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DISEASE MONITORING AND PREDICTION OF BOTRYOSPHAERIA BLIGHT IN CALIFORNIA PISTACHIO ORCHARDS

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Background and Objectives

Botryosphaeria panicle and shoot blight caused by *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & De Not. (imperfect stage *Dothiorella* sp.) is a devastating disease of California pistachios (*Pistacia vera* L.) [1]. Initially this disease was a problem only in pistachios grown in the Sacramento Valley, but in the last 4 to 5 years the disease has spread and caused significant losses in pistachios grown in the San Joaquin Valley [2]. Typical symptoms include shoot blight in early May and during June, and panicle, leaf, and fruit blights during summer. The pathogen also infects and kills buds during late summer and fall. Pycnidia of a *Dothiorella* sp. develop by mid August mainly in the basal portions of shoots, rachises, leaf stems, buds, the center of leaf lesions, and on part or the entire surface of the nut epicarp [1]. The fungus overwinters on the tree in infected shoots, panicles, buds, leaf stems, and leaf blades, and is spread by rains or water from sprinklers [3]. Control of Botryosphaeria blight is difficult and involves recognizing the disease early and pruning infected parts. However, there are currently no methods for a grower to predict the presence/absence of the disease in the orchard until symptoms develop. Waiting for the development of symptoms before deciding on a control strategy can be disastrous as current chemical control measures are ineffective. The objective of this study was to

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develop a disease monitoring method that could help growers predict Botryosphaeria blight and make management decisions before the disease develops to uncontrollable levels.

Materials and Methods

Monitoring was based on the fact that infection or contamination of pistachio buds by *B. dothidea* can be quantified. During January through March 1996 and 1997, more than 100 random buds were collected from more than 15 trees per orchard from 7 and 12 commercial orchards, respectively. Two methods of bud processing were employed: 1) by crushing buds in water and plating the mixtures, or 2) by splitting buds in half and plating half-buds on acidified potato-dextrose agar after surface sterilization in a 0.1% NaOCl solution for 1 minute. The plates were incubated at 30ºC and recorded for *B. dothidea* after 5 days. At harvest time the incidence of Botryosphaeria blight was recorded on 10 pre-flagged trees per orchard by counting all the Botryosphaeria blighted shoots and panicles per tree. Multiple regressions were used to determine possible relationships between the levels of propagules or the incidence of colonization by *B. dothidea* of pistachio buds and the disease incidence in the field at harvest. The best relationships indicated by the highest correlation coefficients (R^2) should indicate the best time for bud sampling, the best method of bud processing, and the most accurate prediction of the disease.

Results and Discussion

For both years of the study, the propagules of *B. dothidea* in pistachio buds or the incidence of colonization of buds by *B. dothidea* during the dormant season were positively correlated to the incidence of Botryosphaeria shoot and panicle blight in the summer. The R^2 for significant correlations in 1996 ranged from 0.68 - 0.88 (P = 0.002 to 0.02) and in 1997 from 0.54 to 0.91 (P = 0.0001 to 0.016). Splitting the buds in two and plating the two halves on acidified potato-dextrose agar was shown to be the most effective method for monitoring and predicting Botryosphaeria panicle and shoot blight in commercial orchards. Sampling buds in late March was shown to be the best time. Therefore, monitoring of *B. dothidea* in pistachio buds in the dormant season can be used to predict Botryosphaeria blight disease occurring during the summer. Predicting the presence/absence and the severity of expected Botryosphaeria blight can help growers in the early detection of the disease allowing the pruning out blighted shoots, panicles and cankers which could reduce Botryosphaeria blight in pistachio orchards in California.

References Cited

1. Michailides, T. J. 1991. Phytopathology 81:566-73.

2. Michailides, T. J., D. P. Morgan, D. Felts, and B. Ribiero. 1997. California Pistachio Industry Annual Report, Crop Year 1996-97, pp. 73-81.

3. Michailides, T. J., and D. P. Morgan. 1993. Phytopathology 83:145-52.

MANAGEMENT OF APHIDS, SILVERLEAF WHITEFLIES, AND CORN STUNT LEAFHOPPERS USING REFLECTIVE PLASTIC MULCH AND INSECTICIDES: 1998 SEASON REVIEW

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Introduction

Reflective mulches have been used successfully to reduce and delay the incidence of aphid and whitefly colonization and to delay the onset of aphid-borne virus diseases (Summers et al. 1996; Stapleton and Summers 1995, 1997; Summers and Stapleton 1998). Summers and Stapleton (1998) also found reflective mulch repelled corn stunt leafhopper resulting in increased growth and yield of sweet corn. However, reflective mulches cease to repel insects after 60+ percent of the surface is covered by the plant canopy (Maelzer 1986). At that point, the incidence of virus diseased and whitefly infested plants rises sharply (Summers et al. 1996; Summers and Stapleton 1998). While yields from crops grown over mulches are significantly higher than those grown over bare soil, added protection should increase yields even more. Insecticides, by themselves, are ineffective in virus control (Gibson and Rice 1989) and offer little relief for whitefly suppression (Costa et al. 1993). During 1998, we continued our studies on the efficacy of reflective mulches in the management of vegetable insects and also evaluated several new generation insecticides to determine if, when used in conjunction with reflective mulches, the suppression of invading insects and/or the virus diseases they transmit could be extended.

