Topics in Subtropics Newsletter

University of California Cooperative Extension

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

News from the Subtropical Tree Crop Farm Advisors in California

Volume 3 No. 3 July-August-September, 2005

Editor's Note:

Please let us know if your mailing address has changed, or you would like to add someone else to the mailing list. Call or send an email message to the farm advisor in the county where you live, or subscribe on-line at http://ceventura.ucdavis.edu/newsletterfiles/newsletter653.htm. Phones numbers and email addresses can be found at the end of this newsletter. Also, let us know if there are specific topics that you would like addressed in subtropical crop production. All of the citations at the end of the "Avocado Foliar Nutrition" article can be found at www.avocadosource.com.
Ben Faber (editor for this edition)

In this issue: .... Page

LTTLE EVIDENCE TO SUPPORT THE USE OF FOLIAR APPLIED NUTRIENTS IN AVOCADO

Simon Newett, Extension Horticulturist. Department of Primary Industries and Fisheries, Maroochy Research Station, Mayers Road, Nambour 4560, Queensland, Australia.
Previously published in: Talking Avocados (published by Avocados Australia Ltd), 11(2), 24-27.

Introduction

Foliar fertiliser application is sometimes promoted as an effective means of supplying nutrients to avocado. On the market are various products being promoted as foliar nutrients for avocado, some proponents even suggest that their products do away with the need for soil applied nutrients. This article briefly reviews the literature relating to foliar feeding of avocado and examines the anatomy of the avocado leaf and flower in relation to nutrient uptake.

The avocado leaf

The structure of plant leaves has evolved primarily to capture sunlight and exchange gases, roots have evolved to absorb nutrients and water and anchor the plant. Any absorption of nutrients by leaves is therefore likely to be more fortuitous than by design. In some crops passive nutrient absorption by leaves is occasionally sufficient to supplement the supply of nutrients taken up by the roots. Most often this involves trace elements, which as their name suggests are required in very small amounts (eg. copper and zinc). However if non-mobile elements or elements with limited mobility in the plant (eg. calcium, phosphorus, zinc, boron and iron) are absorbed when foliar sprayed they are not likely to make it down to the roots where they are also needed. Most nutrients will move freely in the water stream but the movement of many is restricted in the phloem, hence leaf applications don't meet the requirements of deficient trees. Occasionally major elements (such as nitrogen and potassium) are applied to make up for a temporary shortfall or provide a boost at a critical time. Citrus is an example of a crop where some benefits from foliar applied nutrients have been reported.

The ability of the leaf to absorb nutrients from its surface must depend to some degree on the permeability of its epidermis (outer layer) and the presence and density of stomates (pores for the exchange of gases). Scanning Electron Microscope studies of mature leaves and floral structures in avocado show the presence of a waxy layer on both the upper and lower surfaces of mature avocado leaves (Whiley *et al*, 1988). On the upper surface the wax appears as a continuous layer and there are no stomates. On the lower surface the wax layer is globular and stomates are present. Blanke and Lovatt (1993) describe the avocado leaf as having a dense outer wax cover in the form of rodlets on young leaves and dendritic (branching) crystals on old leaves including the guard cells (guard cells surround stomates). The flower petals and sepals in avocado have stomates on their lower surfaces and no wax layers on either surface, which might explain why floral sprays of boron might work.

Literature review

Nitrogen

Based upon total leaf nitrogen concentration, Embleton and Jones (unpublished) in a replicated trial in California in the early 1950's found no response to leaf sprays of urea on mature 'Fuerte' avocado trees in the field. Up to three sprays a year were applied.

Nevin *et al* (1990) reviewed urea foliar fertilisation of avocado and found only one study (Aziz *et al*., 1975) that reported positive results in terms of fruit yield. This trial by Aziz *et al* (1975) involved drenching sprays of significant amounts of urea four times a year (250 to 500 g of nitrogen per tree annually). It is unclear whether or not considerable amounts of the drenching spray reached the ground, nevertheless, the amounts applied were very high for foliar applications. No leaf analysis data was reported.

