UNIVERSITY OF IDAHO
College of Agriculture

CYTOSPORA
CANKER OF PRUNES

A. W. Helton

Department of Plant Pathology

IDAHO Agricultural
Experiment Station

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Figure 1.—CYTOSPORA flagging and die-back. After the canker develops on the branch the first prominent symptom is the flag of abnormal foliage, which usually is pale and drooping. The next year that portion of the branch or tree is dead.

See Page 12 for Control Suggestions

Figure 2

Upper — Typical CYTOSPORA die-back in Italian prune orchard. Sometimes the damage occurs in spots in the orchard.

Lower — Typical die-back in President prunes. Often damage is throughout the orchard.

Cytospora Canker Of Prunes

A. W. HELTON[1]

THE *Cytospora* fungus has been known to occur on several varieties of orchard trees in Idaho for a long time, but there seems to be no record of such a disease on prunes. In July 1951, an infested orchard was discovered, but the nature of the disease was not recognized at the time.

Since 1951, *Cytospora* canker has been found in increasingly severe proportions in Italian and President orchards. The identity of the causal agent was established in 1953. More recent surveys have revealed that *Cytospora* is present in Idaho on cherries, peaches, apricots, apples, willows and possibly other hosts.

As early as 1951, growers were beginning to seek help because of serious damage in prune orchards by strains of *Cytospora.* Requests for aid have come at irregular intervals since that time, and are continuing to come from areas considered to be "hot spots." There seems to be imminent danger of continued spread into areas thus far relatively free of the disease, in which case the industry faces a new problem. Continued profitable production of prunes, particularly of the Italian variety, already has been questioned in some parts of Idaho because of the many deterioration conditions in orchard trees and in the harvested fruits.

Symptoms of Cytospora

Flagging

Several symptom types are associated with *Cytospora* infection in the orchard. Attention was first directed to the disease in Italian prunes in 1951 because of the dead "flags," or discolored terminals, scattered over the trees (*Figure 1*). These resulted when cankers developed on the twigs and killed the parts terminal to the cankers. Often the killing was sufficiently rapid that the leaves failed to abscise; instead, they drooped, turned yellowish to brown, dried up, and continued to hang on the trees. Thus, the tell-tale flag of abnormal color was developed much as the colored "flag" in a pear tree indicates the presence of a fire blight canker somewhere below it.

Sometimes there is a tendency for the parts terminal to the canker to show a wilt or semi-wilt condition as death approaches (*Figure 1,* left). This also results in a betraying flag of abnormal appearance in the tree, whether or not color change is involved, and is particularly striking when viewed from a distance. Often the leaves are slow in appearing in the spring, of small size and pale in color—if they develop at all. This is especially prominent in orchards suffering also from the all too common zinc deficiency.

Die-Back

Sometimes there is little or no indication of abnormal color in the foliage terminal to stem cankers. In these cases the terminal parts have died before or during the preceding winter period (*Figures 1 and 2*) and consequently failed to leaf out in the spring. In those orchards where little or no attempt is made to prune out the dead wood, such

1 Assistant Plant Pathologist, Idaho Agricultural Experiment Station.

die-back soon creates a leafless, brushy appearance (*Figure 2*). If the orchardist removes the dead wood diligently, he often ends up with nothing but stumps (*Figure 7*).

Streak Cankers

One of the most common symptoms found associated with the *Cytospora* disease in prunes consists of a long, depressed streak in the bark of the branch. Shaving off the surface bark reveals dead, necrotic tissue below (*Figure 3*). Italians seem to be most affected by this type

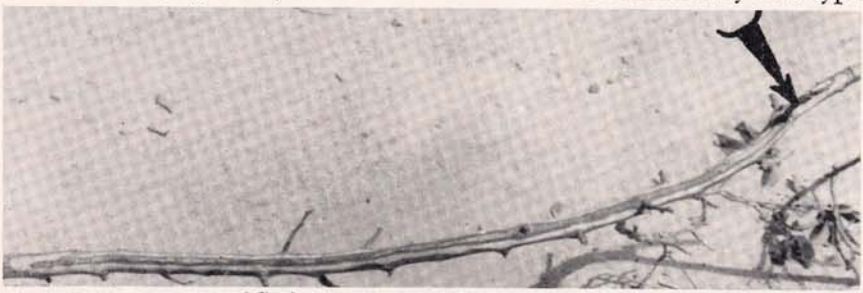


Figure 3.—A CYTOSPORA streak-canker on an Italian branch. The bark has been shaved away the length of the streak, revealing the necrotic margins on both sides. The necrosis appeared to be moving downward from a broken twig (arrow).

