POSTHARVEST APPLICATION OF NITROGEN IN VINEYARDS

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Nitrogen (N) is a major constituent of organic compounds in plants. Amino acids, proteins, nucleic acids and many secondary metabolites are included in this group. As a result, N is essential for grapevine growth and is the most commonly applied fertilizer element in vineyards.

Reduced growth is often the first N deficiency symptom observed in vineyards. Deficiency symptoms in leaves will not become evident until the deficiency is severe (see Christensen, L. P. et al., 1978, or G rtel 1993 for symptoms). Growth and yield of vines will usually be reduced significantly before deficiency symptoms in leaves are observed. However, it should be noted that vineyard pests (such as phylloxera and nematodes), soil physical problems and poor irrigation management can also result in inadequate vine growth. A good program for monitoring N status is the only certain method to determine if N is a limiting factor in your vineyard.

Excessive use of N in vineyards seems to be a greater problem than deficiency of N. Application of N fertilizer should meet the N requirements of the vine. Use of N in excess of vine requirements is correlated with high nitrate in ground water, bud necrosis, reduced bud fruitfulness, excessive vine vigor, increased incidence of stem necrosis disorders, reduced fruit maturity and increased incidence of bunch rot. Also, growers who apply more N than is needed are wasting their money.

Fertilization practices are changing as growers attempt to optimize the use of N. Application of N during the postharvest period can increase the efficiency of N uptake and use. In this article, I will present information on this practice.

Timing of Nitrogen Application

Improved efficiency in N fertilization can be achieved if N applications are done when active uptake of N is occurring. The seasonal pattern of N demand and allocation for grapevines in regions with long growing seasons is described in Table 1. Uptake of N occurs most rapidly from fruit set to veraison and from harvest to leaf senescence. N used by vines during the period from budburst to fruit set comes primarily from reserves stored in permanent woody structures (roots, trunks, cordons, etc.) during the previous growing season. During the veraison to harvest period, developing clusters become the dominant sink for N. N is supplied to clusters at this time by uptake from the soil and redistribution from roots, shoots, and leaves. In viticultural regions with growing seasons shorter than California, the pattern of N demand and allocation may be altered somewhat. Root growth and N-uptake occurs during the veraison to harvest period in grape-growing regions which effectively have no postharvest period. Applications of N in winter or early spring are not as efficient as applications during the growing season. N applied during these times is subject to leaching and denitrification before uptake begins.

The best timing for efficient use of N fertilizer appears to be from fruit set to veraison and postharvest. In general, these periods coincide with root growth flushes when uptake of nutrients is maximal. Field experiments with Thompson and Flame Seedless vines in the San Joaquin Valley confirmed that N applied during fruit set, veraison, and postharvest was compatible with vine growth and fruit development.

Postharvest N application should be

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Table 1. Different phases in the N-nutrition cycle of the grapevine.*

Phase in N-nutrition cycle	Growth Stage	Specific characteristics for N-uptake
I	Budburst to end of bloom	New growth dependent on reserve N accumulated during previous season(s). Little root growth and N uptake.
II	1. End of bloom to end of rapid shoot growth	Active root uptake. Amount of "new" N sufficient to supply demand of new growth.
	2. End of rapid shoot growth to veraison	Leaves and clusters both important sinks for N.
III	Veraison to harvest	Root uptake may stop. Clusters main sink for N. Redistribution from roots, shoots and leaves to clusters.
IV	Harvest to start of leaf senescence	Active root uptake. Redistribution from shoots and leaves to permanent structure.

* Modified after Conradie, W.J. (See References)

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accomplished while vines still have a healthy, functional canopy. Consequently, postharvest N application might not be effective for some late varieties or viticultural regions where the period after harvest is too short to allow sufficient uptake to occur.

Determining the Need for Nitrogen Fertilization

Vineyard N status can be determined by plant tissue or soil analysis. Soil analysis has generally proven to be less reliable than plant tissue analysis. Plant tissue analysis methods most widely used include total N in leaf blades or petioles, nitrate in petioles and arginine in must or dormant cane tissue. In California, determination of nitrate in petioles at bloomtime has been used almost exclusively for measuring N status.

