Controlling

The following procedures are recommended for prevention and control of ceratocystis cankers in almond and prune trees:

Prevent bark injury

(1) Prevention of bark injuries, especially those that involve crushed or loosened bark that in turn provide an attractive environment in which ceratocystis-carrying insects can multiply, is the most effective way to avoid the ceratocystis canker disease.

Remove bruised bark

(2) If bark injuries occur, loosened or injured bark should be shaved away in a diamond-shaped cut with a tool such as a draw-knife or hatchet as soon as possible. The narrow ends at the top and bottom of the wound will improve the formation of callus tissue at these places. After harvest or in the dormant season, open wounds caused by this treatment should be painted with the mercurial wound dressing, Cerano.

If the wounds were made before harvest, application of the dressing must be delayed until after harvest or during the dormant season; however, such wounds should be inspected for ceratocystis infection before the dressing is applied. Usually, amber or dark-colored gum exuding from the edges of the wound indicates the presence of infection by ceratocystis. The infected bark tissue should then be shaved away before the wound is painted with the dressing.

Cut out infection

(3) Frequently, cankers are not observed until they involve large areas of bark on a limb or trunk. If they have not developed more than halfway around the affected limb or trunk, their activity can be stopped and the branch or tree saved by excavating or cutting away the diseased tissue with a draw-knife or hatchet. The infected bark and about ¼- to ½-inch layer of the woody tissue underneath should be removed. The diamond-shaped cut should extend at least 1 inch beyond the visible margins of the canker in the bark, leaving a layer of white wood between the discolored wood and the healthy bark layer. Wound dressing should follow. The bark layer is easily recognized as it turns brown within a few minutes after exposure to air.

In all ceratocystis cankers, a brownish-black stain permeates deep into the heartwood causing black streaks that may extend many inches past the margins of the canker in the bark. This stain, however, extends far in advance of the fungus infection and does no apparent harm. Cutting out existing cankers and treatment of wounds with the mercury dressing should be done from December through April when the fungus is least active. Bark chips or diseased tissues removed in the cleanup process should be collected and burned.

Pruning wounds and other clean cuts in the bark are usually not subject to infection by ceratocystis, whereas bruised or injured bark that may harbor ceratocystis-carrying insects is the most likely place where cankers will start. However, any wounds made during hot weather shortly after an irrigation attract insects and are likely to become contaminated with ceratocystis.

Remove limbs

(4) When a canker has become so extensive that it is impractical to cut the diseased tissues away, removal of the diseased branch or scaffold limb after harvest or during the dormant season will prevent the canker from expanding into the trunk or crotch area. The pruning cut should be made at least 6 inches below the lower margin of the diseased bark tissues and then painted with the wound dressing.

With the exception of the mercurial wound dressing, these measures are also applicable for control of ceratocystis cankers in peach and apricot trees. The mercurial wound dressing is not registered for use on these trees at this time. Other wound dressings such as Bordeaux paste, Ziram, Captan, basic copper, sodium hypochlorite, or lime sulfur have been found ineffective for controlling ceratocystis around open wounds. Possibly contamination of these wounds by various insects occurred shortly after the time of the bark injury and before treatments. Caution should also be exercised when making wounds on apricot trees, since these open wounds also may allow infection by the cytosporina dieback fungus.

Proper clean-up of ceratocystis cankers is important for their control. Bark tissues should be cut away to at least 1 inch beyond the margins of the canker as shown in photo below of an almond tree.

CERATOCYSTIS CANKER OF STONE FRUIT TREES

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After cutting away the diseased canker tissues, and painting the resultant wound with Cerano, the new mercurial wound dressing, the trunk of the peach tree shown below healed rapidly.

Ceratocystis canker disease in stone fruit orchards can be prevented or controlled by wise use of mechanical harvesting equipment and by canker surgery. A new mercurial wound dressing developed by University of California researchers has been registered by the USDA for use on bark wounds of almond and prune trees. Recent discoveries concerning the associations between various insects and the fungus, Ceratocystis fimbriata, have helped to explain not only the rapid spread of this disease in orchards, but also the role of soil moisture in its development.

MALLET WOUND CANKER, a serious gummosis disease of almond tree bark, was discovered several years ago in California to be caused by the fungus, *Ceratocystis fimbriata*. Shortly thereafter, the cause of similar canker diseases in peach, apricot, and prune trees was identified as this same fungus. In all cases, bruised or crushed bark was the starting place for cankers. Apparently the fungus is favored by fresh bark wounds because it tends to grow well on the exposed wood where the bark has been stripped off—and even more vigorously in the cracks and underneath bark that has been crushed and loosened.

