COOPERATIVE EXTENSION UNIVERSITY OF CALIFORNIA

TREE AND VINE NOTES

August 2007

Drought Tips

Managing Irrigation in Fruit and Nut Trees during Drought

Adapted from an earlier version by David A. Goldhamer, Irrigation and Soil Specialist, UC Davis

When water supplies are limited, growers must minimize water losses normally associated with irrigation and apply water only when the trees are most sensitive to stress. If the amount of water available is insufficient to meet orchard water requirements, the question is not whether trees will be stressed, but rather *when* they will be deprived of water.

Drought irrigation strategies must be judged not only on how production is affected in the following seasons. In fact, the risk of catastrophic yield reductions in nut crops is low in a given drought year, but substantial the following season unless effective drought strategies are used. This is true even if the drought lasts only one year.

This principle was illustrated in a recent test in almonds using several irrigation regimes in a simulated drought year. In each regime, a total of 16 acre-inches/acre of water was applied over a season, but with different timings. The results: where most of the water was applied early in the season, marketable yield was relatively unaffected by the drought, but production the following season was reduced by about 75 percent even though the trees were returned to full irrigation the following year. On the other hand, where some water was applied just after the harvest, the following season's yield suffered only about a 30 percent reduction.

Water Stress and Plant Development

Because of the greater separation between the vegetative and reproductive growth stages in trees, tree growers have more potential to minimize adverse effects of deficit irrigation on crop production than do field and row crop growers. This provides flexibility in developing drought irrigation strategies based on controlling the timing of plant stress. However, growers must be careful not to irrigate in such a way that results in good current season production at the expense of tree productivity the following year.

Certain stages of tree crop development are more sensitive to water stress then others. The following recommendations apply generally to the development stages of all fruit and nut tree species appear following these general guidelines.

Early Season (Bud Break Through Fruit Set)

Trees should not be stressed for water in the early season because early-season growth processes are sensitive to water deficits. Bud break, blossom, flowering, fruit set, and rapid shoot growth all occur in the early spring. Adequate shoot initiation and growth are necessary to establish the fruiting positions for the following year's crop. Early in the season, the trees are hard-pressed to supply the carbohydrates required by the developing fruit. Rapid leaf growth is also necessary to maximize tree photosynthesis. Moreover, since the evaporative demand is low during the early spring, trees do not need much water, nor can much water be saved by deficit irrigating. Growers should therefore start the season with a near-full soil water profile.

Fruit Growth and Development

As a general rule, plant water stress should be avoided during rapid fruit growth. Therefore, species with double signoid fruit development patterns can be deficit irrigated relatively safely during the lag (stage 2) phase of growth. Considerable water can be saved if stage 2 occurs during mid-summer and lasts for an extended period. Stone fruit growth is extremely sensitive to stress during the rapid growth phases immediately before and after stage 2. Stone fruit trees should therefore be fully irrigated during these periods.

Nut growth is generally less sensitive to stress than tree fruit growth. However, other nut crop yield factors, such as hull split in almonds, shell splitting in pistachios, and kernel sunburn in walnuts are affected by water deficits. Stress does not affect the ease of harvest of mechanically shaken tree fruit, but may reduce the harvestability of nut crops, especially pistachios.

Postharvest

The after-harvest period is generally the most water-stress tolerant. Irrigation can be safely reduced (not omitted) with most species. The rule of thumb is that as long as the trees do not defoliate, the stress can be tolerated with little impact on production in the following years. Notable exceptions are almonds and apricots, as noted below.

Drought Strategies for Specific Fruit and Nut Tree Species

Peach, nectarine, plum. Early season varieties should receive full irrigation through harvest. Postharvest water can be appreciably curtailed except during bud differentiation (usually mid-to late August) to prevent fruit "doubling." Late varieties can be stressed during stage 2 fruit growth (about four weeks after fruit set, when pit hardening occur, through the start of rapid fruit growth in stage 3) and during postharvest. Clings should not be stressed in late stage 1 or early stage 2 and then irrigated heavily in order to limit "split pit."

