Fall 2002

Weed Management in Ornamental Crops: Then and Now

By Clyde l. Elmore, Extension Weed Specialist, UC Davis

Editor's note: As he retires at the end of the year, we asked Dr. Elmore to reflect back during his long career as an Extension Weed Control Specialist and describe the trends he has seen in weed control and what he foresees as important weed control considerations in the future.

Weed control is a costly management practice that often does not receive a direct cost benefit–no one wants to pay for weed control. Thus, if there is significant cost or time crunch, often weed control is less than complete. Weeds left to produce seed, might require years of weeding to correct the problem. This is very noticeable when the weeds are not cleaned up at the end of the cutting season.

A hoe and a plow

In the early 1960s, weed control was basically accomplished with mechanical machinery and hand hoeing. For years, field crops have been planted in rows so mechanical tillage can be accomplished with a minimum of risk to the crop. In bulb crops, repeated cultivation was used to pile soil over young weeds to smother them, or knives or blades were used to under-cut the young weeds. Hoeing was done with short-handled hoes so workers could get close to the crop without injuring the plants. There were soil fumigants available for preplant soil treatment primarily for soil pathogens and nematodes (methyl bromide/chloropicrin, dazomet, calcium cyanamide and metam). But in the process, weed control was an added benefit. This period was also the beginning of selective chemical weed control.

Selective chemicals

In the early history of California floriculture, there were only a few primary crops: roses, carnations, chrysanthemums, Dutch iris, gladioli and to a lesser extent, Gypsophilia, Limonium, stock and a few others. Over the years some of these crops have decreased in area, and more crops have been introduced. In some of these crops the selective preemergence herbicides, diuron, simazine and DCPA (Dacthal) were available. Later propham (IPC), chloropropham (CIPC), CDEC (Vegadex) and chloramben (amiben) became available in some crops. In the early 70s the herbicide trifluralin (Treflan) was a common herbicide for some flower crops and in woody ornamental crops. Following trifluralin, there were several analogs in the same chemical family including the commonly used herbicides oryzalin (Surflan), pendimethalin

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Elmore and Paulus to be Inducted Into Floriculture Hall of Fame

By Janice Wills, Program Coordinator, CORF, CCFC, KKRF

Dr. Clyde Elmore and Dr. Albert O. Paulus have been selected for induction into the California Floriculture Hall of Fame. Both men have dedicated a large portion of their careers to the ornamental industry.

Dr. Elmore is an Extension Specialist for the Weed Science Program at University of California, Davis and has worked extensively on finding a viable alternative to Methyl Bromide for control of weeds in ornamental crops. He also has provided research to get many herbicides registered for use in California. Dr. Elmore will be retiring from the University late in 2002.

Before his retirement earlier this year, Dr. Albert O. Paulus was instrumental in getting many fungicides registered for use in California and nationally. In his 47 years as a Plant Pathologist at the University of California, Riverside, Paulus provided information and applied research in the area of cause and control of plant disease. Paulus has also been working on finding alternatives to Methyl Bromide for control of plant disease.

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(Pendulum), and later prodiamine. Oryzalin has been used on many ornamental crops. About this time napropamide (Devrinol), oxadiazon (Ronstar) and eventually oxyfluorfen (Goal) became available. Many of these herbicides are currently used either alone or in combination on some crops. Many crops, however, will not tolerate one or more of these herbicides. Until recently there have not been excellent selective post emergence herbicides for many ornamental crops. Even now, there are no effective post emergence broadleaf herbicides that are selective in flower crops. Selective herbicides for the control of many grasses [sethoxydim (Poast), fluazifop (Fusilade) and clethodim (Envoy)] have become available. Most of the other common post emergence herbicides were phytotoxic and could only be used preplant or as a directed treatment [such as paraquat and glyphosate (Roundup)]. Diquat and pelargonic acid have become available for use in greenhouses. At one time oxadiazon and oryzalin were registered for some crops and recommended for use under benches or on pathways in greenhouses.

With the introduction of new herbicides there was another phenomenon that was apparent. Newer herbicides often were effective at lower rates per unit area than older materials. In the early 1960s rates applied often were in the 10 to 20 lb/A range, whereas now they are generally in the 1 to 4 lb/A range or in some cases at rates as low as 0.18 lb/A. Though the unit activity is high, it takes greater care to get exact rates on an acre basis with such small quantities. It often means that the cost is also much higher on an acre basis.

Ornamental crops are high risk

There has always been a high risk associated with the use of herbicides in ornamental crops, thus chemical companies have been somewhat reluctant to register a product for these crops. Many herbicides have been evaluated for selectivity in ornamental crops through the efforts of several researchers at state universities in cooperation with the chemical industry and the USDA IR4 program. Herbicide labels are currently rather expansive but there are always crops that still do not have a good weed control program available for them without extensive hand weeding.

Since we have many more small acreage crops representing many plant families, it has been impossible to find selective herbicides to control our existing weed populations. We have evaluated almost every herbicide currently available and many that aren't available looking for selectivity in field-grown flower crops. Many crops such as snapdragon, often planted as seedling plugs, seem to have no tolerance to herbicides. If growers planted larger transplants there might be some tolerance available. Many direct-seeded crops also do not have selective herbicides available.

How about natural?

There has been an increased interest toward more "natural" or organic methods of control. Weeds can be controlled with mulches, other methods of cultivation such as brushes, rolling fingers, spring weeders and flamers, but each takes a special effort to adapt the technique or method to each crop. Many "natural herbicides" have given inadequate control compared to other traditional treatments. Often they are expensive and have other side effects. Natural products may be a combination of several products, often without knowing what ingredient is in the active fraction. They may have new, novel mechanisms of action, however, and may be helpful in some systems.

The future is...

