Report to the Almond Board of California — 1997
Project Number: 97-ZG6

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Project title: 1) Cause and control of Alternaria leaf spot, 2) bloom and foliage disease control, 3) wound treatments to control Ceratocystis canker, and 4) role of brown rot fungi in green fruit rot.

Cause and control of Alternaria leaf spot

The symptoms of Alternaria leaf spot have been observed in orchards for several years, but little attention was paid to the disease until recently when some orchards experienced severe early defoliation. Leaf symptoms, (lesions on the leaf blade) can be found in many orchards, especially late in summer, but outbreaks severe enough to cause defoliation occur most commonly in the southern San Joaquin Valley.

Our experiments this year were designed to 1) test the effect on disease incidence of heavy pruning (to open the tree canopy thereby encouraging air movement thereby reducing periods of leaf wetness and/or humidity) and the interaction of this cultural practice with fungicide treatment and 2) compare efficacy of several registered and unregistered fungicides for disease control.

In the heavy pruning treatment several large branches were removed in winter and internal water shoots were removed from each tree in late spring. Trees were pruned in the normal fashion in the other treatment. The fungicide treatments applied in these two pruning regimes consisted of a mixture of Rovral + Ziram (these had shown some efficacy last year) at various timings.

All fungicide treatments applied mid April through early July significantly reduced defoliation over that in the control (Table 1). Programs that included four treatments, at two-week intervals, spanning 15 April to 1 June or 15 May to 1 July gave equivalent results and reduced defoliation by half. Two-application treatments, at monthly intervals beginning 15 April, 1, 15 May, and 1, 15 June were somewhat less effective. Treatments made during bloom and at five weeks after petal fall did not reduce disease over that found in the control. Among the fungicides tested for efficacy, an unregistered material from BASF and Zeneca's Abound showed good control as did Rovral + Ziram, Rovral alone, and Dithane Table 2).

Environmental conditions differed somewhat between the heavily and normally pruned treatments. Average daily temperatures were essentially the same in both but the relative humidity tended to be slightly higher in the conventionally pruned treatment (Figs. 1 and 2). The duration of leaf wetness was greater in the conventionally-pruned than in the heavily pruned treatment for 3 days in mid April, 7 days in late May, and 15 days in late July (Fig. 3). The cable connecting the leaf wetness sensor to one of the microloggers was accidentally severed in late

June. The readings taken with the repaired cable were not as accurate as those taken earlier and may have skewed the late season readings. Assuming there were differences in leaf wetness duration at times during the season, these were not reflected in differences in disease incidence in the orchard.

The development of the pathogen population was monitored by washing leaves collected at three to four week intervals beginning when leaves emerged until late July. The fungus was not present in any quantity until early May (Table 3). By the end of May, the population began to increase, in June the increase was more rapid and in July numbers were very high. The largest and quickest escalation occurred in late July and early August. These same leaves were observed for lesions and lesions appeared in late May or early June, shortly after the pathogen began to increase in number.

We also inoculated leaves on 'Butte' trees at Kearney Agricultural Center. Early inoculations resulted in very few infections, and infections began to increase in May, continued to increase through June, and by July so much natural inoculum was present that it obscured our inoculum and all leaves had multiple lesions (Table 4). Thus, the progress of the disease was similar under natural conditions and artificial inoculation.

Bloom and foliage disease control

Various sequences of fungicides designed to control several diseases including brown rot, shot hole, scab, and anthracnose were compared. The sequences compared different choices of fungicide and numbers of applications. The intent was to determine how decisions made for controlling any given disease might affect control of other diseases. Most experiments also included efficacy tests of selected registered and experimental materials.

Experiments were located in Tehama, Colusa, Merced, Madera, and Fresno Counties. Materials were applied by hand-gun sprayers, and evaluations were made throughout the year for whichever diseases developed.

The spring of 1997 was exceptionally dry and disease incidence was low in most trials. Brown rot was generally better controlled by two treatments (at pink bud and full bloom) than by one treatment at pink bud (Tables 5, 6, 7). Several unregistered fungicides, Abound, Break, Elite, Indar, Procure, RH, Switch, and Vanguard + Ziram, provided control equivalent to that of Rovral (Tables 6, 8). Scab was controlled as well by one treatment at 5 weeks after petal fall as by two treatments (one each at two and five weeks after petal fall) using captan and ziram (Table 9). Abound and Bravo, both unregistered, gave very good control of scab. Leaf blight occurred in the Colusa trial and was controlled by bloom treatment, with the full bloom timing better than at pink bud (Table 10). Benlate + captan, Rally, and Abound were the most effective materials.

Role of brown rot fungi in green fruit rot.

