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Irrigation Management for Almond Trees Under Drought Conditions

For maximum growth, yield, crop quality, and orchard longevity almonds trees should be supplied with water to meet their full water requirement. If water is limited, growers can react by applying irrigation water when trees are most sensitive to stress and by taking measures to minimize water losses that occur during irrigations. Supplying less water than the trees need reduces soil water availability, causing tree water deficits and reduced transpiration.

Water deficits affect almond orchards not only in the year in which stress occurs, but also in the following seasons. Nut size is reduced in the first season of significant water stress. Because water stress also reduces vegetative growth, nut load and yield are reduced in subsequent years.

Recent research indicates some stages of almond fruit growth are more sensitive to water stress than others. Understanding these stages permits growers to withhold water while minimizing damage to trees and to current and subsequent crops.

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Early Season. Water stress is most harmful during the early season – from leaf out through shoot growth of terminal and lateral buds. During this period, rapid vegetative development is necessary for canopy development and fruit positions for next season. In addition, orchard water use during this time is low, reducing any potential water savings from an early-season deficit irrigation strategy.

Fruit Growth and Development. Nuts undergo a rapid growth phase early in the fruit development period and are sensitive to water deficits during this time. However, trees can tolerate drought stress fairly well during the two months prior to harvest, allowing for the successful use of deficit irrigation strategies during this period. Providing less than the full water requirement to cause moderate water stress during this period will have little influence on kernel weight. However, severe water stress in the months leading up to hull split will reduce kernel weight and significantly reduce hull splitting. In this situation, a two-inch irrigation prior to hull split will reverse this trend and will improve hull split and reduce the number of hull-tights. If drip irrigation is used possibly less irrigation can cause the same effect.

Post harvest. The effect of water deficits during the postharvest period are substantially affected by 1) pre harvest water relations and 2) the quantity of water use over the remainder of the season. Bud differentiation continues through mid-September. Moderate stress during this period will have little effect on subsequent year's nut numbers, but severe stress during bud differentiation has been found to dramatically reduce fruit set the following spring. In early harvest (early August) districts, more of the high water use season remains after harvest. This increases the necessity for postharvest irrigation. Later harvest (north State) districts have a shorter postharvest period which occurs at a time of lower crop water demand. These factors reduce the chance of moderate water deficits causing bud differentiation problems.

Tree response to postharvest stress can be influenced by the type of irrigation system used, and the previous irrigation management. Low volume systems with limited soil water reserves can result in severe water deficits very quickly after irrigation cut off. In the southern San Joaquin Valley where harvest is earlier than in the north, or

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with drought-sensitive varieties, postharvest irrigation is a necessity. Deep rooted, conventionally irrigated trees may have enough pre-harvest deep moisture remaining to carry them through the critical period of bud differentiation.

Developing a Deficit Irrigation Strategy

Crop Water Use. Almond water use begins when the leaves develop and shoot growth begins. Concurrent with canopy development, the climatic demand increases, driven by longer days, higher temperatures, and lower humidities as the season progresses. Both of these factors result in a seasonal use starting at a low level, peaking in mid-season and falling as season ends.

Sources of water available to trees include: soil-stored moisture (including frost protection water applications if the root zone is less than field capacity when applications are made), any in-season rainfall absorbed by the soil, and applied irrigation water. These all combine to determine the total seasonal water available to the orchard.

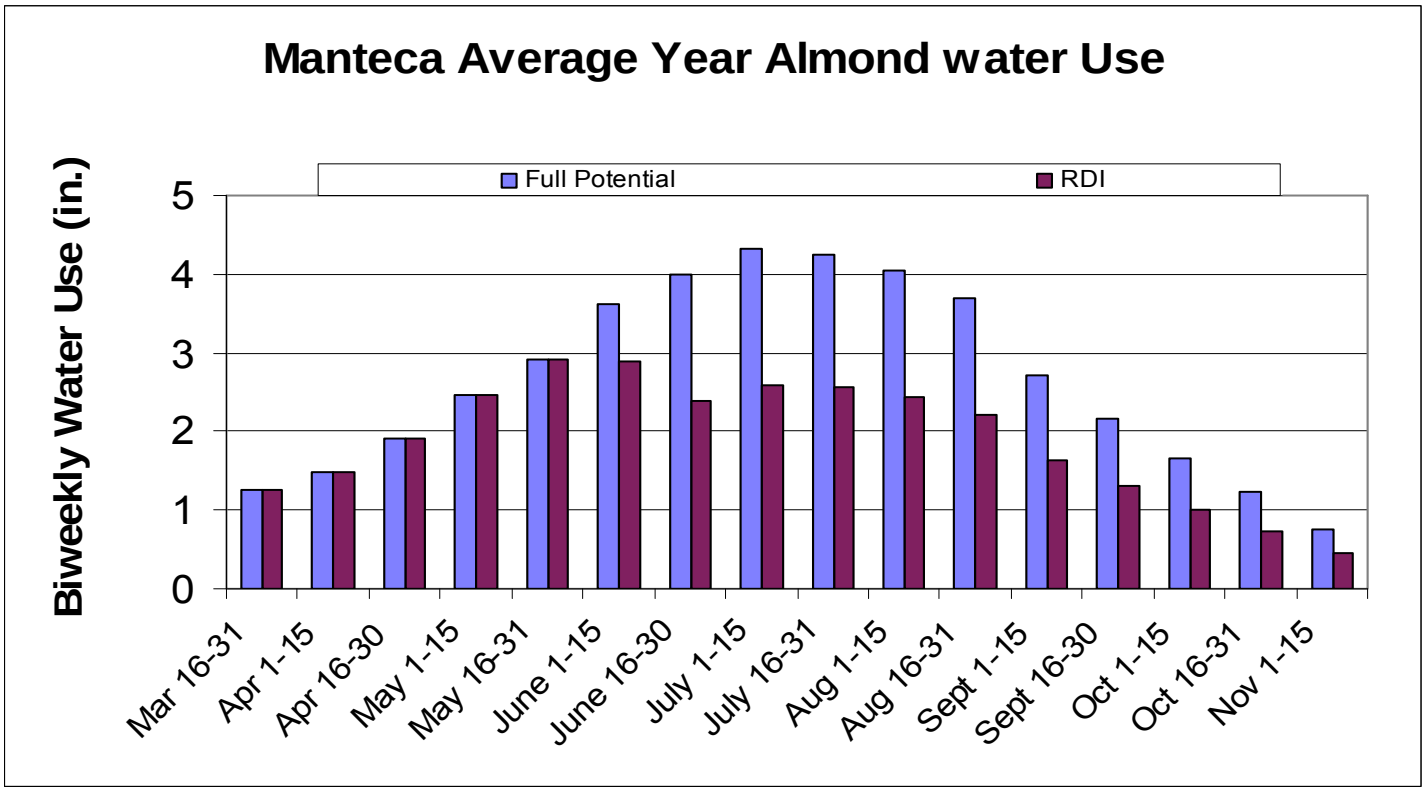
Mature conventionally spaced almond trees in the Southern Sacramento Valley can use about 41-44 inches of water in an average year of unrestricted water use. High-density orchards, long pruned orchards, or those with a cover crop can have even higher use. Figure 1 shows a typical water use pattern for fully irrigated and a deficit irrigation regime for almond in the Manteca area. The moderately deficit irrigated orchard used (in a combination of soil supplied and irrigation water) 28 inches of water or about 34% less than the full potential orchard.

