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Editors

IN THIS ISSUE

ARTICLES

FIRST REPORT OF *RHIZOCTONIA SOLANI* (AG-4) ON PISTACHIO ROOTSTOCK SEEDLINGS

B. A. Holtz, U.C. Cooperative Extension, Madera County, T. J. Michailides and L. Ferguson, U.C. Kearney Agricultural Center, and J. G. Hancock and A. R. Weinhold, U.C. Berkeley.

In March 1995, pistachio rootstock seedlings, *Pistacia atlantica*, *P. integerrima* (Pioneer Gold I), and a hybrid called UCB I (*P. atlantica* & crossed with *P. integerrima*, were reported to be stunted, dying, or killed in a nursery in Madera County. Over 10,000 seedlings were lost. The leaves of infected seedlings turned brown, withered, and clung to the shoots. Brown cortical lesions developed on the roots and roots became discolored. Isolations from roots of dying seedlings resulted in the recovery of *Rhizoctonia solani* Khhn. The isolates were assigned to anastomosis group (AG-4) after hyphal fusion was observed in pairings with known strains. The pathogenicity of three isolates were tested in the greenhouse (15E to 25E C) against 3- to 4-week-old healthy *P. atlantica, P. integerrima* (PG I), and UCB I seedlings by mixing 50 ml of 2-week-old cornmeal sand inoculum (3 g of cornmeal, 100 g of sand, and 20 ml of distilled water) into 9-cm-diameter plastic pots containing a steamed soil:peat:perlite mixture (2:2:1 vol/vol) and one rootstock seedling per

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pot. Six pots were used per isolate, two pots per rootstock. Six pots containing noninfested soil and rootstocks were evaluated for comparison. Two weeks later symptoms were apparent and roots were evaluated for disease severity. Brown discolored lesions were observed on the roots of all three rootstocks, and Koch's postulates were completed by reisolating all three isolates from root lesions. The experiment was repeated with similar results. The disease was controlled in the nursery with the addition of pentachloronitrobenzene (PCNB) into the planting medium and by maintaining clean greenhouse benches.

THE INFLUENCE OF INSECTICIDE USE ON WEBSPINNING SPIDER MITE INFESTATION

Walt Bentley and Mario Viveros, U.C. Kearney Agricultural Center and Kern County Cooperative Extension

Soon after the synthetic pyrethroids were registered in almonds, growers came to realize the impact that these sprays had on developing webspinning mite problems. These mites are commonly known as the two-spotted spider mite, *Tetranychus urticae*, and the Pacific mite, *Tetranychus pacificus*.

Research on almonds in 1983 and 1984 demonstrated that applications of permethrin (Pounce, Ambush), cyfluthrin (Baythroid), or flucythrinate (Payoff) resulted in a greater abundance of mites both during the year of application and the year following application (Bentley et al., 1987). The increase in mite activity was demonstrated following sprays applied in May, July, or August at test plot locations in Durham, Fresno, McFarland, and Arvin CA. Unpublished work by Dr. Marjorie Hoy found permethrin residues remained on the bark of almond trees for as long as 9 months after these applications.

The influence of dormant applications on subsequent webspinning mite infestations was not studied at that time, but research was begun in 1994. From initial trials, residues of permethrin and esfenvalerate (Asana) applications made to almonds at commercial rates on February 3, 1995 were still found on bark samples collected August 24, 1995 (Zalom et al., 1995). Also, western predator mites, *Galandromous occidentalis* exposed for 24 hours to the February treated wood residues of either compound, were dying (80.4% mortality for esfenvalarate and 46.4% for permethrin) (Zalom et al., 1995). However, leaf samples collected during 1995 showed no significant difference in spider mite abundance between trees sprayed with a dormant treatment of either permethrin or esfenvalerate and those untreated or treated with organophosphates.

The influence of the growing season use of synthetic pyrethroids is of immediate concern in managing webspinning spider mite populations on a wide range of deciduous tree crops. Farm Advisors and IPM Advisors are increasingly responding to calls of webspinning spider mite outbreaks in crops such as almonds, peaches, nectarines, plums and prunes. In many of these instances spider mite outbreaks have been preceded by the use of synthetic pyrethroids. This has been particularly true for cling peaches.

The use of permethrin and esfenvalerate in deciduous crops, especially peaches and plums, is probably occurring because of the lower per acre cost, the perception of better control of target pests such as peach twig borer, *Anarsia lineatella* and Oriental fruit moth, *Grapholitha molesta*, and the relatively short worker reentry time.

The most dramatic influence of the synthetic pyrethroids on spider mite abundance has been in the southern San Joaquin Valley and the crop most dramatically affected has been almonds. To demonstrate this, an 8 year old orchard (Merced cv.) was selected for an insecticide efficacy trial in 1983. Treatments consisted of cyfluthrin, flucythrinate, permethrin, carbaryl (Sevin), and diazinon. They were applied to individual trees at a rate equivalent to 375 gallons per acre with a high pressure handgun sprayer and replicated 10 times. Cyfluthrin 2.4 EC was applied at .025, .050, and .075 lbs. (AI)/acre. Flucythrinate 2.5 EC was applied at .04, .08, and .12 lbs. (AI)/acre. These two compounds were sprayed on August 9 and 26, 1983 Both compounds are not registered for commercial use on almonds. Permethrin 3.2 EC at .4 lb. (AI)/ acre , carbaryl 80 SP at 5 lbs (AI)/ acre, and diazinon 50W at 2 lbs (AI)/acre were applied once on August 9, 1983. These materials were all registered for use on almonds. An untreated check was also included. No other treatments had been applied to this orchard in 1983 or 1984.

