LODI-WOODBRIDGE WINEGRAPE COMMISSION

ANNUAL REPORT, MAY 2003

Project Title: **Uptake of Cover-Crop Nitrogen by Wine Grapevines In the Central Valley of California**

Principal Investigator:

Name: Alison M. Berry, Professor
Department: Environmental Horticulture
Address: University of California
One Shields Avenue
Davis, CA 95616
Telephone #: 530-752-7683
FAX #: 530-752-1819
Email Address: amberry@ucdavis.edu

Cooperators and Consultants:

Jeanne Wiltberger
Department of Environmental Horticulture
jmwiltberger@ucdavis.edu

Amy Patrick
Department of Environmental Horticulture
aepatrick@ucdavis.edu

Rik Smith
Department of Environmental Horticulture
riksmith@ucdavis.edu

Robert Abercrombie
Sutter Home Winery

Cliff Ohmart
Lodi-Woodbridge Winegrape Commission

Charles A. Ingels
UC Cooperative Extension
4145 Branch Ctr. Rd.
Sacramento, CA 95827-3898
caingels@ucdavis.edu

Robert L. Bugg
UC-SAREP, University of California, Davis, CA 95616
rlbugg@ucdavis.edu

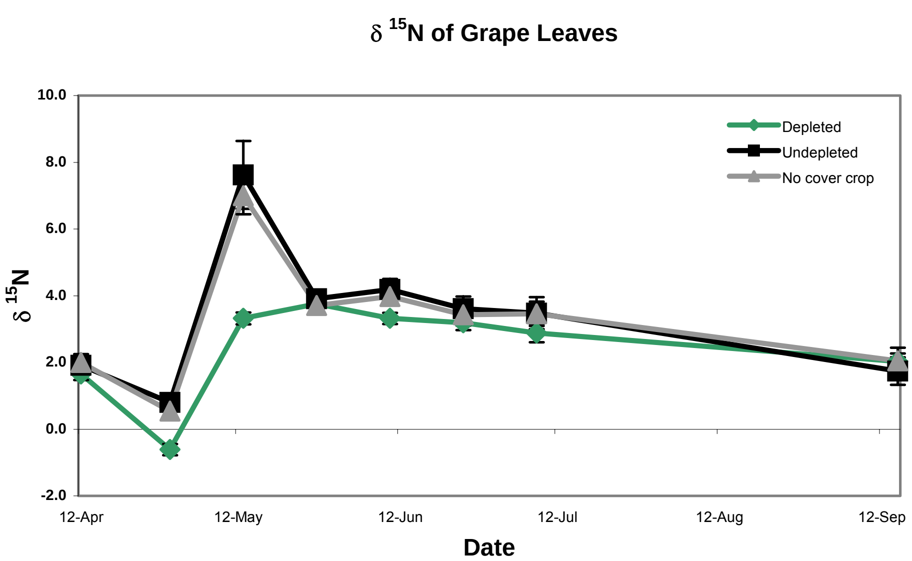
OBJECTIVE 1. Time course of cover crop N release in soil and uptake in grapevine leaves and berries (^{15}N-depleted cover crop replacement)

In April 2002, 24 plots with 48 vines were established in the Delta Ranch vineyard experimental area. Plots were mowed and raked to remove aboveground cover crop biomass. Then 3 treatments were applied: 1. replacement of aboveground biomass with isotopically-labeled cover crop; 2. replacement of aboveground biomass with unlabeled cover crop; and 3. no additional cover crop. Samples of grape leaf tissue, grape berries, and soils were taken at intervals, processed and analyzed for %N and N isotope content ($\delta\ ^{15}N$).

Since the previous Progress Report (Fall 2002), we finished collecting, processing and analyzing eight sets of grape leaf samples, three sets of berry samples, and three sets of soil samples from Delta vineyard. Results from our data analysis are summarized below.

