IMPROVING THE PROCEDURE FOR NUTRIENT SAMPLING IN STONE FRUIT TREES

PROJECT LEADER

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INTRODUCTION

This project was initiated to investigate the possibilities of using a dormant sampling technique to complement the widely used mid summer leaf sampling for nutrient analysis. The

argument was made that this approach might fit better into a grower's typical fertility management program and be more timely for correcting most deficiencies. We have now collected 3 years data on 60 Zee Lady peach and 60 Grand Pearl nectarine trees growing in sand culture. By varying fertilization rates we have been able to obtain a wide range of nutrient levels among the trees and have observed distinct deficiency symptoms for several nutrients. Each year we collected dormant shoot samples from the trees in January and analyzed them for 12 essential elements. Based on tree performance and deficiency symptoms we have established thresholds for some nutrients that have stayed consistent over all 3 years for both the peach and the nectarine. During 2005, our emphasis was on testing these thresholds in commercial peach and nectarine orchards in the San Joaquin Valley. We surveyed about 90 different orchards and applied fertilizer treatments to those that tested low for a given nutrient.

OBJECTIVES

1. To test the feasibility of measuring boron, zinc and nitrogen (and other nutrients if possible) in stone fruit trees during the dormant season or early spring and relate those nutrient levels to the various components of yield and fruit quality.
2. To develop deficiency threshold values for these nutrients that can be used to guide fertilization decisions early in the season.
3. To test the usefulness of these threshold values in commercial orchards.

PROJECT DESCRIPTION

Sixty large plastic tanks measuring 11'x 8' and 4' deep were obtained in 1999 and placed in trenches in the field. In 2000, each tank was filled with sand and planted with a Zee Lady peach, Grand Pearl nectarine (white flesh) and Fortune plum tree. Fifteen different fertilizer treatments have been imposed since 2001 (see 2000 through 2003 FREP reports for details). The main objective was to obtain trees deficient in each essential nutrient. By 2005, there were clear signs of N, P, B and Zn deficiencies in multiple peach, plum and nectarine trees. There were also individual trees exhibiting K and Mn deficiency symptoms and other trees showing indications of other deficiencies as well.

Shoot samples were taken from all 180 trees in January of 2003, 2004 and 2005 and analyzed for N, P, K, S, Ca, Mg, B, Zn, Mn, Fe, Cu and Mo. Measurements were made of yield and fruit quality components including flowering, fruit set, early fruit growth, early shoot growth, fruit drop, final fruit size, fruit defects, fruit quality and total vegetative growth. These parameters were then correlated with nutrient levels in the dormant shoots. Using this approach, deficiency thresholds were proposed for N, P, B and Zn (see 2004 FREP report). Data from 2005 supported these thresholds (Table 1).

The emphasis in 2005 was on applying these deficiency thresholds to commercial orchards. During July, 2004 sixty peach and nectarine orchards were sampled using the standard mid summer leaf sampling technique. Many of these orchards were on sandy soils or in areas where B deficiency had been diagnosed in nearby grape vineyards. Those testing low for any nutrient (18 sites) plus an additional 29 orchards were then sampled in January using our experimental dormant shoot sampling technique. Fertilizer treatments were then applied to those orchards with nutrient levels below or near the thresholds established from the sand tank trees.

RESULTS

The commercial orchard survey showed nutrient ranges similar to those found in the sand tank trees. Many of the nutrients did not appear to be deficient in any of the orchards tested. Only those showing some promising results will be discussed below.

Nitrogen (N)

N in dormant shoots ranged from 0.98 to 1.77% in the orchard survey, very similar to values found in the sand tank trees. Even though we set a deficiency threshold of 1.20%, we don't have a lot of confidence in this value. Many of the trees below or close to the threshold were vigorous and exhibited no symptoms of N deficiency. Likewise, the trees in the sand tanks showed the same sort of variability. In this case, trees that were clearly nitrogen deficient often had dormant shoot values greater than 1.20%. Rather than measuring total N in shoots, we will pursue another test for N that has shown promise in the scientific literature. Specific amino acids such as arginine have been shown to be very indicative of the N status of fruit trees. Arginine is the main storage amino acid in dormant peach trees. Therefore, we will test the strength of the correlation of this amino acid with vegetative growth and nitrogen deficiency symptoms.