Galindo-Tovar (1983) was able to increase leaf nitrogen concentrations in ‘Hass’ avocado seedlings grown in a glasshouse with low concentrations of urea. However similar treatments on 3-year-old ‘Hass’ in the field for each month during spring failed to increase leaf nitrogen in mature leaves sampled a week after spraying. The author cited evidence for crops other than avocado suggesting that urea can penetrate leaf surfaces when grown in a greenhouse, but when grown in the field under full sun, leaf surfaces are different and resist movement of nitrogen into the leaf.

Klein & Zilkah (1986) reported substantial uptake of foliar urea-N when detached leaves of 'Fuerte' avocado were dipped in urea solutions. Zilkah *et al* (1987) reported the translocation of ^{15}N from foliar-applied urea to vegetative and reproductive sinks of both 'Fuerte' and 'Hass' avocado. Despite the apparent response achieved by Aziz *et al* in Egypt, Klein & Zilkah, and Zilkah *et al* in Israel, attempts at the University of California to demonstrate significant uptake of nitrogen from foliar sprays have not been successful (Nevin *et al.,* 1990).

Research at the University of California, Riverside, provided evidence that the leaf nitrogen content of 'Hass' avocado was not increased by foliar application of urea at the same concentration that increased citrus leaf nitrogen content two-fold (Nevin *et al.,* 1990). Maximum uptake of ^{14}C-urea by 'Hass' avocado leaves was physiologically insignificant after 2 days. Over 96% of the ^{14}C-urea applied was recovered from the leaf surface even after 5 days. Maximum uptake of ^{14}C-urea by leaves of 'Gwen' and 'Fuerte' was less than 7%. ^{15}N, ^{14}C-urea and ^{65}Zn are radioactive forms of nitrogen, urea and zinc respectively that are used to track their movement through the plant.

Potassium

Sing and McNeil (1992) conducted a study on an orchard with a history of potassium deficiency where high magnesium levels in the soil competed with potassium for uptake. Foliar applications of 3.6% potassium nitrate were applied at half leaf expansion, full leaf expansion and one month after full leaf expansion. These foliar applications of potassium nitrate were effective in increasing the potassium level in the leaves of 'Hass' avocado trees, however two to three foliar applications per year were required to achieve the same result as one application of potassium sulphate (banded) to the soil once every 2 to 3 years. Accounting for labour and material costs the foliar sprays of potassium nitrate were estimated to be more expensive than soil applied potassium sulphate applied every three years. The foliar sprays also affected the levels of other nutrients in the leaf, some negatively.

Calcium

Calcium is receiving attention as an element in avocado fruit associated with better quality and longer shelf life. Several different calcium products were tested during the 1980’s as foliar sprays in South Africa in an attempt to raise fruit calcium levels but none were found to be effective.

Veldman (1983) reported that the treatment of avocado trees with one, three and six calcium nitrate sprays did not successfully control pulp spot in avocado fruit and there was no increase in fruit calcium levels on sprayed treatments.

Whiley et al (1997) report that calcium foliar sprays during fruit growth have little effect on internal concentrations in most fruit due to poor absorption by fruit, and lack of translocation within the tree.

Boron

Some benefits have been reported from foliar application of boron if applied at flowering. Timing is important because it appears that absorption takes place through flower structures and not leaves.

Jayanath and Lovatt (1995) reported on results of four bloom studies (two glasshouse and two field experiments) which demonstrated the efficacy of applying boron or urea sprays to 'Hass' avocado inflorescences during early expansion (cauliflower stage) but prior to full panicle expansion and anthesis. Anatomical analysis of the flowers provided evidence that the boron prebloom spray increased the number of pollen tubes that reached the ovule and also increased ovule viability, but to a lesser degree than urea. The urea prebloom spray increased ovule viability compared to boron-treated or untreated flowers. Urea also increased the number of pollen tubes that reached the ovule, but to a lesser degree than boron. However, combining boron and urea resulted in a negative effect even when the urea was applied 8 days after the boron. Lovatt (unpublished) provided an update on this work at the World Avocado Congress in 1999, after 3 years of field trials the only treatment to have a positive effect on pollination was the boron in Year 2, the most likely reason why it didn't work in other years was thought to be low temperatures. There were only hardened leaves present at the time of foliar applications suggesting that uptake was through flower parts.

