CORF News

Floriculture Education from the
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TMDL and Nursery Production

By Jay Gan, Water Quality Specialist, UC Riverside

By now, many of us have heard about, or become involved with, the Total Maximum Daily Load (TMDL) program. The University of California, with its technical strength, neutral position, and great familiarity with individual watersheds and local communities, is playing an increasingly important role in this area. In the southern counties, currently there are several TMDL-oriented projects that specifically address pesticide and nutrient runoff from nurseries. These projects are led by UC Cooperative Extension. In this article, we will take a brief look at the TMDL program, try to comprehend what a pesticide or nutrient TMDL entails, and discuss why nursery and floriculture production is involved.

What TMDLs?

TMDLs are pollutant-based. In California, the TMDL program includes many different types of pollutants. According to the state 303(d) list, there will be about 800 TMDLs in California. However, since many TMDLs address multiple pollutants, on a single pollutant basis, the total number of TMDLs is 2125, of which 695 are classified with "high priority." Figure 1 is a breakdown of the high-priority TMDLs.

We are expecting 125 pesticide TMDLs, and 67 nutrient TMDLs. Together, pesticide and nutrient TMDLs

See TMDL & Nursery–Page 2

Water Recycling in Nurseries

By Donald Merhaut, Extension Specialist, Nursery and Floriculture, UC Riverside

This article will provide an overview of water recycling. However, in subsequent newsletters, we are going to provide a series of articles addressing each aspect of water recycling, giving more details regarding installation procedures, different treatment methods, costs, and safety concerns.

Federal and state regulations concerning the quality and quantity of runoff water from nurseries are becoming increasingly stringent. Many areas of the state only permit storm water runoff, forcing nurseries to recycle all runoff water from production sites. Other

See Water Recycling–Page 14

California Water Supply Trends That Nurseries Should Notice

By W. Bowman Cutter, Water Resources Management Specialist, UC Riverside

Water supply trends over the next 10-20 years are likely to alter the business climate for nurseries in California. The gap between water supply and demand is projected to grow, particularly in southern California. This is due to both increased population as well as decreased Colorado River water deliveries. Water districts looking to conserve water supplies will likely look to large water users, such as nurseries, for water savings. However, the larger impact may well be on the product-demand side. Mandatory conservation measures and increased water prices are likely to decrease demand for the more water-hungry plants and increase demand for drought-tolerant and native vegetation.

The most important item on the water supply agenda is California's use of Colorado River water. In the past, California has been able to use more than its entitlement of Colorado water because other southwestern states have not needed their full share. This surplus water amounts to about 1.1 million acre-feet of water to California each year. However, with population growth, Arizona and Nevada now need their full share of water.

California, the other states, and the federal government negotiated a grace period to allow California to gradually reduce its water use to its entitlement by 2015. However, because California did not submit a water reduction plan by the

See Water Supply–Page 12

Editor's Note:

This issue of CORF News focuses on water issues that affect the California nursery industry. Featured articles address water quality, supply, and recycling issues. Each farm advisor addresses regional water quality and supply issues in their respective regional report.

—Steve Tjosvold, Editor, CORF News

In This Issue

TMDL & Nursery

Continued from page 1

account for over 27% of the total high priority TMDLs. Among the pesticide TMDLs, the majority are associated with legacy pesticides such as DDT and chlordane, but some are associated with currently registered pesticides such as diazinon and chlorpyrifos (Dursban) (Figure 2). Among the nutrient TMDLs, many are associated with nitrate, and some are associated with phosphorus.

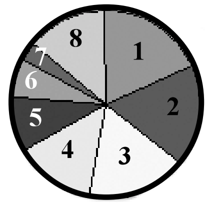
Why Pesticide and Nutrient TMDLs?

We need TMDLs for DDT-like pesticides because these pesticides are extremely persistent and they can still be found in sediment even though they were banned over 30 years ago. These pesticides tend to "bioaccumulate" along the food chain. We need TMDLs for diazinon and chlorpyrifos mainly because these two insecticides are acutely toxic to many aquatic organisms. Both nitrate and phosphorus can contribute to eutrophication, which can subsequently lead to water quality deterioration such as algal bloom, turbidity increase, and shifts in aquatic community structures. Pollution by pesticides and nutrients will therefore affect some of the beneficial uses of the impaired water body, and for this reason, they are considered TMDL pollutants.

Why Nurseries?

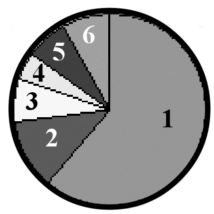
The TMDL program targets all sources, and nurseries are not exempt. In some sense, because nursery sites are highly visible in urbanized regions such as Orange County and other coastal metropolitan areas, nurseries have become easy candidates in the process of TMDL development and implementation. On the other hand, commercial nurseries do need to use large amounts of fertilizers and pesticides in a highly localized fashion. These heavy uses, when coupled with intensive irrigation, often result in substantial runoff. While some nurseries have systems to capture and reuse the runoff water, many do not have such a recycling mechanism and the runoff is simply allowed to flow out of the property. When off-site runoff occurs, it can potentially contribute to the overall problem.

