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IN THIS ISSUE

Understanding and applying information from a soil test: Part 4

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This article (Part 4) discusses micronutrients and the use of soil tests to evaluate their levels in orchard soils. Micronutrients are essential to almonds and other nut crops, yet are required in much smaller amounts than macronutrients such as nitrogen (N), phosphorus (P) and potassium (K) or secondary nutrients such as calcium (Ca), magnesium (Mg), or sulfur (S). The eight micronutrients are boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn). They fulfill important roles in the plant. For instance, zinc is needed for plant cell expansion and it influences pollen development, flower bud differentiation, and fruit set while boron is a building block for the plant cell wall and strongly influences pollen tube germination and growth. Flower abortion in almond and walnut has occasionally been associated with boron deficiency. Nickel has recently been determined to be an essential nutrient and there are no known deficiencies in California.

Zinc, iron and manganese deficiencies are not as commonly found in the Sacramento Valley as in the San Joaquin Valley. Zinc deficiency is most common in almond and other nut crops. Other micronutrient deficiencies that are occasionally seen in almond include B, Fe, and Mn. Copper (Cu), Mo, and Ni deficiencies have not been documented in almonds; however, Cu deficiency is common in pistachios.

Five of the micronutrients (Cu, Fe, Mn, Ni, and Zn) largely exist in the soil as positively charged metal cations bound as minerals or adsorbed to the surfaces of colloids or soil particles. Several factors in orchard soils may affect the solubility and availability of these metal cations to trees. Soil pH greater than 7.5 has the major influence of reducing the tree availability of Zn, Fe, and Mn in the soil and to a slightly lesser extent Cu. Generally, organic matter increases the availability of the metal cations to plants. Dissolved organic substances bind with these metal cations to form chelates which are a soluble metal-organic complex that renders them more available for plant uptake. Organic matter with a high carbon to nitrogen ratio or high carbon to phosphorus ratio may temporarily immobilize these metal cations until the carbon decomposes. Soil pH above 7.5 and low soil moisture conditions will increase metal precipitation, reduce solubility, and nutrient availability to trees. Metal micronutrients tend to be concentrated in the upper soil horizons and are not easily leached. However, loss of soil by erosion or land leveling will result in a loss of these metal micronutrients.

Acidic, sandy soils where leaching with low salt irrigation water occurs may exhibit Zn as well as B deficiencies.

The micronutrients Cl and Mo generally exist in soil as negatively charged anions. Boron generally exists in soils as a non-charged acid in acidic soils and as an anion in alkaline soils. Chlorine and B have a much higher likelihood of leaching than do the positively charged metal micronutrients. Leaching is more likely to occur in sandy soils, particularly with rainfall or low salt irrigation water. Molybdenum (Mo) exists in minerals and is strongly adsorbed to soils so it does not leach as readily as Cl and B. Molybdenum is different from most of the micronutrient cations in that it increases in plant availability as the soil pH increases.

The metal micronutrients are extracted from a soil sample with DTPA (diethylenetriaminepetaacetic acid), a chelate designed to extract the most readily available forms of the positively charged metals. Concentrations of DTPA extractable Zinc (Zn) in soils have the strongest relationship with plant growth responses when zinc fertilizers are applied to soils. Boron deficiency is more likely assessed in a soil sample using a hot water extract method while the toxicity of B is assessed in the soil-water extract from a saturated soil paste. The saturated paste soil-water extract is part of a salinity evaluation to assess risk of boron toxicity in trees and will be the subject of a future newsletter article. Since the toxicity of Cl is more likely than the deficiency, it is usually measured in the saturated paste soil-water extract too. There is no reliable soil test for Mo and because Ni deficiencies have not been observed, it is rarely tested.

Table 2 outlines low, medium, and high soil fertility levels for B, Cu, Fe, Mn, and Zn where the crop is not expected to respond, possibly respond, or be highly responsive to micronutrient additions. The micronutrients have different ranges in fertility levels and anticipated responses.

Table 2. Guidelines for interpreting micronutrient levels measured with soil fertility tests on samples taken in the top 6 inches of soil*.

