NUTRIENT MANAGEMENT FOR TREE FRUITS AND SMALL FRUITS

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While the intended target of the nutrient management legislation is to protect the environment, the goals of nutrient management in fruit crops are a) to maximize healthy plant growth, productivity, and profitability and b) to optimize fertilizer usage and minimize fertilizer runoff, thus reducing water pollution.

Orchards and vineyards generally use less fertilizer than row crops for two reasons. First, high fertility is not required once trees and bushes begin producing, since excess fertilizer stimulates vegetative growth and decreases fruit quality. Secondly, with their deep perennial root systems, fruit trees and bushes are capable of absorbing nutrients throughout much of the growing season. In addition, fruit plants are efficient in absorbing fertilizers and recycling nutrients.

Physiological adaptations such as mycorrhizae and bark storage proteins allow perennial fruit trees to take up and recycle a greater proportion of phosphorus and nitrogen than annual crops. Taken together, these physiological adaptations allow fruit growers to maintain productive plantings while using less fertilizer than most annual crops.

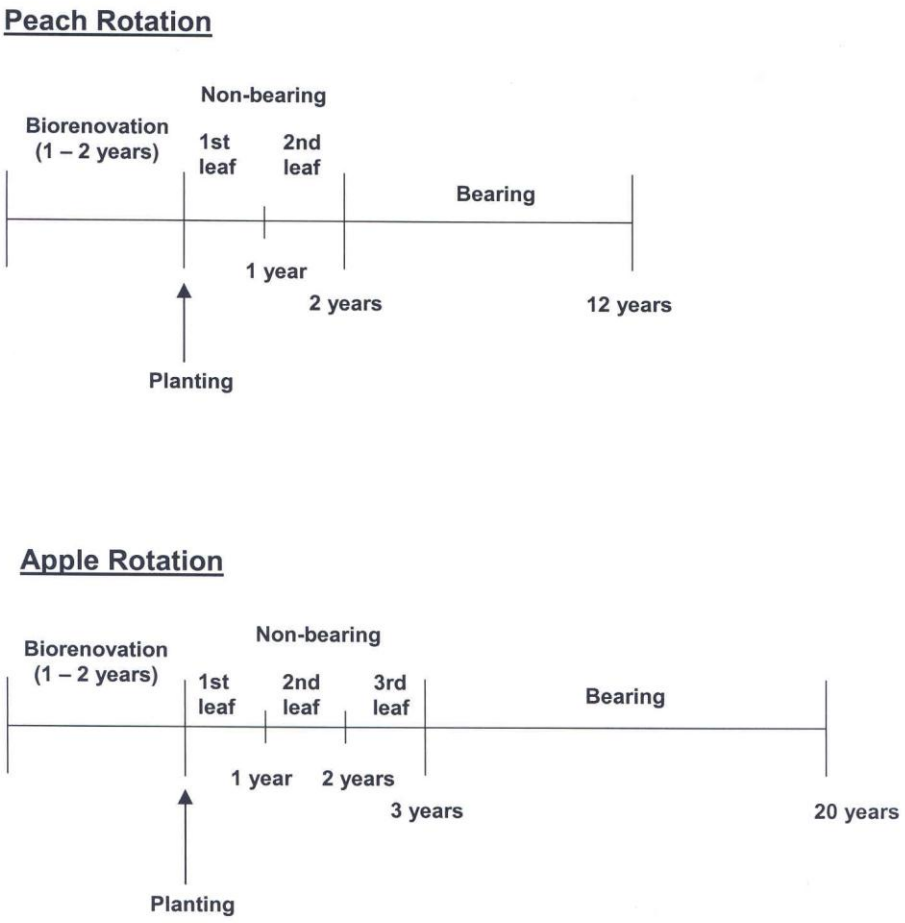
Nutrient Management Throughout the Life of the Planting

Since the various woody perennial fruit crops have many fertility requirements in common, we have chosen to treat these crops in a similar manner. For the purpose of developing nutrient management plans, the life of the fruit planting is separated into three logical age categories. The age categories in the life of a fruit planting are:

I. Pre-planting (biorenovation) year(s)
II. Non-bearing year(s)
III. Bearing years

During these three age categories (Figure 1), fertilizer recommendations, fertilizer applications, and agricultural practices will be handled differently. Thus nutrient management planning must also be handled differently.

Figure 1. A typical rotation for peaches and apples (The life cycles of both trees are similar, except that peach is earlier to come into production and earlier to decline.)



I. Pre-Planting Year(s)

Prior to planting, phosphorus and potassium recommendations and lime requirements will be determined from soil tests. Adjustment of pH and plant-available phosphorus and potassium are necessary to optimize the growth of young trees. Optimal pH for fruit crops is as follows: apples and other tree fruit, 6.5; raspberry, 6.5; blackberry, 6.2; blueberry, 4.5.

To avoid nematode problems, fruit plantings should not be set directly into pasture land. Thus prior to planting, a two-year rotation with nematode-suppressing crops is recommended. Consult EB 242, *Commercial Small Fruit Production Guide's* section on "Pre-Plant Site Biorenovation and Soil Conditioning" for details.

Whatever crop rotation is selected prior to planting, soil tests are needed to determine phosphorus and potassium recommendations, and lime requirements for the rotational crops. Nitrogen recommendations are determined by crop type and yield goal.

After biorenovation and before planting fruit crops, resample and retest soil. This is the last opportunity to incorporate nutrients and lime. Implementing these nutrient recommendations before planting ensures that adequate soil fertility will be present to establish young fruit plants and will

contribute much of the nutrients required throughout the life of the planting. Consult Table 1 for pre-plant phosphorus and potassium recommendations based on soil test.

Table 1. Phosphorus (as P_2O_5 or 0-46-0 fertilizer) and potassium (as K_2O or 0-0-60 fertilizer) recommendations for establishment of woody perennial fruit crops

Soil Test Results		Nutrient (Lbs. Per Acre)		Recommended Fertilizer (Lbs. Per Acre)	
P_2O_5	K_2O	P_2O_5	K_2O	0 - 46 - 0	0 - 0 - 60
L	L	135 - 155	195 - 235	305 - 350	325 - 390
M	M	90	130	205	215
O	O	15	90	35	150
E	E	0	0	0	0

L = Low (FIV 0 - 25) M = Medium (FIV 26 - 50) O = Optimum (FIV 51 - 100) E = Excessive (FIV >100)

II. Non-Bearing Year(s)

Most fruits are grown with permanent grass sod strips between rows, with grass and weed growth beneath the trees or bushes controlled by herbicide sprays. The permanent sod crop (drive middle) and herbicide strip makes spraying and harvesting easier. It also minimizes root damage from plant-parasitic nematodes, and tree and fruit damage from nematode-vectored viruses and direct insect pests.

Fruit growers typically plant into bare ground that is kept weed-free by cultivation during the first growing season. This is done because young fruit plants compete poorly with grasses for water and nutrients. Because it is usually difficult to establish a good sod cover in the spring, permanent sod strips are often not established until the fall after planting.

Some growers prefer to establish the permanent sod cover the year prior to planting. Subsequently, a strip of sod is killed with herbicides, and trees or bushes are set using a “no-till” planter. Regardless of when the sod is planted, nutrient applications to the sod cover are only required until the sod in the drive middle has become fully established.

Repeated studies of plant establishment have shown that hand placement of nitrogen fertilizer during non-bearing years is the most efficient method of applying unincorporated fertilizer. Hand placement of nitrogen fertilizer after the plants have settled in, and in the spring during the next two or three years is the industry standard. The goal is to have plants quickly fill their allotted space, and then reduce their growth by redirecting photosynthate to the fruit crop. Hand placement of fertilizer during the early years maximizes growth while minimizing fertilizer usage

Calcium nitrate has become the material of choice for fertilizing young plants with the exception of blueberries. The benefits of calcium nitrate are two-fold. First, nitrate fertilizers are taken up rapidly and stimulate strong early-season growth. Second, calcium deficiency problems, such as bitter pit and cork spot (York spot) in apples, occur widely in fruits and may be suppressed by calcium nitrate. Later, during the bearing years, many apple growers continue to use calcium nitrate, which helps to minimize fruit softening and breakdown in storage.

Blueberries are typically fertilized using ammonium sulfate, which supplies the nitrogen and keeps the pH reduced. Table 2 gives recommended annual nitrogen application during the non-bearing year(s). While some growers use a blended fertilizer following planting, this is unnecessary if plant-available phosphorus and potassium were optimized prior to planting.

Table 2. Nitrogen fertilizer recommendations for young non-bearing plantings of woody perennial fruit crops (hand-placed nitrogen fertilizer per plant per year)

	Calcium Nitrate (15.5% N)	**Ammonium Nitrate** (33% N)	**Ammonium Sulfate** (21% N)
Tree Fruit			
Apple	8 oz	4 oz	-
Peach and nectarine	12 oz	6 oz	-
Pear Fireblight resistant Fireblight susceptible	 8 oz 4 oz	 4 oz 2 oz	-
Cherry, apricot, and plum	8 oz	4 oz	-
Small Fruit			
Blackberry	10 oz	5 oz	-
Blueberry	-	-	2.25 oz
Raspberry	3 oz	1.5 oz	-

III. Bearing Year(s)

While soil analyses are valuable in adjusting fertilizer recommendations prior to planting, University of Maryland fruit specialists recommend basing nutrient recommendations for bearing trees and small fruit crops on a **combination of soil testing and tissue analysis** for determining fertilizer needs in bearing perennial fruit crops. Soil tests and tissue analyses every 3 years may be sufficient if crop production is adequate, however, if production is poor, annual tests may be advisable.

