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REPORT TO THE ALMOND BOARD OF CALIFORNIA

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Project No. 91-ZG2- Relationship of irrigation and nitrogen fertilization on incidence of hull rot and brown rot.

actual: 94-ZG5

Role of brown rot fungi in green fruit rot.

Bloom and foliage disease control.

Wound treatments to control Ceratocystis canker.

A. Relationship of Irrigation and Nitrogen Fertilization on Incidence of Hull Rot and Brown Rot

Objectives

1. Determine the relationship of various irrigation and nitrogen fertilization regimes on natural occurrence of hull rot.
2. Determine the effects of selected irrigation and nitrogen regimes on infection of fruit inoculated with *R. stolonifer* and *M. fructicola*.
3. Observe the effect of selected irrigation and fertilization practices on loosening of the hull.
4. Investigate the role of insects in transmission of the pathogens.

Procedures

The irrigation experiments: The experiments were conducted on cultivar Nonpareil trees in a commercial orchard in Kern County farmed by Paramount Farms. The irrigation experiment was designed and conducted by Dr. Dave Goldhamer. All measurements of tree response to treatments and yield parameters were collected by him. The experiment tested three amounts of total water per season (22, 28 and 34 inches water) each delivered to emphasize deficit irrigation (hence tree stress) at early, mid and late season (Table 1). Ten treatments (22A, B and C, 28A,

B, and C, and 34A, B, and C and control) replicated six times were arranged in a randomized complete block design. Plots were six rows wide, 12 trees long, and data were collected from the center eight cv Nonpareil trees.

The nitrogen experiments: The orchard, located in Stanislaus County, was planted with Price, Nonpareil and Carmel in a 1:1:1 pattern. Yields and leaf nitrogen contents of individual trees were taken in 1989 before nitrogen treatments were imposed. Trees having similar pre-treatment yields and leaf nitrogen contents were grouped to provide two adjacent trees in each of four replications of each treatment arranged in a randomized complete block design. The two data trees were embedded in the center of plots which are three rows wide and four trees long. The nitrogen treatments were: 0, 125, 250, and 500 lbs nitrogen/acre. Nitrogen was applied as ammonium sulfate, 21 percent, one third the annual total placed in spring and the remaining two thirds in fall. The orchard was irrigated immediately following fertilizer placement. Leaf nitrogen data were obtained from Steve Weinbaum.

The hull rot experiments: In the irrigation trial, inoculation experiments were performed in the following irrigation treatments: normal (control), normal except 50 percent deficit during 1 June-15 July (treatment 34A) and 1 June-31 July (treatment 28B), continuous 85 percent (treatment 34C) and 70 percent (treatment 28C) of normal all year. Inoculations were made on 21 July in the irrigation trial and on 3 and 10 August in the 0 and 125 and the 250 and 500, respectively, lbs/acre annual applied nitrogen treatments in the nitrogen trial. In each plot, twenty-five fruit with firmly attached hulls in early dehiscence and associated with healthy leaves were inoculated with 10^4 conidia/ml suspensions of the hull rot fungi *M. fructicola* and *R. stolonifer*. Inoculum was delivered into the open hull using a calibrated pump atomizer. Noninoculated healthy fruit at the same stage of dehiscence were used as controls. The condition (healthy, dead or gone) of leaves associated with each test fruit were recorded on 4 and 24 August in the irrigation and nitrogen experiments, respectively, and all test fruit were collected and returned to the laboratory

to be examined for hull lesions and presence of the pathogens. To assess natural incidence of hull rot, all hull rot strikes (clusters of dead leaves) were counted and inches dead wood estimated for all trees in each plot on 11 and 31 August, two days after trees shaken, for the irrigation and nitrogen trials, respectively. On the same days that natural incidence of hull rot was evaluated, a random sample of fruit was collected from beneath the data trees and returned to the laboratory and the number per 100 fruit having hull rot counted.

Brown rot (nitrogen trial only): Immediately before the grower treated his orchard on 4 March for brown rot blossom blight, selected branches with open blossoms were covered with plastic bags to prevent them from being sprayed with fungicide. After treatment, the bags were removed, the blossoms inoculated by misting them with 10^4 conidia/ml suspensions of *M. laxa* and *M. fructicola.* The inoculated blossoms were again covered with plastic then paper bags for 48 hrs. Twenty-five flowers per replication were collected on 11 March and the number of infected and total number of stamens counted, and the percent infected stamens was calculated. Four shoots on one Carmel tree per replication were inoculated with *M. laxa* and *M. fructicola* by placing small pieces of agar culture beneath the bark on 10 May. Lesion length was measured on 20 June. Natural incidence of brown rot was evaluated on 10 May by counting all strikes in the three Price and three Carmel trees in each replication.

