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EPIDEMIOLOGY AND CONTROL OF ALTERNARIA LEAF BLIGHT
BLOOM AND FOLIAGE DISEASE CONTROL
WOUND TREATMENTS FOR CERATOCYSTIS CANKER

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EPIDEMIOLOGY AND CONTROL OF ALTERNARIA LEAF SPOT

Alternaria leaf spot causes leaf lesions and defoliation and can be found in orchards throughout the state. In most instances, noticeable defoliation occurs only after harvest and causes no apparent damage. Where severe and repeated preharvest defoliation occurs, most commonly in southern valley areas, trees are weakened and yield losses can exceed 50 %. The disease appears to be exacerbated by dews and high humidity and often is worse on trees that have spreading canopies than those that are more upright.

Our recent research confirmed *Alternaria alternata* as the pathogen and we identified a fungicide, azoxystrobin, (Abound) as a tool in disease management. By tracking disease development and pathogen population levels during the season we found that the pathogen appears in mid-spring and develops rapidly by early summer; symptom development soon follows. This year we continued studies of pathogen populations, disease development through the season, screening pathogen isolates for pathogenicity, comparing the effect on disease of upright vs spreading tree shape, and testing treatment timing and candidate fungicides for disease control.

Objectives

1) Survey orchards to identify common elements among orchards with similar levels of disease severity.

2) Test the effects of tree shape on disease incidence.

3) Evaluate fungicides and application timing for disease control.

4) Monitor climate in selected locations to associate environmental conditions with disease.

5) Monitor population on leaves and disease development as latent infections in leaves during the season.

6) Continue evaluation of variety trial.

Methods

Pathogen population, disease development and climatic factors were monitored in each of two commercial orchards in Kern County. In one orchard, a wind machine was placed at the end of a row of cultivar Kahl trees to test the possibility that dew formation and disease incidence could be inhibited or reduced along the gradient from near to far from the machine. If successful, measurement of weather conditions and disease along the gradient would provide an insight into environmental conditions governing the disease. The maximum air movement and expected effects from the wind machine were greatest at about 100 feet from the machine and diminished to none at 500 feet. The wind machine was operated from 3:00 a.m. to 6:00 a.m. on those nights when the air temperature dropped to within 4 F of the dewpoint, and was first run on 11 June, was operated on 16, 17, and 10 days in June, July, and August, respectively, ending 11 August. Data were collected from either of two trees each located at 90 to 100 feet (near) and 490 to 500 feet (far) from the wind machine. One tree at each location was equipped with a data logger to collect environmental data. Sensors were placed midway in the canopy on the east and west sides of the tree. In addition to these sensors, Hobo monitors were placed on the east and west sides of the tree about 8 feet above and below the micrologger sensors. Additional Hobos were installed midway on the east sides of six other trees evenly spaced down the row. Hobos and microloggers recorded readings once every 30 and 60 minutes, respectively. There were no replications in this experiment. The grower treated the orchard three times in spring with Abound. Tree rows were oriented north to south.

Tree shape was examined in a second orchard by triple tying branches of 'Butte' almond trees such that they had an upright configuration and these were compared to trees pruned to the standard (open and spreading) tree shape. Data were collected from either of the center two trees. There were five replications of each treatment and each plot was three rows wide, with the 'Butte' row in the center, and ten trees long. Microloggers and Hobo monitors were located as described above in one tree in one replication of each treatment. No fungicides were applied and tree rows were oriented east to west.

Pathogen populations were monitored by washing 100 leaves per sample in 200 ml sterile deionized water for 45 minutes, culturing 0.2 ml of the wash water on each of five culture plates, incubating the plates for 7 days, counting the number of *A. alternata* colonies, and calculating the average number of conidia per leaf. Disease development was tracked by counting the number of lesions present on the leaves used for population studies and by evaluating infection of detached frozen and fresh leaves. Detached leaf samples consisted of 40 to 50 leaves that were collected randomly or from exposed or internal leaves from east and west sides of trees. Leaves were surface sterilized for 2 minutes in 10% bleach, rinsed with sterile water, either frozen overnight or not, and incubated on wire racks over water in closed plastic boxes, at room temperature for 7 days. The number of infected leaves was counted and percent infected leaves calculated. Population and disease development data were collected every 2 to 3 weeks from March through September.

Seasonal development of the pathogen on leaves of cultivar Butte trees was similarly monitored at the Kearney Agricultural Center. The pathogenicity of six isolates of *A. alternata* was compared by inoculating 50 leaves on each of four trees with suspensions of 1×10^6 conidia per ml using a hand-held hand pump spray bottle. Immediately after inoculation, plastic bags containing wet paper towels were placed over the branches with the inoculated leaves and secured tightly. Bags were removed 3 days later and leaves were inspected for lesions 7 and 14 days later. On most of the same days and using the same trees, on which leaves were inoculated in the field, similar inoculations of leaves on detached shoots were made. Leavs and shoots were surface sterilized as above then shoots were inserted into foam blocks that were immersed in water, inoculated, and incubated in a mist chamber at 25 C for 7 days. There were four single-tree replicatons of each treatment, including non inoculated controls, arranged in a randomized complete block design.

Timing and efficacy of fungicide treatment were conducted in a third Kern County orchard. Timing treatments included two, three, and four applications of Abound fungicide applied to 'Butte' almond trees begun at various times in spring. Unregistered fungicides were applied to 'Sonora' trees three times at 2-week intervals beginning in mid April. All fungicides were applied to run-off using a hand-gun sprayer. There were four single-tree replications arranged in a randomized complete block design. Two hundred leaves per tree were collected on 12 August and examined for infections. The percent defoliation was estimated on 20 October 1999.

