Topics in Subtropics Newsletter

University of California Cooperative Extension

Fresno Kern Madera Riverside San Bernardino San Diego San Luis Obispo Santa Barbara Tulare Ventura Counties

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Mark W. Freeman is the editor for this issue of the newsletter.

The newsletter is available online at:
http://cefresno.ucdavis.edu/newsletter.htm

or at any of the CE office websites listed on page 9.

Please let us know if there are specific topics that you would like us to address in subtropical crop production. If you would like to change the information on the mailing label, add your email address to receive the electronic issue, or add someone else to the mailing list, please call or send an email message to the farm advisor in the county where you live. Phone numbers and email addresses can be found at the end of this newsletter. Thank you for your outstanding response to the first four issues of the newsletter. We appreciate your interest and your support.

In this issue:

UC Publications and Meetings

Photographic Guide to Citrus Fruit Scarring

Surface scarring can prompt a citrus packinghouse to downgrade fruit from "fancy" to "choice" or even "juice". This publication helps you, the grower, to recognize specific types of scars and their causes so you can prevent costly rind damage in the future. 58 color photos; 3,541KB download.

Free publication that you can download at:
http://anrcatalog.ucdavis.edu/

UCCE Cost Study

Olive Oil 2004, Sacramento Valley (High-Density Orchard, Oil Production)

A study of the economic cost and return of growing olives for olive oil.

Free publication is available (in PDF) at:
http://www.coststudies.ucdavis.edu

Citrus Research Board/Cooperative Extension Grower Seminars:

July 6, 2004	Porterville
July 7, 2004	Dinuba
July 8, 2004	Santa Paula
October 27, 2004	Chico
November 2, 2004	Temecula
November 3, 2004	Indio

For more information, contact the CRB at:

http://www.citrusresearch.org/frameset.html

or **Telephone**: (559) 738-0246, **Fax**: (559) 738-0607

Vertebrate Pests Causing Damage in Citrus

By Mark Freeman

Vertebrate pests that have caused damage to citrus trees include rodents and small mammals, large mammals, and birds. Citrus orchards provide food and shelter for a number of these pests, and damage may be severe if the pest resides in the orchard. Damage can occur to the fruit such as rat chewing or bird droppings. Bark damage and tree death can occur from rodents and larger mammals. Damage to irrigations systems such as chewing on hoses can easily be the most expensive damage.

The goals of a successful management program include reducing the number of pest problems and using control methods that are affordable. There are four key points to establishing and maintaining a vertebrate pest management program. First, one must identify the specific damaging species. Second, review all the management control options. Third, one must take action quickly and early, and use the best option that is appropriate for the time of year and the orchard. Fourth, use a monitoring system to detect when re-infestation occurs and thus more controls are needed.

The first key point is identification and observation. Many of the agricultural commissioners' offices in the counties can help with this problem. In addition, University of California Production Manuals such as almond and walnut have reference material on different pests. It is critical to identify the specific species or type of pest causing damage. You can use direct observations with some pests such as birds or squirrels that are active during the day. With pests that are active at night or tend to hide, one looks for tracks, burrows, or the type of feeding; or one can use traps. With rodents, one can use the size of the incisor marks on plants to help identify the pest. This is also useful on irrigation systems, where one can remove the damaged part and take it to an expert. Traps are also used where trails are established to capture and identify the pest. Pictures, especially close-ups are very useful and can be emailed or sent to experts on the Internet. If you also describe the adjacent habitat such as foothills, streams or rivers, etc., that information will help.

For some pests, there are many possible control options. It is very important to check with the agricultural commissioner's office as animals vary by protected status and how the animal can be legally controlled. The pest's life cycle will determine when and if a certain control method can be used. For example, ground squirrels can be controlled effectively with poisoned baits but not in early spring when the animal is feeding on green material. Gophers can be controlled all year with poisoned baits that are applied into the burrows, but are more active when the soil is moist. Habitat modification may be an economical option, as brush piles near an orchard will provide shelter for pests. Biological control such as attracting owls and hawks to an orchard can assist with control, but seldom keeps rodent levels below economic levels.

It is important to act quickly when a control measure is selected. Some vertebrate pests can increase in population quickly, and control is less expensive with lower numbers of pests. Some pests will reside in the orchard, and create a home there. It is much easier to control them when the pests live outside the orchard.

Finally, it is important to have a monitoring system in place after controlling a vertebrate pest so as to detect if the pest is re-entering the orchard. A good record system is important.

Many of the citrus orchards in the San Joaquin Valley (SJV) are located near the foothills on the eastern side. Some of the more common vertebrate pests include gophers, ground and tree squirrels, mice, rats, rabbit, coyote, feral (wild) hogs, and starlings. Rare tree damage has occurred from bear and beaver. There is more new acreage in the SJV planted in the middle of the valley. Those trees will be susceptible to the vertebrate pests already found nearby.

