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Macronutrient Management for Utah Orchards

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Introduction

Proper fertility management is necessary to maintain fruit tree productivity, maximize the quality and health benefits of the fruit, and optimize the profits for the producer and processor. Much of the research that has been conducted on fruit tree responses to fertilizer application was conducted in the prominent production regions of the country, which are very different from Utah in both climatic and soil conditions.

Typical Nutrient Needs for Tree Fruits

Fruit trees need to maintain an appropriate balance between vegetative growth and reproductive fruit growth. This growth balance is partially influenced by the availability of macronutrients, including: Nitrogen (N), phosphorus (P), and potassium (K). Nitrogen, P, and K are used by plants for structure, nutrient transport, and movement of water, which are among many other important functions. The lack of macro nutrients or nutrient imbalances may result in decreases in both vegetative growth as well as fruit yield. Also, fruit ripening and quality can be negatively affected when nutrient deficiencies are present. Generally, leaf tissue nutrient content is a good basis for determining plant needs.

Nitrogen

Nitrogen deficiency can be detected visually. Trees with N deficiency have little to no new shoot growth. Deficient leaves are pale green to yellow. Symptoms first appear in older leaves because N moves from older tissue into actively growing younger leaves. Leaves from deficient trees tend to drop earlier in the fall. Fruit set might be light and mature fruits can be smaller and mature somewhat earlier than usual. In-season additions of N can be made, but should be made at least 6 weeks prior to fruit ripening to ensure optimum fruit quality at harvest. Fruit from trees with excess N can color poorly and lose firmness in storage. This will also prevent delays in winter dormancy development. Excess N can result in dark green leaves that remain on the tree late in the fall. Growth tends to continue late into the fall and trees will have delayed dormancy and become more susceptible to winter injury. In orchard crops there is a tradeoff between vegetative growth and fruit yield. Too much vegetative growth may reduce fruit set and yield the following year.

In general, the following guidelines are suggested for Utah fruit crops. Typical nitrogen needs are between 0.01 to 0.04 lbs N per tree, per year of age with an annual limit of 0.3 lbs N per tree. The amount that needs to be applied to reach this range will depend on soil texture, soil organic matter content, and leaf tissue content at the start of the growing season, among other indicators. Vegetative growth is the primary indicator for N requirements. New growth in younger trees should be between 10 and 30 inches per year, depending on tree type (see Table 1), but in older trees it should be between 4 to 18 inches depending on tree type. If the growth is greater than this, lower the N rate in subsequent additions and conversely increase the rate if growth is too low.

Table 1. Sufficient annual vegetative growth ranges of important Utah fruits. Growth ranges for young trees as well as mature trees are measured in inches.

Sufficient Annual Vegetative Growth		
Tree Fruit	Young Tree	Mature Tree
Apple	10 to 20	4 to 10
Pear	20 to 30	12 to 18
Peach	10 to 24	8 to 15
Cherry	10 to 20	8 to 15

Phosphorus and Potassium

The level of P and K in the soil does not change as rapidly as that of nitrogen, so their management is monitored more effectively by soil testing (at a depth of 1 foot and 2 feet, within the tree row) and periodic tissue sampling (at each important stage of growth) for sufficiency.

Phosphorus (P) is critical to root growth and function and the proper cycling of energy in the plant. Phosphorus deficiency symptoms affect older leaves first which may be small and bluish green on the margins. Other symptoms might include: reduced flowering, decrease in fruit quality, and delayed fruit maturity. Phosphorus is not very mobile in the soil, so sufficiency at the time of planting a new orchard, or renovation of orchard sections, is important for new plant establishment. Sufficient P should be applied and incorporated within the root zone of new trees before planting. In older plantings, excess P can cause imbalances in the uptake of zinc (Zn) and iron (Fe) and adjustment is best made on soil test levels. Mid-season adjustment of P levels in soils is generally not practical, so providing adequate levels at the beginning of the season is the best strategy for management. Annual adjustment of P nutrition is recommended with the use of mono-ammonium phosphate (11-52-0).

Potassium (K) is critical in the water relations of plants and in the assimilation and cell-to-cell transfer of other nutrients, particularly calcium (Ca) which is so important for fruit quality, particularly in pome fruits. Potassium deficiency symptoms are usually yellowing of leaf tissue (later turning to a bronze color and eventually death) along the margins and appear in older leaves first. Levels of K in Utah soils are regulated by the weathering of clay minerals and are generally sufficient without fertilizer application. However, on the sandy or gravelly soils low in clay content often found on the bench areas in Utah, K deficiencies do occur and will often be expressed by Ca or other micronutrient imbalances in the plant. In-season adjustment of K nutrition is possible with foliar sprays of potassium chloride or potassium sulfate solutions, or injection of these materials into the irrigation water. Adequate tissue levels of N, P, and K for fruit trees in Utah are given in Table 2.

Table 2. Standard adequacy ranges for foliar nutrient contents of important Utah fruits.