A survey was conducted of 17 orchards in Kern County having histories of Alternaria leaf spot and planted with the cultivar Butte in various combinations. One hundred leaves were collected from each of 10 trees in one row in each orchard on one day between 15 and 21 September. Percent infected leaves was calculated. These same trees were evaluated for defoliation on 17 or 18 November.

Results and Discussion

In the wind machine orchard, the pathogen was first detected in April but populations remained low or undetectable until an increase in July on the far tree and in August on the near tree (Fig. 1). There were more conidia on leaves from trees far from than near to the wind machine. Infections on detached leaves were infrequent until August, and there was essentially no difference in the percent infection between near and far trees (Fig. 2). Conidial populations were greater on internal than on exposed leaves (Fig 3), but detached exposed leaves developed more infections than did internal leaves (Fig. 4). There were generally fewer hours of dew but more hours of humidity greater than 95% in the near than the far tree (Table 1). Dew and high humidity were more frequent on the east than the west side of the trees. The slight differences in dew and relative humidity did not result in differences in disease levels, but the incidence of disease in the orchard was too low to draw any conclusions.

In the tree shape experiment, seasonal development of the pathogen followed a similar pattern beginning low in spring then rising in late summer with no differences between upright and standard treatments (Fig. 5). Disease incidence on detached leaves also increased during the season but did not differ between treatments (Fig 6). This lack of difference may in part be due to the light crop load that allowed the standard trees to remain more upright and not spread outward as occurs in heavier crop load years. As with the wind machine experiment, conidial populations were generally greater on internal than on exposed leaves (Fig 7), but detached exposed leaves developed more infections than did internal leaves (Fig. 8). There were more hours of dew and relative humidity greater than 95% in the upright than the open treatment (Table 2). The differences between treatments probably reflects instrument placement or other experimental factors because as mentioned above, the light crop load negated the expected effects of open canopy. Hours of dew were rather similar but hours of relative humidity were greater on the east than the west sides of trees.

The general weather conditions in 1999, and also the Abound treatments in the case of the wind machine orchard, kept the incidence of Alternaria leaf spot very low. Infections on leaves on trees in the wind machine experiment were first observed on 28 July when samples of 200 leaves yielded percent infections of 3.7 and 2.2 for near and far trees, respectively. Percent infected leaves on the trees remained low through the season. Disease incidence in the tree shape experiment, where no fungicide treatments were made, was higher and first observed on 15 July. By mid August percent leaf infection on the trees was 15.6 and 21.7 for the upright and standard treatments, respectively. Neither orchard suffered the debilitating defoliation associated with this disease.

That infection was most frequent on exposed than on internal leaves agrees with orchard observations and fits with the hypothesis that the dews favor the disease. Dew forms first on exposed surfaces thus exposed leaves would be most likely to become infected. Leaf exposure appears to be the overriding variable in determining infection.

At the Kearney Agricultural Center, seasonal development of the pathogen population on trees agreed with previous experience in that it was low to undetectable until late spring then rose quickly by mid to late summer (Fig 9). Disease incidence in the inoculation experiments mirrored that found in natural infection: incidence was low for early inoculation dates and increased during the season (Fig 10). The six isolates were similar in pathogenicity suggesting that there perhaps is not a particular strain of this common fungus that causes disease (Fig 11). Similar results were obtained in laboratory inoculations of detached leaves except that lesions seldom developed on non inoculated controls (data not presented).

The fungicide trial also experienced low disease levels. There were no significant differences among timing treatments (Table 3). The efficacy of experimental fungicides was similar and all were better than the control according to leaf infection count, but none differed from the control in the amount of defoliation that occurred at the end of summer (Table 4).

The survey revealed that the type of irrigation system used--flood, sprinkler or microsprinklers--did not affect the amount of disease although there was some tendency to more disease in flood irrigated orchards.(Fig. 12). Further review of the characteristics of these orchards may point to other variables common to those having greater or lesser amounts of disease.

The variety trial was not evaluated because disease did not develop.

BLOOM AND FOLIAGE DISEASE CONTROL

Objective

1) To test the timing and efficacy of fungicide treatments for control of blossom, fruit and foliage diseases.

Methods

Tests were conducted in Colusa and Madera Counties. We tested 20 materials, including registered and experimental fungicides, in various combinations, sequences, and timings. Materials were applied by hand-gun. In Madera County, timings for post bloom sprays included decisions based upon monitoring for shot hole.

Results and Discussion

Spring was relatively dry thus disease levels were generally low. Break, Elite, Flint, Indar, Rovral, Sedagri XF99002 and Stratego gave excellent control of brown rot and two applications were better than one (Tables 5 and 6). Abound, Elite, Flint, Indar, Stratego, Benlate + Captan and Topsin + Ziram gave the best scab control, and programs that included two treatments of scab-effective fungicides were better than those including only one (Table 7). Abound, Flint, and Stratego protected against leaf blight (Table 6). Shot hole infections and sporodochia were not found thus many entries were sprayed only in bloom. In orchards having no scab but requiring shot hole protection, the shot hole monitoring would have saved the later spray.

WOUND TREATMENTS TO CONTROL CERATOCYSTIS CANKER

Objectives

1) Test several wound dressing materials for prevention and control of Ceratocystis infections.

2) Determine the relationship of time between infection and surgery/treatment on control of current season infections.