See TMDL & Nursery–Page 3



1. Pesticides
2. Metals/trace elements
3. Sediment
4. Other organics
5. Nutrients
6. Coliform/pathogens
7. Ammonia
8. Other

Figure 1. High priority TMDLs in CA



1. DDT
2. Chlordane
3. Diazinon
4. Chlorpyrifos
5. Endosulfan
6. Unspecified

Figure 2. High priority pesticide TMDLs in CA

Pesticide	**Criterion**	**Concentration (ng/L, or ppt)**	
		Fresh water	Salt water
Diazinon	Chronic	50	N/A
Diazinon	Acute	80	N/A
Chlorpyrifos	Chronic	14	9
Chlorpyrifos	Acute	20	20

Table 1. Numeric targets for diazinon and chlorpyrifos

Category	**Diazinon (ng/L)**		**Chlorpyrifos (ng/L)**	
	Acute	Chronic	Acute	Chronic
Wasteload allocation	72	45	18	12.6
Load allocation	72	45	18	12.6
Margin of Safety	8	5	2	1.4
TMDL	80	50	20	14

Table 2. Diazinon and chlorpyrifos allocations for San Diego Creek

TMDL	**December 2002**	**December 2007**	**December 2012**
Newport Bay Watershed Total N – Summer Load	200,097 lbs	153,861 lbs	
Newport Bay Watershed Total N – Winter Load			144,364 lbs
Newport Bay Watershed Total P – Annual Load	86,912 lbs	62,080 lbs	
Newport Bay Watershed Total N – Daily Load			14 lbs

Table 3. Summary of loading targets and compliance time schedules for the Newport Bay nutrient TMDL

Continued from page 2

A Pesticide TMDL Example

In San Diego Creek there are currently a diazinon TMDL and a chlorpyrifos TMDL. These pesticides can cause acute and chronic toxicity to aquatic life in San Diego Creek and its tributaries. Average diazinon concentrations during baseflow (200 ppb) and stormflow (445 ppb) have exceeded the chronic numeric target of 50 ppb, while average chlorpyrifos concentrations in San Diego Creek during baseflow (111 ppb) and stormflow (87 ppb) have exceeded the chronic numeric target of 14 ppb.

The numeric targets given in Table 1 (see pg. 2) are considered to be protective of aquatic life in San Diego Creek and Upper Newport Bay and sufficient to remove impairment caused by organophosphate pesticide toxicity.

Runoff derived from urban land uses accounts for 88% of the diazinon baseflow load and 96% of the stormflow load. For chlorpyrifos, runoff derived from urban land uses accounts for 85-88% of the baseflow and stormflow loads, while agriculture accounts for about 12-15% of the load. From Table 2 (see pg. 2), we can see that in order to meet the chronic and acute numeric targets, the needed reductions for diazinon will be 95% and 93%, respectively. The needed reductions for chlorpyrifos will be 90% and 97%, respectively. It will be up to the individual users, including nurseries, to work collectively to achieve these reductions.

A Nutrient TMDL Example

There is also a nutrient TMDL in the Newport Bay/San Diego Creek watershed. Nutrient loading to the Bay, particularly from the San Diego Creek watershed, contributes to seasonal algal blooms, which creates a recreational and aesthetic nuisance. These algal blooms may also adversely affect wildlife. While there are a number of sources of nutrient input, tail waters from the irrigation of agricultural crops and from several commercial nurseries have been the predominant source.

The nutrient TMDL for the Newport Bay/San Diego Creek watershed requires that the annual loading of total nitrogen and phosphorus to the Newport Bay shall be reduced by 50% by 2012. The seasonal and annual loading targets are listed in Table 3 (see pg. 2). To achieve the load reductions, the Santa Ana Regional Water Quality Control Board have been working closely with Orange County Cooperative Extension, the Orange County Farm Bureau, and growers, to develop watershed-wide nutrient management programs, and to help growers, including nursery growers, to meet Water Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System permits.

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Science to the Grower–Controlled-release Fertilizer Placement Affects Growth of Container-grown Crops

Controlled-release fertilizers (CRFs) can be an effective alternative to continuous liquid feed fertilization for production of containerized ornamental crops. Coupled with proper irrigation, use of CRFs can reduce fertilizer runoff from greenhouses and nurseries. However, although many studies have compared growth and horticultural quality of crops fertilized with CRFs and liquid feed, few have examined how the location of a CRF in a container affects plant growth and quality.

Broschat and Moore, at the University of Florida, addressed this issue in a study of container-grown palms and dicots. They found that fertilizer placement affects yields, root growth and distribution, and weed growth in some crops. In one experiment, they transplanted liners of Chinese hibiscus, bamboo palm, areca palm, fishtail palm, and Macarthur palm into 2-gallon containers. They applied 3 oz. of Osmocote Plus 15-9-12 per pot, either incorporating it into the potting mix, applying it as a top dressing, or introducing a layer of fertilizer just below the root zone of the liner. The Chinese hibiscus grew best with either top-dressed or layered CRF. More roots grew in the upper half of the container of top-dressed plants, and more roots grew in the lower half of the container when the fertilizer was layered. Among the palms, only the areca palms were affected by fertilizer placement. The best growth of both roots and shoots of this palm occurred when the CRF was incorporated into the potting mix.

In a similar experiment, Broschat and Moore grew Chinese hibiscus, downy jasmine, plumbago, shooting star, and alexandra and foxtail palms. They used Nutricote Total 18-6-8, instead of Osmocote, and introduced a one-fourth-inch-deep layer of potting mix between the liner root ball and the fertilizer in the layered treatment. These changes were made because the palm species had shown some signs of stunting and salt injury to the roots. The separation between fertilizer and roots appeared to be effective, since no salt injury was detected. Once again, either layering or top-dressing the fertilizer produced higher yields of Chinese hibiscus, and the greatest root growth occurred in proximity to the fertilizer. Downy jasmine and the two palms also had higher yields when fertilizer was layered or top-dressed, but root distribution was unaffected. Fertilizer placement did not affect growth of the other two crops.