Soil tests during the bearing years provide an important crosscheck of nutrient status. For example, if tissue analysis indicates a low level of phosphorus in leaf tissue while the soil test level for phosphorus is optimum or excessive, the low phosphorus level in plant tissue is most likely due to a nutrient absorption problem, such as disease or nematodes, that would not be ameliorated by application of additional phosphorus. In numerous other situations (high and excessive manganese and low calcium, magnesium, boron, and manganese, for example), both soil tests and tissue analysis must be viewed together to fully understand nutrient status.

Observations of plant growth characteristics and crop management, such as shoot growth, leaf color, and pruning severity should also be taken into account when developing nutrient recommendations.

Phosphorus usage by woody perennial fruit crops should be low once bearing begins. Following pre-plant applications, little or no phosphorus may be required. The limited need for supplemental phosphorus

comes from the development of symbionts in tree roots known as mycorrhizae (literally “fungus-root”). Mycorrhizae aid perennial plants in dissolving and taking up phosphorus, even in soils that have relatively low levels of phosphorus.

Tissue Sampling and Analysis

As previously indicated, in addition to soil sampling and testing, tissue sampling and analysis are essential for developing nutrient recommendations in nutrient management plans. Tissue samples are typically taken during the summer, when nutrient contents in the leaves are relatively stable (Table 3). Soil samples, which may be taken in the fall, should be taken the same year as tissue samples, and sampling sites should be in the same area of the block from which the tissue samples were collected.

At least one sample should be collected from each block. If a block contains a mixture of species and/or cultivars, sample the dominant species and a benchmark cultivar.

Table 3. Sample collection summary

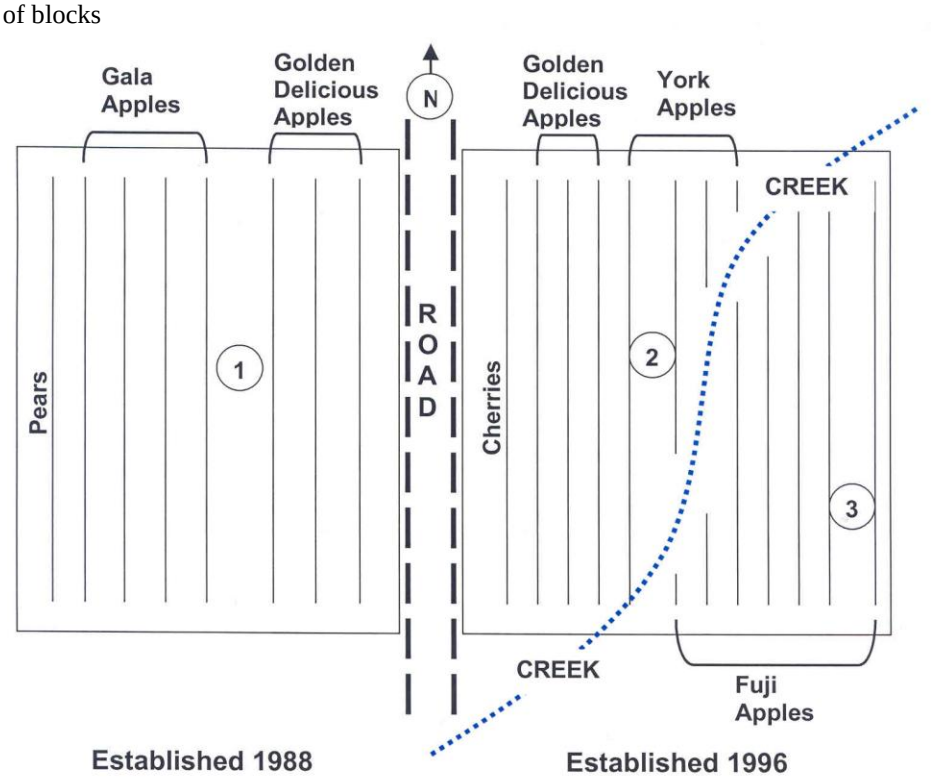
Crop	**Time to Sample**	**Number of Samples per Plant Part**	**Location on Plant**
Blueberries	1st week of harvest	40 leaves (detach petioles)	Current season's growth
Brambles	Aug 1st - Aug 20th	60 leaves (detach petioles)	Non-fruiting canes
Fruit trees	August	50 leaves & petioles	Select shoots at eye level from around outside of tree; select shoots that make a vertical angle of 45-60 degrees to the ground; remove 1-2 leaves from the mid-portion of new shoot growth (Figure 2).

Figure 2

Figure was taken from "Instructions for Taking Samples for Plant Analysis" by Penn State.

Perhaps the biggest hurdle in the tissue analysis process may be in answering the question, "*what is a block?*" and "*what should be sampled within a block?"* A typical block would best be determined by the orchard manager and should be based on tree species and planting date. In Figure 3, two varieties of apples and a row of pears (Field 1) were planted on Murrill gravelly loam in 1998, while Fields 2 and 3 were established in 1996 on a Chandler silt loam and Edgemont channery loam, respectively. Because each of the fields consists of a distinctly different soil, each field should be sampled as a separate block. Within all the blocks, apple is the dominant species. Within Field 1 (block 1), Gala is the variety of greater interest to the producer because of its higher economic value so it should be the cultivar sampled. Using the same logic, the York variety in Field 2 (block 2) is of greater interest to the producer so it should be the cultivar sampled. Since nitrogen usage in cherry is similar to apple, the grower would probably manage the cherries and apples in Block 2 in a similar fashion. In Field 3 (block 3), Fuji is the only variety in the block, thus it will be the cultivar sampled.

Figure 3. Example of blocks



Defining a block becomes increasingly difficult as orchard size decreases, as smaller orchards in Maryland may include many species. This problem may be further compounded in small orchards if the grower has difficulty controlling fertility. Orchards and small fruit production areas smaller than five acres, set in similar soils, could probably be handled as one or two blocks, focusing on apples and peaches.

All leaves for a sample should be collected from the same cultivar. The sampling procedure should be as random as possible. It is best NOT to take multiple leaves from the same tree or bush but collect from a wide selection of plants throughout the block and cultivar being sampled.

In apples, widely grown cultivars such as Delicious, York, or Rome are logical choices for tissue sampling in a mixed planting. Alternatively, sampling high value cultivars such as Gala and Jonagold might be needed, especially in direct market operations.

Interpreting Tissue Analysis

Nutrient sufficiency ranges for common woody perennial fruit crops produced in Maryland are listed in Table 4. These levels are based on a long history of research, conducted to minimize fertilizer usage, while optimizing the production of quality fruit. Complete information on deficient, low, normal, high, and excessive nutrient concentrations for tree and small fruit crops is in the Appendices.

Antique peach cultivars such as 'Belle of Georgia,' 'Elberta' and 'Raritan Rose' will drop green fruit during final swell when fertilized with the standard rate of nitrogen. In the case of those cultivars, growers should only apply half the level of nitrogen recommended for peaches. Typically the grower would only apply the first split-application to these "antique" varieties.

In apples, adequate nitrogen level can be further defined depending on cultivar sampled and maturity. Apple varieties can be divided into three groupings depending on firmness and storage ability (Table 5).

Tissue nitrogen levels will be reduced in biennial bearing apple trees in their 'off' year or in trees carrying a light crop.

Table 4. Nutrient sufficiency ranges and desired annual shoot growth for woody perennial fruit crops used to interpret foliar analyses (dry weight).

	Apple	Pear	Peach	Cherry	Brambles	Blueberry
Desired shoot growth (inches per year)	12 - 18	12 – 18[2] 8 – 12[3]	18 - 24	15 - 18		
Macronutrients						
Nitrogen (%)	1.80 - 2.80[1]	1.60 - 2.40	2.50 - 3.40	2.30 - 3.30	2.00 - 3.00	1.70 - 2.10
Phosphorus (%)	0.18 - 0.30	0.18 - 0.26	0.15 - 0.30	0.23 - 0.38	0.25 - 0.40	0.07 - 0.18
Potassium (%)	1.20 - 2.00	1.20 - 2.00	2.10 - 3.00	1.00 - 1.90	1.50 - 2.50	0.40 - 0.65
Calcium (%)	1.30 - 3.00	1.30 - 3.00	1.90 - 3.50	1.60 - 2.60	0.60 - 2.50	0.30 - 0.80
Magnesium (%)	0.20 - 0.40	0.30 - 0.60	0.20 - 0.40	0.49 - 0.65	0.30 - 0.90	0.20 - 0.30
Sulfur (%)	0.20 - 0.40	0.17 - 0.26	0.20 - 0.40	0.15 - 0.50	0.21 - 0.50	0.12 - 0.20
Micronutrients						
Boron (ppm)	35 - 80	35 - 80	25 - 50	39 - 80	30 - 50	30 - 50
Copper (ppm)	6 - 25	6 - 25	6 - 25	6 - 25	7 - 50	5 - 15
Iron (ppm)	40 - 100	50 - 400	50 - 200	50 - 250	50 - 200	70 - 300
Manganese (ppm)	22 - 140	20 - 200	19 - 150	18 - 150	50 - 200	50 - 500
Zinc (ppm)	20 - 200	20 - 200	20 - 200	20 - 200	20 - 50	15 - 30

1 Nitrogen sufficiency ranges vary depending upon apple type and usage
2 Fireblight-resistant varieties
3 Fireblight-susceptible varieties

Table 5. Recommended levels of nitrogen (%) for apple cultivar groups

	Early Bearing	Mature
Soft apple cultivars Paulared, McIntosh, Empire, Gala, Golden Delicious, Jonagold, Mutsu	2.0 - 2.4	1.8 - 2.1
Fresh market cultivars Delicious, Fuji, Braeburn	2.2 - 2.4	2.2 - 2.25
Fresh market and processing cultivars York Imperial, Rome Beauty, Stayman	2.2 - 2.6	2.2 - 2.4

Sampling and Testing During Orchard Rotation

Sampling and testing are the bases of nutrient recommendations and vary across the life of the orchard. See Table 6 for a summary of sampling and testing requirements for biorenovation years and age categories of woody perennial fruit crops.