Evaluation of the treatment effects on spider mite abundance was made using the presence/absence sampling method described by Zalom et al.(1984). Five leaves were sampled from each tree at random around the periphery and the sprinkler line in 1983. Fifteen leaves were sampled per tree in 1984. Each leaf was examined for the presence or absence of any life stage of growth webspinning and predator mites. Samples were taken five times in 1984 beginning just after petal fall and until hull split when the orchard was treated with a miticide. The data were analyzed using a two-way analysis of variance and Duncan's (1955) multiple range test in 1983. Due to tree mortality in the winter of 1983, replicate numbers were not equal in 1984; therefore Student-Newman-Keuls test (Sokal & Rohhlf 1969) was used to separate means.

Table 1 shows the results of the insecticide treatments on spider mite abundance. Few Pacific mite were present in 1983, with none being detected on the pretreatment sample made on August 3. On September 8, 1983 a highly significant difference (p<0.01). was found between the untreated trees and all the treatments. There was no difference detected between trees treated with insecticides.

Beginning with the earliest sampling date in 1984, the trees that had received any of the pyrethroid treatments the previous summer had higher *T. pacificus* populations. This relationship continued in all subsequent samples. The difference between any of the pyrethroid treatments and the other treatments and untreated control was significant on the last three sampling dates (P<0.5). On each of these three dates, the population level on the pyrethroid treated trees exceeded the control action threshold of 45% infested leaves proposed by Zalom et al. (1984), but the population levels of mites on the other treatments never reached the control action level. The threshold has been established at 45% infested leaves if the predator mite *G. occidentalis* is present in the orchard. It is based on the assumption that premature leaf drop may result in crop loss in subsequent years.

Few predator mites were present in this orchard in 1983 or in the first four samples of 1984 (Table 2). On the last sampling date in 1984 predators were found in all of the treatments. Significantly more leaves with predators were found in the flucythrinate treatments at the two higher rates and the permethrin treatment than in the other Treatments (P<0.05). This response may seem somewhat unexpected but the trial was based on single tree treatments with the pyrethroid treatments resulting in higher pest mite problems. Migration of predators would quickly occur from nearby untreated trees and quickly respond to the increased prey population.

The impact that synthetic pyrethroids can have in subsequent infestation from webspinning spider mites is clear. Even though the example shown in this paper occurs in almonds, experience has shown the same to be occurring where these materials are being used in other deciduous fruit crops. Severe spider mite outbreaks have followed the use of synthetic pyrethroids in pears in Oregon and apples in Washington (Hoyt et al. 1978 and Hall 1977).

References Cited

1. Bentley, W.J., F.G. Zalom, W.W. Barnett, and J.P. Sanderson. 1987. Population densities of *Tetranychus* spp. (Acari:Tetranychidae) after treatment with insecticides for *Amyelois transitella* (Lepidoptera:Pyralidae). J. Econ. Entomol. 80:193-199.

2. Hall, F.R. 1979. Effects of synthetic pyrethroids on major insect and mite pests of apple. J. Econ. Entomol. 72:441-447.

3. Hoyt, S.L., P.H. Westigard, and E.C. Burts. 1978. Effects of two synthetic pyrethroids on the codling moth, pear psylla, and various mite species in northwest apple and pear orchards. J. Econ. Entomol. 71:431-434.

4. Zalom, F.G., P. Verdegaal, W. Bentley, C. Pickel, and J. Connell. 1995. Insect and mite research in almonds. In: Proceedings of 23rd Almond Industry Conference, Modesto, CA. pp 1-4.

Table 1. Effects of foliage spray applications on Pacific mites, *Tetranychus pacificus* (McGregor) on almonds in replicated single tree plot tests, Tejon Ranch (Kern Co.), California, 1983.

	A.I. lbs/	Treatment dates[b]		Percent infested leaves[c]		
Material[a]	acre	8/9	8/26	8/3	8/26	9/8
Baythroid 2.4EC	.025	X	X	0	8	58 b
Baythroid 2.4EC	.050	X	X	0	10	66 b
Baythroid 2.4EC	.075	X	X	0	10	68 b
Payoff 2.5 EC	.04	X	X	0	10	46 b
Payoff 2.5EC	.08	X	X	0	12	50 b
Payoff 2.5EC	.12	X	X	0	16	58 b

Pounce 3.2EC	.4	X		0	16	68 b
Sevin 80S	5.0	X		0	12	64 b
Diazinon 50W	2.0	X		0	10	62 b
Control	---			0	0	12 a

[a] Applied with handgun at 300 psi.
[b] Ten replications.
[c] Five leaves per replicate were sampled in 1983. Treatments followed by the same letter not significantly different at .01 level using Duncan's Multiple Range test.

