COOPERATIVE EXTENSION UNIVERSITY OF CALIFORNIA

Kearney Plant Protection Group

PLANT PROTECTION QUARTERLY

July/October 1999 Volume 9, Numbers 3&4

This newsletter is published by the University of California Kearney Plant Protection Group and the Statewide IPM Project. It is intended to provide UC DANR personnel with timely information on pest management research and educational activities. Further information on material presented herein can be obtained by contacting the individual author(s). Farm Advisors and Specialists may reproduce any portion of this publication for their newsletters, giving proper credit to individual authors.

IN THIS ISSUE

ANNOUNCEMENTS

UC/PPQ NOW ON-LINE!

The editorial board of the UC Plant Protection Quarterly is pleased to announce that UC/PPQ is now available on-line. The newsletter may be accessed via the UC Kearney Agricultural Center website **(www.uckac.edu)** by clicking on the **Research & Extension Programs** button, then selecting **UC Plant Protection Quarterly**. PPQ is presented in exact, PDF format; Adobe Acrobat® software is required (link provided). In addition to the current issue, all previous issues are archived and an inclusive, 8-year subject index is provided which is clickable to the issue level. Since its inception in 1991, UC/PPQ has been distributed to UC DANR personnel for presentation of timely information on pest management research and educational activities. Unfortunately, the publishing budget has never been sufficient to comply with the numerous requests to add non-UC subscribers to the UC/PPQ mailing list. Instead, Farm Advisors and Specialists have been requested to forward UC/PPQ to

University of California and the United States Department of Agriculture cooperating

Cooperative Extension • Agricultural Experiment Station • Statewide IPM Project

This material is based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project section 3(d), Integrated Pest Management

interested clientele or reprint articles in their own newsletters. We now ask UC extension personnel to announce the availability of UC/PPQ on-line to their clientele. We will continue to send paper copies of each edition to DANR personnel on the mailing list.

OTHER PEST MANAGEMENT WEB PAGES AVAILABLE THROUGH THE UC KEARNEY HOME PAGE:

www.uckac.edu/whitefly "The Whitefly Page" is now available by logging on to the homepage, www.uckac.edu and clicking on Research & Extension Programs or by going directly to the URL www.uckac.edu/whitefly. This page contains the following information. 1. Current population status of silverleaf whitefly in Fresno, Tulare, and Kings Counties with information updated weekly. 2. Frequently asked question about whiteflies. This page provides a general discussion of some of the most common and economically important whiteflies, their biology, life history, hosts, damage, and control. Included are numerous links to photographs and additional information on various species. 3. Links to other whitefly pages including university and government information available on the World Wide Web. 4. Publications - a list of important publications on whitefly biology and control. 5. Survey graphs - includes graphs of seasonal distribution of silverleaf whitefly. 6. UC Pest Management Guidelines—A link to UC Pest Management Guidelines of crops susceptible to whiteflies. Includes information about management and control.

www.uckac.edu/citrusent/ "University of California Citrus Entomology Laboratory at the Kearney Agricultural Center". E. E. Grafton-Cardwell and G. Montez. A series of pages explaining degree-day units, a posting of the current degree-day accumulations for California red scale and citrus cutworm, an explanation of the section 18's for new pesticides in citrus, a pesticide resistance management program, and citrus newsletter postings.

www.uckac.edu/treefruitipm/ "UC Cooperative Extension Tree Fruit Pest Management". W. Bentley, E. E. Grafton-Cardwell and G. Montez. A series of pages posting population densities of San Jose scale and peach twig borer and their associated parasites in prunes and almonds.

www.uckac.edu/iwgss/ "International Workgroup on Soil Solarization and Integration Management of Soilborne Pests" Home Page. J.J. Stapleton. This site is the homepage for the international workgroup of researchers and educators engaged in developing alternatives to methyl bromide soil fumigation in general, and those using soil solarization in particular. It encompasses a series of pages giving an overview of the group's rationale and activities, a directory of participants, and abstracts from the two previous international conferences on soil solarization.

ARTICLES

METHYL IODIDE, A POTENTIAL REPLACEMENT FOR METHYL BROMIDE FUMIGATION

Chad Hutchinson, Milt McGiffen, and Ole Becker, U.C. Riverside

Methyl bromide fumigation has been a reliable and effective treatment for soilborne pest control in crop production systems since the 1950s. Its popularity, despite high application cost, is due to the broad-spectrum control of plant parasitic nematodes, weeds, and soilborne diseases with a single application prior to crop planting. Recently, however, methyl bromide has been implicated in contributing to the destruction of the ozone layer. In 1987, the Montreal Protocol, an international treaty sponsored by the United Nations Environment Programme, was inacted to protect the stratospheric ozone layer from substances with high ozone-depleting potential. In its latest update, the treaty calls for a 100% phase-out of methyl bromide use by 2005 in developed countries and 2010 in developing countries.

With the impending loss of methyl bromide, a search for alternative pesticides and production practices has been underway so that crop production will not be adversely affected. Currently, no registered pesticide used alone can replace methyl bromide for all of its uses. However, methyl iodide, a compound chemically similar to methyl bromide, has been proposed as a "drop-in" replacement for methyl bromide. Methyl iodide has been considered a useful replacement for methyl bromide for three reasons. First, unlike methyl bromide, methyl iodide is destroyed by ultraviolet radiation before it can interact with stratospheric ozone; therefore, it would not be regulated by the Montreal Protocol. Secondly, like methyl bromide, methyl iodide controls a broad-spectrum of pests including nematodes, weeds, and soil fungi. Lastly, methyl iodide would not require alternative application equipment or changes in the crop production practices currently used in combination with methyl bromide.