Materials and Methods

Treatments (mulches and/or insecticides) were arranged in a randomized complete block design with 6 replications. Plants were grown on raised beds over which the mulches had been placed and anchored around the edges with soil. Plots were 3 rows wide by 30 feet long and separated from adjacent plots by 10 feet of bare soil. The center row was used for all data collection and the two outside rows remained as guard rows. Mulches evaluated in 1 or more trials included: 1) silver embossed polyethylene (AEP), 2) aluminum metalized polyethylene--Colorup® (Specialty Ag), 3) red polyethylene (Sonoco), 4) aluminum metalized polyethylene (Sonoco), 5) black polyethylene (Sonoco), 6) clear polyethylene. Colorup and the Sonoco metalized mulches both cast the appearance of aluminum foil. Insecticides evaluated included: Thiodan, Knack, Admire, Fulfill, and Actara in the squash trial and Lannate in the second corn trial. No insecticides were used in the first corn trial. In the second trial, Lannate was applied on 4 and 16 September and 1 October at 0.50 lbs. (AI)/acre. In the squash trial, Admire, at 0.25 lbs. (AI)/acre was applied as a pre-plant injection ca. 2-3 inches deep into the center of the planting beds the day before seeding. All other insecticides were applied as foliar sprays using a CO_2 powered backpack sprayer equipped with 8002 T-jet nozzles in the equivalent of 20 gallons of water per acre. The first application (Fulfill @ 0.045 lbs. (AI)/acre, Actara @ 0.045 lbs. (AI)/acre, Thiodan @ 0.75 lbs. (AI)/acre, and Knack @ 0.09 lbs. (AI)/acre) was made on 25 Sept. at 50% canopy coverage. A second application (Fulfill @ 0.045/acre, Thiodan @ 0.75/acre and Knack @ 0.09/acre) was made on 19 Oct.

Alate aphids and adult whiteflies were counted by selecting the youngest fully expanded leaf on each plant, gently turning it over, and counting the number of individuals present on the underside. Whitefly nymphs were accessed by selecting a 2-3 week old leaf from each plant, placing it is a ziplock bag, and returning it to the laboratory where the number of individuals were counted. Following counting, the leaves were processed through a LiCor leaf area meter to determine leaf size. Corn stunt leafhoppers populations were determined by taking 25 D-vac samples per plot and returning the bags to the laboratory where the number of leafhoppers were counted. Data were processed by ANOVA and means separated by Fisher's LSD.

Results and Discussion

Sweet Corn. Two corn trials were conducted in 1998, the first was planted on 24 April and the second on 12 August. The April planting matured before corn stunt leafhopper populations developed. There were no other insect or disease problems noted in the April planting and differences are due principally to the effects of the mulches (Table 1). Yields, both pounds of marketable ears per plot and mean number of ears per plot, were significantly higher in all mulch plots than in the unmulched control. Individual ears from all mulched plots were also heavier than were those from the unmulched plot. These data support the notion that production can be increased approximately 2 fold by growing plants over some type of plastic mulch even in the absence of insect or disease pressure.

Table 1. Mean yield (pounds) per plot, number of ears per plot, weight (pounds) per ear, and mean ear length (inches) of sweet corn, cv. Silver Queen, grown over selected plastic mulches. Trial number 1, planted 24 April, harvested 20 July 1998. Parlier, CA.

Mulch Type	Yield	Number Ears	Weight/ Ear	Ear Length
Red	24.40 bc	34.17 bc	0.45 b	7.2 a
Black	25.90 c	34.83 bc	0.45 b	7.3 a
White	19.99 bc	29.17 bc	0.43 b	7.2 a
Clear	24.63 bc	35.83 bc	0.46 b	7.3 a
Colorup	18.80 b	27.33 b	0.39 b	7.1 a
AEP	25.56 c	36.83 c	0.45 b	7.2 a
Control	9.06 a	14.67 a	0.24 a	7.3 a

[1]Means followed by the same letter(s) are not significantly different, $P < 0.05$. Fisher's LSD.

Corn stunt leafhopper is generally more prevalent in the late summer and early fall and the second trial was planted 12 August. The number of corn stunt leafhoppers, potato leafhoppers, and thrips (species not determined, but probably western flower thrips) from plants grown over selected plastic mulches is shown in Table 2. The reflective mulches, Colorup, Sonoco, and AEP were effective in repelling corn stunt leafhopper. Even the red plastic, for reasons as yet unknown, appeared to repel corn stunt leafhoppers early in the season. Reduction in corn stunt leafhopper number is also reflected in the decrease in the number of plants infected with corn stunt sprioplasm (Table 3). Three sprays with Lannate were not effective in reducing corn stunt leafhopper densities. The level of corn stunt disease was significantly higher in the sprayed plot than in the unsprayed control. Similar results have been reported in the past where insecticides led to an increase in the incidence of insect-borne virus diseases in many crops. The metalized mulches, Colorup and Sonoco, appeared to be more effective than the red or AEP mulches.

We also observed some significant differences in the densities of potato leafhopper and thrips although the numbers were more highly variable than those observed for corn stunt leafhopper (Table 2). The data are presented only to stimulate discussion and encourage additional research or observations. Reductions on the 11 September sample date were generally greater than on other sample dates. By the second sample date, plants were beginning to cover mulches and reflective mulches lose much of their effectiveness when 50-60% of their surface is covered by the plant canopy. At this point, insufficient data are available to determine if these mulches are really effective in reducing densities of potato leafhopper or thrips. Additional studies will be necessary to determine if these insects can be managed by using reflective mulches.