Green fruit rot is caused by several fungi, *Monilina laxa* and *Botrytis cinerea* being the most common. The disease is prevalent in years of extended rains shortly after bloom and on cultivars the have clustered fruit. Infections are associated with fruit that touch or with fruit that have adhering floral cups, petal, or leaves. The adhering tissues are thought to provide a food base for the pathogens and are required for infection to proceed. For pathogens that do not require a food base, wetness period need only be long enough for the spores to germinated and infect. In green fruit rot, the needed wetness period may be longer if the pathogens must first colonize a food base then grow into the fruit.

The importance of cast floral cups and petals and the duration of the wetness period in development of green fruit rot were investigated. Petals and floral cups that had been shed as young fruit enlarged were collected, air dried, and stored in the laboratory. These were surface sterilized for 15 minutes in 10% bleach, incubated for 24 hours in spore suspensions then placed on young green fruit and secured with a twistem tie. Immediately after incubation and before placement onto the fruit, half of the incubated tissues were surface sterilized for 2 minutes in 10 % bleach and half were not. Floral cups and petals also were dipped into spore suspensions immediately before placement on the fruit. Controls included floral cups and petals incubated in water, spore suspensions misted directly onto fruit but without a floral cup or petal, and not inoculated. All treatments were kept wet for 24, 48, or 72 hours by covering them with a dampened plastic bag. Fruit were observed for rot 7 and 10 days after inoculation.

Fewer "Carmel" fruit rotted when petals and shucks incubated in either a spore suspension or water were surface sterilized in bleach before placement on the fruit (Table 11). Those incubated for 24 hours in a spore suspension caused more rotted fruit than those similarly incubated in water. The amount of rotted fruit was similar whether shucks were incubated for 24 hours or dipped briefly in the spore suspension. No fruit rotted resulted if the spore suspension was misted directly onto the fruit surface without the presence of a petal or shuck.

A wetness period of 48 hr generally produced more rotted 'Butte' fruit than did 24 or 72 hr wetness periods (Table 12). More rotted fruit usually were associated with petals than with shucks. Petals incubated in water or not incubated produced similar small percentages of rotted fruit; shucks incubated in water produced small percentages of rotted fruit but no fruit rotted when shucks were not incubated. No fruit rotted resulted if the spore suspension was misted directly onto the fruit surface without the presence of a petal or shuck.

The reduction of rot observed when shucks and petals were surface sterilized after incubation suggests that the inoculum is external on the shed floral parts. Petals resulted in more rot than did floral cups, and spore suspensions alone produced no infected fruit. Susceptibility decreased as fruit grew and fruit became resistant to infection when about 75% of mature length.

Wound treatments to control Ceratocystis canker.

We are examining ways to prevent infection of wounds and to treat existing Ceratocystis cankers. The efficacy of various materials was tested by applying the materials to wounds,

allowing the treatments to dry, then immediately inoculating them with the fungus. Similar wounds and treatments were left uninoculated to assess the effects of the materials on wound healing. Benlate and Nectec were better than Enzone, Spinout, or Treeseal but none adequately controlled the disease (Table 13, interval 0). Wound healing was good in all treatments except Enzone (data not presented).

The efficacy of materials applied to wounds after introduction of the fungus was tested by inoculating wounds then treating them 0 and 4 days later. Benlate + oil showed some efficacy when applied immediately after inoculation (0 interval), the others did not, and none were effective when treatment was delayed for four days after inoculation (Table 14).

The effect on efficacy of applying the fungicides before introduction of the fungus was tested by treating wounds then inoculating them 7, 30 and 59 days later. Complete control was achieved with Nectec through 59 days, Benlate through 30 days, and Spinout and Enzone each provided some (though not statistically different) control at 30 and 59 days (Table 13). Treeseal not only was ineffective, it apparently kept the wounds susceptible throughout fall. The wounds in all other fungicide treatments and the inoculated controls gradually diminished in susceptibility as the interval between treatment and inoculation increased but the Treeseal-treated wounds did not.

A similar experiment which included both post infection surgery and treatment with either Nectec or Enzone was conducted. Nectec provided some control, the best occurring when surgery and treatment were performed 102 days after inoculation (Table 15) Enzone was ineffective.

Topical treatment of existing cankers with Nectec, Benlate + oil, Enzone, or Spinout were completely unsuccessful (data not presented).

Benlate + oil and Nectec appear to offer the best possibilities for fungicide treatment of Ceratocystis. Neither was able to resist infection when the fungus was introduced immediately after wounding, but by seven days after treatment, control was excellent. This suggests that protection shortly after wounds are made may be less effective, protection against later infections may be possible. When surgery is practiced, successful removal and treatment is more likely when done in winter than in fall.

Table 1. Effects of pruning and timing of fungicide treatments on control of Alternaria leaf spot of almond cv Butte trees, Kern County CA, 1997.

