FARMING FOR NITROGEN: INTERCROPPING CORN AND KURA CLOVER

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Introduction

Alfalfa and corn silage, grown in rotation, have long been the primary high quality forages harvested to support the dairy industry in Wisconsin. However, removal of essentially all plant residues with corn silage production results in excessive erosive soil loss (Gallagher et al., 1996), prompting the need for alternative soil conserving systems. The proposed removal of stover for biofuel feedstock after corn grain harvest will result in additional land prone to soil and nutrient runoff because of a lack of cover. Furthermore, the ever-increasing cost of nitrogen fertilizer encourages the search for cropping systems that rely on biologically fixed nitrogen for both corn grain and silage production.

Legume "living mulches" have been tested in the northern USA as a means to meet nitrogen requirements of corn (Eberlein et al., 1992; Hartwig and Ammon, 2002), but those perennial legumes evaluated reduced corn yields or failed to recover after corn harvest. Kura clover seems to be ideally suited to serve as living mulch. It is extremely persistent and produces rhizomes that allow it to fill in gaps that may otherwise be invaded by weeds (Albrecht and Kim, 1998). Our earlier research demonstrated that with adequate suppression, kura clover can be managed to provide minimal competition to corn (Zemenchik et al., 2000) and that the clover will recover to full production in the following growing season. The purpose of this paper is to review performance of herbicide resistant corn hybrids in kura clover living mulch.

Results and Discussion

The Model System

In many early attempts to intercrop corn with forage legumes as living mulches it was a challenge to provide the appropriate amount of suppression to minimize competition from weeds and the companion legume. Too much suppression removed the legume and too little suppression reduced corn yields. Herbicide-resistant corn hybrids have made this task much easier, and corn silage and grain yields in killed or suppressed kura clover are routinely similar (Table 1).

Table 1. Silage and grain yields of corn grown in kura clover living mulch near Lancaster and Arlington, Wisconsin in 1999 and 2000.

Corn/kura treatment	Silage yield	Grain yield
	tons DM/acre	bushels/acre
Roundup Ready Corn		
Kura clover killed	8.9	194
Kura clover suppressed	8.3	196
Liberty Link Corn		
Kura clover killed	8.6	188
Kura clover suppressed	8.4	184

Data from Affeldt et al. (2004).

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A successful model system that has been developed and tested includes suppression of kura clover with glyphosate in mid-April, no-till corn establishment when soil conditions allow, band-killing kura clover over the corn row with a broad-leaf herbicide at corn planting time, and a second application of glyphosate or Liberty herbicide (with appropriate resistant hybrids) 35 days after sowing corn to control both kura clover and annual weeds. This level of suppression is adequate for corn production (Table 1) and allows kura clover to recover to full production for hay or pasture by June of the following season. After identification of an appropriate clover suppression regime, attention was focused on both fertilizer nitrogen replacement value and potential environmental impact of kura clover living mulch.

Nitrogen Replacement Value

Corn grown in kura clover living mulch, as previously described, was fertilized with 0 to 80 lb N/acre (in the form of ammonium nitrate), in a side-dressed application at corn V5 stage. Whole plant corn yield, as for silage, was not increased by nitrogen fertilizer application ($P < 0.05$), although there was a tendency for an increase in silage yield with the first increment of nitrogen fertilizer (Fig. 1). Likewise, there was no significant ($P < 0.05$) increase in corn grain yield associated with nitrogen fertilizer application to corn grown in kura clover living mulch (Fig. 1). We suspect that mineralization of nitrogen from kura clover residues contributes to nitrogen pools available for corn production. These data suggest that in this intercropping system, there seems to be no advantage to applying more than 20 lb/acre of nitrogen fertilizer, an amount that could easily be included in the starter fertilizer at planting.

