Causes, Development and Management of Lower Limb Dieback and Band Canker

Project No.: **10-PATH5-Michailides**

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Objectives:

a) Band canker:

1. Conduct a statewide survey of canker diseases.
2. Determine susceptibility of pruning wounds to band canker pathogens.
3. Summarize the state of knowledge concerning band canker.

b)Lower limb dieback:

1. Perform inoculations of young almond trees with putative pathogens isolated from trees with lower limb dieback (LLD).
2. Summarize the state of knowledge concerning lower limb dieback

Interpretive Summary:

This summary outlines the progress made in understanding the biology, epidemiology, spread, and management of a) band canker and b) lower limb dieback syndrome of almond.

a) Band canker of almond:

The pathogen(s):

1. The pathogen *Botryosphaeria dothidea* and six more species of the *Botryosphaeriaceae* family were confirmed from several commercial orchards in Butte, Glenn, Colusa, Tehama, Yuba/Sutter, San Joaquin, Yolo, Solano, Stanislaus, Merced, Madera, Fresno, and Kern Counties. Although initially it was

believed that band canker was caused only by *Botryosphaeria dothidea*, we discovered now that there are 7 different species that are involved in causing this disease as well cankers in the canopy and fruit blight of almond.

2. We also found that a newly-described species (*Neofusicoccum nonquaesitum* has been isolated from and caused band cankers of almond. In addition, *N. nonquaesitum* is the most virulent in causing cankers among any of the other *Botryosphaeriaceae* species isolated from almonds. Several of the isolated species occur in both band cankers and cankers found in the tree canopy.

Disease development and epidemiology:

1. Both the water-splashed asexual (pycnidiospores of the *Neofusicoccum* spp.) and the airborne sexual (pseudothecia of *B. dothidea*) stages of the pathogen have been discovered in almond. This means that these pathogens can survive and spread on both susceptible and healthy tissues for a long time. In other crops (i.e. pistachio), such cankers can provide viable spores for at least 6 years.

2. Also both the *Neofusicoccum* (water-splashed) and/or the *B. dothidea* (airborne) stages have been discovered in walnuts, pistachios, blackberries, and others grown next to almonds with band canker, suggesting that these plants can provide spore inoculum and vice versa.

3. In lath-house/greenhouse inoculation experiments, *B. dothidea* from willow and blackberry collected next to almonds infected almond trees, caused large cankers, and killed some of these trees, suggesting that *Botryosphaeriaceae* fungi from other hosts serve as sources of inoculum in almond orchard.

4. Infections occur through growth cracks in the trunk of vigorously grown trees, pruning cuts made to develop the primary scaffolds of young trees, pruning wounds in the canopy, wounds on almond fruit, cracks at the base of shoots due to wind moving branches, and lenticels.

5. Serial inoculations of potted trees showed that infections in the spring (March to May) result in significantly larger cankers than cankers caused from inoculations of trees during the rest of the year, suggesting that infections in the spring could be the most destructive.

6. Earwigs and ants do not seem to spread the band canker pathogens.

7. Pruning in February leads to more severe infections than pruning in the fall.

8. Applying fungicides in pruning wounds reduce canker severity to some extent but infections can still occur.

9. Almond pruning wounds can remain susceptible to infection by *Botryosphaeriaceae* fungi for more than 3 weeks.

Disease Management:

1. Manipulation of irrigation (using splitters attached to sprinklers) and moving the micro-sprinklers away from the tree trunk to reduce wetting of tree trunk result in lower incidence of band canker.

2. Trees killed by the band canker pathogens need to be removed entirely; stumps of cut down trees serve as sources of inoculum and they should be removed in advance of the winter rains.

b) Lower limb dieback:

1. LLD continues being a major concern for almond growers in the Central Valley of California.

2. Within an orchard, the incidence of LLD can vary from year to year; although 2011 was a wet year, the incidence of LLD was not as severe as in earlier years.

3. The most frequently encountered fungi at variable frequencies from cankered tissues of branches with LLD symptoms are species of *Botryosphaeria* and *Phomopsis*. However, these fungi can also be isolated at approximately similar levels from branches without any LLD symptoms.

4. In inoculation experiments, neither *Botryosphaeria* nor *Phomopsis* species caused symptoms on branches that resembled the LLD symptoms, suggesting that these fungi may be secondary colonizers of almond woody tissues (both in limbs with LLD and without LLD symptoms).

5. Our research suggests that LLD is most likely a **syndrome** that may be related to multiple unknown "stress" factors.

6. Herbicide drift was hypothesized to be one of these factors that might contribute to LLD. However, experiments showed that herbicide drift has not resulted in any LLD symptoms at least for 3 years after these experiments were completed

7. Another factor that was studied was the presence of fungi isolated from severely stained roots of backhoed trees that showed LLD in the previous season. These include *Paecilomyces variotii,* and *Acremonium, Phaeoacremonium,* and *Cylindrocarpon* species, several of which were shown to cause decline diseases in other woody plants. However, potted Padre trees inoculated with these fungi were not infected and there was no effect on the three height and biomass. However, at this time it is not clear what is the difference between trees with LLD and without (healthy trees) since we have not compared these types of trees side by side in the same orchard.

8. The only consistent factor about trees with LLD syndrome was shown by Dr. B. Lampinen. He found that orchards showing LLD have wetter conditions in early spring and undergo sharp changes in water potential in contrast to orchards without LLD.

