10 Nutrient Management of Apple Orchards

10.1 Introduction

When developing mineral nutrient management programs for tree fruits, it is important to consider the nutrient demand-supply relationship throughout the season. Early season canopy development and fruit growth require large amounts of nitrogen (N), while fruit quality development and the acquisition of adequate cold hardiness by the tree later in the season require only a minimum supply of N. Thus, an ideal seasonal pattern of tree nitrogen status should be to start the season with relatively high nitrogen status to promote rapid leaf development and early fruit growth. As the season progresses, nitrogen status should decline gradually to guarantee fruit quality development and wood maturity before the onset of winter. There are three sources of nitrogen supply tree fruits can use. First is reserve nitrogen that has accumulated in the tree from the previous growing season. This source of nitrogen is readily available for initial growth during the spring. In fact, spur leaf development and early fruit growth is mainly supported by the reserve N. The second source is the natural N supply from the soil mineralization process. This process provides substantial amounts of nitrogen for trees growing on soils with high organic matter. The third is nitrogen fertilizers applied to the soil or to the foliage. To determine the amount of fertilizer nitrogen needed, we need to know the total tree demand and the amounts the other two nitrogen sources can provide. However, there is not enough information currently available on this demand-supply relationship to make this approach practical. Instead, soil and leaf analyses have been developed over the years to help growers diagnose tree nutrient status and soil nutrient availability and make adjustments on their fertilization programs accordingly.

10.2 Soil Analysis

Soil analysis is very useful for determining lime requirement and mineral availability in the soil before orchard establishment. For existing orchards, it provides information necessary for interpreting leaf analysis results and modifying fertilization programs.

A soil nutrient analysis should be performed before planting a new orchard and every 2 to 3 years after orchard establishment. The soil sample taken should be representative of the soil type and conditions within the orchard. Generally, the area included in any one-sample collection should not exceed 10 acres. Scrape away the surface 1-inch of soil, then collect samples from the 1 to 8 inch depth, and separate samples from 8 to 16 inches. In a 10 acre orchard, a minimum of 10 to 20 subsamples is suggested. Thoroughly mix the 1-8 inch subsamples together to provide a representative sample for the topsoil, and treat the 8 to 16 inch subsamples similarly to get a representative sample for subsoil. Soil samples can be sent to **The Connecticut Agricultural Experiment Station Slate Laboratory**, P.O. Box 1106, New Haven, CT 06504 (203-974-8521); **University of Connecticut Soil Nutrient Analysis Laboratory**, 6 Sherman Place, U-102, Storrs, CT 06269-5102 (860-486-4274); **University of Maine Soil Testing Service Analytical Laboratory**, 5722 Deering Hall, Orono, ME 04469-5722 (207-581-3591); **University of Massachusetts Soil & Plant Tissue Testing Laboratory**, West Experiment Station, Amherst, 01003 (413-545-2311); **University of New Hampshire Cooperative Extension Soil Testing Program**, Spaulding Life Science Center, Room G28A, 38 College Road, Durham, New Hampshire 03824 (603-862-3200); or **University of Vermont Agricultural & Environmental Testing Laboratory**, 209 Hills Building, Burlington, VT 05405 (802-656-3030).

10.3 Preplant Soil Preparation

Table 10.3.1. Soil management groups.

Soil Group	Texture
I	Clayey soils, fine-textured soils.
II	Silty loam soils with medium to moderately fine texture.
III	Silty loam soils with moderately coarse texture.
IV	Loamy soils, coarse- to medium-textured soils.
V	Sandy soils, very coarse-textured soils.

10.3.1. Liming

The pH values of orchard soils should be maintained in the range of 6.0 to 6.5 throughout the soil profile to optimize plant growth and nutrient availability. For preplant soil preparation, we recommend the pH of topsoil (0–8 inch depth) be adjusted to 7.0 and that of subsoil to 6.5. Most soils in New York and New England have pH values lower than optimum and need liming to raise the pH prior to planting a new orchard. This also ensures adequate calcium and magnesium supplies in the soil.

