Zinc Movement and Distribution within a Peach Tree

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Zinc (Zn) deficiency is commonly observed in California peach trees, particularly when grown on Nemaguard rootstock. Foliar sprays are generally applied yearly to alleviate the problem or, in many cases, to prevent the problem from occurring. Some of these applications are probably unnecessary. In addition, zinc is not taken up very efficiently into plants, so relatively high rates of different formulations are applied in order to supply a small amount to the trees. One of the objectives of our research has been to improve both the sampling and application procedures for zinc with the goal of eliminating unneeded sprays and/or reducing the amount of material applied. A more thorough understanding of the movement and distribution of zinc within a peach tree should provide clues and suggest strategies for achieving this goal.

Zinc Distribution within a Peach Tree

Zinc within the fruiting shoots of a dormant peach tree shows a very uneven distribution throughout the plant with much higher concentrations in the lower part of the canopy (Table 1). Exposure to sun appears to be a factor as well. Shoots on the inside of the canopy have higher concentrations than those in outer, more exposed locations at the same height. Thus, shoots in the lower interior portion of the canopy can have almost 5 times greater zinc concentration than those in full sun at the top of the trees. This gradient quickly disappears the next spring as new growth pushes out (Table 1). Thus, the gradient is likely created during summer and/or fall as nutrients are translocated towards the roots for storage. Recent research has demonstrated that foliar zinc moves readily into the roots of a peach tree (Sanchez et al., 2006), which may not be the case for other fruit and nut crops (Swietlik, 1999).

As peach shoots grow in length during the spring, a Zn gradient is established in the leaves along the shoot. However, the direction of the gradient depends on the tree's Zn status. Deficient trees have proportionately more Zn near the tip while the opposite is true for high Zn trees (Figure 1). Typical commercial peach orchards, which generally fall somewhere between these two extremes (termed Zn sufficient), show no gradient at all. This information reinforces the conclusion that Zn moves readily in peach trees, especially deficient ones. It also suggests that basal leaves of young developing shoots could be a good indicator of tree Zn status - deficient trees have depleted levels and high Zn trees have enhanced levels.

The pattern of leaf Zn throughout the season adds further evidence for these conclusions and raises questions about the usefulness of mid season leaf Zn values. In deficient trees there is an initial peak of Zn as growth starts, but then the values quickly drop to about 10 ppm and remain there or slightly lower for the rest of the season (Figure 2). High Zn trees maintain leaf levels above 40 ppm until final leaf senescence. Once again, the average commercial orchard (Zn sufficient) has an intermediate pattern. It tends to drop off steadily throughout the whole season. By late summer and early fall, its leaf Zn level is not too different from the deficient trees. Thus, a mid summer leaf sample would not be as accurate as an early spring sample for separating Zn sufficient trees from deficient ones. Some have reported that the standard mid summer leaf sample is not very accurate for determining tree Zn status (Sanchez and Righetti, 2002).

We have proposed an alternate approach to sampling that appears to have great promise for Zn (Johnson et al., 2006). It involves sampling fruiting shoots during the dormant season. When combined with the information on Zn distribution throughout the tree discussed above, we have obtained results showing very substantial differences in lower, shaded shoots among trees of different Zn status (Table 2). Just recently, we further tested an earlier timing of early September and obtained similar results. Finally, root Zn also showed similar differences among treatments. Thus, there are several tissues and timings that could be useful as a sampling tool.

Implications for Nutrient Sampling

This detailed analysis of Zn distribution suggests certain times may improve our ability to determine the true Zn status of the tree. Distinguishing high Zn status from deficiency can easily be accomplished at any sampling period. However, separating typical commercial orchards (sufficient Zn) from deficient ones is more of a challenge. Using leaf samples, it appears the further into the season, the less separation can be expected (Figure 2). Thus, an early spring sample would be best, especially if basal leaves are analyzed (Figure 1). One problem with this procedure is that rapid changes are occurring at this time, which could make it difficult to establish a reliable standard.