Materials and Methods:

a) Band canker:

1. Conduct a statewide survey of canker diseases:
Samples were collected from almond fields either by farm advisors, PCA's, and growers themselves, or personnel of our laboratory. These are cankers that are involved mainly from pruning wounds made to select primary scaffolds and/or wounds from tree shakers (to a lesser extent). Tissues from the margins of cankers were cut in small 5 mm x 5 mm pieces, surface sterilized in 10% chlorine solution (prepared from a 5.25% NaOHCl - household beach) for 2 to 3 minutes and plated on potato dextrose agar acidified with lactic acid to 3.5 pH. This medium is a general isolation medium allowing growth of fungal pathogens and inhibiting bacteria contaminants. The plates with the plated tissues were incubated at 25C for 4 to 6 days and the developed colonies were identified to genus and, when possible, to species. Cultures of the putative pathogens were stored in our long term storage culture collection for further studies.

2. Determine susceptibility of pruning wounds to band canker pathogens.

Inoculations with *B. dothidea* and *N. mediterraneum.*
To determine susceptibility of pruning wounds to *Botryosphaeriaceae* fungi, pruning cuts were made on Padre limbs 1-2 inches in diameter. The first pruning cuts/wounds were made on December 21, 2009. Ten cuts/wounds were inoculated with 7 mm agar discs with either *Botryosphaeria dothidea* or *Neofusicoccum mediterraneum*) which were placed in the center of the pruning cut and covered with Parafilm. This inoculation is to simulate propagules placed by the pruning shears on the cut. Subsequent pruning cuts done on 8, 15, and 22 January 2010 were sprayed with a 5×10^4 spore suspension at about 5 ml per shoot and covered with Parafilm to simulate spore spread and infection during rains. The goal of this experiment here was to determine whether infections of pruning wounds occur during a month when there is plentiful moisture but temperatures are low.

A larger pruning experiment was initiated in early February 2010 and was repeated in November 2010. Because we noticed that a number of almond trees with band canker symptoms had major pruning cuts with extensive cankers initiated from them, this experiment was designed to determine the duration of time a pruning cut/wound is susceptible to *Botryosphaeria* and *Neofusicoccum* infection and whether a chemical application would protect the wound from infection. A total of 180 replicated limbs were pruned and 10 wounds were inoculated immediately (0 days), and 5, 7, 14, and 21 days, and 1 month after pruning with a 50,000 spore suspension with virulent *B. dothidea* or *Neofusicoccum mediterraneum* isolates from almond by spraying about 5 ml of spore suspension on the surface of the pruning cut. Ten each pruning cuts were treated by

painting with a mixture of Pristine or Abound mixed in latex paint and immediately inoculated as above. To avoid desiccation after inoculation the inoculated surface was covered with Parafilm. Ten pruning cuts were not inoculated (*non-inoculated control*). Canker development was recorded regularly. All of these inoculated pruning cuts were removed and the internal extent of canker by *Botryosphaeria* and *Neofusicoccum* was determined in July 2011. Since inoculations of pruning wounds were done at different dates after the pruning, an expected outcome from this experiment would be determining of the duration pruning wounds remained susceptible to infection by these fungi. Another expected outcome would be whether a fungicide application directly on the pruning wound as soon as the cut is made could prevent infection. The fungicides were incorporated at label rates (14.5 oz/acre for Pristine and 15 fl oz/acre for Abound) into a 50% strength paint (interior latex paint diluted 1:1 with water) and painted shortly after the pruning cuts were made The fungicides were applied at label rates and incorporated in a volume of paint estimated to be needed to cover the pruning cuts on an acre of almond trees (5 gallons).

3. State of knowledge summary.
In the Results and Discussion section for this objective, we present the state of knowledge developed thus far from the funded projects on band canker disease of almond by the Almond Board of California.

b) Lower Limb Dieback:

1. Inoculation Experiment. Six young (1 year old) almond trees each of Padre/Nemaguard and Nonpareil/Nemaguard were inoculated using the method described by H. Scheck et al (Grape growers report losses to black-foot and grapevine decline, *California Agriculture* 52(4):19-23). Briefly, on May 21, 2010 root balls of each tree were washed, clipped to injure roots, and dipped in a spore suspension of 1×10^6 for 30 minutes. Cultures of *Phaeoacremonium*, *Cylindrocarpon,* and *Paecilomyces variotii* were used. The trees were then repotted and placed on a bench in the greenhouse September 2010 when they were moved outside until evaluation on July 12, 2011.

2. State of knowledge summary. In the Results and Discussion section for this objective, we present the state of knowledge developed thus far from the funded projects on lower limb dieback by the Almond Board of California.

Results and Discussion:

a) Band canker

1. Statewide survey of canker diseases
The survey of collected samples or samples brought to our laboratory confirms previous years' surveys with fungi of the *Botryosphaeriaceae* isolated more frequently than other fungi (**Table 1)**. This suggests that band canker fungi cause more damage than other canker fungi on almonds, although other canker diseases can also occur and sometimes cause significant damage to almonds. Furthermore, the large acreage of newly planted almonds has probably

contributed to the fact that band canker has become a major disease of young almond orchards, since the trees are pushed hard while coming to early production. Furthermore, some of the commercial cultivars are grafted to more vigorous rootstocks that lead to growth cracks in the trunk opening avenues for infection by *Botryosphaeriaceae* fungi.

