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Editors

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ARTICLES

SEASONAL DYNAMICS OF EPIPHYTIC MYCOFLORA AND INSECT VECTORS ASSOCIATED WITH THE SUMMER BUNCH ROT COMPLEX OF TABLE GRAPES

Roger A. Duncan and James J. Stapleton, U. C. Kearney Agricultural Center

The summer bunch rot complex (caused by species of *Aspergillus*, *Penicillium*, *Botrytis*, *Rhizopus* or other fungi alone or in combination with *Acetobacter* and several yeast species) is the most prevalent form of bunch rot in the Central and Southern San Joaquin Valley where table grapes are grown. A major component of this disease complex is sour rot, characterized by a strong acetic acid odor, leakage of berry juice, and the presence of vinegar flies (*Drosophila* spp.) and dried fruit beetles (*Carpophilus* spp.). *Diplodia natalensis* (syn. *Botryodiplodia theobromae* Pat.) was reported to be the primary causal agent of the summer bunch rot complex on 'Thompson Seedless' grapes (3). *B. theobromae* reportedly infects berries at bloom and remains dormant until the berries begin to mature. When growth of the fungus resumes, breaks in the skin of the berry occur, exposing the internal tissues to infection by secondary organisms including species of *Acetobacter, Aspergillus,*

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Penicillium, and *Rhizopus*. Several yeast species are also associated with the sour rot complex. These organisms can also gain entry through mechanical cracks, wounds caused by insect or bird feeding, or cracks caused by powdery mildew [*Uncinula necator* (Schwein.) Burrill] or other diseases (2). When wounded berries are colonized by *Acetobacter* spp., acetic acid is produced, attracting *Drosophila* flies which in turn may serve as vectors to further spread the disease (3).

The role of individual fungal species in the summer bunch rot complex is not fully understood. Many of these fungi are opportunists, able to colonize only wounded berries, while others are able to initiate primary infection. In order to obtain a better understanding of the development of summer bunch rot complex on table grape varieties other than 'Thompson Seedless', population dynamics of epiphytic fungi on grape berries were monitored biweekly from June until harvest. Fungi present on the surface of grape berries were identified and quantified. Relationships between population densities of commonly recovered fungi and incidence and severity of bunch rots were examined. Insects associated with sour rot were captured from diseased clusters in the field and surveyed for fungal propagules carried on or in their bodies and for transmission of inoculum to wounded or nonwounded grape berries in the laboratory.

Materials and Methods

Berries from 'Thompson Seedless', 'Ruby Seedless', and 'Red Globe' vineyards in Fresno, Tulare, and Kern Counties were collected biweekly throughout the growing season. Berries were transported to the laboratory in ice chests, placed in polyethylene bottles containing a buffer solution, and shaken on a mechanical shaker for 1 hour. Aliquots of wash solution were plated onto agar media (acidified potato dextrose agar + Igepal surfactant) and incubated in the laboratory at 23 $\pm$ 1 C. After 5-7 days, fungal colonies were identified, enumerated, and recorded as colony forming units (cfu) per cm^2 of berry surface. At the time of harvest, 25 clusters from each replication (150 clusters per vineyard) were evaluated for incidence and severity of various rots. The 'Thompson Seedless' trial in Kern County was harvested by the grower before rot data could be collected.

Insects associated with sour rot/summer rot were captured in the field by placing polyethylene bags around clusters affected with sour rot and gently tapping the clusters, causing insects to fall into the bags. Nonsurface-sterilized insects or insects surface sterilized in a 10% bleach + 0.1% Tween 20 solution were plated on agar media and incubated at 23 C or 30 C. Plated insects were monitored for growth of fungi. Fungal taxa growing from plated insects were identified and recorded for each species. Insects captured from the field were also released into large glass jars containing small clusters of surface-sterilized, wounded and nonwounded 'Thompson Seedless' berries. Jars were incubated at 23 $\pm$ 1 C and monitored for development of disease.

Results

Seasonal dynamics of epiphytic fungi (Fig. 1) were similar to those found in a study of fungal dynamics of wine grapes treated with leaf removal in the San Joaquin Valley conducted in 1990-93 (1). Several taxa of fungi were recovered. *Cladosporium* spp. were the most prevalent, with *Penicillium, Aspergillus, Alternaria, and Botrytis* spp., respectively, also very commonly recovered. All are involved in the development of summer bunch rot. Propagules of fungi generally were low early in the season, while numbers of *Aspergillus* spp. (mostly *A. niger*) and *Penicillium* spp. usually increased rapidly later in the season after veraison. Yeast populations increased dramatically just prior to harvest. Compared to other fungal taxa, *Botrytis* spp. populations were generally very low. *Botryodiplodia theobromae*, the fungus reputed to be the major cause of sour rot and the summer bunch rot complex on 'Thompson Seedless' was not commonly recovered from any of the sampled vineyards although all vineyards developed some degree of sour rot and summer bunch rot by harvest.

