CORF News

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Nitrogen Nutrition: Effects of Ammonium Vs. Nitrate on Plant Growth and Development

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

Nitrate (NO_3^-) leaching from agricultural areas continues to threaten local drinking water supplies and the neighboring ecosystems. In an effort to prevent nitrogen (N) contamination, the EPA and various local agencies have enforced stricter regulations regarding the runoff of nitrates. In some areas, the maximum allowable runoff for NO_3^- has been reduced from 10.0 mg N/L to 1.0 mg N/L. Unless fertilization and cultural practices are restructured, nurseries will be unable to comply with the new water quality control programs that have been implemented in recent years. One method of reducing NO_3^- runoff is to increase the proportion of ammoniacal nitrogen (NH_4^+-N) used for N fertilization.

In the soil, NH_4^+ may be converted to NO_3^- through nitrification, a biological process that involves several types of nitrifying bacteria. This process occurs more readily in warm soils of neutral pH. However, cultural practices such as soil sterilization and the use of certain pesticides may reduce or eliminate nitrifying organisms, thus inhibiting nitrification. The types and forms of substrates used in a planting mix will also influence the fate of NH_4^+ and NO_3^-. If you are a grower who uses a lower pH (5.0) media for some crops, or if you have winter growing crops, conditions are more favorable for NH_4^+ fertilizer to remain in the ammoniacal form.

However, before manipulating the ratios of NH_4^+ and NO_3^- in fertilizer programs, it is important to understand how N forms can impact plant performance. There are three primary components of plant growth and development that may be influenced by N form:

1) Soil pH - NH_4^+ and NO_3^- can decrease or increase soil solution pH, respectively.

2) Nutrient uptake - NH_4^+ and NO_3^- fertilizers affect the uptake of other essential elements differently.

3) Plant growth - NH_4^+ and NO_3^- affect overall plant growth and development differently.

The use of NH_4^+ vs. NO_3^- will influence soil solution pH. Nitrification of NH_4^+ and the uptake of NH_4^+ are both processes that will acidify the soil. Uptake of NO_3^-, on the other hand, results in an increase in soil pH. Therefore, when plants are fertilized with NH_4^+ or NO_3^-, soil pH decreases or increases, respectively. This is especially true for mixes with a low buffering capacity such as those high in sand or perlite. In one study with blueberry plants fertilized with NH_4^+, the pH of the

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Texas Gentians Have a Sweet Tooth

By Moon-Soo Cho, Dept. of Horticulture, Taegu University, Kyongsan, Kyongbuk, Korea, 712-714; Linda Dodge and Dr. Michael S. Reid, Dept. of Environmental Horticulture,UC Davis

The Texas gentian, *Eustoma grandiflorum*, commonly called lisianthus and native to the prairie states of North America, continues to increase in popularity as a specialty cut flower. Hybrids developed in Japan provide a wide range of colors, color patterns, and both single and double forms.The popularity of lisianthus is partly attributable to the range of colors available, and the fact that each plant bears as many as 10 flowers during the production season. The flowers (which are truly inflorescences) have a large number of florets, and under the right postharvest conditions, many of the young buds will open into flowers.

Lisianthus flowers are usually harvested when the first one or two florets have opened. A good quality stem will usually have ten or more buds and flowers. If the stems are placed in plain water, few if any of these buds open, and the display life of the inflorescence is therefore determined by the life of the

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soil solution dropped from 6.0 to 3.0 over the course of a 25-week period. For plants fertilized with NO_3^-, soil solution pH increased from 4.0 to 6.0. In most media, effects of N form on soil solution pH are less extreme, but they may be significant enough to cause various physiological and/or nutritional disorders. Nutrient imbalances are partly related to the change in soil solution pH. Many nutrients, especially micronutrients, are less available for uptake when the soil solution pH is near neutral (Graph 1).

Fertilization with NH_4^+ vs. NO_3^- may reduce the amount of total plant growth. In general, NH_4^+ fertilized plants will produce smaller darker green foliage compared to plants fertilized with NO_3^-. This is due to N form effects on photosynthesis and N assimilation. When NH_4^+ is taken up, it must be immediately assimilated into amino acids, a process requiring carbohydrates (photosynthates). Without sufficient carbohydrates, free NH_4^+ can be toxic to the plant. Therefore, if a plant is carbohydrate limited due to low light levels (low photosynthetic rates) or large fruit

GRAPH 1:

Graph 1: Effect of soil pH on the activity of microorganisms and the availability of plant nutrients in mineral soils. N = nitrogen, Ca = calcium, Mg = magnesium, P = phosphorus, K = potassium, S = sulfur, Fe = iron, Mn = manganese, Zn = zinc, Cu = copper, Co = cobalt. (Brady, N.C. 1990. (ed.). The nature and properties of soils, 10th edition. MacMillan Publishing Company, New York).

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load (large carbohydrate sink) then NH_4^+ fertilization is more likely to cause toxicity symptoms. When NO_3^- is taken up, it is reduced to NH_3 and assimilated into amino acids. However, if sufficient carbohydrates are not available, the excess NO_3^- can be stored in the vacuoles of cells until sufficient carbohydrates are available. Thus, unlike NH_4^+, NO3- fertilization will not tie up available carbohydrates from the plant at the expense of plant growth.