of reaction, though it also is found in Presidents. Most often streak cankers appear to be associated with terminal die-back rather than with local cankers that develop at random over the trees. Once the streak begins it seems to move relentlssly down the twig or branch toward the base of the tree, moving along larger branches as it comes to them (*Figure 4*).

Erumpent Cankers

Early in the development of *Cytospora* cankers the infected area often is relatively small, gummy and decidedly erumpent; that is, the bark is rough and broken (*Figure 4*). Such a condition is in direct contrast with the smooth surface of the streak cankers. Oddly enough there may be no such erumpancy and little

Figure 4—Young cankers developing on the branches and twigs of President trees, showing infection of equipment wounds (lower, arrows) and infection through unidentified ports of entry (upper, arrows).

or no gumming under some conditions and in certain varieties; e.g., Myrobalan (*Figure 8*, left). Erumpent cankers such as these may not kill parts terminal to them for 1 to 3 years.

The development of such cankers is not well understood as yet, but it is suspected that the most influential factors are variety and wounds. Both Italians and Presidents develop cankers (*Figure 4*, upper), though they are most common in Presidents. Wounds made by equipment moving through the orchard often are found to be infected (*Figure 4*, lower). It is possible that small wounds of other types are involved in the development of other cankers (*Figure 4*, upper)

Depressed Cankers

In general, the large and depressed cankers are more common, more severe and spread along the branch more rapidly than erumpent types. They seem to be more severe in President than in Italian, although Italian trees suffer equally severe damage on occasion.

Early in its development, the depressed canker is darkly necrotic when the surface bark is shaved away. A little later there is a tendency toward development of flattened or depressed areas very similar in

Figure 5.—Advanced stages of CYTOSPORA infection in President branches. The shaved margin of the canker (upper) shows the necrotic line separating dead and live tissue which is followed closely by the development of numerous pimple-like pycnidial fruit bodies. These bodies liberate multitudes of very tiny spores in the form of a hair-like tendril rising out of the top of each pycnidium. Farther behind the necrotic margin the dead bark begins to crack and slough off (lower), giving rise to a symptom much like some forms of winter injury.

appearance to bacterial gummosis cankers. In these cases the active canker margins stand out as slight ridges in the unshaved bark. Subsequently, small pycnidial pimples containing the spores of the fungus develop in the dead areas (*Figure 5*, upper and *Figure 10*) but this does not always occur immediately behind the margin.

In old cankers the bark tends to split, shred and slough off, revealing the woody cylinder beneath (*Figure 5*, lower). This condition frequently resembles sun-scald and various forms of winter injury. Gumming is common in Presidents on cankered branches between the older portion of the canker and the active part farther down.

Sometimes, for reasons as yet unknown, there is a tendency toward callus development at the edge of the canker during intermediate stages (*Figure 6*) rather than continuous movement of a necrotic margin. When

Figure 6.—A 3-year period of canker development: This is the same canker, observed first when very active on the surface (right) and on two succeeding years during which the entire branch was killed (left). At the right the shaved portion of the margin and the pycnidial pustules near the upright twig reveal typical CYTOSPORA activity. The next year the bark above the canker was shaved in several places in search of the more advanced margin, but without success. Instead a callus ridge had formed at the margins of the previous years canker. This indicated normal healing. But, on the third year all parts of the branch were dead, including the callus.

this happens, perhaps the first impression gained is that the progress of the disease has been halted. However, inspection of the same cankers on successive years has revealed that spread of the necrosis beneath the bark continues at a considerable rate. Such apparent callusing and healing may be another indication of the effect of environmental conditions, or it may indicate a peculiar temporary loss of virulence on the part of the fungus. The real reasons have yet to be determined.