Recent research at the University of California, Riverside, has compared the efficacy of methyl iodide soil fumigation to methyl bromide using root-knot nematode control in carrot production as a model system. Two trials were conducted near Bakersfield, CA in grower's fields where root-knot nematode populations were known to be high. In the first trial, methyl iodide, methyl bromide, and metam sodium were compared. Methyl iodide and methyl bromide were applied to tarped beds as a gas through surface drip-irrigation lines. Metam sodium was applied by the grower through a sprinkler system. At the end of the season in both trials, carrots were harvested and rated for nematode damage. The methyl iodide and methyl bromide treated plots produced more carrots without nematode damage than the non-fumigated control plots (Table 1). All the methyl iodide and methyl bromide treatments reduced root-knot nematode populations over the entire season (1). The metam sodium treatment did not provide season-long root-knot nematode control, resulting in carrots with nematode damage on the secondary roots.

In trial two, methyl iodide, methyl bromide, and 1,3-dichloropropene were compared. Again, methyl iodide and methyl bromide were applied under tarp as a gas through drip-irrigation lines. The 1,3-D was commercially applied by shank injection 18 inches below the soil surface. The methyl iodide, methyl bromide, and 1,3-D applications provided season-long nematode control. Production of carrots without nematode damage was highest in the low rate treatments of methyl iodide and methyl bromide and in the 1,3-D treatment. All fumigated treatments produced more carrots without nematode damage than the non-fumigated control plots (Table 1).

It should be noted that the methyl iodide and methyl bromide applications were made under tarp, which was not the normal practice for methyl bromide application in California carrot production. Before it lost its registration in carrots, methyl bromide was shank injected and the soil compacted to reduce fume-off. Applying the fumigants under tarp through drip-irrigation line, however, is ideal for precise applications and allowed for direct comparisons between the activity of the methyl iodide and methyl bromide. The metam sodium and 1,3-D treatments were used as an industry-standard reference.

This research demonstrated that, under our experimental conditions, methyl iodide was equally effective at controlling nematodes as currently registered fumigants for carrot production. However, in order to be registered for use as a soil fumigant, further toxicological and environmental studies are needed. Continued production of food at the quantity and quality demanded by consumers requires effective pest control options. With the loss of methyl bromide, the registration of methyl iodide would provide vegetable producers with an effective methyl bromide replacement (2,3).

References

1. Becker, J. O., H. D. Ohr, N. M. Grech, M. E. McGiffen, and J. J. Sims. 1998. Evaluation of methyl iodide as a soil fumigant in container and small field plot studies. Pesticide Science 52: 58-62.

2. Hutchinson, C. M., M. E. McGiffen, H. D. Ohr, J. J. Sims, and J. O. Becker. 1999. Evaluation of methyl iodide as a soil fumigant for root-knot nematode control in carrot production. Plant Disease 83 (1): 33-36.

3. Hutchinson, C. M., M. E. McGiffen, H. D. Ohr, J. J. Sims, and J. O. Becker. 1999. Efficacy of methyl iodide soil fumigation for control of *Meloidogyne incognita*, *Tylenchulus semipenetrans*, and *Heterodera schachtii*. Nematology 1: 407-414.

Table 1. Effect of methyl iodide, methyl bromide, 1,3-D, and metam sodium soil fumigation on carrot production.

Fumigant (lb/acre)	Marketable Carrot Weight No-Nematodes		Non-Marketable Carrot Weight With-Nematodes	
	Trial 1	Trial 2	Trial 1	Trial 2
	---------------(tons per acre) ----------------			
Control – No Fumigant	12.0 c[a]	9.9 d	1.3 b	1.3 a
Methyl Bromide (100)	25.0 a	21.2 abc	0.5 b	2.1 bc
Methyl Bromide (200)	23.5 ab	15.9 c	0.3 b	1.2 c
Methyl Iodide (100)	24.3 ab	24.9 a	0.5 b	1.5 bc
Methyl Iodide (150)	24.3 ab	22.3 ab	0.3 b	1.7 bc
Methyl Iodide (200)	25.5 a	17.8 bc	0.2 b	1.4 c
Methyl Iodide (300)	18.9 b	20.5 abc	0.2 b	1.7 bc
1,3-Dichloropropene	NT	20.8 abc	NT	2.9 b
Metam Sodium	4.6 d	NT	5.8 a	NT

NT=Not tested. [a]Values within a column followed by different letters are significantly different

COACHELLA VALLEY COWPEA COVER CROP - WEED CONTROL TRIALS

Chad Hutchinson, Milt McGiffen, and Jose Aguiar, UC Riverside and UCCE Riverside County

Purpose

The purpose of these experiments was to determine if cowpea could produce enough biomass during the hot summer months to act as a mulch for weed control during the following fall cropping season. Pepper was used as the fall crop, and the measurements taken during the season included number of weeds per plot, pepper plant height, and pepper plant and weed weights at the end of the season.

Treatments

A - Cowpea mulch plots hand weeded during the season to determine the influence of the cowpea cover on pepper growth without weed interference.
B - Cowpea mulch plots with no weed control to determine the influence of the mulch on weed control.
C - Conventional bare ground plots hand weeded during the season to determine optimal plant growth in a conventional system.
D - Conventional bare ground plots with no weed control used to determine the underlying weed pressure in the field.

