



PLANT PROTECTION QUARTERLY

January/April 1993

Volume 3, Numbers 1 & 2

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 in the South Central Region. 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.

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IN THIS ISSUE:

ABSTRACTS OF PRESENTATIONS

FIRST ANNUAL KEARNEY PLANT PROTECTION GROUP
PEST MANAGEMENT CONFERENCE
MARCH 10-11, 1993

ABSTRACTS

THE LEAFMINER SPECIES COMPLEX AND THE POTENTIAL FOR ITS BIOLOGICAL CONTROL IN VEGETABLE CROPS IN THE SALINAS VALLEY

William E. Chaney, University of California Cooperative Extension, Monterey County

Leafminers are a persistent and serious pest of several vegetable crops grown in coastal California. The major crops affected are lettuce, celery, spinach and to a lesser degree, peppers, tomatoes, cole crops and other leafy vegetables. In California there are three species involved, all in the genus *Liriomyza*: *trifolii*, *sativae* and *huidobrensis*. These species are somewhat

geographically isolated, with *sativae* having been considered the predominant species from the central coast. This work shows that *L. huidobrensis* now completely dominates the pest situation in this area.

Successful biological control of leafminers has been achieved in greenhouses using a parasite, *Diglyphus begini*. Trials were undertaken in celery in Salinas to see if this approach had any potential in field situations.

Weekly releases of this parasite were made in two celery fields in Salinas in 1992 and the impact on leafminer populations were compared to untreated and normal grower practices in the same fields. The parasite was able to suppress the leafminer populations in the spring during lower pest population pressures, but were less effective under heavier fall pressures.

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

THE EFFECT OF REFLECTIVE MULCHES ON APHID POPULATION DENSITIES AND VEGETATIVE GROWTH OF BELL PEPPER

Tom Turini, Jim Stapleton, Charlie Summers, and Roger Duncan, U. C. Kearney Agricultural Center

Several white and silver polyethylene, and styrene butadiene spray mulches were evaluated for their effect on aphid populations and vegetative growth of fall planted bell peppers in the San Joaquin Valley. The two silver polyethylene films, and the silver spray mulch treatment had the lowest alate aphid numbers. However, the lowest apterous aphid numbers were observed on plants mulched with one of the polyethylene mulches and the white polyethylene mulch treatment. Significantly higher plant weights were associated with one of the silver polyethylene mulches and the silver spray mulch. The results indicate that reflective polyethylene films and spray mulches have potential utility in pepper production in the San Joaquin Valley.

APPLE LEAFHOPPER STUDIES IN ALMONDS

Richard Coviello and Mark Freeman, University of California Cooperative Extension, Fresno County

Apple leafhopper (ALH), *Empoasca maligna*, has become a serious problem in almond orchards in the central San Joaquin Valley. It feeds on foliage and causes damage from slight leaf necrosis to near defoliation of the tree. Observations indicate that varieties with Mission parentage are the most susceptible with Ruby being the most severely affected. In 1992, a pilot project was undertaken to evaluate sampling procedures, phenology and bionomics of the pest and variety influences.

We attempted to obtain data regarding yield and quality loss from early generations in an orchard near Kearney Park. Twelve rows were left unsprayed while the rest of the orchard was sprayed with diazinon. However, no leafhoppers were left in the untreated section either. This corroborates grower reports on diazinon's effectiveness. Sampling of adults with suction machines was done in the almond variety block at Fresno State College. Both the Dietrich D-Vac machine and the Echo-vac machine successfully collected adults. The highest number of adults were collected from the Ruby variety, the lowest was from Nonpareils. An orchard near Clovis was sampled for adults once per week using the Echo-vac after damage was already

noted. Differences in the adult population between varieties in this location appeared to be due to the amount of foliage rather than any inherent attractiveness of one variety over another. An orchard near Selma, with obvious early season damage, was sampled for adults in June using Sentry apple maggot traps. Very few ALH were caught on the traps although high numbers of other species of leafhoppers were caught. Few adults and no nymphs were found when searching the leaves. However, large numbers of *Anagrus epos*, a leafhopper parasite, were observed on the traps, especially near the center of the orchard.

We hope to establish replicated plots this year to evaluate the phenology, damage levels and parasitism of ALH.