What about the future of weed control? With the phase-out of methyl bromide as a broad spectrum preplant pesticide when combined with chloropicrin, there will be some major changes in pest control in some crops. Assuming a replacement for methyl bromide with a material such as iodomethane combined with chloropicrin, there will be an increase in cost of the material, there will be restrictions on its use and there will need to be some cultural changes to get the greatest benefit from the treatment. There are the current preplant treatments that will give control of different organisms such as 1,3-D (Telone), chloropicrin, metam and dazomet (Basamid). Since each of them have strengths and some weaknesses, often they will need to be used together for similar control as the current system. Any replacement currently available will probably mean greater pesticide rates applied on an acre basis to achieve the same control (often with up to three pesticides) and with some organisms there will be poorer control or less consistent control. Some of the pesticides that have been evaluated for alternatives for methyl bromide/chloropicrin include: 1,3-D + chloropicrin (C-35 or Inline formulations), metam + 1,3-D + chloropicrin, metam + C-35, dazomet + C-35, dazomet + 1,3-D + chloropicrin, chloropicrin alone, metam or dazomet alone, sodium azide, propylene oxide, furfural alone and in combination with allyl isothiocyanate(AITC), PlantPro20, corn gluten meal, bloodmeal, ammonia, chicken manure, soil solarization and Brassicaceae crops with soil solarization for biofumigation.

Few herbicides will become available for selective use in flower crops, though there are some herbicides being tested that may fit into some crops if the companies are willing to register them. Since there is a shrinking number of chemical companies producing new compounds, a second layer of companies are building up to take the small market business. These will be the players in ornamentals in the future.

Nonchemical weed control continues to be important today. This includes crop rotation, mulching, cultivation, and hand hoeing as weed control tools. Chemicals will be a tool for weed control for a long time. The grower will need to be familiar with more options to integrate all available techniques to effectively manage weeds in their crops.

I have had the privilege to work on weed management in many ornamental crops in California for many years. It is because of the cooperation and support of many growers that this work has been so gratifying. Thank you.

Nitrogen and Water Use of Container-Grown Woody Ornamentals

By Richard Evans and Linda Dodge, Department of Environmental Horticulture, UC Davis

Nitrogen fertilizer is required in large quantities for commercial production of ornamental crops, but growers usually lack sufficient information about the nutrient demands of their crops and often apply nitrogen over zealously. It is now abundantly clear to most nursery businesses in California that they must reduce or eliminate fertilizer runoff, but the tools for doing so are limited. In our research, we have focussed on identifying crop needs for nitrogen and water. Knowing the amount of nitrogen needed by crops gives growers a target amount of fertilizer to apply. Knowing how much water crops take up helps growers to avoid overirrigation and excessive runoff.

In fertilizing their crops, growers also can make choices about the form of nitrogen to apply. Most recommendations for fertilization of container-grown ornamental crops call for nitrate (NO_3^-) as the predominant form of nitrogen, with ammonium (NH_4^+) used sparingly because of reported toxicity and yield reduction. This is unfortunate, because ammonium is held more tightly than nitrate by container media, and therefore is less subject to leaching. However, most of the recommendations against use of large proportions of ammonium are based on studies in which no effort was made to control soil acidity, which tends to increase (in other words, the pH decreases) when plants take up ammonium. In previous research with roses grown for cut flowers, we found that the form of nitrogen used did not affect yield or quality, as long as soil pH was controlled. The present study was carried out to determine the water and nitrogen uptake preference of some other ornamental crops, and to measure plant preference for ammonium and nitrate.

Five ornamental species—Japanese barberry (*Berberis thunbergii*), big-leaf hydrangea (*Hydrangea macrophylla*), English holly (*Ilex aquifolium*), glossy privet (*Ligustrum lucidum*), and azalea (*Rhododendron* 'Phoenicia')—were obtained as 2-inch liners and grown hydroponically in solution culture containers in a lath-house at the Department of Environmental Horticulture. After initially demonstrating that nitrogen uptake was not affected by nitrogen concentration over a wide range of concentrations, we applied 42 ppm nitrogen (half as nitrate and half as ammonium) during most of the experimental period. We adjusted acidity to pH 6 and changed solutions every 3-4 days to maintain sufficient amounts of water and nutrients in the containers. From day 128 to day 138, the solution for half of the plants of each species was maintained between pH 4.5-5.

To measure water uptake, we weighed the nutrient solution in each container before and after each solution change. We also measured plant fresh weight and the

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Science to the Grower–Limiting Fertilizer Leaching Losses from Container-Grown Crops

Growers are under pressure to reduce the amounts of fertilizer in their runoff water, and those who grow plants in containers face a particularly tough problem: Nitrogen (N) and phosphorus (P), the plant nutrients most likely to contribute to water pollution problems, readily leach from containers. This happens in part because the small soil volume in containers does not leave room for error in application of water and fertilizer, but the greater problem is that container mixes are deficient in the physical and chemical properties of soils that help to retain nutrients. Most mixes are highly porous, allowing water and nutrients to move quickly past the roots, and they lack many of the minerals found in field soils that react with fertilizer salts to decrease nutrient solubility. High porosity must be maintained because it is essential for proper drainage of container mixes, but there are ways to manipulate the chemical properties. The article summarized here describes a method for limiting N leaching losses by intercepting the nutrient before it leaves the pot. Next time, we'll discuss research that addresses ways of managing the solubility of phosphorus in container media.