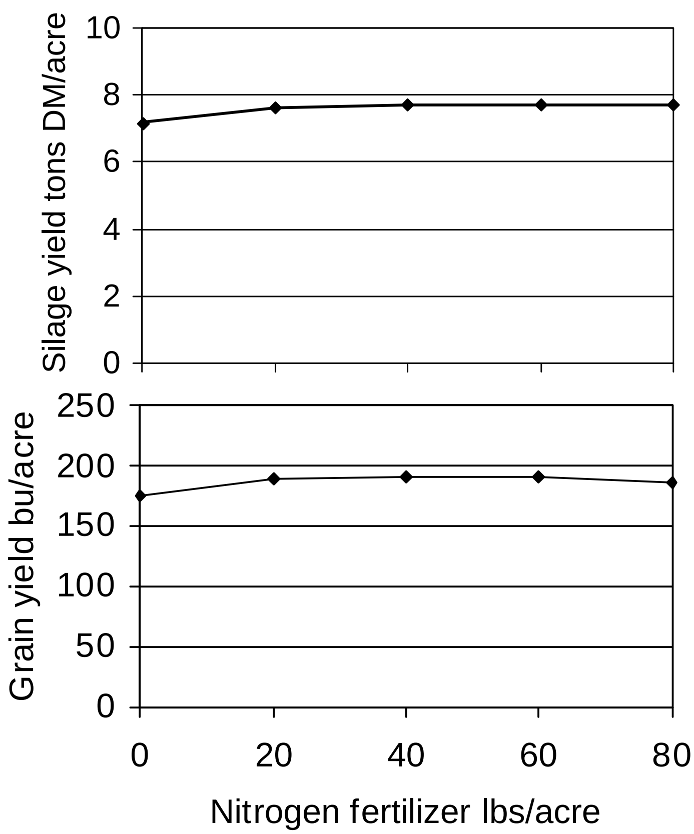

Figure 1. Corn silage and grain yield response to nitrogen fertilizer when grown in suppressed kura clover. Data are pooled over two seasons from Arlington and Lancaster, WI.

Environmental Impact

Our preliminary data from a sloping field at Lancaster suggest that there may be substantial reduction in soil erosion, but less effect on water runoff, from corn intercropped with clover compared to monoculture corn with conventional tillage (Table 2). More extensive research is planned to document the impact of corn production for silage, grain, and biofuel feedstock in living mulch on soil, nutrient, and water runoff from erosion prone landscapes.

Table 2. Sediment loss and water runoff from conventional and living mulch corn production systems at Lancaster, WI with three major rainfall events in 2006.

	Sediment loss (lb/acre)		Water runoff (gal/acre)	
Sample date	Conventional corn	Living mulch	Conventional corn	Living mulch
July 27	85	4	4,700	4,500
August 3	93	11	4,100	3,000
September 11	76	7	4,100	3,500

The concentration of nitrate-N in leachate 40 inches below the soil surface is substantially lower under corn produced in kura clover living mulch than under monoculture corn (Table 3). This is the case whether nitrogen fertilizer is applied to the living mulch or not. We speculate that the deep root system of kura clover captures nitrate that would otherwise potentially leach into the groundwater.

Table 3. Nitrate-N leachate under corn or corn-kura clover living mulch during the growing season and after corn harvest.

Season	Monoculture Corn + 80 lb/acre N	Living mulch corn + 80 lb/acre N	Living mulch corn + 0 N
		ppm nitrate-N	
Growing season	7.5	3.9	4.5
Dormant season	28.0	13.8	6.3

Growing season is April 1 through Sept. 30; Dormant season is Sept. 30 through March 31

Summary

Corn grown in suppressed kura clover requires little or no nitrogen fertilizer, an input cost that is expected to remain high in the foreseeable future. Permanent groundcover in this intercropping system would be expected to minimize soil loss from fields harvested for corn silage or stover for biofuel feedstock, and our preliminary data support this hypothesis. Nitrate concentrations in water below the root zone are substantially lower in the intercropping system than without clover, providing hope that nitrate contamination of groundwater could be reduced even as corn acreage increases to meet food and energy demands. Much work remains to be done to create profitable cropping systems that allow incorporation of legume living mulches into Wisconsin agriculture, and to more clearly document the environmental impact of these systems.

References

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