Project Number: 95-AB1

FINAL REPORT

Leguminous Cover-Crop Residues in Orchard Soils: Decomposition and Fate of Nitrogen

Project Year: 1995

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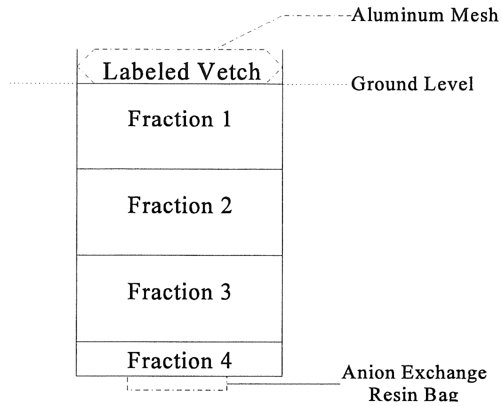
Experimental Methods Development

During summer, 1995, we installed and evaluated the first field experiments, to test the method of ^{15}N enrichment of vetch hay, and to track the appearance of the 15N label in soil columns. A BIOS managed orchard near Hilmar, CA, using sprinkler irrigation, was chosen as the study site. Twenty sampling sites were identified within a randomly-chosen row, at midpoints between trees. Irrigation was monitored initially to determine that each site received approximately equal sprinkler coverage.

The vetch was grown in a greenhouse in steam-sterilized soil mix and fertilized with a Hoagland's nutrient solution enriched with ^{15}N-ammonium nitrate (10 atom% ^{15}N). It was grown to flowering, harvested just before field installation, and applied as fresh hay.

Two PVC pipes, 10" long by 6.25" inner diameter, were driven into the ground at each sampling site in the orchard (2 columns X 20 sites). Vetch hay was placed on the top of one soil column, and the second column was left as a control. The hay was placed on aluminum mesh (1/4") in contact with the soil surface, 67 g per column. Anion exchange resin bags were installed at the base of each vetch column per site, to measure nitrate leaching. Eight additional columns were

Column Design



installed randomly in the row, and vetch hay without label was applied at the same rate, to serve as a non-labeled comparison. Two temperature probes with digital data recorders were placed at one randomly-chosen site-- at the soil surface beneath the vetch, or at the soil surface in the control column.

To quantify loss of biomass due to decomposition, we measured the average biomass of the hay applied at the beginning of the experiment (dry wt), and the average biomass of the hay residue at each sampling date.

Columns were lifted at five sampling dates: T_0 (July 10), and every two weeks after until T_4 (September 5). Five columns per treatment per date were analyzed. Each column was sliced into four, 5-cm fractions. The remaining hay where present was harvested separately. Subsamples of each fraction were dried, weighed and ground prior to being analyzed for total N at the DANR soils laboratory, and ^{15}N content using mass spectrometry. Anion exchange resin bags were refrigerated for later analysis.

B. Results

1. <u>Decomposition of hay and N loss</u>

Approximately 60% of the total hay biomass was lost during the 8-week experimental period (July 10 - Sept. 5, 1995). During this time, 67% of the total N per unit wt was lost. Thus most of the N contained in the vetch hay, 85-90%, was released either to soil or to atmosphere during the experiment.

2. <u>Nitrogen throughput</u>

The ^{15}N label enabled us to follow the course of N throughput in soil profiles. Statistically significant enrichment of each fraction in the 10" soil column was detected by T_1, two weeks after installation of the columns and hay (t-test, $P=.05$), compared to control. Thus nitrogen from the cover crop hay was already released within the first two weeks, and readily detectable with our methods. The amount of label per soil fraction was not different between T_1 and T_4, however, suggesting that a throughput or flux of N through the soil profile was occurring. We have extracted the resin bags and will now analyze extracts , to determine a leach fraction.

3. Changes in 15N enrichment.

The hay residue was analyzed for $^{15}N/^{14}N$ ratio ($\delta^{15}N$) at T_0 and at subsequent sampling dates. Interestingly, we observed a decrease in ^{15}N enrichment over the course of the experiment, of about 29%. This translates to a net enrichment of the lighter isotope, ^{14}N, relative to ^{15}N. Enrichment of ^{14}N relative to ^{15}N results from microbial enzymatic transformations, either nitrification/denitrification or nitrogen fixation. By contrast, enrichment of ^{15}N relative to ^{14}N would be expected to occur as a result of volatilization (Hoefs 1987).

4. Additional findings.

We monitored the timing and amount of irrigation during the 8-week experimental period. We were unable to analyze all of the intermediate time points due to budgetary limitations, but very preliminary data suggest that patterns of isotope enrichment could be explained by timing of irrigation, among other possibilities.

C. Conclusions

1. The experimental methods work.

In the first year of the project, we developed methods to enrich vetch for ^{15}N label, and we installed and sampled soil columns in the field. We have demonstrated that the vetch labeling method will be a successful approach for tracing N throughput. When the leach fraction is determined, we will be able to calculate N volatilization losses by subtraction. Next year, using these methods, we will follow the fate of cover-crop nitrogen during a typical growing season (April through July).

2. Most of the initial nitrogen in the hay was lost within 8 weeks.

Next year, we will monitor N loss during a typical growing season. It will be important to determine changes in N isotope ratio in the hay residue over time.

3. The enrichment in the lighter isotope, ^{14}N, suggests that net mineralization of N in the soil is greater than volatilization-- the N is going into the soil.

To gain a more complete picture of volatilization vs. nitrate formation, we now hope to compare direct calculations of volatilization with changes in isotope ratio, as a function of time. We will also be very interested to monitor N flux and and isotope ratio changes in relation to timing of irrigation (see B.4.above).