Apple Tree Nutrition

Renae Moran
University of Maine

Nutrition is important for winter hardiness, flower bud development, fruit set, and fruit quality. Most of us know this already and do our best to maintain the nutritional status of our orchards.

In Maine, there are chronic shortages of many important nutrients. The only two nutrients consistently in the optimum range are phosphorus and iron. Nitrogen is mostly optimum, but occasionally on the high side despite lack of fertilization. Potassium and boron are typically low but respond to fertilization.

General Status

Low to Deficient

Calcium
Magnesium
Zinc
Manganese
Copper
Potassium
Boron

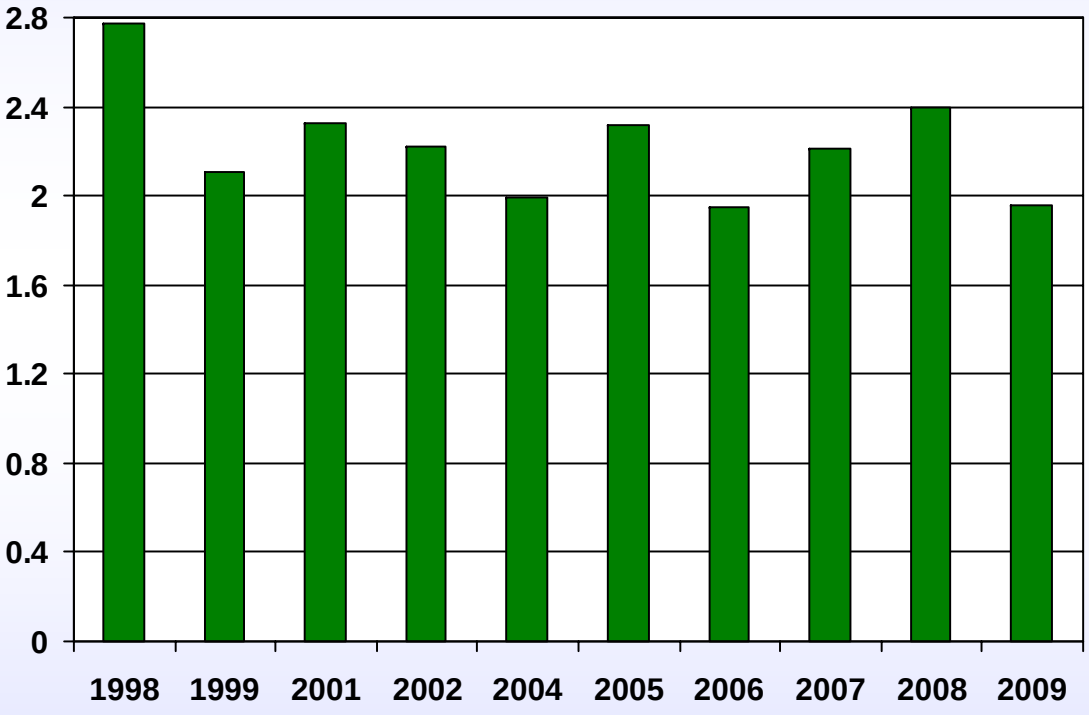
Optimum

Phosphorus
Iron
Nitrogen

For perennial crops, we measure the nutrient status of leaves with occasional soil tests. Soil tests alone do not give the full picture because the tree is sparsely and deeply rooted. Additionally, they take up nutrients over a long period of time and store them for reuse the following season. These factors make soil testing less accurate for apple trees.

Consistent leaf sampling procedure is needed to get results that can be used for comparison with other orchards and with previous years. The best time to collect samples is late July to early August or when shoots stop growing. Collecting samples too early leads to a high nitrogen (N) reading that can be misleading. Sampling too late may indicate deficiency when none exists. Mid shoot leaves from shoots that are one to two feet in length are the ones we use for recommendations. Leaves at the shoot tip will read high in N and at the base of the shoot will read low. Shoots longer than two feet are likely to underestimate N status.

Leaf Nitrogen (%) at the Highmoor Farm



This graph shows leaf nitrogen (N) levels in one orchard over an 11-year period. Trees were fertilized in 2000, 2004 and 2006, but this was not always followed by an immediate increase in N. Weather and tree factors also contribute to changes in N status. Trees with a light crop load have more shoot growth, and this will dilute the N. It usually corrects itself the following year with or without fertilizer. Changes in the amount of N fertilizer can be based on up or down trends over a period of several years rather than the level of leaf N in a particular season.