Fertilization with NH_4^+ or NO_3^- will also influence the quality of plant growth by affecting the uptake of other elements. These effects are attributed partly to the change in soil solution pH. However, impact of N form on nutrient uptake is also attributed to the different ionic charges of NH_4^+, [a cation (positively-charged)], and NO_3^-, [an anion (negatively-charged)]. Since plants attempt to maintain ionic equilibrium, uptake of other cations may be reduced when NH_4^+ is the predominant N form, and the uptake of other anions may be reduced when NO_3^- is the predominant N form. Therefore, plants that take up NH_4^+ may show lower uptake of potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). Similarly, fertilization with NO_3^- may reduce the uptake of phosphate ($H_2PO_4^-$) and sulfate (SO_4^{2-}). It is important to note that since both the uptake of nutrients and overall plant growth may be affected by N form, the interpretation of tissue analyses should be done carefully. For example, NH_4^+ nutrition may reduce total uptake of Ca and Mg uptake. However, since vegetative growth may be lower for NH_4^+ vs. NO_3^- fertilized plants, tissue concentrations of Ca and Mg may actually be higher for NH_4^+ vs. NO_3^- fertilized plants. This effect can be seen in blueberry plants fertilized with NH_4^+ or NO_3^- (Table 1 and 2), where total uptake of Ca and Mg were reduced in the NH_4^+ vs. NO_3^- fertilized plants, but Ca and Mg concentrations in leaf tissue were actually higher in the NH_4^+ treatments due to reduced growth of NH_4^+ fertilized (58.8 g) vs. NO_3^- fertilized (107.4 g) plants.

While most of the effects of NH_4^+ and NO_3^- nutrition on plant growth and development have been elucidated, the actual dynamics of N cycling in artificial growing media is not clearly understood. Additional research must be done is this area so that more effective N management strategies can be formulated to improve crop yield while minimizing or eliminating NO_3^- leaching. ❖

Table 1: Leaf nutrient concentration of 'Sharpblue' blueberry plants fertilized with either NH_4^+ or NO_3^- nitrogen. Plants were harvested after 25 weeks of growth. (Merhaut, D.J. and R.L. Darnell. 1996. Vegetative growth and nitrogen/carbon partitioning in blueberry as influenced by nitrogen fertilization. Amer. Soc. Hort. Sci. 121(5):875-879)

Nitrogen Treatment	Calcium Concentration (%)	Magnesium Concentration (%)	Potassium Concentration (%)	Phosphorus Concentration (%)	Iron Concentration (ppm)
NH_4^+	0.41	0.29	1.20	0.21	37
NO_3^-	0.43	0.20	0.91	0.15	36

Table 2: Total nutrient content of leaf canopy for 'Sharpblue' blueberry plants fertilized with either NH_4^+ or NO_3^- nitrogen. Plants were harvested after 25 weeks of growth. (Merhaut, D.J. and R.L. Darnell. 1996. Vegetative growth and nitrogen/carbon partitioning in blueberry as influenced by nitrogen fertilization. Amer. Soc. Hort. Sci. 121(5):875-879)

Nitrogen Treatment	Calcium Content (g)	Magnesium Content (g)	Potassium Content (g)	Phosphorus Content (g)	Iron Content (mg)
NH_4^+	24.1	17.1	70.6	12.3	2.17
NO_3^-	46.2	21.5	97.7	16.1	3.87

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few flowers that are open at the time of harvest. Frequently, too, unsightly bending of the pedicels of the open flowers and buds reduces the attractiveness of the flowers.

In other flowers with lots of tight buds, adding sugar, either as a postharvest 'pulse' at a high concentration (gladiolus), or in the vase solution (gypsophila), can improve flower opening. In some specific cases, sugar has also been shown to improve color of the newly opened flowers (snapdragons), and to strengthen the stem (gerberas). Dr Moon-Soo Cho, a visitor to our laboratory from Korea, decided to determine whether the opening, vase life, color, and/or stem strength of cut lisianthus flowers could be improved by using pulse pre-treatments or vase solutions containing sugar.

Unfortunately, sugar is also good food for bacteria, which can drastically reduce the vase life of most flowers by restricting movement of water in the stem. For this reason, commercial preservatives contain biocides intended to prevent, or at least slow down the growth of bacteria in the vase. Since some flowers are damaged by particular biocides, Dr Cho also tested the effects of a range of commercial preservatives, and common biocides on lisianthus.

Freshly-harvested 'Heidi Rose Pink' lisianthus flowers were placed in a range of vase solutions and evaluated until the end of their vase life (half the open florets dead). Lisianthus flowers placed in pure (deionized) water (DI) lasted for 6 days. Only two to three florets opened, and the floret stems (pedicels) were bent and floppy such ad in Fig. 1. Similar results were obtained when we used commercial preservatives, and we found that most of them caused the stems of the flowers to go brown. We made our own preservative by combining aluminum sulfate with 1.5% sugar (sucrose). In this solution four flowers opened per stem, and the vase life increased to 8 days.

These findings suggested to us that lisianthus has a really sweet tooth, since sugar in commercial preservatives (typically around 1%) provided no benefit,

Figure 1.

Figure 1. After 21 days in pure water, lisianthus stems are floppy, few buds have opened, and all the florets are dead.

Figure 3.

