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AMERICAN VINEYARD FOUNDATION
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**Project Title**: Improving nitrogen fertilizer efficiency in winegrapes: application timing comparisons and refinement of critical tissue analysis levels in four important cultivars

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**Objectives**:

1. To determine the most efficient timing of nitrogen fertilization in four important wine grape cultivars -- French Colombard, Chenin blanc, Barbera, and Grenache. The purpose is to maximize the cost efficiency of nitrogen, minimize nitrate contamination of the ground water, while optimizing fruit quality and yields.

2. To establish some initial or tentative critical tissue levels for each cultivar, including bloom time petiole nitrate and ammonium nitrogen, and fruit arginine levels at harvest.

**Research Timetable**:

1987 - initiate study, beginning with early spring treatments
1988-90 - continue treatment and study to determine long-term effects on vine response and vine tissue levels

**Summary**:


1989 is the third year of data taking in this 4-year study on N fertilizer management in 4 wine grape cultivars. Budbreak, fruit set, veraison, and postharvest timings are being compared at 50 lb. N/acre along with check-0 and budbreak-100 lb. N/acre as rate comparisons. The trial consists of own-rooted vines of Barbera, Grenache, French Colombard, and Chenin blanc. Bloom and veraison petiole nitrate ($NO_3$) and ammonium ($NH_4$) levels are being used to determine treatment differences in N status. Vine and fruit parameters include cluster numbers, fruit composition analysis and vine yields.

The effects of timing of N fertilization are showing some interesting patterns with vine N status. There is a tendency for petiole $NO_3$ and $NH_4$ to be higher in N treatments which were applied most recently in relation to sample times. This might be expected, as the vines have had an opportunity to pick up and translocate N of recently availability. However, in some cultivars postharvest-50 and fruit set-50 treatments are showing $NO_3$ and $NH_4$ levels equal to or higher than budbreak-50. This is especially true of postharvest-50 which has an even higher N status at bloom than that of budbreak-50. This suggests that budbreak applications, a traditional N fertilizer timing practice, may not be the most efficient N treatment on a long-term basis. Such a conclusion, if supported by further data in 1990, would be in agreement with earlier work in raisin and table grapes which showed the berry set and postharvest treatments to be more efficient in N uptake and in providing for stored N to be utilized in subsequent years. The petiole analysis data also supports previous work showing inherent cultivar

differences, with Grenache and Chenin blanc as high and Barbera and French Colombard as low $NO_3$. The possible benefit of using petiole $NH_4$ as compared to $NO_3$ or the combination of both to determine N status is still in question. Cultivar differences in $NH_4$ levels are apparent in this study, with French Colombard tending to have high $NH_4$ status as compared to $NO_3$ while Barbera tends to have low $NH_4$ as well as $NO_3$ status. The results of this study, when complete, will hopefully indicate possible usefulness of $NH_4$ analysis in future N work.

The most significant effect of N fertilization on fruit composition is with °Brix. Nitrogen fertilization reduced °Brix, regardless of timing, as compared to check, unfertilized. Part of this effect may be because of lower fruit yield. Check, unfertilized had the lowest yield in all cultivars, although the effect was only statistically significant in Grenache. There was also an effect of high N status on fruit °Brix. The high rate of N in this study--Budbreak 100 lbs. N--caused some further delay in °Brix over the other 50 lb. N treatments. This effect of progressively lower °Brix due to higher N status was shown in previous years in this study.

As stated above, there were trends in yield effects due to N fertilization but only at statistically significant levels in Grenache. The improved yield from all N treatments over check would indicate that unfertilized vines in this study are probably in the deficient range.

This should enable us to establish some preliminary critical deficient petiole nitrate levels for these cultivars. No reduced yield effects from high N status have appeared in the study. However, high N status from high N fertilization (100 lbs. N/acre) has contributed to delayed °Brix. Thus, it may be possible to establish tentative excess N levels (as they contribute to delayed ripening without yield improvement) in some of the cultivars.

All of the above findings must be considered to be preliminary until the final year of data (1980) is included in the trial data summary. This will include data from ethyl carbamate analysis of wine samples made by Dr. Linda Bisson, UCD, and fruit arginine analysis from the 1990 harvest.