Methods

The experiment was conducted on mature cultivar Nonpareil almond trees located at the Kearney Agricultural Center in Fresno County. Secondary scaffolds of similar diameter (7.3 to 12.2 cm) were inoculated on 1 October 1998. Using a 1.5 cm diameter cork borer, bark plugs were removed and the exposed bark inoculated by placing 1.2 cm diameter agar plugs collected from 15 day old cultures of the pathogen grown on acidified potato dextrose agar. The wounds were covered with parafilm for 5 days. Inoculated and non inoculated non treated controls were included.

The infections resulting from these inoculations were surgically removed 7, 50, and 100 days later. All tissue displaying necrosis was removed leaving a margin of at least 5 cm of healthy tissue surrounding the wound and infection. Immediately after surgery, wounds were painted with Benlate 10X (100 g Benlate 50) + Omni oil (2 ml) in 98 ml water, Nectec (a propiconazole + imazalil formulation), "Elixir" (0.35 g Kocide 101 + 1.13 ml Hexol + 0.19 ml linseed oil in 99 ml water), and LAB 2 (lanolin + beeswax + copper sulfate + neem oil). Treatments were arranged in a split plot design with the interval between inoculation and surgery/treatment the main plot and materials the subplot. There were two to three scaffolds for each main plot and five replications of the subplots which were arranged in a randomized complete block design. The length of the surgical wounds and cankers was measured on 11 October 1999.

Results and Discussion

The length of the surgical wound required to remove all visible evidence of infection increased with increased time between inoculation and surgery but the average canker length and percentage of wounds remaining infected decreased (Table 8). There were no significant differences among topical treatments and none differed from the surgery/nontreated control.

Although surgical removal soon after inoculation, a time that simulates cleaning up wounds soon after harvest, results in relatively small surgical wounds, most of these remain infected. The pathogen apparently is present is what seems to be healthy bark and wood and thus early surgery misses these invisible infections. Conversely, by winter, the canker has run its course for the year, the damage is clearly visible, and surgery at this time can be quite successful. However, none of the topical dressings improved control. Successful eradication of Ceratocystis infections can be accomplished by careful and well timed surgery without the need for chemical treatment.

Table 1. Average calculated hours per month and per day of dew and recorded hours of relative humidity > 95% on trees located near to and far from the wind machine, as measured by the data logger sensors, Kern County, 1999.

	HOURS PER MONTH							
	Dew				Relative humidity > 95%			
	Near	Far	East	West	Near	Far	East	West
April	117	121	117	122	200	184	195	189
May	34	43	40	37	89	71	86	73
June	40	49	51	39	139	97	134	103
July	25	32	27	19	81	61	82	60
August	26	28	14	13	166	150	184	149
Sept	6	1	4	3	82	79	94	67

	HOURS PER DAY							
	Dew				Relative humidity > 95%			
	Near	Far	East	West	Near	Far	East	West
April	3.9	4.0	3.9	4.1	6.7	6.1	6.5	6.3
May	1.1	1.4	1.3	1.2	2.9	2.3	2.8	2.6
June	1.4	1.6	1.7	1.3	4.6	3.2	4.5	3.4
July	1.0	1.3	1.1	0.8	3.2	2.4	3.3	2.4
August	0.8	0.9	0.4	0.4	5.3	4.8	5.9	4.8
Sept	0.8	0.1	0.2	0.2	5.1	4.9	5.9	4.2

z Dew events calculated from time when air temperature was within 1 C of the dewpoint.

Table 2. Average calculated hours per month and per day of dew and recorded hours of relative humidity > 95% as measured by the data logger sensors , tree shape experiment, Kern County, 1999.

	HOURS PER MONTH							
	Dew[z]				Relative humidity > 95%			
	Upright	Open	East	West	Upight	Open	East	West
April	103	67	90	84	173	151	175	148
May	36	15	26	25	112	92	121	89
June	33	13	22	23	109	75	114	69
July	17	2	8	11	110	---	---	---
August	6	1	3	3	125	2	82	44

	HOURS PER DAY							
	Dew[z]				Relative humidity > 95%			
	Upright	Open	East	West	Upright	Open	East	West
April	3.4	2.2	3.0	2.8	5.9	5.0	5.8	4.9
May	1.2	0.5	0.8	0.8	3.6	3.0	3.9	2.9
June	1.1	0.4	0.7	0.8	3.6	2.5	3.8	2.3
July	0.5	<0.1	0.2	0.4	3.5	---	---	---
August	0.2	<0.1	0.1	0.1	4.0	<1.0	2.6	1.4

z Dew events calculated from time when air temperature was within 1 C of the dew point.

Table 3. Effect of application timing on control of Alternaria leaf spot (*Alternaria alternata*) on cultivar Butte almond trees, Kern County, 1999.

APRIL		MAY		JUNE	Infected leaves (%)	Defoliation (%)
1	15	1	15	1	12 August	20 October
A	A	A	A		2.6	16.2
	A	A	A	A	2.6	17.5
A	A	A			1.2	12.5
	A	A	A		2.9	21.5
		A	A	A	1.8	12.5
A		A		A	3.4	20.0
A	A		A		1.8	15.0
	A	A		A	2.5	18.7
A		A	A		3.8	16.2
	A		A	A	4.4	16.2
R+O	A	A			1.5	12.5
R+O		A	A		2.5	16.2
CK	CK	CK	CK	CK	1.7	25.0
CK	CK	CK	CK	CK	2.0	23.7
					N.S.	N.S.