Table 2. Mean number of corn stunt leafhoppers, potato leafhoppers, and thrips per 25 D-vac samples taken from sweet corn, cv Silver Queen, grown over selected plastic mulches. Trial number 2 planted 12 August 1998. Parlier CA.[1]

Mulch Type	Sample Date	Mean No. Corn Stunt Leafhopper	Mean No. Potato Leafhopper	Mean No. Thrips
Colorup	11 Sept.	8.33 a	4.33 a	3.00 a
Sonoco	11 Sept.	12.17 ab	5.33 ab	2.00 a
Red	11 Sept.	20.17 bc	12.17 c	6.17 ab
AEP	11 Sept.	18.33 abc	10.33 bc	6.50 ab
Unmulched	11 Sept.	35.83 d	13.00 c	5.67 ab
Unmulched + Lannate [2]	11 Sept.	28.83 cd	10.83 c	7.50 b
Colorup	16 Sept.	6.17 a	5.00 a	4.33 a
Sonoco	16 Sept.	15.83 ab	9.17 ab	6.67 ab
Red	16 Sept.	35.50 bc	12.17 ab	14.67 abc
AEP	16 Sept.	19.17 ab	16.17 b	17.17 c
Control	16 Sept.	50.33 cd	11.33 ab	16.50 c
Unmulched + Lannate [2]	16 Sept.	61.67 d	11.83 ab	21.50 c
Colorup	23 Sept.	37.17 a	14.83 a	20.67 a
Sonoco	23 Sept	31.67 a	18.83 ab	19.50 a
Red	23 Sept	138.83 c	27.33 b	33.83 a
AEP	23 Sept	73.00 ab	24.67 b	21.00 a
Control	23 Sept	170.83 c	18.50 ab	15.33 a
Unmulched + Lannate [2]	23 Sept	121.22 bc	20.00 ab	12.83 a

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD. Comparisons are valid only within sample dates and columns of individual insects and not between sample dates or across rows.
[2]Lannate applied on 4 and 16 September and 1 October at 0.50 lbs/acre (AI) in the equivalent of 20 gallons water per acre.

Table 3. Percentage of corn plants infected with corn stunt disease. Trial number 2. Planted 12 August, harvested 4 November 1998.

Mulch Type	Percent Infected Plants
Colorup	0.00 a
Sonoco	1.98 a
Red	2.00 a
AEP	0.00 a
Control	23.28 b
Unmulched + Lannate [2]	30.49 c

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.
[2]Lannate applied on 4 and 16 September and 1 October at 0.50 lbs/acre (AI) in the equivalent of 20 gallons water per acre.

Yields (pounds of marketable ears per plot) from plants grown over the three reflective mulches were significantly higher than from those grown over red mulch, unmulched, or the unmulched plus insecticide treated plots (Table 4). Maximum yields were obtained from plots with metalized mulch. There was no difference in the number of ears per plot among the treatments, but ears from plants grown over the reflective mulches had larger kernels and were fuller than those from the other treatments as indicated by heavier ear weights (Table 4). Mean ear length was not affected by mulch type. Mean stalk weigh, an indication of potential yield in field corn processed for silage, was significantly lower in the unmulched and unmulched plus insecticide plots than in the mulched plots (Table 4). This can be attributed to the significantly higher incidence of corn stunt disease in these plots (Table 3).

Squash. Aphids. The metalized mulch Colorup was used, since in previous studies no differences were found among any of the metalized mulches tested relative to their effectiveness in repelling alate aphids or adult whiteflies. (Stapleton and Summers 1996, 1997; Summers and Stapleton 1998). Admire, applied as a pre-plant soil treatment without reflective mulch, was significantly less effective in preventing colonization by alate aphids during early plant growth than was Colorup alone. (Table 5). The higher rate of colonization in the Admire plots during the early growth period is sufficient to allow the introduction of viruses during the critical early growth stage. Foliar insecticide applications were made on 25 September, a point at which the plant canopy covered approximately 50-60% of the mulch surface. In samples taken 3 days later, none of the foliar sprays were effective in reducing alate aphid population to levels equivalent to the metalized mulches or Admire (Table 5). In general, none of the insecticides in the absence of the mulch, performed as well as they did with mulch or as well as the mulch alone. By 12 October, all treatments were significantly better than the unmulched/unsprayed control. By this time however, aphid populations were declining and it is difficult to draw meaningful conclusions. Because of low numbers, no conclusions regarding aphid numbers can be drawn from the second insecticide application.

Table 4. Mean yield per plot, mean number of ears per plot, mean weight per ear, mean ear length in sweet corn, and mean stock weight, cv Silver Queen, grown over selected plastic mulch. Trial number 2. Planted 12 August, harvested 4 November 1998.