Whiley *et al* (1996) report that despite an increase in fruit set with foliar sprays of boron during flowering there has been no convincing evidence that showed increased final yield. Root growth has a requirement for boron and in deficient trees it is unlikely that sufficient nutrient from foliar applications would be translocated to the roots. Foliar applications have the advantage that specific organs can be targeted to enhance their boron concentrations, but with the disadvantage that insufficient boron can be absorbed through leaves to mediate chronic deficiency in trees. Soil applications have been shown to dramatically improve the health of boron deficient trees.

Mans (1996) experimented with 'Hass' trees that had leaf levels of nitrogen and boron below the accepted norms (N was 1.71% and B was 23ppm). The aim of this trial was to see if supplying nutrients directly on the flowers could increase the yield of 'Hass' trees growing in a cool environment. Mans (1996) found that if a multi-nutrient spray that included nitrogen and boron was applied as the first flowers started to open then he could increase yield and distribution of fruit size. The stage of flowering when spraying takes place was very important. Sprays that were applied pre-bloom, at fruitset or when fruitlets were present were not effective.

Iron

Kadman and Lahav (1971-1972) reported that the only means to control iron chlorosis in already established avocado orchards is soil application of iron chelates since applications of various iron compounds by foliar sprays have not been successful on a commercial scale. Gregoriou *et al* (1983) found that the quickest and most successful treatment of trees suffering from iron chlorosis on calcareous soils was obtained by incorporating Sequestrene 138 Fe-EDDHA in the soil.

Zinc

Kadman and Cohen (1977) found that avocado trees have difficulties in absorbing mineral elements through their foliage. In spite of this, spraying of apparently zinc-deficient orchards was rather common in California and some other countries. In Israel, some growers spray their orchards, but as experiments have shown, no apparent improvement occurs in leaves or fruits following such treatment. The results presented in this paper indicate that the penetration of zinc through the leaves is so slight that there is practically no benefit through supplying it by foliar sprays.

Zinc deficiency is common in avocado and is particularly difficult to address on high pH (alkaline) soils. Crowley et al (1996) evaluated methods for zinc fertilisation of 'Hass' avocado trees in a 2-year field experiment on a commercial orchard located on a calcareous soil (pH 7.8) in California. The fertilisation methods were:

- soil or irrigation-applied zinc sulphate
- irrigation-applied zinc chelate (Zn-EDTA)
- trunk injection of zinc nitrate
- foliar applications of zinc sulphate, zinc oxide, or zinc metalosate.
-

Among the three soil and irrigation treatments, zinc sulphate applied at 3.2 kg per tree either as a quarterly irrigation or annually as a soil application was the most effective and increased leaf tissue zinc concentrations to 75 and 90 mg/kg respectively. Experiments with ^{65}Zn applied to leaves of greenhouse seedlings, showed that less than 1% of zinc applied as zinc sulphate or zinc metalosate was actually taken up by the leaf tissue. There was also little translocation of zinc into leaf tissue adjacent to the application spots or into the leaves above or below the treated leaves. Given these problems with foliar zinc, Crowley *et al* (1996) suggest that fertilisation using soil or irrigation applied zinc sulphate may provide the most reliable method for correction of zinc deficiency in avocado on calcareous soils.

Whiley and Pegg (1990) report that foliar applications of zinc have been found to be highly ineffective in Queensland orchards.

Price (1990) reports that zinc can be absorbed through the leaves (from foliar sprays, e.g. zinc sulfate, zinc chelate) but that insufficient zinc can be absorbed in this manner to meet the plants requirements, especially in avocados. Since zinc is required at the growing points of new roots and shoots, it is essential that most zinc be taken up by the roots.

Foliar fungicide sprays

If leaf applied nutrient sprays in avocado give inconsistent or nil effects why do foliar sprays of phosphorous acid work for the control of root rot? The amount of phosphorous acid uptake required for root rot control is small but even so, several applications per year are required to be effective and the canopy must be dense and healthy. The phosphonate concentration required in the roots for effective root rot control is in the order of 30 mg/kg. To achieve this level either three to four sprays of 0.5% phosphorous acid per year are required at strategic times (Leonardi *et al.,* 2000) or alternatively six or more sprays of 0.16% phosphorous acid per year must be applied. Another factor contributing to the effectiveness of leaf applied phosphorous acid is that, unlike many nutrients, it is extremely mobile in the plant.