Sour rot and rot caused by *A. niger* were the most prevalent forms of bunch rot encountered in all of the vineyards (Fig. 2). While incidence of sour rot was often greater than 25%, *Botrytis* rot incidence was never more than 5%. Correlation between epiphytic mycoflora recovered during the season and incidence and severity of bunch rots at harvest were rarely significant. In general, 'Red Globe' vineyards tended to have the lowest incidence and severity of bunch rots at harvest. Due to the loose architecture of the clusters of this variety, fungi tended to remain confined to the diseased berries and did not tend to move to adjacent "sound" berries. Summer bunch rot tended to be most severe in 'Thompson Seedless' vineyards. Rot in 'Ruby Seedless' vineyards was variable with higher incidence of bunch rot in Tulare County where the vineyard had a higher level of powdery mildew and many split berries and very low rot incidence in the Fresno County 'Ruby Seedless' vineyard.

Three insect species were consistently recovered from clusters of 'Thompson Seedless' affected with sour rot in a vineyard at the Kearney Agricultural Center. These were dried fruit beetles (*Carpophilus hemipterus* and *C.*

freemani) and vinegar flies (*Drosophila* sp.). All insects carried yeast, *Aureobasidium*, *Aspergillus* (mostly *A. niger*), *Penicillium*, and *Cladosporium* spp., as well as *Mucor* sp. Colonies of yeast and *Aureobasidium* grew from surface-sterilized insects. Insects captured from clusters with sour rot transferred fungal propagules from the field, vectoring disease on wounded berries in the laboratory (Fig. 3). Insects preferred to feed on wounded berries and disease was rarely spread to nonwounded berries when wounded and nonwounded berries were placed in insect cages together. When not given a choice, insects fed on and injured nonwounded berries. *Carpophilus* spp. appeared to be better vectors of fungal contaminants to wounded berries while *Drosophila* flies mainly vectored sour rot.

Discussion

Our studies showed that *B. theobromae* can infect nonwounded berries of all tested grape varieties under laboratory conditions. However, this fungus was rarely recovered in our berry washings or observed in the field in the ten sampled vineyards. Despite the apparent lack of prevalence of this fungus, sour rot developed in every field by harvest. Previous studies on wine grapes in the San Joaquin Valley have yielded similar results. Based on this evidence, it is probable that *B. theobromae* plays a smaller role in the development of sour rot and summer bunch rot complex than is currently reputed.

Our laboratory studies showed that *A. niger* can directly infect nonwounded berries. This fungus is ubiquitous in the field, and populations increase markedly later in the season after veraison. It is possible that this fungus plays a larger role in the development of summer bunch rot than simply infecting previously wounded berries.

Correlations between epiphytic fungal populations and bunch rot at harvest in the vineyards were seldom significant. This indicated that epiphytic monitoring of the grape berries is not a good indicator of rot levels one can expect at the end of the season. It is not known how these data correlate with levels of post-harvest decay.

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(Figures Not Available)

DEEP PLOWING FOR NUTSEDGE CONTROL

Tim Prather, Kurt Hembree and Michelle LeStrange, U. C. Kearney Agricultural Center and Tulare Co.

Plowing to bury weed seeds or other propagules such as tubers has potential as a weed control method. Propagules must be short-lived so that they are not brought to the surface at the next plowing. The time between plowing must be longer than the propagule life in order to prevent bringing the propagules to the surface. Most plows are not made to effectively bury propagules. The Kverneland plow is a modified moldboard plow that was designed to invert soil to the plowing depth. This study was conducted to contrast the effectiveness of a moldboard plow and a Kverneland plow at burying yellow and purple nutsedge tubers.

The site was sampled prior to plowing on June 2, 1993 to establish the distribution of tubers in the soil. Holes were dug along transects throughout the plot area and samples taken at 3 depths: 0.75 to 3 in, 5.75 to 8 in, and 9.75 to 12 in. Plots were plowed on June 2 and 3, 1993 and then the field was listed. The plots were sampled again along the same transects as the first sampling on July 13, 1993. Tubers were screened from the soil samples and counted. Emerged nutsedge plants were counted in the field on June 23, 1993 when plants were at the 2 to 5 leaf stage. Differences were observed between the bed top and the furrow so plant density was counted in the furrow and on the top of the bed in each plot.

