IMPROVING THE PROCEDURE FOR NUTRIENT SAMPLING IN STONE FRUIT TREES

PROJECT LEADER

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INTRODUCTION

Mid summer is the recommended period of sampling leaves for nutrient analysis in fruit trees. This practice was first developed in the 1940s and was widely applied to orchards during the 1950s. In 1971 Leece compiled a list of 39 peach studies from seven countries and concluded, "with few exceptions, good agreement existed amongst the studies for any particular nutrient". Thus, the practice became very widespread and is the standard to this date. The timing of about 100 to 140 days after bloom has been established because the concentration of most nutrients remains fairly stable during this time. This corresponds to the period from early June through late July in the central valleys of California.

We see at least two problems with this timing, especially in light of our modern era of environmental concerns and an emphasis on good sustainable fertilization practices. First, the timing of mid summer for sampling does not fit well into a sustainable fertilizer program since many fertility decisions need to be made early in the spring. Growers are generally most interested in fertility management as they watch their trees flower, leaf out and set a crop in the spring. By summer their interest has waned. Second, this timing also does not make sense from a tree physiological perspective. Many critical processes such as flowering, fruit set, initial fruit growth, and shoot growth are all happening in the early spring and should be dependent on tree nutrient status at that time. A dormant or early spring sample should give a good indication of stored nutrients and whether any are limiting.

This study will evaluate the nutritional status of several different plant parts in hopes of finding a reliable and consistent sampling procedure to help guide fertilization practices in the spring.

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 2004, there were clear signs of N, P, B and Zn deficiencies in individual peach and nectarine trees (Table 1). Several other nutrients also showed some indication of deficiency but will not be included in this project until more convincing symptoms are obtained.

Shoot samples were taken from all 180 trees in January of both 2003 and 2004. Root samples were taken at the same time in 2004. Flowers were sampled at full bloom in March of both years. All samples were dried, ground and analyzed for N, P, K, S, Ca, Mg, B, Zn, Mn, Fe and Cu. 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 each tissue. This report will include results from only the peach and nectarine trees.

RESULTS

Nutrient concentrations in dormant roots, dormant shoots, and flowers were all compared. A preliminary evaluation of newly emerging leaves was also made. Of these 4 tissues, dormant shoots appeared to be best for several reasons. First, it was a simple and easy sample to take. Roots took a lot more effort and flowers had to be sampled within a short period of time. Second, the timing was early enough to allow for correction before growth started. By the time of flowering and early leaf emergence, it was too late to affect processes such as fruit set and early fruit growth. Finally, nutrient concentrations in shoots correlated better with mid summer leaf levels and tended to be better than the other tissues at reflecting the wide range of added fertilizers. Some nutrients in the roots were consistently low no matter how much fertilizer had been added. Flowers, on the other hand, had just the opposite situation. Often, their nutrient concentrations were very high, even in trees showing evidence of deficiency. Therefore, shoot samples will be the focus of this report, even though ongoing evaluations will continue with root and flower samples.

In order to determine a deficiency threshold it is necessary to correlate nutrient concentrations to some sort of "problem" in the tree such as the occurrence of leaf symptoms or the inhibition of a physiological process. The only nutrient with distinct and unique deficiency leaf symptoms was zinc. Deficiencies of the other nutrients often caused a general slowing of shoot and fruit growth without any distinguishing leaf marks. In these cases, total vegetative growth, as measured by growth in trunk cross sectional area, and final fruit size were useful in establishing deficiency thresholds. In addition, other processes such as fruit set, fruit drop and fruit cracking, were clearly affected by individual nutrients (Table 1). All of this information was used in establishing N, P, B and Zn deficiency thresholds for dormant shoots of peaches and nectarines.

Nitrogen (N)

N deficiency was easy to impose on these trees growing in sand culture. Typical symptoms of reduced shoot growth, yellow leaves, reddish stems, smaller fruit size, more highly colored fruit, earlier ripening fruit and more smooth fruit finish were all observed. Mid summer leaf samples as low as 1.6% N were obtained, indicating extreme deficiency. At the other extreme, N levels over 4.0% were measured, creating a wide range of values with corresponding large differences in tree vigor.

Despite these substantial differences, the result of the dormant shoot sampling was disappointing. Values ranged from .91 to 1.88%, but often the low N trees were no different than high N trees. It is still unclear why these results were obtained. Perhaps it is somehow related to the sand culture system or the fertilization practices employed there. Other nitrogen experiments conducted by the authors and other scientists suggest dormant wood is a good indicator of the N status of fruit trees. Based on these various studies, a tentative deficiency threshold of 1.5% will be used as the project moves to the phase of surveying commercial orchards.

Phosphorus (P)

P deficiency started showing up in a few peach trees in 2003 and was clearly evident in both peaches and nectarines in 2004. Symptoms included substantial reduction in both vegetative and fruit growth, fruit cracking in nectarines, more flattened fruit (side to side) in peaches, preharvest fruit drop in peaches and premature defoliation in both peaches and nectarines. As these leaves senesced, they tended to have more red or purple coloration rather than the typical yellow or orange color of well fertilized trees.

Concentrations of P in dormant shoots varied from .06 to .18 % which is a little lower than the values found in mid summer leaf samples. Typical summer leaf values in the sand tank trees varied from .10 to .24 %. Most deficiency symptoms were particularly severe below shoot values of about .11 to .12 % P for both peach and nectarine.

*B*oron *(B)*

Over the past couple of years, percent set in the peaches and nectarines has varied considerably from tree to tree (from 5 to 86%). Generally this has correlated best with tree B status, although other nutrients appear to have played a secondary role. Trees low in B also had smaller fruit size at harvest. Other than that, there were no other leaf symptoms or reductions in vigor to indicate a deficiency.