Research Accomplishments:

The trial block is located on a well-drained Hanford sandy loam soil at the U.C. Kearney Agricultural Center. It consists of furrow-irrigated ten-year-old vines of French Colombard, Chenin blanc, Barbera, Ruby Cabernet, and Grenache planted in individual, but adjoining blocks. Trellis design is a standard 7-foot stake system with a cordon wire at 42" and foliage wires at 58" and 64". The trial blocks were originally used for pruning studies but have had uniform treatment (no experimental treatment) for two years prior to the initiation of this study.

Six replications of the following timing treatments were employed in four-vine plots with two guard vines. The trial rows are also separated with guard rows which receive the same treatment as the adjoining plots. 1989 is the 3rd year of trial with the fertilizer treatments listed below.

| Treatment No. | Vine Growth Stage | 1987 | Dates 1988 | 1989 | Rate Actual N/Acre |
|---|---|---|---|---|---|
| 1 | Bud break | 3/23 | 3/9 | 3/21 | 50 |
| 2 | Fruit set | 5/19 | 5/17 | 5/11 | 50 |
| 3 | Veraison | 7/6 | 7/7 | 7/5 | 50 |
| 4 | Post harvest | 9/14 | 9/23 | 9/14 | 50 |
| 5 | Bud break | 3/23 | 3/9 | 3/21 | 100 |
| 6 | | | | | 0 |

The nitrogen was applied as ammonium nitrate and shanked to a 3" to 4" depth about 2′ to 3′ from each side of the vine rows. Each fertilization was followed by a surface irrigation. Irrigation scheduling and farming practices were normal for the area.

Petiole samples were taken from all plots at bloom, 4/21-5/2 and veraison, 7/5-6, as directed by the cultivar's stage of development. They were analyzed at the U.C. Cooperative Extension Diagnostic Laboratory at U.C. Riverside for nitrate-nitrogen and ammonium-nitrogen.

All of the plots for each cultivar were berry sampled (100 berries/plot) and harvested on the following dates according to stage of ripening and progression of bunch rot problems:

| | berry sample | harvest |
|---|---|---|
| Chenin blanc | 8/7 | 8/8 |
| French Colombard | 8/14 | 8/15 |
| Grenache | 8/22 | 8/23 |
| Barbera | 9/6 | 9/8 |

The berry samples were analyzed for °Brix, titratable acidity, pH, and berry weight. The harvest data included yields and number of clusters with rot per plot.

## Nitrogen Status - Petioles

Bloom - Table 1

Petioles were analyzed for $NO_3$-N and $NH_4$-N to represent inorganic or assimilable nitrogen forms. This provides the opportunity to also compare these two analysis as well as their sum in assessing vine N status.

The budbreak-100 treatment is generally resulting in the highest bloom N status. This might be expected, as it is the highest N rate treatment and was the most recent application prior to petiole sampling. All of the other N fertilizer treatments compare timing at the same N rate--50 lbs. There is a tendency for petiole $NO_3$ and $NH_4$ levels to be lower or higher in relation to time of N treatment. Thus, fruit set-50 tends to be lowest at bloom, as no N treatment was applied since almost 12 months ago the previous year. The budbreak-50 treatment shows some exception to this trend especially in comparison postharvest-50. Although budbreak-50 was applied most recently in relation to sampling date it is not resulting in higher petiole $NO_3$ or $NH_4$ levels than postharvest-50. In fact, postharvest-50 shows a higher N status than budbreak-50 in French Colombard. Also, veraison-50 shows bloom petiole N levels to be the same as budbreak-50 in all cultivars. This suggests that budbreak may be one of the least efficient times of N fertilization as shown by carry-over N influencing N status.

The overall bloom petiole $NO_3$ level differences among the cultivars reflect their inherent tendencies in $NO_3$ ranking as shown in previous studies. Grenache and Chenin blanc are high and Barbera and French Colombard are relatively low in $NO_3$. However, French Colombard $NH_4$ levels rank with those of Grenache and Chenin blanc while Barbera $NH_4$ tends to be low. Barbera is the only cultivar showing no treatment differences in bloom $NO_3$ or $NH_4$ status. This may be due to the overall low levels in Barbera and thus a smaller potential spread among treatments.

Veraison - Table 2

Nitrate and $NH_4$ levels decreased across treatments in all cultivars from bloom to veraison. This decrease tended to be least in Chenin blanc as experienced in previous seasons in this trial.

Some of the same overall trends reviewed under bloom analysis can be noted in the veraison results. The budbreak-100 and fruit set-50 tend to be highest overall, with no significant differences in $NO_3$ between them. However, budbreak-100 resulted in the highest $NH_4$ levels in 3 cultivars--Barbera, Grenache, and French Colombard. These results may be explained by the higher N rate and/or proximity of application to petiole sampling time of these treatments.