Table 2. Effects of 1983 foliage spray applications on Pacific mites, *Tetranychus pacificus* (McGregor) on almonds in replicated single tree plot tests, Tejon Ranch, California, 1984.

Material[a]	A.I. lbs/ acre	Percent infested leaves[c] 3/7	4/26	5/22	6/12	7/3
Baythroid 2.4EC	.025	8.10 abc	14.1 ab	41.3 b	80.0 b	93.3 b
Baythroid 2.4EC	.050	5.90 abc	22.2 bc	53.3 b	93.3 b	99.3 b
Baythroid 2.4EC	.075	14.03 c	15.3 bc	60.0 b	94.3 b	100.0 b
Payoff 2.5 EC	.04	6.0 abc	14.7 abc	48.0 b	88.0 b	96.0 b
Payoff 2.5EC	.08	10.40 bc	22.9 c	51.1 b	88.1 b	95.5 b
Payoff 2.5EC	.12	12.60 c	24.5 c	63.7 b	93.3 b	98.5 b
Pounce 3.2EC	.4	9.50 bc	17.1 bc	51.4 b	89.6 b	88.6 b
Sevin 80S	5.0	0.0 a	2.9 ab	11.9 a	15.5 a	34.8 a
Diazinon 50W	2.0	1.7 ab	0.9 a	10.9 a	19.2 a	40.0 a
Control	---	0.7 a	0.7 a	4.0 a	10.0 a	40.0 a

[a] Applied with handgun at 300 psi in August, 1983. Baythroid & Payoff treated 9 and 26 Aug. 1983. Others treated 9 Aug. 1983.
[b] Ten replications.
[c] Fifteen leaves per replicate were sampled in 1984. Treatments followed by the same letter in the same column not significantly different at .05 level using student Newman Keul's test.

Table 3. Effects of foliage spray applications on the Western Orchard Predator mite, *Metaseiulus occidentalis* (Nesbitt) on almonds in replicated single tree plot tests, Tejon Ranch, California, 1983.

Material[a]	A.I. lbs/ acre	Treatment dates[b] 8/9	8/26	Percent infested leaves[c] 8/3	8/26	9/8
Baythroid 2.4EC	.025	X	X	0	0	0
Baythroid 2.4EC	.050	X	X	0	0	0
Baythroid 2.4EC	.075	X	X	0	0	0
Payoff 2.5 EC	.04	X	X	0	0	0
Payoff 2.5EC	.08	X	X	0	0	0
Payoff 2.5EC	.12	X	X	0	0	0
Pounce 3.2EC	.4	X		0	0	0
Sevin 80S	5.0	X		0	0	0
Diazinon 50W	2.0	X		0	0	0
Control	---			0	0	2

[a] Applied with handgun at 300 psi.
[b] Ten replications.
[c] Five leaves per replicate were sampled in 1983. Treatments followed by the same letter not significantly different at .05 level using student Newman Keul's test.

Table 4. Effects of 1983 foliage spray applications on the Western Orchard Predator mite, *Metaseiulus occidentalis* (Nesbitt) on almonds in replicated single tree plot tests, Tejon Ranch, California, 1984.

Material[a]	A.I. lbs/ acre	Percent infested leaves[c]				
		3/7	4/26	5/22	6/12	7/3
Baythroid 2.4EC	.025	0	0.7	0	0.7	14.1b
Baythroid 2.4EC	.050	0	0	0	0.0	10.4b
Baythroid 2.4EC	.075	0	0	0	0.0	12.4b
Payoff 2.5 EC	.04	0	0	0	0.0	31.3a
Payoff 2.5EC	.08	0	0	0	1.5	25.9a
Payoff 2.5EC	.12	0	0	0.7	0.0	15.5b
Pounce 3.2EC	.4	0	0	0.9	0.9	33.3a
Sevin 80S	5.0	0	0.7	0	1.5	16.3b
Diazinon 50W	2.0	0	0	0	1.7	8.6b
Control	---	0	0	0	0.7	16.0b

[a] Applied with handgun at 300 psi in August, 1983. Baythroid & Payoff treated 9 and 26 Aug. 1983. Others treated 9 Aug. 1983.

[b] Ten replications.

[c] Fifteen leaves per replicate were sampled in 1984. Treatments followed by the same letter not significantly different at .05 level using student Newman Keul's test.

SPREAD OF *BOTRYOSPHAERIA DOTHIDEA* IN PISTACHIO ORCHARDS OF THE CENTRAL VALLEY

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Summary

An extensive search for the sources of spore inoculum of *Botryosphaeria dothidea* in pistachio orchards indicated only the presence of pycnidia producing pycnidiospores in all infected pistachio parts. Botryosphaeria blight was detected in several orchards in Colusa, Yolo, San Joaquin, Madera, Merced, Fresno, Tulare, and Kings counties. Botryosphaeria blight was not detected in orchards of Kern County. *B. dothidea* was associated with and isolated from fruit showing punctures and/or epicarp lesion caused by hemipteran insects. Hemipteran insects such as *Leptoglossus clypealis*, *Thyanta pallidovirens*, *Acrosternum* sp., and the Rhopalid, *Liorhyssus hyalinus,* when caged with fruit clusters sprayed with spores of *B. dothidea* resulted in significantly higher levels of infected fruit than on sprayed or non-sprayed fruit clusters not caged with insects. There was a positive linear correlation between the incidence of punctures on fruit caged with hemipterans and the fruit infected by *B. dothidea* or the fruit that had pycnidia of the pathogen. In conclusion, the 1995 results show that Botryosphaeria disease has been spreading in the San Joaquin and Sacramento Valleys and hemipterans may have played a significant role in this spread

