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FIELD NOTES

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Meet The New Farm Advisor

Hello! Please allow me to introduce myself as the new Dairy Farm Advisor in San Joaquin and Stanislaus Counties. As a native of neighboring Merced County, I am very excited to return to the San Joaquin Valley and work with you to achieve common goals that benefit agriculture.

I received my B.S. and M.S. degrees in Animal Science, with an emphasis in Dairy Nutrition, from the University of California, Davis. Upon completion of my M.S. degree, I took the position of Junior Specialist in the Ruminant Nutrition Laboratory at UC Davis, where I continued to collaborate with professors and graduate students in various research projects. Working in that position kept me up to date on emerging issues impacting the dairy industry in California, such as issues related to the care and management of animals, organic farming, genetically-modified organisms, and air and water quality issues.

As I begin my career in Cooperative Extension, I am asking for your help in building a dairy program that is suited to your needs now and in the future. Please feel free to contact me with any questions, concerns or ideas you may have. Better yet, invite me out to your farm and let's talk! I look forward to building a program that will contribute to the continued success of the California dairy industry and you, its farmers.

Jennifer Heguy, Dairy Farm Advisor
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Considerations in Planting Olives For Oil

It is obvious from the number of new plantings around the northern San Joaquin Valley that interest in growing olives for oil is increasing. Most new orchards are so-called "super-high-density" (SHD) plantings of oil varieties Arbequina, Arbosana and Koroneiki. Because of their low vigor and high productivity, these varieties are well suited to the close spacings (4'X12' or 5'X13', or 600-900 trees/acre) of SHD plantings. A few "high-density" plantings (200-350 trees/acre) of other more vigorous (mostly Italian) oil varieties have also been established.

The expectation that this new crop will be successful is based on several assumptions:

- Ability to harvest with machines will keep harvest costs low

(Continued on page 2)

TABLE OF CONTENTS:

Thanking Our Cooperators

In a continued effort to acknowledge and appreciate the valued cooperators who help make our applied research projects possible, we would like to recognize and thank the following individuals for their time, help, and support of our research and extension efforts.

Frank Olagaray
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Leonard Thompson
Craig Thompson
Areli Toledo
Tim Ustick
Ed Vermeulen
Bill Vignolo
Dave Vitolo
Bob Whitaker
Ron Young
Ed Zuckerman

(Continued from page 1)

- Highly precocious and productive oil varieties will allow for early return on investment
- California can establish a reputation as a producer of high quality oil that will command premium prices
- Marketing efforts will induce US consumers to use more olive oil or shift their consumption from imported oils (almost all oil used in the US comes currently from Italy) to higher quality California oils

Considerations for deciding whether this new crop is right for you can be broken down into four areas:

Economics. Most recent cost studies peg the cost of establishing SHD olive orchards at roughly $10,000/acre net accumulated cost through the third year when production starts. SHD plantings under good management reach full production by the 5th year. Grower returns are dictated by production costs (around $1,500/acre per year, excluding overhead and capital recovery costs), tonnage (5-6 tons/acre are reasonable), oil yield (40-45 gallons/ton for Arbequina), price of the oil (current bulk price is $24-30/gallon), and the costs of milling, bottling and sales. As stated above, long-term economic feasibility will depend heavily on the prices consumers are willing to pay for a differentiated product. A 2007 cost study for the northern San Joaquin Valley is available at http://ucce.ucdavis.edu/files/filelibrary/2161/43379.pdf.

Climate/Weather. Olives are sensitive to cold. Areas prone to frost during bloom (late April-early May) or freezing temperatures (<29°F) at harvest time should be avoided. Winter temperatures below 25°F will kill young olive trees and branches of mature trees. Temperatures below 22°F can kill mature trees. Cool/wet or dry/windy conditions during bloom can reduce pollination and fruit set.

Soils. Olives are adaptable to a wide variety of soil conditions, but do not tolerate "wet feet". Avoid heavy clay soils. Successful orchards have been established on soils as shallow as 2 to 3 feet, but the soil must be well drained. "The best" soils needed for other tree crops should be avoided because they can induce excessive vigor and lower fruit/oil production in olives. Sites with a high water table should have at least 4 feet of year-round saturation-free rooting depth. Olives tolerate a wider range of soil pH (5.0 to 8.5) and higher levels of soil salts than most tree crops but do best in pH 6.5 to 7.5 soils with low salts. High soil boron (>2ppm in saturated paste test), sodium (SAR >15) or chlorides (>10-15 meq/l) can