Borys (1986) reports the dry matter distribution of roots to shoots in avocado seedlings average 26% and 74% respectively. Using these figures and some critical nutrient and fungicide levels in avocado we can get some perspective on the relative quantities required. In a tree consisting of say 100 kg of dry matter, about 26 kg would be in the roots and 74 kg in the shoots. This tree with a phosphonate root level of 30 mg/kg would contain a total of about 0.8 g phosphonate in the roots. With the optimal leaf levels of 50 mg/kg of boron and 2.5% of nitrogen, the tree would contain about 4 g and 1850 g of boron and nitrogen respectively in the canopy alone. It can be seen from these relative amounts that the fungicide required is substantially less than the nutrients.

Conclusion

Apart from well-timed boron applications at flowering in situations where leaf boron levels are deficient, there is no clear evidence to support the use of foliar nutrient sprays in avocado to correct nutrient deficiencies or to supply nutrients for growth. Occasionally a foliar nutrient spray may succeed in alleviating leaf deficiency symptoms, however this type of application will not provide the tree's longer-term requirements for this nutrient which should be addressed through soil applications.

Acknowledgments

I would like to thank Drs Chris Searle and Tony Whiley and Mr Garry Fullelove of the Queensland Horticulture Institute for their assistance in compiling this article. The literature search was conducted using the AVOINFO avocado reference database.

Bibliography

Aziz, A.B.A., Desouki, I., El-Tanahy, M.M., Abou-Aziz, A.B. and Tanahy, M.M., El 1975. Effect of nitrogen fertilization on yield and fruit oil content of avocado trees. *Scientia Horticulturae*, 3 (1): 89-94.

Blanke, M.M. and Lovatt, C.J. 1993. Anatomy and transpiration of the avocado inflorescence. *Annals of Botany*, 71 (6): 543-547.

Borys, M.W. 1986. Root/shoot relation and some root characteristics in seedlings of avocado and Chinini. *California Avocado Society Yearbook* 70: 175-198.

Crowley, D.E., Smith, W., Faber, B. and Manthey, J.A. 1996. Zinc fertilization of avocado trees. *HortScience* 31 (2): 224-229.

Galindo-Tovar, G.E. 1983. Effects of urea spray concentration and surfactants on avocados. M.S. Thesis, University of California, Riverside, USA. September.

Gregoriou, C., Papademetriou, M. and Christofides, L. 1983. Use of chelates for correcting iron chlorosis in avocados growing in calcareous soil in Cyprus. *California Avocado Society Yearbook* 67: 115-122.

Jayanath, I. and Lovatt, C.J. 1995. Efficacy studies on prebloom canopy applications of boron and/or urea to 'Hass' avocados in California. *World Avocado Congress III, Proceedings:* 181-184.

Kadman, A., and Lahav, E. 1971-1972. Experiments with various treatments to cure chlorotic avocado trees. *California Avocado Society Yearbook.* 55:176-178.

Kadman, A. and Cohen, A. 1977. Experiments with zinc applications to avocado trees. *California Avocado Society Yearbook*, 61: 81-85.

Klein, I. & Zilkah, S. 1986. Urea retention and uptake by avocado and apple trees. *Plant Nutr.* 9:1415-1525.

Leonardi, J., Whiley, A.W., Langdon, P.W., Pegg, K.G. and Cheyne, J. 2000. Progress on the use of foliar applications of phosphonate for the control of phytophthora root rot in avocados.

Mans, C.C. 1996. Effect of foliar feeding of 'Hass' at various stages of flowering. *South African Avocado Growers' Association Yearbook*, 19: 31-32.

Nevin, J.M., Lovatt, C.J. and Embleton, T.W. 1990. Problems with urea-N foliar fertilization of avocado. *Acta Horticulturae* 275: 535-541. International Symposium on the Culture of Subtropical and Tropical Fruits and Crops. Vol. II. (J.C. Robinson, ed.), International Society for Horticultural Science. Wageningen, Netherlands.

