Developing a Better System for Assessing the Nutritional Status of Peach and Nectarine Trees

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

Introduction

In this modern era of increasing concern over environmental stewardship, every fertilization event needs to be carefully evaluated and fully justified. Excess nutrients can easily escape from the orchard and become environmental pollutants or even remain in the orchard as soil contaminants. It is important to apply fertilizers only when they are needed for optimum production and to make sure they are not applied in excess. Having a method for assessing nutritional status of trees is a critical tool to help guide this process.

The Standard Approach

The established method for nutrient sampling of fruit trees is a mid summer leaf analysis (Shear and Faust, 1980; Robinson et al., 1997). This procedure was introduced about 50 years ago (Batjer and Westwood, 1958) and has been widely applied throughout the world (Leece et al., 1971 and references cited therein). Apparently, the rationale for this timing was based on the observation that leaf nutrient levels remain relatively stable during the summer period, thus providing a wide window for sampling. Unfortunately, the timing is not ideal for many cultural practices. In general, it is too late to have any impact on fruit and shoot growth for that season. Also, once leaves have become more mature, they tend to not take up foliar nutrients as well as young tender leaves in the spring. Finally, soil applications of fertilizers too late in the summer present an increased risk of minimal uptake into the tree and thus a greater risk of environmental contamination. In short, mid summer is not the time of year when fruit growers are thinking about and implementing nutritional programs.

In order to develop an effective and useful sampling procedure for fruit trees the following guidelines should be considered:

1. The sampled tissue should correlate with growth and productivity processes in the tree.
2. The timing of the procedure should be such that immediate corrective measures could be applied if a deficiency is detected.
3. The results should be reproducible from one orchard, variety, season and growing region to another.
4. The sampled tissue should be indicative of the whole tree nutritional status.
5. The test should reveal both deficiencies and excesses for each nutrient.
6. The procedure should be relatively simple and convenient to implement.

The standard method of mid summer leaf analysis generally performs well on guidelines 3-6, but not as well on the first two (problems with #2 are discussed above). Much of the early work that was conducted to establish this procedure was based on leaf symptoms rather than yield parameters. However, leaf symptoms for some nutrients often appear after a reduction in productivity has already occurred. For other nutrients, leaf symptoms can show up without any noticeable effects on growth or yield. Therefore, the deficiency thresholds that have been developed may not relate as well as they should to productivity. In order for a new procedure to be an improvement, it would need to combine the reproducibility, usefulness and simplicity of mid summer leaf sampling with better timing and closer correlation with yield parameters.

A Better Approach

As trees first start to grow in the spring, growers are very concerned about the health and potential size and quality of the crop. Many processes affecting yield and fruit quality happen in the early spring. Flowering, fruit set, fruit cell division (a large factor in potential fruit size), and early shoot growth all occur during the first 30 to 40 days after trees start to grow. Therefore, a sampling procedure during this time would be strategically more useful. There are several tissues that could be sampled for nutrient analysis. These include dormant roots, dormant shoots, flowers and early leaves.

A large experiment with peach and nectarine trees growing in sand culture was initiated in 1999 (Johnson et al., 2003). By applying different combinations of fertilizers, trees with widely varying nutrient contents have been achieved. These trees have been very useful for analyzing the various methods of sampling and comparing them to the standard mid summer leaf procedure. For all the major nutrients (N, P, K, S, Ca, Mg, B, Zn, Mn, Fe and Cu) a 2 to 3 fold range in leaf nutrients has been measured among different trees. In the lower range most have shown some indication of deficiency. The tissues sampled in late winter and early spring likewise showed a similar range of nutrient levels in most cases. However, certain tissues appeared to be more consistent than others. For example, flowers had very high concentrations of N, P and S even in those trees that showed signs of being deficient in these elements. Early leaves showed similar trends. On the other hand, dormant roots had very low concentrations of Ca and Mg even in trees that had been heavily fertilized with these nutrients and had high leaf values. Therefore it seems unlikely that these tissues would be reliable for identifying deficiencies and excesses of all major nutrients. However, dormant shoot sampling has so far proved to be a fairly reliable procedure for all the nutrients. Furthermore, it is a very simple tissue to collect (especially compared to root sampling) and can be sampled over a long time period (in contrast to flower sampling). Therefore, it appears to be a strong candidate for an improved method of assessing peach and nectarine tree nutritional status.