Nutsedge tubers were buried effectively with the Kverneland plow (Figure 1). At the shallow depth, 9 tubers per sample (82%) were buried deeper in the soil. There was a 33% decrease in tubers at the middle depth, but it was not statistically significant. Tubers increased at the lowest depth by 500%. The moldboard plow was not as effective (Figure 1). There was a 17% decrease at the shallow depth. Tubers increased at the middle depth by 25%. Tubers increased by only 50% at the lowest depth. Plant counts compared well with the distribution changes of tubers in the soil. On the bed top there were more nutsedge plants in the moldboard plowed area than in the Kverneland plowed area with 9 versus 4 plants/ft^2 (Figure

2). Densities of nutsedge in the furrows were not significantly different between the two plowing methods (Figure 2).

The Kverneland plow was effective at reducing nutsedge tubers in the top of the soil profile by burying the tubers below 9 in. The moldboard plow had little effect on tuber distribution in the soil. The 50% difference in nutsedge plants on top of the beds was significant but not sufficient for good weed control. With an inversion of the soil, soil at the middle depth will be at the middle after soil inversion. There were significant numbers of tubers at the middle depth, resulting in nutsedge plants on top of the beds. This technique is promising but will require combining plowing with herbicide application.

(Figure Not Available)

Figure 1. Yellow and purple nutsedge tuber distribution in the soil at three depths: 0.75 to 3 in, 5.75 to 8 in, and 9.75 to 12 in. Tubers were counted before and after the field was plowed using either a Kverneland or a moldboard plow.

(Figure Not Available)

Figure 2. Number of emerged yellow and purple nutsedge plants, counted after plowing with a Kverneland plow or a moldboard plow.

OCCURRENCE OF MOLDY CORE AND CORE ROT OF FUJI APPLE IN CALIFORNIA

Themis J. Michailides, D.P. Morgan, E. Mitcham, and C.H. Crisosto, Kearney Agricultural Center and Department of Pomology, University of California, Davis.

Moldy core of apple has been recorded in the United States, Australia, New Zealand, Canada, the United Kingdom, South Africa, and the Netherlands (Spotts, 1990). The most common fungi associated with moldy core and dry core rot are *Alternaria*, *Stemphylium*, *Cladosporium*, *Ulocladium*, *Epicoccum*, *Coniothyrium*, and *Pleospora herbarum*. Many cultivars of apple are affected, including Delicious, Golden Delicious, Gravenstein, and Idared (Spotts, 1990). However, during late summer to early fall of 1993 moldy core was very common in Fuji apple in the San Joaquin Valley.

Moldy core of Fuji apple was brought to our attention on 1 September 1993 when a grower brought the first samples of suspected infected fruit for diagnosis. Several other samples of Fuji apples from various locations in the San Joaquin Valley were brought into our laboratory later in September and October 1993. After apples were cut in half, isolations were made in petri plates containing acidified potato-dextrose agar (APDA) to culture and identify the pathogen involved. All the infected apples were observed under a dissecting microscope and recorded for the presence or absence of a mite which was detected in most of the apples with moldy core brought to the laboratory on 1 September 1993. We isolated consistently (77 to 100%) from the decayed tissues of Fuji apples several strains of a *Coniothyrium* species. Other fungi isolated were *Alternaria* species (2.4 to 7.9%) and a *Fusarium* species (1.6 to 2.4%). Five samples, representing Fuji apples from five different locations, for which systematic counts were made showed a 50, 57, 64, 81, and 86% incidence of the mite. We also examined healthy apples for the presence of this mite in the core area.

The morphology, the mycelial growth, and the spore dimensions (4.5 - 5 6) x 2.3 - 2.5 µm) of the fungus isolated fit with those described for *Coniothyrium sporulosum* (=*Coniothyrium fuckelii*). Mites were not found in the core area of healthy apples examined, but 83% of these apples had the mite among the floral parts in the calyx area.

Moldy core is distinguished from other apple rots by its growth in the center of the fruit. In other words, the rot starts from the center of the fruit (close to the carpels and seeds) and it progresses towards the outside of the fruit, becoming a relatively dry rot. The moldy core caused by *Coniothyrium* species is characterized by the white or light grey mycelium present in the locules; the white mycelium of the fungus, becoming very distinct particularly as a fine layer on the dark brown seeds. The rot invades the fruit flesh, resulting in a firm rot. Tissues from naturally-infected Fuji fruit become light to dark brown. Lesions have distinct edges of lighter brown color while the center of the rot is dark brown. Tissues are firm and spongy, slightly moist and sometimes light brown zones alternating with dark brown zones are obvious. Diseased apples have a distinctive, slightly sweet odor when cut open. Occasionally the rot reaches the external surface of the fruit, usually close to the stylar or the stem-end depressions, where the brown discoloration becomes obvious. Juice leaking from the calyx sinus was found in some of the apples which had very advanced core rot. Occasionally, pycnidia of the pathogen can be found on the surface of the carpels and along the calyx sinus.

Samples brought to the laboratory in mid October showed a 15% incidence of fruit with pycnidia, primarily on the carpels and along the sinus of the calyx.