Rate of hull loosening: On 8 and 26 July (irrigation and nitrogen trials, respectively) fifty fruit that had not begun to dehisce were tagged on one tree in each plot. The attachment of these fruit to the peidicels were examined on 15, 22, 29 July and 3 August and on 2, 10, 17, and 24 August in the irrigation and nitrogen trials, respectively, and rated as: 1=no abscission or dehiscence, 2=no abscission, slight dehiscence, 3= <25 percent abscission, 4=25-50 percent abscission, attachment still firm, 5= >50 percent abscission, attachment loose, and 6= hull yellowing, almost completely detached from pedicel.

Hull moisture content: Hulls of ten fruit at stages of dehiscence similar to those used for inoculation were collected on the same dates listed for hull loosening from each tree in which inoculation treatments were made, weighed immediately in the field then returned to the laboratory to be air dried at 130F for 72 hours to determine the percent hull moisture or nitrogen content.

Role of insect transmission: At approximately monthly intervals from flowering until just before hull split, nonpareil fruit on trees at Kearney Agricultural Center were inoculated with *M. fructicola* by spraying them with conidial suspensions 10^4/ml, and covering them with plastic and paper bags for 48 hr. just before hull split. All were encased in fine mesh bags to exclude insects. All fruit were collected when mature and examined for hull rot. There were four replications on each date.

Analysis: Percent infected hulls, dead leaves and hull moisture content, split and loosening were analyzed using factorial analysis with irrigation or nitrogen treatment as the main factors and fungal species and inoculation date as the subplot factors. Average number hull rot strikes per tree and percent infected fruit were analyzed by analysis of variance. Duncan's multiples range test or orthogonal contrasts were employed to determine the significance of F values where appropriate.

Results and discussion

Irrigation--Natural incidence of hull rot (hull rot strikes and inches dead wood) was greatest in the normal and continuous constant 85% of normal (34C) treatments (Table 2). Reduction of water by 50% of normal during 1 June-15 July (34A) or 1-15 July (34B) decreased the incidence of hull rot by two thirds compared to that found in the normal or 34C treatments. Hull rot incidence in treatments 34A and 34B did not differ from those in treatments 28A, 28B, 28C, 22B or 22C. Thus, one two-week period from 1 to 15 July (34B) reduced the incidence of hull rot by

more than half compared to the continuous 85 percent of normal (treatment 34C) even though the two treatments received similar amounts of water. There were no significant differences among treatments in percent infected hulls. Apparently the ability of the pathogen to infect the hull is not affected by irrigation treatment but the processes leading to leaf and shoot death are.

Similar results occurred in inoculation experiments: more dead leaves were found associated with inoculated fruit in the normal and continuous 85% of normal treatments and few differences were found among the other treatments (Table 3). Less hull rot occurred in short duration deficit treatments than in constant deficit irrigation treatments. *M. fructicola* and *R. stolonifer* responded similarly to the irrigation treatments. Hull abscission and split tended to proceed more rapidly in drier treatments (28B and 28C) and in one of the short duration deficit treatments (34A) (Table 4). The relationship between irrigation treatment and hull abscission remains unclear. Hull moisture content decreased linearly with decreasing water and generally followed the same pattern as natural infection.

Nitrogen -- Natural incidence of hull rot was more in the two greatest (500 and 250) than in the two least (125 and 0) lbs applied nitrogen treatments, and there was a sharp division between the 125 and 250 lbs nitrogen per acre treatments (Table 5). In inoculation experiments, differences among treatments in percent dead leaves or infected hulls were not found. In fact, the numerical values were the reverse of that found in natural incidence: more dead leaves developed in the lower than in the higher nitrogen rate treatments (Table 6). This may be an artifact of the experiment. It was impossible to inoculate all treatments on the same date or at the same stage of fruit maturity because there were insufficient split fruit in the 250 and 500 treatments when fruit in the 0 and 125 treatments were ready for inoculation. This is reflected somewhat in the abscission and percent split data (Table 7). Although significant differences were not found in the abscission rating, the numerical trend was toward more rapid abscission in the lower levels of nitrogen treatments. The same two groups (0 and 125 and 250 and 500) and the sharp division between

the 125 and the 250 treatments found in the natural incidence of hull rot also were observed in percent hull split. (Hull split was defined as any fruit that fell into categories 2 through 6 of the hull abscission rating scale.) Had we waited for more fruit in the 250 and 500 treatments to split, those in the 0 and 125 treatments would have been considerably more mature. We chose to inoculate on two different days to better approximate similar stages of fruit maturity. This apparently compromised our results.

M. fructicola caused higher percent dead leaves than did *R. stolonifer* in both the irrigation and nitrogen experiments (Table 8).

Brown rot: The percent stamens infected by *M. laxa* was greater in the 250 and 500 than in the 0 and 125 lbs per acre applied nitrogen treatments (Table 9). The same sharp division between the 125 and 250 treatments reported for hull rot were observed for infected stamens. *M. fructicola* infected very few stamens and data could not be analyzed due to a preponderance of zeroes. There were no significant differences in shoot lesion length with either fungus, but there was a trend to longer lesions in the higher nitrogen treatments where *M. laxa* was the pathogen. There was very little natural incidence of brown rot, and the disease tended to increase with increasing rates of nitrogen but differences were not significant.