Dates of Activity in the Plots

7/7/97; 7/10/98 - Cowpea (var. Iron Clay) planted double row on 30" beds.

Irrigation turned off to cowpea two weeks prior to transplanting pepper.

9/2/97; 9/22/98 - Cowpea cut at soil line and placed on top of the bed.
- Pepper (var. Keystone)
- transplanted at one foot between row spacing.

12/18/97; 12/15/98 - Final weed counts, weed weights, and pepper plant weights taken.

Results

Cowpea dry weights at the beginning and end of the season (1997:1998).

At transplant:	610; 713 g/m bed
At the end of the season:	288; 181 g/m bed

Table 1. Number of weeds per meter in each non-weeded treatment plot over the season (1997 data).

Treatment	Number of Weeds per Meter of Bed 14 DAT[1]	35 DAT	57 DAT	94 DAT
Cowpea Mulch Plots	13.8 a[2, 3]	25.5 a	15.5 a	48.0 a
Conventional Plots	299.0 b	211.2 b	200.0 b	244.0 b

[1]DAT=Days after transplanting.
[2]Numbers within columns followed by different letters are significantly different at p<0.05.
[3]Weed species present in plots were not significantly different.

Table 2. Total and mean weed weight at harvest in the non-weeded treatment plots (1997 data).

Treatment	Total Weed Weight (g/m bed)	Mean Weed Weight (g/plant)
Cowpea Mulch Plots	12.2 a[1]	0.39 a
Conventional Plots	37.1 b	0.17 a

[1]Numbers within columns followed by different letters are significantly different at p<0.05.

Table 3. Pepper plant height and pepper plant dry weight during the season (1997 data).

Treatment	Pepper Plant Height (cm) 35 DAT[1]	57 DAT	Pepper plant Dry Wgt (g/plant) 94 DAT
Cowpea mulch/Weeded	28.4 a[2]	30.8 a	14.7 a
Cowpea mulch/Non-weeded	27.0 a	29.5 a	16.3 a
Conventional/Weeded	20.6 b	21.9 b	9.9 ab
Conventional/Non-weeded	19.5 b	21.1 b	5.4 b

[1]DAT=Days after transplanting.
[2]Numbers within columns followed by different letters are significantly different at p<0.05.

Key Points

- Numbers of weeds in the cowpea mulch plots were significantly less over the season than in the conventional plots (Table 1). *Cowpea mulch reduced weed pressure in the mulch plots.*
- Total weed weights at the end of the season were significantly less in the mulch plots compared to conventional plots. However, average weed weights in each plot were not significantly different (Table 2). *Cowpea mulch reduced total weed pressure compared to conventional plots.*
- Pepper plants were significantly taller during the season in the mulch plots compared to plants in the conventional plots. At season's end, pepper plants in the mulch plots trended towards larger size compared to plants in the conventional plots (Table 3). *Cowpea mulch did not reduce crop growth during the season and tended to support the production of larger plants.*

Reference

1. Hutchinson, C. M. and M. E. McGiffen. Cowpea cover crop for weed control in desert bell pepper production. HortScience. (Accepted July 16, 1999, 17 manuscript pages; anticipated date of publication, December 1999).

KEEPING HERBICIDES OUT OF RUNOFF WATER

Timothy S. Prather, UC Kearney Agricultural Center

Research funding from California EPA's Department of Pesticide Regulation and Kings River Conservation District made this research possible.

Several herbicides have been found in runoff water and in groundwater. There are techniques available to reduce the risk of off-site movement of herbicides. These techniques include timing of herbicide application, reduced herbicide application rates, injection of herbicides through irrigation systems and shifting to reliance on postemergent herbicides rather than preemergent herbicides, return systems for irrigation water, cover cropping, and filter strip plantings. Using any of these practices should reduce the risk of off-site movement of herbicides.

Timing an application

Preemergent herbicides are applied to soil typically in November through February. The majority of intense storms occur during the period of time that most preemergent applications are made (Figure 1). Delaying herbicide applications in orchards susceptible to runoff reduces the chance of a large precipitation event after the application. Consideration should be given to early emerging weeds that may require the adding or increasing the rate of a postemergent herbicide.

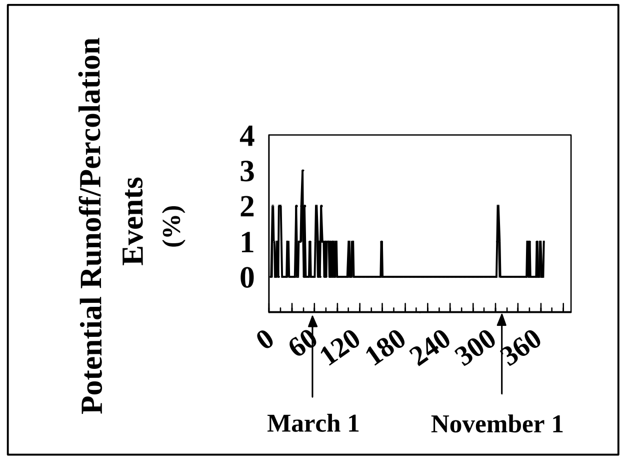

Figure 1. Potential runoff events were defined as 1 inch of precipitation within a 48 hour period. Runoff has been observed under these conditions. This criterion is not all-inclusive; runoff may occur with less precipitation when soils are saturated or in higher clay content soils. Sandy soil textures are less likely to have runoff for the criterion presented here.

