Fertilization

Proper nutrition is a key requirement for the reliable production of pecans. Like other plants, pecans require nutrients for growth and fruit production. Fertilizers supply nutrients to soils and help to correct nutrient deficiencies. Four of the six macronutrients needed by pecans are commonly deficient in Georgia soils. These include nitrogen, potassium, phosphorous, and magnesium. Two of the seven micronutrients required by pecans are commonly deficient as well, zinc and iron. Recent attention has also been given to deficiencies of nickel and boron.

The single most reliable indicator of the nutritional needs of the pecan tree is the foliar or leaf analysis. Soil samples are less efficient for determining nutritional deficiencies in mature orchards, but are quite useful for monitoring soil pH and lime requirements. Leaf analysis is more sensitive to changes in nutrient supply because it measures amounts of specific nutrients in the leaves. Leaves should be sampled for analysis between July 7 and August 7 as this is the period in which nutrient concentrations in the leaves are most stable. Nutrient Sufficiency levels are given in table 1.

Table 1. Sufficiency levels for essential elements.

Element	Sufficiency Range
N (%)	2.5-3.3
P (%)	0.18-0.2
K (%)	1.3-2.5
Mg (%)	0.35-0.6
Ca (%)	1.3-1.75
S (%)	0.25-0.5
Zn (ppm)	50-100
Fe (ppm)	50-300
Mn (ppm)	100-800
B (ppm)	15-50
Cu (ppm)	6-30
Ni (ppm)	5-15

Nitrogen

Nitrogen is the element that most commonly limits pecan growth and ultimately orchard profitability. It provides better tree growth, a higher percent kernel, and a healthier tree. When properly maintained, nitrogen can help to provide optimal year to year production. Nitrogen deficiencies result in poor growth and poor tree health. Too much nitrogen stimulates excess foliage, shading, and in some instances reduced yield. The key to nitrogen management is to balance applications with the needs of the tree.

The management of nitrogen fertilization in the pecan orchard will vary for irrigated versus non-irrigated orchards and from one year to the next within a given orchard, depending upon crop load. Nitrogen uptake in the pecan tree is driven by demand. There

are two critical periods of nitrogen demand during the season; (1) early foliage growth and (2) kernel filling. The early spring foliage flush is nourished primarily from reserves held within the tree, while the nitrogen demand during the kernel fill stage is satisfied from an earlier application made during the current season.

In the absence of leaf sample recommendations, dryland orchards should be fertilized with 75 lbs of N in late February or early March so that winter rains will help to improve soil moisture and ultimately nitrogen uptake. For irrigated orchards, soil moisture, and thus nitrogen uptake can be more easily controlled by the grower, which provides for more efficient use of nitrogen by the tree.

Nitrogen recommendations have evolved greatly over the years. Historically, recommendations for orchards have been to apply nitrogen in March or as a split application in March and May. A general "rule of thumb" for mature, well managed, irrigated orchards is to apply 10 lbs of N /acre for every 100 lbs. of expected crop.

An alternative is to split the application between mid-spring and late summer. This timing works best for orchards bearing heavy crops and where other limiting factors are controlled. Well managed trees coming off an "off" year, begin spring foliage growth with a full supply of nutrients stored in the stems, trunk, and roots. As a result, there is little demand for nitrogen and healthy trees will not remove nitrogen from the soil at this time. A more efficient use of nitrogen may be to apply 1/3 of the nitrogen required when the shoots are 75% expanded, which generally occurs in mid to late April in Georgia.

During "off" years, the April application alone as described above is sufficient. During July, trees may be assessed with regard to their crop load. If the crop load is heavy, another 1/3 of the full rate should be applied in early August. The final 1/3 should be applied in early September to help maintain healthy foliage for optimum kernel filling, leaf retention, and ultimately adequate nutrient storage pools. For example, with an expected crop of 1500 lbs/acre, the N would be applied as 50 lbs/acre in mid-late April, 50 lbs in early August, and 50 lbs in early September.

The kernel filling process pulls nitrogen from the leaves. During an "on" year with heavy crop loads, these leaves must have soil nitrogen to remain healthy and fully functional. Once the kernel-filling process is complete, healthy leaves will maintain sufficient nitrogen to produce stored food. Trees in the "off" cycle of production will have sufficient nitrogen and will not need late-summer applications.

Though more complex than the March or March/May applications, spring and late summer splits make for more efficient use of nitrogen by the tree and can help reduce the alternate bearing tendency in well managed orchards.

Phosphorous

Phosphorous is important for energy storage as well as the production of wood and nuts. Despite its value, phosphorous levels in Georgia soils are often adequate, and additional

phosphorous should not be applied unless called for by leaf analysis. The predominant symptom of phosphorous deficiency is a dull green foliage with no intervienal chlorosis. Such deficiencies are often over-looked and are easily mistaken for mild nitrogen deficiency. In heavy bearing varieties, phosphorous deficiency can be expressed as a marginal leaf scorch, which may begin 7-10 days before shuck split and premature defoliation. High concentrations of phosphorous can inhibit the uptake of nitrogen, as well as iron, zinc and copper, by the pecan tree.