Phosphorus (P)

In the orchard survey of dormant shoots, P values ranged from 0.12 to 0.21% (Figure 1). The sand tank trees that were very deficient had P values as low as 0.06%. Thus, the survey did not reveal any truly deficient trees. Two of the orchards tested 0.12% P which is right at the threshold value we established from the sand tank trees. Phosphorus fertilizer was added to individual trees within these two orchards plus a third that tested 0.13%. During 2005 none of these orchards exhibited symptoms of P deficiency such as low vigor, cracked fruit or early defoliation. In 2006, we will continue to monitor the trees to see if additional P has any effect on productivity or fruit quality.

*B*oron *(B)*

B in dormant shoots ranged from 13 to 45 ppm in the orchard survey (Figure 2). These values are considerably greater than those measured in the sand tank trees over the past 3 years. Typically, the trees showing signs of B deficiency in the sand tanks ranged from 8 to 12 ppm, although we set the threshold at 14 ppm. Therefore, the two orchards that tested 13 ppm in the orchard survey could theoretically benefit from boron fertilization. We applied foliar B at bloom to individual trees in both these orchards but saw no improvement in fruit set or fruit size in 2005. We will continue to monitor the orchards through 2006.

Zinc (Zn)

In the spring of 2003, 2004 and 2005 we observed a range of Zn deficiency symptoms in the sand tank trees which correlated well with dormant shoot Zn levels. However, there have always been some trees with very low Zn levels that showed no symptoms and grew vigorously. Likewise, in the orchard survey there were several sites that tested low in Zn but showed no symptoms. This has prompted us to ask a series of questions about zinc and led to a second FREP project. Hopefully these questions, as well as several more related to increasing zinc uptake efficiency, will be answered by this project (see our other report in this issue).

Manganese (Mn)

Some interesting results regarding Mn were obtained in 2005. In the sand tank trees we have been unable to achieve Mn deficiency other than one plum tree with very minor symptoms. However, in the survey, four orchards tested as low as 8 or 9 ppm in the dormant shoots (Figure 3). Three of these four orchards, as well as several at 10 ppm, all showed early spring symptoms that looked similar to published reports of Mn deficiency. Therefore, we applied Mn fertilizers (both foliar and soil applied) to individual trees in 2 of these locations. Whether trees were fertilized or not, the symptoms generally disappeared and the trees grew vigorously once hot weather arrived. Therefore, it is still uncertain whether this disorder causes any problems with productivity. In 2006 we will make observations of both spring symptoms and productivity indicators.

Potassium (K), Magnesium (Mg) and Calcium (Ca)

We have not observed K, Mg or Ca deficiency in the sand tanks except for one peach tree that showed K deficiency symptoms late in 2005. One of the problems has been fairly hard water that is our main source for irrigation. To help us achieve deficiencies of these cations, we will install a water softening system in 2006 to remove Mg and Ca from the irrigation water. We will also install a 5,000 gallon tank and use it to irrigate a few of the sand tanks with de-ionized water.

CONCLUSION

Although we have been able to induce nutrient deficiencies with mature peach and nectarine trees in sand culture, it has been difficult to find them in commercial orchards in the field. The use of dormant shoots to test for deficiencies of P, B and Zn still seems reliable even though we have not been able to test the procedure fully in commercial orchards. The procedure for N deficiency needs to be refined and hopefully other nutrient thresholds can be added as we induce more deficiencies in the sand tank trees. In 2006 we will also survey commercial almond orchards to see if we find the same range of nutrients and if the same deficiency thresholds can be used.

Table 1. Proposed deficiency thresholds of N, P, B and Zn in dormant shoots of peaches and nectarines.

Nutrient	Proposed Deficiency Thresholds
Nitrogen	1.2%
Phosphorus	0.12%
Boron	14 ppm
Zinc	20 ppm