Reducing preemergent herbicide rate

Many weeds do not require the full rate of preemergent herbicide to control them. Reducing rates 25 to 50% is often possible while achieving acceptable control. Reduced rates are particularly effective when the application timing is delayed. Most herbicides have a short half-life, often from 30 to 50 days. Delaying the application and using a lower rate often is equivalent to an earlier application at a higher rate since some of the original herbicide has dissipated (Figure 2).

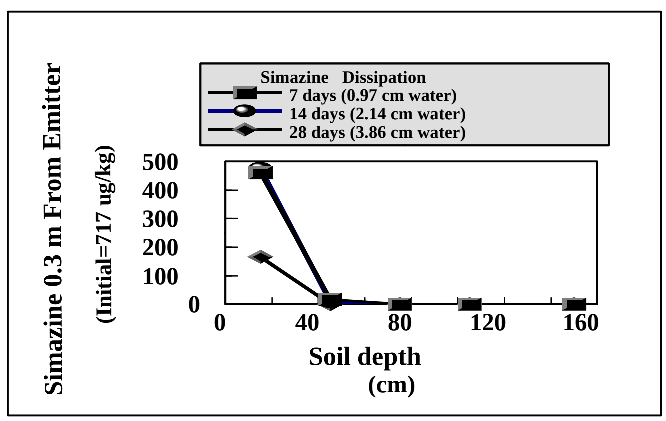

Figure 2. Simazine, the active ingredient in Princep®, dissipates fairly quickly.

Injection of Herbicides in Irrigation Water

Some herbicides can be applied through the irrigation system. Treflan® has been used through irrigation systems, as has Surflan®. Of course, all conditions on the herbicide labels must be met to ensure there is no possibility of moving herbicide into groundwater if a pump failure were to occur. Injection of herbicides allows for flexibility of timing since access to the entire field by sprayers is not required. An understanding of the half-life of the injected herbicide can also be helpful to develop a split application that may extend the duration of control. Using irrigation water to deliver the herbicide has another benefit, in that reliable rainfall for incorporation of the herbicide is not needed.

Reliance on Postemergent Control

Many farmers are increasing reliance on postemergent herbicides. Weed control can be very effective using postemergent herbicides, but timing is critical to apply the herbicide to a susceptible stage of the weeds. Access to the orchard is critical to success of a postemergent program. Access can be increased when a cover crop is encouraged to grow through the winter and spring, because cover crops provide a stable and drier base to operate equipment. A weed sprayer from California made by Patchen Selective Spray Systems can reduce the amount of postemergent herbicides applied by 40 to 80%, depending on the size and density of the weeds. Relying on postemergent herbicides avoids the problem of preemergent herbicides running off the orchard. Often, relying on postemergent application until late winter, followed by a preemergent application in late winter reduces the risk of runoff and provides effective control of weeds farther into the growing season.

Cover Crops and Filter Strips

Surface water runoff can be dramatically reduced when cover crops are used in the orchard. Cover crops increase channels into the soil, reduce compaction and increase soil aggregation. In addition, the cover crop may be active during the winter, drawing water from the soil due to transpiration. There is a greater chance of the soil being unsaturated during rainfall when a cover crop is present. On a hill-side citrus orchard on a higher clay content soil, the amount of surface water moving off the field was reduced by more than 70% (Figure 3).

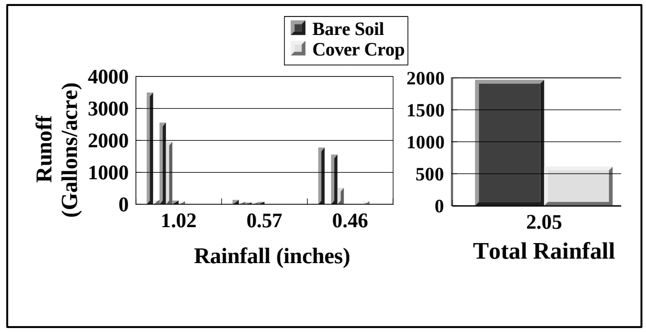

Figure 3. Surface water runoff from a bare soil and a recently emerged annual cover crop from the second year of cover cropping.

Herbicides remain on-site if water does not leave the site. Cover crops allow greater infiltration and reduce the risk of off-site movement. Filter strips can serve a similar purpose, especially when there is little slope to the orchard. The filter strips increase infiltration and also decrease the energy of water flowing through them, allowing soil particles to settle out of the water solution. Herbicides that are moderately adsorbed to soil can also be trapped in this way. Unfortunately, simazine (Princep®) is not well-adsorbed to soil, and only about 10% of the simazine in runoff water may be associated with soil particles. Perennial grasses make excellent filter strips and can be used on road ways and orchard edges. They also reduce dust during the growing season. For best results, at least 5% of the water run should be covered with a filter strip. This may be accomplished with a combination of annual cover crop in the orchard and a perennial cover crop at the orchard edge.

EFFECT OF CULTURAL PRACTICES AND FUNGICIDE TREATMENT ON ALTERNARIA LEAF SPOT, A NEW DISEASE OF ALMOND TREES CAUSED BY *ALTERNARIA ALTERNATA.*

Beth L. Teviotdale, UC Kearney Agricultural Center; Mario Viveros, UCCE Kern County; and Thomas Turini, UCCE Imperial County

Introduction

A defoliating disease of almond trees, Alternaria leaf spot, has become a serious problem in the southern San Joaquin Valley almond-growing region of California. Infections appear in late spring or early summer and consist of tan lesions that vary in size from 5 to 15 mm in diameter. The tan spots are soon covered with the black sporulation of *Alternaria alternata* (Fr.:Fr.)