Water Deficits. Water deficits occur when the climatic water demand exceeds the water absorbed by the roots. As the soil becomes depleted of readily available moisture, water uptake by the roots lags behind water use causing plant stress in the mid- to late-afternoon. This minor crop water deficit has little effect on the crop yield. As soil water becomes increasingly difficult to extract, water stress increases. One way to measure "tree stress" is to use a portable pressure chamber to measure "stem water potential." To use this technique, a few representative leaves in the orchard are first covered with an opaque plastic bag while leaves are still on the tree. The covers need to remain on the leaves for at least 15 minutes, after which they are detached and the water potential measured using the pressure chamber. The chamber measures the amount of pressure needed to force water out of the leaf, and this reading is a measure of the overall water status of the entire tree.

A Moderate Water Stress Strategy

From the previous discussion it can be concluded that tree water use from leaf out through mid June should not be compromised. From mid-June through harvest, reductions up to 50 to 60% of full water use have been successfully used to reduce orchard water use with only minimal reductions in kernel weight. It is important to supply the trees with water near hull split to avoid hull-tights.

There are two ways to implement controlled mid-season water deficits. The simplest strategy is to reduce irrigation run time or lengthen irrigation intervals to obtain the desired percentage reduction in applied water. A more



(Figure 1.)

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accurate approach is to schedule irrigations using periodic pressure chamber readings and irrigating when readings reach a predetermined threshold stress levels. This method effectively extends the irrigation interval, but the interval is determined by tree water status rather than the calendar. Irrigations should be in the volume of a normal set as performed with a full irrigation regime. In a deficit irrigation study conducted on mature almonds in the Manteca area. A threshold value of -16 to -18 bars mid-day stem water potential beginning in June resulted in 34% less water consumed by the trees and no significant influence on yield for the four-year measurement period. It should be noted that a reduction in vegetative growth was measured in this treatment, indicating the use of this threshold for a longer-term strategy (more than four years) may reduce yields by reducing nut numbers.

A More Severe Water Stress Strategy

A more severe strategy that reduces seasonal tree water use by 50% requires that stress be imposed early as well as mid-to-late season. Using this strategy, irrigations in April and May are withheld until trees reach -12 to -14 bars. Using conventional sprinklers, a normal set time is used. If lighter applications are made, more water is lost by evaporation. From June 1st through hull split, stem water potential should be allowed to reach -20 to -22. This strategy will require a pre-harvest irrigation of about two inches with sprinklers - less with micros and drip - to ensure good hull split. Note: this strategy reduces water use significantly but also reduces nut weight the year it is used and nut number in succeeding years. In the Manteca trial discussed above, it took two years of full irrigation for trees to recover from four years of this deficit strategy.

A "Staying Alive" Drought Strategy

Less is known about this strategy since it is rarely used as an option. However, based on past drought conditions, trees may be kept alive with about a foot of applied water. This strategy does not consider growth and yield - just tree survival. This strategy is best conducted using a micro-irrigation system which maximizes water distribution and minimizes evaporative losses from irrigation. Using this strategy, no irrigation is applied until water potential reaches -16 bars, from leaf out through the end of May. Monitor stem water potential until the threshold is reached again, then repeat the cycle. After June 1st, and for the rest of the season, allow the stress to climb to -22 bars. As a guide, try to just retain the leaves on the tree. Good luck, as this is only a guide. Tree recovery to full yield based on full water use in subsequent years can be a few years at best.

Irrigation System Management

Regardless of the water strategy used, all non-beneficial water losses should be minimized. Maximum effort should be directed toward increasing the percentage of applied water stored in the root zone and applying irrigation water as evenly as possible throughout the orchard.

- Do not exceed the soil moisture deficit (holding capacity) of the root zone in the spring or water will be lost to deep percolation from early season irrigations.
- Eliminate runoff from one area to another by turning the system off when runoff begins.
- Use off peak power, or irrigate at night to minimize evaporative losses.
- Evaluate and upgrade irrigation systems to improve application uniformity and distribution uniformity.
- Eliminate or minimize cover crops or weeds which can compete for water use.

Terry Prichard, UC Water Specialist
Paul Verdegaal, Farm Advisor

Locke Ranch IPM Award

At a January 17th ceremony in Sacramento Lockeford walnut grower, Chris Locke, was honored as a 2007 IPM Innovator by the California Department of Pesticide Regulation for his farm and environmental stewardship efforts. Pictured here Chris are wife Christi, sons Cameron and Eliot, California DPR Director Mary-Ann Warmerdam (far left), and Secretary of Cal EPA Linda Adams, (far right). Congratulations, Chris!

