
Commercial Apple Production

Management Highlights

- Target pH: 6.5
- Use tissue analysis to supplement soil analysis for evaluating nutrient requirements of orchard crops. For most accurate results, collect leaf samples between July 15 and August 15.
- Watch for micronutrient deficiency during the growing season.

Introduction

Nutrient management of orchard crops can be divided into three separate programs:

- 1) initial site preparation and establishment of cover crops;
- 2) management of the trees; and
- 3) management of the tree-row middles and the permanent sod or cover crop.

The first program, initial site preparation and cover crop establishment, is very important to the future success of the orchard. It enables the grower to correct problems prior to setting the trees and enhance conditions that will benefit the growth of the trees. For additional information, see the recommendation for *Orchard Sod and Cover Crops*.

Programs 2 and 3, management of the trees and tree-row middles, are interrelated and refer to the annual nutrient management of the orchard. As with several other perennial crops, orchard management may involve either broadcast applications of nutrients or individual tree fertilization. When broadcast applications are used, the nutrient and lime needs of the row middles, and therefore the permanent sod or cover crop, will be met. When an individual tree fertilization program is being used, it is necessary to follow a separate nutrient management program for the row middles to ensure that the permanent sod or cover crop is

properly limed and fertilized. For additional information, see the recommendation for *Orchard Sod and Cover Crops*.

Yield Goals

Yield of apples is influenced by many factors beyond soil test results and fertilizer application. Cultivar selection, tree age, weather conditions, soil type and water-holding capacity, weed, insect and disease pressure and crop management practices are just a few. *For that reason, the University of Delaware does not use yield goals in determining nutrient recommendations for orchard crops at the present time. Instead, recommended rates are designed to produce maximum economic yields of high market quality in a good to average year.* Growers should use these nutrient recommendations along with field history data, tissue testing, knowledge of specific crop requirements, management plans and conditions from the current growing season to develop an appropriate fertilizer program for the crop.

Soil pH and Liming

The target pH for apples on most Delaware soils is 6.5. Soils that are high in organic matter ("black" soils) have a lower target pH (5.6) because organic matter moderates some of the effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field is calculated from the soil pH and buffer pH measurements using the steps outlined in *Calculating the Lime Requirement -- Chapter 3, Section 3.4*. Avoid overliming in order to prevent deficiency of micronutrients such as manganese or iron.

In most cases, the lime requirement can be met by either calcitic or dolomitic limestone.

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Dolomitic limestone is recommended if:

- soil test Mg is less than 50 FIVs, or
- soil test Mg is between 50 and 100 FIVs *and less than soil test Ca.*

Calcitic limestone is recommended if:

- soil test Mg is greater than 100 FIVs, or
- soil test Mg is between 50 and 100 FIVs *and greater than soil test Ca.*

Nitrogen Management

Nitrogen (N) recommendations for established plantings of commercial apple trees are dependent upon the N requirement of individual trees as influenced by the age and development of the trees, the tree type, degree of pruning and the soil management program being followed. A summary of those recommendations is given below in Table 1. For best response, N should be applied one month before bloom. To evaluate the effectiveness of the nutrient management program, use tissue testing of leaf samples collected between July 15 and August 15 to determine adjustments for the following year.

Table 1. Nitrogen recommendations for individual apple trees in commercial production.

Tree Status	N Rate
<u>Immature Trees</u>	— lbs N / yr of age —
Non-bearing	0.1 - 0.2
Immature, bearing	0.05 - 0.1
<u>Mature Trees</u>	— lbs N / tree —
Standard varieties	0.5 - 1.5
Dwarf varieties	0.25 - 0.75

Individual Tree Fertilization

When individual trees are being fertilized, fertilizer should be spread evenly over the drip area beneath the tree according to the rates shown in Table 1, above. For best results, the drip area should be kept free of vegetation to eliminate competition from weeds for nutrients and moisture.

Broadcast Fertilization

The N rates above are specified per individual tree. When a broadcast application is planned, N rates need to be recalculated to ensure that the area beneath the trees receive sufficient fertilizer. To convert the rates shown in Table 1 to lbs N/ac, use the following equation:

$$BC \text{ Rate} = \frac{(RNR \times TPA)}{DA}$$

where:

- BC Rate = broadcast N rate (lbs N/ac)
- RNR = recommended N rate per-tree from Table 1
- TPA = trees/ac
- DA = drip area expressed as a decimal (i.e 50% = 0.50).

Phosphorus Management

Yield-limiting phosphorus (P) deficiency is rarely a concern on Delaware soils. Long-term applications of fertilizers and manures have resulted in P accumulations on many soils that are capable of supplying crop needs for several years with no further additions.

To determine whether P fertilization is necessary for a specific field, conduct a routine soil test. University of Delaware P recommendations for apples are dependent upon the soil test P value and the P requirement of the crop. A summary of P recommendations for commercial apple trees is given in Table 2 below. For best response, P should be applied one month before bloom. To evaluate the effectiveness of the nutrient management program, use tissue testing of leaf samples collected between July 15 and August 15 to determine adjustments for the following year.