Diagnosis in the field. According to observations of apple growers and ours, external symptoms in the field are rare, with the exception that infected Fuji apples are a light yellow color and fall prematurely. Similar premature coloring and dropping of fruit were described in Red Delicious apples in Georgia caused mainly by *Botryosphaeria obtusa*, although such fungi as *Coniothyrium, Alternaria*, and *Fusarium* species were also present (Taylor, 1955). Taylor in 1955 reported that fruit with moldy core may be identified by tapping the outside of the fruit with the a finger. Apples which have a moldy core sound like a hollow ball. In a preliminary experiment, about 40 Fuji apples from a commercial packinghouse were marked as "core-rotted" apples using this method. In addition, 40 more apples were marked as "good" (healthy) apples. When the suspected "core-rotted" apples were cut in half, 90-95% had core rot. When the "good" apples were cut in half only 0-16% had core rot (percent range because we used two replications of 20 fruit for each category).

To diagnose moldy core in the field look for external symptoms which can show first in the calyx or the stem depressions. This is because the decay lesions grow as a sphere (since they initiate from the center of the apple). Therefore, because calyx and stem depressions will be reached sooner by the edge of the decay, the rot will show first on either of these areas of the infected apples. Premature yellowing of fruit while the majority of fruit are still green is a diagnostic symptom that can be used to distinguish fruit with moldy core or core rot.

Although we received several samples of 10 to 30 apples from about six different locations in San Joaquin Valley, we consistently (77 to 100%) isolated strains of *Coniothyrium* species and we are in the process of confirming the identification of the species. Fungi that were associated with core rot of Starking apples in South Africa included *Alternaria alternata* (59%), *Pleospora herbarum* (9%), a *Coniothyrium* species (6.5%), and *Penicillium funiculosum* (6%) (Combrink et al, 1985). In California Fuji apples, however, the most commonly isolated fungus from moldy core or core rot was a *Coniothyrium* species.

Fuji apple has an open sinus which connects the core out to the calyx floral remnants. The mite that was isolated from Fuji apples was identified to be an acarid, *Tarsonemus confusus*, member of the family Tarsonemidae. Members of this family are fungivorous, suggesting that these mites feed on the *Coniothyrium*, planting the minute spores of the pathogen in the core area as they enter the apple sinus. However, because of the lack of experimental evidence some of the above statements are hypothetical.

Disease Cycle. Essentially we know nothing about the life cycle of this pathogen and the disease cycle is unknown. Until we investigate the life cycle of the pathogen we have to rely on findings from other regions. Wet weather during spring can create conditions favorable for growth and sporulation of the fungi that cause core rot. Although we do not know details about moldy core distribution in the field, growers reported that the incidence of the disease was more common in shady areas within the canopy. On one occasion in 1990, we found a Granny Smith apple with lesions on the surface which at that time were tentatively identified as *Coniothyrium* species. In general, *C. sporulosum* is a cosmopolitan species, causing stem blight and cankers in rosaceous plants, especially *Rubus* and *Malus* species (Farr et al, 1989).

Experimental. In a preliminary experiment, Fuji apples obtained from a commercial packinghouse were inoculated with either a spore suspension of *Coniothyrium* or with a suspension prepared from a culture of *Coniothyrium* species contaminated with adults and eggs of *Tarsonemus confusus* mite. The spore suspension contained at least 10^6 spores of *Coniothyrium* per ml solution. Ten to 23 apples were inoculated by injecting the suspension using a 1" (23 G) syringe through the sinus of each apple. Ten non-inoculated, wounded or nonwounded fruit served as controls. None of the wounded or nonwounded, non-inoculated fruit were infected by *Coniothyrium*, however, 65% of the fruit that were inoculated with *Coniothyrium* and mites developed typical moldy core symptoms 25 days after inoculation. Only 28% of the apples decayed after inoculation with a spore suspension of *Coniothyrium* that did not contain mites. Reisolations were made on APDA plates to confirm that decay was caused by the fungus we used to inoculate the apples. Typical colonies of *Coniothyrium* were recovered from 35.7% of the apples showing suspected decay by *Coniothyrium* of those inoculated with *Coniothyrium* spore suspension and mites, and from 20.8% of the apples inoculated with a spore suspension of *Coniothyrium* alone. Reisolation of the fungus inoculated on the apples completed Koch's postulates for the causal agent of moldy core disease of Fuji apples. Isolations from the core area of non-inoculated fruit revealed no fungal pathogens, with the exception of a yeast, *Aureobasidium pullulans*, which was isolated occasionally.

This preliminary experiment indicated that the mite, *Tarsonemus confusus*, which was found associated with moldy core, plays a role in carrying the spores of the fungus and perhaps in creating small wounds that can facilitate infections by *Coniothyrium*. Research needs to be continued to determine the life cycle of *Coniothyrium* species in Fuji apple orchards and discover how the core area is infected by spores of this pathogen.