Past IPM Innovator award recipients from San Joaquin County include Lodi-Woodbridge Winegrape Commission (1994), LangeTwins, Inc. (1999), Vino Farms (2000), and Lodi Rules for Sustainable Wine Growing growers Robert Abercrombie, Jerry & Bruce Fry, John Ledbetter, Kim Ledbetter-Bronson, Joe Dexter, Robert Piere, and Keith Watts (2006).

Grapes & Almonds Crop Digest, Chilling & Rainfall

The eighth year of the millennium began in January of 2008 with wet, windy, and cold conditions and has provided a good chance to be close to normal in rainfall - or at least better than last year. Rainfall at this time last year was 4.9 inches compared to 12.3 inches so far this season. January also was cold, but not as cold as last year. For grapes, unlike almonds, chilling hours are not a common worry except in the Coachella Valley of Southern California. Although we have had some mild conditions in recent years, 2007 and 2008 are relatively cold and no record highs set. Following is a January calendar showing, for each day in the month, the year when a record high was set.

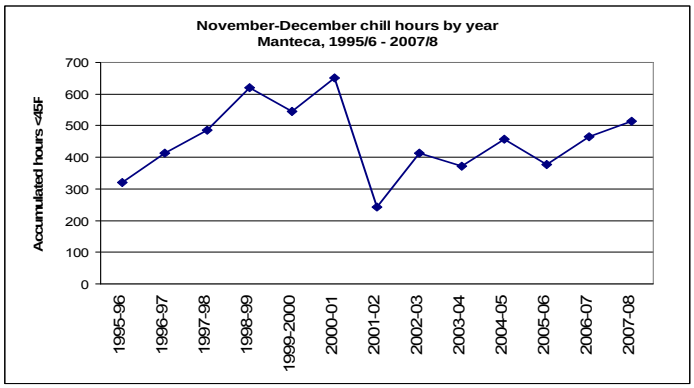
January (Years of record maximum for each day of the month)

1	***1997***	2	***1996***	3	***2003***	4	***1948***	5	***1986***	6	***1953***	7	***1990***
8	***1953***	9	***1962***	10	***1959***	11	***1980***	12	***1980***	13	***1980***	14	***1966***
15	***1970***	16	***1986***	17	***1976***	18	***1981***	19	***1976***	20	***1950***	21	***1970***
22	***1948***	23	***1976***	24	***1987***	25	***1947***	26	***1988***	27	***1976***	28	***1976***
29	***1976***	30	***1976***	31	***1976***								

(Table 1.)

There doesn't appear to be any trend of warming (Table 1). A note to remember is that the warm stretch in 1976 came after widespread concerns of global cooling in 1973, 1974 and 1975. In any case it looks like we are off to a fairly normal start.

As regard to chilling hours, there has been a trend of fewer chilling hours as measured by number of hours below 45º F. The chart below (Fig. 1)shows that total hours for January and December - often considered the period of "quality" chilling – declined in 2001-2 and thereafter but has since returned to totals above the long term average of 452 hours for these two months.



(Figure 1.)

A detailed explanation of chilling and actual data on chilling accumulation (in addition to general information on horticulture) is available at fruitsandnuts.ucdavis.edu. No matter how you look at it, the chilling is good and bloom should be strong, well paced, and fairly uniform. Bud break for grapes should be a lot more uniform this year and for almonds a strong uniform bloom should be possible. The bee situation for almonds is tight and expensive, but may be tolerable.

With spring budbreak only a few weeks away, monitoring for vine mealybug should be one annual priority. There are some different control strategies, but all include starting early to address new infestations. Look for dark sooty mold staining of bark; or better yet, lots of ant activity along the drip hose. If you have any questions, call our office or Cliff Ohmart at the Lodi-Woodbridge Winegrape Commission.

As the new season develops in almonds, be on the lookout for Lower Limb Dieback, where lower small branches may be dying back but shade is not a problem. Research is ongoing and additional information and observations may help sort out what is actually happening.

Weed growth is more than last year, as temperatures have been more normal and rainfall abundant, but the fall and early winter were dry enough to slow general weed development. Good control should be achievable with some normal rainfall patterns with Mother Nature's help. There are some newer materials available and rotation or selection for particular weed species should be considered. If you have questions, check in at www.ipm.ucdavis.edu or www.wirac.ucdavis.edu .

Last year some late winter or early spring irrigation was a good decision, this year we should be back toward a more normal spring soil moisture situation. For grapes

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caution on too much too soon is needed and for almonds it should be easier to stay ahead of early ET demands.

Be on the watch for gophers as they remain active and are already establishing new burrows. Trapping, baits, or even a couple of good cats can reduce population levels. Gopher populations were high last year and these may carry over into this year. Ground squirrels may become active soon with the warm, dry weather. Unfortunately, they begin feeding on seedling grasses, but can be dealt with by initial baiting with toxicant-free bait to get them used to feeding in order to take actual control bait. Smoke bombs in burrows or acute lead poisoning with a long rifle also works.

As spring arrives, be aware of soil moisture conditions and plant water demand, but be careful about "getting too far ahead". If there are soil problems to deal with such as pH issues or water infiltration, soil amendments or physical mixing may be needed. After plant growth is well developed and temperatures have warmed up, the macronutrients nitrogen or potassium can be effectively used. For vines, that's after bloom; for almonds, after petal fall. For micro–nutrients, earlier is better, as early spring growth is needed for efficient uptake of nutrients such as zinc and boron. Besides the cost efficiency more attention is being directed to anything that goes on the ground with a potential for leaching by irrigation or rainfall.

Paul Verdegaal, Farm Advisor

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.