Table 6. Soil and tissue testing summary

Age of Planting	Soil Test	Tissue Test
Biorenovation	Yes	No
Pre-plant	Yes	No
Non-bearing	No	No
Bearing	Yes	Yes

Issues During Bearing Years in Established Orchards

Symptoms of Deficient Nitrogen

Nitrogen deficiency symptoms appear as reduced top growth with short, spindly shoots that have pale green to yellow leaves. Generally speaking, symptoms first become evident in older leaves at the base of the shoots. In stone fruits, deficient leaves appear reddish and may exhibit a "shothole" effect as the condition worsens. Low nitrogen fruits tend to be smaller and mature earlier. This is particularly noticeable in stone fruits. Urea sprays can be used to correct early season nitrogen deficiency in orchards. If, in the springtime, foliage is light yellow and trees are otherwise healthy, the transitional nitrogen deficiency can be corrected by spraying urea at 4 pounds per 100 gallons on a dilute basis after bloom (Pfeiffer, *et al.*, 2001). This should be done no later than the second cover spray on mature trees. Urea may also be added to cover sprays in young, non-bearing trees at the same rate until July 15.

Symptoms of Excessive Nitrogen

Excessive nitrogen application causes excessive shoot growth accompanied by dark green foliage and delayed leaf abscission in the fall. As nitrogen increases above the optimum, fruit color is reduced and maturity is delayed. Fruits develop less red color, and the ground color remains green rather than turning yellow. In apples and pears, flavor and storage life are generally reduced with excess nitrogen. In addition to these direct effects, other physiological disorders such as corking and bitter pit can increase as excessive nitrogen may induce calcium deficiency symptoms.

Timing and Split-Applications of Nitrogen Fertilizer in Peach and Nectarine Orchards

Among all fruit crops grown in Maryland, the nitrogen requirement of peach and nectarine crops is the greatest. To minimize over-fertilization it is common practice for peach and nectarine growers to make two applications of nitrogen fertilizer a year, each application using half of the total recommended rate. The first application is typically made at bloom time and the second after the crop has been set (30-45 days after bloom). This allows growers to avoid excessive vegetative growth in years when the crop is lost following a late spring freeze.

Symptoms of Deficient Phosphorus

Phosphorus deficiencies severe enough to produce visual symptoms are rare in fruit trees (Crassweller and Greene, 1995). When they do occur, symptoms may appear first as limited and slender terminal growth with young expanding leaves that are dark green. The young leaves' lower sides, especially along the margins and main veins, frequently show purplish discoloration. The leaves may have a leathery texture and form abnormally acute angles with the stem. Leaf symptoms are most often seen early in the growing season and diminish later in the season. This likely occurs due to cold soils limiting phosphorus uptake, rather than a deficiency *per se.* When soil moisture is low, lower levels of phosphorus may also be found in leaf analyses.

Symptoms of Excessive Phosphorus

Effects of excessive phosphorus fertilization are usually expressed as deficiencies of one or more essential micronutrients such as zinc, copper, iron, and manganese.

Calcium Deficiency of Apples

Calcium chloride sprays are often recommended when tissue sample analyses indicate low or deficient levels of calcium. Such spray regimes are often not economical for direct market growers unless there has been a history of bitter pit. Calcium chloride is difficult to apply, corrosive to equipment, and potentially phytotoxic. Applying boron (1 pound Solubor® per acre at petal fall) can increase the fruit "sink-strength" and enhance calcium uptake by the fruit.
Processing varieties of apples such as 'York' may require calcium chloride sprays for successful production if bitter pit or cork spot has been a problem. Calcium chloride at an annual rate of 15 – 50 pounds of product per acre can be included in cover sprays 1 through 7.

Estimating Nitrogen Requirements for Established Fruit Plantings in the Absence of a Tissue Analysis

Some Maryland fruit growers may not have results from tissue analyses. In these instances, nitrogen application rates can be based on leaf color and shoot growth. The information in Table 7 is presented only as a temporary aid to nutrient management planners writing initial plans in the absence of tissue analyses. It should not be used as a long-term alternative to tissue analysis.

Table 7. Desired shoot growth and typical nitrogen needed annually in fruit crops

Tree Fruit	**Nitrogen (lbs./acre)***	**Desired Shoot Growth (inches)**
Apple	35	12 - 18
Peach and nectarine	65	18 - 24
Pear **Fireblight-resistant** **Fireblight-susceptible**	 35 20	 12 - 18 8 - 12
	35	15 - 18
Small Fruit		
Blackberry	60	-
Raspberry (Spring-bearing)	35	-
Raspberry (Fall-bearing)		-
Blueberry	30**	-

***** Optimize based on tissue test
****** N rate could be as high as 60 lbs./acre depending upon age of plants, type of mulch, and soil type.

Phosphorus Site Index for Tree Fruits and Small Fruits

In the event that tissue analysis recommends the application of phosphorus, and the producer wishes to apply phosphorus, consideration must be given to the soil test's fertility index value for phosphorus (FIV-P) levels.

Maryland regulations require that the Phosphorus Site Index (PSI) be determined for all agricultural fields whose FIV-P is 150 or greater **if a producer intends to apply any P-bearing fertilizer materials**. It is unlikely that many perennial fruit producers will be impacted by the PSI requirement during the fruit production years if fertility recommendations were followed during pre-establishment period.

The PSI requires that a series of site/transport and management/source characteristics for a field be evaluated and that a P loss rating be calculated.

The site and transport characteristics include soil erosion, soil runoff class, subsurface drainage, leaching potential, distance from the edge of the field to surface water and priority of receiving watershed

Soil erosion, which is estimated via the Revised Universal Soil Loss Equation (RUSLE), and distance from the edge of the field to surface water are the only characteristics over which the producer has any control.

Soil runoff class, subsurface drainage, and leaching potential are a function of the dominant soil-mapping unit in the field and priority of receiving watershed is a function of geographical location.

The management and source characteristics include the following:

- soil test P,
- P application rate (fertilizers and manure);
- and timing and application method (fertilizers and manure)

The P loss rating, which is calculated from site/transport features and management/source characteristics, places a field in one of four categories as shown in table Table 8.

Table 8. Interpretation of P loss rating

P Loss Rating	Interpretation of P loss Rating
0 - 50	• **LOW** potential for P movement from this site given current management practices and site characteristics. There is a low probability of an adverse impact to surface waters from P losses from this site. • Nitrogen-based nutrient management planning is satisfactory for this site. • Soil P levels and P loss potential may increase in the future due to continued nitrogen-based nutrient management.
51 - 75	• **MEDIUM** potential for P movement from this site given current management practices and site characteristics. Practices should be implemented to reduce P losses by surface runoff, subsurface flow, and erosion. • Nitrogen-based nutrient management should be implemented no more than one year out of three. • Phosphorus-based nutrient management planning should be implemented two years out of three during which time P applications should be limited to the amount expected to be removed from the field by crop harvest or soil test-based P application recommendations, whichever is greater.
76 - 100	• **HIGH** potential for P movement from this site given current management practices and site characteristics. • Phosphorus-based nutrient management planning should be used for this site. Phosphorus applications should be limited to the amount expected to be removed from the field by crop harvest or soil test-based P application recommendations. • All practical management practices for reducing P losses by surface runoff, subsurface flow, or erosion should be implemented.
>100	• **VERY HIGH** potential for P movement from this site given current management practices and site characteristics. • No phosphorus should be applied to this site. • Active remediation techniques should be implemented in an effort to reduce the P loss potential from this site**.**

The estimation of PSI is an annual function, calculated any year when P-bearing materials may be added to fields with an FIV-P greater than 150. However, soil erosion, one of the more time-consuming components of the PSI process, is estimated over the entire rotation, including pre-establishment, non-bearing, and bearing years. RUSLE integrates the effect of six factors in calculating soil erosion losses (A) expressed in tons per acre per year, according to the following equation

A=RKLSCP , where

R = rainfall factor	K = soil erodibility factor
L = slope length	S = slope steepness
C = crop rotation and tillage factor	P = conservation practices factor

The rainfall factor is available from published data on a county basis. The soil erodibility factor is a function of the dominant soil-mapping unit of a field and is available in soil surveys and from other published sources. Slope length and gradient are measured in each field. The crop rotation and tillage factor is calculated from published sources based on crop type, tillage method, and canopy cover and is calculated as a weighted average over space and time. (An example of a calculation for the C factor in a typical orchard is shown in Table 9. The widths of grassed “drive middles” and herbicide strips were assumed to be similar for this example.) The conservation practices factor (P) can be determined from published sources.