Good sampling procedure is a requirement for accurate determination of N status. (For further information on bloom time petiole sampling, see American Vineyard Vol. 2, No. 4, p. 4.) Petiole samples should be collected from a representative area of the vineyard. Each sample should not represent more than a ten acre block and less uniform areas should be sampled separately. The same vines should be sampled each year so that comparisons between growing seasons can be made. A random sampling throughout the block will not provide nearly as much information on vine performance as sampling of selected vines each year.

Petioles from leaves opposite the basal cluster on a shoot should be sampled. Approximately 75 to 100 petioles are required for each sample. Fewer for varieties such as Thompson Seedless which have large petioles and more for varieties such as Gewurztraminer which have smaller petioles.

To prepare petiole samples for laboratory analysis, rinse the petioles with clean water, to remove spray residues and other contamination, then allow them to air dry for a short period. For transport to the laboratory, put each sample into separate, clean paper bags. Do not use plastic bags due to problems with moisture condensation and possible mold growth. Sample bags must be labelled with pertinent information, such as, name, date, location, variety, location, condition of vineyard, and foliar sprays used. Also, keep a written record of all samples sent for analysis. Deliver the samples to your laboratory immediately if possible. Otherwise, store the bags with tops open in a warm, well-ventilated place to allow the drying process to begin and prevent mold or decay. The laboratory will ultimately oven-dry and grind the petioles into powder before analysis. Samples which have undergone mold or decay cannot be accurately analyzed for N status.

Amount of Nitrogen Required

Once it has been determined by petiole sampling and assessment of vine growth that N fertilization is needed, another important question must be addressed- How much N should you apply in your vineyard? N fertilization should meet the N requirements of your vines. N inputs are needed only to replace N that is lost from the vineyard soil-plant-atmosphere system. Yield, soil type, irrigation management, crop residue management, and use of legume cover crops influence the amount of N fertilizer required.

For a typical vineyard with crop residues (prunings, leaves, etc.) returned to the soil, the major source of N loss is harvested fruit. Research by Dr. Larry Williams, U.C. Davis and Kearney Agricultural Center, has shown that fruit removal from a 'Thompson Seedless' vineyard results in a loss of 30 lbs. N per acre (see Table 2.). Conradie (see reference) summarized the results of five N allocation studies done in different viticultural regions using various varieties. He found that the average amount of N lost at harvest was 3.2 lbs./ton of fruit (1.6 kg N per metric ton of fruit).

This information can be used to estimate the N requirements of your vineyard. For example, a vineyard yielding 10 tons/acre would have 32 lbs. N /acre removed at harvest. This vineyard would require an input of at least 32 lbs. N /acre to maintain its productivity. Nitrogen inputs from all sources must be considered. Irrigation water, crop residues, atmospheric pollutants, and mineralization of soil organic matter may make significant contributions to the N supply in vineyards. Some vineyards in the San Joaquin Valley are supplied with irrigation water from wells which are high in nitrates. It is likely that many of these vineyards require little or no N fertilization.

This method of calculating vine N requirements should be viewed as only a rough guideline. Rates should be adjusted over time based on vine performance.

In summary, application of N during the postharvest period results in efficient use of fertilizer. The amount of N applied can be reduced and the problems of excessive fertilization such as ground water contamination by nitrates can be avoided. Furthermore, it may be more convenient for growers to apply N fertilizer during the postharvest period rather than the fruit set to veraison period when other cultural practices demand much time.

Table 2. Estimated annual N requirements and subsequent losses for 'Thompson Seedless' grapevines.[z] [y]

Nitrogen status	Vine Part	Amount (lbs. per acre[x])
Requirements	Leaves	35
	Stems	10
	Clusters	30
	Total	75
Losses	Shoot trimming	
	Leaves	5
	Stems	3
	Fallen leaves	20
	Pruning	15
	Fruit harvest	30
	Total	73

z Values were obtained by averaging the data collected over a 3-year period in the same vineyard.

y Modified after L. E. Williams. J. Amer. Soc. Hort. Sci. 112:330-333 (1987).

x The vineyard in this study was on an 8' by 12' (vine by row) spacing, i.e., 454 vines per acre. Average yields were 11.4 green tons per acre.

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