The use of mechanical shakers for harvesting almonds, prunes, and peaches during the past six to eight years has increased the frequency of bark injuries on these trees. This, in turn, has caused a spectacular increase in the numbers of ceratocystis cankers and diseased trees. In 1963, 59% of the bearing acreage of prunes—or over one million prune trees—and a similar number of almond trees in the Sacramento Valley were estimated to be affected by this disease, and in some orchards every tree had one or more ceratocystis cankers. The prevalence and severity of the disease have increased steadily, and ceratocystis cankers now have been found in all prune, apricot, peach, and almond districts in northern California.

Experiments and repeated observations have thrown considerable light on this disease and its possible control. It is known, for example, that infection usually does not occur during the months of December through April; also, that during this time, cankers on diseased trees are expanding very slowly. However, during the summer, especially when the temperatures are high, canker margins may expand 2 to 3 inches a month. Soil moisture also plays an important role in the spread of this disease, since almond trees on dry-land culture are seldom affected, in contrast with trees in irrigated orchards. Moreover, the development of the fungus on injured bark is usually much more pronounced on stone fruit trees that are irrigated a week or two before the injuries occur. Several explanations for the influence of soil moisture have been advanced, but none of them was supported by subsequent experiments. For example, inoculation of ceratocystis into trees under high or low moisture stress has shown that extremes in bark moisture do not markedly affect the growth of the fungus and subsequent canker development. However, recent experiments to determine where the fungus comes from and how it spreads within and between orchards may answer some of these questions.

Elsewhere, it has been shown that various species of ceratocystis causing canker and wilt diseases of oaks, elms, pine, and plane trees are spread by insects that are attracted to fresh wounds. In particular,

The scaffold of the Robe d'Sergeant prune tree, above, was injured by a mechanical shaker and the wounds then became infected by ceratocystis. Both sides of the branch were severely diseased. Bark tissue has been cut away to expose the canker on one side.

nitidulid beetles are important in spreading diseases of oaks and plane trees, and the fungus probably overwinters in these insects.

Evidence has been found that several species of insects (including nitidulid beetles) related to the dried fruit beetle, are also involved as vectors of *Ceratocystis fimbriata* in stone fruit orchards in California. Of importance to growers is the discovery that insects may play a primary role in the transport of the fungus to fresh bark wounds, but apparently only when the soil moisture is favorable, that is, within several weeks after an orchard irrigation.

An extensive study in the summer and fall of 1964 of the possible dissemination of the fungus by air currents or in fine dust gave negative results and further supported evidence that the fungus is primarily dependent on insects for its spread. Insect-fungus associations as related to soil moisture and infestation of bark wounds is the subject of continued research.

Among the stone fruits, apricot trees are the most susceptible to the ceratocystis canker disease, followed by Texas, NePlus, and Nonpareil almonds. French and Robe d'Sergeant prunes are next in order of susceptibility, followed by various cling peach varieties. So far, cherry trees have been resistant in pathogenicity tests, and no ceratocystis cankers have been found in commercial cherry orchards.

Ceratocystis cankers are perennial and continue their activity year after year girdling limbs and eventually killing affected trees. In 1959 it was found that the fungus could only be recovered from the outer margins of cankers and that it seldom invaded the tree deeper than the woody tissue of the previous year's growth. Apparently, when the fungus kills the bark cells and tissues, the resulting environment is lethal to its own cells since it survives and continues to grow only in the tissues at the canker margin.

Experiments in almond, prune, and peach orchards on control of ceratocystis cankers by excavating or cutting out the tissue at the margins of cankers have given excellent results during the past five years. In view of the new information on the invasion of wounds by insects that carry ceratocystis, the occasional failure of growers to eliminate all of the active margin of a canker, especially around the lower end by this technique, is now understandable. Insects often congregate at the lower end of these cuts and work their way under the bark.

In the past, none of the popular pruning wound treatments were effective in protecting the wounds against checking and reinvasion by the fungus and various insects. However, an experimental wound dressing developed by the authors, containing a mixture of 8 parts glycerol, 2 parts anhydrous lanolin, and 0.3% of phenylmercury nitrate was highly effective. Extensive trials along with analyses for mercury residues in the fruit have resulted in the clearance of this material (Cerano) for use on wounds of almond and prune trees in the control of ceratocystis cankers. Research data needed for clearance of this dressing for use on bark wounds of peach and apricot trees are being obtained.

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Outer part of the almond scaffold branch, left photo, was girdled and killed by ceratocystis fungus. The branch was then pruned at least 6 inches below the canker to reestablish the scaffold at a new sucker shown. A small part of a ceratocystis canker was left on almond branch, right photo, during pruning operation and infection quickly spread into the new sucker branch.