Apricot. Apricots can be stressed during the middle part of the fruit development period, but should receive full irrigation early in the season and during rapid fruit growth just prior to harvest. Excessive postharvest stress can result in bud drop, reducing the following year's crop, so the soil profile must not be allowed to dry out after harvest.

Cherry. Cherries should be fully irrigated until just before harvest. Except during the bud differentiation period when irrigation is required to prevent "spur fruit," postharvest deficit irrigation can be used.

Prune. After full irrigation through the rapid initial fruit growth phase (about late May), reduced irrigation can be tolerated with little if any affect on fruit size, weight, or drop. In fact, stress during this period may increase flowering the following season. However, severe stress during fruit development, followed by heavy irrigation, can result in cracking. Postharvest irrigation should be geared to preventing premature defoliation.

Walnut, pecan. For hedgerow plantings, some water should be applied through out the season except for the final two or three weeks in the fall. The appropriate percentage of normal amounts to apply depends on available water supplies. With about 20-acre-inches/acre available, growers should irrigate at about 50 percent of normal rates; with 10 acre-inches/acre available, growers should apply about 25 percent of normal rates. Conventional density plantings suffered an 80 percent yield reduction in the year following a simulated drought when a total of 16 acre-inches/acre was applied mostly during the early part of the season (mid-March through late May), followed by a progressive cutback through harvest. Spreading out applications over the season as for hedgerow plantings appears to be a better strategy. For heat-sensitive cultivars, irrigating at near-normal levels in the two-week period before harvest may reduce sunburn. Applying "whitewash" may also lessen sunburn damage.

Almond. In almonds, full irrigation early in the season is important for good fruitwood growth and therefore necessary for long-term tree productivity. In early to mid-season cultivars, irrigation can be severely curtailed between mid-June and harvest (about a two-month period). Later-harvest cultivars can also tolerate a two-month period of severe water deprivation before harvest. This practice will reduce kernel weight by only about 10 percent but will drastically reduce hull split. Resuming full irrigation two weeks before harvest can improve splitting.

In almonds, on shallow or drip-irrigated soils, postharvest water management is crucial for the following year's crop. Recent research showed that postharvest water deprivation reduced fruit set and, to a lesser extent, also reduced bloom. Growers should reserve at least 3 to 4 acre-inches/acre (of the normal 8 inches) for postharvest irrigation. Irrigation should begin as soon as possible after harvest. With deep soils that are surface or sprinkler-irrigated close to harvest, postharvest irrigation may not be as important. Prematurely defoliating trees indicate inadequate irrigation. Preharvest defoliation followed by postharvest irrigation can lead to refoliation (a new leaf canopy). Contrary to conventional wisdom, this practice benefits the tree by improving tree water status during a critical period of flower morphogenesis. Flowering in the late fall will reduce yield the following year, however. This occurs when orchards refoliate in the fall and when cold weather in October is followed by a warm November. Limiting irrigation during the late fall may reduce premature flowering.

Pistachio. Pistachio trees are fairly stress tolerant from leafout through mid-May. Stress during this period may actually enhance shell splitting at harvest but at the expense of nut size. Research indicates that a controlled deficit irrigation strategy where stress is imposed after full shell size is attained (mid-May) and before rapid kernel growth occurs (early July) results in little or no negative impact on production. Severe stress from late June through mid-August will reduce harvestability and modestly reduce shell splitting. Water deprivation from mid-August through harvest (mid-September) will decrease shell splitting and slightly reduce harvestability and modestly reduce shell splitting. Water deprivation from mid-August through harvest (mid-September) will decrease shell splitting and slightly reduce harvestability. Severe postharvest water stress can be tolerated.

