Nitrogen Recovery by No-Till and Conventional Till Corn from Cover Crops

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A significant portion of the N required by corn can be supplied by legume cover crops. Based on N fertilizer equivalents in pounds per acre, the following estimates of N input to corn from legume cover crops have been reported: 100 from a mixed cover of hairy vetch and spring oats (Mitchell and Teel, 1977), 120 to 180 from hairy vetch (Flannery, 1982), and 80 to 90 from hairy vetch (Ebelhar et al., 1984). Frye et al., (1985) have shown that hairy vetch cover resulted in the highest grain yields and economic returns compared to cover treatments of rye or corn residue only; all were in combination with 90 lb N/acre. Thus, legume cover crops can be considered a viable substitute for a portion of the fertilizer N needs of corn. In order to take full advantage of the legume N and to make judicious N fertilizer recommendations in terms of rates and time of application, more information on the behavior of this system is needed. Therefore, the objective of this study was to determine the pattern of uptake and recovery of N from ^{15}N-labeled legume and non-legume cover crop residues under no-till and conventional till management.

MATERIALS AND METHODS

A field experiment was initiated in the spring of 1984 within a long-term no-till corn experiment that has been in progress since 1977. A thorough description of the established experiment was given by Ebelhar et al. (1984). In 1984, a tillage variable was incorporated into the long-term study by plowing half of each plot, resulting in tillage treatments of no-till and conventional till.

Microplots (2x3 m) were established on plots with cover treatments of corn residue, rye, and hairy vetch, all with 0 N fertilizer. *In situ* rye and hairy vetch were removed from the microplots and replaced with the same amounts of ^{15}N-labeled residues (Table 1).

Whole corn plant samples were taken by randomly cutting 3 plants within the microplot at day 42, 77, and 126 after planting. The plants were dried at 65°C, weighed, ground, and analyzed for total N. Percent ^{15}N in each sample was determined with a mass spectrometer, and by the use of appropriate formulas the recovery of N from the labeled residues was determined.

Table 1. Dry matter quantity of labeled residues added and N content.

Cover Crop	Quantity	N Content
	lb/acre	lb/acre
Hairy vetch	3030	110
Rye	1360	23

RESULTS AND DISCUSSION

The quantity of N removed by corn was dependent on the cover treatment and tillage (Fig. 1). Plowing the soil resulted in greater N uptake (accumulation) for all cover treatments. This suggests that mineralization of the residues and/or soil organic N was greater when the soil was plowed.

An estimate of the differential quantity of N accumulated by corn with a hairy vetch cover over a cover of corn residue for both tillage treatments is shown in Fig. 2. It is apparent that there is an additional quantity of N in the hairy vetch system which can be attributed to its capacity to biologically fix atmospheric N_2. This additional N is released from both the hairy vetch residue and the soil which, over time, has reached a greater equilibrium soil N content. At harvest, the apparent contribution of N from hairy vetch to corn was 70 and 50 lb/acre for conventional till and no-till, respectively.

Grain yields are presented in Table 2. Plowing the soil resulted in greater yields for the corn residue and rye cover treatments, while with hairy vetch there was no significant difference between tillage treatments. The ratio of yield over total N removed for all treatments was near one, except for plowed hairy vetch, which was less than one (Table 2). This implies less efficiency of the greater quantity of N accumulated in the plowed hairy vetch system compared to the other treatments. This is probably due to low available soil moisture in 1904 limiting utilization of this N. Ratios near one indicate an average utilization of N, but ratios less than one suggest that something other than N was limiting. An indication of increased productivity when hairy vetch is used as a cover crop can be seen when one takes the ratio of yield with hairy vetch cover for each tillage treatment over the corresponding tillage treatment of corn residue cover. Ratios of 1.36 and 1.92, resulted for conventional till

hairy vetch/corn residue and no-till hairy vetch/corn residue, respectively. Thus, by the use of a hairy vetch cover crop, grain yield was 36 and 92% greater than corn residue alone for conventional till and no-till, respectively.

Table 2. Effect of tillage and cover treatment on grain yield and yield/lb N removed.