Table 9. An example of the C factor for a 20-year orchard rotation.

Year	Crop Coverage	Crop / Condition	C Factor
Year 1	Biorenovation	Soybeans - conventional tillage	.20
Year 2	Biorenovation	Corn - conventional tillage	.20
Year 3	Planting	6 ft. whips, clean cultivation until fall when sod is seeded	.90
Year 4	Non-bearing year, medium height	50% sod, first year after tillage, no appreciable canopy	.25 & .30, mean = 28*****
Year 5	Non-bearing year, medium height	50% sod, second year after tillage, 25% canopy	.18 & .25, mean = .22
Year 6	Non-bearing year, tall	50% sod, third year after tillage, 50% canopy	.07 & .21, mean = .14
Year 7	Bearing, tall	50% sod, fourth year after tillage, 75% canopy	.07 & .16, mean = .12
Year 8-20	Bearing, tall	50% sod, fifth and following years after tillage, 75% canopy	.07 & .13, mean = .10
20-year average			.17

***** Sub-factors assume 40% ground cover (W) in herbicide strip Year 4 and after.

References and Useful Resources

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Appendices

1. Apple (pp. 15 - 20)
2. Peach and Nectarine (pp. 21 - 234)
3. Pear (pp. 24 - 27)
4. Cherry (pp. 28 - 31)
5. Plum (pp. 32 - 35)
6. Blueberry (pp. 36 - 39)
7. Brambles (pp. 40 - 43)

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Appendix 1: Apple (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
	All Cultivars			
N	Deficient	< 1.6	Nitrogen is very low.	Increase application rate by 50% unless major renovative pruning will be performed this winter, in which case increase application by only 25%. Values lower than 1.40% may indicate other problems. Examine the trees closely and retest next year. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.
	Soft Cultivars: Paulared McIntosh, Empire, Golden Delicious, Gala, Jonagold, Mutsu			
	Low	1.6 - 1.8	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.
	Normal	1.8 - 2.1	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. During the early-bearing years, N levels should range between 2.0 and 2.4. Fruit destined for fresh market will have better color and firmness if N levels are reduced by 0.2%. **Note:** Nitrogen levels, however, can be lower on light-cropping trees.
	High	> 2.1	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate or renovative pruning was performed the previous winter. On mature trees with adequate shoot growth and a normal crop, eliminate nitrogen application next year and retest next growing season. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.

Fresh Market Cultivars: Delicious, Fuji, Braeburn

N (cont.)	Low	1.6 - 2.2	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.
	Normal	2.2 - 2.25	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. During the early-bearing years, N levels should range between 2.2 and 2.4. Fruit destined for fresh market will have better color and firmness if N levels are reduced by 0.2%. **Note:** Nitrogen levels, however, can be lower on light-cropping trees.
	High	> 2.25	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate or renovative pruning was performed the previous winter. On mature trees with adequate shoot growth and a normal crop, eliminate nitrogen application next year and retest next growing season. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.

Processed and Fresh Market Cultivars: York Imperial, Rome Beauty, Stayman

	Low	1.6 - 2.2	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.
	Normal	2.2 - 2.4	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. During the early-bearing years, N levels should range between 2.2 and 2.6. Fruit destined for fresh market will have better color and firmness if N levels are reduced by 0.2%. **Note:** Nitrogen levels, however, can be lower on light-cropping trees.

N (cont'd)	High	> 2.4	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate or renovative pruning was performed the previous winter. On mature trees with adequate shoot growth and a normal crop, eliminate nitrogen application next year and retest next growing season. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 18 inches of shoot growth per year. **Note**: Nitrogen levels, however, can be lower on light-cropping trees.
P	Deficient	< 0.11	Phosphorus is very low.	Broadcast 150 lbs. P_2O_5 per acre as soon as convenient. Retest next year. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.11 - 0.15	Phosphorus is low.	Broadcast 125 1bs. P_2O_5 per acre as soon as convenient. However, unless phosphorus is incorporated it is unlikely you will see a response to surface-applied P on trees older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.15 - 0.31	Phosphorus is adequate.	No further application is needed at this time.
	High	> 0.31	Phosphorus is above normal.	If using a complete fertilizer, discontinue its use. Above normal levels of phosphorus can increase problems of zinc and copper deficiency.
K	Deficient	< 0.70	Potassium is very low.	Broadcast 125 lbs. K_2O per acre as soon as convenient. Retest next year.
	Low	0.70 - 1.2	Potassium is low.	Potassium levels can be 0.4% lower than normal during a dry summer or during years of heavy cropping. Broadcast 100 lbs. K_2O per acre as soon as convenient. Note that if the cultivar is York Imperial, no potassium application is needed unless the level is below 1.0%.
	Normal	1.2 - 2.01	Potassium is adequate.	No further application is needed at this time. If tree density is greater than 500 trees per acre, potassium levels need to be monitored closely due to heavy cropping.
	High	> 2.01	Potassium is above normal.	If using a complete fertilizer, discontinue its use. Excess potassium will compete with calcium and magnesium for uptake by the trees.
Ca	Deficient	<0.31	Calcium is very low	Soil test for possible low pH and apply high calcium lime as needed. If pH is normal, apply calcium chloride foliarly if bitter pit or corking has been a problem in processing apples such as York (15-50 lbs. per acre per year in cover sprays 1 through 7). For other situations, apply Solubor® at petal fall (1 lb. per acre).

Ca (cont'd)	Low	0.31 - 1.3	Calcium is low.	Soil test for possible low pH and apply high calcium lime as needed. If pH is normal, apply calcium chloride foliarly if bitter pit or corking has been a problem in processing apples such as York (15-50 lbs. per acre per year in cover sprays 1 though 7). For other situations, apply Solubor® at petal fall (1 lb. per acre). Low calcium and high potassium and/or magnesium may indicate too much potassium and/or magnesium is absorbed rather than low calcium.
	Normal	1.3 - 3.01	Calcium is adequate.	Apply calcium chloride in cover sprays if corking or bitter pit has been a problem in the past in processing varieties such as York. Calcium levels can be inflated by 0.25% during years of heavy-cropping. Therefore in those years, if your levels are close to the lower sufficiency range of 1.30%, be sure to continue with any foliar applications of calcium during the coming growing season.
	High	> 3.01	Calcium is above normal.	
Mg	Deficient	< 0.03	Magnesium is very low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Low	0.03 - 0.20	Magnesium is low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Normal	0.20 - 0.41	Magnesium is adequate.	If lime is needed based on soil test results apply a high calcium lime.
Mg (contd)	High	> 0.41	Magnesium is above normal.	Excess magnesium competes with calcium and potassium for uptake by the plants. Therefore, avoid the use of dolomitic lime.
S	Deficient	< 0.11	Sulfur is very low.	
	Low	0.11 - 0.20	Sulfur is low.	
	Normal	0.20 - 0.41	Sulfur is adequate.	
	High	> 0.41	Sulfur is above normal.	

Mn	Deficient	< 5	Manganese is very low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Low	5 - 22	Manganese is low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Normal	22 - 141	Manganese is adequate.	
	High	> 141	Manganese is above normal.	This most likely indicates a low soil pH. Soil test and apply lime accordingly. If phosphorus and potassium are low and manganese is above normal this usually indicates low soil pH; however, if they are not below normal it is also possible that the high level may be due to a spray residue contamination.
Fe	Deficient	< 25	Iron is very low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Low	25 - 40	Iron is low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Normal	40 - 101	Iron is adequate.	
	High	101 - 252	Iron is above normal.	High levels can also be the result of spray residue.
Nutrient	**Level**	**Concentration**	**Interpretation**	**Recommendation**
Cu	Deficient	< 4	Copper is very low.	Apply 0.9 to 1.3 lbs. per acre of actual copper during the dormant season or after the fruit is off but the leaves are still active and green. Another method would be to apply a copper sterilant in a fireblight control program.
	Low	4 - 6	Copper is low.	Apply 0.9 to 1.3 lbs. per acre of actual copper during the dormant season or after the fruit is off but the leaves are still active and green. Another method would be to apply a copper sterilant in a fireblight control program.
	Normal	6 - 26	Copper is adequate.	
	High	26 - 202	Copper is above normal.	High levels can also be the result of spray residue.