Introduction

Botryosphaeria panicle and shoot blight caused by the ascomycete *Botryosphaeria dothidea* is one of the most devastating diseases of pistachio grown in California (Michailides, 1991). The first record of this disease in California pistachios is from the summer of 1984. The disease causes blight of shoots, clusters, leaves, and buds and produces shoot cankers. It was observed initially in a commercial pistachio orchard in Butte County and later in other orchards in Glenn and Tehama counties in northern California. Recently, we have found Botryosphaeria symptoms and have isolated the pathogen from orchards of the San Joaquin Valley (see survey below).

B. dothidea, reported previously under the synonym *B. ribis,* causes branch and trunk cankers on a variety of woody plants. In California, a *Dothiorella* sp., the pycnidial stage of the fungus, was reported to cause black cankers in the crotches and limbs and, occasionally, sudden wilting and dying of branches of English walnut (*Junglans regia* L.). The disease was named "melaxuma" of walnut. Similar symptoms caused by the same fungus occurred in willow trees (*Salix lasiolepis* Benth.) (Wolf and Wolf, 1939). In 1994 we reported the fungus on blighted shoots of willow trees growing close to a pistachio orchard. *B. dothidea* attacks more than 50 plant species, representing 34 genera and 20 families (Smith, 1934). It was first reported on almond in California in 1966, causing a band-like canker on the trunk or scaffolds of vigorous young trees (English et al., 1966). Both the pycnidial and the pseudothecial (ascosporic) forms of the fungus have been reported on giant sequoia (*Sequoiadendron giganteum*) and on coast redwood (*Sequoia sempervirens*) in California (Worrall et al., 1986) but not in almond or pistachio. The pycnidiospores need splashing rain or water from sprinklers to move around (Michailides & Morgan, 1993). However, if the fungus produced pseudothecia, ascospores could have been actively discharged, become airborne, and spread at long distances. No systematic surveys have yet been done searching for pseudothecia in pistachio orchards and other host plants. If pseudothecia were present in pistachio orchards, this fact alone could have explained the unusual spread and occurrence of Botryosphaeria disease in orchards of the San Joaquin Valley.

In a previous study, Michailides et al. (1987) showed that orchards close to natural vegetation are usually attacked by a number of small hemipterans early in the season and large hemiptera later in the season. We now suspect that hemipterans may play a role in spreading Botryosphaeria blight. Fruit clusters sent to our laboratory from an orchard in Madera County showed typical pycnidia of *B. dothidea* on pistachio fruits surrounding insect punctures. It is essential to understand the possible involvement of hemipteran insects in the epidemiology and spread of Botryosphaeria blight disease of pistachio. This knowledge would provide additional incentives for growers to effectively control these pests in pistachio orchards, especially since growers discontinue the sprays after shell hardening. Reducing these pests in pistachio orchards would also result in less incidence of epicarp lesion and lower stigmatomycosis disease, the latter being a disease of pistachio kernels transmitted by large hemipterans (Michailides & Morgan, 1990 and 1991).

Both 1995 and 1996 field observations also suggested that birds feeding on infected fruit bearing pycnidia may play a role in spreading the disease from orchard to orchard. In 1996, 58% of 43 bird-damaged fruit when plated on plates with acidified potato-dextrose agar yielded colonies of *Botryosphaeria dothidea*, suggesting that birds may play a role in spreading Botryosphaeria blight in the Central Valley.

The objectives of the 1995 study were 1) to survey pistachio orchards mainly in the Central Valley for presence of Botryosphaeria blight, 2) determine if pseudothecia of the pathogen are produced in pistachio orchards, and 3) determine the involvement of hemipteran insects in transmitting *B. dothidea.*

Orchard surveys. We surveyed 36 commercial pistachio orchards representing 10 different counties where pistachios are grown (Table 1). Up to nine orchards in each county were sampled in the following manner: 20 to 35 shoots exhibiting symptoms of blight and rachises arbitrarily were collected from six to eight rows in each orchard. All these samples were examined in the laboratory for the presence of fruiting structures of *B. dothidea.*

Association of *B. dothidea* with fruit showing insect punctures and epicarp lesion. Fruit with punctures by hemipterans and/or with symptoms of epicarp lesion were collected from seven commercial orchards, split, and examined for presence of mycelium in the inner surface of shells. When mycelia of fungi were found isolations were made to determine the fungal species present.

