IMPROVING THE PROCEDURE FOR NUTRIENT SAMPLING IN STONE FRUIT TREES

PROJECT LEADER

R. Scott Johnson
U.C. Kearney Agricultural Center
9240 S. Riverbend Avenue
Parlier, CA 93648
(559) 646-6547, FAX (559) 646-6593
sjohnson@uckac.edu

Cooperators

Harry L. Andris
UCCE Fresno County
1720 South Maple Avenue
Fresno, CA 93702
(559) 456-7285, FAX (559) 456-7575
hlandris@ucdavis.edu

Robert H. Beede
UCCE Kings County
680 North Campus Drive, Suite A
Hanford, CA 93230
(559) 582-3211 Ext. 2737, FAX (559) 582-5166
bbeede@ucdavis.edu

Kevin R. Day
UCCE Tulare County
4437-B South Laspina Street
Tulare, CA 93274
(559) 685-3309, FAX (559) 685-3319
krday@ucdavis.edu

Nat B. Dellavalle
Dellavalle Laboratory
1910 W. McKinley, Suite 110
Fresno, CA 93728-1298
(559) 233-6129
www.dellavallelab.com

INTRODUCTION

This is the last year of a 3 year project 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 4 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 4 years for both the peach and the nectarine. During 2006, our emphasis was on refining these relationships. We also made an extra effort to induce certain deficiencies that have been difficult to obtain.

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, 2005 and 2006 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 the dormant shoots. Using this approach, deficiency thresholds were proposed for N, P, B and Zn (see 2004 FREP report).

The emphasis in 2005 was on applying these deficiency thresholds to commercial orchards. This part of the project was not very successful as deficiencies in the field were difficult to find (see 2005 FREP report). Both P and B deficiencies appear to be rare in peach orchards in the San Joaquin Valley and N and Zn fertilizers are routinely applied to almost all orchards to prevent these deficiencies.

RESULTS

2006 was the last year of this project. In order to wrap up loose ends there were a number of questions to be answered with each nutrient. Thus, we conducted various experiments with the sand tank trees or in selected commercial orchards surveyed in 2005. The results are discussed under each nutrient listed below.

Nitrogen (N)

After 4 years of analysis we have concluded that total N in dormant shoots is not a very sensitive indicator of the N status of peach trees. Instead, we have been pursuing 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. In 2006 we analyzed some stored shoot samples for all major amino acids including arginine. The initial results were disappointing as there were no differences between N deficient trees and fully fertilized controls. We are continuing to pursue the approach using different methods of sample preparation. Final results will be presented in our 2006 annual report.

Phosphorus (P)

Since 2004 we have had trees in the sand tanks showing obvious symptoms of P deficiency including reduced shoot growth, smaller fruit size, fruit cracking and early defoliation. Dormant shoot samples have had P values consistently below the threshold we initially established (0.12%). Even though we have been unable to find P deficiency in the field, we are confident this threshold will apply to commercial orchards as well.

*B*oron *(B)*

Based on trees in the sand tanks we established a threshold in dormant shoots of 14 ppm B. Deficient trees have consistently tested below this threshold with some as low as 8 ppm. Several commercial orchards had B levels as low as 13 ppm but no benefit from B fertilizers could be demonstrated in 2005 or 2006. Thus, the threshold we have suggested may be a little high.

Zinc (Zn)

Since the spring of 2003, we have observed a range of Zn deficiency symptoms in the sand tank trees that 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. This prompted us to take a closer look at the variability of Zn levels throughout the tree. In 2006, we did several experiments where we sampled extensively in different locations. Preliminary results suggest substantial differences in Zn between the top and bottom of the tree. Once we have analyzed all the samples we should be able to improve the sampling protocol for Zn. These results will be presented in our final report.

Manganese (Mn)

We have never achieved severe Mn deficiency in the sand tank trees. However, in our 2005 survey of commercial orchards, several had dormant shoot levels of 8 or 9 ppm Mn and exhibited minor Mn deficiency symptoms in the spring. None of the orchards showed any ill effects from these symptoms in terms of fruit size, productivity or vigor in 2005 or 2006.

Therefore, we have concluded that this threshold of 8 ppm Mn is not significant and the threshold of concern is probably lower than this for Mn deficiency severe enough to cause problems with tree performance.

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

Since we have not been able to induce K, Mg or Ca deficiency in the sand tank trees, we decided to take drastic measures in 2006. Our main source of irrigation water for the tanks has significant levels of all 3 of these cations. Therefore, our first step was to install a water softening system for the Minus Mg and Minus Ca treatments. The company that supplied the ion exchange tanks was willing to recharge them with K instead of Na (typical of most domestic water softeners) so we didn't need to worry about salt problems. After a full season of treatment we still see no symptoms of Mg or Ca deficiency but leaf and soil samples have been taken to see what changes have occurred. For the Minus K treatment, we used a source of deionized water for irrigation. There is a Reverse Osmosis (RO) unit at the greenhouse complex at KAC. Water from the RO unit was trucked over to the sand tanks and stored in a 5,000 gallon storage container. Several of the trees in this treatment showed symptoms resembling K deficiency. Leaf and soil samples have been taken in this treatment as well. We plan to continue both these treatments for at least another year.

CONCLUSION

Over the 3 years of this project we have been able to establish deficiency thresholds in dormant shoots for several nutrients and have made good progress with several others. Specifically, we have reliable thresholds for P, B and Zn (with a possibly revised protocol) and still have hope for N. In addition, once we induce deficiencies of Mn, K, Mg and Ca we should be able to develop thresholds for these nutrients as well. Even though the project is officially over in 2006, work will continue on the original objectives for at least one more year.