Phosphorous is relatively immobile in the soil, so a single application of 60-100 lbs of P2O5 incorporated at planting can last for several years. Subsequent applications as needed should also be incorporated because surface applications may require several years to be of benefit to the orchard. Applications should be made any time leaf levels fall below 0.12 percent.

Potassium

Potassium is essential for the movement of carbohydrates, regulation of osmosis, and the activation of enzymes within the pecan tree. The resistance of pecan trees to winter injury is also heavily influenced by potassium levels.

Maintaining an appropriate balance of nitrogen and potassium within the tree is of vital importance. If leaf potassium content is near minimum levels, heavy nitrogen applications will induce a visible potassium shortage termed nitrogen scorch. Nitrogen scorch can lead to serious defoliation, which appears first on the basal shoots and leaves, progressing upward. Scorched areas occur along the leaf margins, and are circular or oblong and about the size of a dime. Desirable, and to some extent, Schley trees are often especially sensitive to the nitrogen-potassium imbalance.

Less severe symptoms of potassium deficiency begin as an irregular interveinal chlorosis. As potassium concentrations decrease through the season, the chlorosis may spread up the shoot and leaf. Necrotic spots may develop on the surface of the leaf.

Transport of potassium from the leaves to the fruit often accelerates potassium deficiencies, particularly in heavy crop years. Such deficiencies may induce premature defoliation, shoot die-back, and small, poorly filled nuts. Careful monitoring of leaf nitrogen and potassium levels is required to maintain optimal nutrition.

The most common method of supplying potassium is by soil application of muriate of potash. Rates should be based on leaf potassium and the amount of nitrogen applied. The N/K ratio should be maintained at 2:1 for most varieties in order to prevent leaf scorch. Applications should be made in February before the onset of winter rains. Where late summer applications of N are used, additional applications of K should be made at that time if K levels in the leaf are marginal.

Magnesium

Magnesium deficiency is relatively rare in pecan; however, it can occur in trees growing on acid or sandy soils, especially in orchards with high soil potassium levels. Magnesium deficiencies are characterized by an intervienal chlorosis , which forms a "Christmas tree" pattern on the leaf. In very severe cases, a marginal leaf scorch may follow chlorosis.

Magnesium deficiency is best prevented by maintaining soil pH at 6.0-6.3 and by the use of Dolomitic limestone as a liming material. Dolomitic limestone contains both calcium and magnesium, and generally provides an adequate amount of magnesium for most orchards. Growers will usually be able to observe increases in their leaf magnesium levels the second growing season following application. Where trees are identified as magnesium deficient, magnesium sulfate is more effective at raising leaf magnesium levels, because it is more water soluble. Deficient trees will respond more quickly to foliar sprays of magnesium sulfate (5 lbs/100 gal) applied from the first leaf stage through July, but soil application of magnesium will still be necessary to maintain adequate levels in orchard soils.

Zinc

Zinc has a major influence on the economic return of a pecan operation due to its effect on flowering, fruit size, leaf efficiency, and nut yield. It is particularly important to leaf expansion and shoot elongation. As a result, zinc must be available to the tree at these specific times during the growing season. The most familiar characteristic of zinc deficiency is pecan rosette, which begins as chlorosis and curling of young leaves, resulting in a wavy leaf margin. Additional symptoms may be a rosette pattern, narrow leaves, and terminal die-back.

Even with adequate soil levels, the availability of zinc in the soil depends upon soil pH, nitrogen, and phosphorous application. Liming soils with marginal zinc levels can reduce zinc uptake, particularly when nitrogen and phosphorous are applied in combination with lime. Zinc can usually be maintained at adequate levels under a liming program on acid soils if zinc is also applied. One advantage of soil applied zinc is that one application should provide an adequate supply of available zinc for many years to come.

Zinc moves slowly in the soil, requiring two or more years for a surface application to become effective. Therefore, foliar zinc applications are the most effective means of correcting the problem when deficiencies occur. Three to six applications per season are normally recommended, depending on the severity of the deficiency, with the first spray being applied about two weeks after budbreak. Sprays should be applied at 2 week intervals over the period of shoot elongation. Foliar zinc should be applied anytime leaf concentrations fall below 50 ppm or when visible symptoms of zinc deficiency are present. For rates to apply, see the current pecan spray guide.

Iron

As a component of chlorophyll, iron is essential to the process of photosynthesis. Iron deficiency rarely occurs from lack of iron in the soil, but is induced by over-liming, cold, wet spring weather, or high concentrations of zinc, phosphorous, or manganese in the soil. The deficiency generally occurs early in the growing season, and clears up as the season progresses.

Symptoms of iron deficiency look similar to nitrogen deficiency, exhibiting chlorosis of the leaf. The interveinal chlorosis in iron deficiency sometimes retains very pronounced green veins. Also, with iron deficiency, young leaves are the first to be affected.

Depending upon the cause of iron deficiency, correction may take varying routes, including foliar applications of iron, changing the amount of lime applied to the orchard, or foregoing phosphorous applications. In most cases, the problem will clear up as the season progresses, especially when due to cool, wet spring conditions.