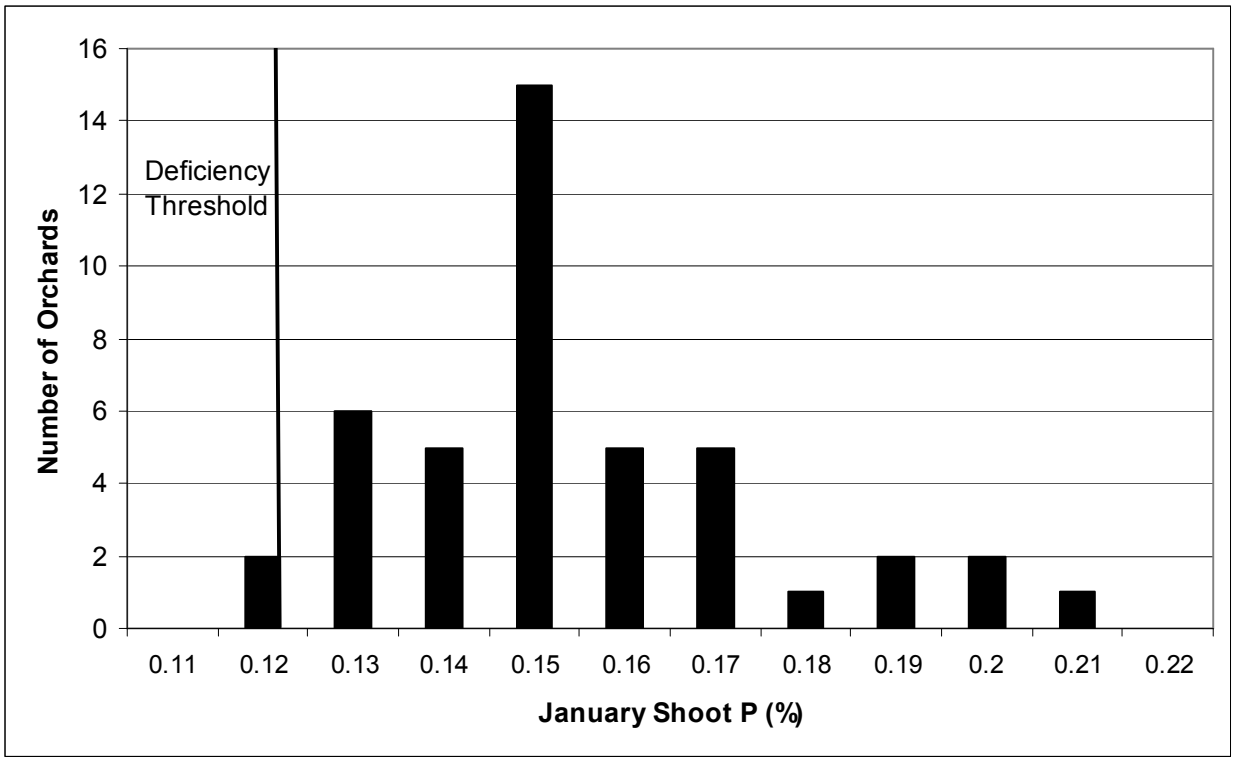

Figure 1. The distribution of dormant shoot P levels in a survey of 44 commercial peach and nectarine orchards in the San Joaquin Valley.