Keissl. Lesions typically occur on the leaf margin or tip but may appear anywhere on the blade. Infections have not been observed on petioles, shoots, flowers, or fruit. When severe, trees are completely defoliated by early summer and continue to lose leaves for several months. Such trees are weakened and fail to set fruit. Losses up to 40% have been estimated.

Little is known about Alternaria leaf spot. The disease is associated with areas of high relative humidity, frequent dew events, and poor air drainage. Control measures are unknown, but alteration of certain cultural practices aimed at making the environment less favorable to the disease seemed a reasonable approach. In addition, fungicide programs coupled with appropriate cultural practices may be more effective than either alone. We tested the effects of weed control, pruning, improved water penetration, and fungicide treatment on disease control. Population levels on leaves were monitored, and companion field and greenhouse inoculations were conducted.

The Experiments

Three cultural practices were altered in attempts to reduce humidity and thus reduce disease. In 1996, natural vegetation on the orchard floor was eliminated during the growing season by repeated applications of glyphosate. Large branches were removed from trees in winter and vigorous shoots in spring of 1997 to open up tree canopies and allow better air circulation. The following year, 1998, gypsum (2.7 Mg/ha) was applied to the soil to hasten water penetration and the drying of the soil surface. Each of these altered cultural practices was compared to the standard practice (non treated control), and the two treatments were replicated six times. Each plot was eight rows wide and 33 trees long. Fungicide efficacy and timing were tested in sub-plots located in the central row of cv. Butte trees in the cultural practices experiment, and non registered materials were tested in nearby trees.

Fungicides were applied by hand-gun sprayer to single tree replications, and treatments in all experiments were arranged in a randomized complete block design. Disease incidence was evaluated on 100 leaves from each tree before harvest and the percent defoliation of trees was estimated after harvest.

Pathogen population development and disease progress were monitored at 21-28 day intervals from April through early August, 1997 and 1998. One hundred leaves collected from sub plot control trees were washed, aliquots of the wash water incubated on dichloran-chloramphenicol-peptone agar plates, and the numbers of *A. alternata* colonies counted. On a similar schedule, leaves on cv. Butte trees in the field and on detached shoots in the greenhouse were inoculated.

Results

Weed control and gypsum application significantly reduced the percent defoliation, but pruning did not diminish the damage caused by Alternaria leaf spot (Fig. 1). Among registered fungicides tested, iprodione and ziram were most effective, maneb was slightly effective, and captan and myclobutanil were ineffective (Fig. 2). The strobilurin fungicides gave control similar to that of iprodione + ziram and were the most effective among the non registered materials (Fig 3). Early timings were generally more effective than later treatments and three or four treatments were superior to two (Fig. 4 and 5).

Pathogen conidia were present on leaf surfaces in early spring before lesions were found on leaves and both conidial and lesion numbers increased through the season. The percent infected leaves in inoculation experiments also increased through the season.

Discussion

Even though defoliation was significantly reduced, in a statistical sense, by some of our treatments, cultural practices, fungicide application or a combination of both did not accomplish truly satisfactory control of Alternaria leaf spot. The relatively simple and inexpensive cultural methods we employed were insufficient to protect almond trees from this disease. Underground drip systems appear to have reduced disease incidence in some orchards, but these systems are costly to install and produce other management problems.

Fungicides offer some defense but even the most effective do not control the disease as well as growers would like. Iprodione may not be used in California later than 5 wks after petal fall which is too early for Alternaria leaf spot treatments. Azoxystrobin, though effective, requires multiple applications. As there is no candidate fungicide to alternate with azoxytrobin in a resistance management program, repeated application of azoxystrobin raises the specter of resistance developing in this or other pathogen populations.

Alternaria leaf spot apparently does not develop readily early in the season. This was seen in the low percentages of infected leaves in both naturally infected and inoculated leaves. Leaves are younger and temperatures are lower in spring than summer. These and other factors probably affect infection and disease development. A better understanding of the environmental factors governing this disease is needed.

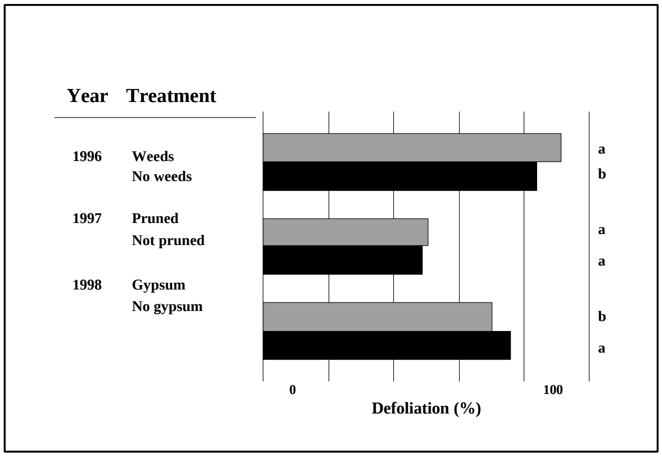

Fig. 1. Effect of cultural practices on control of Alternaria leaf spot.