Weeds are a problem in palm nurseries because those crops do not form a dense canopy that shades out weeds. In these experiments, weeds grew well in top-dressed pots of alexandra, areca, and fishtail palms, but not in pots that had fertilizer layered below the liner and low nutrient levels in the upper half of the medium.

Broschat TK, Moore KK. 2003. Influence of fertilizer placement on plant quality, root distribution, and weed growth in container-grown tropical ornamental plants. *HortTechnology* 13(2):305-308. ❖

By Richard Y. Evans, Department of Environmental Horticulture, UC Davis

San Mateo & San Francisco Counties

Water Management

Water in San Mateo County

Growers and landowners in San Mateo County have developed several local watershed working groups to develop programs that address farm water quality. This program is spearheaded by Tim Frahm, the Water Quality Coordinator for the San Mateo County Farm Bureau. They are working to address agricultural water issues in this county, including water supply, summer diversions of water, cost-share programs to upgrade irrigation systems, water quality, and environmental concerns.

This pro-active approach to protecting water quality and supply by growers and landowners in this county is to be commended. Unlike many agricultural areas in California, growers here do not rely on a water district or agency for their water. Only a few growers use water from the Coastside County Water District; most growers must develop their own water sources from wells and creeks.

Farm Water Quality Plans for Floriculture and Nursery

Farm Bureau's efforts to address water quality in this county coincide with a regional program. The Coalition of Central Coast County Farm Bureaus is addressing water quality in a collaborative program with the University of California.

U.C. and Farm Bureau developed a short course for the central coast counties on Developing Farm Water Quality Plans. The overall purpose is to assist growers and landowners comply with Clean Water Act legislation, and other regulations pertaining to water quality on farms.

The University of California developed the written course curriculum (under the direction of Mary Bianchi, a Farm Advisor in San Luis Obispo County) and teaches many of the programs, while Farm Bureau facilitates the program, and through its coalition, works with local watershed working groups to assist growers and landowners complete their plans, and to address ongoing water issues. The Regional Water Quality Control Board works with U.C. and Farm Bureau to make sure that the plan meets their regulatory needs.

Because water quality is so important to the floriculture industry statewide, I asked Mary Bianchi to spread the program to the floriculture industry throughout California. We called in the U.C. Floriculture & Nursery Workgroup (consisting of farm advisors, specialists, and faculty) to do this.

Our workgroup saw the need to develop a water quality plan and educational materials which are more appropriate to our industry. The workgroup is completing educational materials specific to the floriculture and nursery industry. Within the next year we plan on offering more short courses to the industry in California.

Richard Evans, Floriculture Specialist at UC Davis, recently conducted the first of several statewide CORF workshops on irrigation management. The workshop focused on water management on greenhouse potted plants, but other workshops will address field flower and outdoor production. **Bay City Flower Company** in Half Moon Bay hosted the first workshop.

Topics covered included:

- How to test EC and pH in application and runoff water
- Leaching fractions (how to determine)
- Irrigation systems: Are they distributing water uniformly?
- Measuring crop water use
- Determining application volumes and when to water

In these hands-on workshops, participants learn to calculate the above values. This information can be taken back to their own facility, where it can be used to determine their crop's water use.

Why learn this? So that you can use less water and fertilizer (fewer materials costs; lower labor and equipment costs), have less runoff (lower recycling costs, less risk of pollutants leaving the property), and have better plant quality.

These workshops are subsidized by the Kee Kitayama Research Foundation, and cost only $15 per person to attend. Upcoming workshops are as follows: Encinitas (July 15), San Luis Rey (July 16), and Moss Landing (August 21). If you are interested, contact the CORF office to see what each program will cover—field flowers, potted plants, greenhouse/field, etc.

Another CORF program related to irrigation, offered in Spanish, is Irrigation System Maintenance. The programs will be held in Oxnard (July 23) and Carpinteria (July 24). These half-day programs are $50 per person. For more information, contact the CORF office at 831/724-1130.

Farmer of the Year

At the annual Mel Mello Farm Day Luncheon in Half Moon Bay, Louie Figone was honored as *Farmer of the Year* for San Mateo County. Louie, a respected flower grower in Half Moon Bay, and his family were honored by their peers and many local and state officials. Louie has volunteered for many years with groups such as the Resource Conservation District, Farm Bureau, and Cooperative Extension. Also honored were Jack Olsen, Executive Director of S.M. Co. Farm Bureau, who received the *Dolores Mullin "Like a Rock" Award*, and Jim Rice, who won the *Glenn Ashcraft Chamber Community Service Award*. All of these recipients, along with emcee Stan Pastorino, stressed the need to support local, community-based agriculture in California. Congratulations to all of these winners.

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Regional Report

Santa Cruz & Monterey Counties

Water Management in the Salinas and Pajaro Valley

Ground water has traditionally supplied most of the water needs for urban and agricultural users in the Monterey Bay area. Maintaining ground water levels is especially critical near the coast to prevent seawater from intruding into the underground aquifers. Unfortunately, over-pumping of wells has caused sea water to enter into the aquifers along the coast, leaving some coastal farmers without a usable water source.

The Monterey County Water Resources Agency (MCWRA) and the Pajaro Valley Water Management Agency (PVWMA) manage water use in the agriculturally rich Salinas and Pajaro Valleys. They are well on their way to implementing management plans to meet the future water demands. Both agencies have the same premise—that agricultural pumping should be reduced or eliminated along the coast and new sources of water should be distributed to coastal agricultural users. Hydrologists believe that by not pumping fresh water from aquifers near the coast, the fresh water barrier will be fortified and prevent salt water from intruding further inland. Other management practices encourage water conservation and groundwater recharge. Here are some specific management practices used in each water basin.