This orchard is not fertilized every year, but still manages to have N in the optimum to high range. Lack of N fertilizer does not always lead to deficiency because trees store N in their wood and rely on this source in the first part of the growing season. The soil itself will supply a major portion of the N with the mineralization of organic matter.

Determining Nitrogen Need

The amount of nitrogen fertilizer to apply depends on soil fertility. Fertile soils can, in most years, supply enough nitrogen. Soil nitrogen supply for most soils in the Northeast ranges from 30 to 80 lbs. per acre each year. Sandy soils and soils low in organic matter may not provide enough nitrogen. Experience will tell you how much N fertilizer is needed in your orchards to correct any deficits in what the soil can supply.

Tree size also determines the need for nitrogen fertilizer. Standard-sized apple trees have a large framework that uses more nitrogen than smaller trees, generally 100 lbs. per acre. Dwarf fruit trees have a smaller framework and use less nitrogen, as little as 30 lbs. per acre annually.

Suggested Rates of Nitrogen (lbs. per acre)

Relative Soil Fertility	Semidwarf	Dwarf
High	5	None
Good	10	5
Low	20	15
Poor	30	25

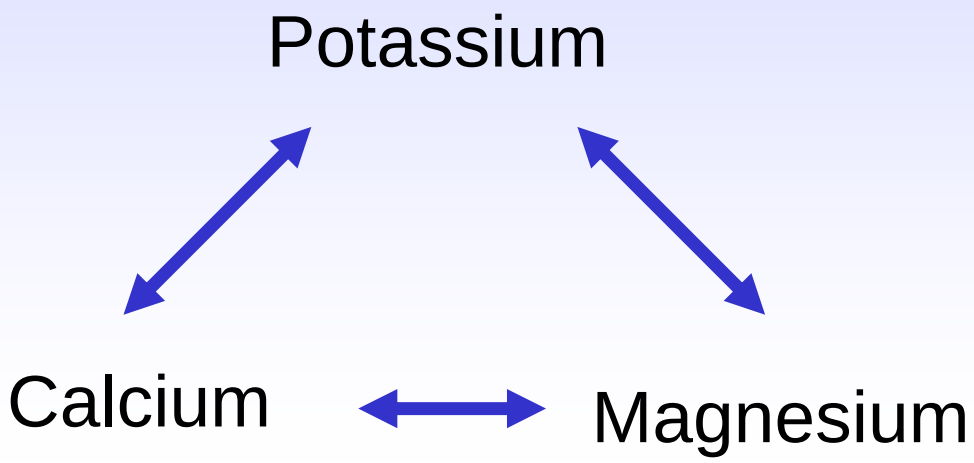
To determine the nitrogen need, consider both tree size and soil fertility. The need for nitrogen will also vary according to cultural practices and weather patterns. Subsequent rates should be adjusted up or down according to leaf analysis.

Nitrogen Fertilizers

	% N	lbs. fertilizer to get 1 lb. N
Urea	45	2.22
Ammonium nitrate	34	2.98
Calcium nitrate	15.5	6.45

Nitrogen recommendations are typically reported as pounds of actual nitrogen per acre. This needs to be converted to pounds of fertilizer. Each type of fertilizer has a different conversion factor depending its nitrogen purity. For example, a recommendation to apply 20 lbs. of actual nitrogen would mean 44 pounds of urea.