The amount of lime required to adjust topsoil pH to 7.0 and subsoil pH to 6.5 is determined by the current pH values of the topsoil and subsoil (determined from a soil analysis) and the buffering capacity of the soil, i.e. exchange acidity or the acid portion of the cation exchange capacity (CEC), of topsoil and subsoil (also determined from a soil analysis). Using these values, the lime requirement can be determined from Table 10.3.2 for topsoil and from Table 10.3.3 for subsoil. The amount of lime to be added is the sum of topsoil plus subsoil requirement. When complete soil tests are not available, Table 10.3.4 may be used to estimate lime requirement.

Exchange acidity (used in Tables 10.3.2 and 10.3.3) may be reported on the soil test, but if not, it can be calculated easily from the percent base saturation and the cation exchange capacity. First, add the percent base saturation of K, Mg, and Ca. Next, subtract that total from 100% to obtain the percent acidity. Finally, multiply the cation exchange capacity by the percent acidity to get the exchange acidity.

Example
Topsoil

1. Soil test: pH 6.0, cation exchange capacity of 10.6 me/100gc, base saturation of 2.4 % K, 6.4% Mg, and 16.2% Ca
2. Calculate total percent base saturation: 2.4% + 6.4% + 16.2% = 25.0%
3. Calculate the percent acidity: 100% - 25.0% = 75%
4. Calculate the exchange acidity: 0.75 x 10.6 = 8.0 me/100gc
5. Determine 100% ENV lime requirement from Table 10.3.2: 2.5 tons/acre

Subsoil

1. Soil test: pH 5.2, cation exchange capacity of 5.7 me/100gc, base saturation of 1.1% K, 3.4% Mg, and 8.0% Ca
2. Calculate total percent base saturation: 1.1% + 3.4% + 8.0% = 12.5%Calculate the percent acidity: 100% - 12.5% = 87.5%
3. Calculate the exchange acidity: 0.875 x 5.7 = 5.0 me/100gc
4. Determine 100% ENV lime requirement from Table 10.3.3: 2.0 tons/acre

Total lime to be applied to the topsoil and subsoil: 4.5 tons 100% ENV lime/acre

The lime recommendations in Tables 10.3.2, 10.3.3, and 10.3.4 are for 100% effective neutralizing value (ENV). The actual lime rate to be applied is calculated by dividing the recommended 100% ENV rate by the ENV of the lime to be used.

The desired levels of soil calcium and magnesium are listed in Table 10.3.5 for different soil management groups. If soil magnesium levels are below the desired level, then high-Mag lime should be used for liming.

Table 10.3.2. Tons of 100% ENV lime per acre required to increase pH to 7.0 for topsoil (0 to 8 inches).

	Exchange Acidity (me/100g soil)																				
Soil pH	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
4.4 - 4.5	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.4	8.0	8.5	9.0	9.6	10.1	10.6	11.2	11.7	12.2	12.8	13.3
4.6 – 4.7	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.9	7.4	7.9	8.4	9.0	9.5	10.0	10.5	11.1	11.6	12.1	12.7	13.2
4.8 - 4.9	2.6	3.1	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.3	7.8	8.3	8.9	9.4	9.9	10.4	11.0	11.5	12.0	12.5	13.0
5.0 - 5.1	2.6	3.1	3.6	4.1	4.6	5.1	5.6	6.1	6.6	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.8	12.3	12.8
5.2 - 5.3	2.4	2.9	3.4	3.9	4.3	4.7	5.3	5.7	6.3	6.8	7.2	7.7	8.2	8.6	9.2	9.6	10.2	10.6	11.1	11.6	12.0
5.4 - 5.5	2.1	2.6	3.0	3.4	3.8	4.2	4.7	5.1	5.5	5.9	6.3	6.7	7.2	7.6	8.1	8.5	8.8	9.3	9.7	10.2	10.6
5.6 - 5.7	2.0	2.3	2.7	3.1	3.5	3.9	4.2	4.6	5.0	5.4	5.8	6.2	6.5	6.9	7.3	7.7	8.1	8.5	8.8	9.2	9.6
5.8 - 5.9	1.8	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.5	5.9	6.2	6.7	6.9	7.2	7.6	7.9	8.3	8.6
6.0 - 6.1	1.6	1.9	2.2	2.5	2.8	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.6	7.9

Table 10.3.3. Tons of 100% ENV lime per acre required to increase pH to 6.5 for subsoil (8 to 16 inches).