Salinas Valley

The Nacimiento and San Antonio Reservoirs, which protect the Salinas Valley from flooding during the winter, are a major source of surface water that help recharge the water basin aquifers. The MCWRA manages the flow of the water into the Salinas River to maximize recharge of the ground water.

In 1998, a tertiary treatment facility, added to the regional water treatment plant, began providing recycled water to 12,000 acres of coastal agricultural land. The supplemental use of recycled water reduces the amount of ground water pumping along the coast by nearly 13,000 acre-ft per year.

In 2003, Monterey County landowners voted to modify the spillway of the Nacimiento Dam so that additional water can be stored in the reservoir and be provided to coastal growers. An inflatable dam will be constructed at the northern end of the Salinas River to divert surface water released from the reservoir to farms along the coast. The diversion dam can be deflated to allow for fish migration.

Pajaro Valley

Several projects are planned that involve utilizing locally derived water—as is done in the Salinas Valley—but a major difference is that the Pajaro Valley will also receive imported water. The plan is to receive 13,400 acre-ft per year from the Central Valley Project. The estimated $130.6 million capital cost of the pipeline construction will be paid for by augmentation fees that will be charged to all basin water users.

Another plan would divert excess surface water from areas such as the Harkins Slough during the rainy season and percolate it into recharge basins. During the irrigation season the water can be extracted and delivered to coastal users. Finally, another plan would provide 4000 acre-ft per year of recycled water after a tertiary treatment is added to the existing treatment facility in Watsonville.

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Field Observations

First Report of Downy Mildew on *Delphinium spp.* caused by *Peronospora ficariae* in California.

On California's central coast, *Delphinium spp.* are grown in the field or greenhouse as a cutflower, or in the field as a cutflower or potted plant. In the spring of 2003, severe downy mildew was observed on three cultivars at two production nurseries in Santa Cruz County. One nursery was a cutflower producer where symptomatic *Delphinium* 'Volkerfrieden' were found in adjacent greenhouse and field production areas. The other nursery produced field grown containerized ornamentals where symptomatic *Delphinium grandiflorum* 'Blue butterfly' and *Delphinium* 'Pacific Giant hybrids' were found.

Initial symptoms on leaves consisted of light green patches. These areas quickly turned dark green to black green, and often were delimited by the central vein of the leaf. Purple-gray sporulation of the pathogen could be seen primarily on the bottom of the leaf. Symptoms were most severe on older foliage. As the disease progressed, the lower leaves withered and dried up. The disease was most severe on *Delphinium grandiforum* 'Blue butterfly', where the disease affected all production plants, and nearly blighted the entire plant except the central leader.

The pathogen was identified as *Peronospora ficariae*. It has been found in other parts of the world and in the United States (Alabama, Idaho, Maine, Michigan, New York, Oregon, Wisconsin, and Wyoming). It has been found on other hosts including many species of *Ranunculus*, *Anemone coronaria*, and *Helleborus purpurascens.*

To view images see http://cesantacruz.ucdavis.edu

Steve Tjosvold and Steve Koike

Field Observations

New Downy Mildew on Foxglove

The Santa Barbara County Agricultural Commissioner's office has reported finding a new downy mildew pathogen, *Peronospora digitalidis,* on common foxglove (*Digitalis purpurea)* in two production nurseries in Carpinteria and Santa Barbara. The pathogen has also been intercepted in county retail nurseries in shipments originating from other areas in southern California, including Ventura County. Until last summer, the only other known incidences of this disease in the United States were found in Santa Cruz County and in a northern California nursery. The first finding was reported by Farm Advisors S. Tjosvold and S. Koike last spring [CORF News 6(3):7]. The disease has previously been found in Europe, Asia, and New Zealand.

Initial symptoms on leaves consist of small light green, rectangular areas that are vein-delimited and later become chlorotic. As the disease progresses, chlorotic spots coalesce and turn necrotic. Under favorable conditions, purple-gray sporulation can be seen, especially on leaf undersides.

This new downy mildew disease may eventually become a chronic problem for growers, similar to downy mildew on snapdragons, Misty statice, and stocks. Until CDFA knows more about the distribution, it is "Q" rated and all symptomatic plants should be destroyed. However, this pathogen has likely already disseminated in the retail nursery trade. If it turns up everywhere it may be downrated.

In the meantime, growers may be able to limit the disease through cultivar selection. From preliminary observations, Koike and Tjosvold reported that cultivars such as 'Alba,' 'Apricot,' and the Foxy hybrids were most susceptible; *D.* x *mertonensis* (= *D. grandiflora* x *D. purpurea*) were moderately susceptible; and *D. grandiflora* appeared disease tolerant. The high susceptibility of the Foxy hybrids is echoed by the Agricultural Commissioner.

Regional Report

Ventura & Santa Barbara Counties

Water Availability

Ventura County. One reason that farmers were originally attracted to Ventura County in the late 1800s was because regional water resources were so abundant, especially underground aquifers. However, as agricultural areas and cities grew, water usage increased rapidly, eventually leading to pumping more water from the ground than could be restored. This overdrafting caused groundwater to drop below sea level, allowing saltwater to intrude into underground supplies. The overdraft problem was improved by the investment of millions of dollars into projects, which, along with the importation of state water, provided fresh water to underground basins and reversed the intrusion of seawater. For example, the Freeman Diversion Dam was constructed to divert water from the Santa Clara River to canals that take the water to percolation ponds, where the water filters down to the aquifers and recharges them.