Insect transmission: Hull rot did not occur in inoculated bagged fruit but was present in noninoculated, nonbagged fruit. Insects may be important vectors of *M. fructicola*.

B. Role of Brown Rot Fungi in Green Fruit Rot

Objectives

1. To demonstrate infection and rot of young green fruit by the brown rot pathogens and to determine susceptible stages of development.

2. To compare the effects of several wetness periods on the development of brown rot fungi in green fruit rot.

Procedures

Green fruit rot and an associated spur and shoot death was widely observed in 1993. The fungus most commonly isolated from such tissues was *M. laxa*. Because green fruit rot, or jacket rot as it is sometimes called, is usually attributed to infection by the fungus *Botrytis cinerea*, we tested these two fungi and *M. fructicola* for their ability to rot green fruit and investigated some factors affecting infection by *M. laxa*.

Experiment 1, objective: to determine the importance of contact surfaces with other plant tissues on infection of green fruit by *M. laxa*.

Young Carmel fruit were misted with water then 1) spray inoculated with a suspension of 10^6/ml conidia, 2) a cast floral cup was misted with the inoculum then placed on the fruit surface, or 3) not inoculated. Similar healthy young Carmel fruit were collected and a fruit place onto the inoculated fruit and held in place by a twistem tie. The floral cup thus was sandwiched between two fruit. All were covered with plastic then paper bags, and bags, detached fruit, floral cups and twistem ties were removed after 72 h. There were 20 fruit per treatment, not randomized. The experiment was conducted on 24 March and data collected on 15 April.

Results: Four fruit rotted where a floral cup was placed between the two fruit. Rot did not occur in any other treatment.

Experiment 2, objective: to compare the amount of green fruit rot caused by *M. laxa*, *M. fructicola* and *B. cinerea*.

Cast floral cups were collected from Carmel trees and autoclaved. Groups of these were incubated for 24 h in conidial suspensions, 10^6 / ml, of each fungus or sterile deionized water. On 29 March, young Carmel fruit were thoroughly wetted then an incubated floral cup placed on the surface, a second healthy almond fruit placed on top of the floral cup and the two fruit secured with a twistem tie. All were covered with plastic then paper bags, and bags, detached fruit, floral cups and twistem ties were removed after 72 h.

Results: On 21 April, all fruit were rotted and all leaves wilted or dead in the *M. laxa* inoculations, six fruit were rotted and associated leaves wilted in the *M. fructicola* treatment, and no fruit were rotted and no leaves were wilted in the *B. cinerea* treatment. *M. laxa* was cultured from fruit, pedicel and stem, *M. fructicola* from fruit only, and *B. cinerea* was recovered from the fruit surface but not other tissues.

Experiment 3, objective: to determine the effect of wetness duration after inoculation on incidence and severity of green fruit rot of fruit inoculated with *M. laxa*.

On 23 and 24 March, 10 clusters per replication of young Carmel fruit, not yet touching, were spray inoculated with a suspension of 10^6 / ml conidia. A noninoculated control was included. Immediately following inoculation, fruit were misted for 24, 48 or 72 hours. There were four single-tree replications of each treatment arranged in a randomized complete block design. Fruit were observed for symptoms on 15 April and 24 June.

Results: No infection occurred except for one fruit in the 72 hr treatment which had a petal stuck to it.

The experiment was repeated on 4 May using cast floral cups incubated with *M. laxa* as described above, attached to fruit with twistem ties, and covered with plastic and paper bags for 72 hours.

There were 10 fruit per replication, four single-tree replications of each treatment arranged in a randomized complete block design.

Results: No fruit were rotted.

Discussion

These experiments in and of themselves are insufficient to reach conclusions about green fruit rot. But the suggest that 1) *M. laxa* is the most important fungus in the green fruit rot complex, 2) clustering alone does not lead to fruit infection, 3) floral trash or perhaps other dead organic matter is a required part of the inoculum for green fruit rot and 4) fruit cease to be susceptible some time before early May.

C. Bloom and Foliage Disease Control

Objective

1. Test various fungicides and application timings for control of almond scab and evaluate these in relation to control practices for brown rot.

Procedures

Scab and brown rot, caused by the fungi *Cladosporium carpophilum* and *M. laxa*, respectively, are not uncommon diseases of almond trees. Both are usually more severe on cultivars such as Carmel, Butte and Sonora though they are found on others as well. Scab has become an increasing problem over the past several years and brown rot is a consistent threat. Very little information was available on scab control whereas considerable information has been developed on the control of brown rot.