Mulch Type	Mean Yield (Pounds)/Plot[1]	Mean Number of Ear/Plot[1]	Mean Weight (Pounds)/Ear[1]	Mean Ear Length (In.)[1]	Mean StalkWeight (Pounds)[1]
Colorup	30.40 c	45.5 b	0.40 c	7.84 bc	66.40 c
Sonoco	35.57 d	46.5 b	0.42 c	8.00 c	64.53 c
Red	24.03 a	42.5 ab	0.35 a	7.51 a	55.71 b
AEP	29.81 bc	45.33 b	0.39 bc	7.81 bc	59.72 bc
Control	25.58 ab	44.67 b	0.36 ab	7.82 bc	36.83 a
Unmulched + Lannate [2]	23.46 a	38.17 a	0.32 a	7.68 ab	36.65 a

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.
[2]Lannate applied on 4 and 16 September and 1 October at 0.50 lbs/acre (AI) in the equivalent of 20 gallons water per acre.

Table 5. Mean number of alate aphids/leaf on squash plants grown over Colorup mulch with and without selected insecticides. Insecticide applications shown by arrow.

Treatment[2]	Sampling Date							
	September			October				
		↓				↓		
	14	21	28	5	12	19	21	23
Colorup	0.2 a	0.4 a	0.1 ab	0.1 a	0.2 a	0.1 ab	0.1 ab	0.1 a
Colorup + Fulfill (1 Appl.)	-	-	0.2 ab	0.1 a	0.1 a	0.1 ab	0.1 a	0.1 a
Colorup + Fulfill (2 Appl.)	-	-	0.0 a	0.1 a	0.0 a	0.0 a	0.1 a	0.1 a
Colorup + Actata	-	-	0.2 ab	0.1 a	0.2 a	0.1 ab	0.0 a	0.1 a
Colorup + Admire	0.2 a	0.0 a	0.0 a	0.1 a	0.2 a	0.1 ab	0.1 ab	0.1 a
Unmulched + Admire	2.6 b	1.6 b	0.2 ab	0.2 ab	0.2 a	0.2 b	0.3 c	0.2 bc
Unmulched + Fulfill (1 Appl.)	-	-	0.7 bc	0.8 cd	0.4 a	0.1 ab	0.2 bc	0.1 a
Unmulched + Fulfill (2 Appl.)	-	-	1.3 cd	0.5 bc	0.4 a	0.1 ab	0.1 ab	0.15 ab
Unmulched + Actara	-	-	0.8 bc	0.3 abc	0.4 a	0.1 ab	0.1 ab	0.1 a
Unmulched + Thiodan (2 Appl.)	-	-	0.7 bc	0.6 bcd	0.3 a	0.1 ab	0.0 a	0.1 a
Unmulched + Knack (2 Appl.)	-	-	2.1 d	1.2 e	0.4 a	0.1 ab	0.1 ab	0.15 ab
Control	4.1 c	3.4 c	1.2 c	1.0 de	1.0 b	0.4 c	0.1 ab	0.3 c

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.

Whiteflies. As in previous years, the metalized reflective mulch was very effective in repelling silverleaf whitefly adults early in the plant growth cycle (Table 6). The Admire plots, in the absence of reflective mulch, had significantly lower silverleaf whitefly adult densities than did the plot with no mulch and no insecticide (control plot) (Table 6). However, Admire added nothing to the efficacy of the reflective mulch when used alone (Table 6). A foliar spray with Knack was ineffective in reducing adult silverleaf whitefly populations (Table 6). Foliar applications of Fulfill, Actara, and Thiodan significantly reduced adult silverleaf whitefly densities 3 days after application (Table 6). The control with Fulfill and Actara appeared to hold up fairly well over the following 3 week period while Thiodan lost effectiveness after 10 days. A second application of Fulfill, Thiodan, and Knack was made on 19 October. All materials except Knack again provided adequate control (Table 6). In the absence of reflective mulch, only Admire was effective in reducing the density of silverleaf whitefly nymphs (Table 7).

None of the insecticides significantly enhanced control by the mulch alone.

Table 6. Mean number of silverleaf whitefly adults per leaf on squash plants grown over Colorup mulch with and without selected insecticide treatments[1].

Treatment	Sampling Date							
	September			October				
			↓				↓	
	14	21	28	5	12	19	21	23
Colorup	1.1 a	3.6 a	1.4 ab	1.0 ab	6.1 ab	10.2 bcde	5.4 abc	8.9 bcd
Colorup + Fulfill (1 Appl.)	-	-	2.2 ab	0.7 ab	2.9 ab	6.2 bc	6.7 abc	7.4 abc
Colorup + Fulfill (2 Appl.)	-	-	1.6 ab	1.1 ab	5.0 a	6.1 abc	4.9 abc	6.8 abc
Colorup + Actara	-	-	0.5 a	0.3 a	5.1 a	4.9 abc	5.6 abc	7.5 abc
Colorup + Admire	1.4 a	1.3 a	0.4 a	0.2 a	1.3 a	0.3 a	0.2 a	1.7 a
Unmulched + Admire	9.3 b	4.4 a	2.2 b	0.7 ab	4.4 a	0.7 a	0.8 ab	3.7 ab
Unmulched + Fulfill (1 Appl.)	-	-	17.8 bcde	8.6 cd	17.4 bc	19.8 f	13.4 de	15.2 de
Unmulched + Fulfill (2 Appl.)	-	-	18.1 bcde	5.9 cd	16.0 bc	8.4 abcd	5.6 abc	7.8 abc
Unmulched + Actara	-	-	3.3 abc	5.1 bcd	16.5 bc	12.8 cdef	4.4 abc	12.9 cde
Unmulched + Thiodan (2 Appl.)	-	-	9.7 abcd	4.0 abc	23.1 cd	17.3 def	10.3 cd	2.6 ab
Unmulched + Knack (2 Appl.)	-	-	32.1 e	15.7 e	28.3 d	19.8 f	17.3 e	23.3 f
Control	17.4 c	31.8 b	21.8 c	9.8 d	24.3 cd	18.8 ef	10.3 cd	17.1 ef

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.