CODE	MATERIAL	RATE/ACRE
A	Abound 2EC	15.4 fl oz
R	Rovral 50W	1.0 lb
O	Omni oil	1% v/v
CK	Non treated	----

Application:	Hand-gun
Psi:	200
Gal/tree:	5.0
Tree/acre:	90

Design:	RCB
Replication:	4

Rainfall CIMIS Station #5 Shafter		
Date	Inches	Days
March	0.47	8
April	0.56	6
May	0.00	0
June	0.00	0
July	0.00	0
August	0.00	0
September	0.12	2

Grower program: Rovral at 20-40% bloom, Break at petal fall

Table 4. Efficacy of unregistered fungicides for control of Alternaria leaf spot (*Alternaria alternata*) on cultivar Sonora almond trees, Kern County, 1999.

Fungicide	15 April	1 May	15 May	Infected leaves (%)		Defoliation (%)
				12 August	31 August	20 October
AUX-2	X	X	X	2.5 b	4.6 bc	78.7
AUX + ABD	X	X	X	4.0 b	5.0 bc	73.7
AUX + FLT	X	X	X	3.0 b	3.9 c	75.0
AUX + STR	X	X	X	4.4 b	7.2 bc	62.5
ACT + STR	X	X	X	3.9 b	8.2 bc	78.7
ABD + ELT	X	X	X	9.8 a	14.1 a	67.5
ABD	X	X	X	3.8 b	3.2 c	50.0
FLT	X	X	X	1.5 b	2.2 c	67.5
SWT	X	X	X	2.6 b	2.5 c	67.5
STR	X	X	X	4.1 b	5.9 bc	76.2
CONTROL				1.9 b	3.7 c	81.2
CONTROL				4.8 b	10.5 ab	85.2
					N.S.	N.S.

CODE	MATERIAL	RATE/ACRE
ABD	Abound 2EC (Zeneca)	15.4 fl oz
ACT	Actigard (Novartis)	2 oz/100 gal
AUX-2	Auxigro (Auxein)	2.0 oz
AUX	Auxigro (Auxein)	4.0 oz
ELT	Elite 45DF + I (Bayer)	5.0 oz
FLT	Flint 50WG (Novartis)	3.0 oz
SWT	Switch 62.5WG (Novartis)	12.0 oz
STR	Stratego 25EC (Novartis)	12.0 fl oz
I	Induce	8.0 fl oz/100 gal

Application:	Hand-gun
Psi:	200
Gal/tree:	5.0
Tree/acre:	90

Design:	RCB
Replication:	4

Rainfall
CIMIS Station #5 Shafter

Date	Inches	Days
April	0.56	6
May	0.00	0
June	0.00	0
July	0.00	0
August	0.00	0
September	0.12	0

Grower program: Rovral at 20-40% bloom, Break at petal fall

Table 5. Efficacy of fungicides for control of brown rot blossom blight (*Monilinia laxa*) on cultivar Ne Plus Ultra almond trees, Madera County, 1999.

Pink bud 16 February	Full bloom 22 February	Petal fall 2 March	Post bloom * 9 April	Strikes/tree 22 April
ROV+O			ABD	13.0 bcd
	ROV+O		CAP	17.2 b
ROV+O	ROV+O		ABD	3.5 cde
	ROV+O	ROV+O	CAP	6.0 cde
BEN+CAP	BEN+CAP		CAP	2.0 e
ROV+O	TOP+ZIR		CAP	7.7 cde
ROV+O	ABD		CAP	4.7 cde
VAN	VAN		CAP	1.7 e
BRK	BRK		BRK	1.5 e
ELT+I	ELT+I		ELT+I	2.2 e
ELT5+ROV8+I	ELT5+ROV8+I		ELT5+ROV+I	3.2 de
FLT	FLT		FLT	6.0 cde
IND+L	IND+L		IND+L	5.2 cde
QST	QST		QST	13.2 bc
RAL+L	RAL+L		IND+L	4.2 cde
SED	SED		SED	5.7 cde
STR	STR		STR	4.2 cde
THR	THR		THR	19.2 b
NON TREATED				21.7 b
NON TREATED				32.7 a

- No sporodochia found, application made at 5 weeks after petal fall.

Table 5 continued

Code	Material	Rate a.f. per acre
ABD	Abound 2EC	15.4 fl oz
BEN	Benlate SP	1.5 lb
BRK	Break 3.6 EC	8.0 oz
CAP	Captan 50W	8.0 lb
ELT	Elite 45DF+I	8.0 oz
ELT5	Elite 45DF+I	5.0 oz
FLT	Flint 50WG	3.0 oz
IND	Indar 75WP	2.0 oz
O	Omni Oil	1.0 %
QST	QRD-713+B	8.0 lb
RAL	Rally 40E + L	8.0 oz
ROV	Rovral 50W	1.0 lb
ROV8	Rovral 50W	8.0 oz
SED	Sedagri XF99002	1.25 lb
STR	Stratego 250ec	12.0 fl oz
THR	Thiram 75WDG	8.0 lb
TOP	Topsin 50W	1.0 lb
VAN	Vangard 75 WG	8.0 oz
ZIR	Ziram 76W	8.0
B	Bond	0.25%
I	Induce	8.0 fl oz/100 gal
L	Latron B1956	8.0 fl oz/100 gal

Application:	Hand-gun
Psi:	200
Gal/tree:	5.0
Tree/acre:	76

Design: RCB	Randomized complete block
Replication:	4

CIMIS Station #80, Fresno State			
Date	T-max	Inches	Days
Feb 1-7	56-61	0.28	2
8-14	52-63	0.66	2
15-21	56-65	0.21	3
22-28	60-70	0.14	1
Mar 1-7	58-69	0.00	0
8-14	57-72	0.00	0
15-21	533-69	0.39	3
21-28	62-70	0.04	1

Table 6. Efficacy of fungicides for control of brown rot blossom blight (*Monilinia laxa*) and leaf blight (*Seimatosporium leichenicola*) on cultivar Butte almond trees, Colusa County, 1999.

