriched with nutrients.

Sunn hemp continued to suppress reniform nematodes until mid season (Pm) in the second crop.

Sunn hemp continued to maintain higher population of beneficial nematodes and EI as compared to the bare ground control (indicating a healthier soil conditions).

Higher nematode richness and diversity also indicating that sunn hemp living mulch maintains a healthier soil condition.

Good and Bad Arthropods



Sunn hemp living mulch provides a niche more favorable for thrips and pickle worms in this trial.

Possibly due to close encounter of winter gourd flowers with SH.

Fig. Numbers of thrip and pickle worm per winter gourd flowers based on 10 flowers per plot in sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots.

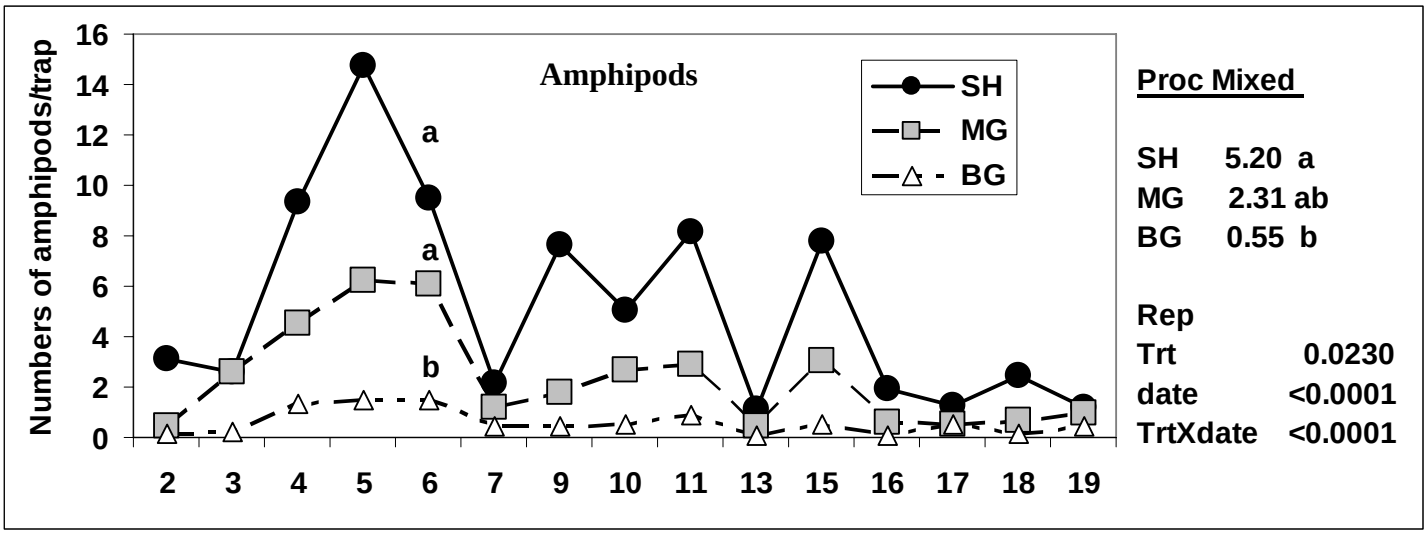


Fig. Numbers of amphipods in a 500ml pit fall traps buried in soil in sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots.

Some amphipods are soil arthropods that feed on decaying organic matter. Thus, they are detritivores that play a role in soil nutrient cycling. Sunn hemp provides continuous source of leaf litters or organic matter to sustain high number of amphipods.

Winter Gourd Yield

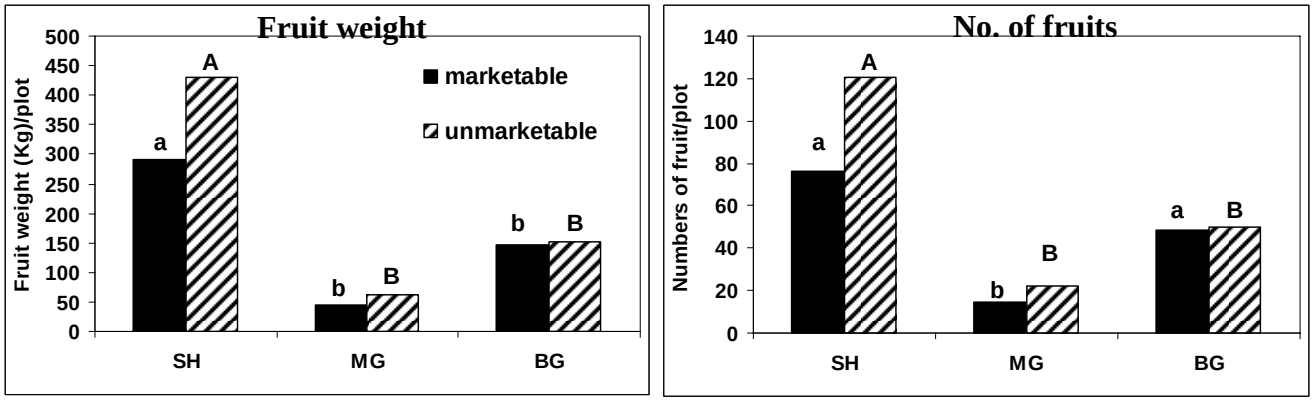


Fig. Winter gourd marketable and unmarketable fruit weight and fruit numbers in sunn hemp (SH), marigold (MG) or bare ground (BG) treated plots.

