

東洋梨

Asian pears . . .

Asian pears have a relatively long shelf life, maintaining their harvest quality for 10 to 14 days at room temperature. If held in cold storage at about 32° F (0° C) after summer or early fall harvest, most varieties keep until the Christmas season; a few varieties, such as Chojuro, Okusan-kichi, and Shinseiki, maintain acceptable quality until February.

Disease and insect susceptibility

Asian pear varieties are susceptible to infection by fireblight (*Erwinia amylovora* [Burr.] Winslow et al.). Although most varieties are not damaged as severely as Bartlett and other susceptible *P. communis* varieties, bactericidal treatment is required during the bloom period to control the disease.

The codling moth (*Carpocapsa pomonella* Linnaeus) is the principal insect pest of Asian as well as of *P. communis* pears. This insect is a constant threat from petal fall until harvest, and a regular seasonal spray program is necessary.

The pear psylla (*Psylla pyricola* Foerster) is another serious pest of pear trees. Although the Asian varieties are subject to attack, in our experience, they are much less attractive to the psylla and suffer much less damage than do *P. communis* varieties.

William H. Griggs is Professor of Pomology and Pomologist in the Experiment Station, and Ben T. Iwakiri is Staff Research Associate, Department of Pomology, University of California, Davis. Photos by Don A. Edwards. Ayako Maeda arranged the material in the photograph on page 8.

Measuring nitrogen loss

Denitrification is the biological reduction of nitrate and nitrite to volatile gases, usually nitrous oxide or molecular nitrogen, or both. Denitrification is accomplished by bacteria capable of using nitrate in place of oxygen. Under aerobic conditions the bacteria oxidize carbohydrates to carbon dioxide and water. In the absence of oxygen these bacteria oxidize carbohydrates in nitrate respiration, yielding carbon dioxide, water, and the volatile gases, nitrous oxide and molecular nitrogen.

The amount of denitrification is generally the unknown in attempts to evaluate the fate of nitrogen fertilizers or wastes applied to soils. Denitrification is usually calculated by difference from measurements of the other components of the nitrogen cycle, such as fertilizer addition, plant uptake, leaching, and residual soil nitrogen. The reliability of such denitrification values is at best no better than the reliability of the other measurements, with all errors accumulating in the difference value. It is not always easy to accurately measure leaching, plant uptake, and residual soil nitrogen, especially in the field. In addition, determining denitrification by difference generally does not allow evaluation of rates or the dynamic nature of the denitrification process. There is also considerable concern about possible nitrous oxide reaction with the ozone layer of the stratosphere. Thus, the amount of nitrous oxide gas resulting from denitrification is also an important environmental consideration.

Field methods for measuring denitrification other than by difference have required placing a sealed compartment over the soil surface and either trapping or sampling the gases evolved. This method measures nitrous oxide evolution reasonably well. However, it is difficult to determine how much nitrogen gas has evolved, because small increases above the ambient atmospheric concentration of 78 percent nitrogen cannot be measured.

Research was conducted to measure both nitrous oxide and nitrogen gas evolved from denitrification of fertilizer applied to a field soil under controlled conditions conducive to denitrification. In an open system, such as a field, some means must be used to distinguish fertilizer-derived nitrogen gas from the nitrogen gas of the soil atmosphere. High

enrichments of the stable isotope, nitrogen-15, were used to learn if the nitrogen gas component of the volatile denitrification products could be measured effectively in a field soil from the isotopic composition of the gas.

Measurement techniques

The field plot (4.6 x 6.1 meters), on Yolo loam soil at Davis, California, was cropped with perennial ryegrass for more than a year before the experiment. The plot was kept constantly wet near saturation by rainfall or by a sprinkler system. The soil-water suction in the top 10 centimeters (cm) of soil was maintained at approximately 0.2 centibar. In the center of the plot were placed tensiometers, soil solution samplers, neutron

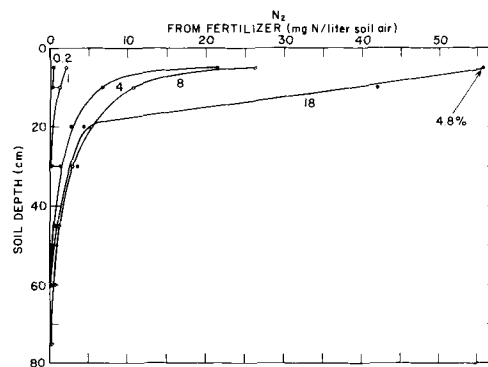


Fig. 1. Nitrogen gas concentration profiles derived from the fertilizer at five sampling times (0.2, 1, 4, 8, and 18 days) after application of potassium nitrate. Each data point is the average from two gas samplers with the open and closed circles used to distinguish different days.

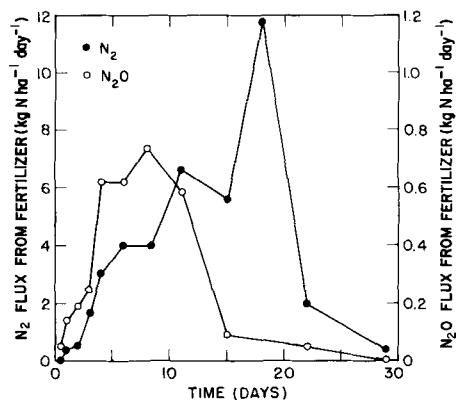


Fig. 2. Nitrous oxide (N₂O) and nitrogen (N₂) gas diffusing from the soil surface as a function of time after applying nitrate fertilizer. Note that the scale for N₂O is ten times smaller than for N₂. Each data point is the average gas diffusion (flux) determined from two gas samplers.

from denitrification

Dennis E. Rolston

access tubes for measuring soil-water content, and soil atmosphere samplers at many depths within the profile. Soil atmosphere samples were taken in 1-milliliter (ml) increments with a gas syringe. The concentration and amount of nitrogen-15 of nitrous oxide and nitrogen gases were analyzed by gas chromatography and mass spectrometry.