	Exchange Acidity (me/100g soil)																				
Soil pH	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
4.4 - 4.5	2.4	2.8	3.3	3.8	4.2	4.7	5.2	5.7	6.1	6.6	7.1	7.6	8.0	8.5	9.0	9.4	9.9	10.4	10.9	11.3	11.8
4.6 - 4.7	2.3	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.0	6.5	7.0	7.4	7.9	8.4	8.8	9.3	9.8	10.2	10.7	11.2	11.6
4.8 - 4.9	2.3	2.7	3.2	3.7	4.1	4.6	5.0	5.5	5.9	6.4	6.9	7.3	7.8	8.2	8.7	9.1	9.6	10.0	10.5	10.9	11.4
5.0 - 5.1	2.2	2.7	3.1	3.5	4.0	4.4	4.9	5.3	5.7	6.2	6.6	7.0	7.5	7.9	8.3	8.7	9.2	9.6	10.1	1.05	11.0
5.2 - 5.3	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10.0
5.4 - 5.5	1.6	1.9	2.2	2.6	2.8	3.1	3.5	3.8	4.1	4.4	4.7	5.0	5.4	5.6	6.0	6.3	6.6	6.9	7.2	7.6	7.9
5.6 - 5.7	1.3	1.6	1.8	2.1	2.4	2.6	2.8	2.9	3.4	3.6	3.9	4.1	4.4	4.6	4.9	5.1	5.4	5.6	5.9	6.2	6.4
5.8 - 5.9	1.0	1.21	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0
6.0 - 6.1	0.8	0.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.4	2.5	2.7	2.8	3.0	3.1	3.3	3.5	3.6	3.8	3.9

Table 10.3.4. General lime recommendations for a depth of 16 inches (tons of 100% ENV lime per acre).

Soil pH	Sands	Sandy Loams	Loams & Silt Loams	Silty Clay Loams
4.5	4.5	10.0	16	22
4.6 - 4.7	4.5	10.0	15.5	21.5
4.8 - 4.9	4.5	9.5	14.5	20.5
5.0 - 5.1	3.5	8.5	13.0	18.0
5.2 - 5.3	2.5	7.0	11.0	14.5
5.4 - 5.5	1.7	5.0	7.0	10.2
5.6 - 5.7	1.7	3.5	5.0	7.7
5.8 - 5.9	1.2	2.5	4.5	6.0
6.0 - 6.1	1.0	2.5	3.5	5.0
6.2 - 6.3	0.7	1.7	2.5	3.5
6.4 - 6.5	0.5	1.2	1.7	2.5
6.6 - 6.7	0.4	0.9	1.2	1.7

Lime should be thoroughly harrowed into the surface soil, then plowed to work it as deeply as possible into the soil. If large amounts of lime are required (more than 3 tons per acre), split application is recommended, working one-half or two thirds of the total amount of lime into the soil as indicated above, plus thoroughly harrowing the remainder into the topsoil after plowing.

10.3.2. Other Preplant Nutrients

Potassium: The desired levels of soil potassium are listed in Table 10.3.5 for the different soil management groups. The difference between the desired level and the soil test result in both the topsoil and the subsoil is the amount to be added to the soil. [(Desired Level topsoil – actual level topsoil) + (Desired Level subsoil – actual level subsoil) = lb./acre K2O per 16-inch depth.

Phosphorus: Incorporation of appropriate rates of phosphorus during preplant soil preparation is the best means of providing adequate phosphorus for the life time of the orchard. The recommended amounts of preplant phosphorus for various soil test levels are listed in Table 10.3.6. The amount of phosphorus to be added is the sum of topsoil plus subsoil requirement.