## Fruit Analysis

Berry Weight - Table 3

No significant differences in berry weight were found for any treatment in all cultivars. This is similar to previous years' results.

Degree Brix

Nitrogen fertilization, regardless of timing, tended to retard °Brix in all cultivars. However, the timing differences were not significant in Chenin blanc. However, the budbreak-100 gave significantly lower °Brix than check in Chenin blanc. These results demonstrate the effect of N in reducing °Brix regardless of timing. It also demonstrates the adverse effects of higher N rates in °Brix as shown in Chenin blanc.

Titratable acidity

Nitrogen fertilization tended to result in higher acidity or inversely to °Brix differences. This was significant only for Grenache and Chenin blanc.

pH

There were no statistically significant differences among treatments. Variability in pH within any cultivar was .07 units or less anyway, of questionable importance to the winemaker.

## Yield

Fruit Yield - Table 4

The trend for check-0 to have the lowest yield in all cultivars could explain the higher °Brix readings in this treatment. However, yield differences were only significant in Grenache, with budbreak-50 and 100 and berry set giving the highest yields followed by postharvest-50 and veraison-50. Check-0 was the lowest, although not significantly different than postharvest-50 and veraison-50.

## Cluster Rot

No N treatment differences are shown. As expected, Chenin blanc has the highest rot incidence, even with the early harvest date.

Table 1. Nitrogen Timing on Wine Grapes
1989 bloom petiole analysis, inorganic N compounds

| | $No_3$-N, ppm | | | | $NH_4$-N, ppm | | | | $NO_3 + NH_4$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time/Rate lbs. N/Acre | Barbera | Grenache | French Colombard | Chenin blanc | Barbera | Grenache[1] | French Colombard[1] | Chenin blanc | Barbera | Grenache[1] | French Colombard | Chenin blanc |
| Budbreak-50 | 700 | 1633ab | 758 b | 1367a | 357 | 938 c | 1016abc | 966 | 1057 | 2572 bc | 1774 bc | 2333abc |
| Fruit set-50 | 550 | 575 c | 517 c | 1042 bc | 331 | 808 c | 841 bc | 894 | 881 | 1383 d | 1357 cd | 1936 bc |
| Veraison-50 | 583 | 992 b | 942ab | 1175 b | 372 | 993 bc | 1097abc | 974 | 955 | 1984 c | 2038ab | 2149 bc |
| Postharvest-50 | 567 | 1617ab | 1292a | 1483ab | 349 | 1297ab | 1315a | 1125 | 916 | 2914ab | 2606a | 2609ab |
| Budbreak-100 | 808 | 2233a | 1167a | 1833a | 393 | 1619a | 1198ab | 1492 | 1201 | 3852a | 2365a | 3326a |
| Check-0 | 383 | 150 d | 417 c | 600 c | 268 | 473 d | 751 c | 717 | 651 | 623 e | 1168 d | 1317 c |
| LSD | 263 | 0.215 | 0.17 | 529 | 92 | 0.14 | 332 | 493 | 344 | 755 | 557 | 973 |
| P=0.05 | .0530 | .0001 | .0001 | .0018 | .1353 | .0001 | .0158 | .0646 | .0639 | .0001 | .0001 | .0078 |

[1]Means represent antilogs of log transformed data.

n.s. = $P > 0.05$
* = $P \leq 0.05$
** = $P \leq 0.01$
*** = $P \leq 0.001$

Table 2. Nitrogen Timing on Wine Grapes
1989 Veraison petiole analysis, inorganic N compounds