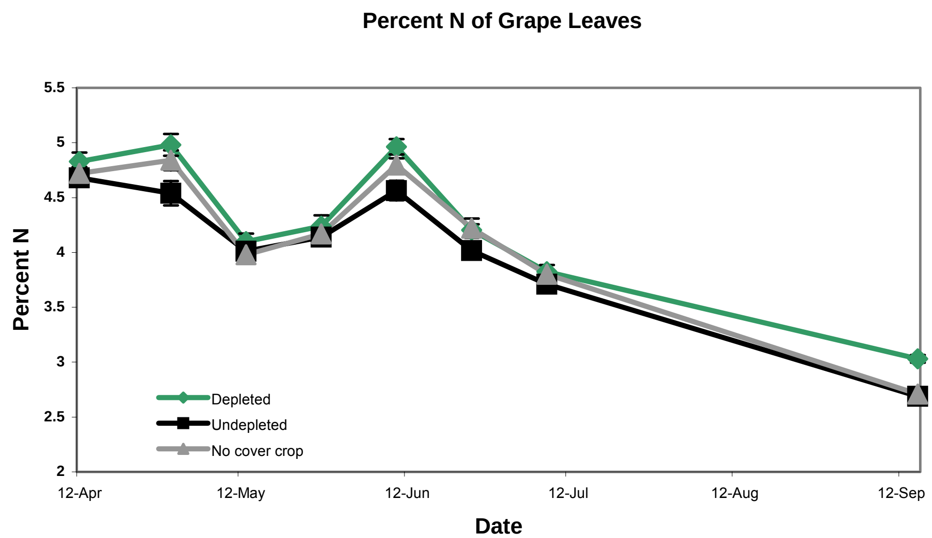
- Grape leaf $\delta\ ^{15}N$. Leaf samples were collected throughout the season, weighed, dried, ground, and analyzed for $\delta\ ^{15}N$. A difference in $\delta\ ^{15}N$ was detected within two weeks of cover crop application in the labeled plots. Label was highest one month after application (Figure 1).

FIGURE 1



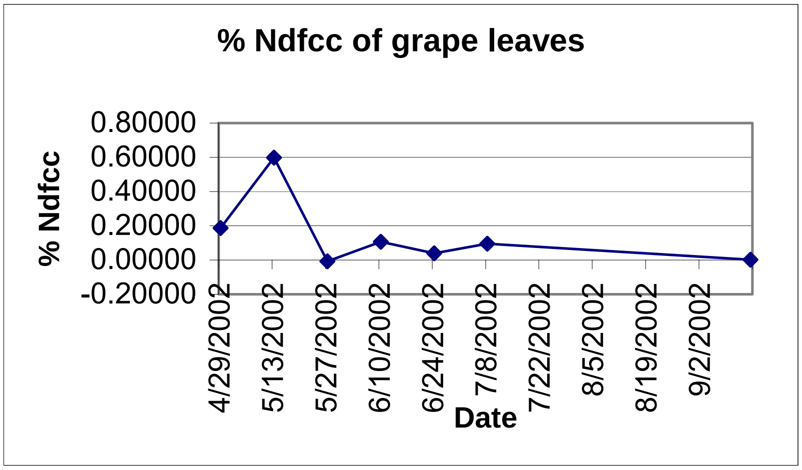
- Grape leaf %N. There was no major difference among treatments in total grape leaf N (Figure 2). The periods of highest leaf N concentration were: two weeks after cover crop incorporation, and two months after cover crop incorporation, a time period (6/12) between fruit set (5/18) and veraison (7/20). These periodic increases in leaf N did not correlate with fertilizer applications, since no N fertilizer was applied. The phases could correlate 1. with soil N turnover following mowing and tilling; and 2. possibly with a renewed root growth period, which has been reported previously in grapevines.

FIGURE 2



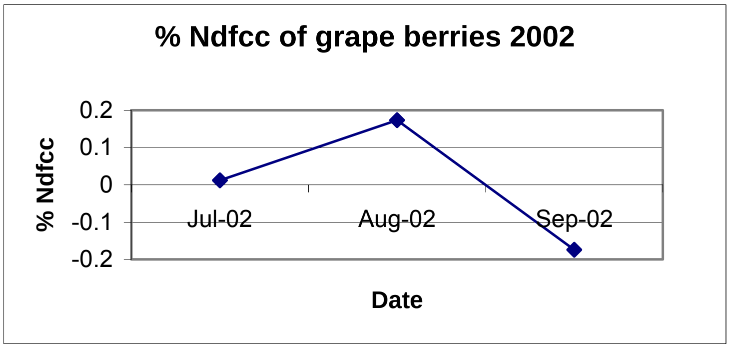
- <u>Grape leaf N derived from cover crop (%Ndfcc)</u>. Perhaps the most important finding from the 2002 season was that the percent nitrogen derived from cover crop (%Ndfcc) in the grape leaves reached a maximum of 0.6% (Figure 3). This was a substantially lower incorporation rate compared with grapevine lysimeter studies in 2001 (25-30% Ndfcc). The difference between field and lysimeter results is partly explained by “dilution” from the large pool of (unlabeled) N present in the rich vineyard soil. We have not yet compared field and lysimeter %Ndfcc on a total N per plant basis, to see if total uptake is comparable. Other factors that could account for the difference in labeled N uptake by grapevines in the field vs lysimeter include: distance of the cover-crop placement in relation to the vine; tillage; and age of grapevines in the vineyard vs. lysimeters. In the lysimeters, cover crop was surface-applied at the bases of the vines, which may have allowed direct N uptake by the grapevine roots. The lysimeter vines were grafted 1-year-old transplants, which may have had greater N uptake and less N storage and recycling, compared with the older field vines. This year (2003 season) we are testing the effect of distance, by placing labeled cover crop in berm plots, rather than in middles (see 6. Additional Experiments).