Figure 3. Lisianthus held for 21 days in 6% sugar have many open flowers, good color, and strong pedicels.

and 1.5%, which is a recommended concentration for many flowers, provided only modest additional opening and vase life. We therefore tried a range of stronger sugar concentrations, up to 6% (about the concentration of sugar in a ripe cantaloupe), and found a marked improvement in the life and quality of the flowers (Fig. 2). As in our previous experiment, 1.5% sugar in the vase solution increased flower opening substantially, and also extended vase life. Our 'sweet tooth' hypothesis was supported by the effects of higher sugar concentrations. In flowers held in 3% sugar, vase life was nearly double that of the controls, an effect that probably can be explained by the fact that the life of the first opened bud was considerably increased by using 3% sugar in the vase solution.

Even after 21 days, flowers that had been held in 6% sugar were in excellent conditions (Figure 3). As we examined the flowers, we noted that the newly opened florets on flowers held in water were distinctly pale compared to those opened with additional sugar. This effect was evident even in flowers held in 1.5% sugar. As can be seen by comparing Figs 1 and 3, another effect of the sugar was to maintain the floret pedicels straight. We thought that the sugar might be increasing the rigidity of the pedicels, so we measured them using a high-tech version of a kitchen scales. Pedicels of flowers treated with 1.5% sugar were more than twice as strong as those from flowers held in DI water.

With flowers such as gladiolus and tuberose, we can provide a shot of sugar by holding them overnight in a high concentration (like 20% sucrose), much in the way that a cyclist eats a large pasta dinner the day before a long race. We tried this ploy with lisianthus, but it was not effective. Pulse treatments with 20% sucrose for 24 or 48 hours did not provide any benefit. However, providing 6% sucrose for 24 hours was as good as providing 6% in the vase solution. Perhaps this sweet-toothed flower gets enough sugar after a couple of days at a

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cantaloupe concentration, but can't take the sweetness of a wine grape!

For growers of lisianthus and those marketing this flower, our results suggest using more sugar than for most flowers. If your operation allows it, pulsing for 2 days with a moderate concentration (say 6%) of sugar in a solution containing a biocide like aluminum sulfate will substantially improve quality, life, and opening of the flowers. ❖

Figure 2

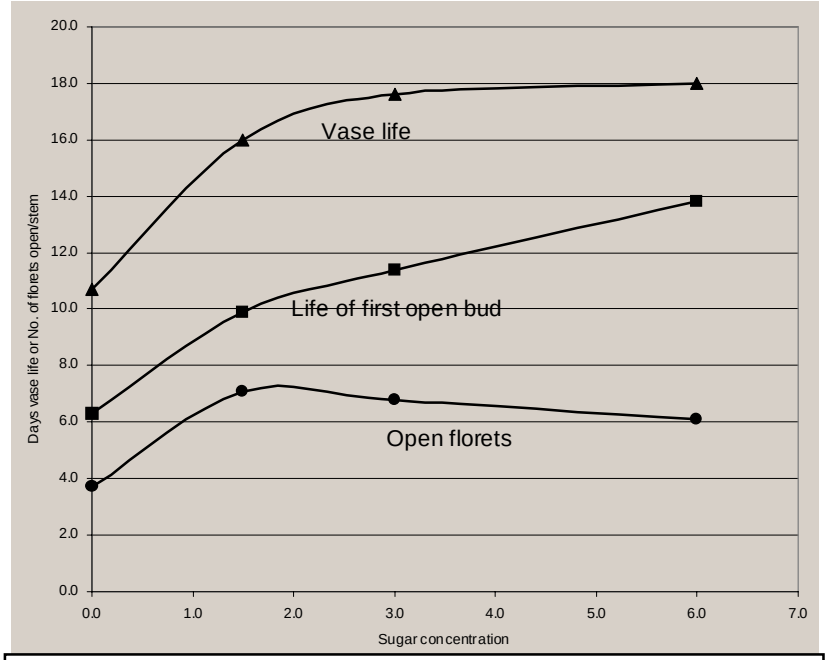

Figure 2. 1.5% - 3% sugar in the vase solution gives the best vase life, life of the first open bud, and floret opening in lisianthus

Field Observations

Rust on Fernleaf Yarrow

At a Monterey Bay area nursery, unhealthy fernleaf yarrow (*Achillea filipendulina*) had what appeared to be two separate diseases, one affecting the stems of the flower and one affecting the leaves and stems. All of these affected areas had elongated lesions with yellow halos, but the flower infections had reddish brown centers while the leaf and stem lesions had black centers. According to plant pathologist, Steve Koike, the yarrow was infected with the same rust fungus, *Puccinia*, probably *Puccinia cnici-oleracei.* But the same fungus had two stages of spores present on the same plant. The flower stems had the teliospore stage, which is a resting or overwintering stage of the fungus. (This stage made identification easy too.) The leaf and stem lesions probably had the aecial stage present.

Rusts have up to 5 spore stages, sometimes even on different host plants. These spores stages may look obviously different, as in *Puccinia* on yarrow.

Impatiens Necrotic Ringspot Virus (INSV) on Annual Statice

INSV continues to be a serious threat to greenhouse and field cut flowers and nursery crops. This time INSV has hit field production of annual statice (*Limonium sinuatum*) in Salinas. Plant symptoms are highly variable: some plants are severely stunted, distorted and yellowed, while other plants seem normal with normal flower production (digital images can be emailed upon request). However, up to 90% of the crop is affected to some noticeable degree in some cultivars. Positive identification can be made with field diagnostic kits or sending samples to private or public labs. Thrips control is of paramount importance since the virus is vectored by this insect. Eliminating infected carriers of the virus, such as nearby infected crops or weeds is essential too.

