Mulching Strategies using Conservation Tillage for Weed Management in Tropical Organic Hot Pepper Cropping Systems

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INTRODUCTION

Conventional cover crop (CC) management strategies developed and adopted in temperate climates utilize seasonal transitions, plant senescence, and mechanical operations (with or without herbicidal burn down) to ensure effective CC termination. In tropical and subtropical climates, temperate strategies are not practical (due to the cost of inputs), not possible (due to the absence of a killing frost to coincide with crop rotation transitions), and not beneficial to soil quality in the long-term. Tropical agroecosystems require unique CC management strategies that meet environmental and cultural conditions. The use of reduced tillage practices have been promoted to increase soil conservation and reduce on-farm expenses. Soil conservation and effective weed management are generally conflicting objectives in tropical organic cropping systems where tillage is the primary means for weed suppression. Cover crops, conservation tillage, and mulching are known practices that provide numerous ecosystem services, but are seldom incorporated together into an integrated cropping system plan.

GOAL

Our overall goal is to develop cover crop technologies in reduced-till organic vegetable cropping systems that lower labor & farm inputs, while providing effective weed control that ensure competitive vegetable yields.

OBJECTIVES

1. Evaluate the cover crop sunn hemp [*Crotalaria juncea* cv. Tropic Sun (SH)] and identify its suitability as surface mulch in reduced tillage vegetable cropping systems.
2. Compare in situ cover crop surface mulch to fabric mulch, hay mulch, and conventional no mulch vegetable systems for weed suppression
3. Determine overall cropping system performance by measuring quality and yield of the pepper crop

Experimental plot development

METHODS

Studies were conducted at the University of the Virgin Islands, Agricultural Experiment Station on the island of St. Croix, US Virgin Islands.

Four treatments were arranged in a RCBD and split to two levels of weeding intensity (high and low) after vegetable transplanting to evaluate weeding management among treatments.

Cropping System

Sunn hemp was planted as a cover crop and allowed to reach full bloom prior to termination. Following termination jalapeno and serrano peppers were transplanted into treatment plots.

Sunn Hemp Cover Crop/Weed Density and Biomass

	Plant Density m²		Biomass kg ha⁻¹	
Cover Crop	Field 1	Field 2	Field 1	Field 2
Sunn Hemp	76a*	112b	3,717	4,367
Weeds				
Broadleaf	9a	39b	263	402
Grass	3	5	460a	141b
Sedge	0	0	0	0
Total	12a	44b	723	543

*Means in the same row group with different letters are significantly different (LSMeans, p ≤ 0.05).

Vegetable Crop Treatments

Surface mulch treatments:

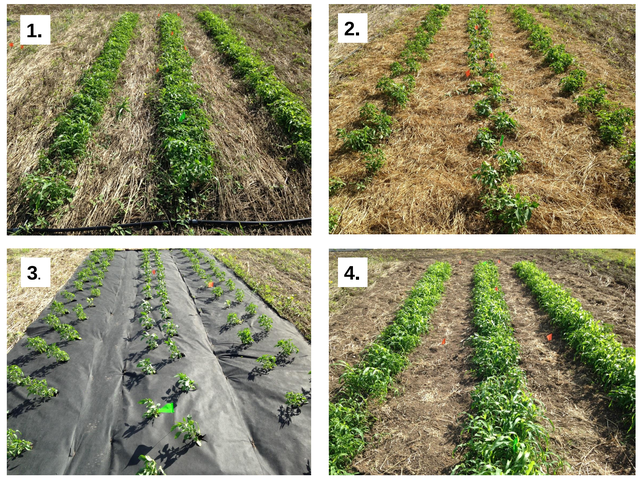
1. **Sunn Hemp Mulch:** Sunn hemp terminated by crimper, residue remains on soil surface (SHM)
2. **Sunn Hemp + Hay:** Sunn hemp terminated by crimper, residue remains on soil surface; hay mulch applied (SH+H)
3. **Sunn Hemp + Fabric:** Sunn hemp terminated by crimper, residue remains on soil surface; landscape fabric mulch applied (SH+F)
4. **NO MULCH:** Sunn hemp mowed and soil incorporated (SH+None)

Two Weed Removal Frequencies:

Each plot was divided in half perpendicular to tractor direction, and weeding treatments were randomly assigned to each plot after pepper **transplanting**.

A. LOW INTENSITY weeding (every 3rd week)
B. HIGH INTENSITY weeding (every week)

Three Weeks After Transplant



Total Weed Biomass 3 wks Post-Termination kg ha⁻¹

MULCH SYSTEM	In Beds	In Bed Middles
Sunn Hemp Mulch	700a	17
Sunn Hemp + Hay	170b	2
Sunn Hemp + Fabric	0c	0
Sunn Hemp + None	706a	9
P	<0.05	0.2058

Total Weed Biomass 12 wks Post-Termination kg ha⁻¹

FIELD 1 MULCH SYSTEM	Weekly Weeding	Reduced Weeding
Sunn Hemp Mulch	95a	498a
Sunn Hemp + Hay	53ab	207b
Sunn Hemp + Fabric	0b	0b
Sunn Hemp + None	38ab	542a
P	<0.05	<0.05
FIELD 2 MULCH SYSTEM		
Sunn Hemp Mulch	115	1,014a
Sunn Hemp + Hay	125	297b
Sunn Hemp + Fabric	48	71c
No Mulch	81	906a
P	0.2954	<0.05