2. Determine susceptibility of pruning wounds to band canker pathogens.

Inoculations with *B. dothidea* and *N. mediterraneum.* Inoculations of pruning cuts with either fungus resulted in large cankers that invaded and stained the wood brown. In all cases, the untreated control had significantly larger cankers than those treated with Pristine (premix of boscalid and pyraclostrobin) while those treated with azoxystrobin (Abound) had cankers that were slightly reduced compared to the control (**Figure 1 A-D**). The results of this experiment also showed that inoculating pruning wounds is a good method to study pathogenicity and differential virulence of the various *Botryosphaeriaceae* fungi. These results also explain the killing of three- and four-leaf trees by invading pruning cuts of trees made to develop the primary scaffolds in commercial orchards.

The fungicides Pristine and Abound (that are generally very effective against *Botryosphaeriaceae* diseases) had only a minor effect in reducing the cankers resulted from inoculations on 11 February 2010 (**Fig. 5**). This effect was more obvious on the cankers from inoculations on 15 November (**Fig. 6**). The lesser effect on the cankers from inoculations on 11 February may be explained by the fact that the infections from inoculations on this date were more aggressive than those from inoculations in November (**Fig. 7**). Pooling the data together, both fungicides resulted in significant reduction of the canker length but were unable to prevent infections of the pruning wounds (**Fig. 8**).

To determine how long the pruning wounds remain susceptible to infection by *B. dothidea* or *Neofusicoccum mediteraneum,* the serial inoculations showed that pruning wounds can be infected for up to at least 30 days (**Figs. 9 & 10**). In general infections close to pruning (up to 5 days) were more aggressive than those inoculated later on. In some instances, the uninoculated control were also infected (**Figs. 9-14**) probably because of the presence of natural inoculum in this orchard. Again, serial inoculations of the pruning wounds indicated that the cankers caused by the pruning done in February 2010 were significantly larger than those caused from serial inoculations of the November pruning (**Figs. 13 & 14**). In general, there were not consistent differences between the two species (**Fig. 15**), suggesting that both these pathogenic species seem to be similarly aggressive in infecting pruning wounds of almonds.

3. State of knowledge summary

Significant progress has been made in understanding the biology, epidemiology, spread, and management of band canker of almond. A summary of the new findings through this research is described below:

The pathogen(s):

1. The pathogen *Botryosphaeria dothidea* and six more species of the *Botryosphaeriaceae* family were confirmed from several commercial orchards in Butte, Glenn, Colusa, Tehama, Yuba/Sutter, San Joaquin, Yolo, Solano, Stanislaus, Merced, Madera, Fresno, and Kern Counties. Although initially it was believed that band canker was caused by *Botryosphaeria dothidea* we know now that there are 7 different species that are involved in causing this disease on almond. We also know that a newly-described species (*Neofusicoccum nonquaesitum* has been recovered from both band cankers and cankers in the canopy of almond.

2. This pathogen (*Neofusicoccum nonqauesitum*) is the most virulent in causing cankers among all the species of *Botryosphaeriaceae* isolated from almond.

Disease development and epidemiology:

1. Both the water-splashed asexual (pycnidiospores of the *Neofusicoccum* sp.) and the airborne sexual (pseudothecia of *B. dothidea*) stages of the pathogen have been discovered in almond. This means that once these pathogens have been established in an orchard, they can survive and spread on both susceptible and healthy tissues for a long time. Specifically, it was shown on pistachio that these cankers can provide viable *Botryosphaeria* spores for at least 6 years.

2. Also, both the *Neofusicoccum* and the *B. dothidea* stages have been discovered in walnuts, pistachios, blackberries, and others woody plants grown next to almonds with band canker and can serve as sources of inoculum and vice versa.

3. In lath-house/greenhouse inoculation experiments, *B. dothidea* from willow and blackberry collected next to almonds infected almond trees, caused large cankers, and killed some of the trees.

4. Infections occur through growth cracks in the trunk of vigorously grown trees, pruning cuts made to develop the primary scaffolds of young trees, pruning wounds in the canopy, wounds on almond fruit, cracks at the base of shoots due to wind moving branches, and lenticels.

5. Serial inoculations of potted trees showed that infections in the spring (March to May) resulted in significantly larger cankers than cankers caused from inoculations of trees during the rest of the year.

6. Prunings shredded and left on the orchard floor may provide spore inoculum sources

of the pathogen, but almond shoots do not seem to be a good substrate for producing spores of the pathogen.

7. Earwigs and ants do not seem to spread the band canker pathogens.

8. Pruning in February leads to more severe infections than pruning in the fall.

9. Applying fungicides in pruning wounds reduce canker severity to some extent but infections can still occur.

Disease Management:

1. Manipulation of irrigation (using splitters attached to sprinklers) to reduce wetting of tree trunks resulted in less canker activity (smaller cankers) and significantly lower incidence of active cankers (i.e., protected trees from infection and canker development).

2. Moving micro-sprinklers away from the tree trunk kept the tree trunk dry and thus created conditions not favorable for infection by the band canker pathogens.

3. Trees killed by the band canker pathogens need to be removed entirely from the orchard before the winter rains begin. Stumps of killed trees are loaded with spore inoculum of the *Botryosphaeriaceae* and frequently harbor the perfect stage (airborne spores).