Sufficient Foliar Nutrient Content				
Element	Apple	Pear	Peach	Cherry
% Nitrogen	1.5-3.0	1.8-2.6	2.5-3.5	2.2-3.4
% Phosphorus	0.11-.0.30	0.12-.25	0.15-0.4	0.16-0.4
% Potassium	1.2-2.0	1.0-2.0	1.5-2.5	1.0-3.0

It has been observed that in high fruit load situations, fruit quality (as measured by soluble solids and titratable acidity) tends to decrease. Recent work in Utah has shown that supplemental P and K improve fruit quality under high crop load conditions when conventional soil tests would indicate sufficiency. Tart cherry is Utah's primary fruit crop, and P and K additions could also benefit fruit quality in heavy crop years.

Case Study: P and K Management in Tart Cherries

Nutrient management is an important part of successful tart cherry production. With the recent increase in input costs, including fertilizer costs, additions of fertilizer to improve fruit quality need to be carefully considered. In addition to fertilizer rate, time of application is also an important consideration. A range of N, P, and K rates and formulations were applied to replicate plots of mature tart cherries (*Prunus cerasus* 'Montmorency') on several Utah County farms in 2010 and 2011. Yield and fruit quality characteristics were compared.

At sites with historically aggressive nutrient management program, additions of P and K maintained adequate yield and fruit quality, but showed no significant increase among treatments (Figure 1). At the aggressively managed sites N, P, and K additions have been (on average) about 1 pound per tree annually over the past 4 to 5 years. Fertilizer additions did result in a significant increase in yield (but not in fruit quality) at sites where nutrient management programs were historically much less aggressive (Figure 2). In order to increase yield and fruit quality where nutrient management is much less aggressive a minimum of 1 pound of Triple-16 (16-16-16) per tree (173 lbs/acre) should be applied in the early growing season.

Summary of Case Study

Applying additional P and K to producing tart cherry trees will positively affect yield and fruit quality. Yield levels will be maintained at historically aggressive managed sites and will increase at both historically

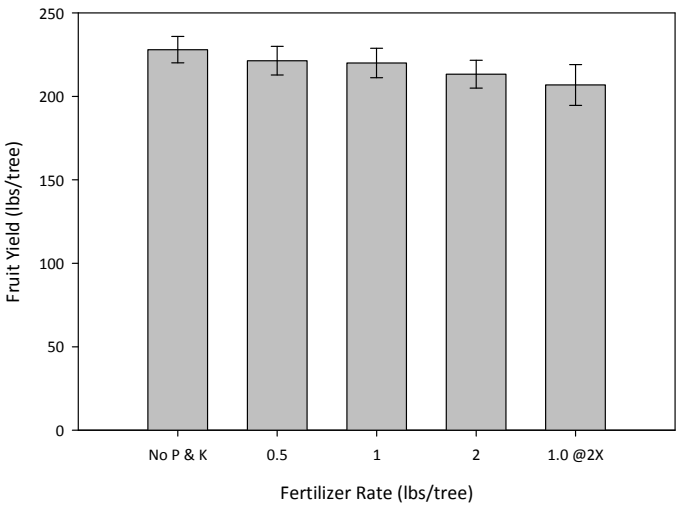

Figure 1. Yield results from an aggressive nutrient management site (annual N, P, and K additions). Fruit yield is measured in lbs/tree. Fertilizer rate is different rates of 16-16-16 fertilizer and is measured in lbs/tree.

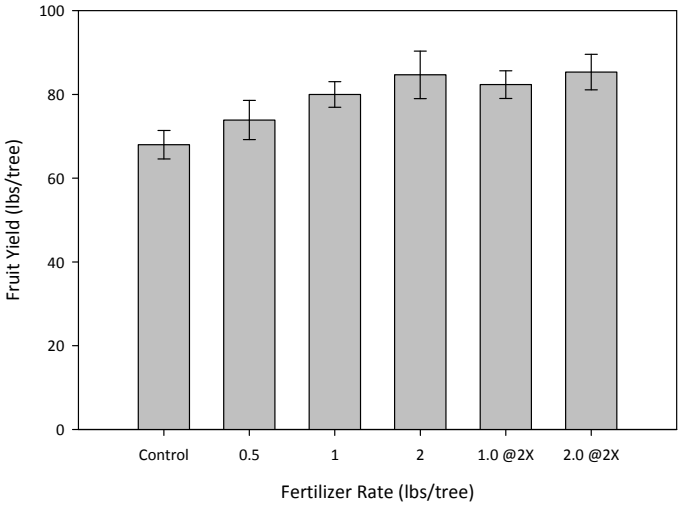

Figure 2. Yield results from a site with less aggressive nutrient management (no previous history). Fruit yield is measured in lbs/tree. Fertilizer rate is different rates of 16-16-16 fertilizer and is measured in lbs/tree.

moderately and minimally managed sites with the additions of P and K. Fruit quality levels are maintained with the addition of P and K at both historically aggressively and moderately managed sites and increase slightly at historically minimally managed sites.

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