B	Deficient	< 11	Boron is very low.	Make two applications of 0.8 lbs. per acre of actual boron (4 lbs. per acre of Solubor®, 20.5% B) as a bloom and petal fall spray or a single post-harvest foliar spray of 1.6 lbs. of actual boron. Do not exceed 1.6 lbs. per acre per year. For trees more than 3 years old apply boron annually to the soil. Apply 0.12 lbs. of actual boron per acre for 4-year old trees. For each additional year of tree age, up to 16 years, increase the rate by 0.06 lbs. per acre of actual boron. Retest the block next season.
	Low	11 - 35	Boron is low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. per acre of Solubor®, 20.5% B) in two separate sprays at bloom, petal fall or first cover or apply a single post-harvest foliar spray of 1.6 lbs. per acre of actual boron. For trees more than 3 years old, apply boron annually to the soil. Apply 0.12 lbs. of actual boron per acre for 4-year old trees. For each additional year of tree age, up to 16 years, increase the rate by 0.06 lbs. per acre of actual boron.
	Normal	35 - 81	Boron is adequate.	Boron should be applied as an annual maintenance program. Each year apply a single spray of 1.0 lbs. of Solubor® (20.5% B) per 100 gallons sometime during the period of full bloom through the first cover spray. For trees more than 3 years old, apply boron annually to the soil. Apply 0.12 lbs. of actual boron per acre for 4-year old trees. For each additional year of tree age, up to 16 years, increase the rate by 0.06 lbs. per acre of actual boron.
	High	> 81	Boron is above normal.	Do not apply boron fertilizers. Watch for toxicity symptoms, e.g. earlier fruit maturation, serious internal breakdown, shoot abnormalities and defoliation.
Zn	Deficient	< 6	Zinc is very low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Low	6 - 20	Zinc is low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Normal	20 - 200	Zinc is adequate.	
	High	> 200	Zinc is above normal.	High levels can also be the result of spray residue.

Appendix 2: Peach and Nectarine (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 2.00	Nitrogen is very low.	Increase application rate by 50% unless major renovative pruning will be performed this winter, in which case increase application by only 25%. To minimize over-application, make two applications using half the total recommended rate at bloom time and the second half after the crop has been set (30 - 45 days after bloom). Values lower than 1.99% may indicate other problems. Examine the trees closely and retest next year. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Low	2.00 - 2.50	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. To minimize over-application, make two applications using half the total recommended rate at bloom time and the second half after the crop has been set (30 - 45 days after bloom). Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Normal	2.50 - 3.41	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed; the same or a reduction in rate of nitrogen is in order. To minimize over-application, make two applications using half the total recommended rate at bloom time and the second half after the crop has been set (30-45 days after boom). Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	High	> 3.41	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate, crop was light this year or renovative pruning was performed the previous winter. On mature trees with adequate shoot growth and normal crop, eliminate nitrogen application next year and retest next season. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
P	Deficient	< 0.10	Phosphorus is very low.	Broadcast 150 lbs. P_2O_5 per acre as soon as convenient. Retest next year. Values this low indicate the possibility of severe problems. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.10 - 0.15	Phosphorus is low.	Broadcast 125 lbs. P_2O_5 per acre as soon as convenient. However, unless phosphorus is incorporated, it is unlikely you will see a response to surface-applied P on trees older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.

P (cont'd)	Normal	0.15 - 0.31	Phosphorus is adequate.	No further application is needed at this time.
	High	> 0.31	Phosphorus is above normal.	If using a complete fertilizer, discontinue its use. Excessive levels of phosphorus can increase problems of zinc and copper deficiency.
K	Deficient	< 1 .70	Potassium is very low.	Broadcast 125 lbs. K_20 per acre as soon as convenient.
	Low	1.70 - 2.10	Potassium is low.	Potassium levels can be 0.4% lower than normal during a dry summer or during years of heavy-cropping. Broadcast 100 lbs. K_20 per acre as soon as convenient.
	Normal	2.10 - 3.01	Potassium is adequate.	No further application is needed at this time.
	High	> 3.01	Potassium is above normal.	If using a complete fertilizer, discontinue its use. Potassium in excess will compete with calcium and magnesium for uptake by the trees.
Ca	Deficient	< 0.01	Calcium is very low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Low	0.01 - 1.90	Calcium is low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Normal	1.90 - 3.51	Calcium is adequate.	
	High	> 3.51	Calcium is above normal.	
Mg	Deficient	< 0.03	Magnesium is very low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Low	0.03 - 0.30	Magnesium is low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Normal	0.30 - 0.46	Magnesium is adequate.	If lime is needed based on soil test results, apply a high calcium lime.
	High	> 0.46	Magnesium is above normal.	Excess magnesium competes with calcium and potassium for uptake by the plants. Therefore, avoid the use of dolomitic lime.

S	Deficient	< 0.10	Sulfur is very low.	
	Low	0.10 - 0.20	Sulfur is low.	
	Normal	0.20 - 0.41	Sulfur is adequate.	
	High	> 0.41	Sulfur is above normal.	If sulfur is routinely used in cover sprays, the high levels are probably due to spray residue.
Mn	Deficient	< 1	Manganese is very low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Low	1 - 19	Manganese is low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Normal	19 - 151	Manganese is adequate.	
	High	> 151	Manganese is above normal.	This most likely indicates a low soil pH. Soil test and apply lime accordingly. If phosphorus and potassium are low and manganese is above normal, this usually indicates low soil pH; however, if they are not below normal it is also possible that the high level may be due to a spray residue contamination.
Fe	Deficient	<40	Iron is very low.	Under Maryland soil and climatic conditions, an economic return from application of iron is unlikely.
	Low	40-50	Iron is low.	Under Maryland soil and climatic conditions, an economic return from application of iron is unlikely.
	Normal	50-201	Iron is adequate	
	High	201-251	Iron is above normal	High levels can also be the result of spray residue.
Cu	Deficient	<4	Copper is very .low	Apply 0.9 to 1.3 lbs. per acre of actual copper as foliar spray during the dormant season or after the first fruit is off but leaves are still active and green.
	Low	4-6	Copper is low	Apply 0.9 to 1.3 lbs. per acre of actual copper as foliar spray during the dormant season or after the first fruit is off but leaves are still active and green.
	Normal	6-26	Copper is adequate	
	High	26-201	Copper is above normal	High levels can also be the result of spray residue.

B	Deficient	<11	Boron is very low	Make two applications of 0.75 lbs. per acre of actual boron (3 lbs. per acre of Solubor®, 20.5% B) as a bloom and petal fall spray or a single post-harvest foliar spray of 1.5 lbs. of actual boron. Foliar sprays are less likely to induce toxicity symptoms than are soil applications. Do not exceed 1.6 lbs. per acre per year. Retest the block next season.
	Low	11-25	Boron is low	Apply 0.75 lbs. per acre of actual boron (3 lbs. per acre of Solubor®, 20.5% B) as a bloom or post-harvest foliar spray of 1.5 lbs. of actual boron. Foliar sprays are less likely to induce toxicity symptoms than are soil applications. Retest the block next season.
	Normal	25-51	Boron is adequate	
	High	>51	Boron is above normal	Do not apply boron fertilizers. Watch for toxicity symptoms, e.g. necrotic lesions on leaves, crinkling margins and tips of leaves, reduced flower bud formation and ser, and pit splitting.
Zn	Deficient	<6	Zinc is very low	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made any time at a rate of 6.4 to 12.8 lbs. per acre of actual zinc. Ground applications of zinc are nto normally as effective, especially under high soil phosphorus levels.
	Low	6-20	Zinc is low	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made any time at a rate of 6.4 to 12.8 lbs. per acre of actual zinc. Ground applications of zinc are nto normally as effective, especially under high soil phosphorus levels.
	Normal	20-200	Zinc is adequate	
	High	>200	Zinc is above normal	High levels can also be the result of spray residues.

Appendix 3: Pear (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 1 .35	Nitrogen is very low.	Increase application rate by 50% unless major renovative pruning will be performed this winter, in which case increase application by only 25%. Values lower than 1.34% may indicate other problems. Examine the trees closely and retest next year. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 16 inches of shoot growth per year.
	Low	1.35 - 1.60	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 16 inches of shoot growth per year.
	Normal	1.60 - 2.41	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 16 inches of shoot growth per year.
	High	> 2.41	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate, crop was light this year or renovative pruning was performed the previous winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 12 to 16 inches of shoot growth per year.
P	Deficient	< 0.15	Phosphorus is very low.	Broadcast 150 lbs. P_20_5 per acre as soon as convenient. Retest next year. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.15 - 0.18	Phosphorus is low.	Broadcast 125 lbs. P_20_5 per acre as soon as convenient. However, unless phosphorus is incorporated it is unlikely you will see a response to surface-applied P on trees older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.18 - 0.26	Phosphorus is adequate.	No further application is needed at this time.
	High	> 0.26	Phosphorus is above normal.	If using a complete fertilizer, discontinue its use. Excessive levels of phosphorus can increase problems of zinc and copper deficiency.

K	Deficient	< 0.16	Potassium is very low.	Broadcast 125 1bs. K_2O per acre as soon as convenient. Retest next year.
	Low	0.16 - 0.20	Potassium is low.	Broadcast 100 lbs. K_2O per acre as soon as convenient.
	Normal	0.20 - 2.01	Potassium is adequate.	No further application is needed at this time.
	High	> 2.01	Potassium is above normal.	If using a complete fertilizer, discontinue its use. Potassium in excess will compete with calcium and magnesium for uptake by the trees.
Ca	Deficient	< 0.10	Calcium is very low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Low	0.10 - 1.30	Calcium is low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Normal	1.30 - 9.01	Calcium is adequate.	
	High	> 9.01	Calcium is above normal.	
Mg	Deficient	< 0.05	Magnesium is very low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Low	0.05 - 0.30	Magnesium is low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Normal	0.30 - 0.61	Magnesium is adequate.	If lime is needed based on soil test results, apply a high calcium lime.
	High	> 0.61	Magnesium is above normal.	Excess magnesium competes with calcium and potassium for uptake by the plants. Therefore, avoid the use of dolomitic lime.
S	Deficient	< 0.09	Sulfur is very low.	
	Low	0.09 - 0.17	Sulfur is low.	
	Normal	0.17 - 0.26	Sulfur is adequate.	
	High	> 0.26	Sulfur is above normal.	