MONITORING AZINPHOSMETHYL RESISTANCE IN ORIENTAL FRUIT MOTH IN PEACHES

William W. Barnett, Statewide IPM Project, U.C. Kearney Agricultural Center

Preliminary tests indicate a diagnostic dose of 100 micrograms azinphosmethyl per gram of adhesive in pheromone traps kills over 98% of a susceptible population of male OFM moths. Survey data in 1990 indicates OFM resistance was limited to the Lomo area north of Yuba City in Sutter County and across the Feather River in Yuba County. The lone Butte County sample exhibited marginal resistance. Data collected in three Butte County orchards in 1991 indicate probable resistance in all three orchards. Sixteen orchards from Kern to Butte county were surveyed in 1992. All three Butte County orchards surveyed appeared to be resistant or are becoming resistant but two Sutter County orchards located south of Yuba City still seem to be susceptible. Three orchards in Stanislaus County were bioassayed in 1992 with two indicating resistance. This is the first time resistance has been detected in the San Joaquin Valley. All orchards south of Modesto still seem to be susceptible.

MANAGING PEACH TWIG BORER WITH *BACILLUS THURINGIENSIS*

William W. Barnett, Statewide IPM Project, U.C. Kearney Agricultural Center

Demonstration plots have been conducted in over 25 prune, peach and almond orchards located in the

Sacramento and San Joaquin Valleys during the past two seasons. Generally, plots consisted of a check plot which received dormant oil only and a Bt plot which received dormant oil plus Bt applied two times during bloom at the rate of 1 lb. per acre. The remainder of the orchard was treated with the grower's normal dormant treatment. Each orchard was visited weekly and observations on fruit phenology and insects were recorded as they occurred. Harvest data were collected in all blocks. PTB control was comparable to standard dormant treatments in all Bt treatments. In late harvested cling peaches, in 1992, neither the Bt nor standard treatments provided season long control. No differences in Bt formulations have been observed. Fruit samples indicate San Jose scale infestations were consistently higher in Bt and check plots than in standard treated blocks in prunes. No significant scale populations have been encountered in other species. Bt was more effective in controlling early season worm pests such as green fruitworm and spring cankerworm in 1992.

PACIFIC MITE (*TETRANYCHUS PACIFICUS*) ON ALMOND

Walter J. Bentley and Jason Kosaroff, University of California Cooperative Extension, Kern County

Monitoring the spring movement of Pacific spider mite from the orchard floor and onto mature almond trees was continued at two locations in Kern County in 1992.

This was the third year at the Bidart orchard which is clean cultivated, drip irrigated, and planted on a 1-1-1 configuration of Nonpareil, Carmel, and Sonora varieties. The Weins orchard has been monitored for two years and is barley/vetch cover cropped, flood irrigated, and on a 1-1 configuration of Nonpareil and Carmel.

Soil samples collected from beneath almond trees were placed in paper cups and the cups placed on Trece® tent traps to collect migrating mites. Peak movement occurred on February 3 and 11 at the Bidart orchard and February 14 at the Weins orchard.

Six replicated treatments of trunk banding were made on February 3 at the Bidart orchard and February 5 the Weins orchard. Ten leaves were selected from each of three heights (3 ft. interior, 6 ft. interior, and 5 ft. periphery) at weekly intervals through August and counted for mites.

At the Bidart orchard, the highest mite populations occurred on the nonbanded trees at all heights. At the 3 ft. and 5 ft. height, the trunk banded treatment had the lowest mite populations. At 8 ft., the scaffold banding resulted in the lowest number of mites. We were unable to separate the effects of banding and prey population on the western predator mite.

At the Weins orchard, the highest mite populations occurred on the nonbanded trees at all heights. At the 6 ft and 8 ft. heights, the scaffold banding resulted in the lowest spider mite populations. The effect on the western predator mite was unclear due to the direct relationship between predator and prey populations.

GROWTH RESPONSE OF TWO PATHOGENS ON FIGS AND A BIOCONTROL AGENT TO DIFFERENT OSMOTIC POTENTIAL x TEMPERATURE COMBINATIONS

K. V. Subbarao and T. J. Michailides, University of California, Davis/U.C. Kearney Agricultural Center, Parlier and U.C. Agricultural Research Station, Salinas

Growth and sporulation of *Aspergillus niger* and *Fusarium moniliforme*, causing smut and endosepsis in figs, respectively, were evaluated at ten osmotic potentials (OP) in the range of -0.46 to -4.46 MPa in combination with different temperatures (15-35 C).