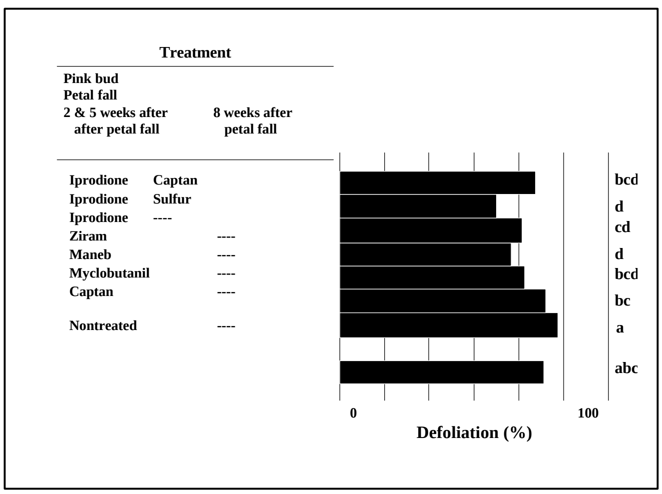

Fig. 2. Efficacy of registered (on almond) fungicides for control of Alternaria leaf spot, 1996.

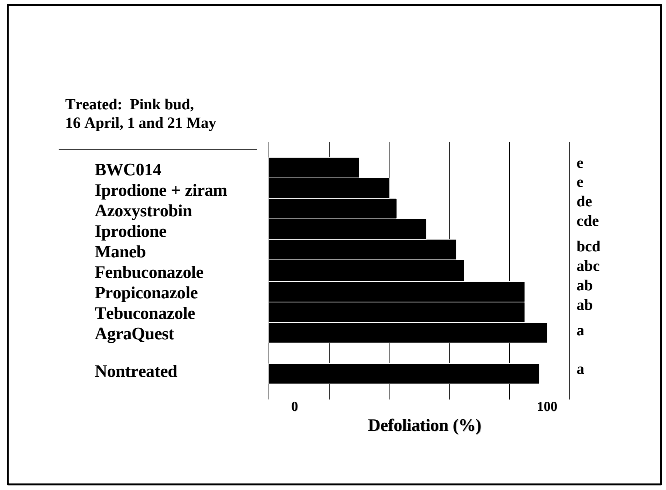

Fig. 3. Efficacy of non registered (on almond) fungicides for control of Alternaria leaf spot, 1997.

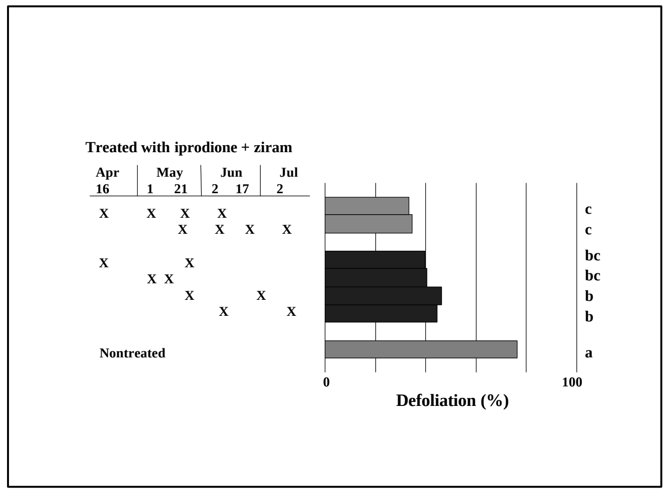

Fig. 4. Timing of fungicide sprays to control Alternaria leaf spot on cv Butte almond trees, 1997.

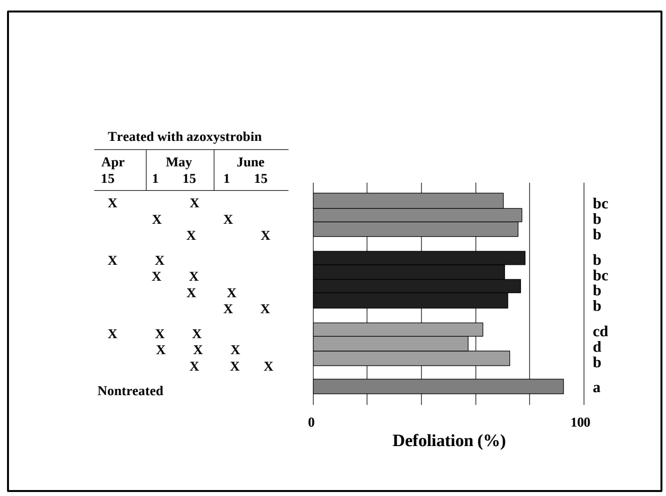

Fig. 5. Timing of fungicide sprays to control Alternaria leaf spot on cv Butte almond trees, 1998.

PESTICIDE DISRUPTION OF VEDALIA BEETLE RESULTS IN COTTONY CUSHION SCALE OUTBREAKS

Elizabeth E. Grafton-Cardwell, UC Kearney Agricultural Center

Cottony cushion scale, *Icerya purchasi*, became a very serious problem in a number of citrus orchards in the San Joaquin Valley during the 1998 and 1999 field seasons. One of the reasons for high cottony cushion scale densities was the extra moisture and cooler than normal temperatures during spring and early summer that provided perfect conditions for scale growth and development. A more significant reason is that vedalia beetle, *Rodolia cardinalis*, is very sensitive to some of the insecticides that have been recently registered to control citrus thrips, *Scirtothrips citri*, and California red scale, *Aonidiella aurantii*.

My research group collected foliage from trees sprayed with various citrus thrips treatments and found that the pyrethroid, Baythroid® (cyfluthrin) is very toxic to vedalia beetles. It kills the beetles and prevents them from laying eggs for 3-4 weeks during the spring period when vedalia are needed for cottony cushion scale control. In contrast, soft insecticides used for citrus thrips control such as Veratran®, Agri-Mek®, and Success® do not seem to have any noticeable effect on vedalia beetles. Growers with cottony cushion scale in their orchards should avoid spraying Baythroid®.