A group from Alabama and Mississippi (Glenn et.al.) has developed a method for capturing N with recycled paper. Recycled paper has been tried as an organic amendment for container media, but crops grown in such a mix are smaller because the paper immobilizes some of the N added as fertilizer. Glenn and others proposed that a layer of recycled paper at the bottom of pots would immobilize nitrogen without hindering plant growth. They put about an inch of recycled newspaper at the bottom of containers, then measured N and P leaching from a 6-inch poinsettia crop. Paper, which had been ground and compressed into pellets reduced leachate N substantially for several weeks, but had little or no effect on P. Unfortunately, it also reduced poinsettia size and quality. The researchers got more satisfactory results if the paper pellets were mechanically crumbled before they were added. Leachate N was still about 50% lower than in the control pots, but the plants were similar in size and appearance to the control plants. In effect, the newspaper acts like a vegetation strip for individual pots. This method may be useful in nurseries where other methods of containing N runoff aren't practical or economical.

Reference:

Glenn, et. al., 2002. Recycled newspaper reduces nutrient leaching from container-grown poinsettia. *HortScience* 37(3):516-519.

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

Regional Report

San Mateo & San Francisco Counties

Liverworts

In this weed-oriented issue of *CORF News*, I am addressing **liverworts** in potted plants, since they are a problem in the cool, coastal climate of San Mateo County. Liverworts are found in outdoor and greenhouse nurseries. They are not limited to potted plant production, but also can be found growing under nursery benches, and in other wet areas. Liverworts thrive in the moist, high nutrient, and high organic matter conditions in nurseries and greenhouses.

Liverworts are considered aquatic weeds because they live in wet conditions. They are "lower plants," with fleshy leaf-like structures (thallus) that form low-growing mats. In potted plant production, the mats grow quickly on the surface of the potting mix. The mats can become so dense that pot watering and fertilization become difficult. Retail consumers also may complain about liverworts growing on the potting mix. Liverworts are a perennial weed in nursery production. Liverworts can also encourage fungus gnat breeding in potted plant production.

Liverworts reproduce by spores, not seeds, this is one reason why they are considered lower plants. The reproductive structures form umbrella-shaped stalks above the thallus (male), or gemma cups on the thallus (female). It is thought that liverworts spread primarily by the very small air-borne and water-borne spores. Liverworts also reproduce vegetatively. They can be spread by broken pieces traveling in liner plants, in growing media, in irrigation water, or on reused pots, flats, and equipment.

Cultural control. Water management is critical for liverwort control. It is important to reduce condensation and wet conditions by avoiding over watering, and providing good drainage and runoff. Subirrigation in the greenhouse may help to keep the top surface of the pots dryer, and to reduce liverwort growth. If you suspect that liverworts are moving into your plants from recycled water, it may be necessary to filter the water with a very fine filtration system. Less-frequent irrigations, which allow the substrate surface to dry between waterings, may also help. If possible, reduce high relative humidities in the greenhouse with ventilation and temperature control. Keep the growing areas clean to reduce excess organic matter.

Physical control. Growers sometimes rely on hand-removal of liverworts, but this is time-consuming and costly. Clyde Elmore's research has examined the use of applying a layer of "surface mulch" on the top of the growing medium, such as sand or crushed pecan shells. These materials dry quickly, which discourages liverwort growth. This can be effective if the material stays in place. Rough handling of plants or intense streams of irrigation water can wash the mulch away, though, thereby allowing liverworts to grow again. Management of the mulches is often difficult.

Chemical control. Traditional herbicides such as Dichlobenil (Casoron; outdoor use only), Metam sodium, Oxadiazon (Ronstar), and Oxyflurofen (Goal; outdoor use only) can give good liverwort control. Some control may be possible with Oryzalin (Surflan), Pendimethalin (Pendulum), and Pelargonic acid (Scythe). These recommendations are from the UC *IPM for Floriculture and Nursery* manual. Many of these materials are for use only on woody container plants, and not on floriculture crops. Always check the label to make sure that the material is labeled for use in your location, for liverworts, and on the crop you are growing. Some materials can be phytotoxic, so be sure that they do not burn your desired crop plant.

There are newer types of herbicides which are being examined for liverwort control. Cinnamite (cinnamic aldehyde) is effective on liverworts, but should be tested for phytotoxicity on the crop plant. In the greenhouse, regular sanitation with materials such as soaps (Safer) and other disinfectants (Physan, GreenShield, ZeroTol, etc.) can help prevent liverworts from establishing. Other materials will be coming onto the market in the future.

Information from: (1) Integrated Pest Management for Floriculture and Nurseries (UC DANR publication #3402); (2) Forest Nursery Notes (www.forestry.auburn.edu/sfnmc/class/fy614cryptogams.html); (3) illus. #1 from www.bio.umass.edu/biology/conn.river/liverwts.html; (4) illus. #2 from www.botany.hawaii.edu/faculty/webb/BOT311/CellTissOrgan/ThalloseLiverworts.htm

Fig. 1: *Marchantia* sp. (liverwort)

Fig. 2: Schematic of *Anthoceros* sp. thallus

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Regional Report

Santa Cruz & Monterey Counties

Phytophthora ramoum: An Update on the Biology & Regulation as it Relates to the Nursery Industry

The biology of *Phytophthora ramorum* is just beginning to be understood. This is a newly described pathogen, causing new diseases on new hosts, in a new part of the world. Because of that, it is exceedingly difficult to confidently develop management guidelines and regulatory requirements. For the time being, we need to garner what we know to help manage the potential effects of this pathogen. As the science of the disease becomes more apparent, we may find that we will need to refine management and regulatory practices.

Plant material

Many of the known hosts support the production of air-borne infective spores on leaf surfaces. Spores are produced in cool, wet conditions and can be moved by the wind. Rhododendrons and California bay seem to be particularly good at producing spores. Infected plant material could present a relatively high risk of moving the pathogen long distances in the nursery trade. In fact, the pathogen was found and first identified by German scientists, infecting nursery-grown Rhododendron and *Viburnum*. It has subsequently been found on Rhododendron and *Viburnum* in other nurseries in Europe. It has been found in one Rhododendron nursery in California. The pathogen has not been found infecting roots of their hosts.