Severe Damage Areas in Idaho

Cytospora canker on Italian prune was first observed in southern Idaho, near Homedale, in 1951. The following year a severely infested President orchard was found in the Sunny Slope area near Marsing. In this case the orchard was adjacent to an Italian orchard where no appreciable evidence of *Cytospora* infection was observed. The President orchard, on the other hand, had a multitude of cankers, both young and old, on most of the trees adjacent to the Italians. Some of the President trees were already dead, many had been variously and severely pruned by the grower in removing dead wood, and many were so damaged that death seemed imminent. Now, after 4 years, the grower has conceded loss of the President orchard, and moderate damage has appeared in the Italians in the adjacent orchard (*Figure 7*).

Figure 7.—Orchard behavior of the disease often is peculiar. Here a photograph was taken from a point on the dividing line between an Italian orchard (the healthy appearing trees to the left) and a President orchard. The Italians show little damage, but most of the Presidents are wiped out.

In 1953, several seriously affected orchards of both Italian and President varieties were found in the vicinity of Fruitland.

In 1954, slight evidence of *Cytospora* infection was observed for the first time in the Emmett area.

A preliminary survey in May 1955 resulted in the location of extremely severe cases near Payette in which most of the trees in the orchards were affected.

The above has been concerned only with preliminary orchard surveys. These have led to the conclusion that most of the western part of southern Idaho could be considered a "hot spot" as far as *Cytospora* infestation and danger of spread are concerned.

Plot and Laboratory Tests

Considerable preliminary work on isolation of the pathogens involved and reproduction of the disease has been done at Moscow.

Results thus far have been confusing but have established reasonably well that the original belief that *Cytospora* is merely a weak and secondary invader of dead or dying wood is outmoded. Inoculations made in field plots at one time of the year often do not react like those made at other seasons or under other conditions. The inoculation technique also seems to have a bearing, as do several other factors.

In 1954, five isolates of *Cytospora* were selected from representative branch infections in prune orchards, cultured to the same age on the same laboratory medium and used in duplicated proof-of-pathogenicity studies and host range investigations. The growth rates varied widely in culture, even in the same isolate; there was variation in virulence among the isolates; and there was variation in varietal reaction to the cultures when artificially inoculated.

The inoculation technique in this case consisted of insertion of a block of the agar culture medium containing the actively growing fungus in a downward and inward slanting cut made through the bark and into the wood. This was then bound firmly with rubber budding strips.

The preliminary host range study may be summarized by the statement that all isolates were severely pathogenic on Lovell peach and Tilton apricot seedlings but produced no reaction at all on apple and

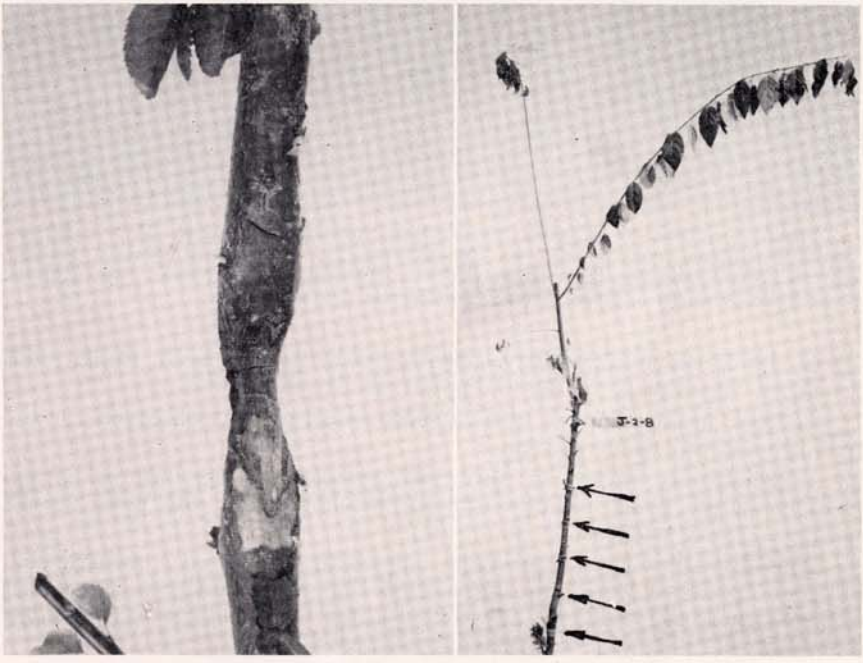


Figure 8.—A month-old canker on the trunk of a 2-year Myrobalan plum seedling (left) artificially inoculated with a culture of CYTOSPORA obtained from an Italian prune canker, and a wilt condition produced on a potted Myrobalan plum seedling in the greenhouse (right) one week after artificial inoculation at the points indicated by arrows. Small inoculation wounds were made and immediately covered with budding rubber strips.