Mark and John Bacchetti
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Don Johnson
Barbara Kutzner
Tom Larsen
Matt Lauchland
Mac Learned
Celina Lemus
Ron Marchini
Larry Mettler
Bruce Mettler
Bob Molloy
Diego Olagaray

Calendar of Events

- **UCCE Annual Bean Growers Meeting**
  February 27, 2008 8 am - noon
  Westley Hotel, 8615 Hwy 33, Westley, CA
  Contact: Mick Canevari 209-468-2085

- **38th Annual Tri-County Walnut Institute**
  February 28, 2008 8 am - noon
  UCCE San Joaquin, Stockton, CA

- **Incentive based pay programs**
  Labor Management Practices in Agriculture
  February 28, 2008 1-4 p.m.
  UC Cooperative Extension Office, Norton Hall
  70 Cottonwood St., Woodland

  To register, please call the Esparto Regional Chamber 530-787-3242 and reserve your seat or email Elizabeth Campbell eac4@mac.com
  The program is free but pre-registration is required.

- **56th Annual Oakdale Livestock Forum**
  March 8, 2008 9:30 am - 3:30 pm
  Location to be determined
  Contact: Theresa Becchetti 209-525-6800

- **Landscape Professionals Workshop**
  March 11, 2008 8 am - 2:30 pm
  UCCE San Joaquin, 420 S. Wilson Way, Stockton
  Contact: Ashley Basinger 209-468-2085

- **Master Food Preserver Demonstration**
  Sausages & Meat Preservation
  March 19, 2008
  UCCE Sacramento
  4145 Branch Center Rd., Sacramento
  916-875-6913

- **San Joaquin County Home & Garden Show**
  April 11-13, 2008
  Fri 1 pm-8 pm, Sat/Sun 10 am –6 pm
  Visit the UCCE Master Gardener Booth
  San Joaquin Fairgrounds, Stockton

- **Dairy Herdsman Shortcourse**
  April 15-17, 2008 8:00 am - 4:00 pm
  UC Davis Veterinary Medicine Teaching & Research Center, 18830 Rd. 112, Tulare, CA
  Contact: Gerald Higginbotham, Dairy Advisor 559-456-7558

- **Olive Production for Olive Oil, UC Short Course**
  April 18-19, 2008
  Hutchins Street Square, Lodi, CA

Managing Fungicides Applications to Avoid Resistance

Many people have been asking why powdery mildew in tomatoes was so difficult to control this past season of 2007. We do know that the summer weather was very conducive for the disease and that some of the newer tomato varieties appear to be more susceptible. And… fungicide resistance has been reported in a powdery mildew isolate from tomatoes growing on the central California coast. We don't yet know how widespread resistant individuals might be or whether they are present in the Central Valley. However, regardless of whether we have resistance here or not, it is always wise to keep this risk in mind and to apply fungicides in such a way that we lengthen their useful life. Hopefully, we will find that mildew goes back to being less of a problem this coming season.

The powdery mildew (PM) fungi as a group are considered to have a high potential for resistance development. In fact, we have learned a lot about the development of resistance from the case of the powdery mildew pathogen of melons (and other cucurbits). In the melon pathogen, resistance to several groups of fungicides has already occurred and, because of this, the DMI fungicide triadimefon (Bayleton) and the benzimidazole fungicide benomyl (Benlate) are no longer registered for use on cucurbits. The first strobilurin fungicides azoxystrobin (Quadris) and trifloxystrobin (Flint) were registered by EPA in 1999, and a new DMI fungicide myclobutanil (Rally) was registered in 2000. By 2002, resistance to strobilurins fungicides had been detected in the melon PM pathogen in the US. And the two DMIs myclobutanil and triflumizole (Procure) have recently exhibited poor control of melon mildew on the East Coast.

The newer fungicides, while effective, are at higher risk for developing resistance than the older protectant or contact fungicides. Part of the reason they are more effective is that they are systemic or translaminar (crossing the leaf). This helps us obtain adequate protection of the undersides of leaves where contact materials usually can't reach. These newer fungicides have a high risk of developing resistance because they have a specific mode of action (acting at a single site in the metabolism of the fungus). The resistance that has been observed in the melon pathogen to DMI fungicides is categorized as "quantitative", meaning that the fungus exhibits a range of sensitivity to the fungicide. With quantitative resistance, we see a slow but ongoing loss of control over time as the population of the fungus becomes more tolerant of the chemical. Such erosion of disease control may sometimes be reversed by using higher rates or more frequent applications. However, eventually complete loss of disease control may occur. With quantitative resistance, failure out in the field may not be apparent until resistance has been developing for some time. On the other hand, resistance to some other fungicide groups such as the benzimidazoles and strobilurins is qualitative, meaning that the fungicide goes from providing control to failing in a short period of time.

Table 1. Materials for powdery mildew control, including examples which may be labeled for melons or tomatoes (note that registrations differ for these two crops). Always check registration status of materials prior to use.

Group Code	Chemical group name	Common names	Product examples (melon & tomato)	Risk
11	Quinone outside inhibitors (QoI)	azoxystrobin trifloxystrobin pyraclostrobin	Quadris Flint Cabrio, Pristine	high – follow label restrictions
3	Demethylation inhibitors (DMI)	myclobutanil triflumizole	Rally Procure	medium
M	M2 – inorganic M5 – chloronitriles	wettable sulfur chlorothalonil	Microthiol Thiolux Bravo, Echo, etc.	low
Not classified	Biofungicides Mineral salts Various others	Bacillus (bacteria) Potassium bicarbonate various	Sonata, Serenade Kaligreen, Armicarb, Milstop, etc. JMS stylet oil Prev-Am, Oxidate, Cinnacure	resistance not known, presumably very low risk

The fungicide resistance action committee (FRAC) has assigned codes to the various fungicide groups. Within a group, cross-resistance is likely, meaning that resistance to one member of the group likely means resistance to all, even to fungicides that have not been used on that particular disease. These codes are also important to consider when planning a spray program because rotation among the groups is important, the riskiest groups (i.e. group 11 fungicides) should not be used in consecutive fungicide applications, and their use within a season should be minimized. FRAC codes often appear on the front of the material label or in the label's resistance management section. Look for "GROUP # FUNGICIDE" on the label.