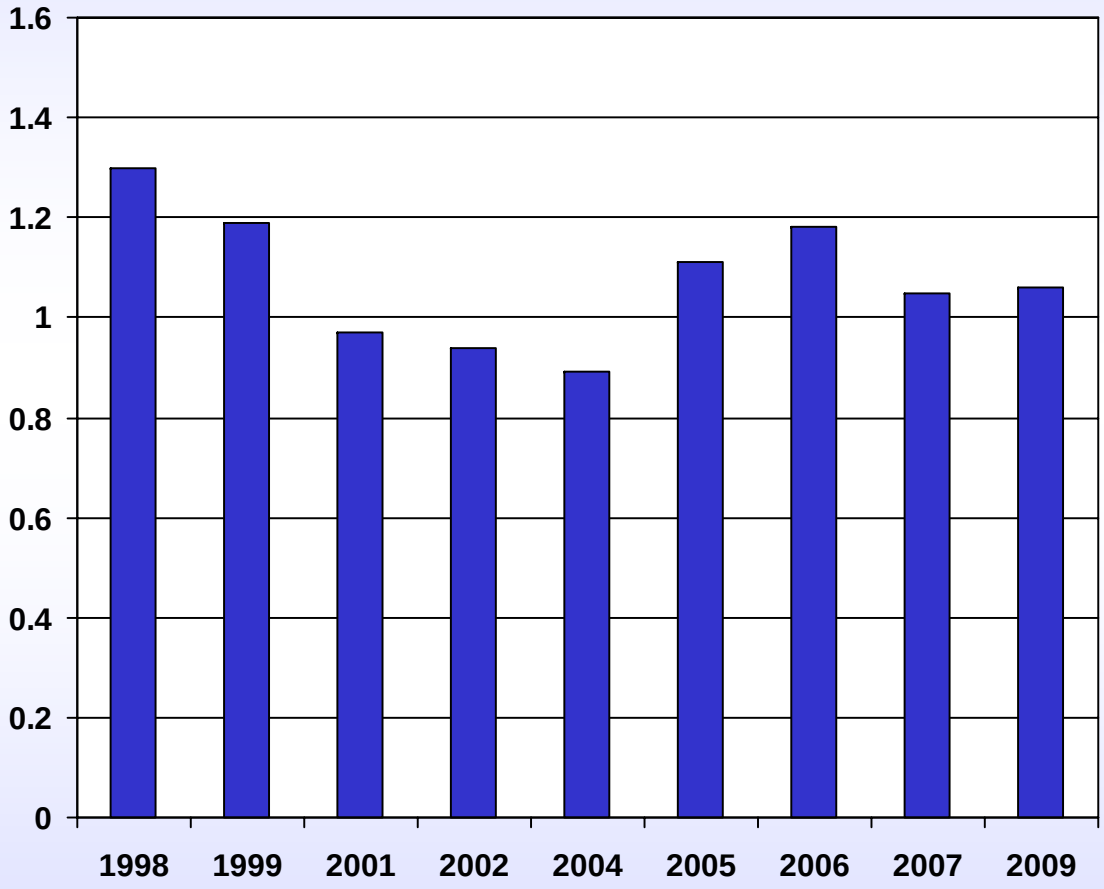
The lab that analyzes your leaf samples will give you a nitrogen requirement based on how much you applied last year if you report this. When they ask for how much nitrogen you applied last year, they are asking for total nitrogen rather than how much fertilizer. In a recommendation, they may adjust this rate up or down depending on your leaf test results. Report the correct amount and specify whether it is straight nitrogen or the type of fertilizer in order to get an appropriate recommendation.



Potassium, calcium and magnesium should be considered together because they have an antagonistic relationship to each other. They compete with each other for entry into plant roots. When one is overabundant, it causes a deficiency in one of the others.

Soils that are high in potassium lead to magnesium deficiency and sometimes low calcium. High levels of magnesium lead to calcium deficiency. A soil test will indicate any imbalances between these three as well as the actual amount in the soil.

Leaf Potassium (%) at the Highmoor Farm



In the example orchard, leaf potassium decreased during the period when the orchard received no potassium fertilizer, 2001 and 2002. This was corrected in 2003 with potassium chloride and in subsequent years with potassium magnesium sulfate. Ground potassium fertilizer moves slowly into the soil and will take a few years to have an effect on foliar levels. Potassium was also low in 2007, a year with a heavy crop, which can deplete potassium.

Potassium Requirement

- Trees need 120 to 200 lbs. of K_2O each year. Half of this ends up in the fruit and is not cycled back to the soil. Consequently, there is a continual depletion of potassium with each harvest.
- Most soils cannot supply all that is needed, so some fertilizer is recommended annually. The amount of potassium fertilizer needed is based on a leaf test.