Dormant Shoot Sampling

The next step to establishing dormant shoot sampling as a reliable nutrient assessment procedure is to correlate nutrient concentrations with productivity processes occurring in the spring (guideline #1). This information can be used to establish deficiency thresholds for each nutrient. Several examples will be illustrated here.

Boron has long been known to have an effect on fruit set in many plants (Shorrocks, 1997). Such was certainly true for both Zee Lady peach and Grand Pearl nectarine trees growing in the sand tank experiment. Figure 1 illustrates the relationship with dormant shoot B in peach for 2003 and 2004. Based on this relationship, a deficiency threshold of about 12 to 15 ppm B could be established. A similar relationship with the same threshold was observed for the nectarine (data not shown).

Phosphorus deficiency symptoms were quite prominent in the sand tank trees in 2004. One striking symptom was fruit cracking in the nectarine trees, affecting more than 80% of the fruit on some trees. There was a good correlation with dormant shoot P (Figure 2) and a secondary relationship with shoot Zn. Deficiency thresholds of about 0.12% P and 20 ppm Zn could be extrapolated from this relationship. Additional relationships between shoot P and fruit shape or premature fruit drop (data not shown) supported the same deficiency threshold.

Besides the effect on fruit cracking, dormant shoot Zn also correlated reasonably well with leaf symptoms in the spring (Figure 3). Once again a deficiency threshold of about 20 ppm Zn could be deduced from the relationship.

By analyzing other yield and fruit quality components, such as flower density, vegetative growth, fruit size and fruit defects, deficiency thresholds can be established for all the other nutrients as well. Often the relationships are not quite as strong as those illustrated above, but field experience and trial and error will help refine those over time.

Future Directions

The final step is to test the procedure in numerous locations with different varieties, rootstocks, soil types and climatic conditions to see how reliable and reproducible it is (Guideline #3). Refinement in the procedure may also be needed in case there is an effect of timing during the dormant season or location within the tree. Contamination from foliar Zn, Cu and other micronutrient sprays may also create complications.

Dormant shoot sampling to assess peach and nectarine tree nutritional status holds great promise as a useful tool to help guide orchard fertilization practices. It seems to have all the characteristics of an effective sampling procedure. Perhaps, over time, it could develop into a standard practice for fruit trees.

Literature Cited

Batjer, L.P. and M.N. Westwood. 1958. Seasonal trend of several nutrient elements in leaves and fruits of Elberta Peach. Proc. Amer. Soc. Hort. Sci. 71:116-126.

Johnson, R.S., C.H. Crisosto, H.L. Andris, K. Day, B.A. Holtz, R.H. Beede and K. Klassen. 2003. The effect of nutrient deficiencies on stone fruit production and quality. Proc. Fertilizer Research and Education Program Conference, Nov. 20, Tulare, CA. p. 8-11.

Leece, D.R., F.W. Cradock, and O.G. Carter. 1971. Development of leaf nutrient concentration standards for peach trees in New South Wales. *Journal of the Horticultural Science* 46, 163-175.

Robinson, J.B., M.T.Treeby, and R.A Stephenson. 1997. Fruits, Vines and Nuts. In. D.J. Reuter and J.B. Robinson (eds.) *Plant Analysis, An Interpretation Manual*.2nd Edition. CSIRO Publishing, Australia. pp. 349-382.

Shear, C.B. and M. Faust. 1980. Nutritional ranges in deciduous tree fruits and nuts. *Horticultural Reviews* 2, 142-163.

Shorrocks, V.M. 1997. The occurrence and correction of boron deficiency. Plant and Soil 193:121-148.

