Decomposition Rates of Legume Winter Cover Crops and Nutrient Release Under Three Kill Methods

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Abstract

The coastal plain region of the southeastern United States has agricultural land with poor soil quality, partly due to intensive cultivation and ineffective crop residue management. Well-managed cover crop residue will increase soil organic matter content and improve soil quality. This study was conducted from October 2011 to October 2012 in Goldsboro, North Carolina. The objectives of the study were: (1) to evaluate the decomposition of residue from two winter cover crops under three different spring kill methods, and (2) to evaluate changes in soil microbial activity under each cover crop/kill method treatment. The cover crops (hairy vetch (Vicia villosa) and Austrian winter pea (Pisum sativum)) were terminated under three kill methods (flail-mow surface residue, roll/crimp surface residue, and flail-mow disk incorporate). Mesh bags containing plant residue were used to observe and collect data for the decomposition study. The flail-mow disk incorporated kill method lead to the most rapid rate of decomposition and the Austrian winter pea decomposes more quickly than hairy vetch. Kill methods did not have a significant effect on soil basal respiration. Austrian winter pea lead to higher basal respiration rates than hairy vetch. Both carbon and nitrogen are lost more rapidly in the flail-mow disk incorporate treatment. Roll kill method used with hairy vetch provide the longest release of nutrients over time.

Introduction

The interactions between agriculture related management practices and soil physical, chemical, and biological processes have affects on the productivity of agricultural soils and their impact on environmental quality. Farmers in Eastern Carolina are facing problems such as ground and surface water contamination, soil erosion, and declining soil quality. Poor nutrient retention is not the only problem that the region faces however, due to the soils sandy loam texture and the relatively poor soil structure there is very little organic matter build up within the soil matrix. Low organic matter content can result in reduced water holding capacity and during dry times throughout the growing season can severely limit crop growth. The implementation of best management practices such as reduced or no-tillage cropping and use of soil amendments are necessary in order to improve and restore damaged soils to optimum productivity levels. Cover crops are known to build up organic matter in soils which leads to improvements in soil water and nutrient retention as well as increased microbial activity over time Trends were noted throughout the duration of the study. Some of the trends observed during study are presented in this poster.

Objective

(1) To evaluate the decomposition of residue from two winter cover crops under three different spring kill methods.
(2) To evaluate changes in soil microbial activity under each cover crop/kill method treatment..

Materials and Methods

The study began in the fall of 2011 at the Center for Environmental Farming Systems (CEFS), Goldsboro, NC (Coastal Plain). The experiment was a split plot randomized complete block design with kill methods (flail-mow surface residue, roll/crimp surface residue, and flail-mow disk incorporate) assigned to the main plots, cover crop levels (hairy vetch (Vicia villosa) and Austrian winter pea (Pisum sativum) assigned to the sub-plots. The winter cover crops, hairy vetch and Austrian winter pea, were planted at a rate of 28kg/ha and 100kg/ha respectively, and was mechanically killed in the spring prior to tillage. Field corn was planted in all experimental plots following the termination of the winter cover crop in the Coastal Plain location. Mesh litterbags were placed in the field at corn planting and collected for analyses throughout the growing season. Soil samples were collected from two depths at predetermined dates throughout the season in order to conduct laboratory incubations and to determine basal respiration. The residual plant tissue collected from the litterbags was ground and analyzed for carbon and nitrogen content.

Photo 1
No tillage, the cover crop was roll/crimped to kill and remained on the soil surface

Photo 2
No tillage, the cover crop was flail-mowed to kill and remained over the soil surface.

Photo 3
Disk tillage, the cover crop flail-mowed to kill and was incorporated into the soil.