To minimize the risk of developing resistance to fungicides:

- Systemic fungicides (Groups 11 & 3, see table below) should be applied prior to seeing symptoms or early in the development of powdery mildew. Once mildew is established, systemic fungicides should no longer be used, but contact materials (Groups 'M' & 'not classified') should be used.
- Rotate between products in different chemical groups.
- At those stages of crop growth where you can tolerate some disease (i.e., late in the season closer to harvest), a contact fungicide should be used. Maximize control obtained with contact fungicides by getting good coverage of the crop.

Newly updated vegetable cost studies

"Sample costs to establish and produce asparagus – San Joaquin Valley – North"
"Sample costs to produce fresh market tomatoes – San Joaquin Valley"

These are free publications which can be downloaded from the internet (http://coststudies.ucdavis.edu/) or contact our office and we can get a printed copy to you.

2007 Statewide UC Processing Tomato Variety Evaluation Trials
http://vric.ucdavis.edu/veginfo/commodity/tomato/2007ProcTomatoVarietyTrials.pdf

Both the statewide report and the report on our local trials in San Joaquin and Contra Costa counties are available online or you can get a printed copy from our office, call or come by.

Brenna Aegerter, Farm Advisor

Packing Shed Quality Control

International fruit markets often demand high quality packing criteria that need to be carefully communicated to packing shed employCrew workers can also improve quality as they better understand quality parameters, and thus increase the number of packs per bin.

If management disagrees on which fruit meets high quality criteria, how can packing shed employees be expected to fare any better? This research report summarizes work carried out with apple sheds in Chile during the 2007 packing season. It is based on a study of a California strawberry nursery plant packing shed. The findings can be generalized to pears, cherries and other fruits where high quality packs are required. Our objective was to measure and improve *reliability* (consistency of decisions made) as well as *accuracy* (validity) of the decisions of apple packing shed personnel—from management to packing staff.

Methods

While the study could have been carried out in a number of agricultural enterprises, we chose apple packing sheds, where employees have to make many decisions quickly. Apples are harvested and brought to the packing sheds in bins and are subsequently sorted and packed according to quality standards. Packing decisions can be quite complex. This study attempted to identify those individuals who were able to make accurate packing decisions given a specific packing norm. Women are prevalently employed in this task, and were paid by the hour. The study involved several steps, including 1) definition of criteria, 2) verification of criteria, 3) personnel training, and 4) personnel testing.

Definition of criteria. The packing shed client or administrative team determined a given norm, in terms of what types of defects would be permitted in packed fruit.

Verification of criteria. Packing shed and quality control management participated in an exercise in which they had to evaluate small samples of apples (25 to 50 fruit per sample), in terms of whether or not each apple should be packed, taking into account the pre-determined criteria. Each member of the team was asked to evaluate the apples independently. After that, a conversation was facilitated in which differences in opinion where fomented.

The goal was to identify at least two management or quality control individuals who had a good eye (consistently obtained at least a 92% accuracy score).

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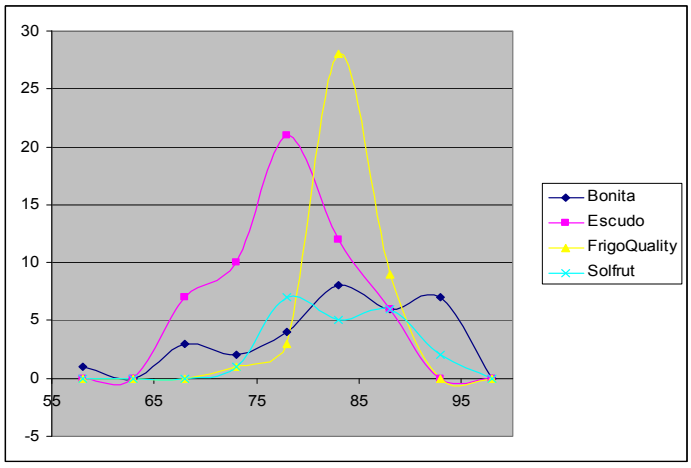
Two costly errors packing errors include: (1) discarding good quality fruit; and (2) packing bad quality fruit.
The average accuracy score for the three packing shed teams, each in turn composed of three individuals (thus, 9 individuals in all) increased from an 85% to a 95% accuracy through this process. It should be pointed out, however, that individuals who did not improve substantially were eliminated from the teams.

Worker training. Packing shed line workers received training in two steps: 1) a detailed explanation of the types of fruit damage and their causes; and 2) hands on exercises in which participants would study, evaluate, and receive feedback on decisions made.

Formal testing. In each of the packing sheds, samples (100 to 150 apples each) were numbered and spread over several tables. Participants were given a sheet of paper and pencil in order to note their opinion as to whether each apple in the sample should be packed. When finished, they turned in their completed sheet to one of the researchers, and were given a new blank sheet in which to evaluate the next sample.

There were two samples per packing shed, and each subject was expected to evaluate each sample twice, resulting in four tests per individual. (For instance, a person might evaluate each apple in sample A; then in sample B; then return to sample A; and finally conclude with sample B.) Subjects were given about 20 seconds per fruit, but these times were reduced as they felt comfortable with the testing process.

For each subject, we wanted to get a: 1) *reliability* rating (how consistent they were, e.g., if they chose to discard apple number 14 the first time through, did they chose to discard or pack it the second time through?) and 2) *accuracy* (how their answers compared to the answer key). Generally speaking, we expected reliability scores to improve with increasing accuracy scores, but realized that it was possible for some individuals to have very high reliability score but a low accuracy one.



Results
We found great variability in terms of people's abilities to make correct decisions. Subjects ranged from 95% to 68% accuracy (which compared to the California study, where individuals ranged from 95% to 59% accuracy). In the California study, participants were also rated in terms of their ability to correctly identify the reasons for making discard decisions (results not shown here) and two of the authors are presently conducting similar studies in a pear packing shed, where subjects will make retain vs. discard decisions as well as identify the reasons for discarding fruit. Such skills are particularly important in order to identify staff that can provide effective feedback to employees.
Individuals who are not too sure of themselves are more likely to throw away good fruit. Furthermore, those who are not too sure of themselves may be seen discarding fruit in a packing shed line in order to seem busy. But what fruit are they discarding?