Nitrogen: During preplant soil preparation, an application of nitrogen at 40 lb./acre is suggested for cover crop establishment. An additional 40 lb./acre is suggested when the cover crop is plowed down or when seeding the permanent grass sod.

Boron: Typical boron levels for different soil textures are given in Table 10.3.7. If soil test shows boron levels are in the low to medium range, then 2 to 3 lb. of boron is recommended for preplant soil preparation.

Table 10.3.5. Approximate levels of Calcium, Magnesium, and Potassium for topsoil (0 to 8 inches) and subsoil (8 to 16 inches) of different soil management groups

Soil Group	CEC (me/100g)		Ca (lb./acre)		Mg (lb./acre)		K2O (lb./acre)	
	Topsoil	*Subsoil*	*Topsoil*	*Subsoil*	*Topsoil*	*Subsoil*	*Topsoil*	*Subsoil*
I	25	17	7800	4600	950	550	520	300
II	20	13	6200	3700	750	450	450	260
III	18	12	5600	3300	700	400	430	250
IV	16	11	5000	2900	600	350	400	240
V	12	8	3700	2200	450	250	330	200

Table 10.3.6. Soil test phosphorus values and rates of phosphate (P_2O_5) application for orchards

Soil Test P Results		Amount of P_2O_5 to Apply (lbs/acre)	
ppm	*lbs/acre*	*Pre-planting*	*Established orchards**
<0.5	<1	120	60
0.5-1.5	1-3	100	60
2-4	4-8	60	30
>4.5	>9	40	0

* Do not apply phosphate to established orchards unless leaf analysis also indicates a need.

Table 10.3.7. Boron soil test levels for soils with different textures

Relative Soil Test Levels	Loamy Sand	Sandy Loam	Loam & Silt	Rate of Boron (lbs/a)
Very High	>0.60 ppm (>1.2 lbs/a)	>0.90 ppm (>1.8 lbs/a)	>1.20 ppm (>2.4 lbs/a)	0
High	0.36-0.60 ppm (0.7-1.2 lbs/a)	0.61-0.90 ppm (1.2-1.80 lbs/a)	0.81-1.20 ppm (1.6-2.4 lbs/a)	1
Medium	0.20-0.35 ppm (0.4-0.7 lbs/a)	0.30-0.60 ppm (0.6-1.2 lbs/a)	0.40-0.80 ppm (0.8-1.6 lbs/a)	2
Low	<0.20 ppm (<0.4 lbs/a)	<0.30 ppm (<0.6 lbs/a)	<0.40 ppm (<0.8 lbs/a)	3

Note: Soil test results for boron should be judged in relation to leaf analysis results. Leaf analysis is considered to be a better indicator of boron status.

10.4 Fertilization Program for Young Trees

When new trees are planted in the spring, immediate supply of adequate water is essential to settle the soil around the roots, but application of nitrogen fertilizer is not recommended. This is because the initial tree growth is mainly supported by the nutrient reserves within the tree and the uptake of nutrients from the soil is often delayed due to the damaged root system. In addition, applying large amounts of dry fertilizers at planting may cause damage to the roots. The first application of nitrogen fertilizer should be made at budbreak at a rate of 0.6 to 1.0 ounce of actual nitrogen per tree. Liquid nitrogen fertilizers are preferred. If dry fertilizers have to be used, make sure to avoid any contact with the trunk. A second application at the same rate should be made 4 weeks after budbreak. To improve early season tree growth, 2 to 3 sprays of 6 lbs of urea per 100-gal water is recommended at 10 to 14-day intervals beginning at 3 weeks after budbreak. In early October, 2 sprays of foliar urea at 25 lbs per 100 gal are also suggested.

In the second year, when new shoots begin their rapid growth (early to mid-May), apply 0.1 to 0.2 pounds of actual nitrogen per tree and a similar N spray program as in year 1. If trees have a substantial crop and the variety is susceptible to bitter pit, a foliar calcium program is recommended.