In spite of these efforts, as a result of continuous mining into lower aquifers, eventually saltwater intrusion will probably become a major issue. For this reason, Ventura County water agencies are developing plans to further increase water supplies. This includes additional importation of state water, as well as better ground water management.

Santa Barbara County. There are many different sources of water that are utilized in Santa Barbara County. The largest surface water source is from the Cachuma Project, a diversion dam on the Santa Inez River. In addition, there are groundwater basins, and, as in Ventura County, these are pumped with fresh water to prevent overdraft. The city of Santa Barbara also has a reclamation project and uses recycled water on landscapes, golf courses, etc.

In addition to local water sources, Santa Barbara can receive State Project water via the State Aqueduct and an extension, which ends at Lake Cachuma. When needed, water will be delivered from Cachuma, along with Cachuma Project water. Little or no deliveries are expected to be requested in the near future, except as necessary to replace local surface supplies lost to drought. The pipeline will be utilized to take advantage of available water supplies via the State Water Bank, or through independent purchases of temporary entitlement to firm up deliveries during drought.

Another emergency water supply is desalinated seawater, using reverse osmosis. This $34 million project was completed in Santa Barbara in 1992, when the drought of the early 1990s showed that the pre-drought water supplies were inadequate. Desalinated water has since been incorporated into a long-term supply plan, along with the State Water Project, as a means of reducing shortages during severe drought. Until needed, the facility has been decommissioned and components that require frequent maintenance have been removed, saving approximately $500,000 per year. When called back into commission, the plant will be activated with state-of-the-art membranes and other mechanical components at an estimated cost of $3 million. Desalinated seawater will cost approximately 7 to 22 times the operating cost of currently-used water supplies, and over 2.5 times the operating cost of State Water, making this supply the last to be utilized during periods of shortage. The high cost is offset by the fact that the facility will only need to operate infrequently. In the interim, it serves as an insurance policy, allowing the use of other supplies more fully.

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Regional Report

San Diego County

Water Quantity and Quality Issues

It is not news that issues of both water quantity and water quality continue to be in the forefront for growers in southern California. Water is in short supply in this area, and therefore maintaining the quality of the water for multiple uses is very important.

Precipitation in San Diego County was just about normal this year, which allows a small amount of comfort for a short period of time. For those growing under outdoor container or field conditions, adequate quantities of rainfall can have the very beneficial effects of both providing high quality irrigation water and leaching salts from soil. However, even in years of normal or high level of precipitation, most water used in growing operations is imported at a high cost. Precipitation aids in the recharge of groundwater tables, but unfortunately, much of the rainfall ends up in the Pacific Ocean. The infrastructure to save rainfall in local reservoirs is very limited, primarily due to environmental concerns. Constructing any new reservoir facility of any substantial size is almost impossible due to habitat and endangered species issues in the likely areas for the location of such a reservoir. There is very little groundwater in San Diego County, and most of the groundwater that is used for agricultural purposes in not of good quality, requiring that some type of blending of well water and district water take place.

The Imperial Irrigation District/San Diego County Water Authority water deal is still being negotiated. If a water deal is finalized, it will allow for a more stable water supply for the San Diego region, in turn providing for continued use of water for agricultural purposes. Most water districts in San Diego have agricultural water rates. Agricultural water is considered an "interruptible" supply, and if the overall supply of residential water runs low, the agricultural use is interrupted. Agreeing to use agricultural water allows the growers to purchase water at a reduced cost (the average cost of water is around $700.00/acre ft. in San Diego, and the cost of agricultural water is about $550.00/acre ft). Some growers have chosen to continue to use water at the residential rates instead of using the interruptible rates, to have a greater certainty that their growing operation will be maintained even in times of drought.

Along with the ongoing concerns with the supply of water, issues of water quality and regulatory pressures continue. The Municipal Stormwater Permit that was adopted in 2002 requires that greenhouse and nursery operations follow the same runoff requirements as any other business. In the unincorporated areas of San Diego County, annual inspections are being conducted by the Department of Agriculture, Weights and Measures. There are approximately 550 greenhouse or nursery operations in the unincorporated areas that will be inspected annually. This does not include the growing operations in the coastal cities that are not under the jurisdiction of the county. The cities will conduct their own inspections. Growers are inspected for a variety of practices and materials that can contribute to polluted runoff.

We have had a program for the last few years that is designed to minimize the impacts of the inspections and potential regulatory action for the growers. Included in this program is a self-assessment process that allows the growers to review their growing operation and make changes to practices that need improvement. While most growers use efficient methods of irrigation, many do not maximize the efficiency of their systems, and this contributes significantly to runoff problems. In addition, we have found that it is not uncommon for non-irrigation uses of water to add to the runoff problem. These uses include vehicle and walkway washing and other practices that are mainly associated with cleaning and sanitation methods. These practices are often overlooked, as they are not perceived as part of the growing operation.

More information on our Ag Water Quality Program can be found on our website: www.uccesandiego.ucdavis.edu, or you can call (858) 694-3393.

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Get Cultured: How to Adjust pH of Irrigation Water

By Donald Merhaut, Extension Specialist, Nursery and Floriculture, UC Riverside

This is Part V of a five-article series on soil/water pH, which started in the summer issue of *Corf News*, 2002.

The process of adjusting water pH is the process of changing the amount of H^+ or OH^- ions that are dissolved in the water. In most cases where water pH modifications are required, it is to lower pH rather than increase pH.