Pink bud 26 Feb	Full bloom 10 Mar	Post bloom 26 Mar	Brown rot Strikes/tree 18 April	Leaf blight Infected leaves Number/60 feet
ROV+O	ROV+O	CAP	11.2 d	18.2 cd
ROV+O	ABD	CAP	43.7 bc	3.7 d
ROV+O	BRK	ABD	3.5 e	11.5 d
ABD	ABD	ABD	26.0 c	5.5 d
BRK	BRK	BRK	8.2 de	51.2 bc
FLT	FLT	FLT	11.0 d	7.0 d
IND+L	IND+L	IND+L	9.2 de	95.2 a
MIR	MIR	MIR	115.0 a	80.5 ab
QST	QST	QST	76.2 ab	93.0 a
STR	STR	STR	9.0 de	11.7 d
NON TREATED			125.2 a	117.7 a
NON TREATED			135.0 a	99.5 a

Code	Material	Rate a.f. per acre
ABD	Abound 2EC	15.4 fl oz
BRK	Break 3.6 EC	8.0 oz
CAP	Captan 50W	8.0 lb
FLT	Flint 50WG	3.0 oz
IND	Indar 75WP	2.0 oz
MIR	Mirage	32.0 fl oz
O	Omni Oil	1.0 %
QST	QRD 713+B	8.0 lb
ROV	Rovral 50W	1.0 lb
STR	Stratego 250ec	12.0 fl oz
B	Bond	0.25%
L	Latron B1956	8.0 fl oz/100 gal

Application:	Hand-gun
Psi:	300
Gal/tree:	2.0
Tree spacing:	12 x 18

Design:	RCB
Replication:	4

Rainfall (CIMIS Station #32 Colusa)		
Month	Inches	Days
February	3.25	14
March	1.23	9
April	0.76	5
May	0.08	1
June	0.12	2
July	0.00	0
August	0.00	0

Table 7. Efficacy and timing of fungicides to control brown rot blossom blight (*Monilinia laxa*) and scab (*Cladosporium carpophilum*) on cultivar Carmel almond trees, Madera County, 1999.

Pink bud 24 February	Full bloom 2 March	5 Weeks* 21 April	Brown rot Strikes/tree 22 April	Scab Infected leaves (%) 13 September
	ROV+O		0.0 b	17.7 a
	ROV+O		0.2 b	23.5 a
	TOP+ZIR		1.0 b	5.5 bcde
	TOP+ZIR		1.5 b	8.7 abcd
	BEN+CAP		0.5 b	0.5 f
	TOP+ZIR	ZIR	0.0 b	3.6 cdef
	ROV+O	ZIR	1.5 b	13.2 ab
	TOP+ZIR	ABD	0.7 b	2.1 def
	ROV+O	ABD	0.0 b	3.6 cdef
BEN+CAP	BEN+CAP		1.7 b	1.2 ef
ROV+O	ROV+O		0.0 b	18.5 a
	ABD	ABD	1.0 b	3.7 cde
	BRK	BRK	0.2 b	6.1 bcde
	CAP	CAP	1.5 b	20.0 a
	ELT+I	ABD	1.0 b	5.2 bcde
	FLT	FLT	1.0 b	1.0 ef
	IND+L	IND+L	0.2 b	5.5 bcde
	SED	SED	1.0 b	10.0 abcd
	STR	STR	0.0 b	0.0 f
	THR	THR	2.2 b	11.0 abc
	VAN	VAN	0.5 b	19.5 a
NON TREATED			0.2 b	11.7 abc
NON TREATED			6.0 a	15.0 ab

* No sporodochia found thus some treatments not sprayed post bloom.

Table 7 continued

Code	Material	Rate a.f. per acre
ABD	Abound 2EC	15.4 fl oz
BEN	Benlate SP	1.5 lb
BRK	Break 3..6 EC	8.0 oz
CAP	Captan 50W	8.0 lb
ELT	Elite 45DF+I	8.0 oz
FLT	Flint 50WG	3.0 oz
IND	Indar 75WP	2.0 oz
O	Omni Oil	1.0 %
ROV	Rovral 50W	1.0 lb
SED	Sedagri XF99002	1.25 lb
STR	Stratego 250EC	12.0 fl oz
THR	Thiram 75WDG	8.0 lb
TOP	Topsin 70W	1.0 lb
VAN	Vangard 75WG	8.0 oz
ZIR	Ziram 76W	8.0 lb
I	Induce	8.0 fl oz/100 gal
L	Latron B1956	8.0 fl oz/100 gal

Application:	Hand-gun
Psi:	200
Gal/tree:	5.0
Tree/acre:	90

Design:	RCB
Replication:	4

CIMIS Station #80, Fresno State			
Date	T-max	Inches	Days
Feb 1-7	56-61	0.28	2
8-14	52-63	0.66	2
15-21	56-65	0.21	3
22-28	60-70	0.14	1
Mar 1-7	58-69	0.00	0
8-14	57-72	0.00	0
15-21	53-69	0.39	3
21-28	62-70	0.04	1

Table 8. Effect of interval between inoculation and surgery plus topical application of wound dressing materials on eradication of *Ceratocystis fimbriata* from inoculated cultivar Nonpareil almond trees, Fresno County.