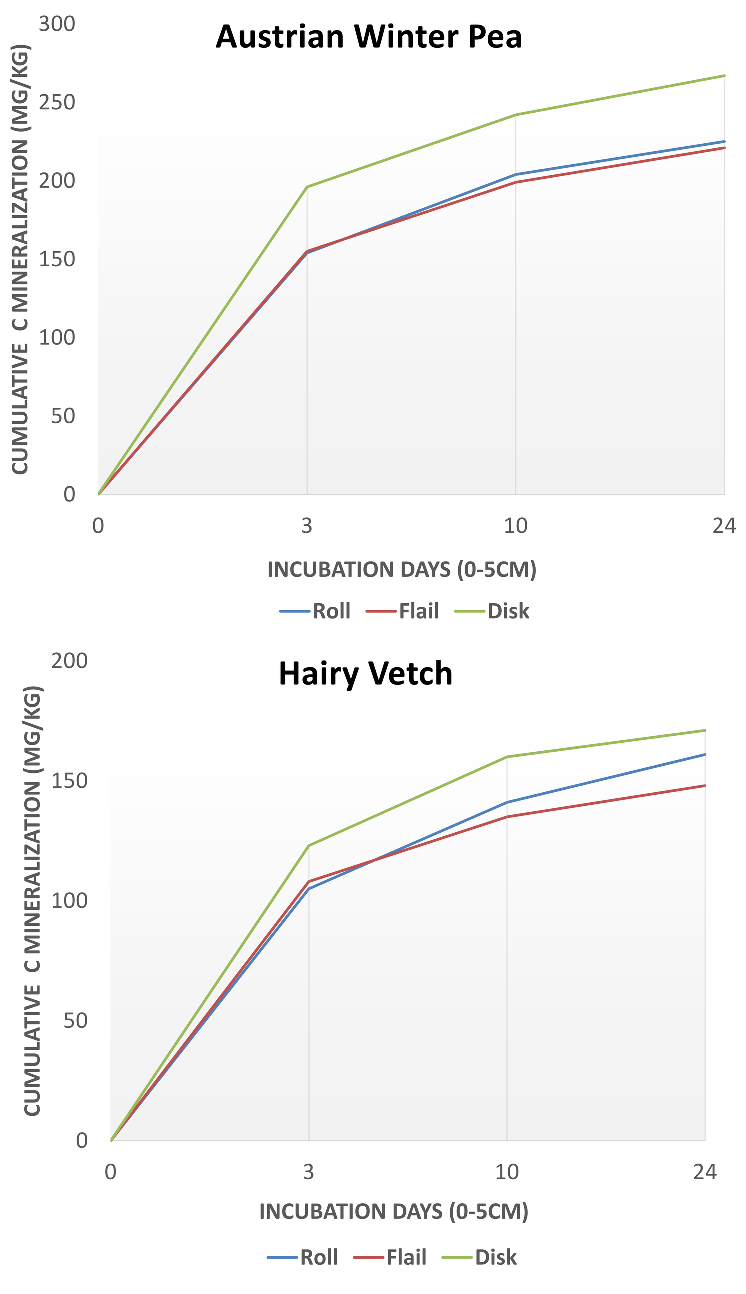

Figure 1. Cumulative C mineralization of soils

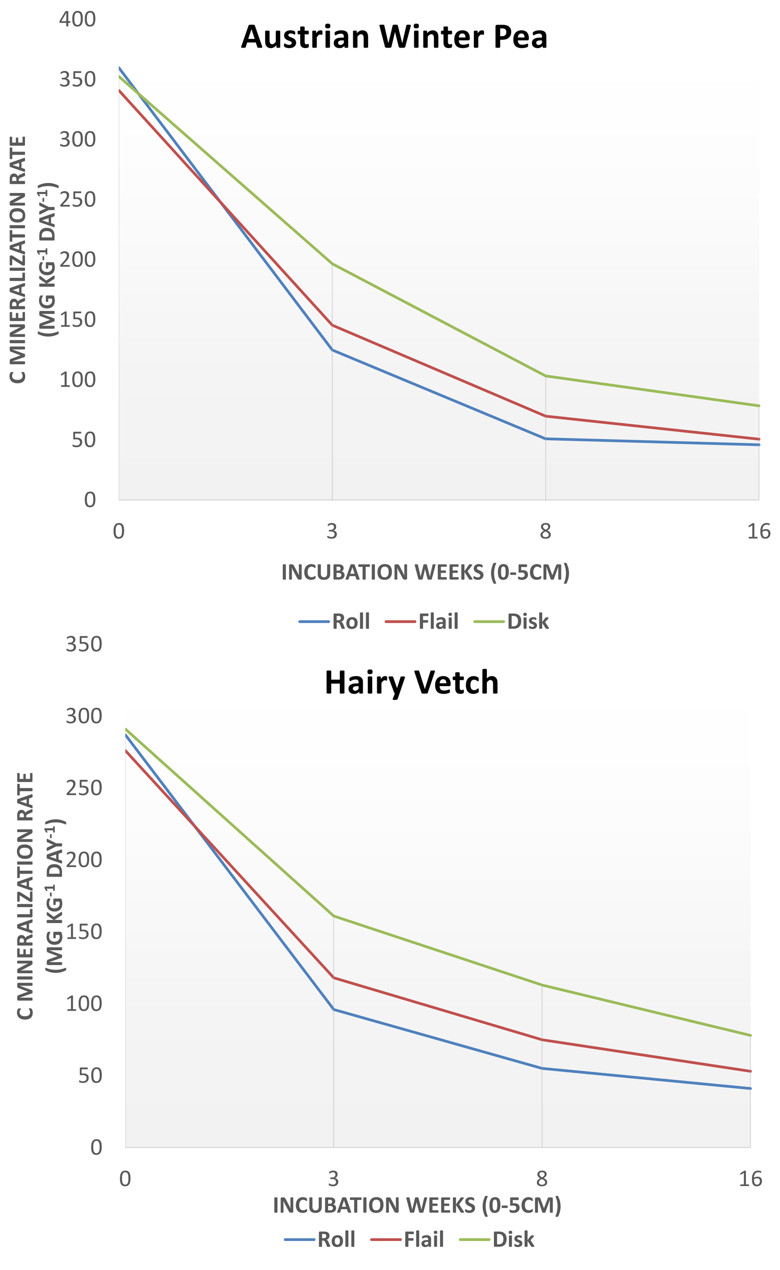

Figure 2. C mineralization rates of soils

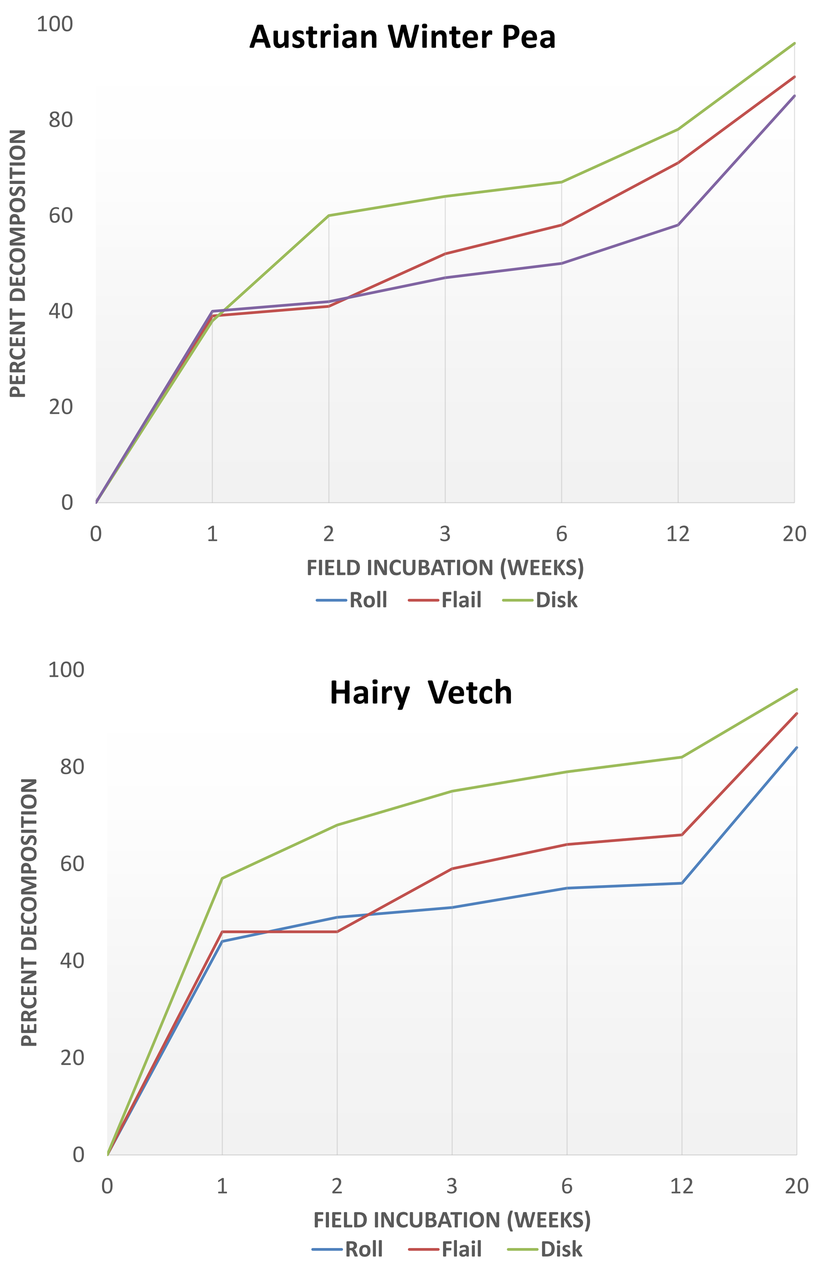

Figure 3. Percentage of plant decomposition

Results/Conclusion

Results:

- Austrian winter pea yields higher basal respiration rates in the upper depth (0-5cm)(Figure 1).
- The disking of cover crop residue lead to a more rapid loss of organic matter than the other kill methods (Figure 2).
- Flail-mow incorporation resulted in significantly more decomposition in both covers when compared to roll/crimp (Figure 3).
- Cover crop compounds do not differ significantly between the two (Table 1).
- Disk incorporation of the cover crop residue leads to accelerated releases of both C and N (Table 2 & 3).

Conclusion:

- The termination method of cover crops will determine the decomposition and mineralization rates of nutrients.
- The use of hairy vetch along with a flail-mow surface residue kill method will yield sustained nutrient release over the summer crop growing season.

Table 1. Cover crop components broken down over time.

	Cover Crop Components					
	Weeks					
	0		3		12	
	AWP	HV	AWP	HV	AWP	HV
Protein %	25	24	8	9	1	2
Carbohydrates %	52	50	44	42	25	28
Hemicellulose %	16	12	12	10	4	7
Cellulose %	39	36	35	31	19	20
Lignin %	13	14	9	11	6	8

Samples analyzed and data produced by the University of Georgia.

Table 2. Means of cover crop residue C content after kill (kg ha^{-1})

	Residual Carbon†					
	Week 1	Week 2	Week 3	Week 6	Week 12	Week 20
Disk	395.7^{a}	219.2^{c}	199.3^{b}	199.4^{b}	182.5^{b}	36.5^{b}
Flail	573.0^{a}	495.4^{a}	380.7^{a}	330.0^{a}	198.3^{ab}	63.1^{ab}
Roll	491.7^{a}	439.3^{b}	418.0^{a}	408.7^{a}	229.5^{a}	92.1^{a}
Hairy V.	518.8^{a}	418.5^{a}	349.8^{a}	366.2^{a}	251.8^{a}	73.6^{a}
Aus. WP.	454.8^{a}	350.7^{b}	315.5^{a}	259.4^{a}	155.1^{b}	54.2^{a}

†Means having the same letter in common are not significantly different as indicated by the Fisher's protected LSD test.

Table 3. Means of cover crop residue N content after kill (kg ha^{-1})

	Residual Nitrogen†					
	Week 1	Week 2	Week 3	Week 6	Week 12	Week 20
Disk	26.8^{a}	18.3^{b}	16.1^{b}	16.7^{b}	13.4^{b}	2.2^{b}
Flail	35.9^{a}	31.8^{a}	24.1^{ab}	21.4^{ab}	13.1^{b}	4.3^{a}
Roll	32.7^{a}	29.9^{a}	29.8^{a}	28.0^{a}	15.7^{a}	5.9^{a}
Hairy V.	32.9^{a}	28.0^{a}	24.0^{a}	25.3^{a}	17.3^{a}	4.9^{a}
Aus. WP.	30.5^{a}	25.3^{a}	22.8^{a}	18.8^{a}	10.8^{a}	3.3^{b}

†Means having the same letter in common are not significantly different as indicated by the Fisher's protected LSD test.

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