Pink bud	Full bloom	Spring and summer							Infected leaves (%)	Defoliation (%)
		April		May		June		July		
		3	16	1	21	2	17	2	28 Aug	17 Sep
RAL*	RAL*		+	+	+	+			15.2 b	33.3 d
RAL*	RAL*				+	+	+	+	17.9 b	34.6 d
RAL*	RAL*		+		+				17.2 b	39.6 cd
RAL*	RAL*			+		+			20.2 b	40.4 cd
RAL*	RAL*				+		+		18.2 b	46.2 c
RAL*	RAL*					+		+	20.0 b	44.6 c
ROV	T+Z	Z							30.8 a	64.6 b
ROV	ROV	Z							28.1 a	67.5 b
UNTREATED									27.9 a	76.2 a

+ = Rovral + Ziram

Code	Material	Rate a.f. per acre
RAL	Rally 40W	8.0 oz
ROV	Rovral 50W	1.0 lb
T	Topsin 70W	1.5 lb
Z	Ziram 76W	8.0 lb

*All Rally treatments include Latron B1956, 8.0 oz/100 gal

Application:	Hand-gun
Psi:	200
Gal/tree:	5
Tree spacing:	22' x 22'
Trees/acre:	90
Design:	Split plot
Main factors:	6 reps, 8-row plots
Culture	
Standard	
Subplots:	12 reps, single-tree plots
Fungicides	

Rainfall (CIMIS Station #5, Shafter/USDA)

Date	Inches	Days
Feb 14-21	0.08	1
22-28	0.09	1
Mar 22-28	0.04	1
Aug 15-21	0.01	1

All precipitation between 14 February and 30 September occurred on dates listed.

Table 2. Efficacy of various fungicides for control of Alternaria leaf spot, Kern CA, 1997.

Pink bud	Spring			Infected leaves (%)	Defoliation (%)
14 Feb	16 Apr	1 May	21 May	28 Aug	17 Sep
BAS	BAS	BAS	BAS	7.2 c	15.0 e
ROV+ZIR	ROV+ZIR	ROV+ZIR	ROV+ZIR	9.2 bc	20.0 e
ABD	ABD	ABD	ABD	10.7 bc	21.2 de
ROV	ROV	ROV	ROV	7.5 bc	26.2 cde
DIT	DIT	DIT	DIT	16.2 abc	31.2 bcd
IND+L	IND+L	IND+L	IND+L	23.7 a	32.5 abc
BRK	BRK	BRK	BRK	20.7 a	42.5 ab
ELT-6+I*	ELT-6+I*	ELT-6+I*	ELT-6+I*	17.0 ab	42.5 ab
AQ	AQ	AQ	AQ	21.5 a	46.2 a
UNTREATED				24.7 a	45.0 a
ROV+O*	ROV+O	ROV+O	ROV+O	36.0✓	28.7 cd

✓ Phytotoxicity obscured readings

Code	Material	Rate a.f./acre
ABD	Abound 25C	16.0 fl oz
AQ	AgriQuest	360 gal
BAS	BWC014	18.4 fl oz
BRK	Break 45WG	4.0 oz
DIT	Dithane DF	8.0 lb
ELT-6	Elite 45DF	6.0 oz
IND	Indar 75W	2.0 oz
O	Omni oil	2.0% by vol.
ROV	Rovral 50W	1.0 lb
ZIR	Ziram 76W	8.0 lb
I*	Induce	8 oz/100 gal

Application:	Hand-gun
Psi:	200
Gal/tree:	5.0
Tree spacing:	22 x 22
Trees/acre:	90
Design:	Randomized complete block
Replication:	4

Rainfall (CIMIS Station #5, Shafter/USDA)

Date	Inches	Days
Feb 15-21	0.08	1
22-28	0.09	1
Mar 22-28	0.04	1
Aug 15-21	0.01	1

All precipitation between 14 February and 30 September occurred on dates listed.

Table 3. Population development of *Alternaria alternata* and incidence of natural infection on leaves of almond cv Butte, Kern County, CA, 1997.

Date collected	Number of *Alternaria* conidia per leaf[y]		Infected leaves (%)
	Total	Pathogenic	
20 March	13.1 e[z]	0.2 f[z]	0.00 d[z]
11 April	93.3 e	0.2 3	0.00 d
30 April	420.8 d	29.2 d	0.00 d
20 May	4354.2 b	583.3 b	0.00 d
2 June	304.2 c	113.8 d	4.25 c
16 June	346.8 bc	304.2 d	24.00 b
2 July	512.5 b	258.3 d	30.58 ab
21 July	917.7 b	612.5 c	36.08 a
12 August	8125.0 a	3187.5 a	34.25 ab

y Average of 100 leaves per replication.

z Twelve replications of each treatment. A log transformation performed on data before analysis of variance and mean separation by Duncan's multiple range test. Means down columns sharing the same letter do not differ significantly, P=0.05.

Table 4. Infection of almond cv Butte leaves inoculated with *Alternaria alternata* at various times, Fresno County CA, 1997.