Figure 1. Curves showing highest to lowest accuracy scores at three apple sheds in Chile (Escudo, Frigo Quality, Solfrut) and at a strawberry nursery plant packing shed in California (Bonita) are shown. Given the small numbers of subjects per packing shed, the normal curves show some anomalies.

Readers interested in additional details in order to carry out this work at their packing shed or field operations, may contact Gregorio Billikopf, at the University of California, 209-525-6800, gebillikopf@ucdavis.edu; Macarena Pons, mpons@mpp.cl; Juan Horacio Grant, jgrantloyer@gmail.com; or Pablo Muñoz, pmunoz@afe.cl Billikopf's website has additional research papers and books on labor management that may be downloaded at http://www.cnr.berkeley.edu/ucce50/ag-labor/ We are grateful to the packing shed management, quality control personnel, and line workers for their cheerful participation.

We found that in some instances we had quality control personnel who scored worse than packing shed employees. Some of the benefits from this work include 1) improving communication among management team members; 2) once standards have been developed, more accurately conveying those to packing shed employees; 3) using this tool as both a selection and placement tool to increase accuracy. While we expect some employees to make major gains in terms of quality decisions they make, others will not be able to improve enough given the rate of speed required of them in making these subjective quality evaluations. Accurately identifying borderline fruit is likely to make an important difference in improving the bottom line. In field operations, these same factors need to be considered.

Gregorio Billikopf, University of California
Macarena Pons, Labor Management Consultant
Juan H. Grant, Labor Management Consultant
Pablo Muñoz, Farm Manager

Fertilizing Wheat for Yield and Quality

There has not been this much excitement in growing wheat since John Sutter introduced it to the Delta in 1860. Prices have reached an all time high and so have the questions on management practices needed to increase yield and grain protein. With recent rains, evaluating the nitrogen (N) status to prepare for spring growth is an important consideration. There is no one simple answer that fits the entire range of plant and soil conditions across the county. However, we know that long periods of rain and saturated conditions will move nitrate N below the active root zone and nitrate N losses from de-nitrification will occur. The amount of N loss varies by soil type, standing water, temperatures and rainfall. Nitrogen losses of 10 to 25% are not unexpected.

Role of Nitrogen. [1]
Nitrogen stimulates vegetative growth and is directly related to increasing yield and grain protein. Excessive rates of nitrogen increases lodging, delays maturity, increases the severity of some diseases and contributes to groundwater pollution. Plants get nitrogen from soil residual N carried over from previous crop fertilization, from soil organic matter and from applied fertilizers. In most soils, the N requirement for wheat grain is 100-180 pounds of N per acre (2/3 at planting, 1/3 topdress) to produce a 3 to 3.5 ton yield. Higher amounts are required for Durham varieties. In the Central Valley a substantial amount of nitrogen uptake begins in January and the rate of accumulation increases throughout the spring until grain filling is complete.

Top dressing for yield

Topdressing is an efficient way to manage in-season nitrogen needs of wheat. An application of 30 to 50 pounds per acre of N is recommended from January to March when plant conditions warrant. N applications made during this growth period are most effective for promoting yield. Tissue sampling for stem nitrate nitrogen (NO_3-N) is an effective tool to monitor N status of the crop. Collect 20 to 40 stems at random from typical areas of the field. Cut off the roots and plants tops and use the bottom 2 inches of the stems for laboratory analysis.

Top dressing for grain quality

Increasing percent grain protein can be achieved by applying nitrogen at a later growth stage: starting at boot (before heading) and into pollination time (after heading). Twenty to 50 pounds per acre of N followed by irrigation typically increases grain protein content about 0.5 to 1.5 percent. Water-run applications of anhydrous ammonia, UAN-32, aqua ammonia, or urea applied during the first irrigation is a preferred method for increasing grain protein. Combining nitrogen with irrigation addresses the issue of irrigation timing for maximizing yield and supplemental nitrogen to raise protein. Foliar nitrogen sources are available but less effective than soil applied even though some moderate benefit can be expected. Cost effectiveness of foliar N as the primary method for maximizing grain protein is questionable.

[1]A more comprehensive overview of wheat management topics is available from the new UC small grains production manual. http://agric.ucdavis.edu/crops/cereals/cereal.htm

Mick Canevari, Farm Advisor

Water-efficient Landscapes in California Central Valley: Where and When to Start?

Figure 1. Water-efficient landscape designed and installed by Dave Roberts Landscaping in Sacramento, CA.

Why should a Central-Valley Californian put in a water-efficient landscape? Most homeowners are well aware of concerns with the state's water supply and necessity to protect the Delta from overuse. "The State of the Bay-DELTA Science 2008" by CALFED Bay Delta Program stated that "the capacity of the Sacramento-San Joaquin water system to deliver human, economic, and environmental services is likely at its limit."

As the Delta water supply is reaching the limit for providing water to Californians, homeowners can be proactive in extending the water supply. California Department of Water Resources estimated water conservation in urban settings could save from 1.2 to 2.4 million acre-feet of water. Currently, the average household uses around 0.5 acre-ft per year, and at this usage amount, potential water conservation savings would supply another 2.4 to 4.8 million homes. Water-efficient landscapes are key in helping California continue to be a thriving state even as population rises and the water supply gets stretched.

So how can you get started on a water-efficient landscape plan that can be implemented in your 2008 garden? A couple of quick tips will be given here to get a water-efficient garden started. For more tips, the resource "Water Conservation Tips for the Home Lawn and Garden", which will give more tips to implement a water-efficient landscape. The best method is to adopt a cou-

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ple of the tips and then add one per year. The most effective plan is one that a homeowner can afford, enjoy, and see water and landscape cost savings in the long term.

An example of a water efficient garden in late November is shown in Figure 1. Even on a slope, this landscape prevents runoff due to use of low water-use plants, good drainage with adequate organic matter soil berms along the slope, and underground drainage added to handle excess rainfall. The homeowner also found this landscape to be kid friendly because of an increase diversity of beneficial insects visiting the garden.