We investigated the efficacy of fungicides and the timing of treatments for control of scab and evaluated the efficacy of these treatments for control of brown rot.

Experiments were conducted in two almond orchards in Merced County. Orchard 1 (LeGrand) was planted 1:1 with Nonpareil and Carmel, flood furrow irrigated, and the trees were mature with dense and touching canopies by early summer. Orchard 2 (Atwater) was planted 1:1:1:1:1 with Carmel, Nonpareil, Price, Nonpareil, Mission, sprinkler irrigated, and the trees were young and their canopies did not touch during the season. Both orchards had histories of scab and holdover scab lesions were easily found on previous year's growth.

Materials were applied to run-off by hand-gun sprayer operated at 280 psi.

Fifty leaves per replication were collected from the outside periphery of each tree on 28 June and 25 August in Orchard 1 and on 20 July and 22 August in Orchard 2. Defoliation was estimated in Orchard 2 on 22 August. There were five and six single tree replications of each treatment at Orchards 1 and 2, respectively, arranged in a randomized complete block design.

Timing: Application timings were compared using a tank mix of Benlate 50 + Captan 50 (1.0 and 8.0 lbs product per acre, respectively). Three applications of the fungicide solution were applied, one each at pink bud, full bloom and either 2 or 5 weeks after bloom. In addition, both of these timing treatments were made following dormant treatment with Kocide 101 (8.0 lbs product per acre) or liquid lime sulfur (16.0 gal/100 gal). Nontreated controls were included.

Single-application timings at full bloom and either 2 or 5 weeks after bloom were compared using 1.0 lb product per acre of Benlate 50.

Results: Dormant treatment did not improve control of scab over that achieved by spring treatments alone, scab control in the 2 and 5 week post bloom treatments did not differ in Orchard 1 and the 5 week post bloom treatment was significantly better than the 2 week post bloom timing in Orchard 2 (Table 10).

Single applications of Benlate 50 significantly controlled scab at all treatment timings compared to the nontreated control in Orchard 1 and the treatment at 2 weeks post bloom provided the best protection (Table 11). In orchard 2, control was best in the full bloom treatment, moderately effective at 2 weeks post bloom and did not differ from the control in the 5 week post bloom treatment.

Efficacy: The efficacies of registered fungicides were compared using a three-application schedule of treatment at pink bud, full bloom and 5 weeks after bloom. Fungicides tested were: tank mixes of Benlate 50 (1.0 lb product per acre) plus Captan 50, Maneb 80 or Ziram 76, each at 8.0 lbs product per acre, Captan 50, Maneb 80, Ziram 76 each alone at the same rates, Manex 37F at 3.2 pts per acre, Rovral 4F at 0.25 pt per acre with 1% v/v Omni oil or without oil. A nontreated control was included.

Results: Scab was best controlled in treatments using the tank mix of Benlate 50 plus Captan 50 or Maneb 80 alone in Orchard 1 (Table 12). Captan 50 or Ziram 76, each alone, were intermediate in efficacy and Rovral 4F with or without Omni oil was least effective in controlling scab. In Orchard 2, the tank mixes of Benlate 50 plus Captan 50, Maneb 80 or Ziram 76 gave similar and superior control of scab, Captan 50, Maneb 80, Manex 37F, and Ziram 76 were similar and intermediate in scab control, and Rovral 4F and Rovral 4F plus Omni oil were least effective.

Brown rot was present only in Orchard 2. There was considerable overlapping in the statistical analysis, but generally, Rovral 4F plus Omni oil and the tank mix of Benlate 50 plus Captan 50 provided the best control followed by tank mixes of Benlate 50 plus either Maneb 80 or Ziram 76, then the contact fungicides alone formed a third group (Table 13). The addition of Omni oil to Rovral 4F improved control of brown rot numerically but not statistically.

Discussion

The excellent scab control achieved by the spring treatment alone may have overshadowed any effect dormant treatments had. Similarly, differences between treatments at 2 and 5 weeks after bloom also may have been obscured. In Orchard 2, the better control found in the 5 as opposed to the 2 week post bloom application treatments contradicts experience in the previous 2 years. Scab developed much later in Orchard 2 in 1994 than in previous years. It may be that the entire disease dynamic was shifted to later in the season and thus perhaps made the later treatments more effective.

Results of the Benlate-only timings in Orchard 1 agreed with those found in previous years (the superiority of the 2 weeks post bloom treatment), but were puzzling in Orchard 2. There, the Benlate-only timings differed not only from previous experience, but also with results from the larger experiment on dormant and spring timing. I have no ready explanation for this. However, the preponderance of evidence over three years continues to point to the 2 week post bloom timing as important for scab control.

Fungicide efficacy for scab control appears to fall into three general categories: a tank mix of Benlate plus any of the contact fungicides Captan, Maneb or Ziram offers the most consistent best protection, all of the contact fungicides alone are effective but less so that the tank mixes with Benlate, and Rovral with or without oil does not provide acceptable control though in some tests scab levels are significantly reduced over that of the nontreated control.