Date	Infected leaves (%)[y]		$P =$[z]
	Inoculated	Not inoculated	
23 April	5.4	2.6	0.078
22 May	38.8	8.8	0.004
5 June	24.2	4.8	0.007
20 June	40.5	15.2	0.086
11 July	60.0	39.2	0.072
15 August	59.0	82.3	0.136

y Fifty leaves per replication inoculated with spore suspension or misted with water, covered with plastic then paper bags for 48 yours, infection assessed 7-14 days later.

z Six replications of each treatment arranged in a randomized complete block design. An arcsine transformation performed on data for analysis of variance, actual percentages reported.

Table 5. Timing of fungicides to control brown rot of almond cv Ne Plus Ultra, Madera County CA, 1997.

Pink bud	Full bloom	Weeks after petal fall		No. strikes/tree
		Two	Five	
24 Jan	3 Feb	4 Mar	27 Mar	27 Mar
ROV	TOP[x] + ZIR	CAP	ZIR	25.2 b
ROV	TOP[x] + ZIR	CAP	ZIR	32.5 b
TOP[x] + ZIR	TOP[x] + ZIR	CAP	ZIR	40.5 ab
ROV	ROV		ZIR	31.7 b
ROV	ROV		ZIR	31.2 b
TOP[x] + ZIR		CAP	ZIR	42.0 ab
TOP[x] + ZIR		CAP	ZIR	49.5 ab
ROV		CAP		56.0 ab
	TOP[x] + ZIR		ZIR	44.0 ab
UNTREATED				50.0 ab
UNTREATED				63.0 a

[x] Benomyl resistance present in orchard

Code	Material	Rate a.f. per acre
CAP	Captan 50	9.0 lb
ROV	Rovral 50W	1.0 lb
TOP	Topsin 70W	1.5 lb
ZIR	Ziram 76W	8.0 lb

Application:	Handgun
Psi:	200
Gal/tree:	4.0 (pink bud), 5.0 (after pink bud application)
Tree spacing:	24 x 24
Tree/acre:	100
Design	Randomized complete block
Replication	4

Rainfall (CIMIS Station #56, Los Banos)

Date	Inches	Days
Jan 15-21	0.99	3
22-28	1.82	6
Feb 1-7	0.04	1
8-14	0.32	2
15-21	0.24	1
Mar 8-14	0.20	1
15-21	0.04	1

All precipitation between 1 January and 30 September occurred on dates listed.

Table 6. Timing and efficacy of fungicides for control of brown rot of almond cv Butte, Colusa County CA, 1997.

Pink bud	Full bloom	Weeks after petal fall		No. strikes/tree
		Three	Five	
21 Feb	5 Mar	7 Apr	22 Apr	15 Apr
RAL+L	BEN+CAP	ZIR	MAN	2.2
RAL+L	RAL+L	ZIR	MAN	2.8
BEN+CAP	BEN+CAP	ZIR	MAN	3.8
RAL+L	RAL+L		MAN	1.2
RAL+L	BEN+CAP		MAN	5.2
RAL+L		ZIR	MAN	8.2
BEN+CAP		ZIR	MAN	9.8
	BEN+CAP		MAN	6.8
BRK	BRK	-----	BRK	0.6
IND+L	IND+L	IND+L	IND+L	1.0
RAL+L	RAL+L	ABD	ABD	1.6
ELT+I	ELT+I	ELT+I	MAN	2.0
RH+L	RH+L	RH+L	RH+L	3.2
ABD	ABD		ABD	3.4
AQ	AQ	AQ	-----	7.2
Untreated				3.0
				NS

Code	Material	Rate a.f. per acre
ABD	Abound 25C	12.8 fl oz
AQ	AQ153	360 gal
BEN	Benlate SP	1.5 lb
BRK	Break 45WG	4.0 oz
CAP	Captan 50W	9.0 lb
ELT	Elite 45DF + I	6.0 oz
IND	Indar 75WP	2.0 oz
MAN	Maneb 75DF	8.0 lb
RAL	Rally 40W +L	8.0 oz
RH	RH1647 30F + L	12.0 fl oz
ZIR	Ziram 76W	8.0 lb
I	Induce	8.0 oz/100 gal
L	Latron B1956	8.0 oz/100 gal
NOTE: Benlate resistance 1&4 ppm		

Application:	Hand-gun
Psi:	300
Gal/tree:	2.0
Tree spacing:	12x18
Tree/acre:	202
Design:	Randomized complete block
Replication:	5

* All precipitation between 1 February and 3 October occurred on dates listed.

Rainfall (CIMIS Station #32, Colusa)		
Date*	Inches	Days
Feb 1-7	0.04	1
8-14	0.04	1
Mar 15-22	1.38	1
Apr 21-29	0.32	2
May 21-28	0.28	1
June 1-7	0.20	1
8-14	0.08	1
Aug 15-22	0.47	2
Sep 15-22	0.20	2

Table 7. Timing and efficacy of fungicides to control brown rot of almond cv Carmel, Tehama County CA, 1997.