Transmission experiments. Various hemipteran insects collected from pistachio orchards were reared in the laboratory for several generations. The following adult insects were used in transmission experiments: *Thyanta pallidovirens*, *Chlorochroa uhleri, Leptoglossus clypealis,* and *Liorhyssus hyalinus.* Two to nine insects from each species were caged with pistachio shoots bearing fruit clusters which had been sprayed with a 4×10^4 spores/ml of *B. dothidea.* Three replications were used per insect species with 12 to 44 fruit per replication. Shoots sprayed with *B. dothidea* and non-sprayed fruit were enclosed in nylon mesh bags without including any hemipteran insects and served as controls. Fruit infection was recorded 2 to 3 weeks after caging the insects. In addition, fruit were recorded for presence of pycnidia and gumming on the punctures. All the insects (dead and alive) were captured and plated on acidified potato-dextrose agar to determine the levels of contamination by *B. dothidea.*

In a separate experiment a 60,000 spores /ml suspension of *B. dothidea* was prepared and sprayed on healthy pistachio clusters caged with each two *C. uhleri*, or 3-4 adults of *T. pallidovirens.* Shoots sprayed with the above suspension without insects and non-sprayed shoots enclosed in nylon mesh bags served as controls.

Results and Discussion

Survey of pistachio orchards for Botryosphaeria blight. *B. dothidea* was found in 70% of the commercial pistachio orchards surveyed and ranged from 5 to 100% of the sampled blighted shoots and 5-90% of the collected blighted rachises (Table 1). Approximately 45% of these orchards had also rachises with pycnidia of *B. dothidea.* Only pycnidia were found; none of the shoots or rachises had any pseudothecia. In addition, shoots and rachises had species of *Phomopsis* (ranging from 4-6%), *Camarosporium* (10-21%), and *Diplodia* (<1% - 45%). *Phomopsis* species have been reported previously causing shoot blight in California pistachios (Michailides et al., 1995) and *Camarosporium* causing a blight (similar to Botryosphaeria panicle and shoot blight) in pistachios grown in Greece (Zachos et al., 1974). The results of the 1995 survey indicate that Botryopshaeria blight has spread in orchards of the San Joaquin, Merced, Madera, Fresno, Tulare, Kings, Colusa, and Yolo counties. Although it may take several years until epidemics of this disease are noticed in these orchards, it is advisable that growers try to control the disease at this early stage. The best method for its control should be the pruning of all the infected shoots and clusters before the initiation of fall rains. Pruning most of the infected plant parts should be possible since presently only sporadic infections are found in a number of orchards. Because ascocarps of the pathogen have not been found in any of the samples from any of the 36 orchards surveyed, spread of the disease cannot be attributed to airborne ascospores at this time.

Association of *B. dothidea* with fruit showing insect punctures and/or epicarp lesion. Of 42-88% of fruit samples with insect punctures and/or epicarp lesion and showing fungal mycelium growing in the inside surface of their shell (Table 2), *B. dothidea* was isolated from 7 to 68% of the fruit samples in five out of seven orchards sampled. In 72-100% of the fruit samples, sap was present in the center of the punctures, which is a characteristic associated with hemipteran punctures.

Transmission experiments. Tables 3 and 4 summarize the transmission experiments. Significantly more fruit infected by *B. dothidea* in shoots caged with *L. clypealis* or *L. hyalinus* (Table 3). Although shoots caged with *Chlorochroa* or *Thyanta* had as much as or more infected fruit than the sprayed control shoots, the differences were not significant because of the great variation among the replications. The unsprayed control developed a low level of disease, suggesting that hemipterans might have fed on these fruit through the mesh bags (Table 3). In fact, we occasionally observed stinkbugs on the outer surface of the bags. Significantly more fruit developed typical pycnidia of *B. dothidea* in shoots caged with *Leptoglossus* or *Lyorhissus.* Fruit caged with 6-9 adult *Chlorochroa* showed trends towards a higher incidence of fruit with pycnidia than those caged with 3 *Chlorochroa* or 3-9 adults of *Thyanta* (Table 3). In general, the higher the incidence of fruit with insect punctures the greater the incidence of infected fruit and fruit bearing pycnidia (Table 3 and Figure 1A-B). This relationship was linear and significant (R^2 = 0.56, P < 0.01 for infected fruit and R^2 = 0.38, P < 0.05 for fruit bearing pycnidia of *B. dothidea*) (Figure 1).

In the second experiment, fruit caged with *T. pallidovirens* or *Acrosternum* species resulted in significantly more infected fruit and fruit bearing pycnidia (Table 4). This is the first experimental evidence that large hemipterans such as those used in this study can play an important role in the infection of pistachio fruit by *B. dothidea.* Hemipteran insects have been shown to transmit yeasts causing stigmatomycosis in pistachio fruit (Michailides & Morgan, 1990 & 1991). The results of this study also suggest that the same species of hemipterans can transmit *B. dothidea* to healthy fruit, resulting in successful infections. The data in Tables 3 and 4 are supported by observations such as those in which mycelia were initiated from stylet punctures in the inner surface of pistachio which have their shells completely sealed. Chitzanidis (1994) reported that infections of Botryosphaeria blight of pistachio fruit cv. Aegina grown in Greece started through wounds caused by an insect [*Palumbina guerini* (Thysanoptera)].

Conclusions

1. Botryosphaeria blight was detected in several pistachio orchards in Colusa, Yolo, San Joaquin, Merced, Madera, Fresno, Tulare, and Kings counties.