Level of Expected Crop Response	Boron (B) (Hot Water Extract)	Copper (Cu) (DTPA Extract)	Iron (Fe) (DTPA Extract)	Manganese (Mn) (DTPA Extract)	Zinc (Zn) (DTPA Extract)
	Soil test level (ppm)				
Highly Responsive	0.0-0.5	0.0-0.8	0.0-5.0	0.0-2.0	0.0-0.7
Probably Responsive	0.5-1.2	0.8-1.2	5.0-15.0	2.0-10.0	0.7-1.5
Not Responsive	> 1.2	>1.2	>15.0	>10.0	>1.5

*Western Fertilizer Handbook, 9th Ed., 2002.

Micronutrient soil tests provide added perspective about the fertility levels of soils and the possibility of a deficiency. They are used effectively in some annual crops to guide management decisions. Almonds and other nut crops are perennials that can store and translocate nutrients and the root systems tend to be more extensive and make acquiring representative soil samples challenging. If a micronutrient deficiency is in question, comparative soil samples from good and poor areas can give added confidence in diagnosing the problem with soil testing. Plant leaf tissue testing and visual plant symptoms are important tools to confirm soil test results and diagnose micronutrient deficiencies. If a deficiency is identified, foliar versus soil applications of micronutrient fertilizers needs to be considered. Foliar applications of micronutrients may be more economical and efficient for managing deficiencies. Since soil pH, particularly when above 7.5 has such a major role in determining the availability of the micronutrients Zn, Fe and Mn and to a lesser extent Cu, banded acidification of soils with materials such as sulfuric acid and elemental sulfur may be a desirable long term solutions in some orchards. Conversely, liming acidic soils with pH below 5.5 may be viable if leaf tissue and soil sample analysis confirm a problem with micronutrients.

Bacterial blast

Joe Connell, UC Farm Advisor, Butte County and Carolyn DeBuse, UC Farm Advisor, Solano and Yolo County

Cold, frosty, and wet weather at bloom often results in bacterial blast killing flowers and spurs on varieties in susceptible growth stages. Bud death leaving blank wood with few leaves on some shoots is another symptom of blast. Leaf spots, irregular leaf lesions, and marginal or leaf tip necrosis can also occur. If blast is severe it can cause significant leaf drop in some areas of the orchard. Some young leaves killed by blast may adhere to the branch for the remainder of the season.

Fruiting and leafy spurs on bearing trees can be killed by blast. As the spur dies, an abscission zone sometimes forms where the spur attaches to the branch. A blasted woody spur can detach and drop off the tree when touched. Sometimes tender new shoots are blasted and blackened on one side of the stem, which results in curling or bending of the shoot as growth continues.

The distinguishing difference between bacterial blast and brown rot (*Monilinia laxa*) is that brown rot attacks flowers only and often has spores present on affected tissues as well as associated gumming while bacterial blast will attack both the flowers and the leaves. Twig and spur dieback occur in both diseases. Most orchards have had adequate fungicide programs in place to control brown rot. If one or two brown rot sprays were applied and damage is present, bacterial blast is more likely the culprit.

The pathogen, *Pseudomonas syringae* lives on all plant surfaces and is spread by splashing rain or sprinkler water. Low temperatures with moisture especially favor the disease. Bacterial blast is usually more severe in orchard areas that are prone to cold air invasion such as along the north edge of a block that receives cold wind drift or in low areas that receive cold air drainage. Trees on Marianna 2624 plum rootstock are significantly more susceptible to blast than are trees on peach rootstocks. This year trees on the Ishtara rootstock were observed to have even more severe blast than trees on Marianna 2624.

Frost and cold pockets are sporadic in orchards and the distribution of blast is similarly sporadic. Sometimes orchards running frost protection sprinklers have more severe blast where water hit the trees. Other orchards that didn't run water can have severe blast as well. Usually one variety in a planting will be more severely affected than the others. Peerless was at an especially susceptible stage of development when cold weather occurred during mid-bloom but other varieties such as Butte are also showing blast damage in some orchards. There are no treatments that can effectively prevent bacterial blast.

If blast occurred in your orchard there is no action you can take to reduce the damage this year. Practice measures such as adequate fertilization and irrigation that will encourage good plant growth. Growth of new shoots from latent buds should help fill in the gaps where shoots or spurs have been killed.

Handling late planted trees

Bill Krueger UC Farm Advisor Glenn County and Joe Connell UC Farm Advisor Butte County

While not ideal, new trees can be, and often are, successfully planted late into the spring if field conditions prevent more desirable earlier planting. Following are some considerations to improve the results of late plantings.