Suggested fertilizer rate in lbs. of K_2O per acre:

low leaf test <1.3%: *120 - 180*

optimum leaf test 1.3 - 1.8%: *60 – 90*

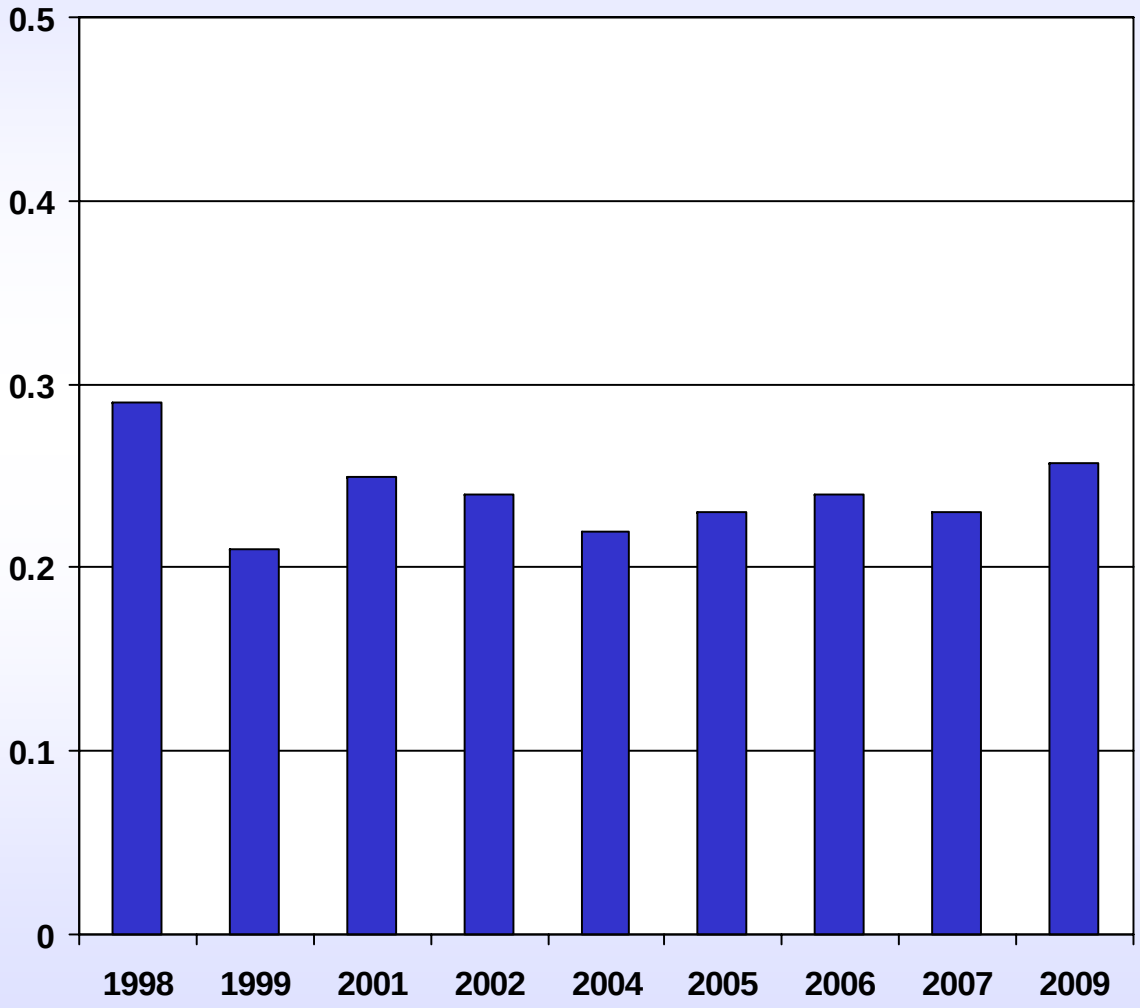
high leaf test >1.8%: *none*

Potassium Fertilizers

	% K_2O	lbs. fertilizer to get 1 lb. K_2O
Potassium chloride	60	1.7
Potassium magnesium sulfate	22	4.5
Potassium nitrate	44	2.25

Choice of potassium fertilizer can be based on the need for both potassium and magnesium. If magnesium levels in the soil are high, select potassium chloride. When magnesium is low to optimum, select potassium-magnesium-sulfate.

