PEAR PRODUCTION AND HANDLING MANUAL

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from foods or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on the grower's crops as well as for problems caused by drift from the grower's property to other properties or crops.

Consult your county agricultural commissioner for correct methods of disposing of leftover spray materials and empty containers. Never burn pesticide containers.

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts or the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents, and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

Contents

18

Nutrition

PATRICK H. BROWN AND FRANZ J. A. NIEDERHOLZER

Pear trees require 14 elements for normal growth and reproduction. These essential elements vary greatly in the concentrations normally found in plants and are classified as either macronutrients (relatively large concentrations) or micronutrients (see table 18.1).

Each of these elements is essential for particular functions in the plant. Nutrients are also important in promoting disease resistance and improving fruit quality, and the balance between the various elements can affect plant health and productivity. Several elements (chlorine, boron, sodium) may be toxic to the tree if present at excessive levels in the soil or irrigation water. Optimizing pear productivity and quality requires an understanding of the nutrient requirements of the tree, the factors that influence nutrient availability, and the methods used to diagnose and correct deficiencies. This chapter briefly discusses important principles of plant nutrition and gives specific recommendations for diagnosing and correcting deficiencies.

THE SUPPLY OF NUTRIENTS TO THE PLANT

Plants obtain nutrients from the soil as ions dissolved in the water the plant takes up or by diffusion from the soil to the root surfaces. In both cases water must be present for a nutrient to be available. Plant species also differ in the effectiveness with which they obtain nutrients from the soil and in the responses (symptoms) they show to a deficiency or excess of a given nutrient. Thus the nutrient requirements of pears are different than the nutrient requirements of other tree crops, such as walnut. Many factors affect plant nutrition by influencing the availability of nutrients to the root or the effectiveness of root uptake of these elements. For example, soil factors such as type and texture, moisture, pH, and depth as well as plant factors including root distribution, rootstock, fruit load, and competition all influence the nutrition of the tree. Environmental factors such as temperature, disease, salinity, and the presence of high levels of other ions may also influence plant nutrition.

Plants may be deficient in one or several nutrients as a result of the following conditions:

- An absolute deficiency of the element in the soil. This may occur in extremely sandy soils or isolated areas in which there are insufficient levels of one or more nutrients in the soil. Nutrients that are used in large amounts, such as nitrogen or potassium, may become deficient as a result of crop uptake. This condition can be remedied only by the addition of fertilizers to the soil.
- Unfavorable soil conditions for nutrient uptake. The pH of the soil has a significant effect on nutrient availability. High soil pH (>7.5) greatly limits the solubility of many elements in the soil (i.e., zinc, copper, manganese, iron), while low soil pH can lead to deficiencies (phosphorus, calcium) and toxicities (aluminum, iron, manganese). Similarly, low soil temperature, poor aeration, low water availability, or the presence of a hardpan can limit the ability of the plant to obtain nutrients by limiting root growth. Under these circumstances, addition of more nutrients may not alleviate the deficiency. The solution lies instead in correcting the soil conditions that limit nutrient availability. Adding lime to raise or sulfuric acid to lower the pH, using gypsum or organic matter as well as other soil amendments to improve soil structure, and maintaining optimal water and soil conditions can influence nutrient availability to the plant. In some instances adding fertilizers may be effective, though only a small percent of the supplied nutrient will be available to the plant.

Table 18.1. Nutrients required by the pear tree, in order of relative amount

Macronutrients	Micronutrients
nitrogen (N)	iron (Fe)
phosphorus (P)	manganese (Mn)
potassium (K)	chlorine (Cl)
calcium (Ca)	boron (B)
magnesium (Mg)	copper (Cu)
sulfur (S)	zinc (Zn)
	nickel (Ni)
	molybdenum (Mo)

Because nutrient deficiencies have distinct causes, it is essential that you consider all aspects of the orchard and the production system before deciding on a course of action.