(Continued on page 3)

Calendar of Events

◊ **UC Davis Small Grains, Alfalfa and Forage Field Day**
May 14, 2008 8:30 a.m. - 4 p.m.
Agronomy Field Headquarters on Hutchison Drive, 1/2 mile west of Highway 113, Davis
Info: Dan Putnam (520) 752-8982

◊ **San Joaquin County Wheat Variety Trial Field Meeting**
May 15, 2008 10:00 a.m. - 12 noon
Victoria Islands, Highway 4, west of Stockton
Info: Mick Canevari (209) 468-2085

◊ **Lodi Regional Research Roadshow**
May 28, 2008 8:45 a.m. - 4:00 p.m.
at Wine & Roses Hotel and Restaurant, Lodi
To attend do one of the following:
1) Register online at http://ucanr.org/lodiroadshow ***or before May 23***
2) Contact Cliff Ohmart before May 23 (209) 367-4727; email cliff@lodiwine.com ***or***
3) Bring $10 per person day of event, cash or check only

(Continued from page 2)

cause problems. Sites with a history of Verticillium wilt in susceptible crops like tomatoes, peppers, melons (and, in fact, most non-grain field and vegetable crops) should be avoided. At a minimum, soil from such sites should be tested for the presence of Verticillium propagules.

Irrigation Water. Young developing olive trees need full irrigation to promote rapid growth until trees fill their allotted space. Mature orchards require less water than other tree crops. Recent studies have shown good production and oil quality can be achieved under controlled deficit irrigation at around 50% ET, or about 2 acre-feet or water per year. Orchard well capacity and irrigation system design must be adequate to meet peak orchard demands for water. Irrigation water for olives should have boron levels under 2 ppm, total salts under 3 dS/m (=mmhos/cm), and sodium under 3 meq/l and chlorides less than 345 ppm.

Terrain. In hilly terrain, avoid planting olives in low-lying areas subject to water-logging and frost. Such areas can also easily impede or prevent harvest machinery, even with a small amount of rain at harvest time. Most harvesters can not self-level on side slopes over 20%. Whether on flat or sloping terrain, harvest operations also require sufficient turn-around space at row ends and flat and conveniently located fruit dumping or staging areas. Check with your harvest operator when planning olive orchards, especially in hilly terrain.

Joe Grant, Farm Advisor

Sampling representative areas of prospective oil olive orchard sites – at 6" and 18" depths - can help identify salt and pH related problems that might make the site unsuitable for olives.

The New Home of the UC Cooperative Extension

The San Joaquin County Agricultural Center, which is located on the corner of Arch/Airport Road, B Street, and East Earhart Avenue will be the new home of the Agricultural Commissioner, Cooperative Extension, and the Office of Emergency Services. This facility includes 110 work stations, three class rooms, an 8,000 sq. ft. auditorium, 20 private offices, and 14 conference and meeting rooms. It is slated to be completed in July 2008.

The photo above is the view from Arch/Airport Rd. and B Street, which is the back of the Ag Center.

Can You Trust The Selection Interview?

During a three-day workshop on agricultural labor management, presenters focused extensively on the selection of farm personnel. During the last day of the seminar, class participants were divided into groups and had the opportunity to work on their interviewing skills.

The assignment for each of the four groups was to first come up with a basic description of a farm operation and then consider effective interview questions. Each group would have the opportunity to interview four separate equipment operator candidates. The assignment required a ranking of each equipment operator from best to worst.

While these farm managers and mid-level supervisors prepared for the interview, I met with the four 'applicants.' It was clear to all that they were not applying for a real job, but were helping us out in the seminar. Two of the equipment operators had been lent to us by neighboring farmers while the other two were employees for the large agricultural cooperative where the seminar was held. I knew that one of these two men only drove a tractor to empty garbage bins and do other like assignments at the plant. As I met with all four operators, I suggested to them, "Don't be afraid to have fun here, and play the role of someone applying for a job. Feel free to make up any information you want to."

When the interviews were concluded, one candidate rose as the clear choice among three of the four groups, and the second choice of the remaining group. All four groups quickly and independently came to the same conclusion about the man who drove a tractor mostly to empty the garbage in the plant, and placed him at the bottom of the list as the least desirable. So much for my instructions "To have fun," I thought. This candidate had been candid about his experience.

The first surprise came when I asked the seminar participants if now that they had ranked the equipment operators, if they would like to know how the equipment operators ranked each group. As I have carried out this little experiment in many nations over the years, it is clear that while farmers are interviewing applicants, these applicants are in turn evaluating the farm employers too.