2. *B. dothidea* was recovered from fruit showing punctures and/or epicarp lesion symptoms in 70% of the orchards sampled in the San Joaquin Valley.

3. *Leptoglossus clypealis, Thyanta pallidovirens, Acrosternum* species (all large hemipterans), and the Rhopalid, *Liorhyssus hyalinus* resulted in a greater incidence of fruit infected by *B. dothidea,* thus these insects may play a significant role in spreading *B. dothidea* from orchard to orchard.

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Literature Cited

1. Chitzanidis, A. 1994. Pistachio nut diseases in Greece (Abstr.). First Intl. Symposium on Pistachio Nut. September 20-24, Adana, Turkey. p. 41.

2. English, H. Davis, J.R., and DeVay, J.E. 1966. Dothiorella canker, a new disease of almond trees in California. (Abstr.) Phytopathology 56:146.

3. Michailides, T.J. 1991. Pathogenicity, distribution, sources of inoculum, and infection courts of *Botryosphaeria dothidea* on pistachio. Phytopathology 81:556-573.

4. Michailides, T.J., and D. P. Morgan. 1990. Etiology and transmission of stigmatomycosis disease of pistachio in California. (Abstr.). Phytopathology 80:973.

5. Michailides, T.J., and D. P. Morgan. 1991. New findings on the stigmatomycosis disease of pistachio in California. Calif. Pistachio Industry. Ann. Rep. Crop Year 1990-91, pp. 106-110.

6. Michailides, T.J., and D.P. Morgan. 1993. Spore release by *Botryosphaeria dothidea* in pistachio orchards and disease control by altering the trajectory angle of sprinklers. Phytopathology 83:145-152.

7. Michailides, T.J., D.P. Morgan, and M.A. Doster. 1995. Foliar and fruit fungal diseases. Pages 148-160 in: Pistachio Production Short Course, Fresno.

8. Michailides, T.J., R.E. Rice, and J. M. Ogawa. 1987. Succession and significance of several hemipterans attacking a pistachio orchard. J. Econ. Entomol. 80:398-406.

9. Smith, C.O. 1934. Inoculations showing the wide host range of Botryosphaeria ribis. J. Agric. Res. (Washington, D.C.) 49:467-476.

10. Wolf, F.T., and Wolf, F.A. 1939. A study of *Botryosphaeria ribis* in willow. Mycologia 31:217-227.

11. Worrall, J.J., Correll, J.C., and McCain, A.H. 1986. Pathogenicity and teleomorph-anamorph connection of *Botryosphaeria dothidea* on *Sequoiadendron giganteum* and *Sequoia sempervirens*. Plant Disease 70:757-759.

12. Zachos, D.G., Tzavella-Klonari, K., and Roubos, J.C. 1974. A disease of pistachio tree (*Pistacia vera* L.) caused by the fungus *Camarosporium pistaciae* n. sp. Ann. De l' Instit. Phytopath. Benaki, N.S.) 11: 53-58.

(Figure not available)

Figure 1. Relationship of incidence of hemipteran insect punctures on pistachio fruit and incidence of fruit infected by *Botryopshaeria dothidea.* **A,** Incidence of fruit bearing pycnidia, and **B,** Incidence of infected fruit with and without pycnidia.

Table 1. Frequency of *Botryosphaeria dothidea* in dead shoots and rachises of pistachio collected in spring and summer 1995 and examined in the laboratory.

County (orchard)	**Shoots with *B. dothidea*** (%)[1]	**Rachises with *B. dothidea*** (%)
Glenn		
1	18	50
Colusa		
1	5	0
Yolo		
1	11	5
2	65	65
San Joaquin		
1	67	
2	100	95
3	85	90
Madera		
1	5	0
2	0	0
3	5	0
4	0	0
5	10	0
6	10	0
7	25	10
8	50	60
9	15	5
Merced		
1	70	75
2	10	0
Fresno[2]		
1	+	ND
2	+	+
3	+	ND
Tulare		
1	5	5
2	0	0
3	40	40
4	15	15
5	40	50
6	90	50
Kern		
1	0	
2	0	0
3	0	0
4	0	0
5	0	0
Kings		
1	31	77
2	0	0
3	0	0
4	0	0

[1] Other fungi present were species of *Phomopsis* (4-6%), *Camarosporium* (10-21%), and *Diplodia* (<1-45%).

[2] Several shoots and rachises were observed in the field with a hand lens.

Table 2. Association of *Botryosphaeria dothidea* with punctures by hemipterans and epicarp lesion of pistachio fruit.

Orchard	Nuts examined[1]	Epicarp lesion (%)	Wounds with gum (%)	Presence of fungal mycelium inside shell (%)	*B. dothidea* (%)[2]
A	15	60	73	60	7
B	50	100	96	88	68
A	50	100	78	70	56
C	17	100	100	42	47
D	80	100	74	74	0
E	100	98	76	73	42
F	100	93	72	47	0

[1] Nuts were selected for presence of punctures by hemiptera and epicarp lesion symptoms.
[2] *B. dothidea* was confirmed by plating mycelia on acidified potato-dextrose agar.