Days between inoculation and surgery	Length, cm		Infected wounds (%)
	Surgical wound	Canker	
7	8.0 b	12.8 a	84.0
50	14.7 a	7.9 b	84.0
100	15.6 a	1.1 c	16.0
Treatment			
Nectec	11.9	4.1 b	53.3
Benlate + oil	13.9	6.1 ab	60.0
LAB 2	13.1	9.0 a	80.0
Elixir	13.8	9.7 a	53.5
Nontreated	11.1	7.5 ab	60.0
Significance of *f*, *P* =			not analyzed
Days (D)	0.0019	0.0003	
Treatment (T)	NS	0.057	
D x T	NS	0.069	
Controls (no surgery)			
Inoculated non treated	----	12.4	100.0
Non inoculated	----	0.0	0.0

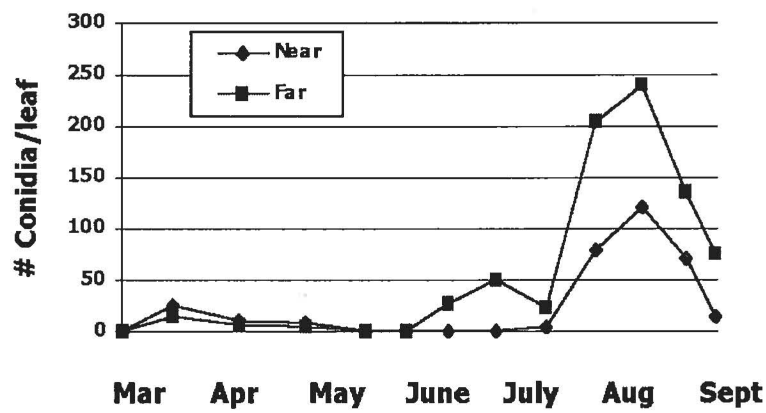

Fig. 1. Seasonal development of *Alternaria alternata* populations on leaves of cultivar Kahl almond trees located near or far from wind machine, Kern County, 1999. One hundred leaves collected randomly from one tree in each location at approximately 2 to 3 week intervals.

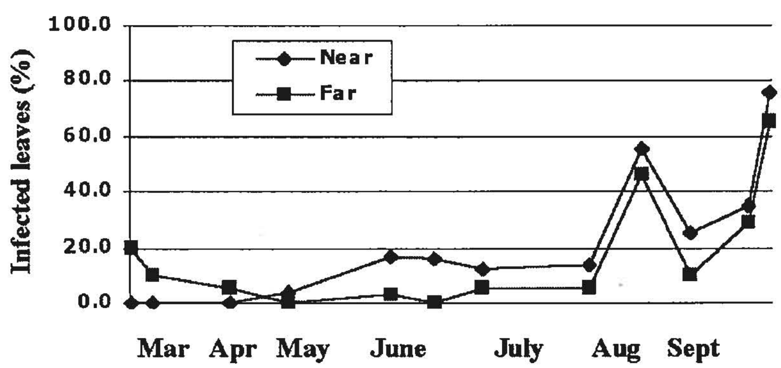

Fig. 2. Incidence of infection by *Alternaria alternata* on detached leaves of cultivar Kahl almond trees located near or far from wind machine, Kern County, 1999. Forty to 50 each exposed and internal leaves collected from the east and west sides of one tree in each location at approximately 2 to 3 week intervals.

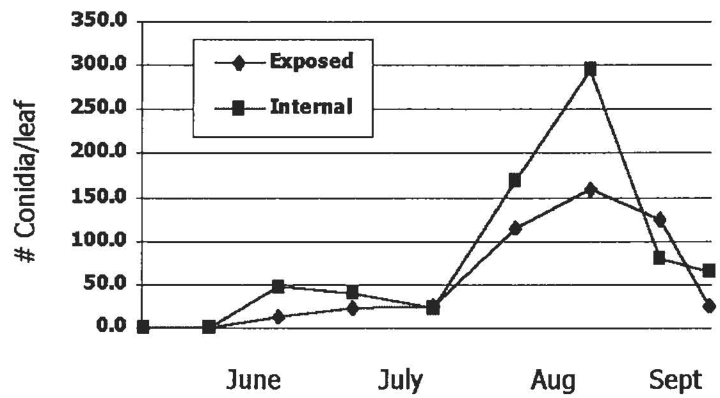

Fig. 3. Populations of *Alternaria alternata* on exposed and internal leaves of cultivar Kahl almond trees located near or far from wind machine, Kern County, 1999. One hundred each exposed and internal leaves collected from the east and west sides of one tree in each treatment at approximately 2 to 3 week intervals.

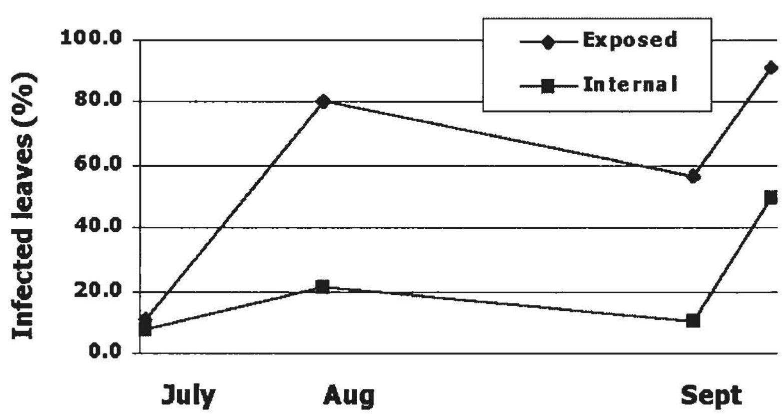

Fig. 4. Incidence of infection by *Alternaria alternata* on detached exposed and internal leaves of cultivar Kahl trees located near or far from wind machine, Kern County, 1999. Forty to 50 each exposed and internal leaves collected from the east and west sides of one tree in each location at approximately 2 to 3 week intervals.