Questions that still remain unanswered:

1. It is still not clear how much long term damage occurs from canker diseases that initiate from pruning to select primary scaffolds, damage from shakers, and wind damage would cause to almonds.

2. Although from survey results we have indications which almond cultivars are affected the most by band canker, there is no systematic study done to determine the relative susceptibility of the most important almond cultivars and rootstocks tested under the same conditions after inoculation with the same species of *Botryosphaeriaceae.*

3. Because *b. dothidea* develops pseudothecia in the almond bark, we assume that the airborne spore inoculum (ascospores) is present in the orchards. However, this has not been quantified nor has its significance been determined in spreading the disease from orchard to orchard.

4. Growers of young plantings report that in general potted trees show more band canker than planted bare-root trees. This observation needs to be investigated scientifically and if it were shown to be true, planting bare root trees in areas where band canker can occur could serve as a management approach for this disease.

5. Furthermore, new and innovative approaches (i.e., surgery, etc.) could be tried to manage band canker and cankers caused by *Botryosphaeriaceae* fungi.

Table 1. Isolations from almond samples collected from problematic orchards and samples received from consultants and cooperative extension personnel in 2009-2011.

Year	County	Number of orchards	Incidence (%)				
			Botryosphaeria	***Phomopsis***	***Eutypa***	***Acremonium***	***Cylindrocarpon***
2009	Colusa	2	0	0	0	0	0
	Fresno	13	15	0	0	0	0
	Glenn	1	100	0	0	0	0
	Kings	4	0	0	0	0	0
	Merced	4	25	25	0	0	0
	Stanislaus	2	0	0	0	0	0
	2009 Total	**26**	**15**	**4**	**0**	**0**	**0**
2010	Colusa	4	50	50	0	0	0
	Fresno	3	67	0	33	0	0
	Glenn	4	50	50	0	0	0
	Kern	3	0	0	0	0	0
	Madera	2	0	50	0	0	0
	Merced	7	14	0	29	29	29
	Stanislaus	1	0	0	0	0	0
	Yolo	1	0	0	100	0	0
	2010 Total	**25**	**28**	**20**	**16**	**8**	**8**
2011	Colusa	1	100	0	0	0	0
	Glenn	1	100	0	0	0	0
	Kings	1	0	0	0	0	0
	Madera	3	0	0	0	0	0
	Merced	3	25	0	0	0	0
	Stanislaus	1	100	0	0	0	0
	Yolo	1	100	0	0	0	0
	2011 Total	**11**	**45**	**0**	**0**	**0**	**0**

b) Lower Limb Dieback:

1. *Inoculation Experiment.*

The inoculation of potted trees (six each 1-year old Nonpareil and Padre trees) which were inoculated with each of the main fungi isolated from discolored roots and trunks of trees affected by LLD) showed that none of these putative pathogens were able to infect the young trees 14 months after inoculation (**Figures 16 &17**). There was no effect on the growth (height and weight) of these trees by the inoculated fungi and trees grew similarly to the non inoculated control trees (**Figures 16 & 17**). We were unable to reisolate these fungi from the trunks of trees or from trees with internal staining. These results suggest that these putative pathogens may be secondary invaders of affected trees and not the primary causes of the lower limb dieback of almond trees.