Rovral and Benlate continue to provide the best control of brown rot.

D. Wound Treatments To Control Ceratocystis Canker

Objectives

1. To test several wound dressing materials for prevention and control of Ceratocystis infections.
2 To evaluate several wound dressing materials for wound healing characteristics.
3. To determine the relationship of time between wounding and infection and infection and treatment on control of current season infections.
4. To test effectiveness of surgery and topical treatment on established cankers.

Work on the first three objectives is in the initial stages and there are no data to report at this time.

Procedures

Three to four year-old cankers (the results of previous inoculations) on scaffolds of mature Mission almond trees grown at the Kearney Agricultural Center were treated on 24-25 January 1993. Materials used as topical dressings were: Nectec, Enzone, Benlate, and Kocide. Each was prepared as a paste or liquid and swabbed onto cankers that had 1) not been surgically removed, 2) been removed by shallow cuts into the outer bark with bark canker margins still present, and 3) been removed by deep cuts into the wood with bark canker margins essentially removed. Benlate and Kocide were applied only to deep surgery wounds. There were six replications of each treatment arranged in a randomized complete block design, using two trees per replication. Cankers were evaluated 2 November 1994 and healing and gumming rated as follows. Healing:

0=no healing, no callus formation, usually severe gumming around canker circumference, 1= more than half the canker circumference healed, little gumming, 2= fully healed, no gumming.

Results and discussion

Results: There was less healing and more gumming in control (no surgery, no treatment) cankers than in treated cankers (Table 14). Cankers treated with Nectec, Enzone or Benlate appeared most healed.

Discussion: The reduction in active symptoms (gumming) and increase in callus formation observed in cankers treated with Nectec, Enzone or Benlate suggest that topical treatment of Ceratocystis cankers may be a useful control tool. More research is needed before recommendations can be made.

Table 1. Regulated deficit irrigation schedule for Kern County almond trial 1993-1995.

	Percent of normal irrigation									
Date	Black Control	Blue 34A	Blue bar 34B	Purple 34C	Green 28A	Red 28B	Rose 28C	Orn Bar 22A	Orn 22B	White 22C
Mar 1-15	100	100	100	85	100	100	70	100	100	55
Mar 16-31	100	100	100	85	100	100	70	100	100	55
Apr 1-15	100	100	100	85	100	100	70	100	100	55
Apr 16-30	100	100	100	85	100	100	70	50	50	55
May 1-15	100	100	100	85	50	100	70	50	50	55
May 15-31	100	100	100	85	50	100	70	50	50	55
June 1-15	100	50	100	85	50	50	70	50	50	55
June 16-30	100	50	100	85	50	50	70	50	50	55
July 1-15	100	50	50	85	50	50	70	0	50	55
July 16-31	100	100	100	85	50	50	70	50	50	55
Aug 1-15	100	100	100	85	50	100	70	50	100	55
Inches of water through harvest (Mar 1 - Aug 15)										
1993	27.8	22.6	25.9	23.8	18.0	20.7	19.3	11.7	16.1	15.3
1994	24.4	19.2	22.0	20.9	15.3	18.0	16.9	12.4	14.4	13.4
1995										
Total inches Mar 1 - Nov 15	39.3	34.1	34.1	33.4	28.3	27.8	27.5	22.5	21.8	21.6

Table 2. Effect of regulated deficit irrigation on natural incidence of hull rot in cv Nonpareil almond trees, Kern County 1994.

Irrigation treatment		Inches water applied		Disease evaluation[y]		
Code	Color	Total	1 Mar-1 Aug	Strikes per tree	Inches dead wood	Infected hulls, %
Normal	Black	39	24.4	18.4 a[z]	26.6 a	26.5
34A	Blue	34	19.2	6.7 b	2.6 cd	22.7
34B	Blue bar	34	21.4	6.2 b	8.1 bc	24.2
34C	Purple	34	20.9	18.0 a	31.1 a	35.0
28A	Green	28	15.3	5.5 bc	6.1 cd	25.5
28B	Red	28	18.0	4.7 bc	2.2 cd	26.9
28C	Rose	28	16.9	7.1 b	8.5 bc	27.5
22A	Orange bar	22	12.4	2.4 c	1.4 d	19.5
22B	Orange	22	14.4	4.1 bc	5.3 cd	21.3
22C	White	22	15.0	6.0 bc	3.8 cd	20.4
Significance of F,P = Treatment				.001	.001	NS

[y] Trees shaken 9 August, data collected 11 Aug 1994. All clusters of dead leaves counted in all eight data trees per replication. Length of dead wood estimated. Fruit gathered from beneath trees throughout eight data trees from which 100 fruit drawn and inspected for hull lesions and presence of hull rot pathogens. *Rhizopus stolonifer* found.