Rodents such as gophers and meadow mice (or voles) feed on plant roots, and can girdle and kill young citrus trees. Occasionally, gophers can kill mature trees, especially if the tree is weakened by other factors such as root rot. Many members of the rat family and deer mice will feed on citrus fruit. The effectiveness of control measures depends on identifying the specific rodent. The Eastern Fox Squirrel (EFS) is a tree squirrel found near big cities in the SJV and throughout the metropolitan areas of Southern California. It has moved to adjacent commercial citrus orchards and will feed on ripe fruit.

Coyotes, rabbits, and squirrels will damage irrigation hoses. By examining the damage, experts can identify the pest. The EFS has caused considerable damage to irrigation systems in some nut crop orchards in the Fresno area.

Larger mammals can be economic pests. Wild hogs will feed on fruit, damage bark, and create large holes or "wallows" on the orchard floor where it is moist. Occasionally, hogs will destroy irrigation hoses. Beavers have destroyed young citrus trees located near streams.

Bird problems have occurred mainly due to large flocks of starlings that nested in orchards at night. The damage resulted from the bird droppings on the fruit.

Useful websites:

http://www.vpconference.org/
http://wfcb.ucdavis.edu/www/Faculty/desley/Programs.htm

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After the Fire in the Avocado Grove Replant or Sucker-Graft?

By Gary S. Bender

The wildfires in San Diego and Ventura Counties during the fall of 2003 were certainly devastating to many avocado groves adjacent to burning native chaparral. Many of the avocado trees were singed in the canopy without extensive damage to the large scaffold branches; these trees will re-grow new foliage with some relatively minor pruning to clear out smaller dead branches. However, other groves have had extensive damage, complete with charring of the bark in the trunk and boiling of the sap through the bark of the trunk. In these cases, the sap became hot enough to steam the cambium layer (the layer of living cells just beneath the bark), killing the tree above the soil line.

In the latter case, the tree above the soil line is dead, but the roots are still alive. Beginning about the first of March 2004, we have noticed that many of these trees are sending up rootstock suckers near the trunk. If left to grow un-grafted, these suckers will become an avocado tree, but not a known cultivar. The question is: should these burned trees be removed and replanted with a new tree? Or should a sucker be tip-grafted back to a known cultivar?

Sucker grafting in avocado is a well-known practice and has been used extensively in the industry when a grower desired to change cultivars. Generally, the tree is cut down leaving a three-foot stump, which is used as a stake for the new tree. A strong sucker growing from the base of the tree is selected (the sucker should be about 3/4 to 1" in diameter and stiff, not rubbery), and the other smaller suckers should be removed. The sucker is cut with a horizontal cut about 6-8" above the soil line, a 2"vertical slit is made down through the center of the sucker, and 3" to 4" long piece of budwood, cut like an arrowhead at the bottom end, is slipped into the slit, matching the cambium layers together on at least one side, and preferably on both sides. The graft is wrapped tightly with grafting tape, and the entire budstick is wrapped with Parafilm to prevent moisture loss, and grafting tape is used to tie the new grafted sucker to the stump (used as a stake).

Advantages from sucker grafting (as opposed to planting a new tree).

- Sucker grafting is cheaper. As recently quoted by a grafter in Fallbrook, sucker grafting usually costs about $2 per tree after the tree has been cut down to a 3 foot stump. If the grafter supplies the budwood and grafting tape, the price will probably be $2.50 per tree. If the grafter has to travel away from Fallbrook, the price will be higher according to the distance traveled. A new replacement tree will cost about $14 on a seedling rootstock, or $19-22 on a clonal rootstock. The labor cost for planting the new tree would be about $2.00 per tree. These costs do not include cutting down the older burned tree, or follow-up care for the young tree.

- The older, burned avocado tree has an extensive root system with a lot of stored energy. When the sucker graft begins to grow it usually grows very rapidly, much faster than a young replant tree. The sucker grafted tree should start to set fruit two years after grafting.

Disadvantages from sucker grafting.

- We are assuming that the sucker-grafted tree is healthy and does not have root rot or some other disease. If the older tree has root rot, it would be better to remove the old tree and replant with a new tree grown on one of the newer root-rot tolerant clonal rootstocks.

- In the system described above, the trunk is used as a stake. When the new tree grows enough to be self-supporting, the old stump should be cut down close to the ground. The stump should be slightly sloped to drain water away from the new tree. This takes some careful chainsaw work.

- Suckers. Until the new tree gains strength and starts to shade the old stump, there will be other suckers emerging. These must be removed or they will take over and shade the grafted sucker.