As with N, P recommendations are expressed on a per-tree basis and must be recalculated if a broadcast fertilizer program is being followed. To calculate the broadcast application rate for P in lbs P₂O₅ /ac, use the equation given above in *Nitrogen*

Management - Broadcast Fertilization. Substitute the recommended rate of P_2O_5 from Table 2 for the variable RNR in the equation.

Table 2. Phosphorus fertilizer recommendations for individual apple trees in commercial production.

Tree Status	P Index Value		
	0 - 25	26 - 50	51+
	— lbs P_2O_5 / yr of age —		
Non-bearing trees	0.2	0.1	0.0
Bearing trees	0.1	0.05	0.0

Potassium Management

The need for potassium (K) fertilization of apples is best determined by the use of a routine soil test. Potassium recommendations are based on the soil test K value and the K requirement of the crop. A summary of University of Delaware K recommendations for apples is given in Table 3. For best response, K should be applied one month before bloom. To evaluate the effectiveness of the nutrient management program, use tissue testing of leaf samples collected between July 15 and August 15 to determine adjustments for the following year.

As with N and P, K recommendations are expressed on a per-tree basis and must be recalculated if a broadcast fertilizer program is being followed. To calculate the broadcast application rate for K in lbs K_2O /ac, use the equation given above in *Nitrogen Management - Broadcast Fertilization*. Substitute the recommended rate of K_2O from Table 3 for the variable RNR in the equation.

Table 3. Potassium fertilizer recommendations for individual apple trees in commercial production.

Tree Status	K Index Value		
	0 - 25	26 - 50	51+
	— lbs K_2O / yr of age —		
Non-bearing trees	0.2	0.1	0.0
Bearing trees	0.1	0.05	0.0

Calcium and Magnesium Management

Calcium (Ca) and magnesium (Mg) needs of apples are usually met through routine liming. *Magnesium application is recommended if the soil test Mg value is less than 38 FTVs.* If liming has been recommended, use dolomitic limestone to raise soil pH and increase soil Mg. If, however, liming is not necessary but Mg fertilization is still indicated, apply soluble Mg as Mg sulfate or Mg chloride to increase soil Mg. Appropriate application rates are given below in Table 4.

Table 4. Application rates for soluble Mg as a function of Mg fertility index value.

Mg Index Value								
0	5	10	15	20	25	30	35	40
----- lbs soluble Mg / ac -----								
80	70	60	50	50	30	20	10	0

Boron Management

An adequate supply of boron (B) is essential for proper growth of apples. Deficiency of B leads to cork formation in the apple flesh, thus reducing the market value of the crop.

Boron deficiency may occur in apples grown on Delaware soils. Soil tests can be used to predict the likelihood of deficiency. Cases of suspected deficiency should be confirmed by tissue testing. To correct deficiency, apply B in a spray (1 lb actual B/100 gallons of water) at full bloom and 1 week after full bloom. Apply no more than 2 sprays per season. Avoid over-application of B. Excessive B is equally detrimental to the crop, hastening maturity and increasing premature fruit-drop.

Manganese Management

Manganese (Mn) deficiency may occur in apples grown on Delaware soils, most often as a result of overliming soils that are naturally low in Mn. The University of Delaware Soil Testing Program uses an availability index based on the soil test Mn

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value and soil pH to predict the likelihood of Mn deficiency. That availability index is calculated using the equation:

$$MNAI = 97.8 - (14.4 \times pH) + (1.63 \times ST-Mn)$$

where:

MNAI = Mn availability index
pH = water pH of the soil
ST-Mn = soil test Mn in lbs/ac.

Table 3-14 in *Chapter 3, Section 3.5.5.2 (Manganese Management)* gives a summary of MNAI values for various soil pH - soil test Mn combinations. Interpretations of the Mn availability index for apples are given below in Table 5.

Table 5. Interpretation of the Mn availability index for apples.

MnAI Value	Interpretation
Less than 12	Mn deficiency is likely at this soil pH and Mn concentration.
12 or greater	Mn deficiency is unlikely.

Suspected Mn deficiency can be confirmed by tissue analysis. Confirmed deficiency situations can be corrected during the growing season by foliar applications of 1 lb actual Mn/100 gallons of water/ac as Mn sulfate or Mn chelate.

Zinc Management

Zinc (Zn) deficiency may occur in apples grown on Delaware soils, most often as a result of over-liming, heavy P fertilization and/or compaction from heavy machinery. Suspected Zn deficiency can be confirmed by tissue analysis. In most cases, confirmed deficiency can be corrected in the following season by an application of 5-10 lbs actual Zn/100 gallons of water as Zn sulfate. Zinc should be applied only in early spring just before trees break dormancy.

Other Nutrients

No other nutrients are known to be limiting to commercial apple production in Delaware.

Additional Information

See Soil Test Notes 1 (Appendix 7) and Extension Bulletin 40-R, *Commercial Tree Fruit Production Recommendations*, for additional information concerning nutrient management in commercial apple production.