Late-fall nitrogen application in vineyards is inefficient

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Grapevines are fertilized with nitrogen (N) in amounts intended to promote proper shoot, leaf, and berry development and to provide for maturation of the crop. The need for N is greatest during rapid shoot growth in the spring through the berry development stage, then diminishes after mid-summer when ripening begins. Application should be timed to ensure an adequate N supply during spring development, but available N in late summer should not be high enough to encourage late-season shoot growth, delay maturity, and promote immature canes. Fertilizer N should also be used to maximize uptake efficiency and minimize losses by volatilization and leaching. Immediate incorporation of all ammonic fertilizers can greatly reduce volatilization. Appropriate timing of nitrogen application and avoiding over-application of water can decrease leaching and denitrification.

Fall application of nitrogen fertilizer in the San Joaquin Valley is convenient for the grower and has increased in popularity in recent years. It allows better use of time and labor, and the grower can take advantage of lower fertilizer prices when working conditions in the vineyard are good. It has been assumed that N applied in the late fall remains in the root zone over the winter and is available for use by the plant when it breaks dormancy the following spring. This assumption is based on the relatively low winter rainfall of the southern San Joaquin Valley, but experimental data to support it are lacking.

A study to evaluate the relative leaching and denitrification losses of late-fall and spring applications of N to vineyards was conducted in 1979-80 at two locations, one in Fresno County on Delhi sand and the other in Tulare County on Greenfield sandy loam. Delhi sand is a wind-deposited soil with a deep, uniform, well-drained profile. Greenfield sandy loam absorbs water readily, but drainage is impeded by a hardpan at 4 feet. Both vineyards are in mature Thompson Seedless grapes produced for raisins.

A randomized complete block design was used with five blocks and three treatments. Plots, with four vines each, were 12 by 24 feet. Treatments consisted of the unfertilized control, 100 pounds N per acre applied November 9, 1979, and 100 pounds N per acre applied March 12, 1980. The fertilizer was ^{15}N-depleted ammonium sulfate, isotopically labeled to permit distinction between fertilizer and soil nitrogen. It was applied in a 6-foot strip on each side of the row by a hand-held boom on a backpack sprayer and then incorporated by disking. Distribution of inorganic N in the soil was followed by sampling the profile to a depth of 4 feet in increments 0 to 0.5, 0.5 to 1, 1 to 2, 2 to 3, and 3 to 4 feet. Soil cores were taken from four locations in each plot, and the cores composited for laboratory analysis. Soil samples were taken from the Delhi location on December 4, 1979, and on April 11 and May 23, 1980. Sampling dates at the Greenfield site were December 6, 1979, and April 13 and May 23, 1980. Soil samples were immediately frozen and stored in a freezer before analysis. In the laboratory, inorganic N, consisting of ammonic and nitrate forms, was extracted and the isotopic composition determined to identify the portion derived from the added fertilizer.

N concentrations in soils

As expected, with no fertilizer application, inorganic N concentrations in the Delhi sand profile remained low at all sampling times and did not vary greatly with depth (fig. 1). During the 25 days between the November fertilizer application and the December 4 sampling, 0.70 inch of rain fell. The December sampling reflects the November fertilizer application: no appreciable leaching had occurred. By April 11, 1980, however, when 10.7 inches of rain had fallen since the November fertilizer application and the grower had applied an additional 3 to 4 inches of water for frost protection, all evidence of the November fertilizer application had disappeared. In the case of the March-applied fertilizer, which had received 0.34 inch of rain and 3 to 4 inches of irrigation water, the April 11 sampling revealed a surface inorganic N concentration somewhat lower than the maximum observed with the November application to this soil. By May 23, even the spring application had disappeared. Presumably all the fertilizer N applied in March had been absorbed by plants or leached below 4 feet.

The Greenfield-sandy-loam location received approximately the same amount of rainfall as the Delhi site. Vines were irrigated for frost protection in the last week of March, and two additional irrigations totaling 8 to 12 inches were applied before the May 23 sampling. Inorganic N after the November fertilizer application was high near the surface on December 6, but by April 13 concentrations were not much different from those of the control soil. By May 23, concentrations had increased a little in the surface 2 feet because of mineralization of soil N as temperatures increased. In the case of the March application, the April 13 sampling reflected the recent addition of fertilizer to the soil. By May 23 some downward displacement of this fertilizer had clearly occurred, but most of the N remained within the surface 4 feet of soil.

Fertilizer-derived N

Figures 1 and 2 reflect the combined fertilizer and soil N present in the profile. Figure 3 shows concentrations of fertilizer-derived N, calculated on the basis of isotopic data. In Greenfield sandy loam, high concentrations of November-applied fertilizer were present in the December sampling, whereas by April and May most of this N had disappeared. Fertilizer applied to this soil in March was displaced downward between the April and May samplings.

In the Delhi soil the concentration of fertilizer N in the surface 6 inches of soil receiving a November application decreased from 22 parts per million (ppm) on December 4 to less than 1 ppm by the following April. Where Delhi sand received fertilizer in March, some leaching had occurred by April, and by May 23 fertilizer N throughout the profile had dropped to a very low value.

Discussion

These data indicate that ammonic nitrogen applied in the late fall was subject to severe leaching losses by normal rainfall and irrigation between November and May. Soil temperature was not low enough during the winter to retard nitrification significantly. This study suggests that N should be applied in the spring just before frost-protection irrigation on loam or sandier soils. Subsequent irrigation will leach the N into the root zone for uptake during the most critical period of need. On very sandy soils, such as the Delhi sand, it would be useful to split the fertilizer application, with half applied in March and the remainder in May.