Table 7. Mean number of silverleaf whitefly nymphs per cm^2 of squash leaf. Leaves were selected from plants grown over Colorup mulch with and without selected insecticide treatments[1].

Treatment	Sampling Date		
	September	October	
	↓		
	21	28	5
Colorup	0.002	0.9 a	1.2 a
Colorup + Fulfill (1 Appl.)	-	1.0 a	1.6 a
Colorup + Fulfill (2 Appl.)	-	0.4 a	1.2 a
Colorup + Actara	-	0.8 a	1.7 a
Colorup + Admire	0.001 a	0.2 a	0.2 a
Unmulched + Admire	0.011 b	1.1 a	1.1 a
Unmulched + Fulfill (1 Appl.)	-	37.3 b	34.0 c
Unmulched + Fulfill (2 Appl.)	-	14.0 b	22.5 bc
Unmulched + Actara	-	4.4 ab	8.4 ab
Unmulched + Thiodan	-	9.3 b	12.9 bc
Unmulched + Knack	-	30.3 b	21.6 bc
Control	0.011 b	20 8 b	22.5 ab

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.

Silverleaf Symptoms. The percentage of plants showing symptoms of squash silverleaf was determined on the final harvest date, 15 November, by visual inspection. The incidence of squash silverleaf was significantly reduced by the metalized reflective mulch (Table 8.). Admire, as a stand alone treatment, was as effective as the mulch or the mulch + Admire combination in reducing the incidence of squash silverleaf. This is readily apparent from the nymphal densities shown in Table 7. None of the insecticides significantly enhanced the reduction in silverleaf symptoms afforded by the mulch alone (Table 8).

Table 8. Incidence of squash silverleaf in plants grown over a metalized reflective mulch with and without selected insecticide treatments[1].

Treatment	Per Cent of Plants With Silverleaf Symptoms
Colorup	0.5 a
Colorup + Fulfill (1 Appl.)	4.2 a
Colorup + Fulfill (2 Appl.)	6.5 a
Colorup + Actara	0.3 a
Colorup + Admire	0.3 a
Unmulched + Admire	3.5 a
Unmulched + Fulfill (1 Appl.)	87.7 c
Unmulched + Fulfill (2 Appl.)	89.4 c
Unmulched + Actara	74.1 bc
Unmulched + Thiodan	54.5 b
Unmulched + Knack	50.5 b
Control	87.7 c

[1]Means followed by the same letter(s) are not significantly different, P < 0.05. Fisher's LSD.

Yields. Total accumulated yield of marketable fruit harvested over 15 dates are shown in Table 9. The results show that the metalized reflective mulch was the key to producing increase yields. The mulch alone was as effective as any of the mulch plus insecticide treatments and significantly more effective than any of the insecticide treatments in absence of the mulch.

Table 9. Mean cumulative yield[1] (pounds per plot) of squash grown over reflective metalized mulch with and without selected insecticide applications[2]

Treatment	Total Pounds of Marketable Fruit per Plot
Colorup	26.0 c
Colorup + Fulfill (1 Appl.)	24.5 c
Colorup + Fulfill (2 Appl.)	23.9 c
Colorup + Actara	27.5 c
Colorup + Admire	22.5 c
Unmulched + Admire	9.0 ab
Unmulched + Fulfill (1 Appl.)	6.5 ab
Unmulched + Fulfill (2 Appl.)	8.3 ab
Unmulched + Actara	10.7 b
Unmulched + Thiodan	6.3 ab
Unmulched + Knack	7.9 ab
Control	5.1 a

[1] Total of 15 harvest dates. Harvest made approximately every other day.
[2]Means followed by the same letter(s) are not significantly different, $P < 0.05$. Fisher's LSD.

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References Cited

1. Costa, H. S., J. K. Brown, S. Sivasupramanism, and J. Bird. 1993. Regional distribution, insecticide resistance and reciprocal crosses between the 'A' and 'B' types of *Bemisia tabaci*. Insect Sci. Appl, 14: 127-138.

2. Gibson, R. W., and A. D. Rice. 1989. Modifying aphid behavior. pp. 209-224. *In*: Aphids, their biology, Natural enemies, and control Vol. 2C A. K. Minks and P. Harrewijn [eds.]. Elsevier, Amsterdam.

3. Maelzer, D. A. 1986. Integrated control of insect vectors of plant virus diseases. pp. 483.512. *In*: Plant virus epidemics-monitoring, modeling and predicting outbreaks. D. L. McLean, R. G. Garrett, and W. G. Ruesink. [eds.]. Academic Press, New York.

4. Stapleton, J. J., and C. G. Summers. 1995. Reflective mulches repel aphids and protect cucurbitaceous crops from virus diseases. UC Plant Prot. Quart. 5(1): 4-6.

5. Stapleton, J. J., and C. G. Summers. 1997. Reflective mulches for managing aphids, aphid-borne viruses, and silverleaf whitefly: 1996 Season Review. UC Plant Prot. Quart. 7(1): 1-5.