[z] Means followed by same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$. Arcsine transformed data analyzed, actual percentages reported.

Table 3. Effect of selected regulated deficit irrigation treatments on hull rot elicited by inoculation with *Monilinia fructicola* and *Rhizopus stolonifer*, Kern County, 1994.

Irrigation treatment		Inches water applied		Disease evaluation[w]			
				Inoculated 21 July[x]		Controls[y]	
Code	Color	Total	1 Mar-1 Aug	Dead leaves, %	Infected hulls, %	Dead leaves, %	Infected hulls, %
Normal	Black	39	24.4	53.3 a[z]	82.3	5.0	34.0 a
34A	Blue	34	19.2	40.4 cd	81.3	3.0	22.3 a
34B	Blue bar	34	21.4	40.2 cd	69.0	2.3	49.0 b
34C	Purple	34	20.9	51.6 ab	80.0	5.0	27.7 a
28B	Red	28	18.0	34.3 d	70.3	1.3	25.7 a
28C	Rose	28	16.9	44.2 bc	83.8	4.0	30.3 a

[w] Data collected 3 Aug 1994, trees shaken 8 Aug 1994. Leaves associated with inoculated fruit rated dead or healthy. Inoculated fruit collected and examined in laboratory for presence of lesions and pathogen.

[x] Twenty-five fruit each, situated near healthy leaves, inoculated by spraying water suspension of spores of *R. stolonifer* or *M. fructicola* into open suture.

[y] Means combined from noninoculated controls from both inoculation dates. Too many zeros to analyze % dead leaves.

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$. Arcsine transformed data analyzed, actual percentages reported.

Table 4. Effect of selected regulated deficit irrigation treatments on hull abscission, split and moisture content, Kern County, 1994.

Irrigation treatment				
Code	Color	Hull abscission rating[x]	Hull split, %[x]	Hull moisture, %[y]
Normal	Black	3.0 bc[z]	60.4 b	71.2 a
34A	Blue	3.5 a	72.8 a	64.5 b
34B	Blue black	2.9 c	60.1 b	68.1 ab
34C	Purple	3.0 bc	62.7 b	72.8 a
28B	Red	3.4 a	70.1 ab	65.2 b
28C	Rose	3.2 ab	73.2 a	67.4 ab

[x] Fifty fruit tagged prior to hull split. Looseness of hull attachment to pedicel rated on a scale of 1 (no detachment, no split) to 6 (almost completely detached). Percent of fruit in categories other than (1) determined for percent hull split.

[y] Ten fruit collected four times at weekly intervals during hull split.

[z] Data combined over four collection dates for factoral analysis of variance. Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

Table 5. Effect of four levels of applied nitrogen on natural incidence of hull rot of Nonpareil almond trees, Stanislaus County, 1994.

Applied nitrogen, lb/acre	Strikes per tree[y]	Infected hulls, %[y]
500	34.5 a[z]	
250	32.7 a	
125	21.5 b	
0	14.0 b	

[y] Data collected 31 August 1994, two days after trees shaken. All strikes counted in both data trees per replication. One hundred fruit collected from beneath trees examined in laboratory for presence of lesions and pathogens. *M. fructicola* most common.

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

Table 6. Effect of four levels of applied nitrogen on hull rot when fruit inoculated with *Monilinia fructicola* or *Rhizopus stolonifer*, Stanislaus County, 1994.

Applied nitrogen, lb/acre	Dead leaves, %[z]	Infected hulls, %[z]
500	30.7	65.5
250	38.5	58.5
125	54.0	70.5
0	49.5	74.5
	NS	NS

[z] Twenty-five fruit per replication situated next to healthy leaves inoculated with *M. fructicola* or *R. stolonifer*. Applied nitrogen treatment 0 and 125 inoculated on 3 August and treatments 250 and 500 on 10 August. Data collected 26 August.

Table 7. Effect of four levels of applied nitrogen on hull loosening, split and moisture content, Stanislaus County, 1994.

Applied nitrogen, lb/acre	Loosening rating[x]	Hull split, %[x]	Hull moisture, %[y]
500	3.7	72.5 a[z]	71.5
250	3.7	72.9 a	72.9
125	4.0	78.9 b	70.4
0	4.1	79.8 b	69.2
	NS		NS

[x] Twenty-five fruit each, situated near healthy leaves, inoculated by spraying water suspension of spores of *R. stolonifer* or *M. fructicola* into open suture.

[y] Means combined from noninoculated controls from both inoculation dates. Too many zeros to analyze percent dead leaves.

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

Table 8. Relative incidence of hull rot in fruit inoculated with *Monilinia fructicola* and *Rhizopus stolonifer*, Kern and Stanislaus Counties, 1994.