Paecilomyces lilacinus, that naturally occurs in the cavities of figs and has shown a potential for biocontrol of the above diseases was also evaluated. The growth of all three fungi was affected more by the temperature than by OP. At optimal temperatures, decreasing OP had the least effect on the growth of *A. niger* (30 and 35 C) and most effect on *P. lilacinus* (25 and 30 C). The growth of *F. moniliforme* was reduced significantly by 35 C at high OP (>-3.12 MPa), and by 15 C at low OP.

Based on their ability to grow in hot, dry environments, the fungi rank as *A. niger*>*F. moniliforme*>*P. lilacinus*.

Regardless of the OP, low temperatures (15 and 20 C) limited the growth of *A. niger*. Regardless of the temperatures, decreasing OP limited the growth of *P. lilacinus*, and thus, among the three fungi tested, it has the least ability to utilize water from the environment.

For *P. lilacinus* to be effective as a biocontrol agent, adequate moisture is required. Experiments were also conducted in the field to study the optimal time for spraying the biocontrol agent. Spraying a spore suspension of *P. lilacinus* on caprifigs suppressed incidence of endosepsis in fruits by 50% compared with

unsprayed trees, and on Calimyrna fig trees, there were no significant differences between sprayed and unsprayed trees. During the caprifig growing season, temperatures did not exceed 30 C, and there were frequent rains to provide optimal conditions for *P. lilacinus*.

THE INFLUENCE OF FRUIT CLUSTERING ON THE DEVELOPMENT OF BROWN ROT AND EPICUTICULAR WAX IN FRENCH PRUNE

Themis J. Michailides, Dept. of Plant Pathology, University of California Davis/U.C. Kearney Agricultural Center

Prune (*Prunus domestica*) flowers are formed in buds which usually contain two (up to four) flowers and no leaves, resulting in fruit clusters with fruits touching other fruits. Twice as many fruits were infected when inoculated with a drop of 1.2×10^5 spores/ml of *Monilinia fructicola* placed on surfaces where fruits contact than on non-contact surfaces. Microscopic examination of contact surfaces, after staining with methylene blue, revealed that they had minute cracks and less epicuticular wax than non-contact surfaces. Removing the epicuticular wax with chloroform from non-contact surfaces of mature fruits and inoculating with *M. fructicola* resulted in significantly larger lesions than in untreated fruits. Inoculation of single fruits with *M. fructicola* resulted in only 10-13% fruit infection while 57-69% of fruits placed in clusters of five were infected 3 days after inoculation. Persistence of free water was greater with clustered fruits (97% wet) than with single fruits (12% wet) 3 hours after spraying them with deionized water. Changes in the histological features of contact surfaces and longer retention of water explain why clustered fruits are more susceptible to infection by *M. fructicola*. Similar phenomena are being studied with other stone fruits and figs.

INFECTION OF KIWIFRUIT BY *BOTRYTIS CINEREA* AND ITS CONTROL BY SEPAL REMOVAL AND ONE OR TWO VINCLOZOLIN SPRAYS

David P. Morgan and Themis J. Michailides, Dept. of Plant Pathology, University of California Davis/U.C. Kearney Agricultural Center

In 1992 we studied sanitation approaches to reduce Botrytis stem-end decay in kiwifruit. In addition, we compared the effectiveness of one spray with

vinclozolin (Ronilan 50DF) at full bloom or at preharvest with two sprays (bloom + preharvest) for reducing disease. In both years 1991 and 1992, vinclozolin reduced Botrytis stem-end rot but in 1992 the disease reduction was not statistically significant. Therefore, it was not possible to compare the effectiveness of one versus two vinclozolin sprays. Removing the sepals from developing fruit during the season and the flowers from male vines tended to result in lower disease levels. In contrast, kiwifruits whose sepals were removed by snails had significantly more decay, suggesting that somehow snails can injure and inoculate fruits with *Botrytis cinerea*. Among the postharvest treatments tested, a sulfur dioxide (SO₂) dip was equivalent to vinclozolin postharvest treatment in reducing the levels and the severity of Botrytis stem-end decay. Iprodione (Rovral 50WP) also reduced Botrytis stem-end decay, but not as much as vinclozolin.