The groups that score well with applicants tend to: 1) have all members of the interviewing team ask questions; 2) allow the applicant to speak more than the interviewers; 3) ask difficult questions but allow applicants to save face if they do not know the answer; 4) listen to and attend carefully to the applicant rather than allow themselves to be distracted or get bored; 5) have a sense of humor, while being respectful; 5) encourage applicants to ask questions; and 6) seem to be united in purpose and not at odds with each other.

While the interviews were taking place, another group of class participants were outside developing a course to use as a practical test of driving skills. They had situated bins in the place of fruit trees, and had spaced them in rows as if we were out in an orchard. Candidates were asked to back their tractor and implement down the road between orchard blocks and then back up into a specific row.

The tractor operator who had refused to exaggerate his experience for the role play did a better job than any of us expected. The real surprise came, however, when the second applicant who had been provided by the farm cooperative had his turn. He had been the clear choice in the morning, after the interviews. Now, it turned out, he was having a great deal of trouble maneuvering the tractor without hitting the bins that represented fruit trees.

The cooperative had not told me that he was their truck driver, rather than an orchard equipment operator. Yet he had managed to come across so well in the interview that most groups had selected him as their first choice. I began to look at the faces of disbelief of the participants. "It must be the tractor," some suggested. The tractor the cooperative had provided was not very smooth, but both cooperative employees had had some experience with it and so chose to drive that tractor rather than a second tractor provided by one of the neighboring growers.

One of the axioms of employee selection is that interviewers look for information to help prove their perspective and tend to discard information that contradicts it. "We want to see him drive the other tractor," they suggested. The driver did just as poor a job using the second tractor.

Practical tests are a much better predictor than interviews, of effective employee performance on the job. For more ideas on designing a selection process using practical tests contact the author at gebillikopf@ucdavis.edu or download chapters two and three of the book Labor Management in Agriculture: Cultivating Personnel Productivity, found at http://www.cnr.berkeley.edu/ucce50/ag-labor/7labor/001.htm

Gregorio Billikopf, Area Farm Advisor

Controlling Medusahead—What Options Do I Have?

Medusahead is an invasive grass which has been slowly and quietly taking up residence on our rangelands. Have you noticed it on your place? Want to figure out how to get rid of it? UCCE livestock advisors and UC researchers have been working on some different options. The following gives some information to help you decide what works best for you and your ranch.

Medusahead has been documented in California since the 1950's, and in the past ten years we have seen a dramatic increase in the acreage and counties infested. The thatch layer that it creates is not only a fire hazard, but also decreases biodiversity and wildlife habitat. Controlling this invasive plant is key to good rangeland health.

Medusahead looks similar to foxtails, although there are some key differences. First, the awns are much longer and tend to be very wavy as the seeds mature, leading to its name. Second, it germinates and matures later than the rest of the annual grasses, often being the only green forage out late in the spring. Third, and maybe most importantly, it is not very palatable to livestock and does not breakdown at the end of the year due in part to its high silica content, creating a thatch layer. This is also how it is able to outcompete other grasses and spread through an area.

The later maturity of Medusahead is a useful characteristic that lends itself to several management practices. For example, burning is an excellent management option. Since Medusahead matures later, the more desirable annual grasses will have already dropped seeds, ensuring a seed bank for the following years. A quick-burning fire will sterilize the current season's Medusahead seeds and remove any thatch layer build up from previous years. Reseeding the area can help establish a more desirable forage base, and outcompete any residual Medusahead seeds from previous years.

If obtaining a burn permit is not something you are able to do, you may want to consider mowing as an option. There is a roughly three-week window of opportunity before there are mature Medusahead seeds when removing the vegetation by mowing can be effective. That window will be slightly different each year depending on rainfall pattern and temperature to name a few variables, but in the valley we can expect it to be roughly late March to mid April. Simply mowing during that time frame dramatically reduces the amount of viable seeds in the area, and also reduces the thatch layer. However, mowing does come with a few cautions, especially if the pasture is very steep or rocky.

If a burn permit is out of the question, and you have too many rocks in your pasture (and you don't want to call CDF to explain how after trying to get a burn permit for a few years how you ended up with a fire without permits!), what next you may ask? Well, believe it or not, grazing can be an option. As I mentioned earlier, livestock do not prefer Medusahead, so you just have to cover the "brussels sprouts" with some sugar to convince them to clean their plates. Low moisture supplement tubs have been shown to attract livestock into an infested area. We have demonstrated a significant decrease in Medusahead owing to the tubs, due to increased trampling activity as well as grazing. Again, we need to target the small, two-week window of opportunity available. There has been mixed results with spraying molasses directly on the thatch to attract livestock. We had limited success with sheep, but local knowledge has had success with grazing dry cows, and we will be evaluating the effect this summer.

