Advancing mulching strategies using conservation tillage for sustainable weed suppression in tropical organic pumpkin and okra cropping systems

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INTRODUCTION

Conventional cover crop (CC) management for CC termination in temperate climates use:

- Seasonal transitions
- Plant senescence
- Mechanical operations
- Chemical burn-downs.

But in tropical climates, many of these strategies are:

- impossible (due to absence of killing frost)
- impractical (due to cost of inputs).

Tropical agroecosystems therefore require unique CC management strategies.

- Cover crops, conservation tillage, and mulching practices provide numerous ecosystem services.
- CC residue left on the soil surface can provide extended weed suppression during cash crop production.
- Little is known about managing sunn hemp residue as in situ mulch for organic weed suppression when integrated with conservation tillage in tropical agroecosystems.
- To promote long-term agricultural sustainability and provide alternative weed management practices, it is necessary to understand relationships between:
  - Sunn hemp (SH) productivity
  - SH residue management
  - conservation tillage
  - weed dynamics
  - vegetable production

GOAL

To develop CC technologies in reduced-till, organic vegetable cropping systems that reduce labor & farm inputs, while providing effective weed control resulting in competitive vegetable yields.

OBJECTIVES

1. **Evaluate the cover crop sunn hemp [*Crotalaria juncea* cv. Tropic Sun (SH)] as surface mulch in reduced tillage vegetable crop systems.**
2. **Compare two in situ SH residue mulching strategies to conventional no mulch vegetable systems in terms of calabaza pumpkin and okra yields.**
3. **Measure weed suppression of SH residue at three-week intervals following vegetable planting.**

METHODS

- Studies were conducted at two adjacent farm sites on the island of St. Croix, US Virgin Islands.
- At each site, three treatments were arranged in a RCBD and split to pumpkin or okra to evaluate weed suppression among treatments.
- Plots were hand weeded at 3, 6, 9, and 12 WAP
- Fish emulsion (5-1-0) was fertigated over the 12-week growing cycle at 224 kg ha^{-1} of N.

Cropping System

Sunn hemp was planted as a cover crop and allowed to reach full bloom prior to termination. Following termination with a roller-crimper, pumpkin and okra were seeded into treatment plots:

- Pumpkin - 1.2 m in-row x 1.5 m row spacing (5,382 plants ha^{-1})
- Okra - 0.6 m in-row x 1.5 m row spacing (10,764 plants ha^{-1})

Mulch Treatments

1. **Sunn Hemp Mulch (SHM):** Sunn hemp terminated by crimper, residue remains on soil surface.
2. **Sunn Hemp + Hay (SHM+H):** Sun hemp terminated by crimper, residue remains on soil surface; hay mulch applied 3 weeks after planting at 5,427 kg ha^{-1}. Hay mulch potential contribution for N, P, and K at 57, 5, and 35 kg ha^{-1}, respectively.
3. **NO MULCH:** Sunn hemp mowed and soil incorporated.

Cover crop termination, roller crimper surface mulching and conventional tillage

Three weeks after planting

Six weeks after planting

RESULTS & DISCUSSION

Sunn Hemp Performance

- Above ground biomass of SH at termination did not differ between fields.
- At termination, the SH above ground biomass contained potentially available N, P and K of 90, 9, and 60 kg ha^{-1} , respectively.
- SH as a standing cover crop effectively suppressed weed development in both fields. Weed biomass in Field 1 was less than the 412 kg ha^{-1} of weed biomass measured in Field 2.

Sunn Hemp and Weed Density and Biomass at Termination

	Plant Density m^2		Biomass kg ha^{-1}	
Cover Crop	Field 1	Field 2	Field 1	Field 2
Sunn Hemp	51a*	55b	5,563	5,701
Weeds				
Broadleaf	12a	30b	8	198
Grass	7	6	12	214
Sedge	0	0	0	0
Total	19a	36b	20a	412b

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

Mulch Treatment Effects on Weeds

Weed data was collected at 3, 6, 9, and 12 weeks after planting (WAP).