6. Summers, C. G., J. J. Stapleton, A. S. Newton, R. A. Duncan, and D. Hart. 1996. Comparison of sprayable and film mulches in delaying the onset of aphid-transmitted virus diseases in zucchini squash. Plant Dis. 79: 1126-1131.

7. Summers, C. G., and J. J. Stapleton. 1998. Management of vegetable insects using plastic mulch: 1997. Season Review. UC Plant Prot. Quart. 8 (1 & 2): 9-11.

ABSTRACTS

JOINT ANNUAL MEETING OF AMERICAN PHYTOPATHOLOGICAL SOCIETY AND ENTOMOLOGICAL SOCIETY OF AMERICA, Las Vegas, NV, November 8-12, 1998

<u>Weather requirements for sporulation of *Monilinia fructicola* on mummified stone fruit from California orchards</u>. *C. X. Hong and T. J. Michailides, U. C. Kearney Agricultural Center.*

Monilinia fructicola (G. Wint.) Honey can survive some winters in mummified stone fruit in California orchards. Subsequently, weather requirements for sporulation of *M. fructicola* on mummified nectarine and plum fruit were determined. Weather factors examined included wetting period from 0 to 12 h, incubation relative humidity (r.h.) from 40 to 100%, and temperature from 4 to 30 C. *M. fructicola* sporulated on mummified plum fruit after at least 2 h wetting period plus 24 h incubation under saturated air at 20 C, and on a few unwetted mummified nectarine fruit under saturated air at 20 and 25 C for 68 h. The incidence of mummified fruit exhibiting sporulation increased as the wetting period increased up to 2 h (nectarine) and to 12 h (plum). After 12 h wetting of mummified fruit, the fungus sporulated under as low as 50% (nectarine) and 58% r.h. (plum). The incidence of the sporulation increased with increasing temperature from 10 to 20 C (nectarine) and 15 to 20 C (plum). This information can help in developing forecast schemes for brown rot blossom blight of stone fruit in California orchards by accurately quantifying the primary spore inoculum.

Host Specificity in *Verticillium dahliae*. *R.G. Bhat and K.V. Subbarao, U. C. Davis.*

Verticillium dahliae isolates from artichoke, bell pepper, cabbage, cauliflower, chili pepper, cotton, eggplant, lettuce, mint, potato, strawberry, tomato, and watermelon, and *V. albo-atrum* from alfalfa were evaluated for their pathogenicity on host from which they were isolated, plus broccoli. One-month-old seedlings were inoculated using a root-dip inoculation technique in the greenhouse with a suspension containing of 10^7 conidia/ml. Plant height, percent disease incidence, disease severity, and dry root and shoot weights were recorded six weeks after inoculation. Bell pepper, cabbage, cauliflower, cotton, eggplant, and mint isolates exhibited host specificity and differential virulence on other hosts whereas isolates from artichoke, lettuce, potato, strawberry, tomato, and watermelon did not. Bell pepper plants were resistant to all *Verticillium* isolates except to its own isolate and to an isolate from eggplant. Broccoli was resistant to cabbage and cauliflower isolates, and immune to all other *Verticillium* isolates. Thus, host specificity exists in some isolates of *V. dahliae*. Implications of these results to crop rotation will be discussed.

Genetic Characterization of *Verticillium dahliae* Isolates using RAPD-PCR and Vegetative Compatibility. *R. G. Bhat and K. V. Subbarao, U. C. Davis.*

Isolates of *Verticillium dahliae* from 14 crops were analyzed using the random amplified polymorphic DNA (RAPD) method, and they were compared with an isolate of *V. albo-atrum* from alfalfa. Forty random primers were screened, and 18 of them amplified DNA from *Verticillium*. Based on RAPD banding patterns, cabbage and cauliflower isolates formed a unique group, distinct from other *V. dahliae* and *V. albo-atrum* groups. Minor genetic variations were observed among *V. dahliae* isolates from other hosts regardless of whether they were host-specific or not. These isolates were also characterized for vegetative compatibility groups (VCGs) through complementation of nitrate nonutilizing (*nit*) mutants. Cabbage and cauliflower isolates did not produce *nit* mutants. The isolate from cotton belonged to VCG 1; isolates from bell pepper, eggplant, potato and tomato to VCG 4; and the remaining isolates to VCG 2. There was no correlation between VCGs and RAPD banding patterns. Even though the isolates belonged to different VCGs, they shared similar RAPD profiles.

Development of a 'slow-dying' resistance screen for lettuce against Sclerotinia minor. *J. C. Hubbard, K. V. Subbarao, and E. J. Ryder, U. C. Davis, and USDA/ARS.*

True resistance to lettuce drop incited by *S. minor* has not yet been positively identified. In the course of greenhouse screening of lettuce germplasm for resistance, it was observed that certain lines took several days longer than others to collapse after the initiation of infection. We have termed this 'slow-dying' resistance and believe that it may offer a novel means of identifying resistance to *S. minor* in lettuce. A total of 177 cultivars and plant introductions were evaluated. Inoculum was produced by growing *S. minor* on rye seed for 3 wk, after which a single rye grain was placed 1 cm from the stem of 4-wk-old lettuce plants. Plants were monitored daily for the first appearance of *Sclerotinia*-induced watersoaking, and the time until ultimate plant collapse was recorded. The total number of dead inoculated plants and the interval between inoculation and plant death were also recorded. Several lines with 'slow-dying' resistance have been identified. Studies are underway to determine the heritability of this resistance and whether this trait is linked to early bolting.