Still want another option? This year we are also looking at Roundup sprays during that same two-week window. The benefit would be that desirable annuals would have already dropped seeds, so spraying at that time should only affect the Medusahead and any other late-maturing winter annuals (such as yellow starthistle) or summer annuals. We have been spraying at different dates, early-, mid- and late-season, as well as at different rates. We should have some preliminary data to share this summer on how well Roundup is working.

If you would like any other information, please feel free to contact me at the Modesto office, 525-6800.

Theresa Becchetti, Farm Advisor

Phytophthora capsici, Cause of Root and Crown Rot of Tomatoes, Peppers and Squash

Last year (2007) we saw a small epidemic of *Phytophthora capsici* in tomatoes and peppers that included a few fields on Roberts and Union Islands, some in the Tracy-area, and a few fields on the east side of the county. While there are other species of *Phytophthora* that can cause disease in each of these hosts, this species is fairly aggressive and can also cause a foliar blight if spores of the pathogen are splashed up onto the leaves or fruit and there is free moisture. This disease is particularly severe on peppers, and also on pumpkins and summer squashes.

Unfortunately, *Phytophthora capsici* has a large host range which includes peppers, tomatoes, eggplants, squash, and other cucurbits such as melons, as well as the weed velvetleaf (doesn't seem to be hurting its reproduction though!). *P. capsici* is a soil inhabitant and forms survival structures (oospores) which are long-lived in the soil.

Symptoms *P. capsici* can cause damping-off of direct-seeded crops. With transplants, you may see a rapid death of the young plants. Established plants will exhibit a crown rot and dramatic wilt; older plants may survive but yield will be reduced. Stems are usually infected at the soil line, but stems can also be infected higher up. These stem lesions have a water-soaked appearance, often appearing dark purplish-brown. With time, the stem lesions may girdle the branch, which will then collapse and die. In the aerial phase of this disease (which is less common in semi-arid climates such as ours), stems, foliage and fruit may become infected and exhibit dark water-soaked lesions and fluffy white mold on fruit. Fruit can also become infected where they touch the ground, a problem for pumpkins in particular.

Conditions for disease The inoculum that begins the disease in a new crop most commonly comes from the soil, where it can survive for extended periods. The pathogen can also be introduced into a field from surface irrigation water from rivers or ponds containing drainage from infested fields. The disease can also come in on contaminated transplants, although commercially-grown transplants are less likely to be the source. This pathogen can be moved from infested to clean fields via soil that adheres to equipment.

Wilt of a pumpkin plant as a result of crown infection with *Phytophthora capsici*. Copyright American Phytopathological Society.

This disease is favored by warm, wet conditions. Infection below ground can occur when soils are saturated for as little as 5 to 6 hours. Heavy soils and compaction can result in severe disease. Optimum temperatures for infection are 75 to 92 °F.

Disease due to *P. capsici* has been shown to be aggravated by salinity problems. Some fields with *P. capsici* problems last year also had salinity issues, but some did not. Nonetheless, the salinity-*P. capsici* connection may have been a contributing factor to last year's epidemic, at least at some locations.

Management. Because this pathogen can survive so well in soil, crop rotation is of limited utility. However, staying out of cucurbits, peppers, and tomatoes for three years may have some benefit. When moving equipment from infested fields, clean them of soil, if feasible.

Choose well-drained fields for susceptible crops and avoid saturating the soil. In heavy soils, root and crown rot may be reduced by irrigating every other furrow and then switching furrows for the next irrigation. Carefully managed drip irrigation may also reduce disease incidence.

Fungicides are not typically used against this disease under our conditions, but may be useful in some situations where there is a history of the disease. This year I'll be conducting a field trial to evaluate chemical control of this disease in peppers. I'll keep you posted of the results.