FIGURE 3



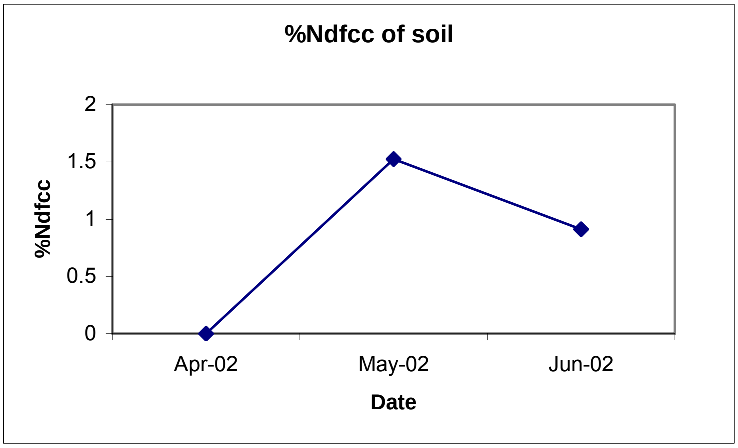
- Grape berry %Ndfcc. Grape berries were sampled at three dates during the season for %N and δ ^{15}N. %Ndfcc peaked in early August, at a maximum of about 0.2% nitrogen derived from cover crop (Figure 4). This may represent recycling of the labeled N within the grapevine (see whole vine results, below).

FIGURE 4



- Soil %Ndfcc. Six sets of soil samples were collected throughout the 2002 season, weighed, dried, and ground. Analysis of the first three sets of soils (T0, T1, T2) showed significant incorporation of label during the first month after cover crop application, to a maximum of 1.5% of total soil N (Figure 5).
- Mid-winter soil %Ndfcc. In January 2003, soils still contained 1.5% nitrogen derived from cover crop. Thus cover crop N in the soil remains at a fairly constant level, and may contribute to grapevine nutrition in the following growing season. We are testing this possibility this year (see Objective 6).

FIGURE 5

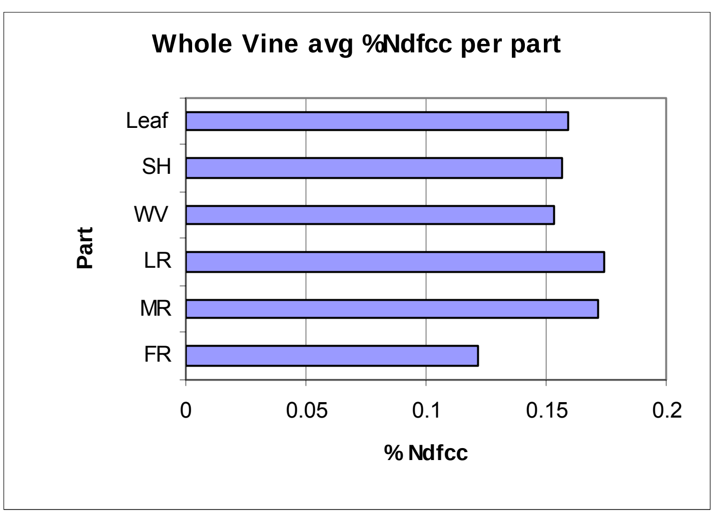


Objective 2. Total Nitrogen Uptake: Whole Grapevine Study

One of the objectives for 2002 was to provide quantitative information on the total grapevine nitrogen derived from the cover crop, including how the N is partitioned among the grapevine parts - leaves, stems, and roots.

- %Ndfcc of whole grapevines. Four whole grapevines, two from "no cover crop" plots and two from labeled cover crop plots, were excavated, sorted by plant part and size (small, medium, and large roots, shoots, woody stem), weighed, dried, ground first by a garden chipper, then by a Wiley Mill, and analyzed for % N and δ ^{15}N. By and large, %Ndfcc was comparable among different plant parts (Figure 6), approximately 0.15%. Large and medium roots had a slightly higher %Ndfcc, 0.17%, during this fall excavation.

FIGURE 6



Objective 3. Nitrogen fixation by cover-crop legume species

- Nitrogen fixation by cover-crop legumes. It is important in understanding the nitrogen balance to determine how much of the legume biomass N is derived from nitrogen fixation, vs. uptake of soil N. The nitrogen-fixing cover crops in the cover crop mix (common vetch, 'Lana' Woollypod vetch, bell bean, and Austrian winter pea) were in a growth chamber, fertilized with nitrogen-free Hoagland's solution, nodulated by rhizobia, and watered regularly with deionized water. Pea and bell bean derived 79% and 92% of their N from nitrogen fixation, respectively. The vetch plants did not grow well, and these will be retested this year.