It is interesting that moldy core or core rot was not recorded in Granny Smith apples in San Joaquin Valley in 1993. Fuji apples observed in this study and Red Delicious as reported by Taylor (1955) apparently are susceptible to core rot because both these cultivars have a characteristic sinus connecting the central core chamber with the calyx cup.

Control. Because we do not know anything about the life cycle of the pathogen, its epidemiology, or its vectors, we cannot propose any effective control measures. At least, if mites are responsible for carrying the spores of the pathogen in the core area of Fuji apples, one can assume that controlling the mites may control the disease. One grower who brought apples with moldy core for diagnosis, when asked whether he had done something different in 1993 from 1992, mentioned that he had not controlled mites in 1993.

Acknowledgments

We thank Dr. B. Grafton-Cardwell and Yuling Ouyang for identifying the mite that was associated with the moldy core of Fuji apple. We also thank R. Beede, M. Devencenzi, K. Doi, D. Katayama, D. Lowe, K. Mohrhusen, and L. Nygren for providing apples with moldy core or core rot, and D. Surabian for donating healthy Fuji apples used in the inoculation experiments.

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(Figure Not Available)

Figure 1. (**A**) Moldy core in Fuji apple in the initial stage of development (no external symptoms). (**B**) Moldy core in an advance stage (external symptoms will show first either in the stem (a) or calyx (b) depressions as d ark brown discolored areas; juice leaking in the calyx area was observed in a number of apples). Note open calyx sinus (**C**) that can explain the contamination (or transmission) of the pathogen *Coniothyrium sporulosum* in the core area.

ABSTRACTS

WESTERN ORCHARD PEST & DISEASE MANAGEMENT CONFERENCE, Portland, OR., January, 1994

<u>Chemical Control of Oriental Fruit Moth in Peaches</u>
J. E. Dibble, U. C. Kearney Agricultural Center

Oriental fruit moth is a serious pest of peaches in California. Limited use of some chemicals along with questionable performance of others gave rise to reevaluate the product Cryolite. Although these trials were targeted for application against the spring population, they were not actually applied until summer.

Other products used for control evaluation and comparison were Asana, Diazinon, Guthion, Imidan and Sevin. Shoot strikes made three weeks after an early July application showed Imidan, Diazinon, Asana and Guthion to be better than Sevin and Cryolite treatments. The average percent infested fruit at harvest again indicated Imidan and Diazinon still to be functional in control. Asana followed closely, with Cryolite equal to the untreated check and Guthion in the middle between the best and worst treatments. The Cryolite results were somewhat anticipated due to OFM feeding habits. Earlier season trials might show a more vigorous feeding and greater chemical ingestion.

Treatment	Form.	Rate/Acre	Total Number[2] shoot strikes per trtmt.	per tree	Average[3] % infested fruit & harvest
Cryolite	96	12 lbs.	49	4.1	6.3 a
Cryolite	96	12 lbs.	37	3.1	4.8 a
+ Asana	XL	2 ozs.			
Asana	XL	10 ozs.	22	1.8	1.3 c
Imidan	50 W	4 lbs.	0	0	0.8 cd
Guthion	50 W	2 lbs.	27	2.3	2.8 b
Diazinon	50 W	4 lbs.	11	0.9	0.3 cd
Sevin	50 W	8 lbs.	44	3.7	4.3 ab
Check	--	--	55	4.6	5.5 a

[1]Applications made in July to Andross cling peaches using high pressure handgun @ 400 gpa. Used third biofix of 6/16 for treatment timing of 7/2-7/6. Fresno Co. 1993.
[2]Shoot strike counts made on each tree 3 weeks after application. Four replications/treatment and 3 trees/rep.
[3]25 fruit/replication examined at harvest, 8/18.

<u>Chemical Control of Navel Orangeworm in Almonds</u>
J. E. Dibble and S. Haire, U. C. Kearney Agricultural Center

The thrust of these trials was to see what effect Orchex 796 oil had on navel orangeworm (NOW) eggs; first in the lab and then in the orchard. Both in the lab and field trials we evaluated Orchex at different rates in an oil/water solution ranging from 1-5%. The laboratory colony eggs were dipped into the oil/water solution, immediately removed and allowed to dry. They were then placed into vented and larva media containing cartons. The cartons were held in a room for approximately two weeks at 80^{o}F. As a backup to this observation, the number of surviving larva were also checked for in the food media. All mixtures were significantly better than the water only control, even the minimum treatment of 1% oil.