Compatibility/seediness among Clemetine mandarins, 'Afourer' mandarin, 'Tahoe Gold' mandarin and 'Gold Nugget' mandarin – Implication for seedless mandarin production in California.

By C. Thomas Chao

The issue of compatibility/seediness between different mandarin cultivars is a major concern for growers in California. If one plants two compatible mandarin cultivars next to each other or near by, there will be a lot of seeds in the fruit. Mandarin fruit with large numbers of seeds will be downgraded and receive less return for the growers. In order to find out more about this issue, I conducted a pollination study in 2002 and 2003 that was funded by the California Citrus Research Board. I did a hand cross-pollination study among different mandarin cultivars at the University of California Lindcove Research and Extension Center near Exeter, CA. The study included three types of mandarins: (1) Clementine mandarins such as 'Fina Sodea' and 'Nules'. 'Nules' Clementine is the leading cultivar with large acreages of new plantings in CA in recent years. (2) 'Afourer' mandarin, also known as 'W. Murcott' mandarin, is sold under the trade name "Delite" mandarin. 'Afourer' mandarin is also one of the leading cultivars that have been planted in CA in recent years. (3) 'Tahoe Gold' mandarin and 'Gold Nugget' mandarin, are both new seedless mandarin cultivars recently released by the citrus breeding program at UC-Riverside (Dr. M. Roose). 'Tahoe Gold' mandarin, also known as 'TDE3', is a triploid mandarin and completely seedless even in a mixed planting. 'Gold Nugget' mandarin is a diploid mandarin and also completely seedless in mixed plantings. Both Clementine mandarins and 'Afourer' mandarin are nearly completely seedless if they are grown in isolation. These two types of mandarin are known to have seeds if they are planted near by, but the severity of the seediness is unknown.

The Clementine mandarins used in the study belong to a Clementine mandarin cultivar trial established by the late Dr. David Gumpf, Department of Plant Pathology, UC Riverside and Citrus Clonal Protection Program (CCPP). The 'Afourer' mandarin belongs to a mandarin cultivar rootstock trial established by Dr. Louise Ferguson, Pomology Department, UC Davis. The 'Tahoe Gold' mandarin and 'Gold Nugget' mandarin are located in the CCPP foundation block. The results from the crosses among different mandarins from 2002 and 2003 experiments are shown in Table 1.

Based on the results from 2002 and 2003, some preliminary conclusions can be drawn and some results can be used as guidelines for future planning of new mandarins in CA.

First, crosses between Clementine mandarins and 'Afourer' mandarin were found to produce very high fruit set and a lot of seeds in the fruit. There were 30-40% fruit sets in 2002 crosses with an average of 23-25 seeds per fruit. The fruit set percent was lower in 2003, but the cross between 'Nules' Clementine and 'Afourer' mandarin had an average of 32 seeds per fruit. The reciprocal crosses between 'Afourer' mandarin and Clementine mandarins had lower fruit set percent, 28% in 2002, and an average 9-12 seeds per fruit. The 'Fina Sodea' Clementine by 'Afourer' mandarin cross had 21% fruit set with an average 11 seeds per fruit in 2003. The Clementine mandarins and 'Afourer' mandarin are highly compatible and could cause

large numbers of seeds in each other. All efforts should be made to keep these two types of mandarins from each other. Large distances should be maintained between these two types of mandarins at all times to avoid seed production.

When the 'Gold Nugget' mandarin was used as the pollen parent in crosses with 'Fina Sodea' Clementine and 'Afourer' mandarin, fruit set was 0.00% in all crosses. 'Gold Nugget' mandarin probably will not cause any seed in Clementine mandarin and 'Afourer' mandarin and it could be planted near them without concern for seed production.

The 'Nules' Clementine x 'Tahoe Gold mandarin crosses gave 14% fruit set with an average 1.5 seeds per fruit in 2002 and 17% fruit set with an average 10 seeds per fruit in 2003. 'Tahoe Gold' Clementine, a diploid, in principal. However, by some unknown mechanism, it is able to cause seeds in 'Nules Clementine. It is however, not compatible with 'Fina Sodea' Clementine and 'Afourer' mandarin in crosses. Based on the preliminary findings, the results suggest that growers should avoid planting 'Tahoe Gold' mandarin near 'Nules' Clementine. 'Tahoe Gold' may be able to cause some seeds in 'Nules' Clementine mandarin.

Currently, I am growing seeds from the 'Nules' Clementine x 'Tahoe Gold' mandarin with the intention of determining what might be the mechanism for the seed production. I will repeat some crosses in spring of 2004 at LREC and include other citrus such as lemon, grapefruit, 'Shasta Gold' mandarin (TDE2) and 'Yosemite Gold' mandarin (TDE4) in the crosses.