Verticillium Wilt of Lettuce. *K. V. Subbarao, J. C. Hubbard, T. R. Gordon, and E. J. Ryder, U. C. Davis, and USDA-ARS.*

Lettuce in a small area of coastal California has been severely affected by a vascular wilt disease since 1995. Symptoms included chlorosis, wilting of mature plants, and vascular discoloration. *Verticillium dahliae* was consistently isolated from root and crown tissue of affected plants. Pathogenicity was established by dipping roots of 30-day-old lettuce plants in a suspension containing 10^6 conidia ml^{-1} for 5 min.; control plants were dipped in sterile distilled water. All plants were potted and incubated in a greenhouse. Only inoculated plants exhibited wilting and *V. dahliae* was reisolated from them. Soil from affected fields yielded the highest number of microsclerotia g^{-1} of soil reported for any cropping system. Isolates from lettuce were pathogenic to strawberry and vice versa, but non-pathogenic to cauliflower. Genetic analyses of isolates from lettuce and strawberry suggested a close relationship between them. All crisphead lettuce cultivars were highly susceptible, and other lettuce types exhibited differential reactions to Verticillium wilt. Lettuce is a new host of *V. dahliae* and the disease could potentially be a major problem.

<u>Mechanism of Broccoli-Mediated Verticillium Wilt Reduction.</u> *K.G. Shetty, J.C. Hubbard, K.V. Subbarao, and O.C. Huisman. U. C. Davis and U. C. Berkeley.*

Broccoli is immune to all isolates of *Verticillium dahliae* except those from cauliflower and cabbage to which it is resistant. Broccoli can be used as a soil amendment to reduce soil populations of *V. dahliae*. In a greenhouse experiment, plant growth response and root colonization in broccoli and cauliflower were studied in soils with different levels of *V. dahliae* inoculum, and with or without fresh broccoli residue amendments. Broccoli amendments had a positive effect on plant height, number of leaves and on shoot and root dry weight despite the presence of the pathogen. Broccoli amendments reduced vascular discoloration and disease development. Colonization of the root cortex was studied on root samples taken at different intervals using an immunoenzymatic staining assay. Colonization of roots by *V. dahliae* was reduced in plants grown in soil amended with broccoli. In unamended soils, the outer cortex of feeder roots of both broccoli and cauliflower was colonized by *V. dahliae*. Broccoli, however, in addition to its attrition effect on *V. dahliae* propagules in the soil, may also possess a potential trap crop effect.

<u>Effects of Soil Moisture and Temperature on the Germination of Sclerotinia sclerotiorum Sclerotia</u>. *J. J. Hao, K. V. Subbarao, and J. M. Duniway, U. C. Davis.*

Germination of sclerotia from three isolates of Sclerotinia sclerototiorum were determined under various soil moisture and temperature combinations in two soil types from California. The soils were equilibrated to matric potentials, of 0, 0.033, 0.066, 0.1, 0.15, 0.3 -Mpa and transferred to petri dishes. Ten sclerotia in two replications from each isolate were buried just beneath the equilibrated soils, plates sealed, and incubated at 5, 10, 15, 20, 25, 30 ^oC under a 12/12 hr light/dark regime. The number of germinated sclerotia, apothecial initials, and mature apothecia was recorded weekly. Viability of ungerminated sclerotia was tested on WA four months later. No germination occurred at 5, 25, and 30 ^oC at all soil moistures. Ten to 20% sclerotia produced apothecia at 10 and 15 ^oC and 0, 0.15 and 0.3 -Mpa, and 40 and 80% at 0.033 to 0.1 -Mpa. At 20 ^oC and 0 to 0.1 -Mpa, only apothecial initials were observed. Soil types affected sclerotial survival. Sclerotia survived longer at low soil moisture at 5 ^oC, and at 0 to 0.066 -Mpa and 10 to 20 ^oC decreased sclerotial viability.

<u>Validation of an Updated Warning System for Lettuce Downy Mildew</u>. *B. M. Wu, K. V. Subbarao, and A. H. C. van Bruggen, U. C. Davis.*

Control of lettuce downy mildew (*Bremia lactucae*) in coastal California has relied on protective fungicidal sprays. Fungicide application before infection is critical in controlling the disease. A previously developed infection-based warning system was modified and validated in commercial fields in the Salinas Valley. In each field trial, 4 or 5 treatments were carried out: a) no spray; b) growers' scheduled spray; c) spray following the updated warning system; d) the original warning system; and/or e) a commercial warning system. The treatments were arranged in a randomized complete block design with 3 replications. Each plot consisted of 16 rows that were at least 60 m long. Downy mildew incidence was evaluated every 3-7 days. Over all trials, fungicide use was reduced 50-67% when sprays followed any of the warning systems compared to the growers' scheduled spray. There were not significant differences in disease incidence among the treatments since weather conditions were not conducive in 1996 and 1997. Errors in weather and leaf wetness forecasts sometimes resulted in one unnecessary spray. Studies are underway to improve both forecasts.