Another test involved the same dipping of eggs into 1-5% mixture of oil/water, but used field collected NOW eggs rather than lab colony eggs. Here the eggs were laid on baited egg traps where the female moths were attracted to media contained therein. After egg laying occurred, the traps were taken down from the almond orchard trees, dipped into the oil/water solutions and replaced back in the shaded portion of the trees. Over 100^{o}F temperatures immediately after initial treatment prompted an early two day count. Egg evaluations were made separately for the white, orange and black head stages; the latter being the stage just prior to larval hatch. In these trials where we counted the number of dead eggs per ten eggs per replication, a definite egg kill progressively occurred as the oil dosage increased. Also, a progression in egg kill occurred within each dosage through time. Although 1 and 2% mixtures were effective, 3% and up gave excellent hatch reduction on white and orange egg stages. The 3% treatment was considerably less effective on the black head stage and required closer to a 5% rate.

Final testing involved a treatment made at hull split (approximately 40-45 days prior to harvest). That is the time when most growers apply an insecticide for NOW control. We timed the oil application to be applied at egg laying which can occur as the first hulls start to split. Since the NOW larva cannot invade the hull (and then the shell and nut) until hull split, this hull stage is a trigger for control treatments. Adult female moths are attracted to, and lay eggs, in the split hulls. Counts made two weeks after applying three mixtures of oil and water (2%, 3% and 4%), controlled up to 50% of the eggs. This is often as good as any material obtains.

EIGHTH INTERNATIONAL ASPARAGUS SYMPOSIUM, Palmerston, North New Zealand, November, 1993

<u>Evaluation of Norflurazon for the Control of Yellow Nutsedge (*Cyperus esculentus*) in Bearing Asparagus</u>
Harry S. Agamalian, Monterey County

The results of a three year experiment using Norflurazon at three rates was found to effectively control yellow nutsedge. The experiment was conducted on a Metz soil with 57% sand, 27% silt, 16% clay and 0.9% organic matter. The asparagus variety was U.C. 157, grown under sprinkler irrigation. Herbicide applications were made during winter dormancy at 2.2, 4.4 and 8.8 kg/ha active ingredient. Applications were made to the soil surface, followed by irrigation. Yellow nutsedge control following the first year of application was 42% for the lowest rate, 60% for the middle rate and 72% for the high rate. Evaluations after two years of application resulted in 68%, 75%, and 92% control of the respective rates of norflurazon. Yield data from the second year of harvest indicated a significant yield increase from the highest treatment.

Assessment at the conclusion of the third year of treatments were 82% control from the 2.2 kg/ha dosage, 95% control from the 4.4 kg/ha and 99% control with the 8.8 kg/ha application. Yield data collected from the third year showed significant yield differences over the untreated control.

AMERICAN PHYTOPATHOLOGICAL SOCIETY/SOCIETY OF NEMATOLOGISTS, Nashville, TN, November, 1993

Verticillium Wilt of Cauliflower in California
S.T. Koike, K. V. Subbarao, R. M. Davis, and T. R. Gordon, Monterey Co., Plant Pathology Depts. U.C. Davis and U.C. Berkeley.

During the past two years, commercial cauliflower in coastal California has been severely affected by a vascular wilt disease. Symptoms consist of chlorosis, defoliation, stunting, wilting, and vascular discoloration. *Verticillium dahliae* was consistently isolated from xylem tissue in stems and roots of affected plants. Disease was widespread and caused significant damage in summer and fall crops. Pathogenicity was established by dipping roots of 30-day-old seedlings (cv. 'White Rock') into conidial suspensions (10^7 conidia/ml) for 5 min. Control plants were dipped into sterile distilled water. All plants were potted into autoclaved soil and incubated in a greenhouse (23/10 C day/night regime). After 3 wk, inoculated plants became stunted and chlorotic, and *V. dahliae* was reisolated from them. Control plants were symptomless. Soil from commercial fields was assayed for microsclerotia (ms) using the modified Anderson Sampler and plating onto NP-10 selective medium. Assays showed that *V. dahliae* was widely distributed in the Salinas Valley, and propagule densities were as high as 93 ms/g soil. Evaluation of cauliflower cultivars in infested fields indicated that all were susceptible. This new disease has become a major threat to cauliflower production in coastal California.

Residual effects of treatment on control of olive leaf spot
B. L. Teviotdale and G. S. Sibbett, U. C. Kearney Agricultural Center and Tulare Co.

We conducted experiments on the control of olive leaf spot, a defoliating disease caused by the fungus *Spilocea oleaginea*. Olive trees were treated with Kocide 101 annually or biennially once in November, once in January or once each in November and January. Annual treatments were applied in winters 1988-1989, 1989-1990 and 1990-1991 and biennial treatments were applied in winters 1988-1989 and 1990-1991. All trees were treated in November 1991 (winter 1991-1992) and 1992 (winter 1992-1993) with Kocide 101. Ten shoots, each bearing ten adjacent pairs of mature healthy leaves, were selected on each tree in November 1988 before treatments were made. Percent healthy, diseased and missing leaves among the ten pairs of leaves on these shoots were determined in May of 1989, 1990 and 1991 and on twenty randomly selected shoots on each tree in May 1992 and 1993. Two years after the experiments ended and following two years of similar treatment, experimental treatment effects were measurable: there were significantly higher percentages of healthy leaves in treated than in control trees, in annually than in biennially treated trees, in trees treated in November and January than in those treated in November only, and in trees treated in November or November and January than in those treated in January only. Comparable results were recorded for percent diseased and missing leaves.