Cover Treatment	Tillage	Grain Yield*	Yield/lb N Removed
		bu/acre	
Hairy vetch	CT+	110 a‡	0.76
	NT	102 a	0.99
Corn residue	CT	81 b	1.10
Rye	CT	80 b	1.10
	NT	53 c	0.96
Corn residue	NT	52 c	0.99

* Adjusted to 15.5% moisture.

+ CT = conventional till; NT = no-till.

‡ Means followed by the same letter are not significantly different at the 5% level of probability based on LSD.

By employing labeled residues we were able to estimate the recovery of N by corn, from the residues (Table 3). It is apparent that turning under the residue by plowing resulted in a greater quantity of N recovered. Mixing the soil with the residue resulted in a more intimate contact between residue and soil, thereby increasing the quantity of residue decomposed. Although in the no-till system less of the residue is likely to decompose, the remaining residue on the soil surface protects the soil from erosion.

Table 3. Total recovery of cover crop N by corn as influenced by tillage.

Cover Crop	Tillage	Total N Recovered
		%
Hairy vetch	CT*	34 a+
Rye	CT	26 b
Hairy vetch	NT	18 c
Rye	NT	18 c

*CT = conventional till; NT = no-till.

+ Means followed by the same letter are not significantly different at the 5% level of probability based on LSD.

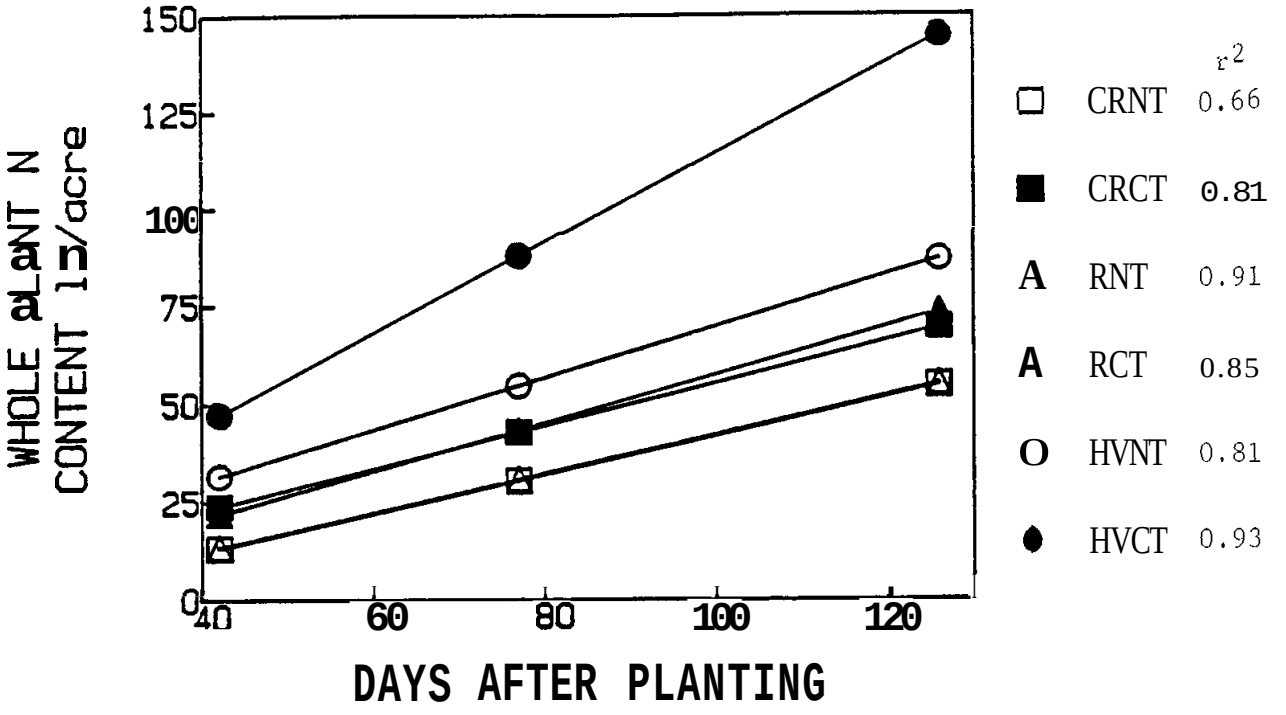

Fig. 1. Nitrogen uptake by corn as influenced by cover treatments of corn residue (CR), rye (R), and hairy vetch (W), and conventional till (CT) and no-till (NT) management.