Mazzard cherry seedlings. This host range study was conducted both in the greenhouse and in the field plots. Mahaleb cherry seedlings suffered considerable damage, but the odd thing thus far apparent is that while severe *Cytospora* cankers can be found on sweet cherry (Mazzard) in orchards, the five isolates failed completely to infect Mazzard seedlings. Also, although there is *Cytospora* on apples in Idaho, the five isolates failed to infect apple seedlings. Pear seedlings were parasitized in some cases, as were Myrobalan plums (*Figure 8*). Symptoms generally seemed to be more severe in the greenhouse.

With one exception, Myrobalan plum seedlings developed severe cankers both in field plots and in the greenhouse (*Figure 8*, left). These, however, were primarily cankerous and did not result in wilting except in one greenhouse case (*Figure 8*, right). However, such wilt symptoms appeared in three days or less in Lovell peach seedlings, almost as soon in Tilton apricot seedlings, and less so in Mahaleb cherry seedlings.

Preliminary sectioning of diseased peach wood did not yield evidence of mechanical plugging sufficient to cause wilting. Thus a toxin is suspected, and a toxin which moves rapidly toward the terminals and slowly, if at all, toward the base of the tree under greenhouse and some field conditions. Lovell trees that were dead in the aerial portions of the wilted condition were cut off below the lowermost margin of the necrosis, after which new shoots came out below the cut and grew normally.

The wilt symptom produced was much like some types of flagging found in orchards in southern Idaho (*Figure 1*).

A laboratory culture study conducted under as nearly constant conditions as possible showed a variation of the fungus that was similar in effect to the often observed variation in severity of reactions of host varieties. Much saltation, or cultural mutation, was observed in which the fungous growth sectored itself into various "pie-shapes" and erratic growth patterns (*Figure 9*).

The immediate question arising at this point is, did this sort of mutation result in the complex and peculiar disease picture we now have? For example, can this explain why a President orchard adjacent to an Italian orchard—without even a fence between—is severely damaged while the Italians have been essentially untouched for years (*Figure 7*)? Also, does this account for the apparent immunity of certain varieties to the isolates tested (apple and Mazzard cherry seedlings), even when those varieties have been known to be susceptible to *Cytospora* infection for a long time?

The questions that arise are many, and answers in most cases are not yet at hand. But, that *Cytospora* is capable of extreme primary infection and virulence is no longer in doubt.

The variability of the types of *Cytospora* found in infested orchards is less surprising, perhaps, when one considers the almost limitless number of chances that exist for different strains of the fungus to devlop in diseased orchard trees. Each of the "pimples" that develop in the dead bark back of the advancing necrotic margin of each of the cankers is capable of liberating an untold number of spores. Each spore is