INTERNATIONAL CONFERENCE ON THYSANOPTERA: TOWARDS UNDERSTANDING THRIPS MANAGEMENT, Burlington, VT, September, 1993

Manipulation of the predatory mite, *Euseius tularensis*, for improved control of citrus thrips, *Scirtothrips citri*.
Beth Grafton-Cardwell and Yuling Ouyang, U. C. Kearney Agricultural Center

The predatory mite, *Euseius tularensis*, feeds on citrus thrips and citrus red mite as well as pollen and small amounts of leaf sap. It is an important biological control agent in orchards where the citrus thrips, *Scirtothrips citri*, has developed resistance to organophosphate and carbamate insecticides. In these orchards, growers use selective botanical insecticides such as sabadilla (Veratran) mixed with sugar or molasses for citrus thrips control. The botanical insecticides act slowly on the citrus thrips population because they must be infested and they are not always effective in keeping citrus thrips fruit scarring damage below an economic threshold. However, they are relatively nontoxic to *E. tularensis*. The objective of our research is to develop methods to augment populations of *E. tularensis* in citrus and so improve their control of citrus thrips. Releases of 400-2000 greenhouse reared *E. tularensis* per tree in early spring significantly increased predatory mite densities in six of eleven release orchards. Within orchards, the percentage of heavily citrus thrips scarred fruit was negatively correlated with the cumulative number of predatory mites sampled per tree. Pruning the inside of trees in late winter resulted in a two-fold higher number of predatory mites in the spring on the outside of the trees where the citrus thrips are active. Pruning the outside of trees in a hedgelike fashion in late winter or summer significantly improved predatory mite densities on the outside of the tree the following season. Pruning may be a more practical method of managing predatory mites populations than mass-rearing and releases.

6TH INTERNATIONAL CONGRESS OF PLANT PATHOLOGISTS, Montreal, Canada, July 28-Aug. 6, 1993

Biocontrol of Fig Endosepsis and "Smut" in Calimyrna Figs by Using *Paecilomyces lilacinus*
T.J. Michailides, K.V. Subbarao, D.P. Morgan, Dept. of Plant Pathology, U. C. Kearney Agricultural Center, Parlier, and U.S. Agric. Station, Salinas, USA.

Paecilomyces lilacinus, a native inhabitant of the fig fruit cavity, was tested as a biocontrol agent to control fig endosepsis of edible Calimyrna figs caused by *Fusarium moniliforme* and "smut" caused by *Aspergillus niger* in 1990 and 1991. *P. lilacinus* was commonly (up to 14%) isolated from caprifigs (fruits of male fig pollinators). Fruits from the winter crop (mamme) of caprifigs trees were split in half and either dipped in or sprayed with a 10^6-10^8 conidial suspension of *P. lilacinus*. A commercial benomyl+dicloran+ chlorothalonil treatment was used for comparison. Both the biocontrol and the fungicide dip or spray treatments significantly reduced the incidence of *F. moniliforme* and *A. niger* in caprifigs. The fig wasp (*Blastophaga psenes*) pollinators successfully carried the fungus from the winter to the spring caprifig crop. Depending on the cleanliness of caprifigs used, *P. lilacinus* treatments reduced fig endosepsis by 35-61% and smut by 52-100% in Calimyrna figs in 1990, and in 1991 by 50% or more than the fungicide treatment. In two tests, recovery of *P. lilacinus* from wasps emerged from profichi injected with *P. lilacinus* ranged from 45 to 58%, significantly (P<0.05) higher than the 17% recovery from wasps emerged from untreated caprifigs. These results suggest that *P. lilacinus* can be carried by the fig wasp pollinator and used as a biocontrol agent for fig endosepsis and smut.

77TH ANNUAL ENTOMOLOGICAL SOCIETY OF AMERICA, PACIFIC BRANCH, Portland, OR, June, 1993

Effects of Differential Irrigation on the Variegated Grape leafhopper, A Pest of Grape Vineyards
Kent M. Daane, Glenn Y. Yokota and Larry E. Williams, U. C. Kearney Agricultural Center

The effects of varying evapotranspiration levels in a Thompson seedless grape vineyard on variegated grape leafhopper (VLH), *Erythroneura variabilis*, were studied. Eight irrigation levels were maintained in a computer driven lysimeter block at the Kearney Agricultural Center. Leafhopper numbers, dispersal characteristics, and weight were measured. Significantly greater VLH numbers were found in higher irrigation levels. From a mark/release study, results showed a greater adult VLH dispersal into well irrigated vines. Similarly, VLH biology was affected by irrigation levels. Results showed larger VLH were produced in higher irrigation treatments. However, the increased size in fifth instar VLH did not correlate with increased fecundity of well-fed adult VLH.