2. State of knowledge of LLD

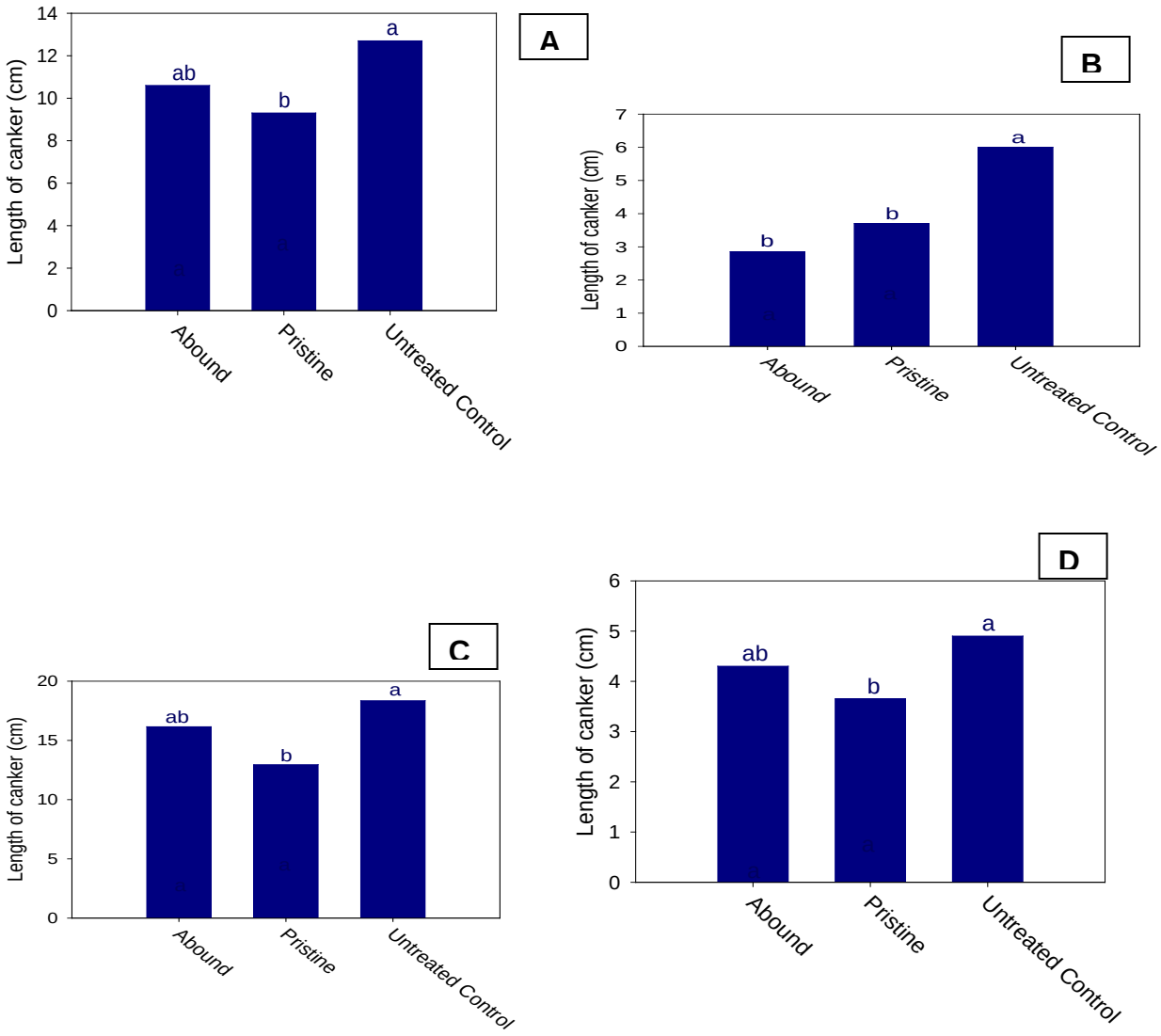
LLD continues being a major concern for almond growers in the Central Valley of California. We continued monitoring lower limb dieback (LLD) and canker diseases including band canker in almond orchards in California. We isolated from cankers collected from more than 70 orchards over the years we were studying LLD. These orchards represented the major counties where almonds are grown, and the samples included both those brought to us by farm advisors, PCAs, growers themselves, and from collections after farm calls to growers' fields. The most frequently encountered cankers were those caused by *Botryosphaeriaceae* fungi (15% in 2009, 28% in 2010, and 45% in 2011), followed by *Phomopsis* sp. *Eutypa* species were isolated only in 2010 from two locations. Finally, *Cytospora* species were isolated very sporadically, while we were not able to isolate *Ceratocystis* from typical Ceratocystis cankers. (*Ceratocystis* is a fungus that it is very difficult to isolate from cankers according to Dr. T. Harrington, Iowa State University.)

In 2010-11, we continued isolating from lower limb dieback (LLD) and band canker almond orchards throughout California, although LLD was not as common in 2011 season as in previous years and we did not receive as many samples, indications that the wetter 2011 year may have alleviated the incidence of LLD. Thus far, our research suggests that LLD may be related to multiple unknown "stress" factors. Although in previous years, *Botryosphaeria* and *Phomopsis* were the most frequently isolated fungi, and at similar levels, from limbs with LLD symptoms, in 2011 only *Botryosphaeria* species (but not *Phomopsis* or other canker fungi) were isolated from LLD branches of various almond cultivars. The results also suggest that, although the *Botryosphaeria* and *Phomopsis* fungi have been frequently isolated from limbs with LLD, they are not the primary causes of LLD because there were instances when these fungi were not isolated form LLD and other instances when these same fungi were also isolated from limbs without any symptoms of LLD at high levels. Furthermore, the frequency of isolation of these fungi is not consistent month from month in a year and from year to year. The question remains whether these fungi enter the woody tissues as secondary colonizers after the woody tissues have been "stressed" due to other factors (abnormally wet soils/and quick depletion of soil from water), herbicide drift, shading and weakening of limbs, etc.). Certainly, more research

is required to determine the factors that are involved with the **LLD syndrome** of almond. In fact, the word “syndrome” may be more appropriate to describe LLD because there may be more than one factors involved in causing it.

In 2008, we performed four herbicide experiments to test the hypothesis whether herbicide drift could cause symptoms resembling LLD. In three commercial orchards where the grower was ready to apply a herbicide spray, squash plants were set up at different heights to measure herbicide drift. Although symptoms of LLD have not developed in these orchards during the following two growing seasons, one wonders if more time is needed until LLD symptoms (if any) appear in these trees.

In early 2010, in Stanislaus County, we removed 4 trees with backhoes that showed LLD symptoms in 2009 growing season. To our surprise some of the roots of these trees had stained cortex tissues and extensive stain in the center of their trunks (see 2009-10 ABC Annual Report). In some cases, the stain was continuous from the roots to the trunk, and to the “cankered” areas of limbs and branches. Isolations from the stained areas of the roots produced fungi such as *Paecilomyces variotii* and species of *Acremonium, Phaeoacremonium,* and *Cylindrocarpon* while isolations from the dark stained areas (“cankered”) tissues of the limbs produced *Phomopsis* and/or *Botryosphaeria.* We thought that the former fungi infected the roots first and predisposed the limbs to infection (colonization) by *Botryosphaeria* and/or *Phomopsis*. However, potted trees inoculated with these fungi were not infected and there was not any effect on their height or biomass production in these trees (Figures 16 & 17). We need to backhoe more trees with LLD in addition to trees without LLD in order to make direct comparisons between the roots, trunks, and branches of trees with and without LLD symptoms. We believe that only after doing extensive sampling and comparisons of healthy vs. LLD “sick” trees, will we be able to make strong, definite conclusions about LLD.