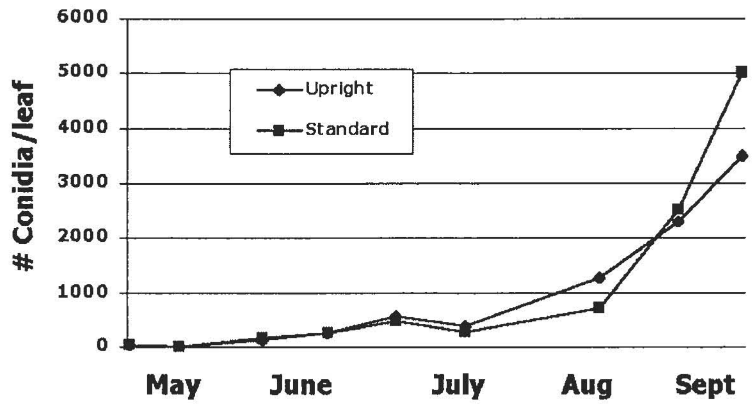

Fig. 5. Seasonal development of *Alternaria alternata* populations on leaves of cultivar Butte almond trees trained to standard (spreading) or upright shape, Kern County, 1999. One hundred leaves collected from one tree in each of five replications of each treatment at approximately 2 to 3 week intervals.

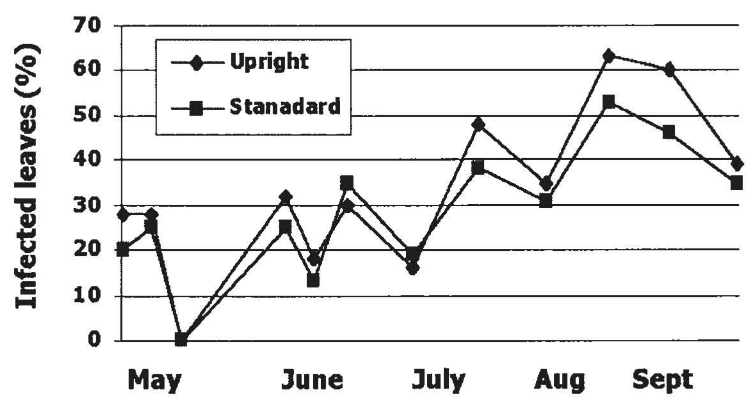

Fig. 6. Incidence of infection by *Alternaria alternata* on detached leaves of cultivar Butte almond trees trained to standard (spreading) or upright shape, Kern County, 1999. Forty to 50 leaves collected from one tree in each of five replications of each treatment at approximately 2 to 3 week intervals, surface sterilized, and incubated in mist chambers for 7 days.

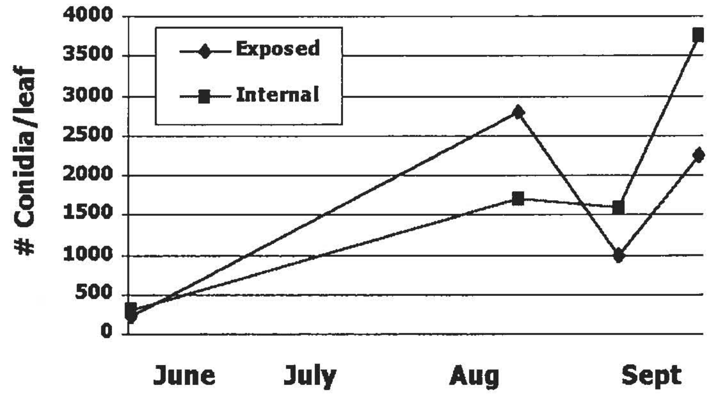

Fig. 7. Populations of *Alternaria alternata* on exposed and internal leaves of cultivar Butte almond trees trained to standard (spreading) or upright shape, Kern County, 1999. One hundred each exposed and internal leaves collected from the east and west sides of one tree in each treatment at approximately 2 to 3 week intervals.

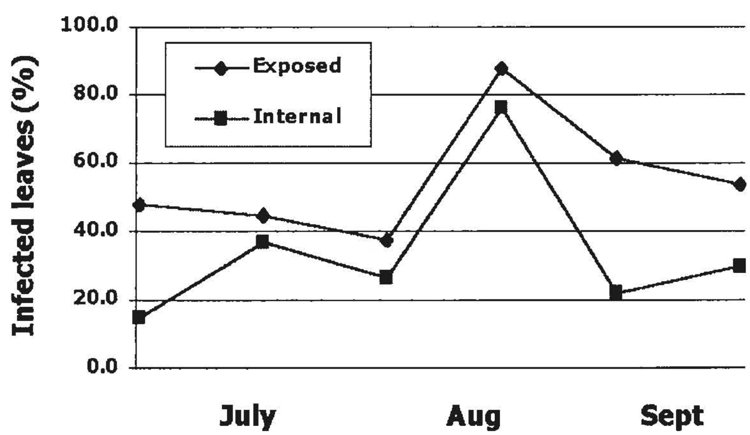

Fig. 8. Incidence of infection by *Alternaria alternata* on detached exposed and internal leaves of cultivar Butte almond trees trained to standard (spreading) or upright shape, Kern County, 1999. Forty to 50 each exposed and internal leaves collected from the east west sides of one tree in each treatment at approximately 2 to 3 week intervals.