ANNUAL MEETING, ECOLOGICAL SOCIETY OF AMERICA, Baltimore, MD, December, 1993

The Effect of Stone Fruit Host Plant Quality on Population Dynamics and Larval Herbivory of *Grapholita molesta* and *Anarsia lineatella*
Kent M. Daane and Jeffery W. Dlott, U. C. Kearney Agricultural Center

In peach and nectarine orchards, the two primary lepidopteran pests are *Grapholita molesta* and *Anarsia lineatella*. A nitrogen fertilization experiment was initiated in a block of Fantasia nectarines with five nitrogen treatments (0, 100, 175, 250, 325 lbs N/acre/year). In each of the treatments, trees were sampled and data on the number of new and old shoots and the number of newly infested shoots were collected. Results showed a greater number of new shoots in the upper canopy where there was a corresponding increase in the number of infested shoots. The number of new shoots and infested shoots and fruit was also greater in trees that received higher nitrogen fertilization levels. We found that a reduction of post-harvest shoot growth led to fewer and poorer quality host sites and further, that host sites affect lepidopteran feeding and development rates.

BELTWIDE COTTON PRODUCITON CONFERENCES, San Diego, CA, January, 1994

Plant Monitoring as an Insect Management Tool
Peter Goodell, U. C. Kearney Agricultural Center

California has a long tradition of using plant based parameters for insect pest management, especially lygus bugs and mites. From the early 1970's when the first plant based lygus management strategies were developed, the technique has evolved into today's sophisticated physiological mapping program. Lygus evaluation has evolved from strictly based on insect numbers to its present state which relates the plant's developmental status to presence of insects. The development of such plant based techniques requires close multi-disciplinary cooperation between agronomy and entomology. While the agronomists have elucidated the growth and development of cotton, the entomologists have quantified lygus distribution within a cotton plant and the rate at which this pest can damage floral buds. This technique has been accepted by pest managers and is especially useful in areas where lygus occur in low but persistent numbers. Such plant based techniques work very well for insects which damage fruit (squares and bolls) but have not been worked out for foliage feeders or honeydew producers.

IPM NOTES

IPM Notes is a feature in PPQ dedicated to providing broad perspectives of IPM. At the national and state levels there are many issues developing which will affect the direction of IPM and those who are working towards implementation of IPM. In the coming year look for items concerning the Clinton Administration's goals for IPM, growers and PCAs perceptions of constraints to adopting IPM techniques, DPR views of pest management, and other issues which are defining the direction of IPM. In this column are several items taken from a national newsletter, the IPM Monitor. This newsletter is available from National Foundation for IPM Education, 8000 Centre Park Drive, Suite 340, Austin TX 78754.

<u>Program Overview: Cooperative Extension's Role in IPM Education</u>, *Michael S. Fitzner, National Program Leader, IPM/USDA/ES*

The USDA Extension Service annually funds $8.5 million to 50 states and six territories supporting 570 full-time people working on IPM.

Additionally, at least 10 states have direct state support of approximately $10 million to implement IPM education programs.

A major objective is to reduce or eliminate unnecessary pesticide applications to fruits, vegetables, field crops, and the urban landscape.

IPM programs are vital to successful implementation of the USDA's Sustainable Agriculture Initiative, Water Quality Initiative, Integrated Crop Management Program (SP-53), Water Quality Incentives Program, and in making American agriculture competitive and profitable.

What Has Been Accomplished?

- More than 100 program areas specifically targeted with 900 IPM programs - everything from livestock, alfalfa, and strawberries to urban IPM programs.
- More than 11 million acres cropland are impacted each year.
- 11,000 scouts trained and
- 45,000 producers trained - In total, extension staff directly influence the pest management strategies used by more than 150,000 producers

Planned for Fiscal 1994

1) Continued incorporation of biological controls and other non-chemical management alternatives into IPM education and delivery programs;

2) Increased support for on-farm IPM validation trials and demonstrations conducted by state and county extension staff;

3) Regional and national evaluations that document the economic and environmental benefits of IPM so that this information can be used to demonstrate the advantages of IPM to U.S. agricultural producers, and

4) More urban IPM programs that educate homeowners, commercial turf and ornamental pest control operators, institutional and golf course managers responsible for turf and ornamental pest management, and commercial growers and dealers of turf and ornamental plants about IPM strategies.