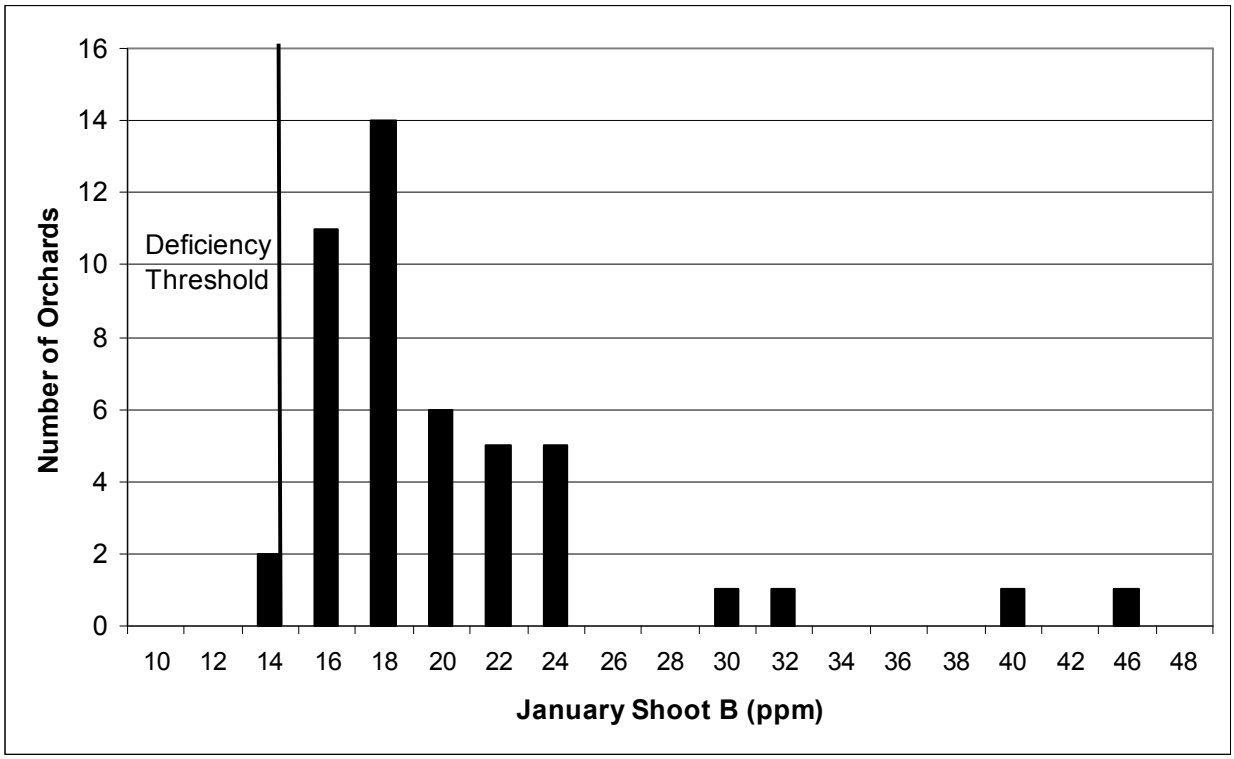

Figure 2. The distribution of dormant shoot B levels in a survey of 47 commercial peach and nectarine orchards in the San Joaquin Valley.

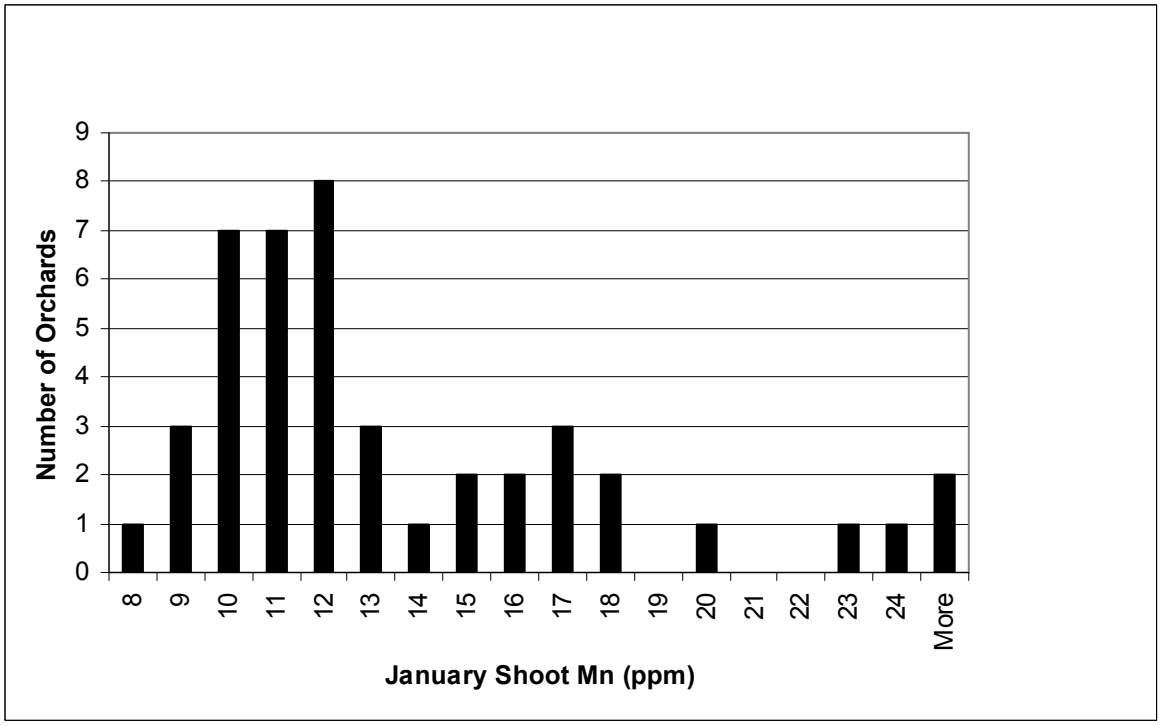

Figure 3. The distribution of dormant shoot Mn levels in a survey of 44 commercial peach and nectarine orchards in the San Joaquin Valley.