Figures 1-4. Effect of fungicides painted on shoots pruned on 11 February 2010 (**A, C**) or 15 November 2010 (**B, D**) and inoculated with *Botryosphaeria dothidea* (**A, B**) or *Neofusicoccum mediterraneum* (**C, D**), and recorded on 30 June 2011.

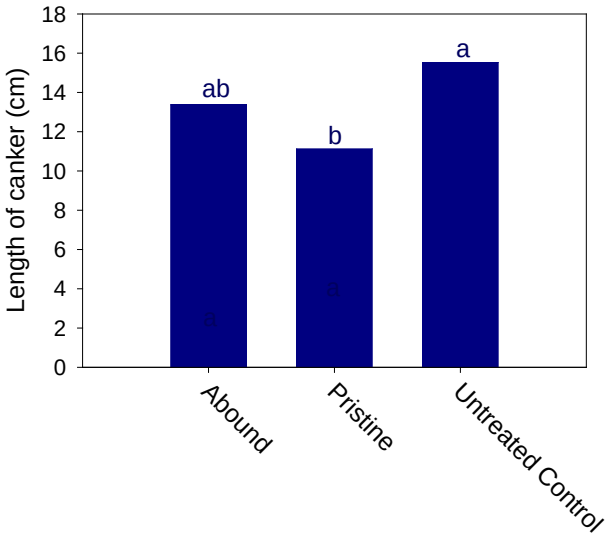


Figure 5. Effects of February 11, 2010 fungicide application by painting on the pruned surface and inoculatingd with both *Botryosphaeriaceae* species.

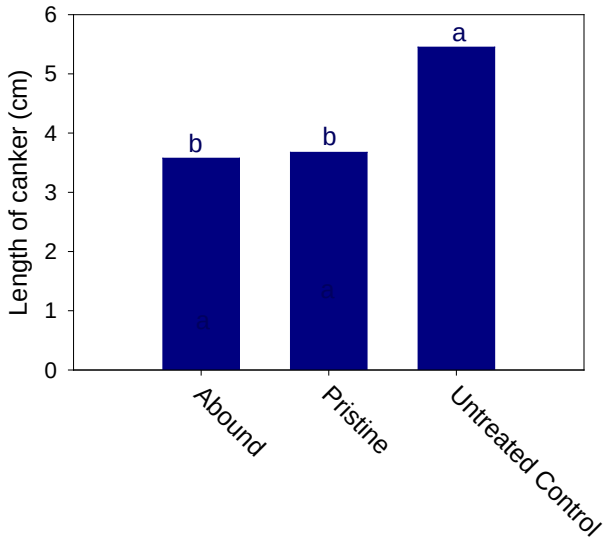


Figure 6. Effects of November 15, 2010 fungicide application by painting on the pruned surface and inoculating with both *Botryosphaeriaceae* species.

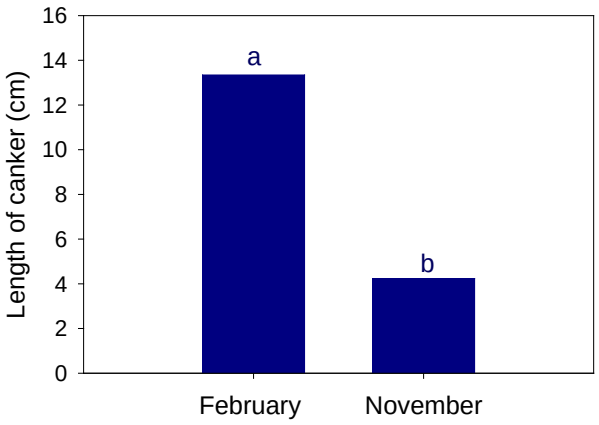


Figure 7. Overall effect of pruning in February or November regardless of the treatment (Control, Abound, & Pristine) on length of cankers caused from inoculations of pruning wounds with *B. dothidea* or *N. mediterraneum*.

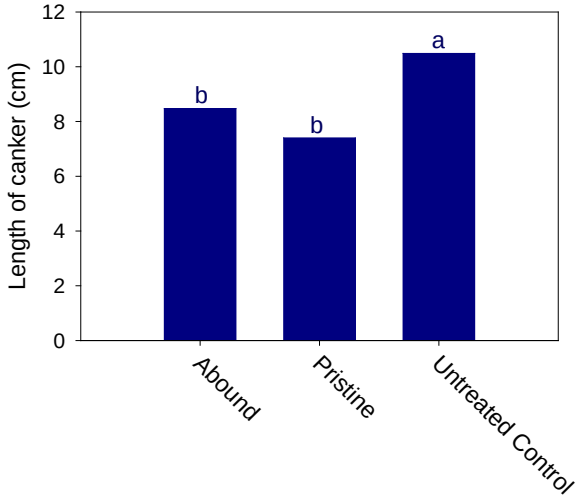


Figure 8. Overall effect of treatment (Control, Abound, & Pristine) regardless of pruning time (February or November) on length of cankers caused from inoculations with *B. dothidea* or *N. mediterraneum.*