There are two factors to consider when adjusting water pH:

1. The pH of the water.
2. The alkalinity of the water.

1. pH. pH is the free H^+ and OH^- ions in the water and ranges on a scale of 1-14. The optimum pH for most crops ranges from 5.0 to 7.0, mostly due to the effect of pH on nutrient availability to plants. (See *CORF News,* Summer 2002, Volume 6, Issue 3, Figures 1 and 2).

2. Alkalinity. Alkalinity is the measure of the concentration of bicarbonates (HCO_3), carbonates (CO_3) and other alkali compounds dissolved in the water, which can neutralize acids that are added to the water. These are the same liming materials that can be added to soils as limestone to increase the soil pH. However, in the case of irrigation waters, these materials are in solution. The most common bicarbonates and carbonates are those of calcium bicarbonate [Ca $(HCO_3)_2$] and calcium carbonate [$Ca(CO_3)$]. However, other carbonate complexes include those of magnesium (Mg) and sodium (Na). These chemicals act as buffers in the water to prevent acidification. Therefore, acidifying a source of irrigation water with high alkalinity may require more acid than a water source of similar or lower pH but with lower alkalinity. If your irrigation water is derived from water sources around limestone—i.e. underground limestone caverns, then there is a greater probability of higher bicarbonates and carbonates in the water. The relative amount of these chemicals dissolved in most irrigation waters usually ranges from 0 to 10 meq $Ca(CO_3)$/L (Figure 1).

Vocabulary Alert: *alkaline—*is the term used to indicate a pH that is greater than 7.0. Even though alkalinity and alkaline have similar spellings, they have different meanings.

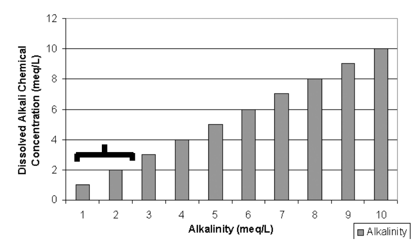

Figure1: Graph of levels of alkalinity in relation to the concentration of dissolved alkali chemicals such as carbonates and bicarbonates. Black bracket indicates the range of alkalinity suitable for most crops.

Steps to adjust irrigation water pH:

1. Know the recommended pH for the crop in question.

2. GET A WATER TEST DONE–**CAUTION:** Follow recommended procedures for sampling. Most labs will provide guidelines.

3. Follow recommendations of the lab. Most laboratories will measure pH, alkalinity and then conduct a titration, a process where they determine the amount of acid required to lower the water pH to a recommended set point.

Labs may report alkalinity in one of four ways: 1) meq $CaCO_3$/L, 2) mg $CaCO_3$/L, 3) ppm $CaCO_3$. These values can be converted to each other as follows:

1 meq $CaCO_3$/L = 50 mg $CaCO_3$/L
1 ppm $CaCO_3$= 1 mg $CaCO_3$/L
1 mg $CaCO_3$/L = 0.02 meq $CaCO_3$/L
1 meq $CaCO_3$/L = 60 ppm HCO_3
1 ppm HCO_3 = 0.017 meq $CaCO_3$/L
1 ppm HCO_3 = 0.83 mg $CaCO_3$/L

Methods of lowering water pH and decreasing alkalinity:

All methods involve the injection of acids. The most common acids used are sulfuric acid, urea sulfuric acid, phosphoric acid, hydrochloric acid (muriatic acid), and citric acid.

CAUTION: ALL ACIDS ARE DANGEROUS.

NEVER ADD WATER TO ACID – always add acid to water.

Methods of increasing alkalinity:

In some cases, it may be necessary to increase alkalinity to prevent rapid acidification in certain systems caused by acidic media or fertilizers. In these cases, chemicals such as potassium bicarbonate may be required.

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New Publications

Compiled by Ann King

Ball Redbook, 17th edition. Yes, a new edition (2 volumes!) is arriving. Volume 1 ($50) covers Greenhouses and Equipment, and Volume 2 ($68.95) covers Crop Production. These can be ordered through Ball Publishing at 1-888-888-0013 or at http://www.ballpublishing.com/commerce

Hydroponic Production of Vegetables and Ornamentals. This new book has 463 pages, 81 tables, and 71 figures. It has chapters written by a number of international experts, and is a useful book especially for beginning hydroponics growers. Heiner Lieth from the Environmental Horticulture Department at UC Davis, a frequent contributor to CORF News, co-wrote the chapter "Irrigation Control in Hydroponics." Available for 94 Euros from Embryo Publications in Greece (http://www.embryopub.gr/). Once we locate an American distributor, we will let you know.

Labor Management in Agriculture: Cultivating Personnel Productivity. This book can be downloaded from the UC Berkeley website: http://www.cnr.berkeley.edu/ucce50/ag-labor/ (then click on BOOK).

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Water Supply

Continued from page 1

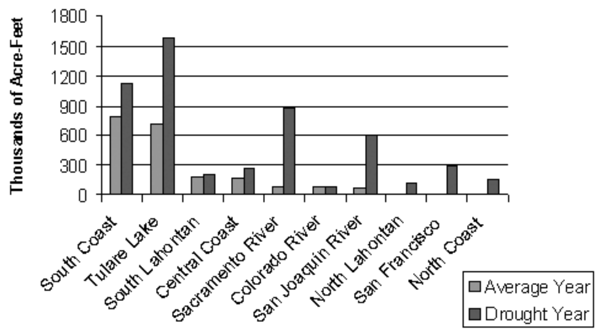
deadline of December 31, 2002, surplus water delivery is currently suspended. The main sticking point is a disagreement between California water agencies over the environmental side effects of a proposed sale of water from the Imperial Valley to San Diego.