Irrigation System Management and Modification

Water is precious even in normal rainfall years, and under drought conditions, particularly, nonbeneficial losses of applied water must be minimized. The goal is to apply water as efficiently as possible and to maximize the percentage of applied water stored in the root zone. This requires effective irrigation scheduling – knowing when to irrigate and how much water to apply – and proper irrigation system design, maintenance, and management. The skill of the irrigator and the value placed on efficient water use will determine how much applied water is lost.

The University of California offers numerous publications describing irrigation scheduling, crop water requirements, and other fundamental aspects of water management for normal water years. (See for example, "Irrigation Scheduling – A Guide for Efficient On-Farm Water Management," Publication No. 21454). The following discussion focuses only on how to adjust system management in drought years.

Surface systems. How uniformly water infiltrates depends mostly on the rate at which water advances across the orchard and on the variability of soil intake rates. Growers should use the highest inflow rates possible to achieve the quickest advance. If it is not possible to increase the rate at which water is delivered to the field, faster advance can be achieved by reducing the number of rows irrigated at one time.

It is important to remember that at higher inflow rates, set times must be reduced to prevent runoff and over-irrigation. All tailwater should of course be collected and reused.

Systematic deficit irrigation (SDI) is the practice of applying less water than normal per irrigation and not completely recharging the soil profile. This limits the loss of water to deep percolation. For example, high inflow rates would be used to get water just to the end of the orchard and the water would then be shut off. When the rootzone is refilled only partially, more irrigations than normal may be required for the season. This practice may increase total soil evaporation losses, but in orchards prone to deep percolation, such losses would be more than balanced by total water savings. SDI may require furrows that do not wet the entire orchard floor, in place of borders, since this configuration encourages the lateral movement of water, limits deep percolation, and reduces surface evaporation. Irrigating alternate furrows or drive rows is another useful SDI technique.

Sprinkler systems. How uniformly water is applied depends on the design and maintenance of the sprinkler system and on wind conditions. The irrigator should make sure that correct sprinklers and nozzles are used (nozzle types should not be mixed) and that spray patterns are at the correct angle and not directed into tree canopies. Worn nozzles and leaky pipe joints should be replaced. Irrigating at night reduces spray evaporation and drift losses and can save energy costs if time-of-use rates are in effect. Increasing the interval between irrigations decreases soil evaporation and should be considered if water supplies are especially limited.

Additional Considerations

Young trees. To maintain maximum tree development rates, growers should not under irrigate young trees. Soil moisture in the root zone should be frequently checked and irrigations applied to maintain adequate levels. Applied water should be directed to the developing root zones to minimize irrigation losses. With drip or micro-sprinklers, emitters should be placed close to the trunk except where root disease is a problem. With all surface systems, small furrows should be pulled on either side of the tree row.

Pruning. Heavy pruning can improve the survival chances of drought-sensitive trees, but only at the expense of production for years to come. "Dehorning" – cutting all scaffolds at waist level – should be considered only under extreme drought conditions (with about 8 acre-inches/acre or less water available) where the survival of the trees is in question. It is highly unlikely that this drastic step would be necessary for pistachio or walnut trees.

Thinning. Thinning may result in slight reductions in tree water use. In drought conditions heavier than normal thinning may be necessary to produce fruit of acceptable size.

Fertilizing. Normal fertilizing practices should be maintained or modestly reduced if less than normal tree growth is anticipated.

Cover crops. Growers must carefully weigh the value of cover crops against the water used by the cover crop that would otherwise be available for tree use. Unless the cover crop is vitally important, it should be removed or suppressed. Exceptions would be winter annuals that die in the early spring and thereafter act as mulch, limiting soil evaporation.

More Information. UC Cooperative Extension has many publications on irrigation. Drop by the office for a list and to look at what we have.

Tools for Efficient Irrigation

Dan Rivers, Staff Research Associate, UC Cooperative Extension, Merced County

Irrigating efficiently saves money, helps keep trees and vines healthy, minimizes runoff and unwanted leaching and can conserve water for use in subsequent years during times of drought. "I irrigate every two weeks, just like my father did and my grandmother before him." This approach may work for many growers and water managers and is often a good starting point. Fortunately for those who can't rely on such generational knowledge or who want to follow up on their seat-of-the-pants irrigation decisions, there are many tools available to help manage water wisely. Following is a brief list of some of these tools.