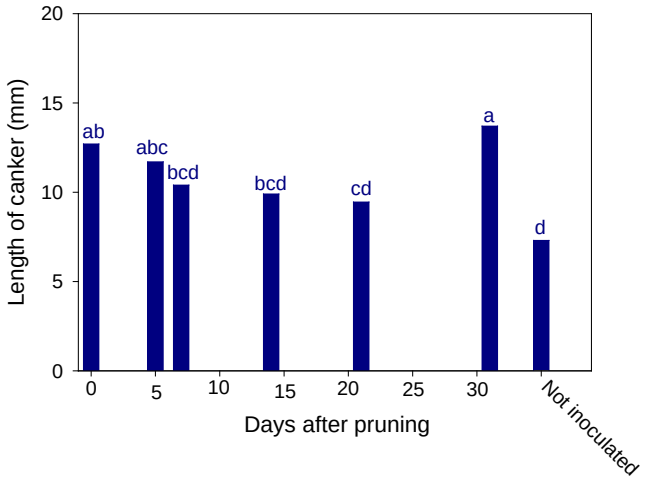


Figure 9. Effect on canker length resulted from serial inoculations with *B. dothidea* on shoots pruned on February 11, 2010.

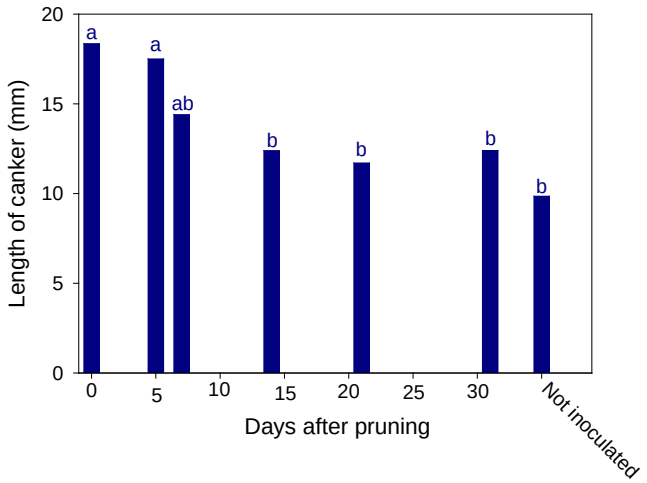


Figure 10. Effect on canker length resulted from serial inoculations with *N. mediterraneum* on shoots pruned on February 11, 2010.

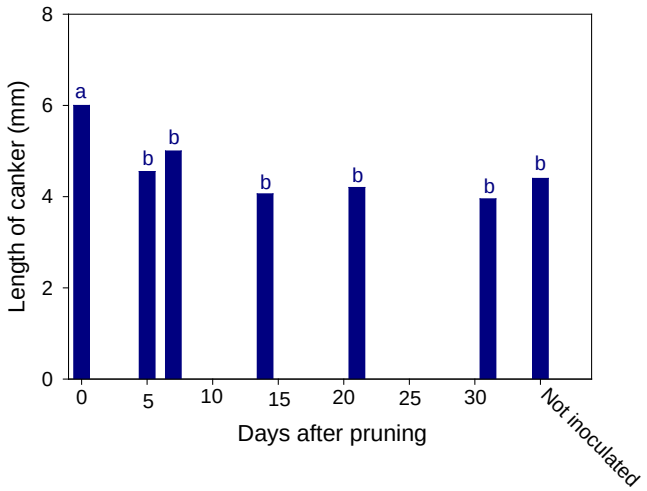


Figure 11. Effect on canker length resulted from serial inoculations with *B. dothidea* on shoots pruned on November 15, 2010.

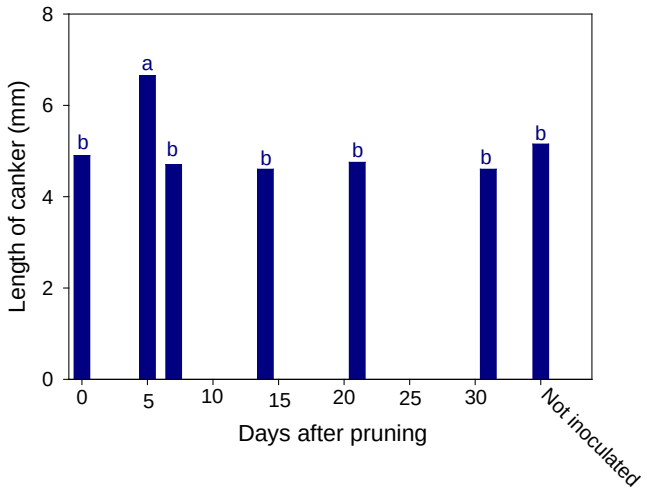


Figure 12. Effect on canker length resulted from serial inoculations with *N. mediterraneum* on shoots pruned on November 15, 2010.