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Table 1. Parents, total crosses made, total fruit number, % fruit set, average seed number per fruit, minimum and maximum seed number per fruit from crosses among 'Nules' Clementine, 'Fina Sodea' Clementine, 'Afourer' mandarin, 'Tahoe Gold' mandarin and 'Gold Nugget' mandarin in 2002 and 2003.

Year	Female Parent	Male Parent	# Cross made	Total fruit #	% fruit set	Average seed #	Seed # range
2002	Nules	Afourer	106	42	39.62%	25.36	1-41
	Nules	Tahoe Gold	103	14	13.59%	1.50	1-4
	Fina Sodea	Afourer	107	33	30.84%	23.42	3-35
	Fina Sodea	Tahoe Gold	116	1	0.86%	4.00	4
	Afourer	Nules	107	30	28.04%	9.47	1-24
	Afourer	Fina Sodea	113	32	28.32%	12.00	5-17
2003	Nules	Afourer	61	3	4.92%	31.66	26-43
	Nules	Tahoe Gold	103	17	16.50%	9.82	5-14
	Fina Sodea	Afourer	110	0	0.00%	-	-
	Fina Sodea	Tahoe Gold	137	0	0.00%	-	-
	Fina Sodea	Gold Nugget	97	0	0.00%	-	-
	Afourer	Nules	99	1	1.01%	5	5
	Afourer	Fina Sodea	101	21	20.79%	11.00	4-17
	Afourer	Tahoe Gold	101	1	0.99%	5	5
	Afourer	Gold Nugget	110	0	0.00%	-	-

Irrigation Scheduling

By Ben Faber

Irrigation efficiency requires not only uniform irrigation, but also the proper timing and amount of applied water. It is important that the irrigator know the system water application rate, either in inches per day, inches per hour, or gallons per hour.

Irrigation scheduling which determines the time and amount of water to be applied can be accomplished through a variety of methods, including measuring soil moisture, determining plant moisture status and determining evapotranspirational loss (ET crop or ETc). Evapotranspiration values are a measure of the actual amount of water well watered plants would use. This information is available in many areas of California from newspapers, irrigation districts, and over the Department of Water Resources CIMIS network (California Irrigation Management Information System, http://www.cimis.water.ca.gov, CIMIS Help Line (800) 922-4647).

Evapotranspiration varies seasonally and from year to year for a given location. DWR has developed a map of the average daily ET for various zones in California. These zones are distinctive because total sunlight, wind, relative humidity and temperature are the parameters that drive water loss and differ in each zone. Where the Central Valley becomes hot and cloudless in the summer, along the coast the intensity of the marine layer and its effect on sunshine differs from year to year.

Scheduling, as opposed to a fixed amount applied at a fixed time, is especially important in Southern California coastal valleys. Although the average annual irrigation requirement is about 2 feet of applied water per year (2 acre-feet per acre or 651,702 gallons per acre), this value varies tremendously from year to year, from as little as 18 inches to as much as 3 feet.

One of the most important variables in the quantity of applied water is the length of the rainfall season and the effectiveness of the rainfall. The rainfall season determines the length of the irrigation season and effective rainfall determines how much the plant can use. Effective rainfall is defined as the amount of rainfall, which is retained in the root zone of the tree. For example, consider a rooting depth of 2 feet and each foot holds 1 inch of available water. If you have just irrigated or if it rained 2 inches yesterday and it rains 2 inches today, none of today's rain is effective since the soil was already moist. It did leach salts out, however. Rain events of less than 0.25 inches are also not considered effective.

Determining an irrigation schedule based on tree water requirement falls into three broad categories of technology - plant-based, soil-based and weather-based. Many of these technologies are proven and have been in use for years. Others are more experimental and have not been fully tested. In several cases improved electronics and digitalization have put a new spin on older technologies. A method of determining when to irrigate should be learned by all growers and often a combination of techniques can be employed.

Plant-based Scheduling Methods

The plant is the ideal subject to measure, since it is integrating all the various factors driving water loss as well as soil moisture and any stresses such as soil salinity and plant health. To be a useful tool in irrigation scheduling, plant-based measuring devices must provide indicators of stress before that stress reaches levels that result in yield decreases. The methods include:

- pressure chamber (pressure bomb or Schollander pressure chamber) measures plant water tension by applying a comparable air pressure to a leaf or stem. The amount of pressure required to equilibrate with the plant sap indicates how much stress the plant is under.
- trunk diameter fluctuations (shrink/swell), measured continuously with linear variable displacement transducers (LVDTs), can be used to calculate parameters that are directly related to tree stress.
- stem flow gauge estimates transpiration by placing a heat source on the trunk of the tree and then measuring the temperature differential along a trunk.
- porometer measures the ability of a leaf to transpire, so when the leaf is under water stress then less water is transpired.
- infrared thermometry measures the canopy temperature as affected by the rate of transpiration, so as the plant goes under water stress, the leaves gets warmer.
- visual symptoms (wilting, leaf curling) are the cheapest method, but the most expensive in the long run.

