Small Footprint Corn Production in Kura Clover Living Mulch

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Background

- Alfalfa and corn silage are the primary high quality harvested forage crops in the upper Mississippi Valley of Wisconsin, Iowa, Illinois, and Minnesota. This region is also one of the most concentrated areas of organic producers in the United States (Figure 1).
- Researchers at the University of Wisconsin-Madison have developed a corn (*Zea Mays* L.) kura clover (*Trifolium Ambiguum* M Bieb.) living mulch system to meet the nitrogen demand of corn grain and silage production while providing permanent soil cover.
- The kura clover must be suppressed to avoid corn yield losses associated with water and nutrient stress. This system currently relies on herbicides to suppress clover growth over and in-between corn rows.
- Organic and reduced herbicide growers have been very interested in this corn-kura clover system as a source of biologically fixed nitrogen, and current row crop production is tillage intensive making it expensive and erosion prone. This system could allow these producers to incorporate this perennial forage into their annual rotations.

Objective

- To determine if mechanical or thermal suppression of kura clover would be adequate for corn and silage production.

Materials and Methods

- Experiment conducted near Arlington and Lancaster, WI in 2007 and 2008 where kura clover line KTA202 had been established in monoculture for at least two years prior to experiment initiation (2008 trial is ongoing).
- Complete randomized block design with four replications. Plots 9.1m long and four corn rows wide set on 76 cm center.
- In late April, 30 cm wide zone tillage was imposed on the entire plot area on 76 cm centers, and kura clover in control plots was chemically killed with a mixture of flumetsulam, clopyralid, dicamba, and glyphosate.
- Kura clover was mowed to a uniform 5 cm height the day of corn planting and tilled zones were flamed using a walk behind propane flamer to create a stale seedbed (application rate approx. 117 liters of propane ha-1).
- Croplan Genetics hybrid 3456RB RR/BT corn seed was planted into the tilled strips with a no-till planter at both locations in the third week of May in 2007 and 2008.
- Corn in control plots was side-dressed with 67 kg N ha-1 (ammonium nitrate) at V5. Living mulch plots received no additional nitrogen.
- Inter-row mowing was conducted biweekly from the previous suppression event using a push mower set to 5cm height. Treatments outlined in Table 1.
- Inter-row flaming suppression of clover was accomplished weekly after the previous suppression event using a walk behind propane flamer (application rate 327.6 liters of propane ha-1). Treatments outlined in Table 1.
- Erratic precipitation led to drought-like conditions and 38mm of irrigation was applied on 30 July 2007 at the Arlington site to save the experiment.
- One center row of each plot was harvested for whole plant yield at approximately 50% milk line. Corn grain was harvested from the other center row at black layer, and yields were adjusted to 155 g kg-1 moisture.
- Data were analyzed with the MIXED procedure in SAS statistical software.