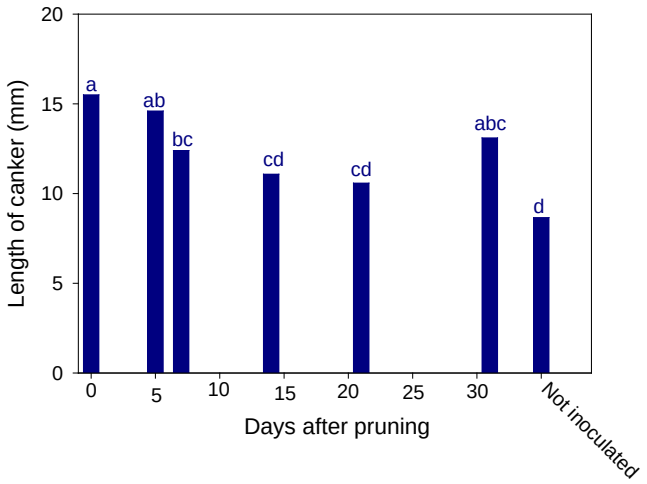


Figure 13. Effect on canker length resulted from serial inoculations with both species of *Botryosphaeriaceae* on shoots pruned on February 11, 2010.

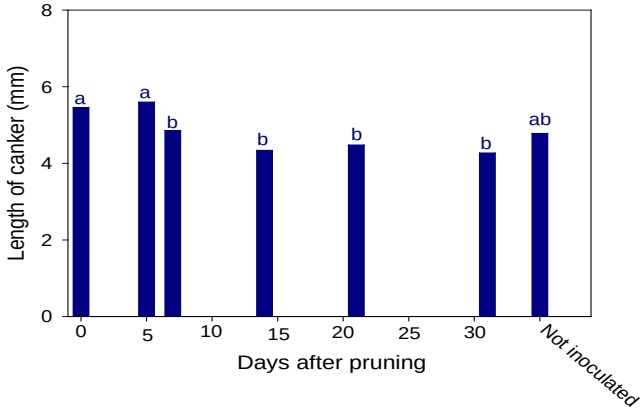


Figure 14. Effect on canker length from serial inoculations with both species of *Botryosphaeriaceae* on shoots pruned on November 15, 2010.

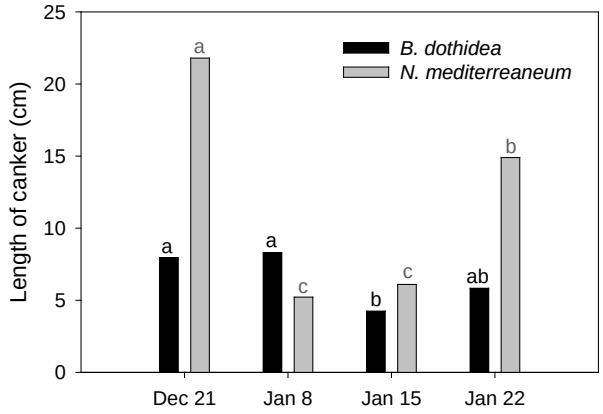


Figure 15. Effect on canker length resulted from serial inoculations with two species of *Botryosphaeriaceae* on shoots pruned on November 15, 2010. (The December 21, 2010 inoculations were with plugs while the subsequent inoculations in 2011 were with spores suspensions.)

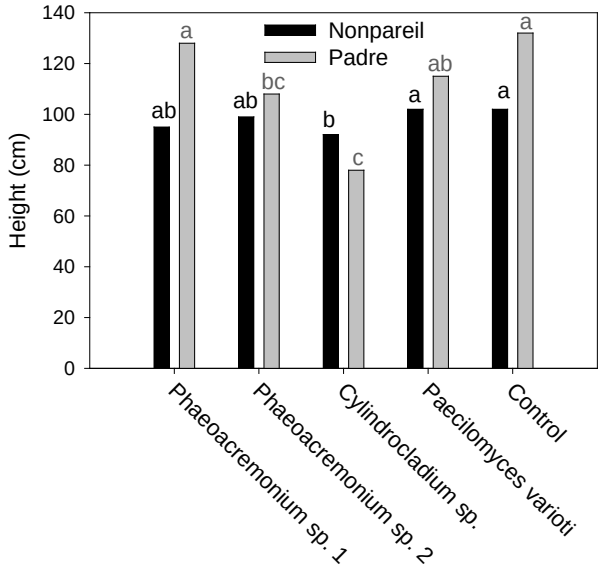


Figure 16. Effects of various fungi after inoculation of the roots of almond potted trees on the height of these trees recorded 14 months after inoculation.

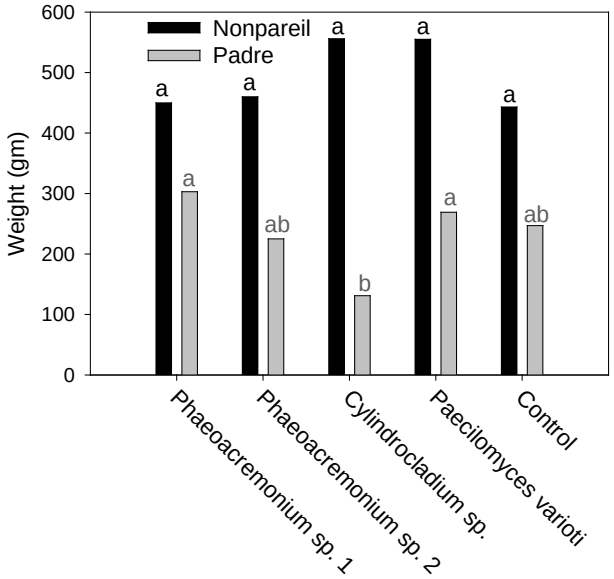


Figure 17. Effects of various fungi after inoculation of the roots of almond potted trees on their biomass (weight of trees) recorded 14 months after inoculation.