The water use reduction deal mainly affects whether the Colorado River supply reduction occurs now or in 2015. In any case, the total supply of Colorado water to southern California will decrease. However, the decrease in Colorado water will have water supply implications across the state. Metropolitan Water District (MWD), the main wholesale water supplier in southern California, will seek to partially offset this loss with water purchases and transfers from elsewhere in California. For example, this year MWD exercised an option agreement with rice farmers in the Sacramento Valley to receive 97,200 acre-feet of water from crop fallowing.[1]

Table 1 shows water shortfalls are likely to be more prevalent in southern California (south coast) and the Tulare Lake region (southern Central Valley).[2] However large increases in net water shortfall relative to the present shortfall are only projected to occur in southern California and the Lahontan (east of the Sierra) region. Southern California's net shortfall is projected to increase by about 783,000 acre-feet by 2020.[3] This implies that southern California will likely implement more stringent water conservation measures than any other region in the state over the next two decades. Other regions will not be as hard-pressed to combat shortages. The numbers in this table are dated because comprehensive water budgets have not been constructed since 1998. However, population growth is up since 1998, so the net water shortfalls may be larger than this table indicates.

Large commercial water users, including nurseries, will be logical targets for water conservation. Water districts may seek water reductions either by requiring conservation measures or by raising water prices. Also, non-household water users may face requirements to use recycled water in water-short regions like southern California. MWD is planning large investments in water recycling and reuse and will need to find or mandate users for this water.

Table 1: Net Water Shortfall in 2020 With 1995 Facilities and Programs



Important as water supply is to nurseries, the demand side effects of water shortages may have a larger impact on nurseries that sell to southern California. Water agencies are likely to employ many measures that will affect the mix of nursery product demands. For example, MWD, in partnership with other water agencies, is encouraging the adoption of native or drought-tolerant vegetation.[4] Also, water costs are likely to go up to cover increased water supply and treatment costs. MWD is already planning on increasing rates by 12% over the next five years.[5] In addition, many agencies are considering new water rate structures with low costs per gallon up to the estimated household use and higher costs per gallon for water use above the estimated household use.[6] This rate structure would increase the cost of landscape water use. Higher landscape water prices will likely shift demand towards low-water-use plants.

Large commercial landscapes are likely to be targeted for water use reduction even more than households. Therefore, managers of these landscapes may shift towards plants with lower water use. Current law (AB 325) seeks to restrict the landscape industry to a water use equivalent to 0.8 evapotranspiration. Future legislation may push down the evapotranspiration requirement further. In addition, water agencies are likely to use price-based water conservation with commercial landscapes to an even greater extent than with households (i.e., proposed AB 607). These water conservation measures are likely to increase the demand for low-water-use plants. In addition, as nursery customers face a greater possibility of water rationing during droughts, they may find drought-tolerant vegetation more convenient.

Water supply affects nurseries on both the cost and revenue sides of the ledger. Though an agreement over California's use of Colorado River water will postpone the adjustments to water shortages, eventually California, and in particular southern California, will need to come to terms with limited water supplies and a growing population. The water use of large water users such as nurseries will come under particular scrutiny in water-short areas of the state. However, even nurseries that are located in other regions are likely to be affected by a shift in customer demand towards low-water-use plants.

[1] Metropolitan Water District of Southern California. *"Metropolitan Calls On Water Transfer Options From Sacramento Valley Rice Farmers."* February 14, 2003.

[2] California Water Plan Update Bulletin 160-98. Tables 6E-1 -6E10. Department of Water Resources. 1998.

[3] Ibid.

[4] Metropolitan Water District of Southern California. *"Outside Water Use."* June 6, 2003. http://www.mwd.dst.ca.us/mwdh2o/pages/conserv/save/tentips/tentips02.html

[5] Sprague, Mike. *"Water costs expected to rise."* Los Angeles Newspaper Group 6, June 6, 2003.

[6] The Irvine Ranch Water District now operates a tiered water rate structure and other areas have expressed interest.

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Water Recycling

Continued from page 1

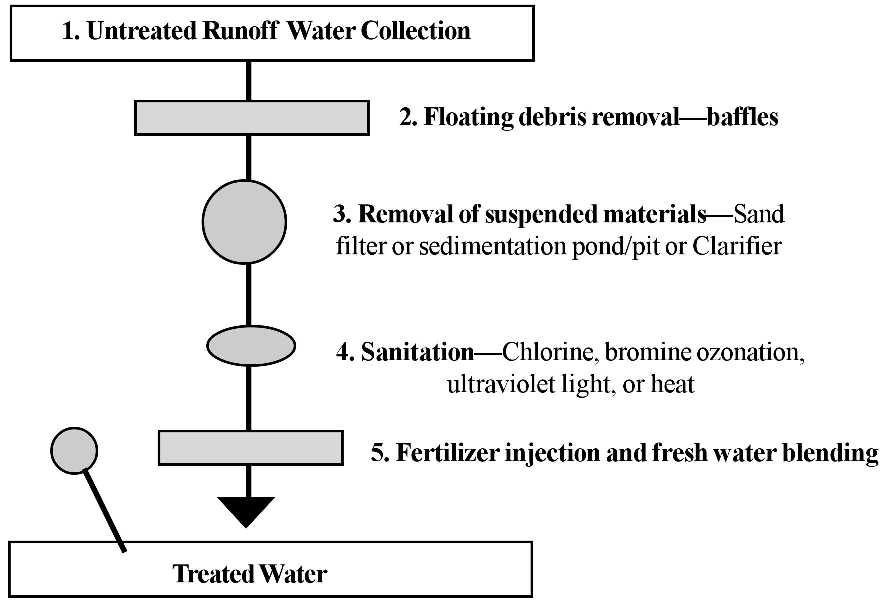

Figure 1: Schematic diagram of a typical recycling system. Not all recycling systems will contain all steps and the order of treatment methods may vary depending on the type of treatment facility required

regions of the state are permitted to release runoff water into storm drains. However, the regulations for the quality of the runoff water are so strict, that most nurseries cannot comply. For example, many policies limit the concentration of nitrates to less than 10 ppm nitrate-nitrogen. This is low, considering that many nurseries fertilizer with 100 ppm or more of nitrogen. There are other regulations regarding the concentrations of other nutrients, pesticides, and physical characteristics such as odor, floating debris, and suspended particulate matter. For these reasons, more and more nurseries are recycling their runoff water.