Brenna Aegerter, Farm Advisor

Management Strategies for Offsetting Rising Fertilizer Costs

Fertilizer prices have escalated to an all time high of over two to three times the cost of last year. Nitrogen, phosphorous, potassium and sulfur have been impacted by price increases, and unfortunately these are the major nutrients needed for most crops. A frequently asked question is how to reduce fertilizer costs without causing yield and quality loss. Here are some general guidelines to consider;

1. Sample the soil and plant tissues to determine crop needs. One should not guess at crop nutrient needs especially when cutting rates. Soil and tissue testing is inexpensive compared to the cost of fertilizers or the potential yield loss that may occur. Historically, growers use recipes that have worked for years but unknowingly may have been applying excessive amounts. Some nutrient levels could be building up over years while others could be gradually depleted. Our nutrient crop values and methods of analysis are very dependable. Soil testing for nitrogen, phosphorus and potassium is accurate. Tissue testing is even more accurate and much more accurate for micronutrients.

2. The acid test. If soil or plant tissue samples come back in the marginal category but you are unsure of what to do, add some fertilizer in a portion of the field or in test strips. In alfalfa, grass hays, and even in row crops, this test will help in making a more accurate decision in the future.

3. Split applications. Split applications of nitrogen and potassium are more efficient than a large single application. A large single application generally does not last long enough to supply the crop needs for the entire season. Large amounts of nitrogen can move below where the roots can utilize it and possibly end up in groundwater. If you plan a split application, time it far enough in advance of peak needs that the plants have time to utilize it.

4. Fertilize at the optimum time. In alfalfa, fertilize at least 60 days before first cutting to see optimum results from phosphorus and potassium. This is generally how long it takes for maximum uptake. Each crop has its own use-curve which describes its nutrient needs over the course of the crop's development. In general, phosphorus and micronutrients are basic starter elements used at planting while nitrogen and potassium requirements increase during plant growth.

5. Buy the least expensive fertilizer type. Many studies have shown that fertilizer type (liquid vs. granular) have little influence on yield efficiency. Unless there is a reason otherwise, use the least expensive form of that nutrient. Fertilizers may contain multiple elements or nutrient values such as urea, ammonium sulfate, or mixes and custom blends. Cost varies greatly as you increase the number of nutrient components. Buy only what is needed for that crop and time.

6. Variable rate applications. Precision technology offers agriculture innovative methods that utilize site-specific information at the field level. These practices precisely match fertilizer and pesticide quantities to the needs of the crop or pest level as they vary in a field. By reducing application rates at spots where less is required, nutrient and chemical runoff to the environment may be reduced. Many fertilizer companies now offer variable rate equipment and nutritional monitoring services for most crops.

7. Fertigation. The application of nutrients through drip or sprinkler irrigation systems is called "fertigation," a contraction of fertilization and irrigation. The most common nutrient applied by fertigation is nitrogen. Elements applied less often include phosphorus, potassium, sulfur, zinc and iron. This technique can reduce fertilizer application costs by eliminating an operation. It also improves nutrient efficiency by applying them closer to the root zone. Also, it could conceivably reduce leaching or denitrification (gaseous) losses of nitrogen and lower the luxury uptake (excessive nutrient uptake that exceeds the plant's requirement) of nutrients by plants.

8. Delayed injection method. Apply water-run nitrogen using the delay injection method, in which nitrogen is injected only after the irrigation water has advanced half way down the field. This can improve distribution uniformity and save on the total amount nitrogen applied.

9. UAN vs. NH_3. Applying anhydrous ammonia (NH_3) nitrogen through water-run applications can result in a 50% loss created by volatilization as this material is transported across the field in the water -- more so on hot, windy days. Consider switching to urea ammonium nitrate (UAN), a less volatile fertilizer. UAN applied by the delayed injection method would allow a lower nitrogen use rate resulting in cost savings.

Mick Canevari, Farm Advisor & County Director

Grapes and Almonds

After a very dry winter in January 2007, this year started out much more "normal" but March and April are turning out extremely dry, although relatively cool. The dry conditions and relatively mild temperatures have encouraged more weed growth than last year but not severe by long term experience. It is good to stay ahead of weed problems, as last year was a good (or rather bad year) for gophers and voles. They are back and active at this time and probably need some attention, even with the benefit of owls, hawks and snakes.

Almonds

For the almond growers bloom was later than last year, but about on time compared to the long term. Bloom did progress fast, to the point of being a potential problem for bees to make all the rounds. At this point it appears the bees got the job done for at least a decent potential crop. The recent strong winds did create an early, but relatively light, "June drop". If the true June drop is heavy, reducing the normal nitrogen application and putting some of that savings towards potassium might be a good idea, especially if potassium hasn't been part of a normal program in the last few years. While leaf tissue analysis is not infallible, a good representative sample from each area of an orchard or block is good for detecting problems in productivity or tree growth over time.