While these techniques can be valuable for scientific use, there has been little adoption in commercial agriculture. With the exception of the pressure chamber and LVDTs, this is due to the aforementioned problem of being able to identify mild water stress. Another reason for their lack of use by commercial agriculture, specifically subtropicals, is that there are logistical problems with mature trees, such as with the stem flow gauge and infrared thermometry. At this time, the pressure chamber is the state of the art in measuring tree water stress in subtropicals while recent research indicates that the LVDTs show promise for automating irrigation scheduling.

Soil-based Scheduling Methods

A rule of thumb is that irrigation timing should occur when about 50% of the water available to the plant has been depleted from the soil. The 50% figure is arbitrary; it allows a buffer of water in the soil in case the weather suddenly turns hot and windy.

Of course a sandy soil will hold less water than a clay soil, so irrigation will be more frequent. A common perception is that it takes more water to grow plants in sandy soil than clay soil. The total amount required for the whole year by the tree will not be changed by the soil type. This is because it is the sun, wind, temperature and humidity, which decides how much water the tree, will need. The soil is only the reservoir.

To check the water content in the soil, take a trowel, shovel, or soil tube and dig down 8 to 16 inches. A soil that has about 50% available water remaining will feel as follows:

Soil texture

- coarse - appears almost dry, will form a ball that does not hold shape;
- loamy - forms a ball, somewhat moldable, will form a weak ribbon when squeezed between fingers, dark color;
- clayey - forms a good ball, makes a ribbon an inch or so long, dark color, slightly sticky.

Irrigation timing can be determined and also mechanized with the use of a tensiometer. These water filled tubes with a pressure gauge accurately reflect the amount of energy a plant needs to extract water from the soil. The pressure gauge measures "tension values" in centibar units (cbars). When the gauge reads 30 cbars, it is a good time to irrigate.

Placement of the tensiometers requires that they be within the root zone, between the emitter and the tree trunk. Having two tensiometers next to each can be helpful in deciding both when to turn the system on and when to turn it off. A tensiometer at a one-foot depth tells when the water should be turned on and a tensiometer at three feet tells when to turn the system off. Placing a plastic milk crate over the device will prevent pickers from kicking them over.

There are other devices on the market for measuring soil moisture. Gypsum blocks are very effective. Although the part in the ground is inexpensive, the reading device costs in the $250 range. This cost means a large enough acreage is required to spread out the cost of the system.

There are portable meters on the market for measuring soil moisture. These meters rely on an electrical current carried by water in the soil. Even the cheap $10 ones can give a rough estimate of the soil water content. None are very effective in rocky ground, because their sensitive tips break easily.

The amount of water to apply at an irrigation depends on the amount of water held within the root zone. A loamy soil where a microsprinkler with a 20-foot diameter throw has wetted a two-foot depth will hold about 200 gallons of water at 50% of the soils water holding capacity. Exceeding this amount of water will help leach salts; but if far in excess, additional water is only pushing existing water out of the root zone.

It is best to follow one or two irrigation cycles to find out how long to run the system to achieve a certain depth of infiltration. This can be done with a shovel or more easily with a pointed rod or tensiometers. Water moves in a wetting front, and the wetted soil will allow the rod to be pushed in to the depth of dry soil. The system should be run to find out how long it takes water to infiltrate to a depth of two and three feet. That information will indicate how long to run the system when irrigating.

Applying water to achieve a two to three foot depth may take several hours. If run-off occurs, the system may be turned off for a few hours, then turned on again to get the total run time required to infiltrate to a given depth. If run-off is severe, use emitters with a smaller flow rate.

Soil-based methods monitor some aspect of soil moisture which, depending on the method, requires some correlation to plant water use. Some of the methods are well understood and inexpensive, others are expensive, inaccurate, inappropriate or not well researched. Some of the techniques allow multiple site readings while others require a device to be left in place. Some measure soil water directly, like oven-drying and others measure some other parameter with is associated with water content, such as electrical conductance. Some are affected by salts or soil iron content and others have limited value in the desired soil moisture range. Some, like tensiometers and gypsum blocks, give a reading from a porous material, which comes to equilibrium with soil moisture, while many others use the soil directly as the measured media. This is an important distinction since discontinuities in the soil caused by rocks or gopher holes can affect readings when the soil is used to carry a signal. Also, times have changed and some of the old techniques have been improved. For example, gravimetric oven-drying can now be done by microwave, considerably speeding up the process. Tensiometers and gypsum blocks can now be found with digital readouts and connections to data loggers, which make data easier to manage. There are quite a number of devices on the market and the following chart will shed some light on their differences.