Mid summer leaf concentrations ranged from 12 to 36 ppm B in the sand tank trees. Dormant shoot samples were considerably lower, but showed about the same variability, ranging from 8 to 22 ppm. Generally, when values dropped below about 13 to 14 ppm, there was a substantial decrease in fruit set or fruit size. Figure 1 is an example of the relationship between dormant shoot B and fruit set in Zee Lady peach for 2003.

Zinc (Zn)

In the spring of 2004, about half the sand tank trees exhibited some degree of Zn deficiency symptoms. Four pomology experts independently rated the trees on a scale from 0 to 5, with 5 indicating severe symptoms. The average of these 4 scores was graphed against dormant shoot Zn concentration for that tree (Figure 2). Although some trees with Zn values as low as 9 and 10 ppm showed no detectable deficiency symptoms, the majority of trees with these levels exhibited extreme deficiency. At concentrations above 20 ppm, there were no indications of deficiency in any trees.

Several other yield components were also affected by Zn deficiency. Fruit size tended to be smaller and nectarine cracking was increased. A deficiency threshold of 20 ppm in dormant shoots applied to these parameters as well.

CONCLUSION

Based on two years of data, dormant shoots appear to be a reliable tissue for determining the nutrient status of N, P, B and Zn in peaches and nectarines. Deficiency thresholds have been proposed for these nutrients (Table 2) and will be used to evaluate commercial orchards in the next phase of the project.

Table 1. Sand tank nutrient deficiencies 2004. Summary of deficiency symptoms and effects.

Nutrient	Evidence of Deficiency	July Leaf Sample: Published Deficiency Threshold (Peach)	July Leaf Sample: Lowest Level in Sand Tank Trees	Reduced Fruit Size	Other Symptoms and Comments
N	**	2.3%	1.61%	*	Greatly reduced shoot growth, good fruit quality
P	**	–	.06%	*	Fruit drop, nectarine cracking, early defoliation
K	–	1.0%	.82%	–	No clear deficiency effects yet
S	*	-	830 ppm	*	Reduced shoot growth, often closely correlated with N
Ca	*	–	.79%	–	A few fruit quality problems, some leaf symptoms in 2003, not 2004
Mg	?	.25%	.20%	–	Some leaf symptoms in 2003, not 2004
B	**	18 ppm	14 ppm	*	Reduced fruit set and shoot growth
Zn	**	15 ppm	5 ppm	*	Definite leaf symptoms, fruit quality problems
Mn	–	20 ppm	26 ppm	–	No deficiency yet, some plums as low as 23 ppm
Fe	*	60 ppm	39 ppm	*	Minor effects
Cu	*	–	3.1 ppm	*	Minor effects
Mo	?	-	<.05	–	Very low in plums

Table 2. Proposed deficiency thresholds of N, P, B and Zn in dormant shoots of peaches and nectarines.

Nutrient	Proposed Deficiency Thresholds
Nitrogen	1.5%
Phosphorus	.12%
Boron	14 ppm
Zinc	20 ppm

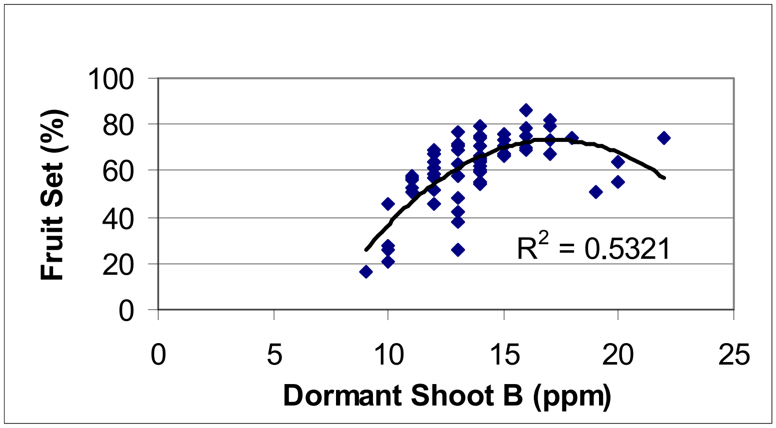

Figure 1. The relationship between dormant shoot B and percent fruit set of Zee Lady peaches in 2003.

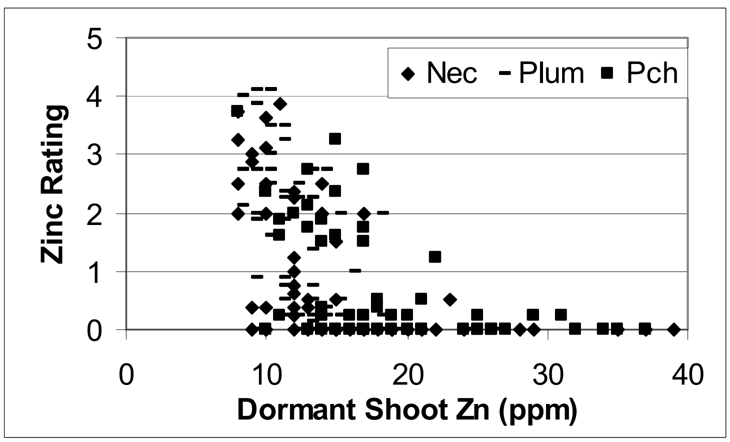

Figure 2. The relationship between dormant shoot Zn and spring Zn deficiency symptoms of peaches, plums and nectarines in 2004. Zinc rating is the average of 4 experts and is based on a 0 (none) to 5 (severe symptoms) scale.