Green tip	Full bloom	Weeks after petal fall		No. strikes/tree
		Two	Five	
7 Feb	19 Feb	5 Mar	28 Mar	14 Apr
ABD	ABD	CAP	ZIR	0.0 c
ROV	TOP+ZIR		ZIR	0.0 c
TOP+ZIR	TOP+ZIR	CAP	ZIR	0.4 bc
ROV	TOP+ZIR	CAP	ZIR	0.4 bc
ROV	BRV-4 1/8	BRV-3 1/8	ZIR	1.2 bc
ROV	ROV	ABD	ABD	1.4 bc
TOP+ZIR		CAP	ZIR	1.4 bc
ROV	ROV		ZIR	1.6 bc
ROV	ROV	CAP	ZIR	1.8 bc
ROV		CAP	ZIR	3.8 ab
UNTREATED				8.2 a

Code	Material	Rate a.f. per acre
ABD	Abound 25C	12.8 fl oz
BRV	Bravo Weather Stik	4 1/8 or 3 1/8 pts
CAP	Captan 50W	9.0 lb
ROV	Rovral 50W	1.0 lb
TOP	Topsin 70W	1.5 lb
ZIR	Ziram 76W	8.0 lb

Application:	Hand-gun
Psi:	350
Gal/tree:	5.0
Tree spacing:	25' x 25'
Trees/acre:	70
Design:	Randomized complete block
Replication:	5

Rainfall (CIMIS Station #61, Orland)

Date	Inches	Days
Jan 15-21	0.48	3
22-28	5.16	5
29-31	0.04	1
Feb 1-7	0.12	1
15-21	0.08	1
Mar 15-21	1.73	1
Apr 15-21	0.28	1
22-29	0.04	1
May 22-29	0.43	1
Jul 1-7	0.47	1
Aug 15-21	0.63	2

All precipitation between 15 January and 31 September occurred on dates listed.

Table 8. Efficacy of fungicides for control of brown rot of almond cv NePlus Ultra, Madera County CA, 1997.

Pink bud	Full bloom	Weeks after petal fall		Number strikes/tree
		Two	Five	
24 Jan	3,4 Feb	4 Mar	27 Mar	27 Mar
ELT+I	ELT+I	ELT+I	ELT+I	7.7 b
SWT	SWT	SWT	SWT	10.7 b
IND+L	IND+L	IND+L	IND+L	11.5 b
PRO	PRO	PRO	PRO	13.5 b
BRK	BRK	---	BRK	15.2 b
VAN+ZIR	VAN+ZIR	VAN+ZIR	VAN+ZIR	15.5 b
ABD	ABD	CAP	ZIR	16.2 b
RH+L	RH+L	RH+L	RH+L	17.5 b
ROV	ROV	ABD	ABD	20.0 b
FUN	FUN	CAP	ZIR	36.0 ab
UNTREATED				50.5 a
UNTREATED				63.0 a

Code	Material	Rate a.f. per acre
ABD	Abound 25C	12.8 fl oz
BRK	Break 45WG	4.0 oz
CAP	Captan 50W	9.0 lb
ELT	Elite 45DF	6.0 oz
FUN	Funginex	16.0 fl oz
IND	Indar 75WP	2.0 oz
PRO	Procure 50W	12.0 oz
RH	RH1647	12.0 fl oz
ROV	Rovral 50W	1.0 lb
SWT	Switch 62.5 WG	12.0 oz
TOP	Topsin 70W	1.5 lb
VAN	Vanguard 75WP	5.0 oz
ZIR	Ziram 76W	8.0 lb
I	Induce	8.0 fl oz/100 gal
L	Latron B1956	8.0 oz/100 gal

Application:	Handgun
Psi:	200
Gal/tree:	4 (at pink bud), 5 (all subsequent applications)
Tree spacing:	24 x 24
Tree/acre:	76
Design:	Randomized complete block
Replication:	4

Rainfall (CIMIS Station #56, Los Banos)

Date	Inches	Days
Jan 15-21	0.99	3
22-28	1.82	6
Feb 1-7	0.04	1
8-14	0.32	2
15-21	0.24	1
Mar 8-14	0.20	1
5-21	0.04	1

All precipitation between 15 January and 30 September occurred on dates listed.

Table 9. Timing and efficacy of fungicides for control of scab of almond cv Carmel, Tehama County CA, 1997.