EFFECT OF NITROGEN FERTILIZATION ON THE BLOSSOM BLIGHT AND OVERWINTERING PHASES OF BROWN ROT ON FANTASIA NECTARINE

Hugo T. Ramirez and Themis J. Michailides, Dept. of Plant Pathology, University of California, Davis/U.C. Kearney Agricultural Center

Because previous studies have shown that high nitrogen (N) levels favored the susceptibility of nectarine fruits to brown rot (caused by *Monilinia fructicola*), we initiated a study to determine the effects of N fertilization on the susceptibility of blossoms to brown rot and on the overwintering phase of the disease. In 1992, spray inoculations with *M. fructicola* on Fantasia nectarine blossoms indicated significant trends toward increased stamen infection levels (18-65%) of blossoms with increasing N fertilization from 0 to 325 lbs/acre, respectively. Overall results of spray inoculations with *M. fructicola* on green fruits showed a linear relationship ($R^2=0.89$) between incidence of infected fruits at harvest and N fertilization. In addition, increased N fertilization resulted in greater number of fruits dropped, and of these fruits, 76% were infected with brown rot as opposed to 32% of the fruits from low nitrogen rates. Furthermore, fewer brown rot mummies (3.2/tree) were found hanging on the unfertilized trees as compared to 9.9/tree of the high (325 lb/acre) nitrogen rates. Understanding the mechanism and increasing fruit resistance to brown rot by balanced fertilization may lead to a more integrated control of brown rot in stone fruits.

RELATIONSHIP OF PESTICIDE APPLICATION AND ENERGY REDUCTION

J. E. Dibble and S. M. Haire, U. C. Kearney Agricultural Center

There has been a concern that energy consumption in agriculture could be reduced in certain areas. One such area is that energy used in making spray applications and another in the amount of spray material used. This work, funded in part by the California Energy Commission, was aimed at investigating and demonstrating energy savings in low vs. high volume spray applications in deciduous trees and vines. The study involved not only these two spray techniques and their relative costs, but also included the feasibility of less material used per acre, easier coverage possibilities according to tree design, spray coverage of only part of the tree, spraying every other row, opening the tree or vine through pruning, and electrostatic coverage evaluations.

The resultant data was based on comparisons of companion low vs. high volume spray applications on two pome, three stone fruit, and two nut crops. These comparisons were made using spray dyes, chemical residues and pest control evaluations. Chemical reductions when used were generally one quarter to one-third less in low volume. Cost relationships, even without material reduction, resulted in a plus for low volume and energy savings. In the area of spray coverage and control, both techniques are generally comparable but for a few exceptions.

A TACTIC FOR KILLING OLD TREE ROOTS: I. LOWER RATES AND DEEPER INJECTIONS OF METHYL BROMIDE

M.V. McKenry and T. Buzo, Department of Nematology, University of California, Riverside/U.C. Kearney Agricultural Center

Spot injections of methyl bromide (MB) applied at 0.45 kg/ha beneath old trees at 75 cm depth kills most of the old roots if soil has been well-dried. Depending on tree spacing, this treatment can be expected to reduce MB treatment rates by 1/4 to 1/3 and thereby reduce MB volatilization to the atmosphere. Broadcast treatments of MB at 224 kg/ha applied at 75 to 90 cm depth followed in 14 days by flipping of the surface 30 cm and re-treatment with 112 kg/ha MB at 45 cm depth has provided complete kill of old peach and plum roots.

Additionally, weed seed and nematode control in the surface 1.6 m of soil is comparable to that attained with conventional 448 kg/ha treatments at 45 cm depth. This latter treatment could reduce total volatilization of MB by half. Lower treatment rates need additional efficacy testing and monitoring for MB volatilization.

A TACTIC FOR KILLING OLD TREE ROOTS: II. FOLIAR APPLICATIONS OF GLYPHOSATE

M. V. McKenry, D. McDonald, and J. Kretsch, Department of Nematology, University of California, Riverside/U.C. Kearney Agricultural Center

A dual application, within a 24 hour period, of 1% glyphosate sprayed to foliage has resulted in 90 to 95% kill of fifteen-year-old peach and plum roots throughout the surface 1.6 m of soil. Treatments were made to Friar plum grafted onto Nemaguard, Lovell, Marianna 2624 or Myrobalan 29C, and root mortality evaluated 60 days later. No adjuvants were utilized. A foamy formulation of glyphosate may be helpful in limiting drift. Soil population levels of plant parasitic nematodes are not immediately reduced by this treatment but the protective habitat for endoparasitic nematodes is greatly reduced.