Objective 4. Sutter Ranch: Study of Nutrient Cycling in a Perennial Cover Crop System

The Chardonnay acreage at Sutter Road Ranch is planted half to a perennial strawberry clover cover crop, and the other half to the Big Three perennial native bunch grass cover crop. These two systems were analyzed for differences in nitrogen and water status, since the clover is a legume. The natural abundance of ^{15}N was used to characterize N flow. The full results of this study are in preparation and will be submitted for publication within the month.

Highlights

1. In the clover system, N content and and water content were both increased, in the soil and in grape leaves.
   - Soil in the clover cover crop system had high water content; high total N and soluble N; high vegetative cover and low weed density.
   - Soil in the bunch grass cover crop system had low water content, low total N and soluble N; low vegetative cover and high weed density.
   - Grape leaves in the clover system had higher water content, percent N and $\delta^{15}N$ than those in the bunch grass system.
2. Increased soil moisture and N input from the leguminous clover cover crop probably worked together to enhance N turnover and N availability to the grapevines in this system.
3. The perennial clover was very effective in excluding weeds.
4. Further study on the use of perennial clovers in vineyards is warranted, despite previous studies that have found that strawberry clover uses more water than summer-dormant native bunch grasses. Our findings may be attributable to the high water tables and heavy clay soils in the Delta region, or to the fact that the cover crops had been in place for several years. This should be tested in other soils.
5. The observed high $\delta^{15}N$ in the clover system may be due to increased rates of denitrification and other fractionating processes associated with N turnover in the wet, N-rich clover system.

Objective 5. Completion of project data analysis, writeup and presentation

- The above results represent data collected and analyzed to date.
- Amy Patrick has completed her Master's Thesis, including writeups of results from the Sutter permanent cover crop study and 2001 data from the Delta Ranch vineyard. She gave two presentations on the results of both projects at the 37th Annual Meeting of the Association of Applied IPM Ecologists in San Luis Obispo in January 2003, and at the Napa Valley Grape Growers Association Seminar in February 2003. She will present a poster at the American Society of Enology and Viticulture (ASEV) conference in Reno, Nevada June 18-June 20.
- Rik Smith is currently finishing the writeup on lysimeter studies in comparison with other nitrogen cycling studies, as one chapter in his PhD dissertation.
- Jeanne Wiltberger will continue to collect and process samples and analyze Delta data from 2002. She will present a poster at the ASEV conference in June, on the Delta data.

Objective 6. Experiments for 2003.

- Cover-crop N carryover. Four whole vines were excavated in March 2003, 2 each from labeled and unlabeled 2002 plots. These are currently being processed for analysis, to determine the %Ndfcc. Samples of soil, berries, and grape leaves will be taken from the 2002 plots during bud break, fruit set, veraison, and harvest to determine carryover effects from the previous year's cover crop residue. Depending on these results, four vines will be excavated in Fall 2003 and analyzed for total nitrogen and $\delta\ ^{15}N$. Because no additional labeled cover crop has been added to the 2002 plots, the comparison will allow us to determine whether N derived from cover crops applied in 2002 continues to be taken up by the vines in 2003.

Additional Experiments

- Pilot study: cover crop windrows. We are conducting a pilot experiment in 2003 to test whether placing the cover crop directly around the bases of the grapevines improves uptake of cover-crop N. As in 2002, we grew a labeled and unlabeled cover crop at UC Davis for the replacement experiment at Delta ranch. In April, cover crop was placed in windrow plots around the vines in the berm area, rather than tilled into the middles of the row. δ 15N and total N for leaf, berry, and soil will be determined weekly for the first month following cover crop application, and monthly thereafter. The results will be compared with last year's results for %N and %Ndfcc, when the cover crop was tilled into the middles; and with the lysimeter studies from 2001.

- Litterbag studies. To more closely analyze the pattern of N release from the cover crop, in 2002 we conducted a four-week study of cover-crop decomposition and N release, using litterbags. Results of this study indicated that both decomposition and N release took place largely during the first 2 weeks following placement of the cover crop in the litterbags.

- Mycorrhizal networks. In 2003, we will continue the litterbag studies begun in 2002. This year, we will be looking at mycorrhizal networks form between the grapevines and the decomposing cover-crop litter, that could facilitate N transport to the grapevines. This will provide information on possible pathways of N transfer from the decomposing cover crop into the grapevine, and may have implications for best cover-crop management practices to enhance nitrogen transfer.