Green tip	Full bloom	Weeks after petal fall		Infected leaves	Defoliation
		Two	Five	(%)	(%)
7 Feb	19 Feb	5 Mar	28 Mar	19 Sep	19 Sep
ROV	ROV	CAP	ZIR	5.6 b	24.0 bc
ROV	TOP + ZIR	CAP	ZIR	6.0 b	26.0 bc
TOP + ZIR	TOP + ZIR	CAP	ZIR	10.6 ab	32.0 bc
TOP + ZIR		CAP	ZIR	7.6 b	25.0 bc
ROV		CAP	ZIR	9.2 b	35.0 b
ROV	ROV		ZIR	11.4 ab	32.0 bc
ROV	TOP + ZIR		ZIR	10.4 ab	28.0 bc
ROV	ROV	A	A	5.8 b	21.0 c
ROV	BRV	BRV	ZIR	5.0 b	21.0 c
A	A	CAP	ZIR	5.4 b	28.0 bc
UNTREATED				30.8 a	71.0 a

Code	Material	Rate a.f. per acre
ABD	Abound 25C	12.8 fl oz
BRV	Bravo Weather Stik	4 1/8 or 3 1/8 pts
CAP	Captan 50W	9.0 lb
ROV	Rovral 50W	1.0 lb
TOP	Topsin 70W	1.5 lb
ZIR	Ziram 76W	8.0 lb

Application:	Hand-gun
Psi:	350
Gal/tree:	5.0
Tree spacing:	25' x 25'
Trees/acre:	70
Design:	Randomized complete block
Replication:	5

Rainfall (CIMIS Station #61, Orland)

Date	Inches	Days
Jan 15-21	0.48	3
22-28	5.16	5
29-31	0.04	1
Feb 1-7	0.12	1
Mar 14-21	1.73	1
Apr 15-21	0.28	1
22-29	0.04	1
May 22-29	0.43	1
Jul 1-7	0.47	1
Aug 15-21	0.63	2

All precipitation between 15 January 30 September occurred on dates listed.

Table 10. Timing and efficacy of fungicides for control of leaf blight of almond cv Carmel, Colusa County CA, 1997.

Pink bud	Full bloom	Weeks after petal fall		No. infected leaves/20 feet
		Three	Five	
21 Feb	5 Mar	7 Apr	22 Apr	3 Oct
	BEN+CAP		MAN	0.4 f
RAL+L	BEN+CAP		MAN	0.6 f
BEN+CAP	BEN+CAP	ZIR	MAN	1.2 f
RAL+L	BEN+CAP	ZIR	MAN	1.6 ef
ABD	ABD		ABD	2.4 ef
RAL+L	RAL+L	ABD	ABD	7.0 de
RAL+L	RAL+L		MAN	8.0 cde
RH+L	RH+L	RH+L	RH+L	11.4 bcd
RAL+L	RAL+L	ZIR	MAN	12.8 bcd
IND+L	IND+L	IND+L	IND+L	14.2 abc
BRK	BRK	-----	BRK	16.2 abc
BEN+CAP		ZIR	MAN	16.5 ab
AQ	AQ	AQ	-----	19.6 ab
ELT+I	ELT+I	ELT+I	MAN	27.0 ab
RAL+L		ZIR	MAN	30.0 ab
Untreated				33.0 a

Code	Material	Rate a.f. per acre
ABD	Abound 25C	12.8 fl oz
AQ	AQ153	360 gal
BEN	Benlate SP	1.5 lb
BRK	Break 45WG	4.0 oz
CAP	Captan 50W	9.0 lb
ELT	Elite 45DF + I	6.0 oz
IND	Indar 75WP	2.0 oz
MAN	Maneb 75DF	8.0 lb
RAL	Rally 40W +L	8.0 oz
RH	RH1647 30F + I	12.0 fl oz
ZIR	Ziram 76W	8.0 lb
I	Induce	8.0 oz/100 gal
L	Latron B1956	8.0 oz/100 gal

NOTE: Benlate resistance 1&4 ppm

Application:	Hand-gun
Psi:	300
Gal/tree:	2.0
Tree spacing:	12x18
Tree/acre:	202
Design:	Randomized complete block
Replication:	5

Rainfall (CIMIS Station #32, Colusa)

Date	Inches	Days
Feb 1-7	0.04	1
8-14	0.04	1
Mar 15-22	1.38	1
Apr 21-29	0.32	2
May 21-28	0.28	1
June 1-7	0.20	1
8-14	0.08	1
Aug15-22	0.47	2
Sep15-22	0.20	2

All precipitation between 1 February and 3 October occurred on dates listed.

Table 11. Infection of young green almond cv Carmel fruit inoculated with *Monilinia laxa*, 1997.