A TACTIC FOR KILLING OLD TREE ROOTS: III. METHYL ISOTHIOCYANATE LIBERATORS APPLIED VIA A SOIL DRENCHING DEVICE

M. V. McKenry and T. Buzo, Department of Nematology, University of California, Riverside/U.C. Kearney Agricultural Center

Application of methyl isothiocyanate liberators such as Vapam® or Soil Prep® at 2240 kg/ha formulated rate can completely kill old peach and plum roots in the surface 1.3 m of soil. At conventional treatment rates of half the above, the root kill is incomplete below 0.6 m depth. Strip treatments at the higher rate need field testing, especially where a dripper or mini sprinkler system is already in place just prior to tree or vine removal. In this field site, with a sandy subsurface layer beneath 0.9 m, nematode control was inadequately delivered into the sand layer. In other field sites nematode control to 1.5 m has been attained. In combination with other soil cleansing methods, such as rotation crops, one may be able to avoid replant problems, including those with a nematode component. The duration of an effective rotation period is unknown.

ASPERGILLUS MOLDS AND AFLATOXINS IN PISTACHIO ORCHARDS

Mark A. Doster and Themis J. Michailides, Dept. of Plant Pathology, Univ. of California, Davis/U.C. Kearney Agricultural Center

More than ten different species of *Aspergillus* have been isolated from pistachio nuts in California. Although *A. niger* is the most common mold, the greatest concern is for *A. flavus* and *A. parasiticus* because these molds produce aflatoxins (potent mycotoxins and carcinogens). Aflatoxin-contaminated nuts were found in six out of the nine pistachio orchards tested. *A. flavus* has been found in all pistachio orchards examined, although at low levels. Possible ways to reduce aflatoxin in pistachio nuts that have been investigated are 1) manage debris on the orchard floor (particularly male inflorescences) in order to decrease development of *A. flavus* in the debris; 2) alter cultural practices (such as type and amount of irrigation); 3) identify distinct physical characteristics of the nuts most likely to be contaminated with aflatoxin (so that these nuts may be separated from healthy nuts); and 4) use antagonistic microorganisms as biological control agents to inhibit the growth of *A. flavus*.

ESTABLISHMENT OF ORCHARDS WITH BLACK POLYETHYLENE FILM MULCHING: EFFECT ON NEMATODE AND FUNGAL PATHOGENS, WATER CONSERVATION, AND TREE GROWTH

Roger A. Duncan, James J. Stapleton, and Michael V. McKenry, Statewide IPM Project, University of California Kearney Agricultural Center

Placement of a 3-m-wide, black polyethylene film mulch down rows of peach (*Prunus persica* 'Red Haven' and 'Elberta' on Lovell rootstock) and almond (*Prunus dulcis* 'Nonpareil' and 'Butte' on Lovell) trees in the San Joaquin Valley allowed irrigation water conservation of 75%. Soil moisture was higher in mulched, drip irrigated trees despite the reduced rates of irrigation, although midday pressure bomb readings indicated slightly higher water stress levels. Mulching also resulted in higher soil temperatures in the surface 60 cm, a tendency toward greater root mass, elimination of weeds, and a greater abundance of root knot nematode (*Meloidogyne incognita*) second-stage juveniles in soil but reduced root galling when compared to nonmulched controls. Population levels of root lesion nematode (*Pratylenchus hexincisus*) were

reduced by mulching, as were those of citrus nematode (*Tylenchulus semipenetrans*), which survived on old grape roots remaining from a previously planted vineyard, and stubby root nematode (*Paratrichodorus minor*) which probably fed on roots of various weed species growing in the nonmulched soil. Trends toward lower *Pythium* spp. populations were not significant, probably due to the moderate soil heating level.