Method	Cost	Ease of Use	Accuracy	Reliability	Salt-affected	Stationary
Gypsum	L	H	H	H	L	YES
Tensiometer	L	M	H	M	L	YES
Portable Tensiometer	M	M	H	M	L	NO
Solid-state Tensiometer	M	H	H	H	L	YES
Time domain Reflectometer	H	M	H	H	M	BOTH
Neutron probe	H	L	H	H	L	YES
Feel (soil probe)	L	H	H	H	L	NO
Gravimetric (oven)	L	M	H	H	L	NO
Conductance	L	H	M	M	H	BOTH
Capacitance	M	H	M	H	M	BOTH

H – High; M – Medium; L - Low

As with any tool, the value of these devices increases with use and familiarity. Even though several of these are listed as stationary devices, by placing them in representative positions in the orchard, they can accurately reflect the rest of the orchard. Several of the devices are listed in the table as being both stationary and portable; this is because there are various models that can act one way or the other. The "Ease of Use" category in the table indicates not just the ease of reading the device, but also the maintenance required for it.

Weather-based Methods of Irrigation Scheduling

Another scheduling technique that has become popular is the use of weather data that has been converted to a crop water use value. This value is the estimated amount of water an orchard would use. The value is often referred to as the evapotranspiration (ET) of the crop. ET is the amount of water that can be lost by a well-watered crop either through the leaves (transpiration) or evaporation from the surface of the soil. By applying the ET amount at an irrigation, the trees are kept at optimum moisture content. The technique is often called the water budget method or checkbook scheduling.

The CIMIS network of over 50 weather stations calculates reference evapotranspiration (ETo). This value is an estimate of the amount of water lost from a well-watered field of grass. Grass is the standard or reference for all other crops. ETo is modified for the specific crop with a crop coefficient (kc). The formula for converting ETo to crop ET is:

ETo X kc = ETcrop.

For a full-grown subtropical orchard a kc of 0.65 is used in most of the State, but in the desert growing areas, 0.56 is used. With smaller trees, a smaller kc is used. When trees are young and intercept little energy to drive water loss, a kc of 0.05 works well. As the trees increase in size to where their shade covers about 65% the soil surface, the kc is gradually increased each year. With rapidly growing trees, the kc increase is usually about 10 % each year, until about year 8 when the 65% figure is reached. A correction factor needs to be incorporated for the irrigation system distribution uniformity, as well.

If the orchard is cover cropped for part or all of the year, the period during which the cover is present needs to be recognized in the water use calculation. A soil that is covered by a cover crop and trees uses water just like a mature orchard. Therefore, if the young orchard is covered by a perennial cover crop a kc of 0.65 is used regardless of tree size. If a winter annual cover is used, that uses only rainfall for its growth, correction is not usually necessary in a high rainfall year. But in low rainfall years, the water requirements of the cover need to be recognized in the irrigation program.

Reference evapotranspiration values are available from many irrigation districts, CIMIS, several weekly journals and magazines. In Ventura County, the values are available through County Flood Control, and in San Diego County, they are available from the Resource Conservation Districts.

One of the drawbacks of the centralized weather stations is that in hilly terrain with different sun exposures, the station values can be quite different from the water loss at a grove. When using evapotranspiration figures it is always important to back up the estimates with field checks in the grove. An alternative to using the centralized weather stations is establishing one of your own. These electronic stations cost in the range of $5,000 and require regular maintenance as well.

A simpler weather station can be developed with an evaporation pan or an atmometer (atmosphere meter). Both of these devices actually measure the loss of water due to evaporation and since the physics of evaporation and transpiration are very similar, the values can easily be used in a water budget.

The major drawback to the evaporation pan is the maintenance required to keep birds, coyotes, and bees from causing inaccurate readings. Algae also needs to be kept free of the pool. An atmometer is a closed system with a ceramic head, much like a tensiometer. As water is drawn out of a reservoir, a sight tube shows how much water has been evaporated. The atmometer is more expensive (~$300) than a pan, but it is much easier to maintain.

Regardless of what scheduling technique or combination of techniques is used, a thorough evaluation of the system needs to be performed so that a known amount of water is being applied. Until volume and distribution of water are known, it makes little sense to schedule applications.

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An Update of Agricultural Waivers in California – Water Quality Programs for Irrigated Agriculture

There has been considerable discussion around the state about a developing regulatory program for irrigated agriculture, often referred to as "the waiver program". The following article explains a little of the history of irrigated agriculture waivers, as affected by regions in the state. If you are unsure which Water Quality Control Board Region you are in, you can access the State Water Resources Control Board's website at http://swrcb.ca.gov or look it up in the state government listings section of your phone book under Water Quality Control Board.