Regional Report

Santa Cruz & Monterey Counties

As the countdown to the elimination of methyl bromide continues, researchers are hard at work to identify possible alternatives to control important soil inhabiting nematodes, insects, weeds, and pathogens. Several chemical alternatives have been suggested and are being actively tested in the field. However, EPA registrations may be a long way off.

In hot summer conditions, experiments demonstrate that some soil pests can be controlled by soil solarization. Basically, this treatment heats up the soil under a clear plastic tarp for 4 to 6 weeks, and high soil temperatures kill soil pests.

In the summers along coastal California, however, the efficacy of soil solarization is often marginal, limited by naturally cool conditions. We now have directed our research efforts into enhancing the soil solarization process under these cool summer areas where the majority of commercial floriculture and nursery production exists. The products we are testing are mostly natural products that would require little, if any, regulation. Some chemicals are used too, but they are already registered. Some results are reported here in an ongoing field and laboratory study headed by Dr. Jim MacDonald with co-investigators Clyde Elmore and Steve Tjosvold. The research was funded by the University of California Sustainable Agriculture Research and Extension Program and the Kee Kitayama Research Foundation.

Field experiments were done at four locations: UC Davis (as a Central Valley location where solarization would be maximally efficacious) and three Watsonville sites were chosen for variation in climate. One Watsonville site was only several hundred yards from the ocean and the other sites were several miles inland.

Following is a consolidated listing of the treatments used in field experiments, although not all treatments were used in every experiment:

· Control – no treatment

· Clear polyethylene for 4 weeks (short solarization)

· Clear polyethylene for 6 weeks (long solarization)

· Clear polyethylene plus bubble wrap for 6 weeks (insulated solarization)

· Clear polyethylene over water bags for 6 weeks (heat retention)

· Metham sodium (Vapam) @ 50 gpa with and without solarization

· Metham sodium (Vapam) @100 gpa with and without solarization

· Blood meal (2% by weight top 3 inches of soil) + solar 6 weeks

· Composted chicken manure (8T/A) with and without solarization

· Corn gluten meal (40lb/1000ft^2) with and without solarization

· Acetic acid (300 gpa) + solar 6 weeks

· Ammonia (300 gpa) + Solar 6 weeks

· Broccoli chop 5 dry tons (7:1 wet to dry ratio) with and without solarization

The soil temperatures achieved at the Watsonville ocean site with solarization were insufficient to reduce germination of calla bulbs relative to controls. Growers consider residual bulbs from previous crops to be one of their greatest weed problems. In this experiment, excellent control was achieved with metham sodium (100 gal/acre) overlaid with plastic tarps for 6 weeks (i.e., a combined solarization treatment). Good control also was achieved when broccoli residues were incorporated at the rate of 5 tons / acre, and overlaid with plastic tarps for 6 weeks. Broccoli residues without tarping had no effect. The beneficial effect of tarping probably was related to trapping of volatile materials within the soil rather than a solarization effect. It is known that chemical and biological changes occur in soil during solarization, and that adding organic amendments (e.g., debris from Brassica spp., or chicken manure) can greatly enhance efficacy through the phenomenon of "biofumigation." Contact Steve Tjosvold to obtain the complete progress report.

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Regional Report

San Diego County

Ag/Urban Interface Issues Compromise Presented to Oceanside City Council

The Oceanside City Council has postponed until Nov. 1 their decision on an amendment to their permitting process for the construction of new ag facilities within the city's ag zone. This will allow more time to study the impacts of the amendment on the growing community.

This amendment before the city council would include a new set of development standards and represents a compromise between residents of Morro Hills, which is in an agricultural zone, the city planning department and several growers in Morro Hills. This process was predicated by a conflict between a nursery operation and a residential neighbor, who happened to be a city planning commissioner. The conflict arose when the owner leased the land to a more intensive container nursery operation, with increased levels of activity, noise, parking, deliveries, etc.

Initially, city planning department staff and an ad hoc planning commission committee were considering requiring a conditional use permit (CUP) for agricultural structures as well as any agricultural production that included potted plant material.

Several of the growers in Morro Hills were concerned about operating under CUP conditions. Under a CUP process, an applicant would be faced with an open-ended list of conditions. Of even greater concern to the growers was the fact that a CUP can be reopened and new conditions imposed even after the use is established. These growers formed a workgroup to work with the planning commission ad hoc committee to find a less onerous solution for the ag/urban interface issue than a CUP.

Under this new amendment, the new development standards must be met by the applicant and discussed in a public hearing. Existing operations will not be affected by these standards, which apply only to new applications to construct greenhouses, shade houses, packing sheds, loading docks, and offices. If a grower is able to locate the permitted structure 500 feet from any property line or all the property owners within 500 feet sign a waiver, no public hearing will be required.

Is everyone happy with this amendment? No. Some of the growers don't want ANY new restrictions of any kind. These growers feel that this compromise sets a dangerous precedent. After all, this area is zoned for agricultural uses. Furthermore, some small growers in Morro Hills are concerned whether they will be able to meet the parking and truck accommodation standards if they apply for permits for new structures.