Mn	Deficient	< 5	Manganese is very low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Low	5 - 20	Manganese is low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Normal	20 - 199	Manganese is adequate.	
	High	> 199	Manganese is above normal.	This most likely indicates a low soil pH. Soil test and apply lime accordingly.
Fe	Deficient	< 40	Iron is very low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Low	40 - 50	Iron is low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Normal	50 - 400	Iron is adequate.	
	High	> 400	Iron is above normal.	
Cu	Deficient	< 2	Copper is very low.	Apply 0.9 to 1.2 lbs. per acre of actual copper during the dormant season or after fruit is off but the leaves are still active and green.
	Low	2 - 6	Copper is low.	Apply 0.9 to 1.2 lbs. per acre of actual copper during the dormant season or after fruit is off but the leaves are still active and green.
	Normal	6 - 25	Copper is adequate.	
	High	> 25	Copper is above normal.	
B	Deficient	< 5	Boron is very low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. of Solubor, 20.5% B) as a foliar spray either during bloom or after harvest while the leaves are still active and green. Ground applications of boron are not normally as effective, or as easy to apply as the foliar applications.
	Low	5 - 35	Boron is low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. of Solubor, 20.5% B) as a foliar spray either during bloom or after harvest while the leaves are still active and green. Ground applications of boron are not normally as effective, or as easy to apply as the foliar applications.
	Normal	35 - 80	Boron is adequate.	
	High	> 80	Boron is above normal.	Do not apply foliar or ground applications of boron fertilizers.

Zn	Deficient	< 5	Zinc is very low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Low	5 - 20	Zinc is low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Normal	20 - 200	Zinc is adequate.	
	High	> 200	Zinc is above normal.	

Appendix: 4 Cherry (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 2.00	Nitrogen is very low.	Increase application rate by 50% unless major renovative pruning will be performed this winter, in which case increase application by only 25%. Values lower than 1.80% may indicate other problems. Examine the trees closely and retest next year. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Low	2.00 - 2.30	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Normal	2.30 - 3.31	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	High	> 3.31	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate, crop was light this year or renovative pruning was performed the previous winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
P	Deficient	< 0.20	Phosphorus is very low.	Broadcast 150 lbs. P_20_5 per acre as soon as convenient. Retest next year. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.20 - 0.23	Phosphorus is low.	Broadcast 125 1bs. P_20_5 per acre as soon as convenient. However, unless phosphorus is incorporated it is unlikely you will see a response to surface-applied P on trees older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.23 - 0.38	Phosphorus is adequate.	No further application is needed at this time.
	High	> 0.38	Phosphorus is above normal.	If using a complete fertilizer discontinue its use. Excessive levels of phosphorus can increase problems of zinc and copper deficiency.

K	Deficient	< 0.80	Potassium is very low.	Broadcast 125 1bs. K_2O per acre as soon as convenient. Retest next year.
	Low	0.80 - 1.00	Potassium is low.	Broadcast 100 lbs. K_2O per acre as soon as convenient.
	Normal	1.00 - 1.91	Potassium is adequate.	No further application is needed at this time.
	High	> 1.91	Potassium is above normal.	If using a complete fertilizer discontinue its use. Potassium in excess will compete with calcium and magnesium for uptake by the trees.
Ca	Deficient	< 0.30	Calcium is very low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Low	0.30 - 1.60	Calcium is low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Normal	1.60 - 9.01	Calcium is adequate.	
	High	> 9.01	Calcium is above normal.	
Mg	Deficient	< 0.03	Magnesium is very low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Low	0.03 - 0.49	Magnesium is low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Normal	0.49 - 0.65	Magnesium is adequate.	If lime is needed based on soil test results apply a high calcium lime.
	High	> 0.65	Magnesium is above normal.	Excess magnesium competes with calcium and potassium for uptake by the plants. Therefore, avoid the use of dolomitic lime.
S	Deficient	< 0.10	Sulfur is very low.	
	Low	0.10 - 0.15	Sulfur is low.	
	Normal	0.15 - 0.50	Sulfur is adequate.	
	High	> 0.50	Sulfur is above normal.	

Mn	Deficient	< 5	Manganese is very low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Low	5 - 18	Manganese is low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as a foliar spray during the dormant season or after fruit is off but the leaves are still active and green.
	Normal	18 - 150	Manganese is adequate.	
	High	> 150	Manganese is above normal.	This may indicate a low soil pH. Soil test and apply lime accordingly. If a recent soil test indicates normal pH, the high manganese is probably the result of spray residue contamination.
Fe	Deficient	< 40	Iron is very low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Low	40 - 50	Iron is low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Normal	50 - 400	Iron is adequate.	
	High	> 400	Iron is above normal.	
Cu	Deficient	< 1	Copper is very low.	Apply 0.9 to 1.3 lbs. per acre of actual copper during the dormant season or after fruit is off but the leaves are still active and green.
	Low	1 - 6	Copper is low.	Apply 0.9 to 1.3 lbs. per acre of actual copper during the dormant season or after fruit is off but the leaves are still active and green.
	Normal	6 - 26	Copper is adequate.	
	High	> 26	Copper is above normal.	

B	Deficient	< 5	Boron is very low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. per acre of Solubor®, 20.5% B) as a foliar spray either during bloom or after harvest while the leaves are still active and green. Ground applications of boron are not normally as effective or as easy to apply as the foliar applications.
	Low	5 - 39	Boron is low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. per acre of Solubor®, 20.5% B) as a foliar spray either during bloom or after harvest while the leaves are still active and green. Ground applications of boron are not normally as effective or as easy to apply as the foliar applications.
	Normal	39 - 81	Boron is adequate.	
	High	> 81	Boron is above normal.	Do not apply foliar or ground applications of boron fertilizers.
Zn	Deficient	< 5	Zinc is very low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Low	5 - 20	Zinc is low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc.
	Normal	20 - 200	Zinc is adequate.	
	High	> 200	Zinc is above normal.	

Appendix 5: Plum (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 1.60	Nitrogen is very low.	Increase application rate by 50% unless major renovative pruning will be performed this winter, in which case increase application by only 25%. Values lower than 1.39% may indicate other problems. Examine the trees closely and retest next year. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Low	1 .60 - 1.80	Nitrogen is low.	Increase application rate by 25% unless shoot growth was excessive or if major renovative pruning will be performed this winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	Normal	1.80 - 2.61	Nitrogen is adequate.	Continue past practices if terminal growth was adequate and fruit color satisfactory. If terminal growth was excessive, fruit color inadequate or major renovative pruning was performed, the same or a reduction in rate of application of nitrogen is in order. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
	High	> 2.61	Nitrogen is above normal.	Reduce rate of application unless shoot growth was inadequate, crop was light this year or renovative pruning was performed the previous winter. Shoot growth can help determine your nitrogen program. Bearing trees should have 18 to 24 inches of shoot growth per year.
P	Deficient	< 0.07	Phosphorus is very low.	Broadcast 150 lbs. P_20_5 per acre as soon as convenient. Retest next year. Values this low indicate the possibility of severe problems. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.07 - 0.09	Phosphorus is low.	Broadcast 125 1bs. P_20_5 per acre as soon as convenient. However, unless phosphorus is incorporated it is unlikely you will see a response to surface-applied P on trees older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.09 - 0.30	Phosphorus is adequate.	No further application is needed at this time.
	High	> 0.30	Phosphorus is above normal.	If using a complete fertilizer discontinue its use. Excessive levels of phosphorus can increase problems of zinc and copper deficiency.

K	Deficient	< 1 .05	Potassium is very low.	Broadcast 125 1bs. K_2O per acre as soon as convenient. Retest next year.
	Low	1.05 - 1.10	Potassium is low.	Broadcast 100 lbs. K_2O per acre as soon as convenient.
	Normal	1.10 - 2.91	Potassium is adequate.	No further application is needed at this time.
	High	> 2.91	Potassium is above normal.	If using a complete fertilizer, discontinue its use. Potassium in excess will compete with calcium and magnesium for uptake by the trees.
Ca	Deficient	< 0.10	Calcium is very low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Low	0.10 - 1.00	Calcium is low.	Soil test for possible low pH and apply high calcium lime as needed. Calcium uptake may also be limited by high levels of potassium or magnesium.
	Normal	1.00 - 9.01	Calcium is adequate.	
	High	> 9.01	Calcium is above normal.	
Mg	Deficient	< 0.03	Magnesium is very low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Low	0.03 - 0.20	Magnesium is low.	Soil test for possible low pH and apply magnesium as recommended. If soil test does not indicate a magnesium recommendation, apply 15 lbs. magnesium sulfate (11% Mg) foliarly at petal fall.
	Normal	0.20 - 0.46	Magnesium is adequate.	If lime is needed based on soil test results apply a high calcium lime.
Mg (cont.)	High	> 0.46	Magnesium is above normal.	Excess magnesium competes with calcium and potassium for uptake by the plants. Therefore, avoid the use of dolomitic lime.
S	Deficient	< 0.10	Sulfur is very low.	
	Low	0.10 - 0.15	Sulfur is low.	
	Normal	0.15 - 0.50	Sulfur is adequate.	
	High	> 0.50	Sulfur is above normal.	