Where to start in developing a water-efficient garden.

Always start with the soil

The first step to any garden, ornamental or edible, is to have a well draining, water absorbing, and nutrient, providing soil. A plant will thrive with less water when the soil it is planted in is "healthy." A healthy soil will regulate water, sustain living organisms, filter potential pollutants, and cycle nutrients. The Natural Resource Conservation Service (NRCS), states the most practical way to enhance the soil quality is to promote better management of soil organic matter (carbon). San Joaquin soils vary in organic matter and texture (mix of sand, silt and clay, which are minerals that differ in size). You can go online at the NRCS website (http://websoilsurvey.nrcs.usda.gov/app/) to find your actual location and what soil type you have. You can also find the survey at a local NRCS or Cooperative Extension office. Along with an adequate amount of fertilizer, organic matter should be added every year because the plants and microorganisms will continue to break it down. Available organic matter products you can add to your soil are compost and humus.

Compost is an organic matter product (decayed plant and animal material) that has gone through a process to properly decompose and kill out any unwanted microorganisms and weed seeds. It is readily available at most

Figure 2. Natural decomposition of leaf material used as mulch in a landscape bed over a winter period. A top covering of 2-4 inches of organic mulch is necessary for weed control and larger particle size being better for week control. *Pictures courtesy of Dave Roberts*.

nursery stores, and can be bought in bulk locally as well. When starting a new landscape bed, compost should be applied uniformly to a depth of two inches and incorporated into the soil at a depth of six inches minimum. Compost should be added to perennial beds and trees as a mulch at a rate of three inches. Compost should be kept at least a foot away from tree trunks and extend as far laterally as possible. You can estimate compost volume using this approximation: one (1) inch compost spread over 1000 square feet = three (3) cubic yards. Different compost application rates will depend upon soil conditions.

Once the soil is conditioned properly, mulch should be used to help control weeds, thus reducing competition with desired plants for water. Different types of mulch can be made out of organic matter, however, unstable, raw woody material is not recommended because it will compete with plants for nitrogen which may cause stunted growth and yellow foliage. Woody mulches should be applied on top of the soil at a minimum of three inches to six inches for adequate weed suppression. Mulches made out of organic matter will break down, and should be added as they breakdown to a two inch height. Leaf litter produced by your landscape is an excellent source of annual mulch to keep your landscape beds covered during the winter months (Figure 2). Leaf litter will need to be added once the decomposition reaches around two inches to keep up weed suppression. UC Master Gardeners are available to our office discuss composting and mulching methods and how to apply it to your garden.

Pick the right plant for the right place

What is the right plant? The right plant for San Joaquin County is one that adds beauty to the garden while handling the hot, dry summers that are a constant in the Valley. UC Davis Arboretum staff have evaluated and identified garden plants that survive under twice-a-month watering in Central Valley conditions. Plant favorites have been put into an "Arboretum All-Star" plant list available online at http://arboretum.ucdavis.edu/, under All-Star plant search. Local demonstration gardens such as the Fair Oaks Garden in Fair Oaks, and the UC Davis Arboretum are great resources for ideas on water-efficient gardens for plant combinations. By the end of the summer, a demonstration garden will also be available at San Joaquin County's new Ag Center being constructed on Arch-Airport road near the Stockton Airport. If you have any questions on plants or need a printed copy of the All-Star list, please call the Master Gardener Hotline at 209-468-8457.

Drought tolerant California native plants that live in the Central Valley also make excellent landscape plants, as do many plants of Mediterranean origin, where winters are wet and summers dry. These plants are becoming more readily available due to the increased demand by gardeners and better techniques in commercial production. While many California natives and Mediterranean plants work well in a low water use garden, they need ample water during the first year to grow well and become established.

Don't forget about the right place. You can have the right plant, but if it is not in the right place in your landscape,

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your plant will not thrive, no matter how much or little water you add. Finding the right place can be trial and error, but if you know a plant's sunlight and water needs, you can increase your success on the first trial. Before you buy a plant, know what landscape area you want to fill. Once you designate an area to plant, consider the sunlight hours and temperatures which that area receives each season. If you are living in San Joaquin (on the Northern Hemisphere), the sun is always south. If the landscape area is on the south side with no shading, it will get approximately 14 hours in the longest days of the summer and be the warmest part of your landscape. The north and east side of the house will usually be cooler and less sunny than south and west sides. There will be microclimates (a local atmospheric zone where the climate differs from the surrounding area) that need to be considered to find a successful spot to grow a plant. This is part of increasing your landscape water efficiency. A plant that has high water needs has the potential to be maintained with less water when it gets adequate shading during the afternoon hours of the day.

Using hydrozones

An important consideration for a water efficient garden is the concept of landscaping in "hydrozones"; plants with high water demands should be managed separately from those with lower water needs. Lawns, for example, may need frequent and shallow watering, while shrubs and trees need less frequent and deeper watering than turf because of their deeper root systems. "A Guide to Estimating Water of Landscape Plantings in California" provides information on the water needs of many landscape plants and groups plants into water use categories. Turf water needs are detailed in "Best Management Practices to Reduce Production of Organic Materials in Landscape Plantings."

The hydrozone concept can be used effectively to conserve water in landscapes watered by hand or by an irrigation system. Irrigation systems - whether controlled manually or automatically - should be valved so that individual hydrozones can be watered separately according to water need. A controller is a clock with the ability to be programmed to set date and time, and separate timing of each station (hydrozone) to be turned on for a desired duration. "Smart" irrigation controllers are irrigation controllers that use weather, site, or soil moisture data for determining an appropriate watering schedule. This scheduling technology is relatively new to homeowners, but has been used by golf courses, parks, and athletic departments for more than 20 years.