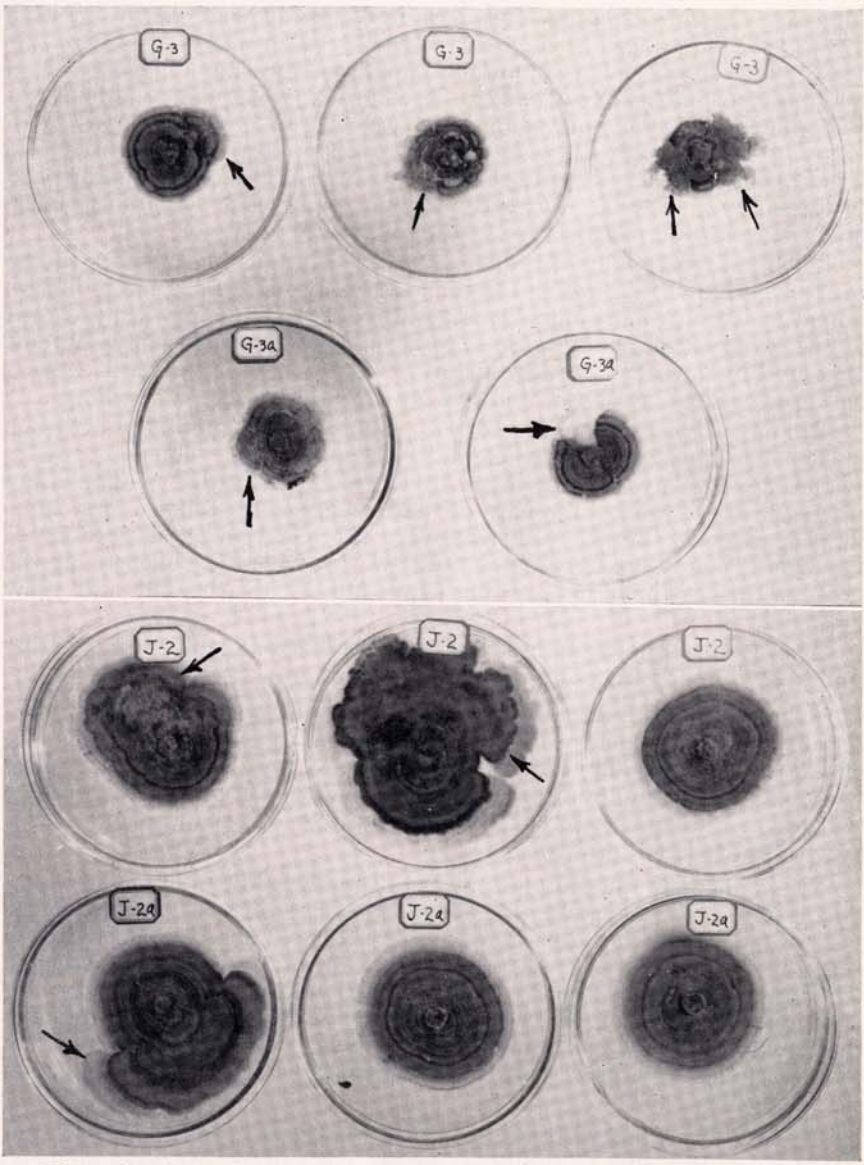
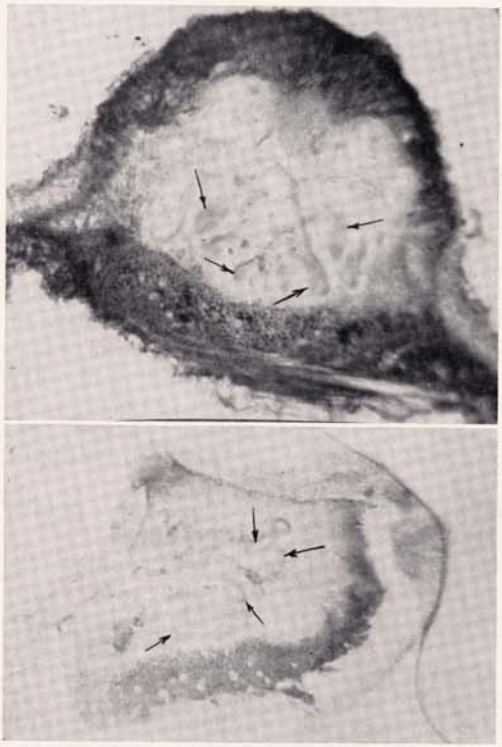


Figure 9.—7-day-old cultures of CYTOSPORA isolated from Italian (upper) and President (lower) prune cankers. G-3 and J-2 are the original cultures obtained from the orchard cankers: G-3a and J-2a are cultures re-isolated from the disease produced on Myrobalan plum seedlings in a field plot. Varied growth types and rates are shown, including several apparent mutations (arrows.)

theoretically capable not only of causing disease but of being a "different" individual. In each of the pycnidial pimples there are many "cavities" in which the spores are produced (*Figure 10*). Since the



pimple itself is no larger than the head of a pin, and since the individual spores are so small that they cannot be seen in the photographs (*Figure 10*), anyone familiar with genetics can readily visualize the infinite number of chances that exist for "change" to take place in the recognizable fungus itself.