Mn	Deficient	< 5	Manganese is very low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Low	5 - 17	Manganese is low.	Apply 0.5 to 1.2 lbs. per acre of actual manganese as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Normal	17 - 200	Manganese is adequate.	
	High	> 200	Manganese is above normal.	This most likely indicates a low soil pH. Soil test and apply lime accordingly.
Fe	Deficient	< 40	Iron is very low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Low	40 - 50	Iron is low.	Under Maryland soil and climatic conditions, an economic return from the application of iron is unlikely.
	Normal	50 - 400	Iron is adequate.	
	High	> 400	Iron is above normal.	
Cu	Deficient	< 1	Copper is very low.	Apply 0.9 to 1.3 lbs. per acre of actual copper as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Low	1 - 6	Copper is low.	Apply 0.9 to 1.3 lbs. per acre of actual copper as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green.
	Normal	6 - 26	Copper is adequate.	
	High	> 26	Copper is above normal.	

B	Deficient	< 5	Boron is very low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. per acre of Solubor®, 20.5% B) as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green. Ground applications of boron are not normally as effective or as easy to apply as the foliar applications.
	Low	5 - 31	Boron is low.	Apply 0.8 to 1.6 lbs. per acre of actual boron (4 to 8 lbs. per acre of Solubor®, 20.5% B) as foliar spray during the dormant season or after the fruit is off but the leaves are still active and green. Ground applications of boron are not normally as effective or as easy to apply as the foliar applications.
	Normal	31 - 81	Boron is adequate.	
	High	> 81	Boron is above normal.	Do not apply foliar or ground applications of boron fertilizers.
Zn	Deficient	< 5	Zinc is very low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc. Ground applications of zinc are not normally as effective, especially under high soil phosphorus levels.
	Low	5 - 20	Zinc is low.	Apply 3.2 lbs. per acre of actual zinc as a foliar spray after harvest while the leaves are still active and green or in the dormant season before the buds break. Broadcast soil applications of zinc can be made anytime at a rate of 6.4 to 12.8 lbs. per acre of actual zinc. Ground applications of zinc are not normally as effective, especially under high soil phosphorus levels.
	Normal	20 - 200	Zinc is adequate.	
	High	> 200	Zinc is above normal.	

Appendix 6: Blueberry (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 1.65	Nitrogen is very low.	Increase rate of nitrogen application by 10% for each 0.1% the sample is below desired level. If soil pH is above 5.0, use ammonium sulfate; if below 5.0, use urea. Do not use ammonium nitrate or chloride fertilizers. Apply no later than April 20.
	Low	1.65 - 1.70	Nitrogen is low.	Increase rate of nitrogen application by 10% for each 0.1% the sample is below desired level. If soil pH is above 5.0, use ammonium sulfate; if below 5.0, use urea. Do not use ammonium nitrate or chloride fertilizers. Apply no later than April 20.
	Normal	1.70 - 2.10	Nitrogen is adequate.	No alteration of present program is necessary.
	High	> 2.10	Nitrogen is above normal.	Reduce rate of nitrogen application by 10% for each 0.1% the sample exceeds desired level. If soil pH is above 5.0, use ammonium sulfate; if below 5.0, use urea. Do not use ammonium nitrate or chloride fertilizers.
P	Deficient	< 0.06	Phosphorus is very low.	Apply 180 lbs. per acre of triple superphosphate (0-46-0) at any time. Retest next year. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.06 - 0.07	Phosphorus is low.	Apply 180 lbs. per acre of triple superphosphate (0-46-0) at any time. However, unless phosphorus is incorporated it is unlikely you will see a response to surface-applied P on bushes older than 5 years. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.07 - 0.18	Phosphorus is adequate.	No alteration of present program is necessary.
	High	> 0.18	Phosphorus is above normal.	Omit phosphate from fertilizer program.
K	Deficient	< 0.35	Potassium is very low.	Apply 400 lbs. per acre sulfate of potassium-magnesia or 160 lbs. per acre potassium sulfate in fall or early spring.
	Low	0.35 - 0.40	Potassium is low.	Apply 400 lbs. per acre sulfate of potassium-magnesia or 160 lbs. per acre potassium sulfate in fall or early spring.

K (cont'd)	Normal	0.40 - 0.65	Potassium is adequate.	If potassium/magnesium ratio > 4.00, omit potassium from your fertilization program to improve the balance between potassium and magnesium in your plants.
	High	> 0.65	Potassium is above normal.	Omit potassium from fertilization program.
Ca	Deficient	< 0.25	Calcium is very low.	Refer to soil test and apply lime as needed if soil pH is below 4.0. Apply 1000 lbs. per acre of calcium sulfate in fall or early spring if pH is above 4.0.
	Low	0.25 - 0.30	Calcium is low.	Refer to soil test and apply lime as needed if soil pH is below 4.0. Apply 1000 lbs. per acre of calcium sulfate in fall or early spring if pH is above 4.0.
	Normal	0.30 - 0.80	Calcium is adequate.	No alteration of present program is necessary.
	High	> 0.80	Calcium is above normal.	Refer to soil test for pH adjustment.
Mg	Deficient	< 0.18	Magnesium is very low.	Refer to soil test and apply dolomitic limestone if pH is below 4.0. If pH is above 4.0, apply 250 lbs. per acre of magnesium sulfate or use 400 lbs. per acre sulfate of potassium-magnesia if potassium is also low. Apply in fall or early spring.
	Low	0.18 - 0.20	Magnesium is low.	Refer to soil test and apply dolomitic limestone if pH is below 4.0. If pH is above 4.0, apply 250 lbs. per acre of magnesium sulfate or use 400 lbs. per acre sulfate of potassium-magnesia if potassium is also low. Apply in fall or early spring.
	Normal	0.20 - 0.30	Magnesium is adequate.	If potassium/magnesium ratio is > 5.00, increase magnesium application to a total of 80 lbs. per acre actual magnesium to improve the balance between potassium and magnesium.
	High	> 0.30	Magnesium is above normal.	May indicate high soil pH. Refer to soil test.
S	Deficient	< 0.06	Sulfur is very low.	
	Low	0.06 - 0.12	Sulfur is low.	
	Normal	0.12 - 0.20	Sulfur is adequate.	No alteration of present program is necessary.
	High	> 0.20	Sulfur is above normal.	

Mn	Deficient	< 45	Manganese is very low.	Apply a foliar spray of 6 lbs. per 100 gal per acre of manganese chelate twice during the growing season. If product label is different from this recommendation, follow label recommendations.
	Low	45 - 50	Manganese is low.	Apply a foliar spray of 6 lbs. per 100 gal per acre of manganese chelate twice during the growing season. If product label is different from this recommendation, follow label recommendations.
	Normal	50 - 500	Manganese is adequate.	No alteration of present program is necessary.
	High	> 500	Manganese is above normal.	Refer to soil test for possible pH adjustment.
Fe	Deficient	< 65	Iron is very low.	Apply a foliar spray of 6 lbs. per 100 gal per acre of iron chelate in late summer and again after bloom the following year, but check product label and follow its recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 25 lbs. per acre of iron chelate or 15 lbs. per acre of ferrous sulfate to soil in early spring. If product label is different from this recommendation, follow label recommendation.
	Low	65 - 70	Iron is low.	Apply a foliar spray of 6 lbs. per 100 gal per acre of iron chelate in late summer and again after bloom the following year, but check product label and follow its recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 25 lbs. per acre of iron chelate or 15 lbs. per acre of ferrous sulfate to soil in early spring. If product label is different from this recommendation, follow label recommendation.
	Normal	70 - 300	Iron is adequate.	No alteration of present program is necessary.
	High	> 300	Iron is above normal.	No application necessary.
Cu	Deficient	< 4	Copper is very low.	Apply a post-bloom and post-harvest spray of 2 lbs. per 100 gal per acre of copper chelate. If product label is different from this recommendation, follow label recommendation.
	Low	4 - 5	Copper is low.	Apply a post-bloom and post-harvest spray of 2 lbs. per 100 gal per acre of copper chelate. If product label is different from this recommendation, follow label recommendation.
	Normal	5 - 15	Copper is adequate.	No alteration of present program is necessary.
	High	> 15	Copper is above normal.	No application necessary.

B	Deficient	< 29	Boron is very low.	Apply 1.5 lbs. per 100 gal per acre Solubor® (20.5% B) as a foliar spray in late summer and again during early bloom. If product label is different from this recommendation, follow label recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 5 lbs. per acre Solubor® to soil surface in early spring.
	Low	29 - 30	Boron is low.	Apply 1.5 lbs. per 100 gal per acre Solubor® (20.5% B) as a foliar spray in late summer and again during early bloom. If product label is different from this recommendation, follow label recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 5 lbs. per acre Solubor® to soil surface in early spring.
	Normal	30 - 50	Boron is adequate.	No alteration of present program is necessary.
	High	> 50	Boron is above normal.	Consult Extension agricultural science educator or small fruit specialist if over 100 ppm.
Zn	Deficient	< 9	Zinc is very low.	Apply 2 lbs. per 100 gal per acre zinc chelate post-bloom, post-harvest and late summer. If product label is different from this recommendation, follow label recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 10 lbs. per acre zinc sulfate to soil surface in early spring.
	Low	9 - 15	Zinc is low.	Apply 2 lbs. per 100 gal per acre zinc chelate post-bloom, post-harvest and late summer. If product label is different from this recommendation, follow label recommendation. If condition persists for several consecutive years and soil pH is within desired range (4.5 - 5.0), apply 10 lbs. per acre zinc sulfate to soil surface in early spring.
	Normal	15 - 30	Zinc is adequate.	No alteration of present program is necessary.
	High	> 30	Zinc is above normal.	No application necessary.