Leaf Magnesium (%) at the Highmoor Farm

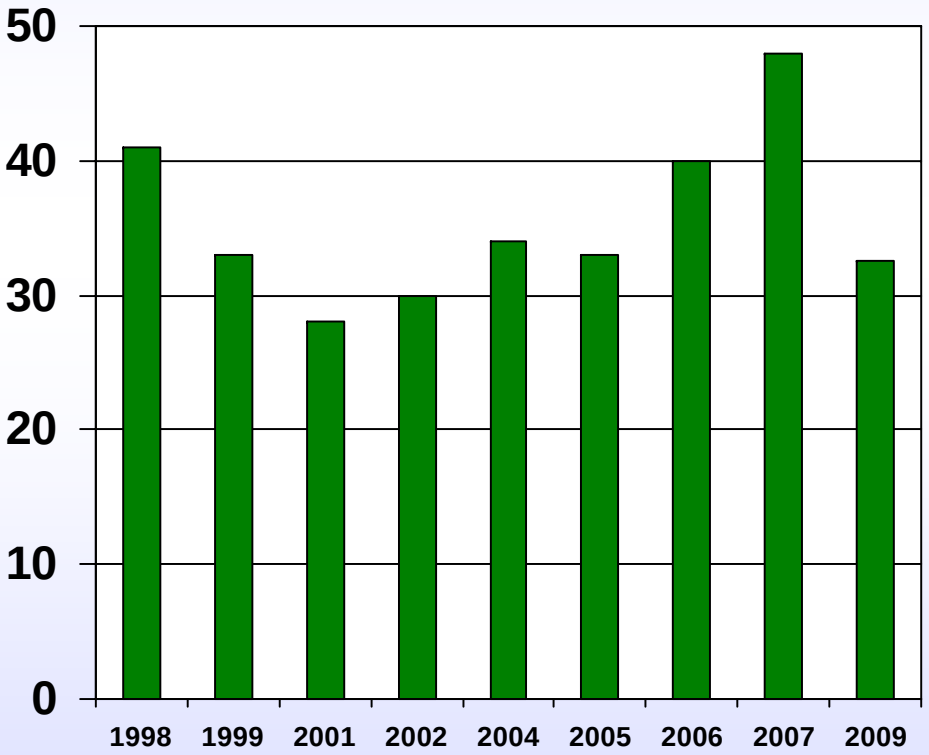


Magnesium has been consistently deficient in this orchard despite annual foliar applications of magnesium sulfate. In 2005 and 2008, magnesium was ground applied with potassium. A soil test indicated too much potassium in relation to magnesium. Our trees need potassium, but not to the detriment of magnesium. Switching to a fertilizer that contains both will prevent this problem.

Calcium levels are dependent on soil moisture, soil pH, and shoot growth, all of which are variable from year to year. In order to ensure sufficient calcium within the fruit, apply a foliar calcium fertilizer such as calcium chloride or calcium nitrate in summer.

Calcium deficiency causes bitter pit in fruit, which resembles the symptoms shown in the photo. Honycrisp and Cortland are highly prone to bitter pit and should receive at least two foliar applications each year, particularly if fruit will be put in storage. Trees that are young in age will produce fruit that is more likely to develop bitter pit.

Leaf Boron (ppm) at the Highmoor Farm



Boron is important for fruit set and root growth. Chronically low boron is common, but seems easier to fix than other problems. This orchard gets consistent soil and foliar applications which has been sufficient to maintain near optimum levels. If boron steadily increases with annual applications, stop applying boron before it reaches 60 ppm to avoid boron toxicity. Leaf boron should in the range of 35 to 50 ppm.

Boron Fertilization

Maintenance Program

Ground: 1 lb. Boron per acre (Solubor 20%, 5 lbs. / acre)

Foliar at pink or in June: 1 lb. Solubor / 100 gal.

A maintenance program will prevent boron deficiencies. Severe deficiency causes corking in the apple flesh, but this level of deficiency is rare. Low to deficient levels usually have a more subtle effect on tree and fruit growth.