Effects of solar Radiation on Survival of *Bremia lactucae* Sporangia on Lettuce Leaves. *B. M. Wu, K. V. Subbarao, and A. H. C. van Bruggen. U. C. Davis.*

The effects of solar radiation, UVA, and UVB on the survival of *B. lactucae* sporangia were studied. In an outdoor experiment, sporangia deposited on lettuce seedlings were exposed to 100, 50, 25, and 0% sunlight. Sporangia were also exposed to two levels of UVA (315-400 nm), one level each of fluorescent light and darkness in a separate growth chamber experiment. After exposure for 0, 2, 4, 6, 8 and 12 hr, 2 pots of seedlings were sampled from each treatment, and sporangia were washed off from 15 leaves. Germination of sporangia was determined in water after incubation in the dark at 15 degrees C for 24 hr. The remaining leaves on sampled seedlings were incubated further, and infection recorded 9 days later. Germination and infection were similar after exposure to 0 and 25% sunlight, but were significantly reduced after exposure to 50 and 100% sunlight. While UVB significantly reduced sporangium viability compared to darkness or fluorescent light, UVA did not. These results are being incorporated into an existing disease forecasting model to improve its accuracy.

Moving Air and Relative Humidity Affect Sporulation of *Bremia lactucae*. *H. Su, A. H. C. van Bruggen, and K. V. Subbarao, U. C. Davis*.

Field observations indicated that high wind speed at night inhibited sporulation by *Bremia lactucae*. In a preliminary growth chamber experiment there was no sporulation when the speed of moving air was above 1 ms^{-1}. In subsequent experiments, lettuce cotyledons inoculated with *B. lactucae* were exposed to moving air with speeds of 0, 0.1, 0.5 and 1 ms^{-1} and relative humidities (RH) of 81, 90, 95 and 100% and 15 ^{o}C in a growth chamber. There were significant interactions between air speed and RH in their effect on the numbers of cotyledons with sporulation (P=0.0001) and the number of sporangia produced per cotyledon (P=0.008). Numbers of sporulating cotyledons and sporangia per cotyledons declined exponentially with increasing air speeds between 0 and 1 ms^{-1}. The slopes were steeper at higher RH. Sporulation was most abundant between 90% and 100% RH at wind speeds between 0 and 01 ms^{-1}. These results have important consequences for prediction of conditions conducive to epidemic development of lettuce downy mildew.

Spore Release of *Bremia lactucae* is Affected by Timing of Light Initiation and Decrease in Relative Humidity. *H. Su, A. H. C. van Bruggen, and K. V. Subbarao, U. C. Davis.*

A suction-impaction mini spore trap was developed to study the spore release of *Bremia lactucae.* Lettuce with sporulating cotyledons was exposed to light periods of 4:00 to 16:00 hr, 6:00 to 18:00 hr and 8:00 to 20:00 hr at constant relative humidity (RH) of 100% and 15 ^{o}C in a growth chamber. Few spores were released during the dark periods, but spore release increased sharply after the initiation of the three light periods. Spore release reached a maximum after one hour of light and then declined until only a few spores were detected. In additional experiments, sporulating cotyledons were exposed to a reduction in RH (from 100% to 94%) 2 hr before and after initiation of the light started, spore release continued to increase after an initial increase following light initiation, reached a maximum three hours later and then declined. When relative humidity decreased two hours before light started, spore release increased within one hour after the drop in RH followed by a second increase after light initiation.

Studies on sources of inoculum of Alternaria late blight of pistachio. *N. Evans, T. J. Michailides, D. Morgan, and D. Felts, U. C. Kearney Agricultural Center.*

Alternaria late blight, caused by *Alternaria alternata*, is a devastating disease which occurs annually in California pistachio orchards. Latent infections occur on leaves and fruit early in the season, and severe symptoms develop in late July/early August as weather conditions become conducive to pathogen growth. A sharp increase in the number of airborne *Alternaria* conidia is also observed at this time. Sever symptoms include defoliation, shell staining, and the development of moldy kernels. In order to determine levels of infection which occur early in the season, a bud splitting and washing technique was carried out on samples from 26 orchards (Sacramento/San Joaquin valleys). The mean percentage of buds contaminated with *Alternaria alternata* was 93.2% (max. 100%, min. 63%) with a mean of 170 infective propagules per bud. A detailed examination of levels of infection on bud scales, flowers, leaves and fruit at two orchards indicated that some infection occurred immediately following bud break. The importance of *Alternaria* propagules in buds as a source of inoculum influencing the development of late blight is currently under investigation.

Staining of pistachio nutshells indicates fungal decay in the kernels. *M. A. Doster, T. J. Michailides. U. C. Kearney Agricultural Center.*

Pistachio nuts were collected from several commercial orchards at harvest (1992-1997) and from two processing plants after storage (1994). Typically, fungal kernel decay in California orchards occurs in "early splits" (ES), which are nuts with hulls that have ruptured along the shell split. For the ES, about 10% had no external shell staining, over 80% had staining along the shell suture, and the rest had staining but not along the suture. For moderately stained nuts (between 1-10% of surface stained), suture-stained ES had more decay caused by *Aspergillus* fungi, dematiaceous fungi (mainly *Alternaria* and *Ulocladium*), and fungi in general than ES with no staining along the suture. Similarly, more than 18% of the moderately stained processed nuts with suture staining had fungal decay, whereas none of the processed nuts without suture staining had kernel decay. For both ES and processed nuts, as the amount of shell staining increased, the incidence of fungal kernel decay also increased. The amount and type of external shell staining indicate the likelihood of kernel decay in pistachio nuts and are useful characteristics for the removal of decayed nuts.