Table 3. Effects of hemipteran insects in transmitting *Botryosphaeria dothidea* in Kerman pistachios (Kearney Agricultural Center).

Insect species[1]	Insects caged	Infected fruit (%)	Infected fruit with pycnidia (%)	Fruit showing punctures by hemiptera (%)[2]
Leptoglossus clypealis	3	45.5 a[3]	18.2 a	22.7 a
Liorhyssus hyalinus	2	36.8 a	15.8 ab	10.5 a-c
Chlorochroa uhleri	9	17.4 b	8.7 b-c	17.4 ab
Chlorochroa uhleri	6	16.7 b	12.5 a-c	8.3 a-c
Chlorochroa uhleri	3	11.1 b	0.0 d	11.1 a-c
Thyanta pallidovirens	9	8.1 b	2.9 d	11.4 a-c
Thyanta pallidovirens	6	6.6 b	3.9 cd	5.6 bc
Thyanta pallidovirens	3	8.4 b	1.0 d	5.9 bc
Sprayed control	0	6.6 b	4.4 cd	1.4 c
Nonsprayed control	0	2.5 b	0.0 d	4.4 bc

[1] Insects were caged with clusters sprayed with 40,000 spores/ml of *B. dothidea* on 29 August.
[2] Punctures were characteristic of the feeding patterns by large hemiptera.
[3] Numbers followed by different letters in the same column were significantly different according to an LSD test at $P = 0.05$.

Table 4. Effect of caging hemipteran insects with healthy pistachios in transmitting *Botryosphaeria dothidea* (Kearney Agricultural Center).

Insect species[1,2]	Infected fruit (%)	Fruit with pycnidia
Thyanta pallidovirens	13.9 a[3]	2.8 ab
Acrosternum sp.	9.1 a	6.1 a
Sprayed control	1.3 b	1.3 b
Nonsprayed control	1.2 b	0.0 b

[1] Insects were caged with pistachio fruit on 8 August and recorded on 22 August.
[2] At the end of the experiment all insects were plated on acidified potato-dextrose agar to determine levels of contamination with *B. dothidea*.
[3] Numbers followed by different letters in the same column are significantly different using LSD test at $P = 0.05$.

ABSTRACTS

PACIFIC DIVISION, THE AMERICAN PHYTOPATHOLOGICAL SOCIETY OF AMERICA, Fresno, CA, May 30-June 1, 1996

The Influence Of Soil Flooding And Temperature On The Survival Of *Thielaviopsis Basicola*, *Brent A. Holtz, Bruce A. Roberts, U.C. Cooperative Extension, Madera and Kings Counties, respectively, Joseph G. Hancock and Albert R. Weinhold, U.C. Berkeley*

Flood irrigation of fallow cotton fields has become a fairly common practice for farmers in the Tulare Lake Basin area of the San Joaquin Valley. Over 20,000 hectares of land have been flooded to reduce black root rot, caused by *Thielaviopsis basicola*. Growers have flooded fields at various times of the year with mixed success. Previously, we found flooding to be more successful in the summer than in the winter. The influence of soil flooding and temperature was studied on naturally-occurring field populations of *T. basicola*. Soils from cotton fields were flooded for 10, 20, 30, and 40 days and incubated at 10, 20, 30, and 40 ^{o}C. The inoculum density (chlamydospores/aleuriospores) was monitored using the TB-CENP semiselective medium (Holtz et al., Plant Dis. 78:986-990). When soil was flooded and incubated at 10 or at 20 ^{o}C, survival of *T. basicola* was significantly greater ($P < 0.01$) and comparable to that in nonflooded soil. However, when soil was incubated at 30 or at 40 ^{o}C, the recovery from flooded soil was significantly reduced ($P < 0.01$). These results indicate that *T. basicola* inoculum can survive soil flooding for long periods when temperatures are less than 20 ^{o}C. These findings have practical applications for growers trying to determine when to flood their fields. Summer, when temperatures are above 20 ^{o}C, should be the ideal time to flood in order to reduce inoculum.

Chemical and Biological Control of the Summer Bunch Rot Complex of Wine Grapes in the San Joaquin Valley,
R.A. Duncan, J.J. Stapleton, and G.M. Leavitt, U.C. Cooperative Extension Stanislaus Co., Kearney Agricultural Center, and U.C. Cooperative Extension Madera Co.

Summer bunch rot is a serious disease complex of many wine and table grape (*Vitis vinifera*) varieties grown in the San Joaquin Valley. Many fungal and bacterial genera are involved, including, *Botrytis*, *Aspergillus*, *Penicillium*, *Cladosporium*, *Rhizopus*, and *Acetobacter*. Three field trials (two in Sacramento and one in Madera Counties) were conducted in 1995 to determine the efficacy of several registered, non-registered, and experimental fungicides on various components of the disease complex on cv. Zinfandel. In the Sacramento County trials, several biological agents were recovered from immature flower clusters, mass reared in the laboratory, and compared against commercial fungicides, basal leaf removal, and pre-bloom applications of gibberellic acid for rot reduction. As in previous trials conducted by these authors, iprodione was not efficacious against this disease complex and resulted in increased incidence of some rot components. Some biological agents, including isolates of *Aureobasidium*, *Cladosporium*, *Cryptococcus* spp. and an unidentified bacterium reduced rot incidence equivalent to most tested fungicides (P<0.05). Only gibberellic acid reduced incidence of sour rot in these trials.