By Christine French (Regional Agency Liaison) and Laosheng Wu (Associate Director), UC Center for Water Resources

Section 13260 of the Porter-Cologne Water Quality Control Act, 1969 (California Water Code (CWC), Division 7) mandates that "any person discharging waste… that could affect the quality of the waters of the state," must file a report of waste discharge with their Regional Water Quality Control Board (regional board). Such discharges are regulated by the regional boards through Waste Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES, 1972) permits. As non-point sources, however, agricultural discharges are specifically exempted from NPDES permits. Furthermore, CWC Section 13269 gives regional boards the authority to waive the requirements for WDRs for specific types of discharge if the waiver is not against the public interest.

Over the past twenty years, all nine regional boards have used this authority to grant waivers to many categories of discharges, including irrigation return flows from agricultural operations. The Central Valley Water Quality Control Board (CVWQCB), for example, adopted such a resolution in 1982 (Resolution No. 82-036), and the San Francisco Bay and Central Coast Regions followed suit in 1983. At the time, regulatory efforts of the regional boards were focused on point source discharges, and for the most part, adopted waivers did not require monitoring or reporting and established conditions were not enforced.

On 10 October 1999, Senate Bill 390 amended Section 13269 to require all waivers in effect as of 1 January 2000 be terminated on 1 January 2003 if not specifically renewed. Additionally, the bill required new waivers to be conditional, limited in duration to no longer than five years, and revocable at any time by the regional board. As a result of this action, new conditional waivers for agricultural waste dischargers are being developed and implemented in some regions, while others have chosen to work with their irrigated agricultural operators through other processes. Following is a summary of the actions being taken in each of the state's nine regional boards.

Region 1 (North Coast): No new agricultural waivers have been adopted, or are currently in process. Options are being evaluated.

Region 2 (San Francisco Bay): No new agricultural waivers have been adopted, or are currently in process. The Board is working with agricultural interests through means other than waivers.

Region 3 (Central Coast): The Central Coast Region, with approximately 600,000 acres of irrigated agriculture, currently has a draft waiver under review.

Two tiers with different requirement levels are proposed for conditional waivers. All dischargers must apply for coverage by 1 October 2004. Tier 1 Conditional Waivers would be valid for five years and require 15 hours of farm water quality education by the enrollment deadline, completed farm water quality plans, and a management practice implementation checklist submitted to the Regional Board biennially. Tier 2 Conditional Waivers will be valid for only one year, renewable for up to three years, and are intended for dischargers that are in the process of meeting the requirements of Tier 1, but cannot do so by the enrollment deadline. Monitoring will be required from both tiers and can be conducted on an individual, group/watershed, or approved regional basis. More information is available at: http://www.swrcb.ca.gov/rwqcb3/workshops/Documents.htm. (**This waiver has not yet been adopted and any information here may change prior to adoption; information provided is only proposed. The regional board is scheduled to consider the draft conditional waivers 18 March 2004.*)

Region 4 (Los Angeles): The Los Angeles Region currently has a draft waiver under review as one component of their agriculture policy. As proposed, the waiver would require implementation of Best Management Practices, documentation of fertilizer and pest control applications, and monitoring, which could be completed on the property or as part of a regional sampling program. Operations that do not meet the waiver requirements, or are near an impaired waterbody, would be subject to either a general or individual permit. Development of a pilot program covering a single watershed is also being considered. (**This waiver/agriculture policy has not yet been adopted and any information here may change prior to adoption; information provided is only proposed.*)

Region 5 (Central Valley): With jurisdiction over more than seven million acres of irrigated cropland, the CVWQCB adopted two conditional waivers – one for coalition or watershed groups and a second for individual dischargers – on 11 July 2003 (R5-2003-0105). (A prior waiver, R5-2002-0201, was adopted 5 December 2002 and rescinded on 10 July 2003.) Under this program, growers have three options: 1) join a coalition group and apply for a group waiver; 2) apply for an individual discharge waiver, or 3) obtain an individual waste discharge permit. To receive Regional Board approval for the waiver, individuals or groups were given a deadline of 1 November 2003 to file a notice of intent to discharge. Additional information, including a watershed or farm evaluation report and monitoring plan, are scheduled for submission on 1 April 2004. For operations that do not meet the conditions of the conditional waiver, WDRs may be imposed. This waiver is set to expire 31 December 2005, and is intended as the first step in an evolving Irrigated Lands Program. Additional information can be found at: http://www.swrcb.ca.gov/rwqcb5/programs/irrigated_lands/index.html.

Region 6 (Lahontan): No new agricultural waivers have been adopted, or are currently in process. With few areas of irrigated agriculture in the region, and even less that discharge to waterways, issues will be dealt with as they arise, likely through means other than a waiver.