Now is the time to keep an eye out for the lower limb dieback problem that has been popping up the last couple of years. The symptoms are smaller twigs and branches that quit growing and die back a short distance with no obvious cankers and seem limited to the lower third of the tree canopy. There may be several factors involved, one of them being disease, but there is still no definitive answer as to what is going on. There seems to be a species of *Phomopsis* and/or *Botryosphaeria* that are often, but not always, detected. Farm advisors Roger Duncan and Brent Holtz, along with Dr. Themis Michailides are investigating the problem. If you have symptoms show up or intensify from last year give me a call, as I hope to get involved and get the experts to look at some of the local incidents.

The crop looks about normal at this early date and as irrigation has been ongoing, nutrient programs have also started. Recent UC surveys and research will be aimed at refining old guidelines, but "spoon feeding" with microsprinklers or drip systems can be adjusted after a leaf tissue sample taken in late June or early July. Often a good estimate is to take the guideline percentages and apply them to last year's yield as a basic replacement strategy. If a well source is used, a water sample can help determine nitrate-nitrogen contributions from the well water source. The aim is to help optimize production while lowering costs (especially this year with inflationary costs) and reducing potential leaching into groundwater. For general production information check out the Fruit and Nut Center at UC Davis. The web site is at the following address: http://fruitsandnuts.ucdavis.edu.

Food for Thought:
"Everyone talks about the weather, but nobody does anything about it."
Mark Twain

Grapes

In contrast to last January, temperatures were more normal and rainfall a lot better but the upper root zone (down to 18 or 24 inches) is drying out fast due to evaporation and use by cover crops and vines. Budbreak was about average, beginning just before March 12th for Chardonnay. It seemed to indicate a fairly normal start to the season. In general, cluster counts across most varieties look average to above average. The strong winds during April 14th to 16th did cause some shoot loss of Chardonnay and Sauvignon blanc, but as strong as the winds were, cluster loss will be minimal. There was a brief cold snap on April 15th (just coincidental to Tax Day) so that a very few low-lying and wind-protected areas were hit by frost, especially in early varieties such as Chardonnay.

Soil water availability is better than last year but below average. That may help encourage more manageable canopies this year by reducing vegetative growth. The probability is for an average or slightly above average crop, but that depends on summer growing conditions. Irrigation shouldn't be a big concern, but it is time for some applied water in many varieties and sites. Just be cautious of applying much more than crop demand as it will only cost money, possibly percolate past active roots, or even cause excessively wet root zones that only slow new root growth. The hope is that more controlled conditions this year may provide for an excellent vintage with a little luck.

More Food for Thought:
"The wages of sin are death, but after they take the taxes out, it's more like a tired feeling."
Paula Poundstone

Paul S. Verdegaal, Farm Advisor

Salt: Can We Cut It Out of Our Plant's Diet?

For the eight months I have been looking at ornamental plant problems in San Joaquin County, the most common plant problem has been connected to salinity. The specific problems I have encountered have been: salt and boron toxicity in the soil, salts in the irrigation water, and salt buildup in the soil due to low rainfall years.

Salts are naturally occurring in soil from the weathering of rocks and minerals. Salts can be added to the soil during rainfall, irrigation, fertilization, or from the addition of saline soil amendments or during deicing of roads. Salty irrigation water may be due to use of surface water that includes drainage water from other uses or groundwater that is affected by seawater intrusion.

The dissolved salts in water are ions. The major ions involved in salinity issues are: the positively charged cations sodium (Na^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}), and the negatively charged anions chloride (Cl^-), sulfate (SO_4^-), and bicarbonate (HCO_3^-). Boron can also be present in groundwater, however, it rarely occurs in high concentration in surface water. Even though the water-soluble salts are necessary for plant growth, high concentrations of salts can cause extensive plant damage and death.

Figure 1.
Marginal necrosis of almond leaves caused by excessive soil salinity

Salinity Symptoms. Salt toxicity symptoms vary depending on whether the salt is absorbed by the roots or sprayed on the plant foliage through irrigation. Symptoms of root-absorbed salt on broadleaf plants are leaf necrosis on the edges and tips of the older leaves first (Figure 1). This is caused by an accumulation of the salt within the old leaf tissue. Conifers will exhibit a leaf necrosis that starts at the tip of the needles and moves down, with symptoms again starting and being most severe in the old growth.

Salt spray damage on the foliage is more evident than root absorption because it is usually confined to the portion being sprayed by the salt water (Figure 2). Plants are usually damaged at lower concentrations, when salts are applied to the foliage, compared to the concentration of salt being absorbed from the soil.