	Irrigation (Kern)[y]		Nitrogen (Stanislaus)[y]	
	Dead leaves, %	Infected hulls, %	Dead leaves, %	Infected hulls, %
M. fructicola	51.6 a[z]	85.1 a	48.1 a	83.5 a
R. stolonifer	44.9 b	70.5 b	38.2 b	51.0 b

[y] Means of data combined over all irrigation or all applied nitrogen treatments.

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

Table 9. Effect of four levels of applied nitrogen on natural incidence of brown rot, infection of flowers and short lesion length of flowers and shoots inoculated with *Monilinia fructicola* and *M. laxa*, Stanislaus County, 1994.

Applied nitrogen	Shoot lesion length, mm		Infected stamens, %		Number strikes/ tree	
lbs/acre	*M. laxa*	*M. fructicola*	*M. laxa*	*M. fructicola*	Carmel	Price
500	116.6	105.1	15.1 a	5.5	4.7	3.7
250	99.5	75.2	14.6 a	0.2	4.0	4.5
125	96.4	128.9	8.2 b	0.2	3.5	1.5
0	92.9	98.4	7.5 b	0.0	2.5	2.2
	NS	NS			NS	NS

Evaluated 10 May 1994.

Inoculated 4 March at full bloom, infected stamens counted 11 March.

Four shoots on one cv Carmel tree per plot were inoculated with each fungus 10 May and lesions measured 20 June 1994.

Table 10. Effect of dormant treatments and timing of spring treatments on almond scab control on cv Carmel almond trees. Merced County, 1994.

Treatment[w]		Spring treatment timing[x]	Scabbed leaves, %[y]				Defoliation, %[y]
			Orchard 1 (Atwater)		Orchard 2 (LeGrand)		Orchard 2 (LeGrand)
Dormant	Spring		28 June	25 Aug	20 July	22 Aug	22 Aug
Kocide 101	Benlate 50 + Captan 50	PB, FB, 2 wk	2.4	3.2	1.0	17.3	4.7
Kocide 101	Benlate 50 + Captan 50	PB, FB, 5 wk	0.8	1.6	0.0	1.7	4.3
Kocide 101	None	none	19.6	70.8	---	---	---
Liquid lime sulfur	Benlate 50 + Captan 50	PB, FB, 2 wk	1.6	6.4	0.0	17.0	4.2
Liquid lime sulfur	Benlate 50 + Captan 50	PB, FB, 5 wk	2.4	2.6	0.3	3.0	4.5
Liquid lime sulfur	None	none	25.2	64.0	2.0	36.7	2.0
No dormant	Benlate 50 + Captan 50	PB, FB, 2 wk	5.2	5.6	0.7	15.0	3.2
No dormant	Benlate 50 + Captan 50	PB, FB, 5 wk	0.8	7.6	0.0	4.3	7.8
No dormant	None	none	32.0	87.6	1.0	49.0	12.5
Significance of *F*, *P* =[z]							
Treatment vs. control			.000	.000	---	.000	NS
2 wk vs. 5 wk			NS	NS	---	.000	NS
Dormant vs. no dormant			NS	NS	---	NS	NS

Table 10 footnotes:

[w] Kocide 101 and liquid lime sulfur applied at 8.0 lbs/acre and 16.0 gal/100 gal water, respectively. Benlate 50 and Captan 50 applied as a tank mix at 1.0 and 8.0 lbs product/acre, respectively. Materials applied by hand-gun sprayer operated at 280 psi. Approximately 400 gal/acre.

[x] All treatments, except the dormant-only treatments and the control, treated at pink bud (PB), full bloom (FB) and either 2 (2W) or 5 (5W) weeks after bloom.

	Orchard 1	Orchard 2
Dormant	28 January	3 February
PB	28 February	1 March
FB	4 March	7 March
2W	18 March	23 March
5W	8 April	11 April

[y] Five and six single-tree replications of each treatment at Orchard 1 and 2, respectively. Fifty leaves/replication collected from the outside periphery of each tree. Leaves rated healthy (no scab lesions) or diseased (one or more scab lesions present). Defoliation visually estimated. Mite damage severe in both orchards so defoliation not estimated in Orchard 1 or later in Orchard 2.

[z] Arcsine transformed data analyzed, actual percentages reported. Means separated by orthogonal contrasts.

Table 11. Effect of timing of Benlate-only treatments on almond scab control on cv Carmel almond trees. 1994.

	Scabbed leaves, %[x]				Defoliation, %[x]
	Orchard 1 (Atwater)		Orchard 2 (LeGrand)		Orchard 2 (LeGrand)
Timing[y]	28 June	25 Aug	20 June	22 Aug	22 Aug
FB	16.8 b	56.8 b	1.3[z]	22.0 c[z]	1.3
2W	3.2 c	9.2 c	2.0	30.0 bc	2.0
5W	10.0 bc	26.8 c	1.3	45.0 a	1.3
Control	50.0 a	89.6 a	1.0	49.0 a	1.0
					NS

[x] Five and six single-tree replications of each treatment in Orchard 1 and 2, respectively. Fifty leaves/replication collected from the outside periphery of each tree. Leaves rated healthy (no scab lesions) or diseased (one or more scab lesions present). Defoliation visually estimated. Mite damage severe in both orchards so defoliation not estimated in Orchard 2 or later in Orchard 1.