For collectors and propagators of the native hosts of this pathogen:

If you wish to collect this plant material in regulated counties, know that the movement of this material could be quarantined. Contact the local Agricultural Commissioner's office for restrictions. When you collect, select plant material from only healthy plant parts. Be aware of the symptoms of the disease on the native host species you are collecting.

For retail nurseries, production nurseries, and greenhouses:

Inspect known hosts of Sudden Oak Death in the nursery. Be aware of the symptoms of the disease. Insure that host plants you are receiving from areas of infestation are certified to be free of disease by the originating Agricultural Commissioner's office. Inspect the plant material yourself.

For nurseries in affected areas surrounded by native hosts, there is a higher probability that the pathogen's spores might be present in the nursery. It may be especially important to reduce wetting of foliage and encourage rapid drying of foliage, especially in the winter. Providing cover over sensitive crops to prevent rainfall from wetting foliage might help reduce the likelihood of infection.

Stream water

Streams flowing through woodland containing Sudden Oak Death may be contaminated with *Phytophthora ramorum*. Avoid using water from these streams to irrigate known hosts of this pathogen, especially with overhead irrigation.

Container soil

Experiments have demonstrated that infective spores can be splashed from soil and cause infection on nearby hosts. When Rhododendron was found infected in the nursery trade, infective spores were also found in the container's soil.

Soil mix manufacturers may have some difficulties with California's quarantine now that redwood and Douglas fir are quarantined hosts and various products from these species are used extensively as components for container soils. Presently, California's regulation restricts movement of coast redwood and Douglas fir basal sprouts, leaves, and shoots less than one inch in diameter. Christmas trees, boughs and wreaths, and greenwaste from these hosts are regulated. Sawdust from a lumber mill is not regulated since the common practice is to de-limb and de-bark logs prior to sawing. But technically, sawdust from a shoot one inch or less in diameter would be regulated.

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Field Observations

New Sudden Oak Death Hosts: Coast Redwood and Douglas fir

Phytophthora ramorum, the causal agent of the disease commonly known as Sudden Oak Death is a prevalent pathogen in California with its effects evident in 12 counties and, up to recently, found on 14 different oak, tanoak and non-oak hosts. Now this pathogen has been found naturally infecting two new important hosts, coast redwood and Douglas fir.

As confirmed hosts, they will now fall under state and federal regulations limiting the movement of host plant material. Nurseries producing plants of known hosts within a regulated county must understand these quarantine requirements. Regulations on soil with components from these species are possible (see adjacent article). County Agricultural Commissioners' offices will be responsible for the implementation of these regulations. Regulated counties include: Alameda, Contra Costa, Humboldt, Marin, Mendocino, Monterey, Napa, San Mateo, Santa Clara, Santa Cruz, Solano, and Sonoma.

On coast redwood (*Sequoia sempervirens*) the pathogen was isolated from discolored needles and cankers on small branches on 27 saplings at two locations in California. Symptoms were observed on branches throughout the affected trees. The pathogen was also detected in dying basal sprouts on mature redwood from an additional five locations in coastal California.

On Douglas fir (*Pseudotsuga menziesii*) the pathogen was isolated from branch tips of saplings. Symptoms on these saplings included cankers on small branches resulting in wilting of new shoots, dieback of branches and loss of needles. On several smaller saplings infection resulted in the death of the leader and the top several whorls of branches. For more information see www.suddenoakdeath.org

Regional Report

Ventura & Santa Barbara Counties

Proposed Runoff Regulations Affecting Santa Barbara County Agriculture

"Basin Plan" Amendments. Last July the Central Coast Regional Water Quality Control Board drastically changed the way greenhouse runoff was regulated. Now the board is proposing nonpoint source pollution program amendments to their "Basin Plan" which may further substantially change existing regulation of agriculture. A hearing is scheduled for December 6, 2002. Contact Howard Kolb at 805/549-3332 or hkolb@rb3.swrcb.ca.gov to review the full proposed revised documents and for further information.

NPDES Phase II Implementation. The National Pollution Discharge Elimination System (NPDES) is a federally mandated law to prevent polluted storm water runoff in urban areas from entering water bodies. All states must abide by the NPDES but can also add additional rules and regulations. Major urbanized areas with greater than or equal to 100,000 inhabitants have been developing regulations and litigation measures under Phase I of the NPDES storm water regulations during the past decade. Most agricultural grading in fields is exempt; the NPDES requirements under phase I applied only to new construction that disturbed greater than or equal to 5 acres. Now the second phase of the NPDES is to be implemented which applies to municipalities with greater than or equal to 10,000 people and to construction sites greater than or equal to 1 acre.

Santa Barbara County is subject to Phase II NPDES requirements. Growers were informed of the potential impacts to agriculture in County workshops held in August in three site locations by county staff Robert Almy and Julie Harris. It was explained at these workshops that the proposed changes apply to already existing County grading ordinance requirements for construction sites. The existing ordinance is close to the necessary NPDES construction standards, and in some cases more restrictive. By amending the current ordinance, the county can reach full compliance without needing to write a new ordinance.