DIAGNOSING ORCHARD NUTRIENT STATUS

Soil Analysis

Measurements of nutrient concentrations in the soil or in the tree can be used to determine whether nutrient deficiencies are limiting crop production. However, because of the large soil volume occupied by pear roots and the long lifetime of pear trees, it is often difficult to obtain a soil sample that is representative. This is the primary limitation to soil analysis for pears, as well as for other tree crops. Nevertheless, soil analysis provides information on nutrient levels and soil conditions (pH, lime), which may be important in predicting the occurrence and determining the cause of a deficiency.

Pear tree roots spread through a large volume of soil, and the variability of the soils can be quite high. Most soils differ in composition with depth: surface soil can be quite different from the soil a foot down, and the soil further down could be different again. Samples should be taken from the site of most-active root growth. This is usually the surface soil to a depth of 24 inches (0.6 m), but it will vary depending on the irrigation method used, the texture of the soil, and the tree's rootstock. Deeper soil sampling may be necessary to identify textural changes with depth that might influence tree growth or irrigation management. For a thorough analysis, soil samples should be taken from three to ten different spots around the tree and composited. Replicate samples should then be taken across the orchard. It is quite common for different soil types to occur within a single orchard. Nutrient deficiencies can be linked to localized soil differences, such as those associated with old riverbeds, differences in topography, sand deposits, cuts or fills, or old corral or pasture sites. In these cases it is necessary to sample from within each soil type and relate the findings only to trees growing in that soil type. This difference in soil type can be very localized and may only impact a few trees in an orchard.

Interpretive guides

It is more difficult to interpret soil analysis data than it is to interpret leaf analysis data. A soil can contain considerable amounts of a nutrient, and yet trees grown on this soil may suffer from deficiency. This shows that the nutrient is in a form that is unavailable to the tree or that the roots are not healthy enough for nutrient uptake. To correct this, various methods of extracting nutrients from soils have been used that better reflect the "plant available" nutrients in a soil. The methodology used and the principles behind the choice of extractant will not be discussed further here. In general, soil testing laboratories interpret the soil analysis based on the procedures utilized in their laboratory.

Determining the soil pH can be an excellent guide to the diagnosis of nutrient deficiencies. Soil pH affects the availability of mineral nutrients. Low pH (<5.5) may result in deficiencies of calcium, magnesium, phosphorous, or molybdenum and perhaps excesses of manganese, iron, or aluminum. High pH (>7.5), on the other hand, may immobilize manganese, zinc, iron, or copper, making them unavailable to the plant. In the case of excess salts in soil, the approximate conductivity of the saturation extract (EC_e) at which yields have been reduced is about 2.5 mmhos/cm (at 25°C) for pear. Soil chloride (Cl^-) in excess of 10 meq/liter and boron in excess of 1.5 ppm (in saturation extracts) can also reduce yield and long-term productivity. High levels of calcium carbonate ($CaCO_3$, lime) in the soil can induce deficiencies of iron, manganese, or zinc and may also make acidification of the soil difficult. The presence of any soil physical characteristic that is likely to limit root growth or water penetration is also likely to affect nutrient uptake.

Plant Analysis

For pear, leaf analysis is more useful in diagnosing mineral deficiencies and toxicities than is soil analysis. The mineral composition of a leaf depends on many factors, such as its stage of development, climatic conditions, availability of mineral elements in the soil, root distribution and activity, irrigation, and so on. The beauty of using leaf samples is that the tree integrates all these factors so that leaf analysis provides an estimate of which elements are available to the roots of the plant. The main problem with leaf analysis is that it does not tell us why the nutrient is deficient (see "Supply of Nutrients to the Plant," above).

Sampling procedure

Concentrations of nutrients in leaves vary with time, leaf age, position in the canopy, and the presence or absence of fruit. Trees within an orchard may also vary in their nutrient status as a result of differences in soils, water, or sunlight exposure. Biological factors that influence nutrient status include rootstock, crop load, and variety. Because of this variability, sampling techniques must be standardized if valid comparisons are to be made. The choice of sampling method also depends on the purpose of the survey. If the aim is to identify the problem only in an isolated tree or area, sampling of just a few poor