[y] Benlate 50, 1.0 lb/acre applied by hand-gun sprayer operated at 280 psi. Approximately 280 gal/acre.

	Orchard 1	Orchard 2
FB (full bloom)	4 March	7 March
2W (2 weeks after bloom)	18 March	23 March
5W (5 weeks after bloom)	8 April	11 April

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$. Arcsine transformed data analyzed, actual percentages reported.

Table 12. Fungicide efficacy for control of almond scab on cv Carmel almond trees, Merced County, 1994.

Treatment[w]	Product as formulated lbs/acre or pts/100 gal	Scabbed leaves, %[x]				Defoliation, %[x]
		Orchard 1 (Atwater)		Orchard 2 (LeGrand)		Orchard 2 (LeGrand)
		28 June	25 Aug	20 July	22 Aug	22 Aug
Benlate 50 + Captan 50	1.0 lb + 8.0 lb	0.4 d[z]	8.4 d	0.7	4.3 cd	3.2
Benlate 50 + Maneb 80	1.0 lb + 8.0 lb	---	---	0.3	6.7 cd	2.8
Benlate 50 + Ziram 76	1.0 lb + 8.0 lb	---	---	0.0	0.3 d	2.7
Captan 50	8.0 lb	6.4 cd	26.4 c	0.0	17.3 bc	6.2
Maneb 80	8.0 lb	3.6 d	4.0 d	0.3	10.7 bc	3.8
Manex 37F	3.2 pt	---	---	1.0	11.3 bc	---
Ziram 76	8.0 lb	4.0 cd	26.8 c	1.7	13.0 bc	1.8
Rovral 4F	0.25 pt	24.0 b	65.6 b	0.0	26.7 b	10.5
Rovral 4F + Omni oil	0.25 pt + 1% v/v	15.6 bc	52.8 b	0.7	25.7 b	6.3
Control		50.0 a	89.6 a	1.0	49.0 a	12.8 NS

Table 12 footnotes:

[w] Materials applied three times:

	Orchard 1	Orchard 2
pink bud	28 February	1 March
full bloom	4 March	7 March
5 weeks after bloom	8 April	11 April

Materials applied by hand-gun sprayer operated at 280 psi. Approximately 400 gal/acre.

[x] Five and six single-tree replications of each treatment at Orchard 1 and 2, respectively. Fifty leaves/replication collected from the outside periphery of each tree. Leaves rated healthy (no scab lesions) or diseased (one or more scab lesions present). Defoliation visually estimated. Mite damage severe in both orchards so defoliation not estimated in Orchard 2 or later in Orchard 1.

[y] Not analyzed, disease counts too low.

[z] Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$. Arcsine transformed data analyzed, actual percentages reported.

Table 13. Efficacy of several fungicides for control of brown rot on cv. Carmel almond trees, Merced County, 1994.

Treatment[x]	Product as formulated lb/acre or pt/100 gal	Average number strikes/tree[y]
Benlate 50 + Captan 50	1.0 lb + 8.0 lb	18.2 c[z]
Benlate 50 + Maneb 80	1.0 lb + 8.0 lb	38.0 bc
Benlate 50 + Ziram 76	1.0 lb + 8.0 lb	34.5 bc
Captan 50	8.0 lb	43.8 b
Maneb 80	8.0 lb	46.7 b
Manex 37F	3.2 pt	45.5 b
Ziram 76W	8.0 lb	46.0 b
Rovral 4F	0.25 pt	29.0 bc
Rovral 4F + Omni oil	0.25 pt + 1% v/v	20.0 c
Control	---	79.2 a

[x] All materials applied three times:

pink bud	1 March
full bloom	7 March
5 weeks after petal fall	11 April

Materials applied by hand-gun sprayer operated at 280 psi. Approximately 400 gal/acre.

[y] Read 12 May 1994.

Six single-tree replications of each treatment. Means followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

Table 14. Topical treatments for control of established Ceratocystis cankers, Kearney Agricultural Center, 1994.

Treatment[y]	Canker activity[z] rating
Surgery-shallow	
Nectec	1.2
Enzone	1.7
No treatment	1.4
Surgery-deep	
Nectec	1.0
Enzone	1.2
Kocide	1.3
Benlate	1.7
No treatment	1.2
No surgery	
Nectec	1.8
Enzone	1.4
No treatment	0.2

[y] Established cankers treated 27 January 1993. Six cankers/treatment.

[z] Evaluated 2 November 1994. Rating scale: 0 = no healing, gum present full circumference of canker, 1 = gum half of circumference, not healed, 2 = fully healed, callus present, little or no gum.

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