Not all of the residents of Morro Hills are happy either. Some of the residents couldn't see a need for a change in requirements. They felt that homeowners and ag had been and should continue to peacefully coexist in this area. Other residents didn't want "high intensity" (read ornamental plant production) production in their area. One resident stated: "(this operation) no longer constitutes agriculture in that the activities conducted presently are inappropriate to be conducted in an agricultural zone and in fact constitute the manufacturing of botanical product, thereby constituting an industrial activity."

Regardless of whether or not the city council adopts this amendment, the growers will still be faced with unhappy neighbors who now believe that they have not acted in good faith in negotiating this compromise amendment. This process, which has lasted over a year, has emphasized once again the need for growers to be proactive with their neighbors and to avoid or deal with conflicts as soon as they arise, before the continued viability of ornamental operations is compromised through regulations.

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Field Observations

Redgum Lerp Psyllid Parasites Released in San Diego County!

Tiny stingless encyrtid wasps (*Psyllaephagus bliteus*) were released in San Diego County September 15 to combat the Red Gum Lerp Psyllid, which attacks some species of *Eucalyptus* trees. This is the first release in San Diego County as part of a statewide biological control program sponsored by University of California, Berkeley and University of California Cooperative Extension.

Although the program has experienced delays in the mass rearing of the parasites, releases were initiated within 10 months of collection in Australia, rather than the usual two years.

We will continue to monitor release sites for establishment and dispersal of this parasite. Although these parasites are not commercially available, additional releases are planned for sites throughout San Diego County.

For more information, see the web site at www.cnr.berkeley.edu/biocon/dahlsten/rglp/index.htm

Another Lerp Psyllid Discovered Attacking Eucalyptus in California

I am starting to think there is some merit in the theory that bioterrorists are releasing pests of *Eucalyptus* in California as a method for removing these non-native species. Just kidding, (I think). Another lerp psyllid species *has* been found attacking *E. maculata* and *E. citriodora*, however.

This new psyllid, *Eucalyptolyma maideni*, is being referred to as the lemon gum lerp psyllid. The lerp on this psyllid does not resemble the conical lerp of the redgum lerp psyllid, but is more elongated, with an almost open lattice appearance. More than one psyllid nymph has been found beneath a single lerp, as well.

To date, this new pest has only been found in Orange County and near LAX. Hopefully, this pest can be eliminated before it spreads throughout the state. However, be on the lookout and let your local farm advisor know if you see something unusual on your eucalyptus.

Regional Report

San Mateo & San Francisco Counties

Postharvest Research Studies

Leaf Yellowing and Leaf Drop

One of the projects I am working on with Dr. Michael Reid at UC Davis is to develop methods to reduce leaf yellowing and leaf drop on potted plants and cut flowers. While ethylene is involved in petal drop, and flower abscission & senescence, other physiological factors are more involved with leaf yellowing and leaf drop.

I am experimenting with a chemical spray to reduce leaf yellowing on potted plants, while other researchers in the lab are looking at the chemical's effect as an additive to cut flower vase solutions. The work is promising so far, and we are going to explore its use as a commercial material for growers and shippers.

Leaf yellowing and leaf drop are a major postharvest problem on some crops, and they occur at all stages during shipping and handling.

Vacuum Cooling for Potted Plants?

Another project that Michael Reid and I are about to undertake is the use of vacuum cooling prior to the shipping of potted plants. One of the major postharvest problems with potted plants is that they are not pre-cooled adequately before shipping, which reduces their postharvest life and increases the odds of problems with postharvest diseases such as botrytis.

Cooling the soil mass in potted plants has always required a long period in the cold room prior to shipping, and has been a difficult task to achieve by most growers. During busy packing times, growers often do not have the time or the cooler space to adequately pre-cool the potted plants. Forced-air cooling, which is used for cut flowers, is not used by potted plant growers because it does not quickly cool the soil mass. Growers rely on leaving boxes of potted plants in the cold room to pre-cool them, but this takes too long in most situations.

Vacuum cooling is used extensively in the lettuce industry, and on some other vegetable crops, to pre-cool the produce before shipping. Vacuum cooling should work well to cool soil in pots, as long as it does not "over cool" the top portions of the plants. This will be a very interesting project and the results will be of interest to potted plant growers. If vacuum cooling is successful, it should do a lot to increase the postharvest life of potted plants and to reduce botrytis.

What Causes Cut Flowers to Die?

Dr. Don Hunter (from New Zealand) and Dr. Antonio Ferrante (from Italy) are visiting scientists in Dr. Reid's lab at UC Davis. They are working together on several projects to examine the molecular (genetic) reason why flowers senesce. Certainly ethylene is involved in flower senescence in some flower species, but ethylene alone does not explain the reasons for flower senescence.

With an understanding of the molecular basis for flower senescence, postharvest physiologists should be able to use the information to breed flower species with longer postharvest life, or to develop methods to treat flowers to delay senescence. This is very exciting research. Although the results will not have *immediate* application in our industry, we should support this type of basic research because it could have a profound impact on the floriculture industry in the future.

Grafting for Better Rhododendrons

Jason Julian is a graduate student in Michael Reid's lab who is working on grafting "new" (new to California, anyway) species of rhododendrons onto native rhododendron rootstocks. His goal is to develop new-to-California rhododendron species that will tolerate California's tough landscape conditions. Many rhododendron species will not grow in California's alkaline, dry soils.