The Board of Supervisors will review the proposed changes at a public hearing on September 24. The Santa Barbara Flower Growers Association has voiced concern about the proposed amendments, which they feel may unnecessarily hinder operations. The principal proposed amendments are in the requirement of Erosion and Sediment Control plans for construction sites. Changes that may affect agriculture include:

- Erosion control measures that currently apply only to the rainy season must now be implemented year round on construction sites greater than or equal to 1 acre. Additional inspections will be required during the rainy season.
- Erosion and sediment control plans will be required for all grading permits (not just those on hillsides, slopes or mountainous terrain specified in the current ordinance) and the inclusion of county approved construction site BMPs. A Storm Water Pollution Prevention Plan (SWPPP) in lieu of erosion and sediment control plans may be accepted, provided it meets County requirements.
- Additional changes:

1. Construction sites with greater than or equal to 1-acre disturbance must submit a copy of a Notice of Intent and a SWPPP.
2. Maintenance security may be required to ensure proper function of drainage systems and erosion and sediment control measures.
3. Erosion and sediment control plans (or SWPPP, if required) are to be kept on site at all times while work is in progress.
4. No discharge of pollutants year round from construction sites (e.g. paint, concrete slurry, trash, etc.).
5. The addition of a new ordinance section referencing construction site BMP manuals to be adopted.

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Field Observations

Daylily Rust Alert

Many daylily cultivars are highly susceptible to daylily rust, which has been intercepted in a number of Ventura County nurseries this summer. The fungus, a native of Asia (as are daylilies), was first detected in US nurseries in the summer of 2000. Since then, samples have been intercepted in 23 states. In California, in addition to Ventura County, the fungus has been found in Orange and San Diego Counties. The causal organism, *Puccinia hemerocallidis* requires an alternate host (*Patrinia* spp) for sexual reproduction, although asexual spores produced on daylilies are viable and virulent. Another reported host is *Hosta spp*., though disease development has not been confirmed. USDA APHIS is investigating potential foreign entry. One of the difficulties of ports-of-entry inspection is that most leaf material is removed from the tubers before importation, making it difficult to detect any fungus. Because the rust is now found in almost half of US states and in several counties in California, pest risk status is being reviewed. CDFA may down-rate the fungus from a 'Q' to a 'B' or 'C'. For now, however, intercepted plants are quarantined, and a CDFA treatment protocol is followed. This includes removing the infected foliage, which is then double bagged and disposed of in an approved landfill with County Agricultural Commissioner (CAC) verification of proper disposal. The treatment plan calls for 3 applications of propaconizole (Banner Maxx), azoxystrobin (Heritage), or myclobutanil (Systhane) at label rates to protect new foliage, under CAC supervision. Alternating between chemicals is recommended to avoid resistance. After the 3rd fungicide treatment, symptomless plants may be eligible for movement or sales upon inspection by the CAC. For other details concerning the CDFA treatment protocol and this disease, contact your CAC.

Regional Report

San Diego County

West Nile Virus Alert: Be Aware of Mosquito Infested Areas

A probable case of West Nile Virus has been detected in Los Angeles County. The virus sickens fewer than one percent of those bitten by an infected mosquito and most of those individuals exhibit mild symptoms and recover without treatment. Only about one in 150 infected people exhibit severe symptoms; those who do are usually very young, elderly or have weakened immune systems.

Mild symptoms of the virus include fever, headache, and body aches, occasionally with a skin rash on the trunk of the body and swollen lymph glands. Symptoms of severe infection (West Nile encephalitis, meningitis, and meningoencephalitis) include headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness and paralysis.

This virus is transmitted by mosquitoes. Therefore, mosquito abatement is the first line of defense. In your growing operations, you will want to avoid breeding mosquitoes by:

- Eliminating standing water in pots, discarded tires, etc.
- Stopping leaks in irrigation systems, avoid over watering
- Keeping water collection areas clean

What impact does this have on your plans to recapture runoff water on your nursery? None, actually. It should be considered in the design, of course, but this is not really a change, since construction of any water collection system has always had the requirement that it not become a nuisance source (of mosquitoes). Low impact pesticides, such as *Bacillus thuringiensis israeliensis* or insect growth regulators can be applied to this water. If the water is clean and free of clogging plants, mosquito-eating fish (gambusia) are available.

You and your employees can reduce their risk of mosquito-borne diseases by taking these precautions:

- Avoid outdoor activity when mosquitoes are most active, especially at dawn and dusk.
- Apply insect repellent containing DEET when outdoors, in accordance with the manufacturer's instructions. OR
- Wear long-sleeved clothes and long pants treated with repellents containing permethrin or DEET, since mosquitoes can and do bite through thin clothing. Do not apply repellents containing permethrin directly to exposed skin. If you spray your clothing, there is no need to spray DEET on your skin under your clothing.

For more information, see the website http://westnile.ca.gov.

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Field Observations

Warning Issued in San Diego County for Areas Containing Ticks

Individuals in fields or other areas containing ticks should take necessary precautions to avoid tick bites. Ticks and a wild rabbit in this county have tested positive for tularemia.

Tularemia, or rabbit fever, is caused by the bacterium *Francisella tularensis* that is normally found in wild rabbits. It can be transmitted to humans by various species of ticks, biting flies such as deer and horse flies, as well as other arthropods. Tularemia usually causes an ulcer on the hand, accompanied by localized swollen and painful lymph nodes, or a person may not have an ulcer, but still have swollen lymph nodes.

If a person gets a tick or insect bite and starts to develop a fever within two to ten days after working in tick-infested areas, then he or she should seek medical advice. They should be sure to mention their exposure during their medical evaluation. Untreated cases can last two to three weeks. Tularemia cannot be directly transmitted from person to person.

If individuals are in areas containing ticks, they should;

- Wear light-colored clothing so that ticks can be easily seen before they attach to the skin;
- Wear long pants and long-sleeved clothing;
- Tuck pants into boots or socks, and shirt into pants;
- Apply insect repellent to clothing and footwear;
- Frequently check themselves and others for ticks.