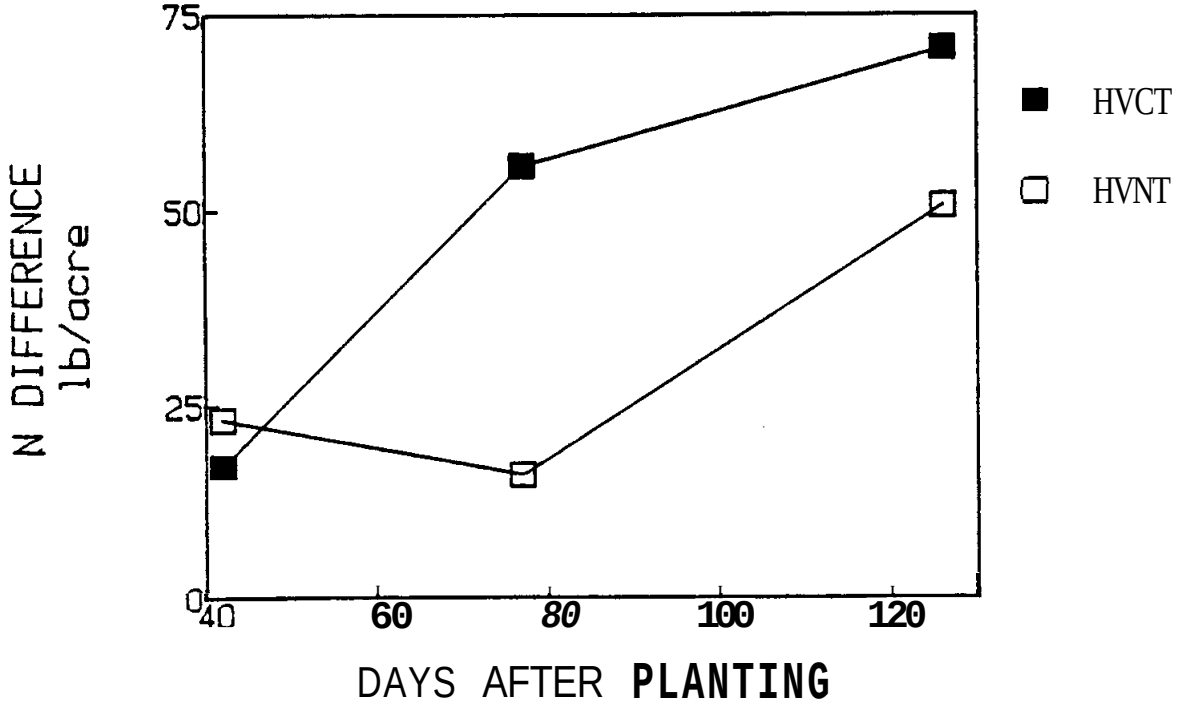

Fig. 2. Nitrogen uptake by corn planted into hairy vetch (HV) residue, in excess of N accumulated by corn planted into corn residue (CR), as influenced by conventional till (CT) and no-till (NT) management.

SUMMARY

Turning the residues under by plowing resulted in a greater quantity of N accumulated by corn compared to no-till. As measured by the use of ^{15}N-labeled residues, more residue N was recovered by the conventionally grown corn. These effects are the result of a more enhanced mineralization of N from the residue and soil organic matter with conventional till. Although N removal and recovery of hairy vetch residue N were greater with conventional till, N efficiency by no-till corn was greater due to more available moisture. Also with the no-till system, the residue remaining on the soil surface will provide protection against soil erosion.

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