Decomposition of Cover Crop Biomass and Nitrogen Release

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With the increased use of legume cover crops in crop rotation, there is need for a better understanding of their role in nitrogen cycling. Information on cover crops nitrogen release patterns after incorporation are important for crop management decisions. Legume cover crops fix atmospheric nitrogen, while cereal cover crops absorb nitrogen remaining after the previous crop reducing nitrate leaching potential.

Field studies were conducted at the Univ. of Massachusetts Agronomy Research Farm have been examing dry matter and nitrogen release after cover crop incorporation. The soil at the Research Farm is a Hadley fine sandy loam (coarse, mixed, mesic, Fluventic Dystrochrept). Cover crop decomposition was determined from cover crop residue samples placed in the soil, in nylon mesh bags. In this study the 7 x 18 cm mesh bags were recovered at 1, 3, 5, 8, 12, and 18 weeks after placement. Cover crop samples were collected for placement in mesh bags at the end of the first week in June when rye was fully headed.

Decomposition of residues was best described using a two-pool model for each cover crop as follows. For vetch the model was:

Organic Matter Remaining (%) = $100 \times (0.521e^{-0.9992t} + 0.479e^{-0.02503t})$ (R^2=0.997**)

and for rye:

Organic Matter Remaining (%) = $100 \times (0.252e^{-0.749t} + 0.748e^{-0.04165t})$ (R^2=0.998**)

where t = time in weeks.

The first weekly decomposition constant (k_1) indicates more rapid initial decomposition and the second decomposition constant (k_2) reflects a slower rate of decomposition over a longer time period. High decomposition rates in the first pool were indicative of the rapid decay of simple carbohydrates, protein, and other low C:N ratio compounds, and the lower decay rates in second pool were representative of slow decomposition of recalcitrant materials such as lignin. The two cover crops had different pool sizes. Vetch had a larger readily decomposable pool (P_1 =0.521), while the rye had a larger recalcitrant pool (P_2 = 0.748). In this study the vetch residue lost 50% of its dry matter during the first 3 weeks. For rye this took 9 weeks (Fig. 1). Increasing lignin concentration reduces the decomposition rate of plant residues.

The C:N Ratios of vetch and rye during decomposition are shown in Figure 2. Legume cover crops which have low C/N ratio released pronounce amounts of N after incorporation whereas non-legumes which have a high C/N ratio and high lignin content immobilized N from soil after incorporation. The rapid decrease in C:N ratio for rye from 78:1 to 40:1 indicates that rye quickly immobilized N during the first few weeks of decomposition. Research shows N immobilization occurs if the plant residue has a C:N ratio of ≥30, and net immobilization lasts until the C:N ratio of the decomposing material has been lowered to ≈ 20. Residues like corn stover and rye have C:N ratios higher than this critical value and thus they immobilized N.

In line with their C:N ratios vetch released 60% of N in 2 weeks with only 20% left after 18 weeks compared to rye which had 60% of total N remaining in the residue bag at the 18th week (Fig. 3). Prior to incorporation the soil NO_3-N levels under vetch and rye cover crops were low. However, soil NO_3-N levels were significantly higher for vetch one week after incorporation and remained so throughout the study.

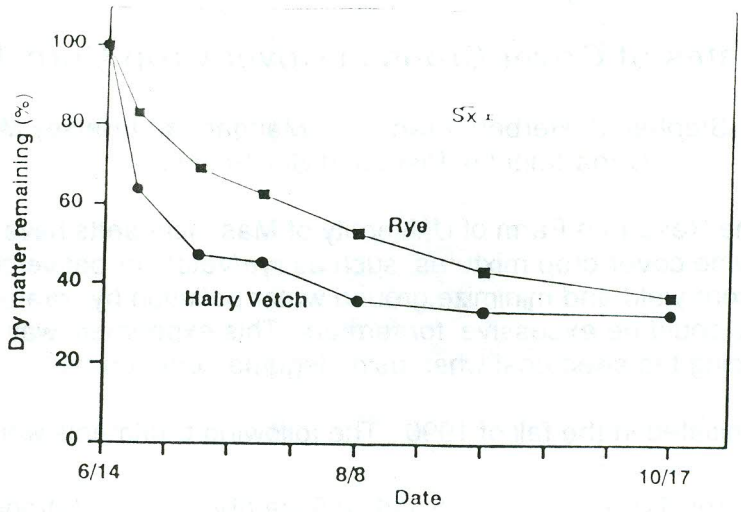

Figure 1. Dry matter remaining of cover crops during decomposition.

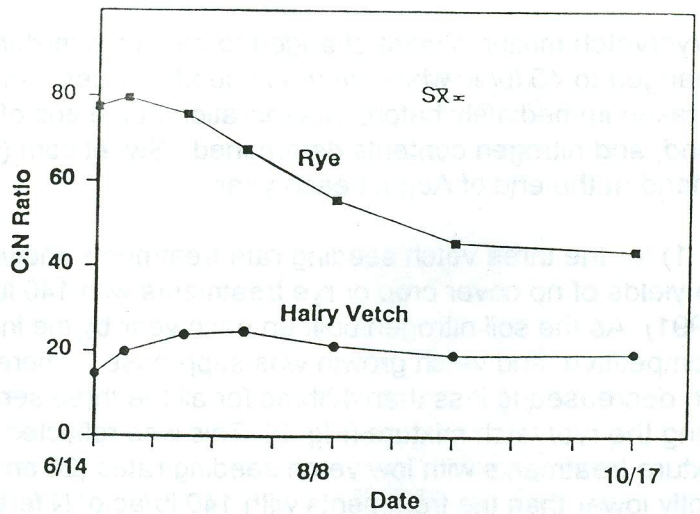

Figure 2. C:N ratio of cover crop residues during decomposition

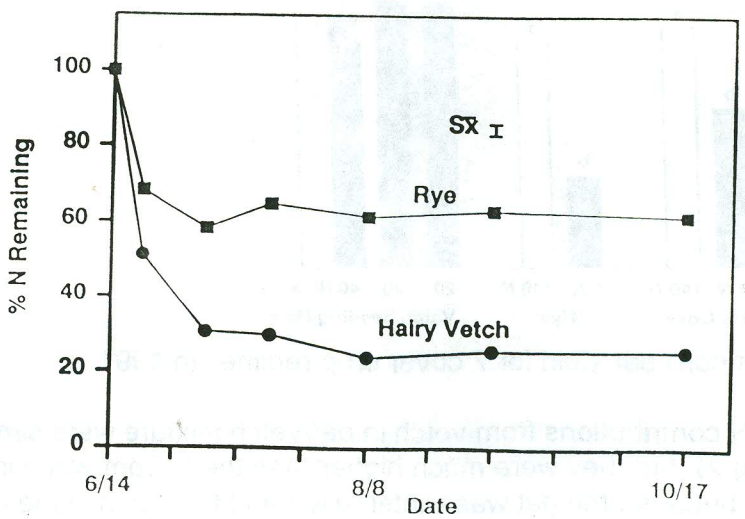

Figure 3. Percent nitrogen remaining of the quantity initially incorporated.