Conclusion

While effect of sunn hemp living mulch on above ground pests and beneficial insects varies between 2008 and 2009, sunn hemp continued to enhance below ground beneficial soil organism (nematodes and microarthropods) in both years. It is especially encouraging to observe great increase in omnivorous nematodes from 2008 to 2009. These are nematodes that take time to build up and they are indicators of more stable soil communities, i.e. a healthier soil environment.

Sunn hemp eventually increased crop yield in the second year. Although this is partially due to better survival of winter gourd seedlings in SH plots during the outbreak of charcoal rot, it is also due to better plant growth in the SH plots. It is common to see that organic farming approaches take times to show positive output. After all, time required to build up beneficial organisms in an agroecosystem might be paid off in a long run.

Extending the Sunn hemp Superhero Status

1. Integration of sunn hemp cover cropping and soil solarization

Soil solarization is using solar energy to heat up soil by covering soil with low-density (25-μm-thick), uv-stabilized, polyethylene mulch.

Soil solarization can suppress pests and pathogens in the soil that are sensitive to high heat, including nematodes, weeds, and other soil-borne pathogens. Please note that this is not regular clear plastic mulch that you can find from home garden stores. It is much thinner so that UV lights can pass through easily.

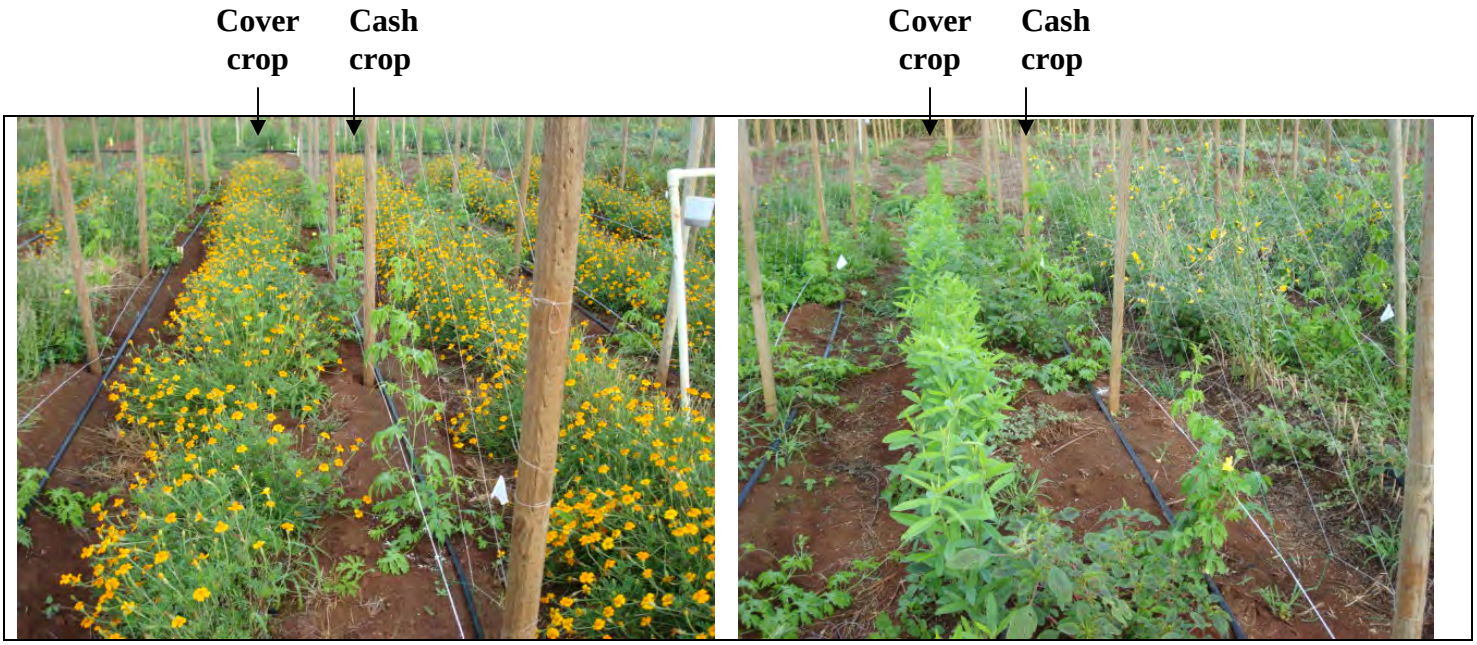
We found that in fields where sunn hemp established vigorously, incorporation of sunn hemp materials followed by soil solarization (6 weeks during the summer in Hawaii) heat up top soil layer (0-10 cm) more efficiently than solarization alone. However, soil solarization alone also heat up soil significantly as compared to non-solarized conditions. Weeds flush out about 3 weeks after removing solarization mulch were significantly lower in solarized vs non-solarized plots. Growers in Hawaii should take advantage of solar heat to suppress various soil-borne pests.

Fig. Weeds coverage in solarized vs non-solarized plots about 3 weeks after removing of solarization mulch.

2. Rows Switching

Many vegetable crops are very susceptible to root-knot nematodes. This nematode can survive in the soil year after year. Farmers might not have the luxuries to leave the soil fallow for long period before next crop planting to reduce nematode population.

In a living mulch system, rotate or switch the cash crop planting rows with nematode suppressive cover crop /living mulch rows from one crop cycle to another. This will avoid the continuous build up of nematode population over time and avoid sacrificing field for long term fallow rotation. However, manipulating tiller in this system might be challenging. We are planning to examine no-till planting in sunn hemp living mulch system.



Additional Information on Sunn Hemp

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Acknowledgement

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