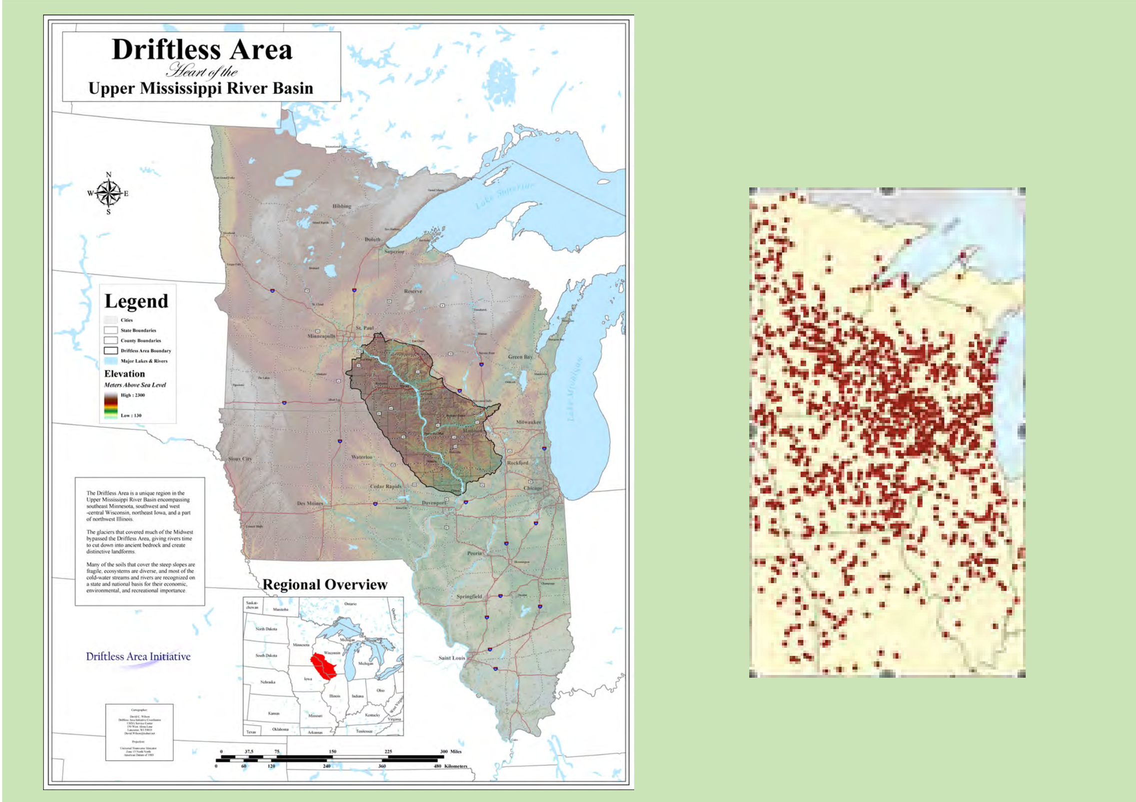

Figure 1: The driftless area of the upper midwest is prone to erosion due to its hilly topography. Red dots in the left map denote organic producers in 2006 (adapted from Driftless Area Initiative and ERS/USDA).

Table 1: 2007 corn grain and whole plant yield response to inter-row kura clover suppression. Data from two locations are pooled. Numbers followed by the same letter are not significantly different ($p<0.05$).

Kura Treatment	Corn Grain Yield (Mg ha^{-1})		Whole Plant Yield (Mg ha^{-1})	
Control (kura killed)	14.49	a	21.90	a
3 Mowings	10.12	b	13.37	bcd
3 Flamings	9.83	bc	14.27	b
2 Mowings	9.79	bc	13.89	bc
Flame, Mow, Flame	9.77	bc	13.60	bcd
2 Flamings	9.14	bcd	13.07	bcd
1 Mowing	9.13	bcd	12.77	cd
Flame, Mow	9.04	cd	12.45	d
1 Flaming	8.43	d	11.16	e