10.5 Fertilization Program for Established Orchards

10.5.1 Using Leaf Analysis

Leaf analysis indicates the concentration of nutrients that are present in the foliage. If leaf samples are taken correctly and the results are interpreted properly, it provides a good tool for developing an effective fertilization program. Leaf analysis standard for fruit trees are listed in Table 10.4.1.

Leaf samples should be collected between 60 to 70 days after petal fall, which generally corresponds to late July and early August. Mid-shoot leaves should be sampled from current season terminal shoots on the periphery of the tree. Sample trees should represent the general conditions of the orchard in terms of vigor, crop load, etc. Each sample should consist of about 100 leaves collected from several trees in the area being sampled. Do not mix leaves from different varieties, soil conditions, tree vigor, or crop load. Record observations on terminal shoot length, thickness, crop load, and fruit size. Leaf samples can be sent to: **Maine Agricultural and Forest Experiment Station Analytical Laboratory**, 5722 Deering Hall, University of Maine, Orono, ME 04469-5722 (207-581-3591); **UMass Soil & Plant Tissue Testing Laboratory**, West Experiment Station, University of Massachusetts, Amherst, 01003 (413-545-2311); **University of New Hampshire Cooperative Extension Soil Testing Program**, Spaulding Life Science Center, Room G28A, 38 College Road, Durham, New Hampshire 03824 (603-862-3200); or **University of Vermont Agricultural & Environmental Testing Laboratory**, 209 Hills Building, University of Vermont, Burlington, VT 05405 (802-656-3030).

Please note that the desired levels in Table 10.4.1 are given as general references. Individual state plant-tissue testing laboratories may use somewhat different optima. If given, follow the nutrient recommendations of the laboratory conducting the analyses and your local fruit specialist.

It should be recognized that leaf analysis has its limitations. First, leaf samples are taken relatively late in the growing season. Even if you can get the leaf analysis results back immediately, you may not have enough time left during the season to correct mineral deficiencies if there are any. Secondly, routine leaf analysis cannot detect the transient nutrient demand by certain physiological processes early in the season. For example, trees have a large transient demand for boron at bloom. Finally, even if leaf analysis shows no mineral nutrient deficiency, you still need to have a maintenance program in place to make up the amount of nutrients that is lost in harvested fruit and fallen leaves every year. Therefore, two fertilization programs are suggested here for established trees. One is a maintenance program. The other is a corrective program for trees with nutrient deficiency.

Table 10.5.1. Leaf analysis standards for tree fruits (dry weight basis).

Element	Crop	Desired Level
Nitrogen	Young nonbearing apples and pears	2.4-2.6%
	Young bearing apples and pears	2.2-2.4%
	Mature soft apples and pears	1.8-2.2%
	Mature hard apples and processing	2.2-2.4%
	Cherries, plums, prunes	2.4-3.4%
	Peaches	3.0-4.0%
Phosphorus	All crop	0.13-0.33%
Potassium	All crops	1.35-1.85%
Calcium	All crops	1.3-2.0%
Magnesium	Apples and pears	0.35-0.50%
	Stone fruits	0.40-0.60%
Boron	Apples and pears	35-50 ppm
	Stone fruits	30-40 ppm
Zinc	All crops	30-50 ppm
Copper	All crops	7-12 ppm
Manganese	All crops	50-150 ppm
Iron	All crops	50+ ppm

10.5.1.1. Maintenance Program

This program is suggested when leaf analysis shows no nutrient deficiency or no deficiency symptoms are observed.

Timing	Foliar Sprays	Ground Applications
Green tip	One spray of 2 to 4 lbs of a fixed copper product per 100 gal (C-O-C-S or Kocide).	
Tight cluster to pink	One spray of tank mixed 3 lbs of urea and 1 lb Solubor/100 gal	Apply 20 to 40 lbs of actual nitrogen/acre to soil.
Petal fall to early cover sprays	One spray of Zn-EDTA at label rate at second cover. **Plus** One spray of 3 to 4 lb of calcium chloride/100 gal at third cover. **Plus** Two sprays of 15 lb of Epsom salt/100 gal at petal fall, and second cover.	Apply 40 to 60 lbs of potassium/acre to soil at petal fall.
End of shoot growth to harvest	Three to four sprays of 3 to 4 lbs of calcium chloride/100 gal at 14-day intervals for bitter pit susceptible varieties.	
After harvest		Apply 40 to 60 lb of potassium/acre to soil. **Plus** Every 2 to 3 years, apply appropriate amount of lime determined from soil analysis.