Figure 10. — Microscopic sections through CYTOSPORA pycnidial stromata showing the many randomly arranged pycnidial cavities (arrows) before rupture (upper) and after the pore is formed (lower) through which the spore tendril is extruded. These illustrate the interior of the small pimples that develop in the dead bark behind the advancing necrotic margin.

Factors Likely to Affect Cytospora Damage

Investigations have not progressed far enough to reveal the precise predisposing factors contributing to infection in Idaho orchards. Many more years will be required for this. Until such information is accumulated, there can be only speculation, based somewhat on previous knowledge of the behavior of the *Cytospora* fungi. However, even this must be tempered by the realization that here we may be dealing with quite different strains and possibly somewhat different predisposing factors.

Ordinarily we think in terms of wound reduction for reduction of numbers of infection sites. Any sort of damage to the tissues can be considered wound damage, whether it be weather (hail, sunburn, freeze cracking, and wind breakage, or snow breakage), cultural practices (pruning, spraying, cultivation); or some other processes including the damage done by diseases, insects and many abnormal conditions which tend to weaken the trees or lower their thriftiness (e.g., faulty irrigation, fertilization, thinning, etc.) and, hence, their "resistance" to injury by various agencies. All these have been recognized as possible contributory factors in the orchard tree decline causable by *Cytospora*. Now, however, it is becoming ever more apparent in Idaho that the tree need not be unusually low in vigor to be damaged by *Cytospora*. In such a case those wound conditions associated with normal growth, e.g., pruning, spraying and cultivation become of prime importance.

Wounds on the trunks and lower branches caused by cultivation

and other equipment often can be avoided. In an orchard where optimum productivity is desired, avoiding pruning wounds presents more of a problem. Nevertheless, it is possible to modify the pruning practice, and in this modification lies a reasonably satisfactory preliminary control or spread-suppression measure. This is particularly true when trees not only are pruned correctly from the horticultural viewpoint but so that orchard equipment can move through with a minimum of resulting branch wounds. Such wounds offer ideal opportunities for *Cytosporo* invasion.

Control Suggestions

The fungus seems to be most active during periods when pruning normally should be done, and wounds made by pruning tools may well be functioning as prime entry points. Natural wounds in the form of leaf scars may act as entry pathways. Whether the fungus is capable of entry through lenticels (pores in the bark) is not known but is considered unlikely. If subsequent investigations reveal that lenticel or leaf scar entry does occur, development of a good control program will be difficult indeed.

Winter injury may be an important factor in providing entry points. These can be reduced by many standard protective procedures.

The effect of sprays is unknown, but this approach alone is not likely to hold the answer to satisfactory control. The cankers are too deep-seated and the fungus too versatile. Rather than investigating control materials that can be used in the form of sprays, effort is currently being concentrated on learning how the various strains behave with respect to the environment, in relation to each other and in various host varieties. Definite information of this kind is necessary in formulation of a control schedule for mixed-fruit-growing areas. The information accumulated thus far suggests that previous concepts of the nature of *Cytospora* and its behavior can be accepted only with considerable caution.

As the matter now stands, it is suggested that the grower diligently prune out all suspicious parts during the usual pruning season, but that he do this wisely. Cutting wisely means cutting close and cutting clean. It also means cutting far enough below the lowermost edge of the canker to be certain that all of the infection is pruned out. One foot below the recognizable canker edge is a good place to start.

When the cut is made, painting with a good disinfectant such as Bordeaux paint is suggested. Copper spray materials mixed with standard wound-treating compounds should be effective also. It is recommended that the pruning tools be dipped in a disinfectant solution carried at the grower's convenience—perhaps on a tractor. It is suggested that a trailer be attached to the tractor and that all pruned off material be placed on it, hauled out of the orchard and destroyed by fire.

When all this is said, the grower is reminded that such measures do not constitute cures. He is reminded that *Cytospora* can and will come in from neighboring orchards, and from considerable distances—perhaps even from wild hosts nearby. He is reminded, too, that it will help if he maintains a good disease or other pest control program for the common disorders he is accustomed to, because a fungicide covering on the trees at all times possible will constitute additional insurance when the spores do come in. He is encouraged to follow all recommended cultural practices for maintaining his orchards in optimum condition.