Bare root trees. Bare root trees need to be dormant when planted regardless of the time of planting. Keeping the trees in cold storage until they are ready to be planted creates an opportunity for problems and must be done properly. Occasionally Phytophthora infections occur on the trunk. These cankers can girdle and kill the trunk from the infection point up. Sometimes this occurs in groups of trees tied together in bundles and may be referred to as ‘bundle rot’. This can show up in a field pattern of infected trees related to how infected bundles were planted. Proper handling and sanitary conditions in cold storage can minimize these types of problems.

Hot temperatures during the time of planting trees coming from cold storage can damage the tree because they are not acclimatized to the heat. Plant in the cooler morning hours, avoid planting during heat waves, tank the trees in quickly with water and whitewash the trunk the same day when planting directly from cold storage in late spring to minimize heat damage.

Potted trees. Potted trees are becoming more common and can be planted at any time of the year although fall planting and early spring planting have generally given the best results. They have a limited root system and proper ground preparation and frequent wetting of the root ball is critical to tree survival and performance especially if planted during warm conditions. It is recommended that the irrigation system be installed before planting and that the site be pre-irrigated 5-7 days before planting if the soil moisture is less than ideal. The trees should be irrigated the day of planting with enough water to completely wet the pot and eliminate air pockets. Moisture in the area of the pot should be monitored frequently to be sure that this area does not dry out until the roots have moved out into the soil.

Preventing “Wrapper Burn”. Any late planted trees need to be protected from sunburn. This can be accomplished by using reflective tree wrappers and by whitewashing with white interior latex paint diluted 1:2, paint to water. If weather turns hot newly planted trees can experience “wrapper burn”, sunburn damage from the top of the wrapper to about 4 inches down. The tree usually sprouts and regrows below the damage but this setback can be avoided by combining wrappers with whitewashing. Be sure trunks are protected all the way to the ground. Improvements in some tree wraps have been made recently with the inside top of the carton colored dark green to reduce reflection. This change reduced the temperature inside the carton and presumably should help reduce “wrapper burn”. The extra whitewashing step should eliminate the problem.

Late planting requires special attention to irrigation to insure success. Light frequent irrigations are recommended. Be sure water penetrates to the bottom of the root ball and check soil moisture in the root zone often to insure that trees are adequately watered without being over-irrigated.

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Determining sprayer speed in the field

Franz Niederholzer, UC Farm Advisor, Sutter/Yuba Counties

Accurate sprayer speed measurement is essential to equipment calibration and effective spray material application. This is true for airblast as well as weed sprayers. Tachometer speed readouts are unreliable. Relying on tach speed for sprayer calibration can waste pesticide material and/or contribute to poor pest control. For the most uniform spray coverage and best pest control efficacy, air blast sprayer speed should not exceed 2.0 MPH.

There are a couple of simple ways to measure sprayer ground speed in an orchard. Either of these methods can be used for initial sprayer calibration and/or spot-checking sprayer speeds during an application.

Method 1. Count trees/minute down the row. The number of trees passed per minute = (speed of travel in MPH x 88 ft/sec) divided by tree spacing in feet. One MPH=88 ft/min. The following table converts trees/minute to MPH and feet per minute. Use a stopwatch to time travel down the row.

For example, reading off the chart below, if I want to travel 2.0 mph and my trees are spaced 22 feet apart I should pass 8 trees in one minute. Or put another way, if my trees are 18 feet apart and I passed about 11.5 trees in one minute, I'm travelling between 2.3 and 2.4 mph….a bit too fast!

Trees/minute at different sprayer ground speeds at various down-the-row tree spacings.

---------------------------Tree spacing (in-row)--------------------------

Sprayer Speed (MPH)	Ground travel Feet/Min.	12’	14’	16’	18’	20’	22’	24’
2.5	220	18.3	15.7	13.8	12.2	11.0	10.0	9.2
2.4	211	17.6	15.1	13.2	11.7	10.6	9.6	8.8
2.3	202	16.9	14.5	12.7	11.2	10.1	9.2	8.4
2.2	194	16.1	13.8	12.1	10.8	9.7	8.8	8.1
2.1	185	15.4	13.2	11.6	10.3	9.2	8.4	7.7
2.0	176	14.7	12.6	11.0	9.8	8.8	8.0	7.3
1.9	167	13.9	11.9	10.5	9.3	8.4	7.6	7.0
1.8	158	13.2	11.3	9.9	8.8	7.9	7.2	6.6
1.7	150	12.5	10.7	9.4	8.3	7.5	6.8	6.2
1.6	141	11.7	10.1	8.8	7.8	7.0	6.4	5.9
1.5	132	11.0	9.4	8.3	7.3	6.6	6.0	5.5

Method 2. Use a simple, hand-held GPS unit to determine speed down the row. These units are accurate and can be moved from sprayer to sprayer.