Our bioassays found that the vedalia beetle is extremely sensitive to the insect growth regulators (IGR), Esteem® (=Knack®, pyriproxifen) and Applaud® (buprofezin), which are applied for California red scale control. During 1998 and 1999, citrus growers in Fresno, Tulare, and Kern counties obtained a section 18 use of these two insecticides. Applaud® is a chitin synthesis inhibitor and Esteem® is a juvenile hormone mimic. In California red scale, they prevent the insect from molting from one stage to the next. In vedalia beetles, they prevent vedalia from pupating normally and emerging as an adult. Esteem® also prevents the adults from laying fertile eggs. A sign that the insect growth regulators are killing vedalia is the presence of dead vedalia pupae. Pest control advisors saw large numbers of dead vedalia pupae in San Joaquin Valley citrus during the summers of 1998 and 1999 and have been experiencing difficulty controlling cottony cushion scale since they began using insect growth regulators in the summer of 1998. Admire® or Provado® (imidacloprid) is another insecticide nearing registration for California red scale control, and it is also toxic to vedalia beetles.

Applications of Esteem® or Applaud® will control cottony cushion scale populations, but these insecticides act very slowly because cottony cushion scale molts infrequently. Interestingly, the orchards that are experiencing the worst cottony cushion problems are not the orchards that were sprayed with these insecticides, but the nearby orchards. This is because the spray drift from the IGR-treated orchard or the movement of the beetles between treated and untreated blocks stops egg laying and pupation of the vedalia beetles but does not affect the cottony cushion scale. The residues of these insecticides are long lasting (4-6 months). Esteem® seems to be more toxic to the beetles and its effects last longer than Applaud®. Sprays of IGRs for California red scale control were applied during June-September. Live vedalia beetles could not be found in the San Joaquin Valley in citrus during the summer and fall of 1998 and they did not return to citrus until April-May of 1999. In 1999, the numbers of vedalia were very low during July and August throughout Fresno, Tulare, and Kern counties, but we began to find small numbers of vedalia in a few orchards in late September. We hope that these vedalia will increase sufficiently to control cottony cushion scale this fall or early next spring.

The vedalia beetle is the best method of controlling cottony cushion scale. Vedalia are very fast growing, they can complete 3-4 generations in the time it takes cottony cushion scale to complete one generation. They consume huge numbers of cottony cushion scale eggs and nymphs in a very short amount of time. When vedalia beetles arrive in an orchard they can clean up a severe problem in 3-4 weeks. Insecticides such as malathion or Supracide® (methidathion) are used with oil for cottony cushion scale control. However, these insecticides are often not as effective as the vedalia beetle and are very toxic to natural enemies such as *Aphytis* needed for California red scale control. As stated earlier, Esteem® and Applaud® will kill cottony cushion scale, but they work very slowly and the drift can cause the cottony cushion scale in the neighboring blocks to blow up. The orchards that are having the worst problems are those in which *Aphytis* wasps are being released and broad spectrum pesticides have been avoided for several years. Without vedalia beetle control, cottony cushion scale populations grow very fast and require organophosphate insecticides for control. These growers are forced to spray for cottony cushion scale with the very pesticides they have successfully avoided using for California red scale. Their *Aphytis* wasps and other natural enemies are severely reduced by malathion and Supracide® and so they may experience California red scale outbreaks.

This is not the first time that vedalia beetle has been disrupted and cottony cushion scale outbreaks have occurred. Ebling (1951) wrote in Subtropical Fruit Pests…"the cottony-cushion scale has been revived as a pest of citrus in California, particularly in the central valleys, by the extensive use of insecticides that have resulted in the reduction of the vedalia beetle population. Since the majority of these insecticides do not control cottony cushion scale, their use results in a rapid increase in the numbers of this pest." The major concern, especially with Esteem®, is that the residues last for many months and the effects on vedalia beetle are far-reaching. Pest Control Advisors observed dead vedalia pupae in orchards that were several miles from IGR sprays. In addition, both Esteem® and Applaud® are registered for whitefly control in cotton and will soon get registration as a dormant application in stone fruits for San Jose scale control. Thus, even if we were to limit the use of these pesticides in citrus, use in neighboring crops is likely to have a devastating effect on vedalia beetle in citrus.

To better understand how to integrate these insecticides into the citrus IPM program, I am currently conducting research to determine how long the insect growth regulator residues harm various vedalia beetle stages. I may be able to find a narrow time window for IGR use that does not disrupt vedalia beetle or growers may need to stop using one or both of them altogether. In addition, I am evaluating whether or not we can mass-rear vedalia beetles and successfully control cottony cushion scale through fall or spring releases. The beetles naturally disperse from citrus when the have eaten all of the cottony cushion scale. The IGRs eliminated vedalia from some orchards before they finished cleaning up the cottony cushion scale. Through releases of vedalia, we hope to speed up the process of nature's re-inoculation of orchards with beetles.