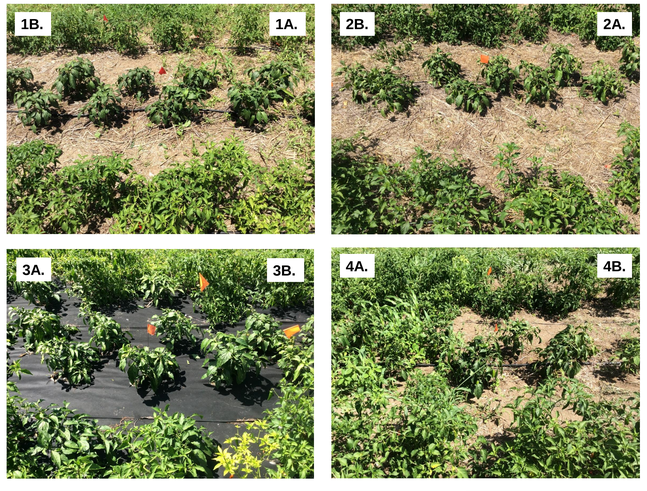
Total Weed Biomass 6 wks Post-Termination kg ha⁻¹

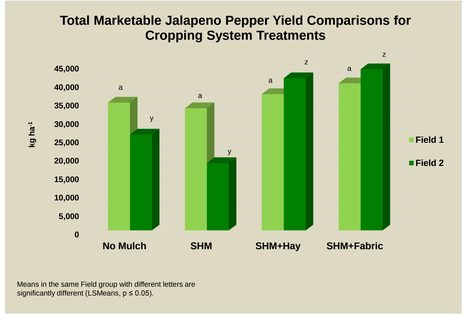
FIELD 1 MULCH SYSTEM	Weekly Weeding Beds	Reduced Weeding Beds	Weekly Weeding Bed Middles	Reduced Weeding Bed Middles
Sunn Hemp Mulch	0	510a	17	489a
Sunn Hemp + Hay	0	414a	0	511a
Sunn Hemp + Fabric	0	0b	0	0b
No Mulch	3	309a	0	117b
P	0.4133	<0.05	0.0655	<0.05
FIELD 2 MULCH SYSTEM				
Sunn Hemp Mulch	0	1,091a	0	631a
Sunn Hemp + Hay	0	420b	0	137b
Sunn Hemp + Fabric	39	151b	0	122b
No Mulch	0	406b	0	198b
P	0.0692	<0.05	1.0	<0.05

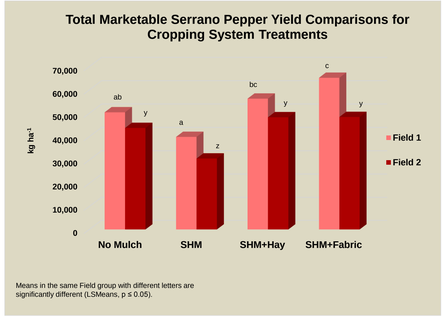
Total Weed Biomass 9 wks Post-Termination kg ha⁻¹

MULCH SYSTEM	Weekly Weeding Beds	Reduced Weeding Beds	Weekly Weeding Bed Middles	Reduced Weeding Bed Middles
Sunn Hemp Mulch	44	367	167a	537a
Sunn Hemp + Hay	18	363a	9.3b	215bc
Sunn Hemp + Fabric	2	0b	0b	8c
No Mulch	35	254a	7.3b	302b
P	0.1596	<0.05	<0.05	<0.05

12 Weeks After Transplant







RESULTS & DISCUSSION

Above-ground biomass of sunn hemp at termination did not differ between fields; and measured 3,717 kg ha^{-1} in field 1 and 4,367 kg ha^{-1} in field 2. Total weed biomass was also similar between fields 1 and 2 prior to sunn hemp termination. Weekly weed removal in the high frequency sub-plots resulted in similar weed biomass across all treatments at 3, 6, and 9 weeks after transplant (WAT). In the Low Frequency, three-week weed removal subplots, in-bed weed suppression differed by treatment. At 3 WAT, weed suppression was greatest for SHM+fabric, followed by SHM+hay, and lowest for SHM and SH+none treatments. At 6 WAT, SHM+fabric provided the greatest in-bed weed suppression with the lowest weed biomass and similar weed biomass for the remaining treatments in field 1. In field 2, SHM+fabric suppressed weeds as well as SH+none and SHM+hay. A similar trend was observed at 9 WAT for both fields as described for field 1. Similar pepper yields were recorded for both low and high frequency weed removal sub-plots. This implies that 3 week weed removal intervals are generally as effective as weekly weed removal and could greatly reduce weed removal labor costs in organic hot pepper production. Generally, weed biomass in the full-till SH+none and the reduced tillage SHM treatments were similar and implies that full soil tillage does not necessarily correlate to reduced weed biomass compared to no-till vegetable cropping systems using SH residue as mulch.

Overall, the SHM+fabric and SHM+hay treatments had the greatest Jalapeno yields with no differences between the SHM and SH+none treatments. Serrano pepper yields were greatest in the SHM+fabric, SHM+hay, and SH+none treatments. The greatest pepper yields resulted from insitu sunn hemp mulch plus the application of an additional mulch.

Cropping System Management

Cover crop management and the proper timing of cover crop termination followed by pepper transplanting is critical to system performance. Low to moderate SH biomass may have led to a decrease in weed control for the SHM treatment. A reduced weeding frequency at 3 week intervals may help farmers to reduce weed control costs without compromising pepper yields. Precise cropping system management is needed to fully achieve the benefits of cover crops and reduced tillage in integrated organic vegetable cropping systems.

Acknowledgements

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