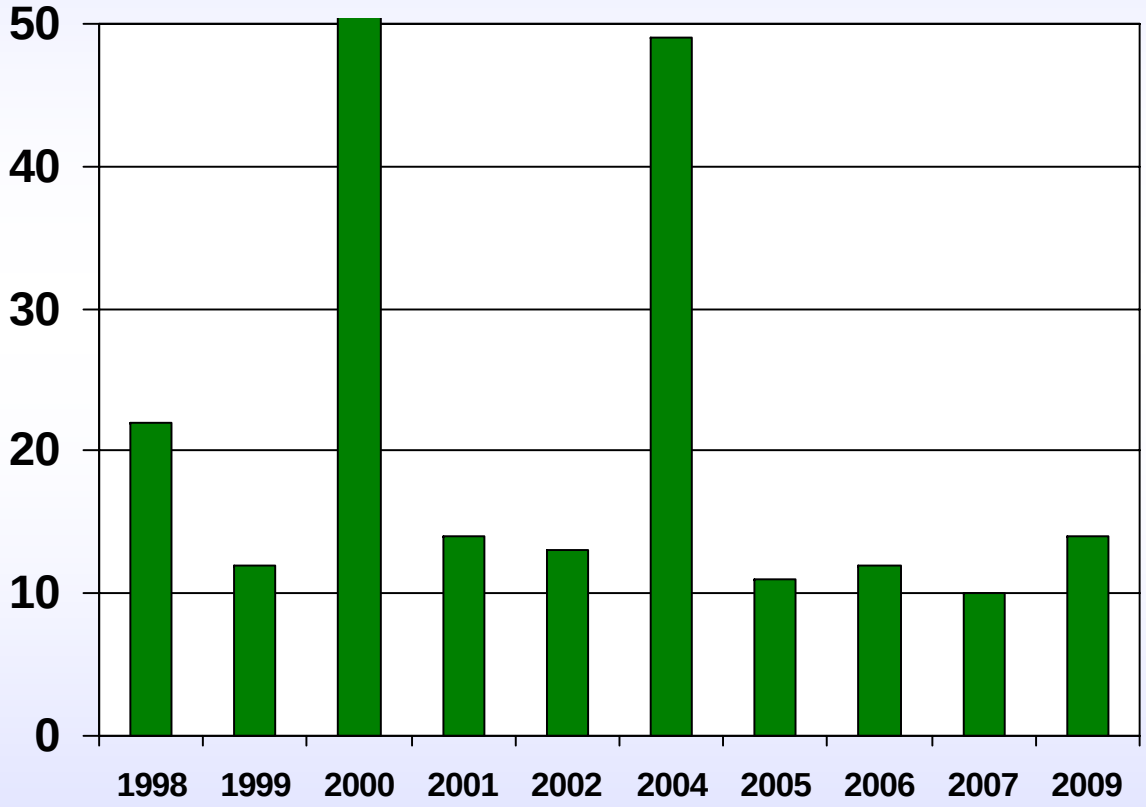
Boron maintenance entails periodic soil applications of 1 to 3 lbs. per acre depending on leaf and soil tests. When this is not enough, a foliar application at the pink stage of bloom or after bloom can maintain sufficient levels in the tree. Foliar boron applied in summer can interfere with normal fruit ripening. With foliar feeding, pay attention to incompatibilities with other spray materials.

The amount of boron fertilizer to apply depends on how much boron it contains. Solubor with 20% total boron would be foliarly applied at 1 lb. per 100 gals. for a conservative rate.

Foliar Feeding Tips

- Any time materials are applied directly to the tree, there is a risk of phytotoxicity or burning of fruit and foliage.
- Pay close attention to incompatibilities and apply those materials separately and at different times in the season.
- Apply materials when weather conditions are less likely to cause chemical burning.
- Where company or brand names are used, it is for the reader's information. No endorsement is implied nor is any discrimination intended. Always consult product labels for rates, application instructions and safety precautions. Users of these products assume all associated risks.

Foliar Zinc (ppm) at the Highmoor Farm



The example orchard has leaf levels of zinc consistently below 20 ppm which is considered deficient. Very high levels occur sometimes, but this is from not properly washing the leaves before the analysis. Each year during the growing season, we apply chelated zinc which prevents deficiency symptoms, but does not increase leaf levels. Long term solutions involving ground applications have not proven to be cost effective, so the recommendation is to apply a foliar zinc fertilizer at least once a year.