Appendix 7: Brambles (Any)

Nutrient	Level	Concentration	Interpretation	Recommendation
N	Deficient	< 1 .80	Nitrogen is very low.	Increase rate of nitrogen application by 10% for each 0.1% the sample is below desired level. Fall fruit types should be near the high end of the range. The best source of nitrogen is ammonium nitrate or calcium nitrate. Apply nitrogen prior to April 20.
	Low	1.80 - 2.00	Nitrogen is low.	Increase rate of nitrogen application by 10% for each 0.1% the sample is below desired level. Fall fruit types should be near the high end of the range. The best source of nitrogen is ammonium nitrate or calcium nitrate. Apply nitrogen prior to April 20.
	Normal	2.00 - 3.00	Nitrogen is adequate.	No alteration of present program is necessary.
	High	> 3.00	Nitrogen is above normal.	Reduce rate of nitrogen application by 10% for each 0.1% the sample exceeds desired level.
P	Deficient	< 0.23	Phosphorus is very low.	Apply 200 lbs. per acre triple superphosphate (0-46-0) at any time to soil surface. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Low	0.23 - 0.25	Phosphorus is low.	Apply 200 lbs. per acre triple superphosphate (0-46-0) at any time to soil surface. In Maryland, the Phosphorus Site Index must be performed before adding any phosphate-bearing fertilizers when soil test FIV-P is 150 or greater.
	Normal	0.25 - 0.40	Phosphorus is adequate.	No alteration of present program is necessary.
	High	> 0.40	Phosphorus is above normal.	Omit phosphate from fertilizer program.
K	Deficient	< 1.45	Potassium is very low.	Apply 50, 55, 75, 95 or 110 lbs. per acre K_2O for soil textural classes clays (including silty and sandy clays), clay loams (including sandy and silty clay loams), silt loam and loam, sandy loams and sands/loamy sands, respectively. If magnesium is also low, sulfate of potassium-magnesia may also be used at 2.5 times the above rates. Do not use muriate of potash.
	Low	1 .45 - 1.50	Potassium is low.	Apply 50, 55, 75, 95 or 110 lbs. per acre K_2O for soil textural classes clays (including silty and sandy clays), clay loams (including sandy and silty clay loams), silt loam and loam, sandy loams and sands/loamy sands, respectively.
	Normal	1.50 - 2.50	Potassium is adequate.	No alteration of present program is necessary.
	High	> 2.50	Potassium is above normal.	Discontinue use of potassium fertilizer.

Nutrient	Level	Concentration	Interpretation	Recommendation
Ca	Deficient	< 0.57	Calcium is very low.	Apply lime as needed if pH is less than 6.0. See soil test recommendation for adjustment of soil pH. If pH is greater than 6.0, apply 1000 lbs. per acre calcium sulfate.
	Low	0.57 - 0.60	Calcium is low.	Apply lime as needed if pH is less than 6.0. See soil test recommendation for adjustment of soil pH. If pH is greater than 6.0, apply 1000 lbs. per acre calcium sulfate.
	Normal	0.60 - 2.50	Calcium is adequate.	No alteration of present program is necessary.
	High	> 2.50	Calcium is above normal.	May indicate a higher than optimal soil pH.
Mg	Deficient	< 0.27	Magnesium is very low.	If pH is below 6.0, apply dolomitic limestone according to soil test recommendation. If not, apply 200 lbs. per acre magnesium sulfate OR sulfate of potassium-magnesia to soil surface in late fall or early spring. Three foliar sprays of magnesium sulfate at 15 lbs. per 100 gal per acre at leaf expansion, after harvest and in late summer will temporarily correct the deficiency.
	Low	0.27 - 0.30	Magnesium is low.	If pH is below 6.0, apply dolomitic limestone according to soil test recommendation. If not, apply 200 lbs. per acre magnesium sulfate OR sulfate of potassium-magnesia to soil surface in late fall or early spring. Three foliar sprays of magnesium sulfate at 15 lbs. per 100 gal per acre at leaf expansion, after harvest and in late summer will temporarily correct the deficiency.
	Normal	0.30 - 0.90	Magnesium is adequate.	No alteration of present program is necessary.
	High	> 0.90	Magnesium is above normal.	Omit use of magnesium.
S	Deficient	< 0.11	Sulfur is very low.	
	Low	0.11 - 0.21	Sulfur is low.	
	Normal	0.21 - 0.51	Sulfur is adequate.	No alteration of present program is necessary.
	High	> 0.51	Sulfur is above normal.	

Mn	Deficient	< 45	Manganese is very low.	Apply a spray of manganese sulfate (2 lbs. per 100 gal per acre) or manganese chelate (6 lbs. per 100 gal per acre) after harvest but before September 15. Check soil pH. For fall fruiting types, apply in June.
	Low	45 - 50	Manganese is low.	Apply a spray of manganese sulfate (2 lbs. per 100 gal per acre) or manganese chelate (6 lbs. per 100 gal per acre) after harvest but before September 15. Check soil pH. For fall fruiting types, apply in June.
	Normal	50 - 200	Manganese is adequate.	No alteration of present program is necessary.
	High	> 200	Manganese is above normal.	May indicate a low soil pH or contamination by fungicide of irrigation water. Consult soil test recommendations to determine need for lime.
Fe	Deficient	< 48	Iron is very low.	Apply 4 lbs. per 100 gal per acre ferrous sulfate or 8 lbs. per 100 gal per acre iron chelate as a foliar spray between harvest and September 15. For fall fruiting types, apply in June. If condition persists for several consecutive years and soil pH is within desired range, apply 25 lbs. per acre iron chelate or 15 lbs. per acre ferrous sulfate to soil in early spring.
	Low	48 - 50	Iron is low.	Apply 4 lbs. per 100 gal per acre ferrous sulfate or 8 lbs. per 100 gal per acre iron chelate as a foliar spray between harvest and September 15. For fall fruiting types, apply in June. If condition persists for several consecutive years and soil pH is within desired range, apply 25 lbs. per acre iron chelate or 15 lbs. per acre ferrous sulfate to soil in early spring.
	Normal	50 - 200	Iron is adequate.	No alteration of present program is necessary.
	High	> 200	Iron is above normal.	May be toxic if levels exceed 250 ppm. Contamination from sprays may give artificially high readings.
Cu	Deficient	< 6	Copper is very low.	Apply copper chelate (4 lbs. per 100 gal per acre) in a foliar spray during leaf expansion in May. If condition persists for several consecutive years and soil pH is within desired range, apply 20 lbs. per acre copper sulfate to soil in late fall.
	Low	6 - 7	Copper is low.	Apply copper chelate (4 lbs. per 100 gal per acre) in a foliar spray during leaf expansion in May. If condition persists for several consecutive years and soil pH is within desired range, apply 20 lbs. per acre copper sulfate to soil in late fall.
	Normal	7 - 50	Copper is adequate.	No alteration of present program is necessary.
	High	> 50	Copper is above normal.	May indicate low soil pH or contamination from sprays. Consult soil test recommendations to determine the need for lime.

B	Deficient	< 28	Boron is very low.	Apply Solubor® to the soil in early spring at 4 lbs. per acre OR apply a foliar spray of Solubor® (20.5% B) at the rate of 1.5 lbs. per 100 gal per acre in early spring. For summer bearers, apply again after harvest.
	Low	28 - 30	Boron is low.	Apply Solubor® to the soil in early spring at 4 lbs. per acre OR apply a foliar spray of Solubor® (20.5% B) at the rate of 1.5 lbs. per 100 gal per acre in early spring. For summer bearers, apply again after harvest.
	Normal	30 - 50	Boron is adequate.	No alteration of present program is necessary.
	High	> 50	Boron is above normal.	Discontinue use of boron. May be toxic if levels exceed 100 ppm.
Zn	Deficient	< 18	Zinc is very low.	Apply 3 1bs. per 100 gal per acre zinc chelate at leaf expansion and after harvest in a foliar spray. For fall fruit types, apply in May and early July. If condition persists for several consecutive years and soil pH is within desired range, apply 10 lbs. per acre zinc sulfate to the soil in fall.
	Low	18 - 20	Zinc is low.	Apply 3 lbs. per 100 gal per acre zinc chelate at leaf expansion and after harvest in a foliar spray. For fall fruit types, apply in May and early July. If condition persists for several consecutive years and soil pH is within desired range, apply 10 lbs. per acre zinc sulfate to the soil in fall.
	Normal	20 - 50	Zinc is adequate.	No alteration of present program is necessary.
	High	> 50	Zinc is above normal.	May indicate fungicide contamination. Toxicity may occur if levels exceed 300 ppm.