Flower growers, always interested in new species, should find this type of applied research interesting. Success with grafting rhododendrons could lead to new rhododendron species which have potential as potted plants, cut flowers, and, of course, landscape plants. Once Jason refines the grafting techniques, his techniques may have application to additional flower species with commercial potential.

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Regional Report

Ventura & Santa Barbara Counties

Reflective Mulches on Field Grown Asters: Help for Thrips and Aphids?

Plastic mulches with reflective surfaces have been shown to be a practical and economical reduced-risk method that growers can use to deter insect pests in row crops, especially aphid and whitefly virus vectors. Exciting results were achieved by Charles Summers and James Stapleton, entomologists at the Kearney Agricultural Center, as well as numerous other researchers. Summers and Stapleton report that the use of reflective mulches in certain vegetable crops prevented colonization by Homoptera including aphids, whiteflies, leafhoppers, and perhaps some Hemiptera. In zinnia flowers, there was a decrease in the abundance of leafminers and whiteflies in plants growing over reflective mulch.

Cost of ground mulches are only about $140 per acre, and can easily be offset by reduced pesticide application costs. However, because the planting density used for ornamental plants is denser than for vegetables, it is possible that ground mulches will be effective for a shorter period of time, as the ornamental crop will eventually cover the mulch. Reflective netting developed for bird control may be a better solution for field grown flowers. The costs of bird netting is about $40 per 1000 linear feet. Evaluation is needed to validate that the use of reflective mulches is an effective and cost productive method for insect control in commercial flower production.

Plots for evaluating reflective mulches were established on 'Matsumoto' asters in a commercial nursery in Oxnard last spring and were visited by 130 participants at the annual CORF Grower Tour in June. We are evaluating six treatments: 1) reflective mulch, 2) plastic mulch with an imprinted reflective surface, 3) standard rows without reflective mulch, 4) standard mulch (without the reflective surface), 5) reflective bird netting, and 6) combination treatment containing both ground reflective mulch and bird netting. Four replicated treatments rows were laid out in a RCB design, each 30 feet long. We had 3 adjacent beds for each treatment. Sticky card data was collected weekly from the center of treatments in middle plots; 3 plant samples were collected for insect presence.

Additional research plots will soon be set up in Santa Cruz and San Diego Counties by Farm Advisors Steve Tjosvold and Karen Robb. Asters will be evaluated in all 3 regions using the same protocol to increase replications and demonstrate efficacy statewide.

We have recently harvested our plots and are currently analyzing the Oxnard data. With only 4 replications it is difficult to make any statements yet until the data from the other sites is available. In addition, we ended up with a myriad of different colors within each row, so this could also affect our results. However, from the sticky card data there appears to be a trend that all reflective mulch treatments reduced thrips and aphids on yellow sticky traps in those plots. We did not see the same trend for whiteflies or leafminers. In addition, weeds were significantly reduced in the ground mulch plots. It may be important to have a way of moving overhead reflective mulch up as the crop matures, keeping it just over the top canopy for it to be most effective.

This project is funded by the California Department of Pesticide Regulation, the Hansen Trust, and Kee Kitayama Research Foundation.

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Field Observations

Glassy-winged Sharpshooter

The Glassy-winged Sharpshooter (GWSS) is costing local nurseries shipping into northern California millions of dollars. One Ventura County nursery recently lost $100,000 in sales, returned and destroyed shipments, and additional labor for monitoring, pesticide applications, and leaf stripping. Another nursery expects to lose $4 million -$6 million this year. Rick Redak's lab at UC Riverside identified numerous pesticides that effectively controlled GWSS adults and nymphs. In addition, they found that Marathon (imidacloprid 60WP, 1G), currently registered for nurseries, effectively killed newly hatched nymphs when they fed. Tame (fenpropathrin) was the only nursery product to effectively control larvae as they emerge from eggs. Two other products that controlled emerging larvae are slated for nursery registration. Imidacloprid 2F (Marathon II, Olympic) is expected in two months and acetamiprid 70 WP (Aventis) should be available next spring.

Two GWSS evaluations are currently in progess in Ventura County nurseries. Ian Greene (Whitmire), John Kabashima (UCCE, Orange County) and I are evaluating control in shipping trailers because several growers who made spray applications in nurseries before shipping have had plants rejected upon arrival due to hitchhiking GWSS. We hope to improve coverage with an aerosol application of bifenthrin, using AttainTR. Preliminary data look promising. Aerosol treatment could be made in trailers prior to shipment if Whitmire, CAN, and CDFA can work out a third party 24C registration. Another trial is in progress with Todd Birchler, Olympic Horticultural Products, at two nursery sites in Ventura County. Todd is determining the lowest dosage for effective and economical GWSS control on nursery plants using Marathon. He reports complete systemic control of adults up to 10 weeks on 24" containers at a low dosage of .4 g a.i.

Internet Sites

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

In each newsletter, I will be updating you on the variety of web sites pertaining to articles in the current newsletter – formerly the job of Dr. Heiner Lieth. I now have control of the mouse.

There are several sites that you should always have book marked. Those include the following:

* CORF webpage at http://envhort.cudavis.edu/CE/CORF This site will keep you updated on all of CORF's activities.
*Environmental Horticulture at UC Davis at http://envhort.ucdavis.edu
* The California Cut Flower Commission at http://www.ccfc.org

The following sites will provide information about plant nutrition as well as general growing guidelines for different crops. Some of the publications in these websites can be printed out while others must be purchased.