Sampling dormant shoots, especially in the lower part of the canopy, could also be a useful tool for distinguishing between sufficient and deficient trees (Table 2). In orchards where foliar summer or fall Zn treatments have been made, this procedure would generally not work as it is very difficult to wash Zn materials off the surfaces of leaves and shoots. In these situations, root samples could be taken, even though it takes a little more effort. Finally, there appears to be promise in an earlier shoot sampling procedure that could fit well into a fall Zn treatment program. These approaches still need to be more widely tested in commercial orchards.

Implications for Zinc Treatments

In commercial (Zn sufficient) orchards, Zn appears to steadily decline in mature leaves throughout the season (Figure 2). This is in contrast to nitrogen which stays fairly constant in the leaves until senescence in the fall. The continual drop in Zn suggests it is constantly being exported out of the leaf (and perhaps into storage in the shoots and roots). Thus, one approach to supplying the tree with Zn might be to tie into this steady export by providing small amounts throughout the season. This could be expensive as it would require multiple applications, but might be the most effective method.

Another approach might be to take advantage of the remobilization of Zn that takes place during leaf senescence in late fall, although this seems to only occur in high Zn trees (Figure 2). Thus, it may be necessary to have an abundance of leaf Zn in order for this to occur. This suggests an approach of loading up the leaves with Zn during early fall so it is available for remobilization during senescence. In some plants it has been suggested that the movement of certain nutrients like Cu and Zn are closely tied to the remobilization of N (Hill et al., 1979). Field trials with different rates and timings are needed to test these strategies of supplying zinc to a peach tree.

Literature Cited

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Table 1. Zinc distribution throughout a Grand Pearl nectarine tree at different times of the season.

Date	Location						
	Low Shaded	Low Exposed	Low Water sprouts	Mid Shaded	Mid Exposed	High Exposed	High Water sprouts
12/21/05 (shoots)	70.3 a*	39.7 bc	32.6 cd	47.9 b	28.5 de	19.1 d	16.3 f
	Low			Mid		High	
4/21/06 (leaves)	52.6 a			47.6 b		44.3 b	
5/23/06 (leaves)	38.9 a			38.2 a		36.1 a	
7/6/06 (leaves)	20.6 a			21.4 a		19.9 a	

*Values in a row followed by the same letter are not significantly different at p=0.05 by Duncan's Multiple Range Test.

Table 2. Zn content of shoot or root samples from Grand Pearl nectarine trees of deficient, sufficient or high Zn status.

		Zn status		
Date	Tree location	Deficient	Sufficient	High
December 2006	Low shoots	10.1 c*	35.6 b	74.5 a
December 2006	Mid shoots	8.1 c	21.6 b	50.0 a
December 2006	High shoots	6.4 c	13.7 b	26.5 a
December 2006	Roots	6.6 c	24.3 b	62.5 a
September 2007	Low shoots	6.4 c	26.0 b	92.0 a

*Values in a row followed by the same letter are not significantly different at p=0.05 by Duncan's Multiple Range Test.