Nitrogen contribution from irrigation water

Richard P. Buchner – UC Farm Advisor Tehama County

Irrigation water can contribute a significant amount of nitrogen to irrigated orchards. In 2000, irrigation water analyses from seventeen locations in six Sacramento Valley counties (Table 1) showed an average of 3.42 ppm nitrate nitrogen (NO_3-N) with a range of 0 to 10.42 ppm NO_3-N. In terms of orchard management, one acre-foot of water with 3.42 ppm NO_3-N would contain 9.30 pounds of nitrogen. A seasonal water application of 3 acre-feet of this water could contribute 27.90 pounds of nitrogen per acre depending upon irrigation efficiency. If you would like to check your irrigation water, here's how:

- Elevated nitrogen is most often associated with ground water so typical water samples would be taken from irrigation wells. Surface water is typically low in nitrogen unless runoff has contributed nutrients or organic material. Use a clean, thoroughly rinsed plastic bottle with a volume of about 16 ounces. Bring the irrigation system up to operating pressure and after about 30 minutes take a sample as close to the pump as possible. Make sure any fertilizers or other chemicals previously injected are completely flushed prior to sampling. Samples can be taken any time during the season when the system is running. Sampling the first irrigation of the season may be more useful for same season nitrogen management decisions.

- Store the sample in a cool location with the lid on tight. As soon as possible submit the sample to a commercial laboratory experienced with agricultural water sampling and have nitrate nitrogen (NO_3-N) determined in parts per million (ppm).

- Agricultural labs that specialize in commercial testing or diagnostics report nitrate as ppm NO_3-N (nitrate levels expressed as elemental N) because N fertilizers are considered in terms of percent or pounds of elemental N. For those lab reports, multiply the nitrate nitrogen (NO_3-N in ppm) value for each sample by 2.72 to calculate pounds of nitrogen per acre-foot. In the data from the 2000 orchard survey, the average value was 3.42 ppm NO_3-N so 3.42 x 2.72 = 9.30 pounds of nitrogen per acre-foot. If you applied 3 acre-feet of water per acre during the season and all of it entered the soil (100% application efficiency) the applied nitrogen would be 27.90 pounds per acre (9.30 x 3 = 27.90).

- Laboratories that specialize in evaluating water for drinking quality are more likely to report nitrate as NO_3 ppm and not as elemental N because that is the unit of measure typical for drinking water quality standards. Both labs use similar analysis procedures but report the results differently depending upon the end use. For labs that report as NO_3 (ppm), multiply the nitrate value (ppm NO_3) for each sample by 0.61 to calculate the pounds of nitrogen per acre-foot of irrigation water. For example, if your lab reported 15.24 ppm nitrate NO_3 then the calculation would be 15.24 x 0.61 = 9.30 pounds of nitrogen per acre-foot of irrigation water. As above, if you applied 3 acre-feet of this water through the season at 100% application efficiency the applied nitrogen would be 27.9 pounds (9.30 x 3 = 27.9).

- Adjust nitrogen applications to account for nitrogen contribution from irrigation water.

Irrigation Water Nitrogen Survey

Location	NO_3-N in irrig Water (ppm)	Pounds of Nitrogen per acre-ft of water
Glenn #1	2.09	5.68
Tehama #1	0.0	0.0
Tehama #2	2.72	7.39
Butte #1	3.15	8.56
Sutter #1	1.04	2.82
Butte #2	10.42	28.34
Sutter #2	3.36	9.13
Butte #3	0.0	0.0
Sutter #3	0.0	0.0
Butte #4	5.21	14.17
Tehama #3	1.65	4.48
Butte #5	1.53	4.16
Yuba #1	2.60	7.07
Yuba #2	1.60	4.35
Glenn #2	8.30	22.57
Yolo #1	6.1	16.59
Sutter #4	8.51	23.14
Average	3.42	9.30

Table 1. 2000 water analyses for NO_3-N content (ppm) for selected orchards in the Sacramento Valley. Since the data collected was reported as ppm NO_3-N, the conversion factor is 2.72 to calculate pounds of nitrogen per acre-foot of irrigation water.