| Time/Rate | $NO_3$-N, ppm | | | | $NH_4$-N, ppm | | | | $NO_3 + NH_4$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lbs. N/Acre | Barbera | Grenache | French Colombard | Chenin blanc | Barbera | Grenache | French Colombard | Chenin blanc | Barbera | Grenache | French Colombard | Chenin blanc |
| Budbreak-50 | 267 bc | 423 b[1] | 150 b[1] | 625a | 155 b | 190 bc | 150 b | 222a | 422 bc | 613 b | 300 bc | 847a |
| Fruit set-50 | 347ab | 470ab | 217a | 700a | 162 b | 213 b | 147 b | 232a | 508ab | 683 b | 363 b | 932a |
| Veraison-50 | 185 cd | 64 c | 112 c | 265 b | 150 b | 168 cd | 145 b | 155 b | 335 cd | 222 c | 257 c | 420 bc |
| Postharvest-50 | 260 bc | 108 c | 128 bc | 437ab | 140 b | 167 cd | 133 bc | 212a | 400 bc | 272 c | 262 c | 648ab |
| Budbreak-100 | 425a | 870a | 270a | 678a | 185a | 250a | 192a | 232a | 610a | 1120a | 462a | 910a |
| Check-0 | 127 d | 72 c | 53 d | 197 b | 113 c | 135 d | 115 c | 150 b | 240 d | 207 c | 168 d | 347 c |
| LSD | 97 | 0.36 | 0.13 | 250 | 22 | 35 | 24 | 55 | 105 | 199 | 75 | 286 |
| P = 0.05 | .0001 | .0001 | .0001 | .0006 | .0001 | .0001 | .0001 | .0086 | .0001 | .0001 | .0001 | .0004 |

[1]Means represent antilogs of log transformed data.

n.s. = $P > 0.05$
* = $P \leq 0.05$
** = $P \leq 0.01$
*** = $P \leq 0.001$

Table 3. Nitrogen Timing on Wine Grape:
1989 Berry analysis at harvest

| Time/Rate lbs. N/Acre | Mean berry wt. grams Barbera | Grenache | French Colombard | Chenin blanc | Degree Brix Barbera | Grenache | French Colombard | Chenin blanc | Barbera |
|---|---|---|---|---|---|---|---|---|---|
| Budbreak-50 | 2.37 | 2.06 | 2.11 | 2.05 | 23.9 bc | 22.1 b | 19.3 b | 18.2ab | .83 |
| Fruit set-50 | 2.34 | 2.08 | 2.04 | 2.05 | 24.0 bc | 21.8 b | 18.6 b | 18.3ab | .81 |
| Veraison-50 | 2.35 | 2.04 | 2.08 | 2.10 | 24.6ab | 22.3 b | 19.1 b | 18.3ab | .82 |
| Postharvest-50 | 2.35 | 2.10 | 2.12 | 2.12 | 23.5 c | 22.0 b | 19.0 b | 18.2ab | .84 |
| Budbreak-100 | 2.38 | 2.04 | 2.05 | 2.05 | 23.5 c | 21.3 b | 19.0 b | 17.8 b | .83 |
| Check-0 | 2.37 | 2.02 | 2.11 | 2.16 | 24.9a | 23.9a | 20.2a | 18.7a | .79 |
| LSD | .09 | .12 | .10 | .09 | .80 | 1.11 | .81 | .53 | .04 |
| P = 0.05 | .9498 | .7627 | .4717 | .0817 | .0042 | .0022 | .0169 | .0347 | .1324 |

n.s. = $P > 0.05$
* = $P \leq 0.05$
** = $P \leq 0.01$
*** = $P \leq 0.001$

Table 4. Nitrogen Timing on Wine Grapes
1989 Harvest Data

| Time/Rate lbs. N/Acre | Yield, lbs./vine | | | | No. clusters w/rot | | | |
|---|---|---|---|---|---|---|---|---|
| | Barbera | Grenache | Colombard | Chenin blanc | Barbera | Grenache | Colombard | Chenin blanc |
| Budbreak-50 | 49.4 | 88.8a | 70.6 | 45.5 | 21 | 15 | 6 | 41 |
| Fruit set-50 | 49.4 | 79.1abc | 70.4 | 42.9 | 16 | 18 | 9 | 31 |
| Veraison-50 | 45.7 | 71.4 cd | 73.4 | 43.2 | 16 | 17 | 13 | 46 |
| Postharvest-50 | 53.2 | 77.2 bcd | 77.5 | 45.7 | 17 | 27 | 9 | 37 |
| Budbreak-100 | 50.7 | 85.7ab | 66.8 | 48.1 | 15 | 16 | 11 | 40 |
| Check-0 | 46.0 | 66.6 d | 58.8 | 39.8 | 11 | 15 | 8 | 39 |
| LSD | 8.98 | 10.50 | 11.95 | 7.48 | 7.34 | 10.82 | 5.64 | 12.32 |
| P = 0.05 | .5282 | .0024 | .0657 | .3211 | .1977 | .2324 | .2677 | .2773 |

n.s. = $P > 0.05$
* = $P \leq 0.05$
** = $P \leq 0.01$
*** = $P \leq 0.001$