Project Number: 81-X1
Project Name: Epidemiology and Control of Ceratocystis Canker of Almond
Researchers: Bostock/Teviotdale/Moller

Epidemiology and Control of Ceratocystis Canker of Almond

Annual Report

Objectives

The objectives of this project as defined by the previous project leaders, Drs. B. L. Teviotdale and W. J. Moller, are to:

1. Develop a method of treating fresh bark injuries to prevent infection.
2. Test selected fungicides and biological agents for efficacy in protecting wounded tissues.
3. Establish the longevity of cankers and their annual growth cycles as a foundation for pruning recommendations.
4. Study in more detail the ecology of the disease and insect vector-fungus relationships.
5. Investigate methods of eradication of existing cankers.
6. Compare almond varietal susceptibility.
7. Investigate cultural control practices, such as method and timing of irrigation and pruning.

Leadership of this project was recently transferred to Dr. R. M. Bostock, a new staff member in the Department of Plant Pathology at Davis. The objectives of this project for 1982 are essentially the same except that additional emphasis will be placed on insect vector control and studies of host resistance.

Interpretive Summary

Ceratocystis canker, which is caused by the fungus Ceratocystis fimbriata, is a serious problem for almond growers in many areas of the state. Research during the 1960's demonstrated that the fungus gains entry through shaker injuries to the bark, that the dried fruit beetle and other insects are attracted to these injuries and serve as vectors of the fungus, and that a mercurial wound dressing applied during the winter effectively eradicated the fungus from existing cankers. This material is no longer registered for use. Presently, the most effective control for the disease is to reduce or eliminate shaker injury to the trunks and scaffolds. However, if a certain amount of shaker injury is unavoidable, then there is little growers can do to control this disease.

Initial work by Dr. B. L. Teviotdale conducted during 1980-81 involved the evaluation of ten different materials and mixtures of these for their efficacy in protecting fresh bark injuries from infection. Studies were conducted on almond (varieties Nonpareil and Merced) in Butte, Kern and Merced counties and on prune in Tulare County. Materials were painted on bark wounds immediately after injury. Of all the materials tested Treeseal, Topsin M

(1 oz/3.3 fl oz water) and a mixture ("Elixir") containing 20 lbs Kocide, 3-3 1/2 gal boiled linseed oil, and 2 gal Hexsol appeared to be most effective in preventing infection. These results are preliminary and further testing will be necessary.

Experimental Procedures

Bark injuries were made in one of two ways--either a "window" cut or a "clean" cut. In both types of injury, the cambium was damaged by pounding the tree surface lightly with a hammer. For the window cut, a 2" x 2" three-sided area was cut into the bark over the injured cambium using a chisel and thereby creating a bark flap over the exposed wood. For the clean cut, a larger than 2" x 2" piece of bark was removed using a chisel from around the injured cambium leaving a smooth surface exposed. The test materials were applied immediately after making the cuts and then evaluated 2-8 weeks later for infection by C. fimbriata.

During the summer of 1981, an experiment was initiated in Kern county to evaluate whether timing of irrigation influences disease incidence. Two plots of twenty trees each (Nonpareil) received a deep irrigation (24 hr, sprinkler) and several days later one window cut per tree was made in a scaffold limb. Three more cuts were made at weekly intervals in these scaffolds. Two weeks after the deep irrigation, the orchard also received a shallow irrigation (12 hr). Two more plots of twenty trees each were injured similarly as above after this shallow irrigation. Trees were evaluated for the presence of C. fimbriata four weeks after making the final window cut.

Results

The results from experiments in which various materials were tested as wound protectants are summarized in Tables 1 and 2. A number of clean cuts were made on scaffolds and trunks of each tree and then each wound was treated immediately with one of the test materials. Data are expressed in two ways--
1) Percentage of wounds infected by C. fimbriata in all trees tested or
2) percentage of wounds infected by C. fimbriata in only those trees having at least one infected wound. Of all the materials tested, Topsin M, Elixir and Treeseal appeared to be most effective in preventing infection by C. fimbriata. Kocide 101 appeared to be phytotoxic and caused excessive gumming in the trees. These results, however, are preliminary and should be regarded as such. More intensive studies under higher disease pressure conditions will be necessary before any recommendations can be made.

Little, if any, disease was apparent in the irrigation experiment. This was surprising because the orchard had a history of canker problems. The trees will be evaluated again next spring and summer for the presence of C. fimbriata.

Discussion and Future Plans

Because of the rather low disease pressure in the experimental plots, it is difficult to draw conclusions from these data. Treeseal, Topsin M and Elixir may be useful as wound protectants but further testing will be necessary. Nevertheless, these experiments illustrate some of the problems in working with the disease. It is difficult to know with certainty whether bark wounds

are infected by C. fimbriata, particularly with new infections. It will probably be necessary to increase disease pressure by introducing the pathogen or contaminated dried fruit beetles in future test plots.