Specific ion toxicity refers to the buildup of particular ions. For example, boron, sodium, and chloride can be damaging to sensitive plants at certain concentrations. In many plant species, boron toxicity will have a blackening around the necrotic areas on the leaf (Figure 3). Again, older leaves will have the first symptoms, with

(Continued on page 10)

Table 1. Depth of leaching water required per foot of rootzone to be reclaimed given the initial average salinity and final desired salinity.

Desired Rootzone Salinity (mmhos/cm)	*Inches of water/foot of rootzone Required to leach initial salinity of:			
	6 mmhos/cm	**8 mmhos/cm**	**10 mmhos/cm**	**12 mmhos/cm**
3	1.2	2.0	2.8	3.6
5	0.2	0.7	1.2	1.7
7	0	0.2	0.5	0.9

*Applicable for all irrigation waters less than 1.0 mmhos/cm. Table adapted from research reported by Hoffman, GJ. 1986. Guidelines for reclamation of salt-affected soils. Applied Agricultural Research, Vol 1(2):65-72.

Figure 2. Plant damage on lower foliage due to foliar spray by saline water in irrigation system

Figure 3. Marginal necrosis and pitting on a leaf of Prospector Elm (*Ulmus wiloniana* 'Prospector') are symptomatic of boron toxicity.

(Continued from page 9)

new growth staying green until a certain amount of salt has accumulated in the leaf.

Salinity Diagnosis. When trying to diagnose salinity problems, be aware that other disorders that may look like salinity include mineral deficiency, drought, herbicide toxicity, wind burn, acute air pollution, and high light exposure. When a potential salt problem is suspected, the soil should be analyzed for its electrical conductivity (EC), a measurement of salinity. If the EC is greater than 4 millimhos per centimeter (mmhos/cm), the soil is saline (this number may also be reported as decisiemens per meter - dS/m). If the irrigation water is the source of salts, the water should be tested for total dissolved solids (TDS) and ECw. See the recommended

Figure 4. Severe boron toxicity symptoms on redwood (*Sequoia sempervirens*) causes needle death (White areas are the dead foliage, with new leaf growth showing no symptoms)

reference section for tables on EC values for water and soil that plants can tolerate. Plant tissue analysis can also give an indication of accumulation of salts in the leaf, and should be used particularly when foliar spray is the problem.

Salinity Solutions in the Landscape. When soils have salt buildup from irrigation water, then leaching the salt out of the root zone is the first step. If drainage is poor, this must be improved first so that water can move through the salt buildup zone. The water used in leaching needs to be low in salt. Table 1 gives depth of leaching water depending on amount of soil root zone area with salt buildup (Saden et al.). For plants with deep root zones, soil samples should be taken at many depths. In the case of sodic (soils with build up of the ion sodium) and high boron soils, gypsum should be incorporated into the soil or to irrigation water to replace sodium with calcium. Sodic-calcareous soils can be amended with sulfuric acid or elemental sulfur. After

(Continued on page 11)

(Continued from page 10)
incorporation, the sodic soil should also be leached with low-salt water.

If foliage has been sprayed by saline irrigation water, the foliage should be washed off with low-salt water. The irrigation system should also be evaluated to prevent spraying foliage such as using nozzles with less misting and lower arch. Individual trees may need a separate valve system to allow deeper watering and to eliminate the sprinkler system watering so close to the tree. Even though modifying the irrigation system is an added expense, if the tree is of good quality and mature then the cost will be higher to replace the tree than to remedy the problem.

In landscapes where salinity and boron toxicity are an ongoing problem, sensitive plant species should be replaced with salt/boron tolerant plants. Table 2 shows an example list of plants ranging from very sensitive to very tolerant of salinity. An extensive plant list giving salt and boron tolerance can be found in the reference on abiotic disorders given in the reference section.

References:

L. Costello; Perry, E.; Matheny, N.P.; Henry, J.M. and Geisel, P.M.

A recent publication that has a great chapter on salinity issues is “Abiotic Disorders of Landscape Plants, A Diagnostic Guide. Ec values for water and soil in terms of salt and boron are provided. A table on salt and boron tolerance is given for over 500 plant species. Salt-related problems are also summarized in a table with information on types of symptoms, test types to diagnosis the problem, potential causal factors, look-alike disorders and proper treatment.

Other References:
B.H. Hanson; Grattan S.R.; and Fulton, A. 2006. Agricultural Salinity and Drainage UCANR publication 3375.