10.5.1.2. Corrective Program

This program is suggested when leaf analysis shows nutrient deficiency, or deficiency symptoms are observed. Match fertilizer applications to specific nutrient deficiency. (See table on next page.)

Timing	Foliar Sprays	Ground Applications
Green tip	One spray of 2 to 4 lbs of a fixed copper product per 100 gal (C-O-C-S or Kocide)	
Prebloom period	Two sprays of tank-mixed 1 lb of Solubor, 3 lbs of urea, and Zn-EDTA at label rate per 100 gallon, one at 1/2" green and the other at tight cluster to pink	Apply 40 to 60 lbs of actual nitrogen/acre to soil.

Timing	Foliar Sprays	Ground Applications
Petal fall to early cover sprays	Two foliar sprays of 5 lbs of urea/100 gal at petal fall and first cover. **Plus** Two sprays of Zn-EDTA at label rate at petal fall and second cover. **Plus** Two foliar sprays of 1 lb of Solubor/100 gal at first and third cover. **Plus** Three sprays of 15 lbs of Epsom salt/100 gal applied at petal fall, first and second covers. **Plus** One foliar spray of 3 to 4 lbs of calcium chloride per 100 gal at third cover.	Apply 60 to 150 lbs of Potassium/acre to soil at petal fall.
End of shoot growth to harvest	Five to six sprays of 3 to 4 lbs of calcium chloride/100 gal at 14-day intervals.	Apply 60 to 150 lbs of potassium to soil at the end of shoot growth.
After harvest	Two sprays of 25 lbs of urea/100 gal at 7 to 10-day intervals. P**lus** One spray of 1 lb of actual copper/acre as copper sulfate.	Soil application of 60 to 150 lbs of potassium/acre as sulfate of potash-magnesia. **Plus** Soil application of dolomitic lime to increase calcium and magnesium supply based on soil and leaf analyses.

10.5.2 Special Considerations in Foliar Application of Nutrients

To minimize the number of sprays applied in the orchard, it is frequently desirable to combine various nutrient materials or to add them in tank mixes with pesticides. Before doing so, however, one needs to make sure they are compatible.

Generally, urea, Solubor, Zn-EDTA, and Epsom salts are compatible. Urea, Solubor, and Zn-EDTA have been used together safely in prebloom sprays on apples and pears. A tank mix of urea and Epsom salts has sometimes injured young apple foliage; if both are required, they should be applied separately. Epsom salts and some of the boron products listed in Table 10.4.5 may increase the pH of the tank mix, and if used with pH-sensitive pesticides, pH of the tank mix should be tested and adjusted by using a suitable acidifying agent. Solubor and presumably other forms of boron should not be tank-mixed with any pesticide contained in water-soluble plastic packages because it inhibits the dissolution of the plastic. Foliar nutrients, in general, and Solubor, in particular, should not be tank-mixed with oil.

Although Epsom salts, Solubor and Zn-EDTA are compatible for use in postbloom sprays, many orchardists prefer not to add all three to one tank. A petal fall spray may then contain Epsom salts alone or with Solubor; the first cover spray a combination of Epsom salts and Solubor; the second cover spray a combination of Epsom salts and Zn-EDTA; and the third cover spray a combination of Solubor and Zn-EDTA.

Calcium chloride may be physically incompatible with Epsom salts, resulting in plugging of sprayer nozzles. Calcium chloride cannot be tank-mixed with Zn-EDTA because some of the dissolved calcium may displace Zn, causing phytotoxicity.

It should be pointed out that some Zn-chelate products contain a large percentage of unchelated Zn, which may cause injury to foliage and fruit. Therefore, before using a new Zn product in your orchard, test the product by spraying a few trees at the label rate to see if any phytotoxicity occurs.