Still unanswered is the question of the value of early-fall application (September to mid-October), when the vines may be active enough to take up a significant amount of N and store it in canes, trunk, and roots. There is concern as to whether this uptake can be accomplished without stimulating undesirable late shoot development. Further study is in progress to develop information on summer and early-fall fertilizer application to grapes, but present evidence suggests that late-fall fertilization is highly inefficient.

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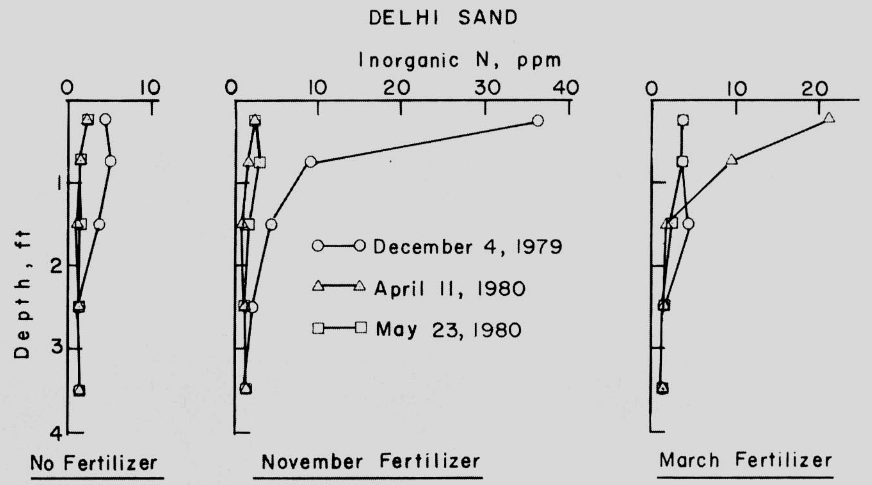

Fig. 1. Inorganic nitrogen concentrations in Delhi sand plots.

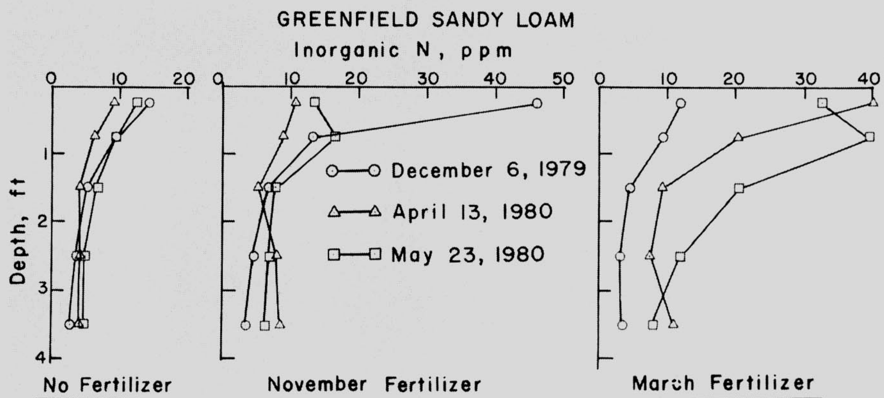

Fig. 2. Inorganic nitrogen concentrations in Greenfield sandy loam plots.

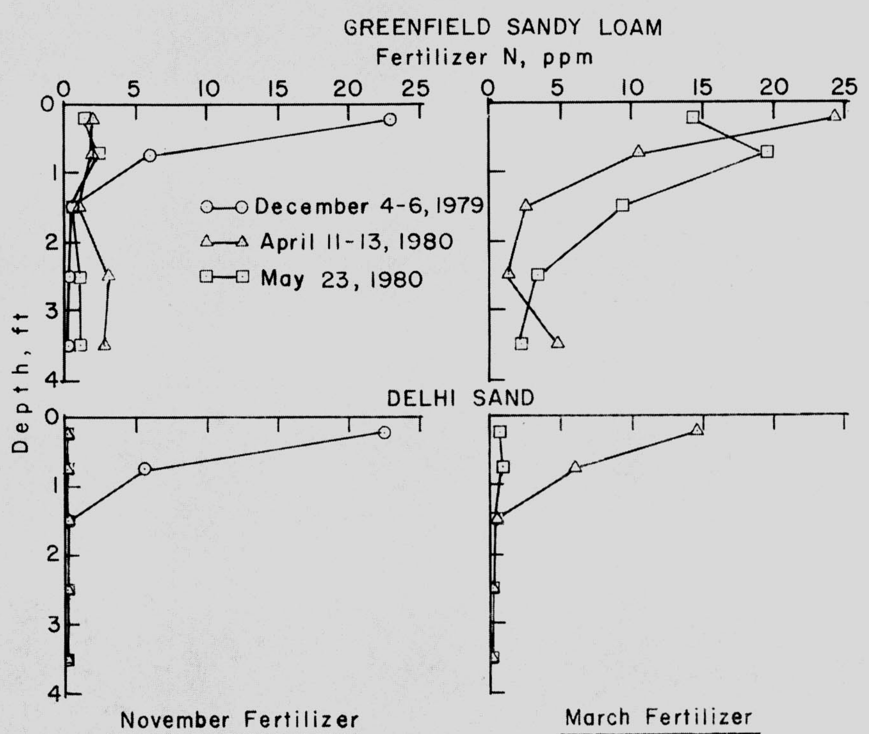

Fig. 3. Inorganic N from fertilizer as affected by treatment and sampling time.