Irrigation Schedulers –Many scheduling programs can be found online. These generally use the water-budget method to project when the soil moisture supply will reach a limiting threshold. These vary in sophistication but most programs use historic weather data and plant developmental stages to indicate when and/or how much to irrigate, then make adjustments in subsequent periods as current weather data becomes available. To learn more about irrigation scheduling check out http://wwwcimis.water.ca.gov or contact your local Cooperative Extension office.

Soil Moisture Monitoring – Knowing how much moisture is available in the soil at the beginning of the season is useful for efficient irrigation management. This could be a simple estimate based on dormant season rainfall amounts (e.g. total rainfall ÷2) or a direct measurement such as weighing and drying soil samples. Either way, a little knowledge of your soil type and depth is helpful; knowing these soil parameters is necessary when using an irrigation scheduler or calibrating certain soil moisture monitoring tools. Soil surveys, backhoe pits and auguring can all provide you with this information.

Once early-season available soil moisture is established, a schedule can be set up. Once irrigation begins, you can check the effectiveness of your irrigation program by monitoring soil moisture. Moisture monitoring tools include tensiometers which indicate available water amounts by measuring soil water tension. These are economical but limited to use in well-watered situations or in sandy soils where available water is held loosely in relatively large soil pores. Gypsum blocks (and other granular matrix blocks like the Watermark sensor) work by measuring electrical resistance. These work in a wider range of soil moistures, work in finer textured soils and can be useful in deficit irrigation situations. Tensiometers and electrical resistance blocks are permanently installed at various depths (e.g. 24" and 48") and when properly placed can indicate whether an irrigation effectively fills/remains in the root zone.

Various other soil moisture monitoring tools are available including capacitance probes and neutron probes which are raised and lowered in permanently installed access tubes and can service multiple sites. Soil moisture monitoring tools vary greatly in cost and their effective uses can depend on the situation. Most all can be read manually or connected to data loggers and uploaded to a computer to create charts of water usage. This visual interpretation of real-time data can be quite useful. Also, once calibrated, these tools (tensiometers and gypsum blocks as well) can be used to establish early-season available soil moisture mentioned above.

Plant-Based Monitoring – Possibly the most telling way to monitor irrigation effectiveness is to go to the plant itself. This could be as simple as a visual assessment of the plant's overall health, inspecting growing tips and rating them by some established rating system or measuring physiological responses like leaf- or plant- water potential with a pressure bomb. A pressure bomb can be quite useful when implementing a deficit irrigation strategy under drought conditions. Traditionally used as a research tool, more portable and economical pressure bombs are being developed for the grower/water manager. Websites for two pressure bomb (plant water status console) manufacturers are http://www.soilmoisture.com and http://pmsinstrument.com. More information about this and other plant-based monitoring tools and strategies can be found at your local Cooperative Extension office.

New Free Publications Recently Posted to the Online Catalog
If you don't want to type in the below links you can view this newsletter on-line at **cemerced.ucdavis.edu/newsletters.htm** and just click on the links.

8205 Asian Citrus Psyllid
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=8205
8194 Erodibility of Agricultural Soils, with Examples in Lake and Mendocino Counties
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=8194
8195 Vegetative Filter Strips for Nonpoint Source Pollution Control in Agriculture
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=8195

New Pest Note
74130 Common Groundsel
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=74130

Recently Updated Pest Notes
7400 Giant Whitefly
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=7400
7488 Hobo Spider
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=7488
7480 Oleander Leaf Scorch
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=7480

Recently Updated Pest Management Guidelines
3448 Grape
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=3448
3451 Nectarine
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=3451
3464 Prune
http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=3464

These publications can be accessed for free as an HTML web page or as a downloadable PDF document from http://anrcatalog.ucdavis.edu.