Irrigation workshop – getting motivated

An irrigation workshop is being offered on March 11, 2008 to discuss California's new water policies, how to be more efficient with your irrigation system, and what to look for in the new "smart" controllers. The location is at the UCCE San Joaquin County office in Stockton. For more details visit the UCCE San Joaquin website at: www.cesanjoaquin.ucdavis.edu and click on Landscape Professionals Workshop under Calendar. Please call the UCCE office at 209-468-2085 for any questions regarding this workshop.

Ashley Basinger
Environmental Horticulture Advisor

Water Efficient Gardening Resources:

Water Conservation Tips for the Home Lawn and Garden, Publication 8036, available online at: anrcatalog.ucdavis.edu/LawnsLandscape/8036.aspx

A Guide to Estimating Irrigation Needs Water of Landscape Plantings in California, www.owue.water.ca.gov/docs/wucols00.pdf

Best Management Practices to Reduce Production of Organic Materials in Landscape Plantings
www.ciwmb.ca.gov/Publications/Organics/44301022.pdf

Compost Use for Landscape and Environmental Enhancement, www.ciwmb.ca.gov/Publications/Organics/44207002.pdf

Water efficient Landscapes, Available online at:
www.owue.water.ca.gov/landscape/pubs/pubs.cfm

Bay-Friendly Landscaping, Available online at:
www.stopwaste.org

River-Friendly Landscaping, Available online at:
www.riverfriendly.org

Sustainable Landscape Construction - A Guide to Green Building Outdoors, by J. William Thomason and Kim Sorvig, Island Press.

Recommended Native Garden books:

California Native Plants for the Garden, by Carol Bornstein, David Fross and Bart O'Brien
Designing California Native Gardens, by Glenn Keator and Alrie Middlebrook

Other Resources:
The State of the Bay-Delta Science 2008
http://science.calwater.ca.gov/publications/sbds.html

Availability of UC Clonal Paradox Rootstocks

New clonal Paradox walnut rootstocks available

While new clonal Paradox rootstocks have created interest and excitement in the walnut industry, some questions and confusion have also arisen about the supply and availability of trees on these new rootstocks from commercial nurseries. Questions on these rootstocks break roughly down into two categories:

Q. "What's the big deal with these rootstocks? Why should I consider planting them?"
This question has been addressed previously in this newsletter, in trade magazines and, in all likelihood, in conversations you have had with your nursery supplier. Three clonal Paradox rootstocks are currently being produced. From testing and experience to date, the key features of these rootstocks are:

VLACH was one of the first Paradox clones to be propagated (originally from a large vigorous Paradox tree in the Modesto area). It has been available from nurseries for several years. Vlach is vigorous and has shown resistance to Phytophthora root and crown rot in some controlled greenhouse and orchards tests.
RX1, developed by the University of California and released in 2007, has superior resistance to Phytophthora root and crown rot disease.

VX211, also from UC, is considered tolerant of lesion nematodes because it survives and grows vigorously in soils with (or without) high lesion nematode populations.

Q. "When and where can I get them?"
In addressing the question of what to expect in terms of future supply and availability of these rootstocks, some background information on how they are produced is helpful.

These rootstocks are clones; individual trees of each clone are identical. Commercial production of trees begins in the lab with tissue culture where small pieces of green shoots are grown into tiny plantlets. These plantlets must grow, develop, and – in a series of specialized and well controlled steps – are acclimatized to growth outside the lab and greenhouse.

The earliest and youngest product of this tissue culture and acclimatization process is a small rooted plantlet, normally potted, around ⅛ to ¼ inch in diameter and 4 to 10 inches tall.

These plantlets may be transplanted directly to establish an orchard where, with good care, they reach graftable or buddable size in a year.

The plantlets may also be planted in a nursery, where they are grown for one to two years and sold as larger, more conventional ungrafted whips or top-worked finished trees.

There are currently four companies producing cloned Paradox plantlets by tissue culture, and at least six commercial nurseries from which growers can purchase clonal trees. Availability of clonal Paradox trees from nurseries depends on the final product each decides to sell. Nurseries selling small acclimatized plantlets began shipping product to growers in mid-2007. Because this product and planting approach are new for walnuts, it will take time, testing, and experience to refine orchard establishment and management practices suited to them. Nurseries that have elected to produce and sell the clones as larger, older, more traditional bare-root or potted trees should begin having trees available in 2009, and more thereafter.

Of course, availability will also depend on supply and demand for these new rootstocks as we learn how to take advantage of the unique characteristics they offer in orchard settings.

Joe Grant, Pomology Farm Advisor

AgVenture

Can you imagine 4000 third graders on a field trip all in one day? Welcome to AgVenture, a county-run event to educate schoolchildren and promote local agriculture. AgVenture is part of a recent expansion of the Select San Joaquin program to promote local agriculture.

The UC Cooperative Extension has become involved with this program in San Joaquin County. Advisors, nutrition staff and Master Gardeners have all volunteered their time to teach third graders throughout the county a little about local agriculture and eating healthy. In January about 4,000 third-graders from the Stockton and Lincoln Unified School Districts turned out for the affair at the San Joaquin County Fairgrounds. UC Advisor Bob Mullen says "It's a great program for young kids, it experiences them to agriculture and it allows them to take what they have learned back to the classroom. I enjoy volunteering my time at these events. The kids get a better appreciation for what ag really is."

Inside buildings at the fairgrounds, the children assembled in front of exhibits in packs to learn about produce from local farmers or do jumping jacks at stations touting health and nutrition. UC Advisors covered topics from asparagus and grapes to walnuts and beans. Students learn about production and processing of local commodities.

Outside, the students saw cows, sheep, rabbits, horses, tractors, an antique butter-churning device, mushrooms, bushels of vegetables and a cowboy poet. Master Gardeners were present teaching the kids about composting at one table and butterflies at another.

Agriculture is an important industry in San Joaquin County, and children should know about it. The goal is to have all the third graders in San Joaquin County participate in this event. The county held a similar AgVenture event last fall in Manteca for schoolchildren in the south county. The next AgVenture will be held in Lodi for the North end of the county. In all nearly 12,000 third graders will make their way through this event in a year's time.

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Notes from the Field

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For assistance regarding our programs, please contact us.