Saden, B., Fulton, A., and L. Ferguson. Managing Salinity, Soil and Water Amendments. Available as a pdf at: http://cekern.ucdavis.edu/Irrigation_Management/MANAGING_SALINITY,_SOIL_AND_WATER_AMENDMENTS.htm

All book references can be found on the ANR publication website. This hyperlink will take you directly to the sources mentioned.
http://anrcatalog.ucdavis.edu/Search/salinity.aspx

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Table 2. Salt tolerance of ornamental shrubs, trees and ground cover.

Crop	Maximum Salinity
Very sensitive	1-2 mmhos/cm
Star jasmine	
Photinia	
Sensitive	2-3 mmhos/cm
Tulip tree	
Crape myrtle	
Moderately sensitive	4-6 mmhos/cm
Southern Magnolia	
Japanese black pine	
Moderately tolerant	6-8 mmhos/cm
Weeping bottlebrush	
Oleander	
European Fan Palm	
Tolerant	>8 mmhos/cm
Bougainvillea	
Ceniza	
Italian Stone Pine	
Very Tolerant	
Iceplant (white, rosea, purple, croceum	>10 mmhos/cm

*Adapted from book written by Hanson, Grattan and Fulton. 2006. Agricultural Salinity and Drainage. UCANR Publication 3375

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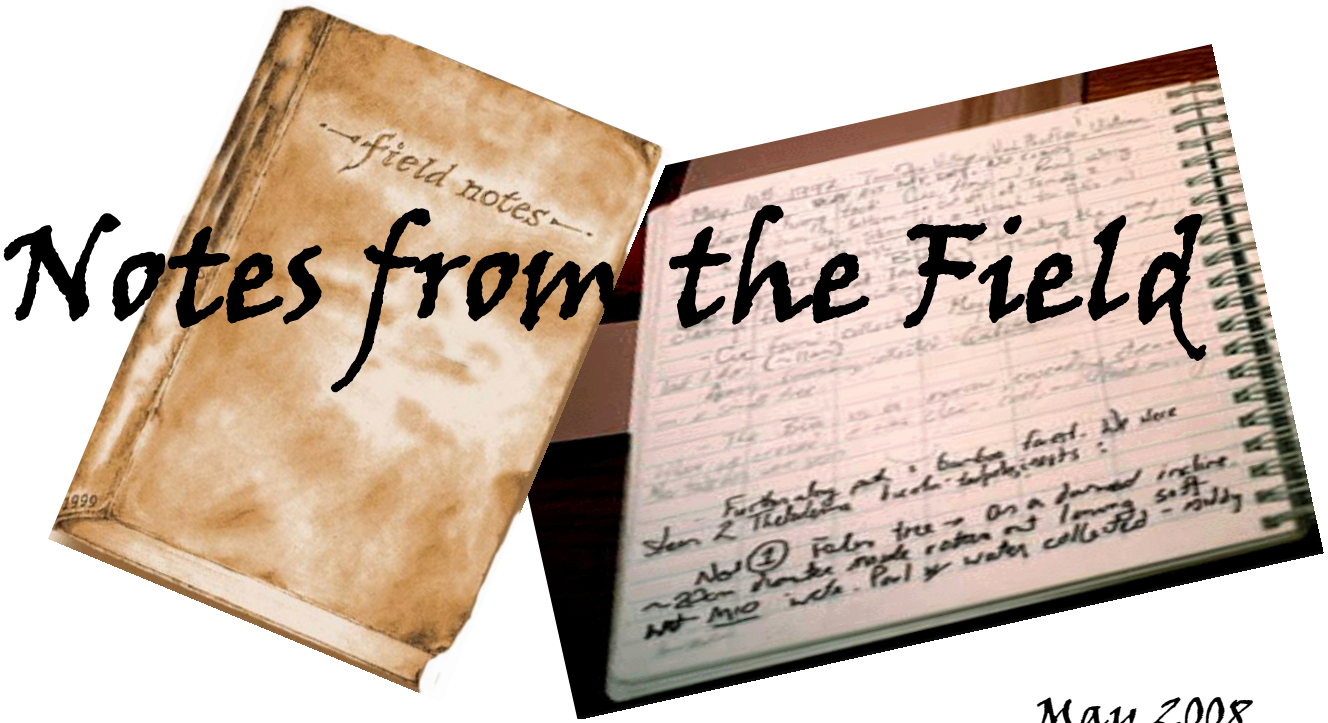

Notes from the Field

May 2008