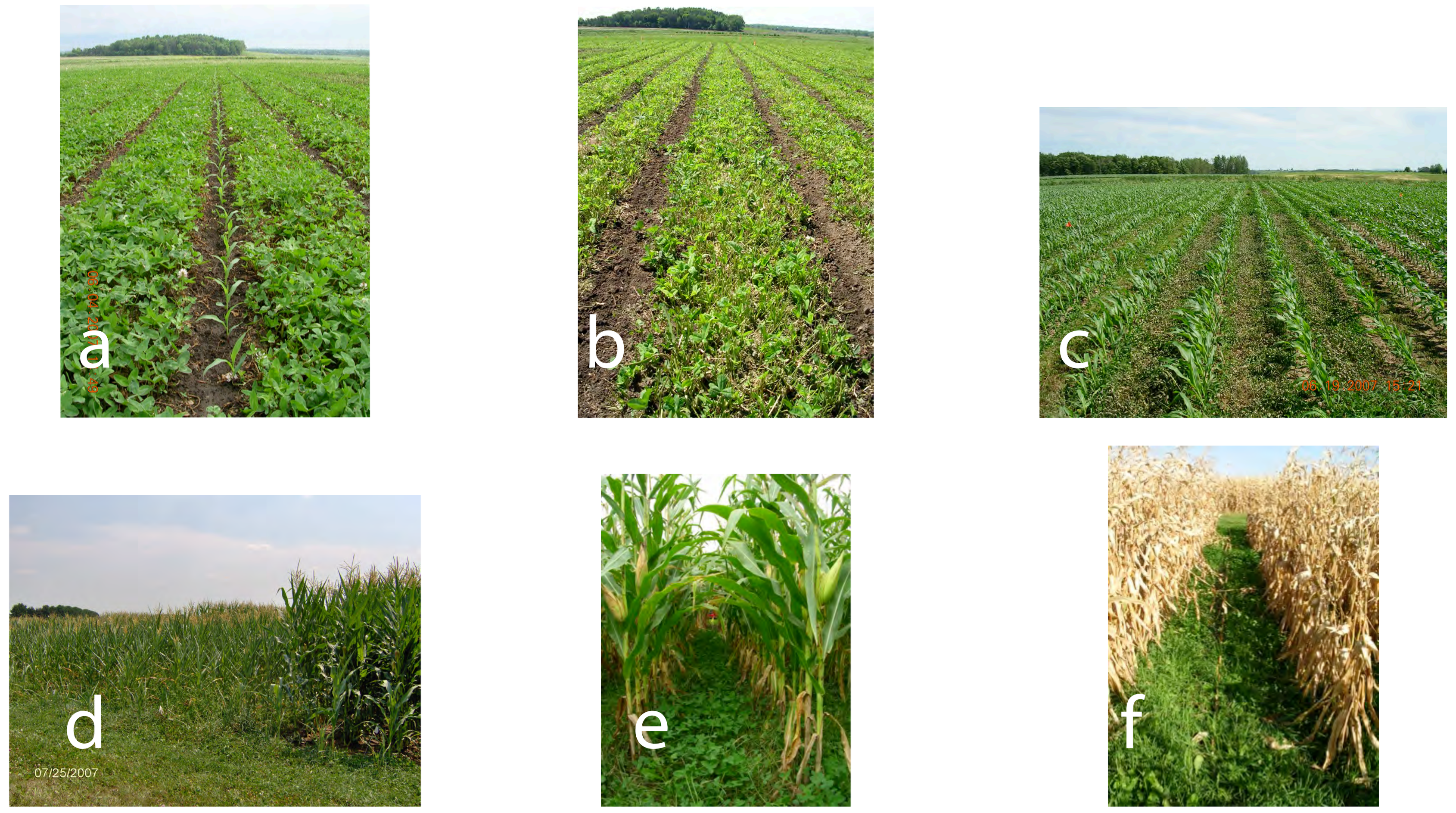

Figure 2: a) Experimental area post corn planting (25 May 2007); b) Corn emergence (8 June 2007); c) After a flaming treatment (19 June 2007); d) Drought stress in living mulch. Control plots are at right (25 July 2007); e) Prior to whole plant harvest (6 September 2007); f) Grain harvest (12 October 2007)

Results

- Location was not significant for either corn grain or whole plant yields ($p>0.1$), therefore yield data from both locations were pooled.
- Corn grain and whole plant yields were significantly greater in the control versus any of the living mulch treatments ($p<0.0001$) (Table 1).
- Mowing inter-row a second or third time failed to significantly increase corn grain or whole plant yields compared with mowing only once. (Table 1).
- Flaming a second time significantly increased both whole plant and grain yields, but flaming a third time did not significantly increase yields. (Table 1).
- For both corn grain and whole plant, treatment combinations of mowing and flaming were not significantly different from one another (Table 1).

Conclusions

- Mechanical and thermal means of corn grain and silage production in a kura clover living mulch is a challenge and can be risky.
- Living mulch treatments yielded at least 30% less grain than the control, and whole plant yield was at least 35% less than the control. Very dry periods and severe water stress to corn in living mulch plots was observed and contributed to reduced yields.
- Due to dry conditions in 2007, increased mechanical or thermal kura clover suppression did not always translate to increased yields.
- Assuming a nitrogen (urea) cost of $1.30 per kg of N and a recommended application rate of 179 kg N ha-1, living mulch treatments save $233 ha-1 in nitrogen cost. For conventional producers, at a corn grain price of $4.70 per 25.4 kg, cost associated with a loss in grain yield due to living mulch competition is at least $575 ha-1. Therefore, a living mulch managed with mechanical or thermal suppression may not be well-suited for conventional corn grain producers.
- This system is viable for organic producers who already utilize cover crops for nitrogen credits and receive twice the conventional price for corn grain. Dairy farmers can use kura clover as a high-quality forage crop after corn production since kura clover does not need to be planted the following year.
- Grain yields in this experiment are close to the range of yields currently being obtained in the University of Wisconsin organic grain trials. Future research could be focused on evaluating organically certified seed performance in living mulch.

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