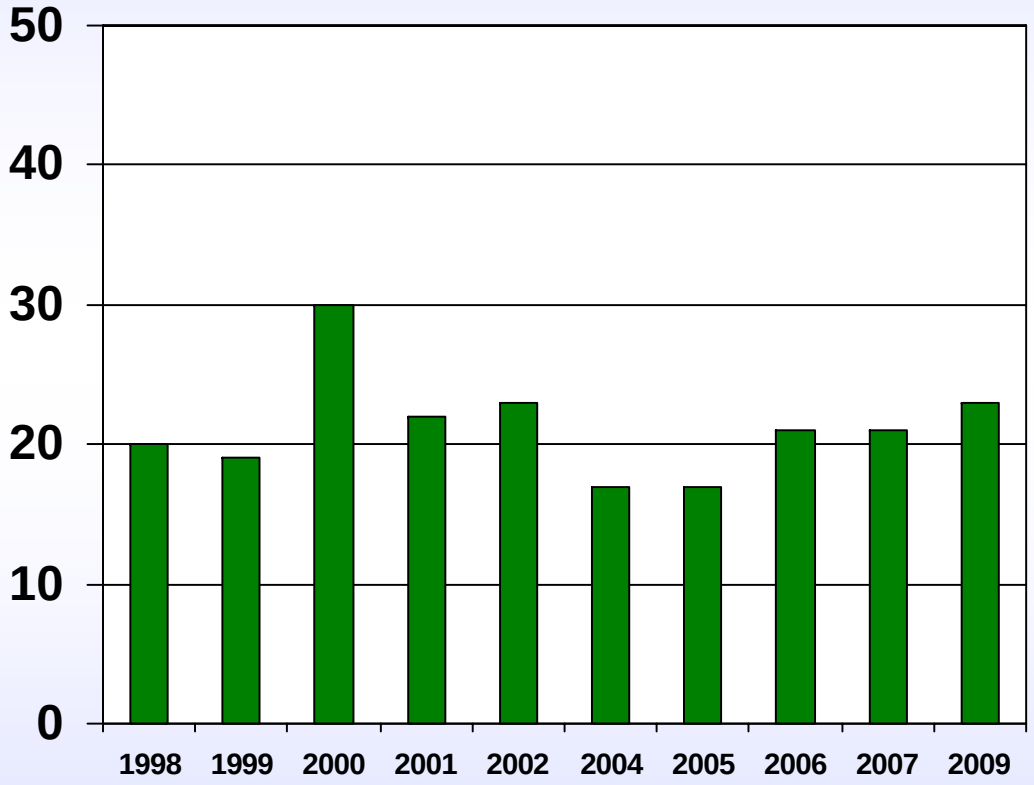
Zinc Maintenance

Zinc sulfate (36%) 35 lbs. per acre at silver tip.

Chelated zinc in June. Select a product that will not burn foliage or fruit. Follow rate and application instructions on the label.

Zinc is important for normal bud development. Strong buds lead to large fruit.

Foliar Manganese (ppm) at the Highmoor Farm



Chronically low manganese is common, but little research has been done to find a solution. Preplant soil adjustments may work to correct low manganese, but are too costly.

As with zinc, application of 2-5 lbs. per 100 gals. manganese sulfate (24%) in spring before growth starts can prevent symptoms of deficiency. As with any new product, test it out first on a small scale to ensure no burning of foliage or fruit.

Heavy applications of lime to the soil reduce availability of manganese. Frequent maintenance of soil pH with small doses of lime may prevent drastic changes in the availability of manganese.

Correcting Copper

Levels of copper are frequently low to deficient but can be corrected with an application of copper sulfate at green tip. Application at later dates can lead to fruit russeting or burning of the foliage and fruit as shown in the photos to the right.

Additional Resources

1. Orchard Nutrition Management, by Warren Stiles and W. Shaw Reid. Cornell Cooperative Extension Bulletin #219.
2. Tree Fruit Nutrition Short Course Proceedings, edited by Peterson and Stevens. Published by the Good Fruit Grower.
3. The New England Tree Fruit Pest Management Guide.
4. The Pennsylvania Tree Fruit Production Guide, available on their website at: http://agsci.psu.edu/tfpg