Internet Sites–Weed and Herbicide Related Sites

Submitted by Cheryl Wilen, Area IPM Advisor, Ornamentals, UC Statewide IPM Project

Herbicides

From C&P Press, search for labels and MSDS sheets: www.bluebooktor.com

Herbicide susceptibility chart. See what herbicides work on your weeds: http://wric.ucdavis.edu/information/weedchart.html

This page is full of links to sites dealing with pesticides: http://www.west.net/~plawler/index.htm

Understanding herbicide additives: http://stephenville.tamu.edu/~eric/additives/index.htm

Factors that affect soil applied herbicides: http://www.ianr.unl.edu/pubs/pesticides/g1081.htm#HERBSOL

California Department of Pesticide Regulation: http://www.cdpr.ca.gov/

Weed control information

Pest Management Alliance for Containerized Nursery Crops – information for California: www.pmacni.com

Pacific Northwest Weed Manual: http://weeds.ippc.orst.edu/pnw/weeds

Integrated weed management from Canada. Good overview for field grown crops:http://www.agf.gov.bc.ca/cropprot/weedman.htm

Another overview of weed control: http://pubs.cas.psu.edu/freepubs/pdfs/uc175.pdf

Controlling Weeds in Nursery and Landscape Plantings from Penn State–very good and practical information: http://pubs.cas.psu.edu/FreePubs/pdfs/uj236.pdf

Similar to above but more herbicide information. From Auburn Univ.: http://www.aces.edu/department/extcomm/publications/anr/anr-465/pdf/anr-465.pdf

Sites that have a lot of weed related information and links to other good sites

Weed Related Links: http://www.ces.ncsu.edu/depts/hort/consumer/hortinternet/weeds.html

Weed Research Information Center at UC Davis: http://wric.ucdavis.edu

Weed Science Society of America – weed control, weed information, photoherbarium: http://www.wssa.net/

UC Statewide IPM Program: www.ipm.ucdavis.edu

A horticulture search engine that only looks in university and government sites: http://plantfacts.ohio-state.edu/

Continued from page 3

concentration of NO_3-N and NH_4-N in the nutrient solution before and after each solution change.

We found that the total amount of nitrogen uptake varied greatly by species. The average daily nitrogen uptake ranged from 4.4 milligrams (mg) in azalea to 25.3 mg in hydrangea (see Table 1). In fact, the fast-growing hydrangea took up more than twice as much nitrogen as any of the other species. With the exception of hydrangea, all of the species preferred ammonium to nitrate when both forms were provided. However, all would take up either form of nitrogen if the other form was not available. Lowering the solution pH did not significantly affect plant preference for ammonium or nitrate.

During the first 50 days of growth, average daily water uptake of all five species was 50-75 milliliters (mL) per day. After about 3 months of growth, water uptake rates for most of the species were between about 160-225 mL per day (Table 1). This is less than a half-pint per day. Hydrangea was thirstier, averaging 470 mL per day (about 1 pint). These rates of water use are much lower than the irrigation rates in use at most commercial nurseries that grow these crops, indicating that growers may be able to decrease irrigation volumes substantially without fear of causing water stress. The daily water use of each species could be predicted from the reference evapotranspiration (ET_o) data for Davis published by the California Irrigation Management Information System. Predicted values of water use were within 6% of actual values, once the ratio of transpiration to ET_o was established for each of the species. Thus, it should be possible to manage irrigation efficiently by calibrating crop water use to local ET_o values.

Plant water use was strongly correlated to nitrogen uptake in some species (e.g., hydrangea, barberry, and privet), but not in others (holly and rhododendron). The ratio of nitrogen uptake to water uptake provides a good estimate of the ideal nitrogen concentration in a nutrient solution for a liquid feed system (Table 1). The highest ratio occurred in hydrangea (54 mg/L) and the lowest in rhododendron (23 mg/L). It is noteworthy that these values are substantially lower than the liquid feed N concentrations applied in most commercial nurseries. This indicates that, for crops such as these, growers could apply much lower nitrogen concentrations without affecting plant growth.

Although the species studied are primarily used in the nursery trade, not floriculture, the results may be transferable to similar woody species used for cut flowers. The technique is applicable to other floricultural crops, and the results of such studies would be useful to growers who seek finer adjustment of application rates of nitrogen and water, as well as to fertilizer companies and others who wish to match nitrogen application rates or release rates to woody ornamental crop needs.

Acknowledgments

This research was partially funded by the Fertilizer Research and Education Program of the California Department of Food and Agriculture and by the University of California Hansen Trust. The authors thank Lisa Bruni, Carmen Garcia-Navarro, and Chithra Krishnamurthy for their assistance.

Table 1. Average daily uptake of N (in mg), water (in mL), and the ratio of total N uptake to water uptake, in mg/L.

	mg N	mL water	mg N/L
Berberis	6.4	160	39.9
Hydrangea	25.3	470	54.0
Ilex	5.1	169	30.2
Ligustrum	11.0	226	48.7
Rhododendron	4.4	187	23.3

Hall of Fame
Continued from page 1

Both men will be inducted into the California Floriculture Hall of Fame at a ceremony later this year.

The California Floriculture Hall of Fame was started in 1986 to honor the individual or individuals who have made a lasting contribution to the California floral industry. Past inductees include Paul Ecke, Sr., Paul Ecke, Jr., Ron Enomoto, Kee Kitayama, and LeRoy Franzoia, Jr., among many other industry notables. The selection committee for the award consists of representatives from California floral industry associations and is managed by the Kee Kitayama Research Foundation and the California Ornamental Research Federation. Plaques are presented to each inductee and their names are added to the perpetual plaques at the San Francisco Flower Mart, the Los Angeles Flower Market and the San Diego Flower Trade Center.

The Call for Nominations for the 2003 California Floriculture Hall of Fame will be mailed to industry organizations in early 2003. If you would like more information or a nomination form, please contact the CORF office at 831/724-1130 or ccfc@ccfc.org.