Essentially any size nursery can install a recycling system. In a recent evaluation of nurseries in southern California, nurseries from 10 acres to 200 acres were successfully recycling their runoff water. The cost of installing a recycling system is often recovered in the savings resulting from the use of less water and fertilizer.

There are basically five steps (Figure 1) that are performed when recycling water:

1. Collection of runoff water.
2. Removal of floating debris.
3. Removal of suspended particulate matter (sand, silt, clay, and organic matter)
4. Sanitation—treatment for pathogen contamination
5. Control of fertilizer levels.

1. Collection of runoff water

The factors that must be considered include:

a. Size of the collection basin—The size of the collection basin must accommodate all runoff water from the nursery site. This may include not only runoff from production sites, but also greenhouse roofs, driveways, parking lots, and other areas of the nursery. Local regulations may specify what runoff must be collected. If regulations in your area specify collection and capture of runoff from the first storm event, then an estimation of the volume of storm water runoff must also be known.

b. Location of collection basin(s). The topography of the nursery and space available must be taken into consideration. Also, if there are different types of production sites, i.e. propagation, plug production, field crops, or container crops, there may be multiple water sources and water recycling units. If the nursery is situated on a hill, then the collection basin can often be located at the lower elevation so that gravity can be used to collect runoff.

2. Removal of floating debris

Most floating debris can easily be removed via baffles located at or near the collection basin or sedimentation pits.

3. Removal of suspended material

Several methods may be used to remove suspended matter from runoff water. The technique to use will be determined by the degree of purification desired and the type of suspended residues in the water.

a. Sedimentation. Sedimentation through gravity is the most common and economical process used by nurseries. Most suspended material will settle out in the sedimentation pond or collection basin within a few hours. However, clay, being a very fine colloidal material, may require several days to settle out of the water. Sedimentation pits will need to be cleaned out occasionally to remove the build up of particulate matter on the bottom.

b. Flocculation. This is the process where ferric sulfate or alum and a polymer are added to the water to flocculate the suspended clay particles, resulting in a rapid (5 minutes) sedimentation of flocculated clay.

c. Sand/Charcoal filtration. This process is done to filter out any remaining suspended materials.

4. Sanitation

Runoff water and irrigation water derived from surface waters usually contain pathogens such as *Phytophthora*, *Pythium*, and other water molds. There are several methods of

See Water Recycling–Page 15

Water Recycling

Continued from page 14

sanitation available on the market. The type of method to use will be determined by the cleanliness of the water, the degree of sanitation desired, the type of recycling system being used, and local regulations. The most common sanitation practices include:

a. Chlorination—Many nurseries utilize chlorine.

c. Brominating

d. Surfactants

e. Heat treatment—Heating water to 95°C (203°F)

f. Ultraviolet light

e. Ultra filtration

5. Fertilizer injection

Fertilizer injection is usually the final step in the process. This step is usually done in conjunction with mixing of fresh water with recycled water in a way that the electrical conductivity does not increase in the production system.

In the next issue, we will focus on the first aspect the water recycling—Collection of runoff. We will address the sizes and types of the collection basin(s) and where to locate them in the nursery for maximum efficiency.

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CORF
Floriculture education from the Kee Kitayama Research Foundation

CORF News is the quarterly publication of CORF, the California Ornamental Research Federation, a statewide partnership of growers, floriculture associations, allied industry and researchers/educators whose mission is to identify and meet the research and educational needs of the California floriculture industry.

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Calendar of Industry Events

July

15 .... CORF Hands-On Irrigation Training Workshop, Encinitas, 831/724-1130
16 .... CORF Hands-On Irrigation Training Workshop, San Luis Rey, 831/724-1130
21–23 . CCFC Growers Open House, various locations, 831/728-7333
23–26 Fun'N Sun Weekend 2003, Anaheim, CA, 831/722-2424
23 .... CORF Maintenance of Irrigation Systems (Spanish), Oxnard, 831/724-1130
24 .... CORF Maintenance of Irrigation Systems (Spanish), Carpinteria, 831/724-1130

August

3–5 ..... CSFA Floriculture Weekend Retreat, Carlsbad, 916/448-5266
12–16 . WF&FSA Management Institute & Summer Sales Camp, TBA, 410/573-0400
20–22 . CalScape Expo, Irvine, 707/462-2276
21 .... CORF Hands-On Irrigation Workshop, Moss Landing, 831/724-1130

September

9 .... CORF Growers' School: Bulb Crops, Montecito, 831/724-1130
10-13 .. ICFG 2003 Annual Meeting, Lake Tahoe, NV, 516/655-3726
16 .... CORF Floriculture & Nursery Marketing Workshop, Watsonville, 831/724-1130
24-27 .. SAF Annual Convention, Boca Raton, FL, 703/836-8700

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