ABSTRACTS

XIVth International Plant Protection Congress (IPPC), Jerusalem, July 25-30, 1999

<u>Soil Solarization In Various Agricultural Practices</u>
James J. Stapleton, UC Kearney Agricultural Center

Soil solarization is a natural, hydrothermal process of disinfesting soil of plant pests that is accomplished through passive solar heating. Solarization occurs through a combination of physical, chemical, and biological effects, and can be an effective soil disinfestant in numerous geographic areas for certain agricultural and horticultural applications. Commercially, it is used on a relatively small scale worldwide as a substitute for synthetic chemical toxicants, but its use is expected to increase as methyl bromide, the major chemical fumigant, is phased out due to its ozone-depleting properties. Solarization currently is an important and widespread practice for home gardeners. Commercially, the principal use of solarization on a treated area basis is probably in conjunction with greenhouse grown crops. Greenhouse solarization is now being commonly used in many Mediterranean, Near-Eastern, and East Asian locations. Another application for which solarization has come into common use is for disinfestation of seedbeds, containerized planting media, and cold-frames. As with use in greenhouses, these are ideal niches for solarization, since individual areas to be treated are small, soil temperature can be greatly increased, the cost of application is low, the value of the plants produced is high, and the production of disease-free planting stock is critical for producing healthy crops. Around the world, solarization for disinfesting soil in open fields is being implemented at a relatively slow but increasing rate. It has been mainly used on a commercial basis in areas where air temperatures are very high during the summer and much of the cropland is rotated out of production due to excessive heat. Soil solarization is compatible with other disinfestation methods, including organic amendments, biological control organisms, and pesticides.

<u>Adoption of Soil Solarization in the USA</u>
James J. Stapleton, UC Kearney Agricultural Center

Soil solarization, as any other soil disinfestation method, has both benefits and drawbacks. While it is simple, safe, effective within its use limitations, and can be readily combined with biological and chemical control measures, solarization is dependent upon high air temperatures, is most effective near the soil surface, does not consistently control certain heat-tolerant pests, should be done during the hottest part of the year (possibly interfering with planting schedules), and requires disposal of plastic film. Its routine use as a viable alternative to chemical fumigants in several areas of the world indicates that solarization has already achieved limited user acceptance. In the USA, solarization for disinfesting soil in open fields is being implemented at a relatively slow but increasing rate. Most growers in California who are now using solarization in production fields are those that have some aversion to the use of methyl bromide or other chemical soil disinfestants, either because of their close proximity to urban or residential areas, personal preference, or because they are growing for organic markets. Implementation of production field solarizaiton in other areas with suitable, but more tropical climates, such as Florida, appears to be progressing at a similar rate. In addition to commercial use, the importance of solarization in home gardening is widely recognized. Although most of these users do not use chemical soil disinfestants under any circumstances, solarization has been widely embraced and mainstreamed by gardeners, and contributes to improved plant health and production in these settings. Computerized models for predicting treatment duration and efficacy probably would aid the adoption of solarization, but they have not been successfully implemented as agricultural production tools. Nevertheless, because of the potential utility of such predictive models, they continue to be a focus of development. Situations are presented where it may be desirable to increase the efficacy and/or predictability of solarization through combination with other methods of soil disinfestation. Since solarization is a passive process with biocidal activity dependent to a great extent upon local climate and weather, there are occasions when even during optimal periods of the year, inclement weather or other factors may not permit effective soil treatment. In these cases, integration of solarization with other disinfestation methods may be essential in order to increase treatment efficacy and predictability. As methyl bromide is phased out, many current users will turn to other pesticides for soil disinfestation. Combining these pesticides with solarization may prove to be the most popular option for users who wish to continue using chemical soil disinfestants.

Management of Silverleaf Whitefly, *Bemisia argentifolii*, melon aphid, *Aphis gossypii*, and virus diseases in vegetables using reflective plastic mulches

C. G. Summers and J. J. Stapleton, UC Kearney Agricultural Center

Silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring, and melon aphid, *Aphis gossypii* Glover, are pests of vegetables in the San Joaquin Valley of California. Melon aphid attacks cucurbits, while silverleaf whitefly impacts cucurbit, solanaceous, and cruciferous crops. Melon aphid also transmits several viruses which often cause complete crop failure in cucurbits. Insecticides are ineffective, particularly for control of the aphid-borne viruses. We found that metalized and silver-embossed plastic mulches were effective in both reducing and delaying colonization and buildup of whiteflies and aphids, and reducing and delaying the incidence of aphid-borne viruses. In our experiments, plants were grown on raised beds over which the mulches had been placed and secured with soil. Plots consisted of three planting beds, 7.5-m long, with each mulch replicated six times in a randomized block design. The width of individual planting beds varied depending on the crop grown. Metalized reflective mulch was also evaluated in 2 ha grower fields of cucumber, pumpkin, and zucchini squash. Adult whiteflies and alate aphid populations were determined by counting the number of individuals on the newest fully expanded leaf on each plant in the center plot row. Density of immatures was determined by returning a leaf from each plant to the laboratory and counting the number of individuals present. Fruit was harvested from the center row of each plot, weighed, and graded. Data were evaluated by ANOVA and Fisher's LSD. In cantaloupe and cucumbers, reflective mulches reduced alighting by alate aphids and delayed the incidence of aphid-borne viruses by six weeks. Aphid and whitefly numbers and the incidence virus infected plants were lower and yields higher in plants grown over reflective mulches. Yields from mulched plots were 200 to 300% higher than those from unmulched plots. In grower trials, aphid and whitefly numbers and the incidence of squash silverleaf were significantly lower and yields significantly higher in cucumber, pumpkin, and squash grown over metalized reflective mulches. In sweet corn, metalized mulches repelled the corn stunt leafhopper, *Dalbulus maidis* (DeLong and Wolcott), resulting in a significant reduction in the incidence of corn stunt disease, caused by *Spiroplasma* sp., and produced significantly higher yields.