Region 7 (Colorado River Basin): No new agricultural waivers have been adopted, or are currently in process. Areas of impairment are being dealt with by TMDLs. A sediment TMDL has been adopted, a nutrient TMDL is expected within the next couple of years, and further TMDLs for pesticides and selenium may also be following.

Region 8 (Santa Ana): No new agricultural waivers have been adopted, or are currently in process. Most nurseries are regulated under WDRs, and other agriculture is currently dealt with on a case-by-case basis.

Region 9 (San Diego): On 11 September 2002, the San Diego Regional Board adopted a new Waiver Policy, which became effective 1 January 2003 and expires 1 January 2008. Under this Policy, two categories of discharges are identified. Category 1 dischargers must enroll for coverage while Category 2 does not require enrollment. Agricultural Irrigation Return Water is considered a Category 2 discharge and the waiver applies under the specific conditions "Where management measures and best management practices have been implemented as described in the Plan for California's Nonpoint Source Pollution Control Program." Under this same Policy, Nursery Irrigation Return Water is considered a Category 1 discharge. Enrollment is covered through the "Application for License to Sell Nursery Stock" submitted to the California Department of Food and Agriculture. The Waiver Policy is available at: http://www.swrcb.ca.gov/rwqcb9/rb9board/waiver%20policy%2011-01-02.pdf.

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Integrating Admire Treatments for GWSS with Citrus IPM in the San Joaquin Valley

By David Haviland, UC Cooperative Extension, Kern County, and Beth Grafton-Cardwell, Entomology Department, UC Riverside, stationed at the Kearney Ag Center

Managing insect and mite pests in citrus requires a delicate balance between utilizing biological control and augmenting that control with insecticides. Unfortunately, due to the nature of insecticides, every time we intervene we inadvertently affect our allies, the biocontrol organisms. Mitigating the effects of 'friendly fire' can be accomplished, but requires an understanding of the interactions between pest and

beneficial organisms, and can only be done using the right insecticide in the right place at the right time.

During the first year of coordinated GWSS treatments in Kern County in 2001, nobody was sure what effects these treatments would have on pest and beneficial insects in citrus. In fact, they weren't even sure how well the treatments would control the glassy-winged sharpshooter. Basic research on pesticide efficacy on pests and beneficials, as well as research on optimal application timing, were in their infancy. It was also anticipated that the control program would have to be repeated each year for many years to keep this pest in check.

Since the early days of the program we have learned a lot about the glassy-winged sharpshooter and the insecticides we use to control it. The spring portion of the control program is now based on the use of Admire (soil applied imidacloprid). This product is generally considered soft on beneficials compared to the broad-ranging effects of organophosphate, carbamates and pyrethroid insecticides because it is applied systemically through the irrigation system. Yet, this nerve toxin is not completely benign to all beneficial insects.

Protecting the vedalia beetle

Admire is highly toxic to vedalia beetle. When vedalia feeds on cottony cushion scale that have taken up the Admire into their bodies, the vedalia beetle dies. Admire treatments should be timed to not disrupt this valuable biocontrol organism. Vedalia beetle is most active and suppresses cottony cushion scale from March through May, and then disperses or declines in the summer heat.

If more that 5% of the trees in an orchard have live cottony cushion scale, Admire treatments should not be made until after petal fall. Treatments applied shortly after late April or early May will begin to take effect after Vedalia has finished controlling the scale. As long as applications are not made too long after petal fall, they will still be effective against GWSS by killing the nymphs before they develop wings and disperse to neighboring crops.

Continuing *Aphytis* release programs

Augmentation of biocontrol of California red scale through releases of *Aphytis* wasps has been a valuable tool for many citrus growers. In the past, reliance on *Aphytis* has decreased in locations with insecticide programs for GWSS. Primarily this was due to a general belief that treatments would be recurring and so disruptive that *Aphytis* control programs would be obliterated. Fortunately, this has not been the case and many of these growers are returning to *Aphytis* for red scale control programs.

Growers should not be afraid to continue, or return to, *Aphytis* release programs. When relying on this program, it is critical to establish *Aphytis* in orchards in early spring (Feb-Mar) when 3rd instar scale are available for parasitism. Theses early releases are creating small insectaries that will later expand throughout the orchard.

Growers in areas being targeted for GWSS treatments this spring (i.e., southern Tulare County), should also continue their programs, primarily because most growers won't know if their groves will be targeted for treatment until some time between late March and the end of May.

In the case where GWSS treatments with Admire are used in a grove, growers can expect that *Aphytis* populations will be reduced, but not eliminated. Those that remain will continue to reduce populations of scale. *Aphytis* releases can then be resumed immediately after an Admire treatment. Since Admire is most effective against scale infesting leaves and fruit, these parasites are particularly important for controlling scale infesting wood and twigs. The combined effects of the insecticide and parasite can provide control of this pest.

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