Treatment[v]	Bleach[w]	Infected fruit (%) Petals 21 Mar	Infected fruit (%) Shucks 25 Mar
Incubation[x]			
in spore suspension			
24 hr	yes	4.8 bc[y]	4.3 bc
24 hr	no	35.0 a	15.4 a
dip	yes	—	7.9 ab
dip	no	—	5.8 ab
in water			
24 hr	yes	1.1 bc	0.0 c
24 hr	no	7.1 b	6.6 ab
Spore suspension[z]	—	0.0 c	0.0 c
Contrasts, P =			
bleach vs. no bleach		0.000	0.000
24 hr vs. dip		—	NS

v Inoculated fruit kept wet for 72 hours after inoculation by covering them with plastic bags.

w Immediately after the incubation period, petals or hypanthia rinsed 5-10 seconds in 10% household bleach then in sterile deionized water before placement on fruit.

x Petals or hypanthia (shucks) were incubated for 24 hours or dipped for 1-2 seconds in water suspensions containing 10^5 *M. laxa* conidia/ml or incubated for 24 hours in water prior to placement on green fruit.

y Four replications of each treatment in a randomized complete block design. Means followed by the same letter do not differ significantly according to Duncan's multiple range test.

z Spore suspension misted directly onto green fruit, no petals or hypanthia present.

Table 12. Infection of young green almond cv Butte fruit inoculated with *Monilina laxa*, 1997.

Treatment	Wetness period (h)[w]	Infected fruit (%) 31 Mar	Infected fruit (%) 1 Apr
Incubation[x]			
Floral cups			
in spore suspension	24	3.4 bcd[y]	1.1 b
	48	14.6 a	4.6 ab
	72	5.7 abc	2.3 b
in water	72	5.8 abc	1.2 b
no incubation	72	0.0 d	0.0 b
Petals			
in spore suspension	72	10.0 ab	13.6 a
in water	72	1.2 cd	5.3 ab
no incubation	72	5.2 bcd	4.5 ab
Spore suspension[z]	72	0.0 d	0.0 b
Contrasts: P =			
Floral cups vs. petals		NS	0.005

w Inoculated fruit kept wet for 24, 48, or 72 hours after inoculation by covering them with plastic bags.

x Petals or hypanthia (shucks) were incubated for 24 hours in water suspensions containing 10^5 *M. laxa* conidia/ml or incubated for 24 hours in water prior to placement on green fruit.

y Four replications of each treatment in a randomized complete block design. Means followed by the same letter do not differ significantly according to Duncan's multiple range test.

z Spore suspension misted directly onto green fruit, no petals or hypanthia present.

Table 13. Effect of interval between treatment and later inoculation on efficacy of fungicides for control of Ceratocystis canker of almond cv Nonpareil trees. 1997.

	Avg. canker length (cm)[x]			
	Days between treatment and inoculation[y]			
Treatment	0	7	30	59
Nectec	7.2 cd[z]	0.0 b	0.0 b	0.0 c
Benlate + oil	13.0 bc	0.0 b	0.0 b	1.0 bc
Enzome	29.7 a	14.5 a	3.5 b	4.5 b
Spinout	18.7 b	16.5 a	3.0 b	2.2 bc
Treeseal	22.7 ab	25.0 a	20.7 a	20.2 a
Inoculated control	18.2 b	20.5 a	18.2 a	5.4 b
Uninoculated control	0.0 d	0.0 b	0.0 b	0.0 c

x Measured 10 through 14 November 1997.

y Wounds made, treated and inoculated on 15 August 1996 for the 0 day interval; all other wounds made and treated on 10 September 1996 and inoculated on 17 September, 10 October and 8 November 1996.

z Four replications of each treatment arranged in a randomized complete block design. Letters down columns do not differ significantly according to Duncan's multiple range test.

Table 14. Effect of interval between inoculation and treatment on efficacy of fungicides for control of Ceratocystis canker of almond cv Nonpareil trees, Fresno County, CA, 1997.

	Avg. canker length (cm)[x]	
	Days between inoculation and treatment[y]	
Treatment	0	4
Nectec	16.0 ab[z]	18.5 a
Benlate + oil	5.8 bc	27.2 a
Enzone	18.7 a	17.5 a
Spinout	22.2 a	20.0 a
Treeseal	22.0 a	26.7 a
Inoculated control	24.5 a	13.5 a
Uninoculated control	0.0 c	0.0 b

x Measured 10-14 November 1997.

y Wounds made on 6 September 1996; inoculated 6 or 10 September 1996.

z Four replications of each treatment arranged in a randomized complete block design. Letters down columns do not differ significantly according to Duncan's multiple range test.

Table 15. Effect of interval between inoculation and surgical removal of cankers and fungicide treatment on control of Ceratocystis canker of almond cv Nonpareil trees, Fresno County, CA, 1997.

	Avg. canker length (cm)[x]		
	Days after inoculated when cankers removed and wound treated[y]		
Treatment	7	49	102
Nectec	13.0 bc[z]	9.5 cd	1.7 b
Enzone	52.2 a	56.2 cd	46.2 a
Inoculation, surgery, no fungicide	24.5 abc	24.0 bc	24.0 ab
Inoculation, no surgery, no fungicide	30.0 ab	30.0 b	30.0 a
Uninoculated, no surgery, no fungicide	0.0 c	0.0 d	0.0 b

x Measured 1 November 1997.

y All wounds made and inoculated on 12 September 1996. Cankers removed and treated with fungicides on 19 September, 29 October, and 23 December.