Get Cultured–What is pH–Part II?

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

This is Part II of a five-article series on soil/water pH, which started in the summer issue of CORF News, 2002. As I mentioned in the summer issue, the pH of soil and water is one of the most important chemical factors to consider aside from nutrient concentrations since soil pH influences nutrient availability to plants.

Factors to consider when evaluating the pH of soils/media/water.

- Plants are always the best indicators of problems in the soil. Remember to look at roots as well as the shoots.
- As a grower, one should always conduct a soil/media analysis to determine the chemical characteristics of the growing media.
- Different plant species have different pH requirements.
- Different soil/media types will have different pH requirements.
- When recommendations for a specific pH are given, it is not necessary to waste time and money to attain the exact pH that is recommended. Usually a pH in the range of ± 0.5 pH units is adequate.
- Field soils (mineral soils) differ from potting media in that field soils are usually lower in organic matter (0.5 – 3.0%) and higher in micronutrients than potting media, which generally have high concentrations of organic matter (30-100%) and low levels of micronutrients. These factors will influence recommended pH values.
- Other factors such as soil environment, climate, and fertilizer type will accentuate the positive and/or negative effects that pH has on plant growth and development.

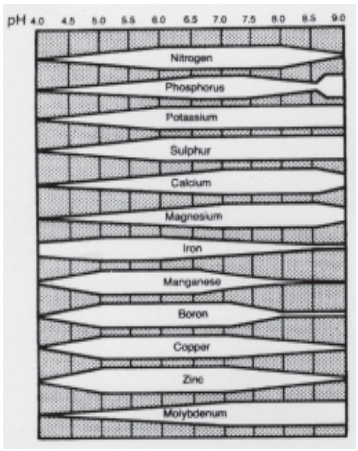
Soil/water pH affects nutrient availability in primarily two ways:

1. By increasing or decreasing the solubility of certain minerals.
2. By affecting root integrity and thus the ability of roots to take up nutrients.

1. Effects of pH on Mineral Solubility.

Field Soils– For most field soils the ideal pH range with regard to nutrient availability is between pH 6.0 and 7.5 (Figure 1), except for the acid-loving plants such as azalea, rhododendrons, etc. As the pH goes up, the availability of most micronutrients (iron, manganese, copper, boron, zinc, molybdenum) decreases because these elements combine with other elements such as calcium to form compounds of very low solubility. Likewise, as the pH decreases, micronutrient availability increases. In addition, below pH 4.0, the availability of aluminum and manganese can increase to toxic levels, causing root death.

Potting Media – For most potting media, the ideal pH range with regard to nutrient availability is between pH 5.5 and 6.3 (Figure 2). However, as in field soils, crops such as azalea, rhododendron, etc. require a more acid medium. The primary problem with higher pH media is that iron is tied up in the organic complex at higher pH. At a lower pH, nutrients such as manganese, and sometimes iron and zinc are available at concentrations that are toxic to plants. Boron toxicity symptoms are also more likely to be expressed at lower pH, especially if irrigation water contains boron concentrations in excess of 0.50 ppm (mg/L).



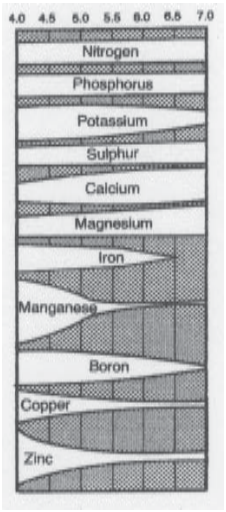


Figure 1. (Far left) Nutrient availability in mineral soils as affected by pH. The wider the band for a particular element, the more available that nutrient is for plant uptake in the given pH range. (E. Truog. 1941-47.U.S. Dept. of Agr. Yearbook, p. 566-576).

Figure 2. (Left) Nutrient availability in organic planting media as affected by pH. The wider the band for a particular element, the more available that nutrient is for plant uptake in the given pH range. (K.A. Handreck and N.D. Black. 1999. Growing media for ornamental plants and turf. p. 86).

2. Effects of pH on nutrient uptake

At low pH (<3.0) and high pH (>9.0) toxicity to roots can occur directly by extreme pH conditions due to the high concentration of hydrogen ions (H^+) in acid conditions or hydroxyl ions (OH^-) in alkaline conditions. Other factors will contribute to 'pH toxicity' even under less extreme conditions. As pH decreases (<5.0) in field soils, aluminum concentrations in soil solution increase, especially as pH drops below 5.0. This exposure of roots to aluminum is toxic, resulting in stunting and/or death of the root tips, which are the primary areas of the root where nutrient uptake occurs. In more organic media, such as those used for container production, elements such as manganese, boron, and sometimes iron can increase to high concentrations. This results in the excessive uptake of these nutrients to the point that they accumulate to toxic levels in the shoots and roots.

Campus News & Research Updates

Submitted by Julie Newman, UCCE Farm Advisor, Ventura and Santa Barbara Cos.

Campus News

UC RIVERSIDE. Stephen Wegulo is a new Assistant CE Specialist in the Department of Plant Pathology, responsible for extension and research on floriculture and nursery crops. He plans to organize and provide in-service training and extend information on plant disease management to farm advisors through visits, talks, workshops and educational material. The objective is to assist advisors in providing better educational opportunities for growers, pest control advisors and associated clientele in current techniques and methods of plant disease management. Dr. Wegulo will also be developing an innovative applied research program that emphasizes identification of the cause of disease and the development of relevant sustainable and integrated disease management strategies. He is the newest UC addition to the CORF Educational Planning Committee.