Due to warmer soil temperatures, mulched trees grew much faster during March-May, but slowed during the hot summer months, and resumed faster growth when temperatures declined in the fall. When planted in sandy loam soil infested with *M. incognita* and *Pythium* spp., mulched 'Red Haven' peach trees were taller, had larger diameter trunks, and greater pruning weights than nonmulched trees, but trunk diameters of 'Nonpareil' almond trees were reduced by the mulch treatment, with no significant difference in trees height or pruning weights. Second leaf almond trees with the mulch removed after the first year quickly caught up to nonmulched trees, while previously mulched peach trees continued to outgrow nonmulched trees. Mulching and/or preplant fumigation with methyl bromide generally resulted in smaller trunks and lower pruning weights of first-leaf 'Elberta' peach and 'Butte' almond trees planted in soil with low populations of nematode and fungal pathogens. Bloom was increased by mulching in both tree species after the first growing season, especially almond, presumably in response to higher root temperatures (stress) during the summer months. Leaf petiole analysis indicated that differences in concentrations of mineral nutrients due to mulching were inconsistent, except for a significant increase in Ca in both tree species.

BEHAVIORAL CONTROL OF ANTS ON CITRUS

Harry Shorey, Department of Entomology, University of California Davis/U.C. Kearney Agricultural Center

Research is continuing, directed toward finding the most effective ant repellents and methods for banding them around the trunks of citrus trees. Repellent chemicals were tested in laboratory bioassay and also in citrus groves, to compare activity as foraging disruptants. We have tested 52 chemicals against Argentine ants, 26 against native fire ants, and 26 against native gray ants. Against each of these ant species, the sesquiterpene alcohol, farnesol, has been found to be equal to or more powerful than any other tested chemical in providing

disruption. Laboratory and field bioassays have shown that nerolidol, an isomer of farnesol, is equal in activity to farnesol against Argentine ants. The terpene alcohol, methyl eugenol, is close to (within 1/10) the activity of farnesol against both Argentine ants and native gray ants. Substrates for banding repellents around trunks of citrus trees have emphasized the polybutene mixture, "Stickem." When soaked into cotton string and wrapped around trunks, 50:50 mixtures of Stickem:farnesol provided over three months of complete exclusion of Argentine ants and over 2 months exclusion of native gray ants. A band of wax paper over sticky tape is being tested for slow release of farnesol contained in the space between wax paper and tape. Disruption of foraging of Argentine ants is presently in its 16th week, in ongoing testing. Other promising means of banding tree trunks with farnesol are presently being investigated.

SMITH-LEVER CITRUS ARTHROPOD MONITORING PROGRAM

Ashley Eller and Beth Grafton-Cardwell, Dept. of Entomology, University of California, Riverside/U. C. Lindcove Field Station/U.C. Kearney Agricultural Center

The USDA Smith-Lever program provided funding to monitor the insect and mite populations in twelve San Joaquin Valley commercial citrus orchards during the 1992 field season. We monitored pests of citrus including the fruit tree leafroller, citrus cutworm, citrus red mite, California red scale, yellow scale and citricola scale. The beneficial organisms monitored included the predatory mite *Euseius tularensis* and the parasitic wasp *Aphytis melinus*. Each site was monitored on a weekly or bi-weekly basis and the population trends were recorded in a bi-monthly newsletter which was distributed to those interested in commercial citrus. We used these results of our local studies to educate the cooperating growers and pest control advisors about the integrated pest management options in citrus.

We were interested in observing the consequences of broad spectrum pesticide use compared with the consequences of selective pesticide use in this project. Six of the orchards monitored were on a broad spectrum pesticide program. These growers used organophosphate and carbamate insecticides such as Carzol, Cygon, Lorsban, Supracide and Sevin to control the pests. In the other six orchards, the growers used more selective pesticides such as the microbial

materials Dipel and Javelin, the botanical material Sabadilla and narrow range petroleum oils. We used our monitoring data to compare the results of the various pesticide practices in the San Joaquin Valley.

PESTICIDE EFFICACY RESEARCH IN CITRUS AT THE LINDCOVE FIELD STATION

Chris Reagan and Beth Grafton-Cardwell, Department of Entomology, University of California, Riverside/U.C. Lindcove Field Station/U.C. Kearney Agricultural Center

In the 1990's we continue to see pest resistance to pesticides, particularly in the organophosphate and carbamate categories. Research is underway to find effective pesticides that are more favorable to the natural enemies, as well as methods which help to improve and preserve the effectiveness of the existing pesticide tools we use to sustain our agricultural production.