FIGURE 1. Average daily temperatures in an almond orchard with a high incidence of Alternaria leaf spot, Kern County, CA, 1997

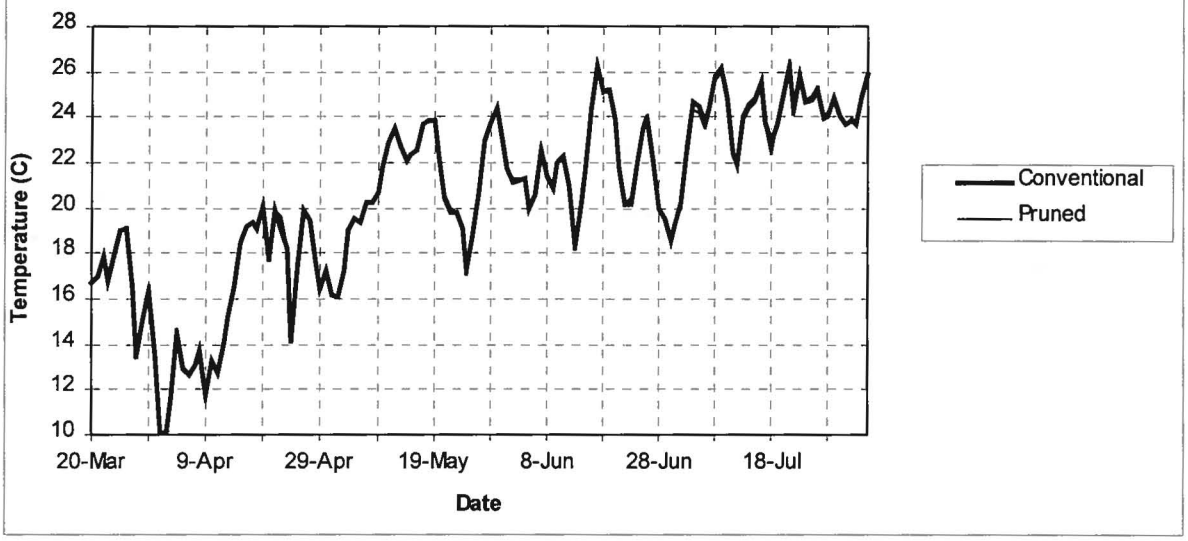

FIGURE 2. Average relative humidity in an almond orchard with a high incidence of Alternaria leaf spot, Kern County, CA, 1997

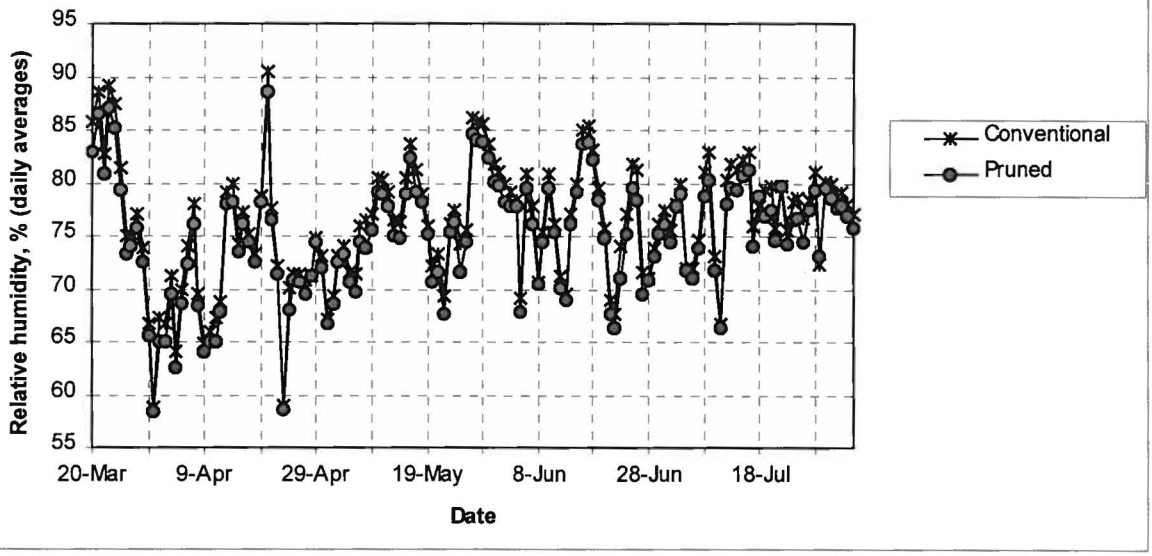

FIGURE 3. Hours of leaf wetness in an almond orchard with high incidence of Alternaria leaf spot, Kern County, CA, 1997