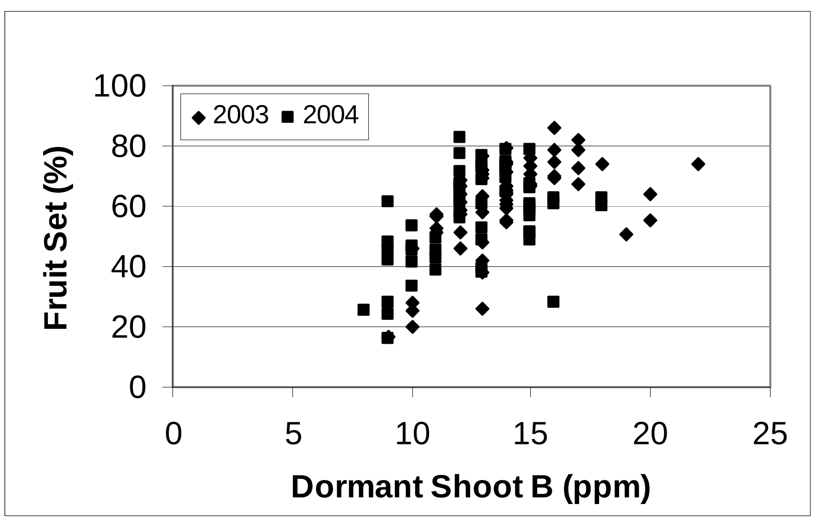

Figure 1. The relationship between fruit set and dormant shoot B for Zee Lady peach in the sand tank experiment in 2003 and 2004.

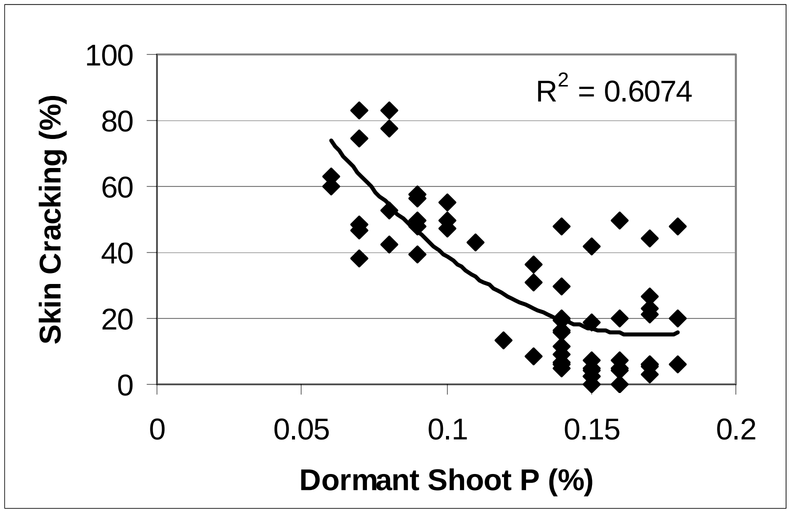

Figure 2. The relationship between Grand Pearl nectarine fruit cracking and dormant shoot P in the sand tank experiment in 2004.

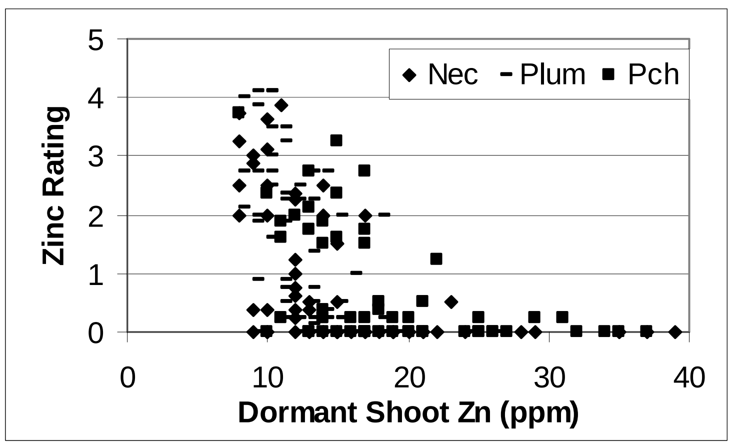

Figure 3. The relationship between Zn deficiency symptoms (0 = none, 5 = severe) and dormant shoot Zn for Zee Lady peach, Grand Pearl nectarine and Fortune plum in the sand tank experiment in 2004.