During the 1992 citrus growing season, we conducted several experiments on navel oranges at the University of California Lindcove Field Station to determine the efficacy of experimental pesticides compared to the registered pesticides used in citrus. We monitored the effects of the broad spectrum pesticide chlorpyrifos, the selective pesticide cryolite and various formulations of registered and unregistered microbials (*Bacillus thuringiensis*) on the citrus cutworm. Scalicides applied for California red scale control were the broad spectrum insecticides chlorpyrifos and carbaryl, the selective insecticide petroleum oil and various experimental insecticides (NTN-33893, AC303,630 and buprofezin).

Natural enemies monitored were the parasitoid wasps, *Aphytis melinus* and *Comperiella bifasciata* and the predatory mite *Euseius tularensis*. In addition, we looked for phytotoxicity by monitoring the effects of these insecticides on leaf abscission.

AUGMENTATION OF THE PREDATORY MITE, *EUSEIUS TULARENSIS*, IN CITRUS

Yuling Ouyang and Beth Grafton-Cardwell, Department of Entomology, University of California, Riverside/U.C. Kearney Agricultural Center

The predatory mite, *Euseius tularensis*, is a native, generalist predator that feeds on leaf sap, pollen, citrus

red mites, citrus thrips and other small arthropods. It increases in citrus in spring as the new growth flush appears on the trees. Peak densities of the predatory mite coincide with emergence of citrus thrips on leaves and newly forming fruit. Thus, we know that *E. tularensis* is a factor helping to control citrus thrips. *E. tularensis* is common in San Joaquin Valley citrus, except where broad spectrum organophosphate and carbamate insecticides are applied for thrips, scale and orangeworm control. Often, when growers decide to shift from a broad spectrum pesticide program to a softer one utilizing microbials, botanicals and oils, the citrus thrips becomes a severe problem because natural enemies are rare. We are conducting experiments to determine if releases of the predatory mites, addition of pollen through covercrops, or pruning of citrus can help to augment natural populations of *E. tularensis*. In this way we hope to improve control of citrus thrips, a severe cosmetic pest of citrus fruit.

CURRENT PEST PROBLEMS IN SAN JOAQUIN VALLEY CITRUS

Beth Grafton-Cardwell, Department of Entomology, University of California, Riverside/U.C. Kearney Agricultural Center

The three major pest groups driving pesticide usage in San Joaquin Valley citrus are citrus thrips, armored scale (California red and yellow scale) and Lepidopteran pests (fruittree leafroller and citrus cutworm). Citrus thrips and armored scale are becoming increasingly difficult to control because of resistance to broad spectrum pesticides. Our laboratory has initiated projects to improve integrated management of these key pests as well as secondary pests such as citricola scale and katydid that emerge when growers shift to selective pesticides. To combat thrips, we are developing ways to promote the predatory mite, *E. tularensis*, through mass-rearing and releases, planting of pollen producing covercrops and tree pruning. To improve control of armored scale, we are monitoring for insecticide resistance, testing experimental pesticides and working with oil sprays and *Aphytis* wasp releases as an alternative to broad spectrum pesticides. For citrus cutworm, we are determining if we can use pheromone traps to collect male moths and so indicate the timing and severity of larval infestations. Finally, we are surveying arthropods in 12 citrus orchards on a weekly basis to observe how different IPM strategies affect pest densities, natural enemy densities and scarring and packout of fruit.

INSECTICIDE RESISTANCE AMONG ARMORED SCALE POPULATIONS IN SAN JOAQUIN VALLEY CITRUS

Stacy Vehrs & Beth Grafton-Cardwell, Department of Entomology, University of California, Riverside/U. C. Kearney Agricultural Center

Citrus fruits infested with California red scale and yellow scale insects (Homoptera: Diaspididae) were collected from 70 sites throughout 4 counties in the San Joaquin Valley of California over three seasons for the purpose of testing the insects for insecticide resistance. The insecticides tested were Lorsban 4E (at 10 and 100 ppm), Supracide 2E (at 31.6 and 100 ppm), and Sevin 50WP (at 1,000 and 3,162 ppm). First instar nymphs (whitecaps) were tested by dipping the field-collected fruit in the appropriate concentration and observing the insects for 7-10 days to determine mortality. Results varied considerably among populations and among the three different seasons. For example, the average percentage of mortality ranged from < 10% to 100% for 10 ppm of Lorsban. However, resistance to Lorsban, and to a lesser extent, Supracide and Sevin, has been confirmed in California red scale and yellow scale. The most resistant populations were located in eastern Tulare County, near Porterville, and eastern Kern County, near Edison. Yellow scale populations were collected from various locations in Tulare County, but none were found in the other 3 counties surveyed. Resistance levels were similar between the two species; however, no completely susceptible yellow scale populations have been found.