- At 3 WAP, there was no difference in total weed biomass between crops or treatments.
- Rows had nearly four times more weeds (77.4 kg ha^{-1} of total weeds) compared to row-middles (19.8 kg ha^{-1} of total weeds) due to in-row drip irrigation.
- At 6 WAP, differences in total weed biomass were only observed in rows and did not differ by crop (see table). The SHM+H (39 kg ha^{-1}) treatment was less weedy than either the SHM (111 kg ha^{-1}) or No Mulch (118 kg ha^{-1}) treatments.
- At 9 WAP, there were no differences in total weed biomass for crop, treatment, or by row/row-middle.
- At 12 WAP, a Field x Treatment interaction was detected. However, the pattern of treatment differences was similar in both fields (see table).

Total Weed Biomass 6 wks Post-Termination kg ha^{-1}

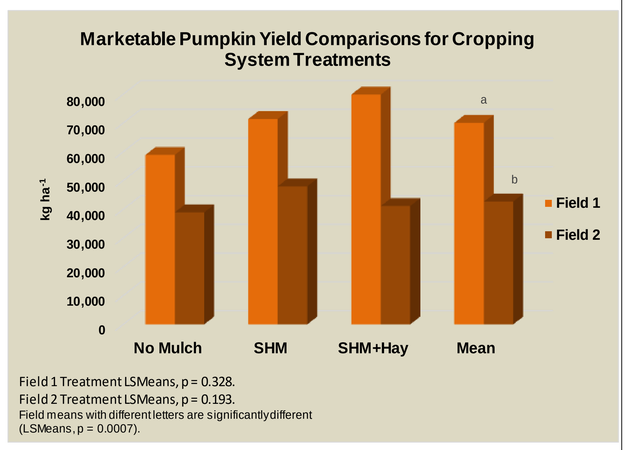
MULCH SYSTEM	In Rows	In Row-Middles
Sunn Hemp Mulch	111a	46
Sunn Hemp + Hay	39b	34
No Mulch	118a	22
P	<0.05	0.5549

Total Weed Biomass 12 wks Post-Termination kg ha^{-1}

MULCH SYSTEM	Field 1	Field 2
Sunn Hemp Mulch	107a	146a
Sunn Hemp + Hay	16b	12b
No Mulch	126a	328a
P	<0.05	<0.05

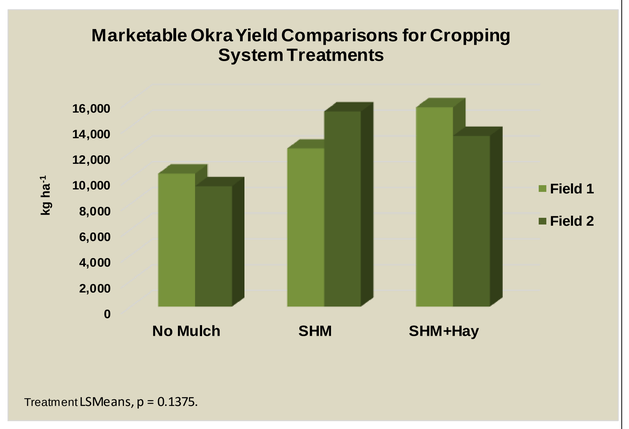
Pumpkin Yield

Pumpkin yield differed by field, but not treatment. However, the yield difference of 22,441 kg ha^{-1} between SHM+H and No Mulch in Field 1 could make a considerable difference in farm profitability (see graph).



Okra Yield

Okra yield did not differ by field or treatment (see graph). Lack of difference indicates no yield loss from alternative conservation tillage CC practices while potentially realizing soil health benefits in the longer term.



CONCLUSION

- Full tillage did not increase weed suppression.
- Pumpkin and Okra yields were generally greater in treatments utilizing conservation tillage with SH residue surface mulch compared to the conventional full tillage with No Mulch treatment.
- Pumpkin and okra can be grown organically in the tropics using conservation tillage, direct seeding, and alternative weed management and obtain high yields.

9 WAP, pumpkin canopy closure

12 WAP

Pumpkin harvest