Testing Pathogenicity of *Xanthomonas campestris* pv. *juglandis*. *B.L. Teviotdale, T. Turini, and S. Lindow, U.C. Kearney Agricultural Center and U.C. Berkeley*

Inoculation of walnut cv. Chico fruit in late April through mid-May resulted in levels of infection optimum for determining relative pathogenicity of *Xanthomonas campestris* pv. *juglandis* isolates. To test experimental variability, an inoculation with one isolate was replicated 40 times, and the data were analyzed as a randomized complete block design with ten treatments in four replications. There were no significant differences among inoculation treatments. Twelve isolates were similarly tested using four replications per isolate. One isolate consistently produced higher percentages of blighted fruit. Each experiment was conducted on three dates. April to early May inoculations produced 73 and 83% blighted fruit in 1994 and 1995, respectively. Inoculations before mid-April and after mid-May produced lower incidences of blighted fruit. In the earliest inoculations, 20 and 35% of fruit dropped fruit in 1994 and 1995, respectively and less than 5% in the two later inoculations in both years. There were no differences between the inoculation and control treatments. The advantages of conducting pathogenicity studies, from late April to mid May, are that you avoid premature drop in early April and decreased susceptibility to infection in early June.

THIRD INTERNATIONAL CONGRESS OF NEMATOLOGISTS, July 1996, Guadaloupe

Performance Of Various Cultural Control Methods Used Prior To Replanting Tree Or Vine Crops, *M. McKenry, U.C. Kearney Agricultural Center*

Four years of fallowing or nonhost crops can provide relief from most components of tree and vine replant problems. Forty days of flooding followed by fallowing one year does not reduce population levels of endoparasitic nematodes but does provide first-year growth of replants similar to that achieved from methyl bromide treatments. Foliar treatments of glyphosate herbicide to Nemaguard Peach trees 60 days before their removal followed by 18 months of fallowing also provide replant growth similar to that of methyl bromide treatments but with no reductions in populations of endoparasitic nematodes. Replanting trees in the drive row 3 m away from the old row can double first-year tree growth but that is only one-third of the growth resulting from a methyl bromide treatment. An 18-month crop rotation involving nonhosts for *Pratylenchus vulnus* and *Tylenchulus semipenetrans* gave half the growth achieved by methyl bromide treatments but no protection against nematode buildup. Applications of water extracts from *Tagetes tenuifolia* even when followed in 30 days by 1 m water proved phytotoxic to replanted trees and vines. Urea treatments of 654 kg/ha drenched to 1.7 m depth gave 95% reduction of nematodes in soil but like foliar glyphosate, flooding, crop rotation and Tagetes extracts, provided no reductions of those nematodes present in remnant roots. Effective soil fumigants or their replacement methods must kill remnant roots and nematode stages therein wherever endoparasitic nematodes pose a production problem and resistant rootstocks are unavailable.

XX INTERNATIONAL CONGRESS OF ENTOMOLOGY, Florence, Italy, August 25-30, 1996

Influence of Ground Covers, Parasitoids and Spiders on Variegated Leafhopper (Erythroneura variabilis) in California Grape Vineyards, *M.J. Costello and K.M. Daane, U.C. Cooperative Extension, Fresno Co., and U.C. Kearney Agricultural Center*

An experiment was conducted from 1993-95 in a table grape vineyard in the San Joaquin Valley of California, to better understand the role of cover cropping, parasitoids and predators as mortality agents of leafhoppers (*Erythroneura variabilis* and *Erythroneura elegantula*) on grapes. Ground cover was a combination of autumn-sown purple vetch and barley followed by warm season resident grasses. Parasitoids were primarily *Anagrus* spp., which attack leafhopper eggs; spiders (Araneae) comprise over 90% of the predator community. Third generation leafhopper nymphal density was consistently reduced by approximately 25% in the ground cover treatment compared to clean cultivation. We offer four possible explanations for this finding: 1) parasitism is higher with ground covers; 2) altered microclimate has negative effect on leafhoppers; 3) ground covers favor spider populations and 4) competition from ground covers makes grapevines a poorer host for leafhoppers. Treatment effects on parasitism were not consistent and cannot be explained at this time. Microclimate differences were recorded, e.g., vine canopy temperature was about 1.5 degrees C cooler with ground covers in July and August, but this is unlikely to have greatly affected leafhopper or natural enemy populations. Total spider numbers were not significantly different between treatments. However, in the months of August and September numbers of one spider, *Trachelas pacificus*, were 64% higher on vines with ground covers, which amounts to about 7 more spiders per vine. This is not because the ground covers provide supplemental habitat for *Trachelas*, because the spider species complex on the ground covers is very different from that in the vine canopy. A more likely explanation is that prey which build up on the ground covers, especially Diptera (flies), fly into the vine canopy and provide food for canopy spiders. Competition from the ground covers, as evidenced by higher berry brix measurements and lower brush weights, may have made the vines poorer hosts for leafhoppers and contributed to their higher mortality.