EFFECT OF DIFFERENTIAL IRRIGATION LEVELS ON THE BIOLOGY OF THE VARIEGATED LEAFHOPPER, ERYTHRONEURA VARIABILIS

*Kent M. Daane, Glenn Y. Yokota and Larry E. Williams
U. C. Kearney Agricultural Center*

The variegated leafhopper (VLH), *Erythroneura variabilis*, is the most serious insect pest of grapes in California's San Joaquin Valley. Past research has sought to develop and improve upon biological and chemical controls, while less attention has been given to cultural controls. In 1992 we studied the effects of vine condition on VLH population dynamics in an experimental lysimeter block. Leafhopper densities

were monitored in each of the three leafhopper broods. Results found leafhopper numbers were significantly greater in higher irrigation treatments. To investigate effect on leafhopper size, fifth instar VLH were collected from all irrigation treatments, oven-dried at 250°F for 1 hour, and weighed. Results show VLH from the higher irrigation treatments weighed significantly more indicating greater feeding on the healthier vines. However, there was no significant difference in adult egg production with leafhopper reared as nymphs on either 0.0, 0.6, or 1.2 irrigation treatments and caged on clean leaves in a nearby vineyard. To study VLH dispersal, over 30,000 adults were collected, marked with a fluorescent dye, and released near the vineyard. Results show that there were significantly greater numbers of total adult VLH and a greater number of marked and recaptured adult VLH in the higher irrigation treatments, indicating a greater attraction of reproductively active VLH to well-irrigated vines. From this work we conclude that vine condition, in this case irrigation levels, can effect VLH biology and subsequent pest status.

AUGMENTATED RELEASE OF LACEWINGS

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Green lacewings have been used as a biological control agent for variegated leafhopper, but methods of release and lacewing effectiveness need further investigation. The lacewing was found to be an effective predator of leafhoppers under laboratory conditions. Predation rate under field conditions was tested. Although results have not had a consistent pattern, there appears to be a reduction in leafhopper population for plots with lacewing releases. Current commercial methods of lacewing release were evaluated for effectiveness. In three commercial vineyards, the commercial machine release was compared with a hand release done at the same rate. Total leafhopper numbers in release plots were reduced, but these reductions were not always significantly different from control plots. Lacewing releases need to be timed carefully with the leafhopper life cycle to be most effective. It appears that the number of lacewings needed to get large reductions in leafhopper populations could be cost prohibitive. *Crysoperla carnea* is the species most often commercially available, but our data show that other species may be more effective and thus more economical. This year we will also be investigating use

of an adult food attractant as a less costly way of introducing high numbers of lacewings into vineyards.

INTEGRATED MANAGEMENT OF THE SUMMER BUNCH ROT COMPLEX OF GRAPES

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Botrytis bunch rot is a serious concern in coastal and northern grape growing areas of California. Under suitable environmental conditions, Botrytis rot can cause devastating crop loss. It has been clearly shown that an integrated program including basal leaf removal can effectively manage the disease while reducing the number of fungicide sprays previously required. In the hotter and drier climate of the San Joaquin Valley, Botrytis rot is usually less pervasive, and the summer bunch rot complex is more important. Historically, chemical control measures have not been consistently effective, because the rot pathogens, including *Aspergillus niger*, *Penicillium* spp., *Alternaria* spp., as well as *Botrytis*, enter grape berries through wounds caused by insects, mildew, and other agents. Nevertheless, bloomtime sprays are often routinely recommended to protect developing clusters. Recent data showed that epiphytic populations of fungal pathogens are usually low in early and mid-season, and dramatically increase shortly before harvest. In 1992, developing clusters of 'Petite Sirah' grapes in a Stanislaus Co. vineyard were inoculated with conidial suspensions of the above-mentioned fungi, and either covered with paper bags or left exposed prior to a bloomtime spray. One week later, numbers of fungi recovered on inoculated clusters were higher than on noninoculated clusters, except for *Alternaria*. Only *Botrytis* numbers were significantly reduced by the fungicide, indicating that, in absence of conditions conducive for *Botrytis* development, bloomtime sprays may be of negative economic value.