· http://www.attar.org/attar-pub/cutflower.html. A sustainable flower production guide. This website is sponsored by the Appropriate Technology Transfer for Rural Areas (ATTAR). The guide discusses what is needed to start and maintain sustainable flower production. Information is also available on IPM, fertilizer alternatives, weed management, marketing strategies as well as reference and resource information.

· www.hortnet.co.nz/publications/hortfacts/hfinall.htm.htm#hf308001 This site is hosted by HortNET, a website for New Zealand's agricultural industries. Very little information is really available regarding aspects of NH_4^+ and NO_3^-. Also there is no information related to quality of runoff water. However, this site is good for general information. Please keep in mind that information is based on growing conditions in New Zealand. Factors such as climate, soil type and water quality will be different and may impact certain aspects of the production practices.

· http://www.colostate.edu/depts/soilcrop/extension/wq/wqpubs.html This site is hosted by Colorado State University. Information is available regarding water quality. It has an overview of N cycling in soils. Unfortunately, most of the information is geared toward agronomic systems.

· http://www.ces.ncsu.edu/depts/hort/floriculture This site is hosted by North Carolina State University. A lot of information is available regarding all aspects of flower production, from propagation to postharvest.

· http://aesop.rutgers.edu/~floriculture/publications/florpub.htm This site is hosted by Rutgers Cooperative Extension and contains a plethora of information regarding all aspects of flower production – worth browsing.

· http://www.epa.com Hosted by the EPA. This site will give you all the information that you ever wanted to know, and then some, regarding water quality standards. It will help you understand what MCLs (Maximum concentration levels) and TMDLs (Total Maximum Daily Load) are about and how these regulations were created. ❖

Campus News & Updates *Submitted by Julie Newman, Farm Advisor UCCE*

Campus News

CAL POLY, SLO. ***Dr. Barry Eisenberg*** will be the new department head for the Environmental Horticultural Science Dept. at Cal Poly starting October 1. Barry graduated from Cal Poly in 1975 with a degree in Ornamental Horticulture. He received both his masters and Ph.D from Ohio State University. Barry is a postharvest horticulturist and was an assistant professor at the University of Illinois from 1981-86. He was the Postharvest R/D Coordinator for Campbell Soup from 1986-91 and the

Director of Quality and Technical Services for Chiquita Brands International from 1986-1999. Dr. Eisenberg owned and operated a private consulting firm, Postharvest Research Solutions, prior to taking the department head position at Cal Poly.

UC DAVIS. Last May, the ***Ornamental Horticulture Research and Information Center*** (OHRIC) and the Department of Environmental Horticulture hosted the annual OHECC meeting (Ornamental Horticulture Extension Coordinating Conference). Cooperative Extension advisors and Specialists belonging to the ***Floriculture/Nursery, Landscape, Turfgrass*** and newly-organized ***Urban Horticulture*** workgroups met to exchange information about ongoing research and form collaborations for new research projects. Presentations on water quality issues (including TMDL mitigation for impaired water bodies), the pros and cons of genetically-modified organisms (GMOs) and setting workgroup priorities based on target issues identified by the Division of Agriculture and Natural Resources sought to prepare advisors and specialists to meet future clientele needs.

Dr. Ann King, Farm Advisor in San Mateo and San Francisco Counties is spending her sabbatical leave in ***Dr. Michael Reid's*** laboratory, doing postharvest research on cut flowers and potted plants (see her Regional Report for details). Ann also contributed to the department by acting as instructor for the upper division class, Analysis of Horticultural Problems (ENH 241) during Spring Quarter. Dr. Reid's lab group continues to swell. ***Dr. Mohammed Eraki*** is here from Egypt to study effects of the anti-ethylene compound, 1-MCP, on carnations and sweet peas. High school student ***Michael Teng***, a participant in the UCD Young Scholars program, worked under the supervision of ***Dr. Don Hunter*** to study the senescence of four o'clock flowers. ***Fabio Mencarelli*** has recently arrived from the University of Tuscia, Viterbo, in Italy to study molecular techniques used in postharvest research.

UC RIVERSIDE. The California Association of Nurserymen (CAN) held their 2000 Ornamental Horticulture Conference at UC Riverside. Morning program topics included TMDL issues, methyl bromide alternatives, giant whitefly, red imported fire ant, red gum lerp psyllid, glassy-winged sharpshooter, invasive plants, and irrigation management. These topics were further addressed in the afternoon through exhibits and hands-on demonstrations. The afternoon session also included exhibits on insect identification, nutrient management, IPM education for retail nurseries, Eucalyptus long horned borer, and Eucalyptus tortoise beetle. In addition, laboratory visits in the Departments of Plant Pathology, Nemotology and Entomology were highlighted. UC presenters and exhibitors included ***Phil Roberts, Mike Rust, Tom Bellows, Les Greenberg, Rick Redak, Heather Costa, Don Merhaut, Michael Stanghellini, Antoon Ploeg, Tim Paine*** (UC Riverside); ***Jim MacDonald, Heiner Lieth, Mary Louise Flint*** (UC Davis); ***Andrew Lawson*** (UC Berkeley***); John Kabashima, Cheryl Wilen, Karen Robb, Valerie Mellano, and Julie Newman*** (County UCCE). Other presenters included Ken Theisen (Regional Water Control Board), Kean Goh (DPR), Kim Wilenius (C&M Nursery). ***Cheryl Wilen*** (UCCE, San Diego County) and ***John Kabashima*** (UCCE, Orange County) served on the Planning Committee with CAN industry representatives.