More detailed information concerning nutrient management for orchards can be found in Cornell Cooperative Extension Information Bulletin 219, *Orchard Nutrition Management* by Warren Stiles and Shaw Reid. See the section on “Tree Fruit Reference Materials” at the end of this publication for ordering information.

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10.6 Characteristics of Commonly Available Fertilizers

Table 10.6.1. Nitrogen fertilizers

Common Name	N (%)	Pounds of Formulated Product per pound of N	Acidity or Basicity (lb $CaCO_3$/lb	
			Acidity	*Basicity*
Ammonia, anhydrous	82	1.22	1.8	—
Ammonia, aqua	20	5.00	1.8	—
Ammonium nitrate	33.5	2.98	1.8	—
Ammonium polyphosphate	12	8.33	4.1	—
Ammonium sulfate	20.5	4.88	5.4	—
Calcium nitrate	15.5	6.45	—	1.3
Diammonium phosphate	16-18	5.56	4.1	—
Monoammonium phosphate	11	9.09	5.3	—
Nitrate of soda-potash	15.5	6.45	—	1.3
Potassium nitrate	13	7.69	—	2.0
Sodium nitrate	16	6.25	—	1.8
Urea	45	2.22	1.6	—
Nitrogen solutions	variable[1]	—	—	—

[1]Nitrogen solutions may consist of mixtures of urea plus ammonium nitrate, aqua ammonia, or anhydrous ammonia plus urea or ammonium nitrate or both of these materials. Consult supplier for analysis.

Table 10.6.2. Phosphorus fertilizers

Common Name	P_2O_5 (%)	Pounds of Formulated Product per Pound of P_2O_5	N (%)
Ordinary superphosphate	20	5	0
Concentrated superphosphate	46	2.27-2.17	0
Ammoniated superphosphate	40*	2.5*	5*
Monoammonium phosphate	52*	1.92*	13*
Diammonium phosphate	46*	2.17*	18*
Urea-ammonium phosphate	28	3.57	28

*Values may vary depending on fertilizer source.

Table 10.6.3. Potassium fertilizers

Common Name	Chemical Formula	K_2O (%)	Pounds of Formulated Product per Pound of K_2O
Muriate of Potash	KCl	60	1.67
Sulfate of Potash	K_2SO_4	53	1.89
Sulfate of Potash Magnesia	$K_2SO_4 \cdot 2MgSO_4$	22	4.54
Potassium polyphosphate	KPO_3	40	2.50
Potassium carbonate	K_2CO_3	67	1.50
Potassium nitrate	KNO_3	44	2.27

Table 10.6.4. Boron fertilizers[1]

Product Name	B (%)	Form of B*	Increase in Spray Water pH	Cost per Pound of B
B-17	17.0	BA	none	low
Mor-Bor 17	17.3	BA	none	low
Spray-Bor	16.5	NaB	moderate	low
Solubor	20.5	NaB	high	very low
Solubor DF	17.4	NaB	high	n/a
Albion Liquid B	5.0	NaB	high	high
Liquibor	2.5	BA, NaB	high	high
Borosol 10	10.0	BA	very high	moderate
N-Boron	5.4	BA	very high	n/a

*Form of boron indicates boron compound used in formulating the product: **BA:** boric acid; **NaB:** sodium polyborates.

[1]From Dr. Frank Peryea, Washington State University.

Table 10.5.6. Miscellaneous fertilizers

Name	Mineral Element	Content (%)
Gypsum	Ca	24
Superphosphate	Ca	20
Concentrated superphosphate	Ca	14
Calcium nitrate	Ca	24
Calcium chloride (77-80%)	Ca	27.8
Calcium chloride (35% liquid)	Ca	12.6
Calcium chelates	Ca	variable
Epsom salts	Mg	10
Kieserite	Mg	17.3
Magnesium oxide	Mg	49-56
Magnesium sulfate	Mg	16
Zinc chelate	Zn	variable
Zinc sulfate	Zn	36%
Basic zinc sulfate	Zn	50-52
Copper chelate	Cu	variable
Copper sulfate	Cu	25%