Several times after applying fertilizer, the amount of volatile denitrification products diffusing from the soil was calculated by measuring the gas concentrations derived from the fertilizer (nitrogen-15) within the soil profile and measuring the ability of the soil to transmit gas by diffusion. Simple diffusion theory was used to calculate the amount of gas diffusing from the soil profile from measured concentration profiles and gaseous diffusion coefficients.

Nitrogen, at 108 kilograms (kg) per hectare (96.6 pounds per acre), was applied as ammonium sulfate to the plot in November 1973. In November 1974, 300 kg of nitrogen per hectare (268.3 pounds per acre), as potassium nitrate, were applied to the plot. The nitrogen fertilizer was enriched with approximately 10 percent nitrogen-15.

Soil solution and soil atmosphere sampling was initiated shortly after the fertilizer application. The amount of nitrogen leached from the plot was determined by measuring the nitrate concentration in soil solution samples. Plant samples were taken after the fertilizer band had passed the 300-cm depth and were analyzed for total nitrogen and amount of nitrogen-15.

After the nitrate band had passed the 300-cm depth, the plot was allowed to dry slightly, and soil samples were taken in 30-cm increments down to 180 cm at several sites. These samples

were analyzed for total nitrogen and percent nitrogen-15 of the inorganic and organic soil nitrogen fraction.

After the ammonium fertilizer application, only small increases over the natural nitrogen-15 concentrations were measured in the nitrogen gas of the soil atmosphere. Nitrous oxide was not detectable with the instrumentation available for this experiment. However, considerable nitrogen-15 was measured in the nitrous oxide and nitrogen gas from the nitrate fertilizer application. Figure 1 shows that the denitrification process took place very rapidly, began almost immediately after application of the nitrate, and occurred mostly within the top portion of the profile. After day 18 the concentrations began to decrease everywhere within the profile. Calculations of water and nitrate movement showed that the decrease occurred at about the time the nitrate pulse moved out of the top 60 cm of the soil profile.

Concentration profiles for nitrogen gas (fig. 1) and similar profiles for nitrous oxide gas were used in conjunction with values for the gaseous diffusion coefficient to calculate the amounts of nitrous oxide and nitrogen gas diffusing from the soil surface over time after application of the nitrate (fig. 2). Nitrogen gas was the predominant volatile denitrification product under these conditions. Figure 2 demonstrates that diffusion at the soil surface of gases from denitrification began immediately after the fertilizer application, reached a maximum in about 18 days, and decreased to approximately zero in 30 days. After day 18, the rate of gas loss from the profile exceeded the rate of gas production from denitrification.

The table gives nitrogen balances for the fertilizer added to the field plot for both the ammonium and nitrate applications. Although the total nitrogen denitrified was fairly large from both fertilizer sources, no comparison between the direct and the difference methods could be made for the ammonium application, because nitrogen-15 labeled nitrogen gas in the soil profile was only slightly detectable. For the nitrate application, the amount calculated by sampling gas was less than that calculated by difference.

Both methods of calculating denitrification result in uncertainties. In

calculating denitrification from gas profiles, the soil atmosphere cannot be sampled accurately very near the soil surface, and there is variability in measuring the gaseous diffusion coefficient in a field soil. Small changes in the value of the diffusion coefficient can greatly change the amount of denitrification calculated from gas fluxes. In the difference method, the variability in sampling the nitrate leaching component and residual soil nitrogen can be extremely large under field conditions.

Some of the error and uncertainty in measuring concentrations and diffusion coefficients in the field can be overcome by more extensive sampling and by a clearer understanding of the variability, both spatially and with water content, of the gaseous diffusion coefficient. Regardless of possible error in the absolute amount of denitrification, direct sampling of the gaseous denitrification products gives information on the dynamics of the process and the position within the profile at which denitrification is occurring.

The denitrification amounts given in the table are most likely the maximum values that would occur for this particular soil and temperature regime. Since the profiles were kept very close to water saturation for the entire experiment, the inability to detect excess nitrogen-15 in the nitrogen gas from the ammonium application probably resulted from small nitrate-release and denitrification rates over a fairly long time and at a low soil temperature. Also, less ammonium than nitrate was applied. The results demonstrate that the ability to directly measure the volatile products of denitrification is dependent upon the rates of nitrate formation and subsequent denitrification. It is also significant that essentially no nitrogen was lost by leaching from the ammonium application.

In current research, denitrification is being directly measured in the field under various extremes of temperature, water content, and organic matter to more fully determine the absolute magnitude and rates of denitrification that can be expected when nitrogen is applied to soil.

Dennis E. Rolston is Assistant Professor of Soil Science, Department of Land, Air, and Water Resources, University of California, Davis.

NITROGEN BALANCE OF A CROPPED FIELD PLOT FROM AMMONIUM AND NITRATE FERTILIZER APPLICATIONS*

Fertilizer	Kilograms nitrogen per hectare					Denitrification [‡]	
	Fertilizer rate	Leaching	Soil [†]	Plant	Directly	Difference	
Ammonium	108 (100)	0 (0)	44 (41)	24 (22)	—	40 (37)	
Nitrate	300 (100)	68 (23)	40 (13)	22 (7)	135 (45)	170 (57)	

* Values in parentheses are percent of fertilizer added.

[†] Total nitrogen.

[‡] Amount of denitrification determined directly by sampling the soil atmosphere compared with that calculated by difference for the application of nitrate.