Research Updates

Energy Use and Plant Growth in a Greenhouse Heated with Recirculating Hot Water Above or Below plant containers

Richard Evans and Tom Byrne
Department of Environmental Horticulture
University of California
Davis, CA 95616

With the nursery industry facing the prospect of increasing energy costs, we investigated the effect of heating tube placement on energy consumption and citrus tree growth in a greenhouse heated with recirculating hot water. Some research has shown that energy efficiency is highest when the plant canopy, not the soil, is heated, but there are many advocates of heating systems placed below containers. 'Okitsuwase' citrus in a greenhouse near Orange Cove were grown in amended mineral soil in polyethylene film tubes, 16 inches deep and 7 across. Hot water (~120°F) was pumped through loops of plastic tubing that lay either on the soil floor beneath the containers or at the surface of the container soil. During the winter, we monitored the temperatures of the plant canopy, container soil, and recirculating water. Soil temperatures were 2-7°F lower in the raised heating system, but the canopy temperature was nearly the same. Recirculation under the containers extracted nearly 5 times more heat than raised heating did, but growth of shoots and roots was not significantly affected by placement of heating tubes. We conclude that heating tube placement does not affect yields, but substantial savings of energy costs may be obtained by directing heat into the canopy rather than into the root zone.

Use of Myccorhizal Fungi to Reduce Phosphorus Leaching Losses from Florist Chrysanthemums

Lisa Bruni and Richard Evans
Department of Environmental Horticulture
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Container media lose large amounts of fertilizer phosphorus—as much as 80% of the amount applied—because they lack the chemical properties of mineral soils which limit phosphorus mobility. Phosphorus (P) is a pollutant of surface waters, and is likely to be in short supply in the future, so control of leaching losses

Campus News and Updates
Continued from page 14

is important. Two approaches have been taken in the past. One has been to supply P in a less soluble form—for example, adding rock phosphate instead of superphosphate to the container medium. Unfortunately rock phosphate usually releases P too slowly to meet plant demand. The other approach has been to add chemical amendments that contain iron or aluminum to tie up P in the medium. This has sometimes worked, but it requires careful management to prevent either over-acidification or excessive precipitation of P so that plant demand is not met.

We tried another approach, infection with mycorrhizal fungi, which can associate with plants and effectively increase water and nutrient uptake by roots. Successful infection requires an appropriate chemical environment and a fungal species that is compatible with the crop. We studied the interactions of P and a mycorrhizal fungus (*Glomus intraradices*) with potted chrysanthemum plants ('Butterfield'). Plants in 5-inch containers were irrigated with a complete nutrient solution in which P varied from 0-50 ppm. After 6 weeks we harvested the plants and measured their weights, leaf P concentration, and rate of infection of roots by the fungus. Significant amounts of infection occurred only when the applied P concentration was 1 ppm or less. Yields and leaf P declined when applied P was less than 10 ppm, even in the presence of mycorrhiza. We conclude that mycorrhiza are not beneficial to florist crops because they form only under conditions that substantially reduce crop yields. ❖

New Publications

Compiled by Ann King, Farm Advisor UCCE

The ***UC IPM Pest Management Guideline: Floriculture and Ornamental Nurseries*** is now complete, with the recent publication of a new chapter on insects and mites, and another on weeds. These two new chapters join the previously published disease chapter. The new insect and mite section, written by Karen Robb, Heather Costa, Jim Bethke, Richard Cowles, and Michael Parrella, covers 16 groups of pests including aphids, whiteflies, mites, scales, and leafminers, and has accompanying sections on managing pesticide resistance, monitoring with sticky traps, establishing treatment thresholds, and biological control.

The new weed section, by Clyde Elmore and Cheryl Wilen, is divided into separate sections on managing weeds in container nurseries, in field-grown trees and shrubs, in field-grown flowers, and in greenhouse crops (both inside and outside the greenhouse).

The guidelines contain the official UC treatment recommendations for flower and nursery crops and will supplement the upcoming UC IPM manual ***Integrated Pest Management for Floriculture and Nurseries***. They are available from many county UC Cooperative Extension offices, and from DANR Communication Services in Oakland (800) 994-8849, and are on the web with links to color photos at http://www.ipm.ucdavis.edu/PMG/selectnewpest.floriculture.html

Special Thanks to these Sustaining Sponsors of the 2000 CORF Grower Education Programs...

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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 research/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
3.....CORF Bugs 2000 Seminar, Ventura, 707/462-2425
13-15 .. CSFA *Calif Flora 2000*, Newport Beach, 916/448-5266
14 ..... Kee Kitayama Research Foundation Dinner, Newport Beach, 831/724-1130
18.....CORF Frost Control Seminar, Watsonville, 707/462-2425
26.....CORF Soil Steaming Seminar, Salinas, 707/462-2425

November
30.....CORF CA Ornamental Plant Disease Control Symposium, Watsonville, 707/462-2425
December
7.....CORF Container Media Seminar, Half Moon Bay, 707/462-2425
January

February
21-23 .. Plant Tour Days 2001, San Diego Co. Flower & Plant Assoc., 760/431-2572