Dr. Wegulo received M.S. and Ph.D. degrees from the Department of Plant Pathology, Iowa State University, in 1994 and 1997, respectively. He then worked as a post-doc in the same department until his appointment at UCR on July 1, 2002. Most recently, he has worked on integrated management of diseases of fruits, vegetables, and turfgrasses. Dr. Wegulo's specialization is epidemiology and management of plant diseases. Welcome aboard!

Research Updates

Pesticide Runoff and Mitigation at Nurseries

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With the increased enforcement of environmental regulations, runoff from agriculture and urban developments are under constant scrutiny. In nursery and floriculture productions, runoff is generated from the use of intensive irrigation. Runoff-borne pesticides, especially certain insecticides, are considered harmful to aquatic organisms such as fish and invertebrates, and are the target for regulatory restrictions. In collaboration with J. Kabashima, D. Haver (Orange County CE) and L. Wu (UCR), we have initiated a number of laboratory and field-scale studies. These experiments fall under three topics: risk assessment, source identification, and mitigation. For risk assessment, we have taken the "up-and-down-the-stream" approach to understand the distribution of runoff-borne pesticides over distance and time, and to evaluate pesticide partitioning between the sediment layer and the over flowing water. So far we have made over 20 trips to a commercial nursery site near Irvine and have analyzed over 1,000 runoff and sediment samples. This study will lend us an understanding of the scope and magnitude of the potential pesticide-related impact. We are also conducting experiments to pinpoint where and when pesticides are making their way into the runoff. This knowledge will likely allow us to reduce or eliminate pesticides from the runoff directly at the source. In Orange County, best management practices (BMPs) have been installed at selected nursery sites. These BMPs include the use of polyacrylamide (PAM), sediment traps, sediment settling ponds, and vegetable strips. However, the efficiency of each of these BMPs for reducing pesticide runoff has not been adequately evaluated. We are taking the "before-and-after" approach to quantify pesticide removal by each practice. Our research is currently supported by UC Water Resources Center and FMC Inc. We believe that our research findings may be directly beneficial to many other nurseries in California.

A *Pasteuria* species host-specific to the sting nematode

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The sting nematode, *Belonolaimus longicaudatus*, is a root-feeding ectoparasite that is considered one of the most damaging pests in the Southeastern United States. In recent years, this exotic nematode was discovered in the Coachella Valley. Although it has been found only in a few golf courses in the Rancho Mirage area, in moist, warm and sandy soils this pest must be considered a major threat to most agricultural and horticultural crops. In collaboration with a research team from the University of Florida, we have started to investigate a microbial antagonist that appears to suppress the sting nematode population at a golf course near Ft. Lauderdale. This bacterium, designated as strain S-1, is a member of the genus *Pasteuria* that are obligate, endospore-forming microparasites of many plant-parasitic nematodes. However, the morphology and ultrastructure of the bacterium is considerably different from described *Pasteuria* species. In addition, the sting nematode is the only known host for strain S-1. Sequence data of part of its 16S rDNA showed only 96% identity with *P. penetrans* and 93% identity with *P. ramosa*, supporting its classification as a new *Pasteuria* species.

Bekal, S., J. Borneman, M.S. Springer, R.M. Giblin-Davis, and J.O. Becker 2001. Phenotypic and molecular analysis of a *Pasteuria* strain parasitic to the sting nematode. Journal of Nematology 33:110-115.

Giblin-Davis, R.M., D.S. Williams, W.P. Wergin, D.W. Dickson, T.E. Hewlett, S. Bekal, and J.O. Becker 2001. Ultrastructure and development of *Pasteuria* sp. (S-1 strain), an obligate endoparasite of *Belonolaimus longicaudatus* (Nemata: Tylenchida). Journal of Nematology 33:227-238.

Giblin-Davis, R. M., D.S. Williams, S. Bekal, D.W. Dickson, J.A. Brito, J.O. Becker, and J.F. Preston 2002. '*Candidatus Pasteuria usgae*' sp. nov., an obligate endoparasite of the phytoparasitic nematode, *Belonolaimus longicaudatus*. International Journal of Systematic and Evolutionary Microbiology (in press).

Campus News & Updates submissions can be directed to:
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New Publications

Compiled by Ann King, UCCE Farm Advisor, San Mateo & San Francisco Cos.

1. The Calif. Dept. of Pesticide Regulation has a new 125-page guide on the state's pesticide regulatory system. ***Regulating Pesticides: The California Story*** (Publ.#203) has information on pesticide law, DPR organization, regulatory and registration processes, enforcement activities, and DPR grants. The guide can be downloaded free from the DPR Web site (http://www.cdpr.ca.gov/docs/pressrls/dprguide1.htm). Paper copies cost $8.

2. The UC Integrated Pest Management web site (www.ipm.ucdavis.edu) has three new publications that may interest you. If you do not have Internet access, contact your local UCCE office or local library for assistance.

Spotted Spurge: Pest Notes for Landscape Professionals, Citrus Growers, the Container-grown Ornamental Industry, and Home Gardeners
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7445.html

Dodder: Pest Notes for Home Gardeners and Professional Horticulturists
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7496.html

Sudden Oak Death in California
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7498.html

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

October
4–6 ..... CSFA Annual Event & Top Ten Competition, Universal City, 916/448-5266
9–12 ... ICFG 2002 Annual Meeting, Monterey, 517/655-3726
10 ..... CORF IPM & Biocontrol Symposium, Watsonville, 831/724-1130, www.corf.org
30 ..... CORF Technology Growers' Tour, San Marcos, 831/724-1130, www.corf.org

November
14 ..... CORF, Floriculture & Nursery Marketing, Watsonville, 831/724-1130, www.corf.org
21 ..... CORF Methyl Bromide Alternatives School, Ventura, 831/724-1130, www.corf.org

December
3–4 ..... CCFC Committee & Board of Commissioners Meetings, TBA, 831/728-7333