Price, G. 1990. Thinking about zincing your trees? *Talking Avocados*, Third Edition, Aug/Sept, p.5.

Sing, J.L. and McNeil, R.J., 1992. The effectiveness of foliar potassium nitrate sprays on the 'Hass' avocado (*Persea americana* Mill.), *World Avocado Congress II, Proceedings: "The Shape of Things to Come" (Lovatt, C.J. ed.)* 1: 337-342.

Veldman, G. 1983. Calcium nitrate sprays on avocados at Westfalia Estate with the objective to reduce pulpspot. *South African Avocado Growers' Association Yearbook*, 6: 64-65.

Whiley, A.W., Chapman, K.R. and Saranah, J.B. 1988. Water loss by floral structures of avocado (Persea americana cv. Fuerte) during flowering. *Australian Journal of Agricultural Research*, 39 (3): 457-467.

Whiley, A.W., and Pegg, K.G.1990. Correction of micro-nutrient deficiencies and control of Phytophthora root rot in avocado. *Talking Avocados*, Second Edition, May/June, p. 11.

Whiley, A.W., Smith, T.E., Saranah, J.B. and Wolstenholme, B.N. 1996. Boron nutrition of avocados, *Talking Avocados*, 7 (2): 12-15.

Whiley, A.W., Hofman, P.J and Coates, L.M. 1997. From seed to tray - some field practices to improve avocado fruit quality. *Proceedings of the Australian Avocado Growers' Federation and the New Zealand Avocado Growers' Association Conference '97, 'Searching for Quality'.* Rotorua, New Zealand, pp. 83-97.

Zilkah, S., Klein, I., Feigenbaum, S. and Weinbaum, S.A. 1987. Translocation of foliar-applied urea ^{15}N to reproductive and vegetative sinks of avocado and its effect on initial fruit set. *J. Amer. Soc. Hort. Sci.* 112:1061-1065.

Web Sites that Can Help Your Production

UCCE Ventura: http://ceventura.ucdavis.edu/ contains avocado handbook

UC Cooperative Extension: http://danr.ucop.edu

UC Avocado Production Cost Data (Ventura and San Diego): http://coststudies.ucdavis.edu/cost-studies/AvoVent2001-2.pdf http://coststudies.ucdavis.edu/cost-studies/AvoSDiego2001.pdf

Tree Loss Calculator: http://www.agecon.ucdavis.edu/outreach/treevinecalc.htm

UC Avocado Info: http://www.ucavo.ucr.edu

UC Fruit & Nut: http://fruitsandnuts.ucdavis.edu

UC Integrated Pest Management Program: http://www.ipm.ucdavis.edu/

UC Small Farm Center: http://www.sfc.ucdavis.edu/

UC Sustainable Agriculture Research and Education Center: http://www.sarep.ucdavis.edu/

UC Postharvest Inform: http://postharvest.ucdavis.edu

UC Publications: http://danrcs.ucdavis.edu/

UC Avocado Biocontrol: http://www.biocontrol.ucr.edu

UC Agricultural Labor Management: http://www.cnr.berkeley.edu/ucce50/ag-labor/

UC Bee News: http://entomology.ucdavis.edu/faculty/mussen/news.html

UC Ag Econ Cost Studies for various crops: http://coststudies.ucdavis.edu/

UC Gardening: http://homeorchard.ucdavis.edu

UCR Subtropical Horticulture: http://library.ucr.edu/agnic/

The following links are to sites outside of the UC domain. No endorsement is intended of products, services or information, nor is criticism implied of similar sites that are not mentioned.