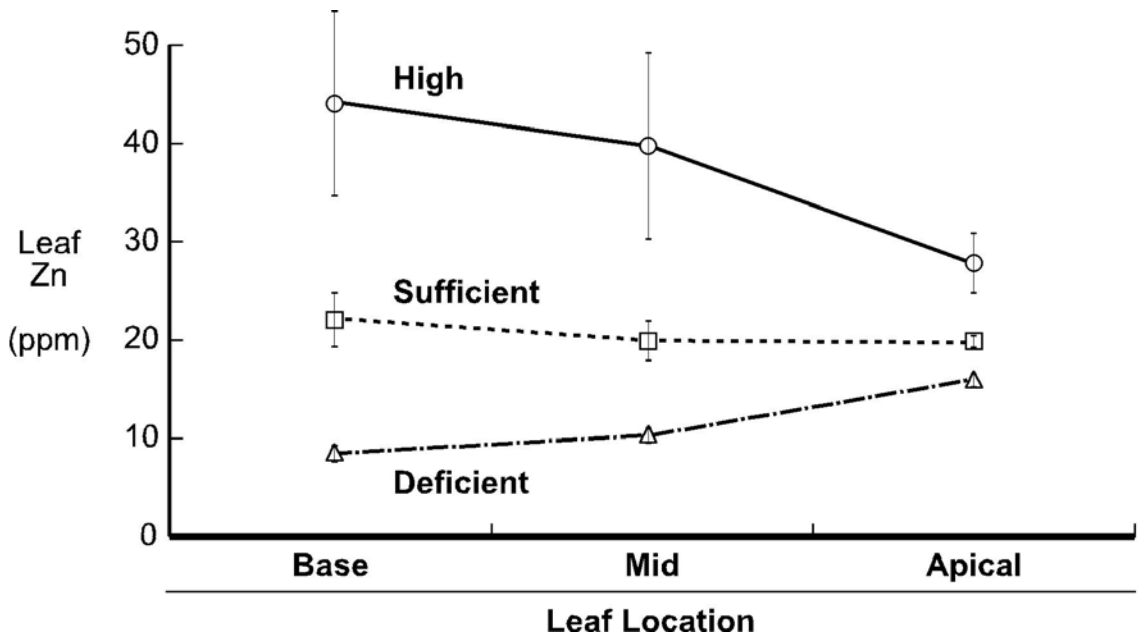

Figure 1. The distribution of Zn among leaves sampled from different locations on growing shoots of Grand Pearl nectarine in June, 2006. Six or seven trees were classified as Deficient, Sufficient or High based on deficiency symptoms and Zn fertilization rates.

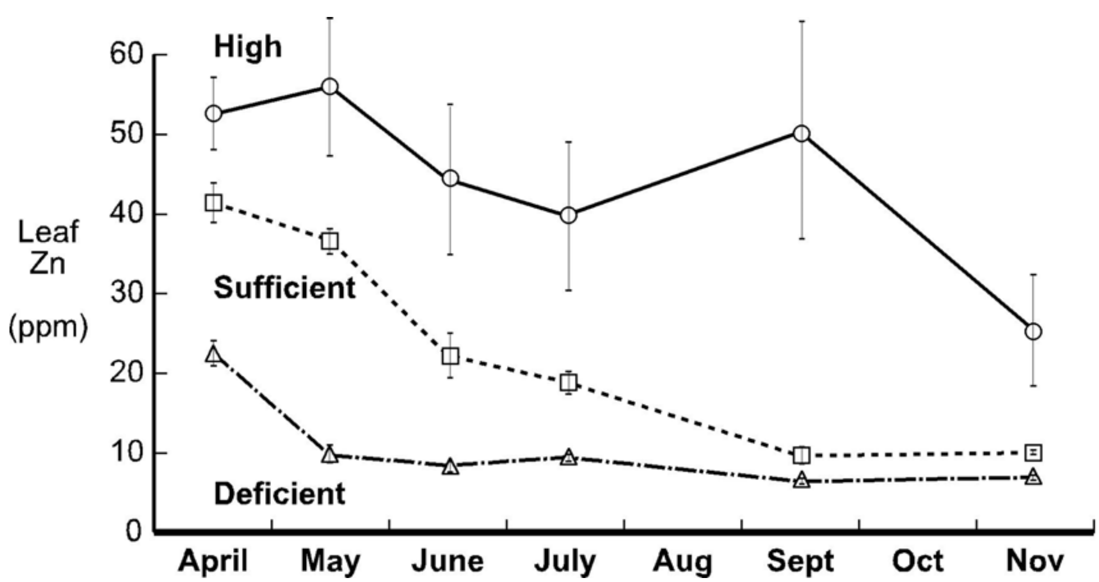

Figure 1. The Zn content of Grand Pearl nectarine leaves sampled throughout the 2006 season. Six or seven trees were classified as Deficient, Sufficient or High based on deficiency symptoms and Zn fertilization rates. The November sample was senescing leaves.