Additional emphasis will be placed on insect vector control. Nitidulid and Drosophila insects are known vectors of the Ceratocystis canker and hull rot pathogens. In cooperation with Drs. Ogawa (U.C. Davis) and Soderstrom (U.S.D.A., Fresno), we will try to obtain an experimental use permit to test Dichlorovos for its impact on populations of the vectors. Some pyrethroid insecticides which may have repellent properties will be investigated for possible testing in the field. Application of a material which prevents infection at the time of injury by repelling the insect vectors would seem to be a very desirable strategy.

Other materials, such as the Elixir and some fungicides, will be tested as wound protectants and as eradicants. Cleaning up existing cankers is of interest to growers and, in fact, was a strategy employed during the 1960's until the mercurial dressing used for this purpose was banned from agricultural use.

The importance of pruning wounds as infection courts needs to be determined. Research during the 1960's indicated that pruning cuts were not infected by C. fimbriata. However, recent observations by several farm advisors suggest that this may not be the case and that this aspect should be reexamined. If pruning wounds are sites for infection then effective wound dressings will need to be developed for use in disease control programs.

In addition to evaluating chemicals for control of Ceratocystis canker, we will explore the use of biological agents as wound protectants. Certain species of the genus Trichoderma have been reported to protect tree wounds from attack by decay microorganisms and it would be interesting to see if these fungi are beneficial for controlling Ceratocystis canker.

Previous research demonstrated that bark wounds in almond trees became resistant to infection fourteen days after injury. The basis for this disease resistance is unknown. This observation is extremely important because it illustrates the fact that almond trees have a very effective mechanism for resistance. This fact also indicates that wound protectants must be effective for at least fourteen days after injury. An ideal wound treatment would be one which protects injuries from infection and stimulates this resistance response. Studies will be initiated to better understand the nature of this resistance and factors which control it. Initially, tree moisture status will be examined for its impact on this resistance response.

A new graduate student in Plant Pathology, Mr. Jon Sommer, recently began research on this project and will study some of these aspects for his doctoral degree.

Table 1. Ceratocystis Canker Control Trial

May-June, 1980

Kern, Butte, Tulare and Merced Counties

Treatment	Total number cuts infected with *Ceratocystis fimbriata*	Percentage cuts[d] infected w/*Ceratocystis fimbriata*	
		In all trees	In all infected trees
Window Cut			
1. 10% Bleach	33	47	92
2. 50% Bleach	26	37	72
3. Check	30	43	83
Clean Cut			
4. 50% Bleach + Latex Paint	20	29	56
5. Latex Paint	16	23	44
6. Check	24	34	67
7. Vinegar	16	47	44
8. 95% Ethanol	2	6	18
9. Elixir[a]	8	24	32
10. Topsin M[b]	0	0	0
11. *Penicillium* spores	8	24	32
12. Kocide 101[c]	0	0	0

a) A mixture containing 20 lbs Kocide, 3-3 1/2 gal boiled linseed oil and 2 gal Hexsol.

b) A suspension containing 30 g/100 ml water.

c) A suspension containing 30 g/100 ml water. Caused excessive gumming in trees.

d)

	Total no. trees	Total no. infected
Treatments 1-6	70	36
Treatments 8, 10, 12	35	11
Treatments 7, 9, 11	34	25

Table 2. Ceratocystis Canker Control Trial

July-August, 1980

Kern, Butte, Tulare and Merced Counties

Treatment[a]	Total number cuts infected with *Ceratocystis fimbriata*	Percentage cuts infected w/*Ceratocystis fimbriata*	
		In all trees (n=75)	In all infected trees (n=31)
Check, window cut	25	33	81
Check, clean cut	19	25	61
Treeheal	6	8	19
Treeseal	0	0	0
Penicillium spores	10	13	32
Kocide 101	3	4	13
Topsin M	1	1	3
Elixir	1	1	0.3

a) Concentrations of test materials were the same as in Table 1. All treatments were clean cut except as indicated.

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COLLEGE OF AGRICULTURAL AND
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DAVIS, CALIFORNIA 95616

January 7, 1982

Mr. Bob Curtis
Associate Research Director
Almond Board of California
P. O. Box 15920
Sacramento, CA 95852

Dear Bob:

Please find enclosed two copies of the Ceratocystis canker project annual report. The report summarizes some of the work done by Dr. Beth Teviotdale and my plans for future work on this project. Since most of the funds for the past year have not been spent due to the change in leadership, we will carry over whatever is left which will make our budget needs somewhat less than the $12,000 requested for 1982. I am still waiting to hear from the accounting office the exact figures and will let you know as soon as possible. Please let me know if you have any questions.

Sincerely,

Rick

R. M. Bostock
Assistant Professor

RMB:rl

Encl.