Fixation and Release of Nitrogen From Novel Cover Crops for Use in Reduced Tillage Organic Corn Production in North Carolina

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INTRODUCTION

Nitrogen (N) limitations and weed pressures are the most challenging factors in organic production. Legume cover crops are an important supplier of N, but the common practice of incorporating these crops prior to planting a corn crop can often lead to early N release leading to lack of crop-N synchrony. Weeds are often managed using cultivation, but this can reduce soil structure and organic matter and increase erosion. The roller-crimper tool offers roller-crimper tool offers a potential solution to these problems by rolling legumes in-place, leaving a thick mulch of biomass that provides N to the succeeding crop while suppressing weeds. Challenges with this system arise in that cover crops must be at full flower in order to be successfully killed and that the N-mineralization process is changed due to reduced soil-residue contact. Early flowering cultivars of several winter annual legumes have been developed that could complement the use of the roller-crimper in a reduced-tillage organic corn system.

OBJECTIVES

- Determine the total biomass N accumulated by each cover crop at their appropriate roll date
- Quantify the proportion of N derived through biological N fixation
- Investigate dynamics of N mineralization and uptake through the following growing season under the roll-killed mulch

MATERIALS AND METHODS

1. 14 winter annual legume cover crops were planted at the Tidewater Research Station in Plymouth, NC, and at the Piedmont, Research Station in Salisbury NC in fall 2008 in North Carolina
2. Cover Crops were roll-killed on 3 dates per site in April and May 2009
3. 0.5 m^2 biomass samples were collected, dried and weighed, for each roll-date.
4. Tissue samples were ground to pass a 2mm sieve and analyzed for total C and N
5. Stable isotope 15N natural abundance measurements were conducted on plant tissue to determine the % N derived from the atmosphere*

* Data for this measurement is unavailable at this time

Hairy Vetch biomass harvest in Spring 2009

Species	Cultivars	Abbreviation
Vicia villosa (Hairy Vetch)	Auburn Merit	AUM
	Auburn Early Cover	AUE
	Winter Hardy Early Cover	EAR
	Purple Prosperity	PRO
Vicia sativa (Common Vetch)	Variety Unstated	VET
Trifolium incarnatum (Crimson Clover)	Auburn Sunrise	AUS
	Auburn Robin	AUR
	Dixie	DIX
	Tibbee	TIB
Trifolium alexandrinum (Berseem Clover)	Bigbee	BIG
Trifolium subterraneum (Subterranean Clover)	Denmark	DEN
(Pisum sativum sp. Arvense) Field Pea	Whistler	WHI
	Variety Unstated	PEA
(Lupinus angustifolius) Lupin	TifBlue 78	TIF

NITROGEN RELEASE AND AVAILABILITY

1. At the time of roll-kill, corn was planted in 76-cm rows at a seeding rate of 90,000 plants ha^{-1}.
2. Plant Root Simulator (PRS) Probes™ (Western Ag Innovations, Canada) were installed in soil under hairy vetch and crimson clover residues and in control plots with 0 kg N ha^{-1} and 150 kg N ha^{-1}. Probes were exchanged every 2 weeks for 12 weeks, and analyzed for NH_4 and NO_3.
3. Soil samples (0-20 cm) were collected at two week intervals. Soils were air dried and extracted with 1M KCl. Extracts were analyzed for NH_4 and NO_3 content using a Lachat analyzer.
4. Twenty row feet of corn was hand harvested in September 2009 in each plot. Yields from cover crop and fertilizer N treatments were compared to develop fertilizer equivalency rates for each cover crop.*

The cover crop decomposition study was conducted in plots from the 2nd roll date except for the hairy vetch plot at the Plymouth site, which was conducted in plots from the 3rd roll date.

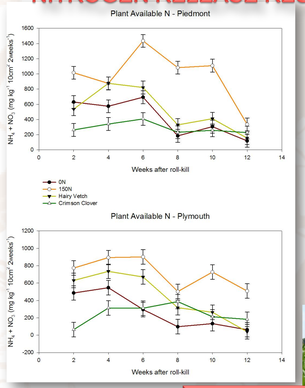
* Data for this measurement is unavailable at this time

Top: PRS probes were placed in soil under rolled cover crop mulches

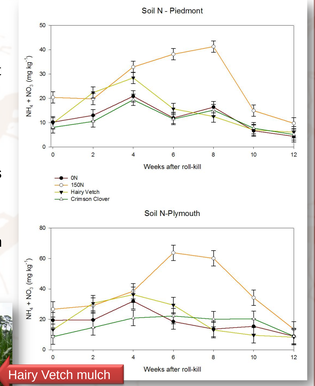
Above: PVC root excusion collars were installed to prevent roots from interfering with PRS probes

Left: Corn was no-till planted in 76-cm rows

NITROGEN RELEASE RESULTS



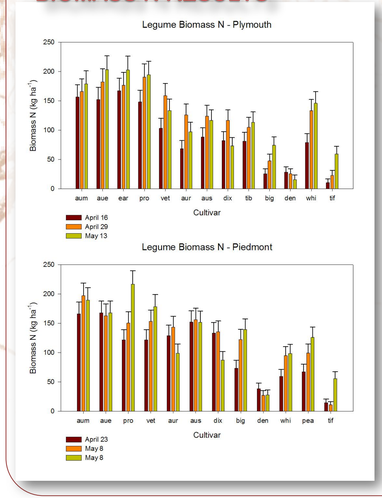
Data from both the PRS probes and soil samples indicate that the rolled hairy vetch cover released N immediately, but that the crimson clover mulch immobilized N over the first 6 weeks after roll-kill. This reflected visual observations of N deficient corn seen in the photo below.

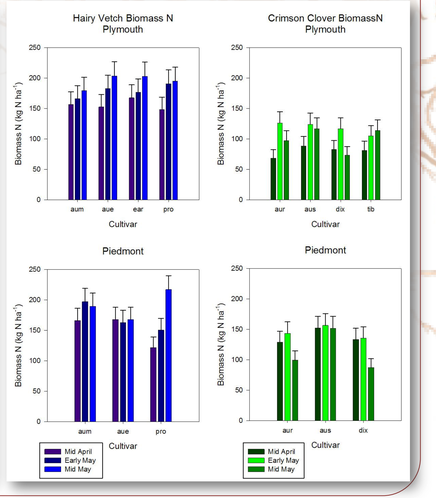


Crimson clover mulch

Hairy Vetch mulch

BIOMASS N RESULTS





CONCLUSIONS

The four cultivars of hairy vetch tested produced greater biomass than the cultivars of crimson clover or Austrian winter pea.

Subterranean clover and lupin had significantly lower biomass N, this was due to low overall biomass production.

Of the cover crops tested, crimson clover had the earliest peak N production

North Carolina corn producers tend to plant corn in mid April; however most cover crops tested did not reach peak biomass N production until mid May, much later than growers' desired corn planting time.

Nitrogen was mineralized under hairy vetch mulch while crimson clover mulch showed net N immobilization for the first six to eight weeks.

Corn planted in crimson clover mulch showed signs of N deficiency, whereas those planted in hairy vetch did not.

As a surface mulch, Hairy vetch seems to provide a more reliable source of N than crimson clover.

An organic reduced-tillage system using a roller-crimper implement shows promise for corn production in North Carolina, however corn planting dates will have to be adjusted until later in order to accommodate maturity dates of the cover crops

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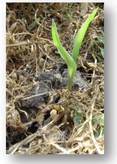

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