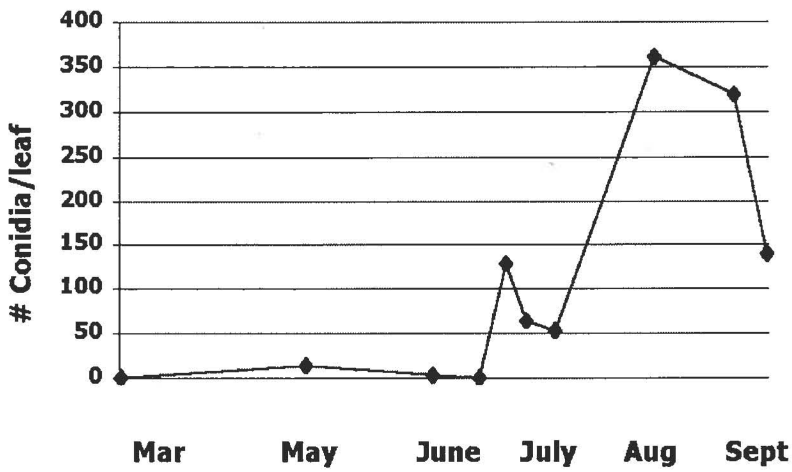

Fig. 9. Seasonal development of *Alternaria alternata* populations on leaves of cultivar Butte almond trees, Kearney Ag Center, Fresno County, 1999. One hundred leaves collected randomly from each of two trees at approximately 3 week intervals.

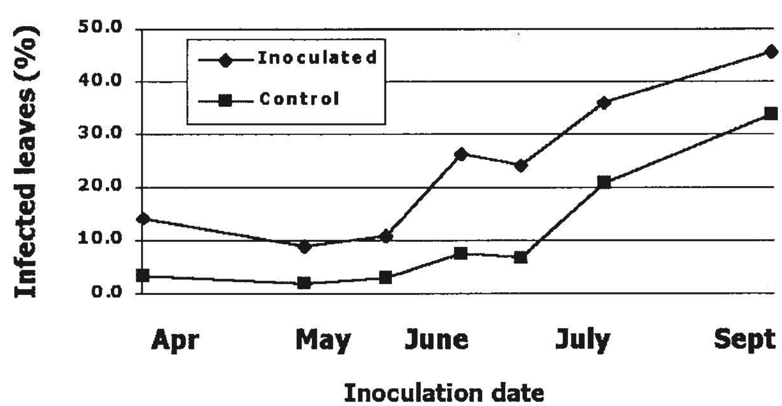

Fig. 10. Infection of cultivar Butte almond tree leaves inoculated and incubated on the tree with $1x10^6$ condia per ml *Alternaria alternata* conidia at approximately 3 week intervals. Four single-tree replications of each treatment. Data shown are average of six isolates on each date.

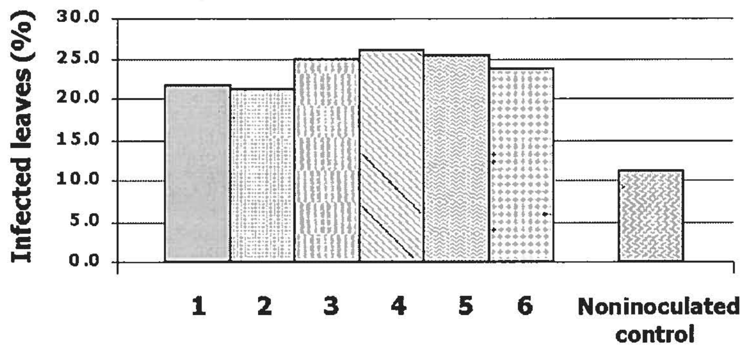

Fig. 11. Relative pathogenicity of six isolates of *Alternaria alternata* to cultivar Butte almond trees. Fifty to 100 leaves in each of four single-tree replications inoculated with conidia per ml at approximately 3 week intervals. Data shown are averages of seven inoculation dates.

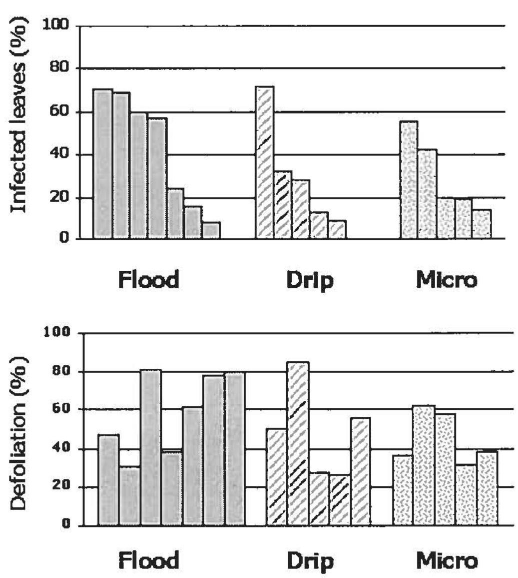

Fig. 12. Incidence of Alternaria leaf blight (*Alternaria alternata*) on cultivar Butte almond trees in 17 orchards in Kern County, 1999. One hundred leaves collected from each of 10 trees in center of one row of each orchard on one day between 15 and 21 September1999.