CA Cherimoya Association: http://www.cherimoyas.org

Julia Morton's Rare Fruit Descriptions: http://www.hort.purdue.edu/newcrop/morton/index.html

California Rare Fruit Growers: http://www.crfg.org/pubs/frtfacts.html

Various ag suppliers:
http://www.rinconpublishing.com/Directory/directorymenu.html
USDA Market News Service: http://www.ams.usda.gov/
Great Avocado Information:
http://www.avocadosource.com
ATTRA, source of diverse ag info: http://www.attra.org/

CUT-OFF DEADLINE SET FOR LANDOWNERS APPLYING FOR 2006 EQIP FUNDS

September 1, 2005–Applications are now being accepted from agricultural producers wishing to participate in the 2006 Environmental Quality Incentives Program (EQIP), a voluntary conservation program that assists producers on a cost-share basis to meet local, state, and federal regulations. EQIP funds help farmers and ranchers reduce soil erosion, improve water quality, protect grazing land, and minimize air pollution.

Through the EQIP program, farmers and ranchers can receive financial and technical assistance for conservation practices on cropland, orchards, rangeland and nurseries.

The application cut-off date for most counties is **December 1, 2005.** Agricultural producers interested in participating in EQIP should contact their local Natural Resources Conservation Service (NRCS) office or USDA service center to submit an application

The NRCS will evaluate each application and give highest priority to those applicants willing to use the most cost-effective conservation practices; treat multiple resource concerns; address national, state, or local priorities; and provide the most environmental benefits. Once 2006 funds have been exhausted, eligible applicants will remain on file until additional funding becomes available.

The 2002 Farm Bill included major changes for EQIP to help farmers and ranchers live up to new environmental standards. Among the changes:

- Eliminating the competitive bidding process, thus allowing small and limited resource farmers to compete on an equal basis with large producers
- Decreasing the minimum contract length from five years to one year after the last practice is installed. (The maximum contract length remains the same at ten years).
- Establishing a maximum payment limit of $450,000 for the total of EQIP contracts entered into by an individual or an entity.

United States Department of Agriculture
www.ca.nrcs.usda.gov

Intensive Training Course on “How to Export Your Food or Agricultural Product” Targets Small California Farmers and Women or Minority-owned Businesses.

Contact: Dawn Klose
(916) 638-8986; Dawn.Klose@comcast.net

California farms and food companies are now eligible to enroll in an intensive training course designed to make them competitive in today’s global markets.
Termed “Export Readiness Training”, the program is funded by the US Department of Agriculture (USDA), and is specially designed for minority- or women-owned businesses that grow or process food or agricultural products that are at least 51 percent U.S. origin, and have not previously exported.

Supported through a grant from the USDA’s “Emerging Markets Program”, each participant will receive training valued at over $5,000. Ultimately, participants will develop an international marketing plan for their product and participate in an export promotion event (such as a foreign trade show, or international trade mission).

The program begins on October 18, 2005, and will be held in each of three locations throughout California – Sacramento, Fresno, and Long Beach. As the program provides intensive “hands-on” training, the number of participants per location is limited, and eligible companies will be admitted on a “first come, first served” basis. Applications will be accepted through October 8, 2005. Further meetings are planned for the future.

To register or for further details of the Export Readiness Training Program, log on at http://**www.wusata.org/ert** or call (888) 638-7888 or (562) 938-5018.

Cal/OSHA HEAT ADVISORY

When employees work in hot conditions, employers must take special precautions in order to prevent heat illness. Heat illness can progress to heat stroke and be fatal, especially when emergency treatment is delayed. An effective approach to heat illness is vital to protecting the lives of California workers.

California law requires employers to identify and evaluate workplace hazards and take the steps necessary to address them. The risk of heat illness can be significantly reduced by consistently following just a few simple steps. Employers of outdoor workers at temporary work locations must be particularly alert and also plan for providing first aid and emergency medical services should they become necessary. All workers should be accounted for during and at the end of the work shift. Heat illness results from a combination of factors including environmental temperature and humidity, direct radiant heat from the sun or other sources, air speed, and workload. Personal factors, such as age, weight, level of fitness, medical condition, use of medications and alcohol, and acclimatization effect how well the body deals with excess heat.

Heat Illness Risk Reduction

1. Recognize the Hazard. There is no absolute cut-off below which work in heat is not a risk. With heavy work at high relative humidity or if workers are wearing protective clothing, even work at 70_{o}F can present a risk. In the relative humidity levels often found in hot areas of California (20 to 40 percent) employers need to take some actions to effectively reduce heat illness risk when temperatures approach 80 F. At temperatures above 90 F, especially with heavy work, heat risk reduction needs to be a major concern.

2. Water. There must be an adequate supply of clean, cool, potable water. Employees who are working in the heat need to drink 3-4 glasses of water per hour, including at the start of the shift, in order to replace the water lost to sweat. For an eight-hour day this means employers must provide two or more gallons per person.

Thirst is an unreliable indicator of dehydration. Employees often need ongoing encouragement to consume adequate fluids, especially when the workload or process does not encourage breaks.

3. Shade. The direct heat of the sun can add as much as 15 degrees to the heat index. If possible, work should be performed in the shade. If not, employers where possible, should provide a shaded area for breaks and when employees need relief from the sun. Wide brimmed hats can also decrease the impact of direct heat.

4. Acclimatization. People need time for their bodies to adjust to working in heat. This "acclimatization" is particularly important for employees returning to work after (1) a prolonged absence, (2) recent illness, or (3) recently moving from a cool to a hot climate. For heavy work under very hot conditions, a period of 4 to 10 days of progressively increasing work time starting with about 2 hours work per day under the working conditions is recommended. For less severe conditions at least the first 2 or 3 days of work in the heat should be limited to 2 to 4 hours. Monitor employees closely for signs and symptoms of heat illness, particularly when they have not been working in heat for the last few days, and when a heat wave occurs.

5. Rest Breaks. Rest breaks are important to reduce internal heat load and provide time for cooling. Heat illness occurs due to a combination of environmental and internal heat that cannot be adequately dissipated. Breaks should be taken in cooler, shaded areas. Rest breaks also provide an opportunity to drink water.

6. Prompt Medical Attention. Recognizing the symptoms of heat illness and providing an effective response requires promptly acting on early warning signs. Common early symptoms and signs of heat illness include headache, muscle cramps, and unusual fatigue. However, progression to more serious illness can be rapid and can include unusual behavior, nausea/vomiting, weakness, rapid pulse excessive sweating or hot dry skin, seizures, and fainting or loss of consciousness. **Any of these symptoms require immediate attention.**
Even the initial symptoms may indicate serious heat exposure. If medical personnel are not immediately available on-site, and you suspect severe heat illness, you must call 911.

Regardless of the worker's protests, no employee with any of the symptoms of possible serious heat illness noted above should be sent home or left unattended without medical assessment and authorization.

7. Training. Supervisors and employees must be trained in the risks of heat illness, and the measures to protect themselves and their co-workers. Training should include:

- Why it is important to prevent heat illness
- Procedures for acclimatization
- The need to drink approximately one quart per hour of water to replace fluids.
- The need to take breaks out of the heat
- How to recognize the symptoms of heat illness
- How to contact emergency services, and how to effectively report the work location to 911.

Farm Advisors:

Gary Bender – *Subtropical Horticulture, San Diego*
Phone: (858) 694-2856 Email: gsbender@ucdavis.edu

Mary Bianchi – *Horticulture/water management, San Luis Obispo*
Phone: (805) 781-5949 *mlbianchi@ucdavis.edu*

Ben Faber – *Subtropical Horticulture, Ventura/Santa Barbara*
Phone: (805) 645-1462 bafaber@ucdavis.edu

Mark Freeman – *Citrus and Nut Crops, Fresno/Madera*
Phone: (559) 456-7265 mwfreeman@ucdavis.edu

Craig Kallsen - *Subtropical Horticulture and pistachios, Kern*
Phone: (661) 868-6221 cekallsen@ucdavis.edu

Peggy Mauk – *Subtropical Horticulture, Riverside*
Phone: (951) 683-6491 Ext. 221 pamauk@ucdavis.edu

Neil O'Connell – *Citrus/Avocado, Tulare*
Phone: (559) 685-3309 ext 212 nvoconnell@ucdavis.edu

Eta Takele – *Area Ag Economics Advisor*
Phone: (951) 683-6491 ext. 243 ettakele@ucdavis.edu

Upcoming 2005 California Small Farm Conference
November 13-15, 2005
Ventura Beach Marriott
www.californiafarmconference.com