UNIVERSITY OF IDAHO
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Fire-Blight of Apples and Pears

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Spray Stages for Timing Treatments

Dormant Spray	A dormant spray is too strong to use on actively growing tissue. It should be applied when leaves are off, either in the fall after leaf drop or in early spring before the buds swell.
Delayed Dormant	When the bud tips are beginning to show green.
Pre-Pink	When leaves are unfolding and flower buds are just beginning to show occasional pink at their tips.
Pink	When leaves have expanded and flower buds are mostly pink balls.
Pop-Corn	When flowers are just unfolding, so that they resemble "popped" popcorn grains.
Bloom	When the flowers have unfolded their petals.
Calyx (Petal-Fall)	When the flower petals have fallen, leaving only the green calyx "petals."
Shuck-Fall	When the calyx parts dry up. They either drop or hang on, depending on variety.
First Cover	Two to three weeks after petal-fall, or the calyx stage.
Other Covers	Two to three week intervals thereafter.
Pre-Harvest	Sprays applied any time from three weeks or so before harvest to the day before picking begins. Materials must be chosen carefully because of residue problems.
Post-Harvest	Sprays applied after the fruits have been picked but before fall rains.

Conversion Table

1 fluid oz.=2 tablespoons
8 fluid oz.=1 cup=16 level teaspoons
2 cups (16 oz.)=1 pint
2 pints=1 quart
4 quarts=1 gallon
1000 milliliters (ml.)=1 liter
1 liter=1.07 quarts
1 ppm.=1 part per million
1 acre=43,560 square feet

Fire-Blight of Apples and Pears

A. W. HELTON*

ONE of the most common and most serious problems in Idaho pome fruit orchards is fire-blight, a bacterial disease. We find that damage varies with location of the orchard, its surrounding environment and with the efforts of the grower to keep the disease out.

Fire-blight has been found on a large number of bramble, stone and pome fruits; and on such ornamentals as mountain ash, spirea, hawthorn and flowering almond. Apples and pears suffer more than other fruits, and pears are damaged more than apples. However, serious injury has occurred on Jonathan apples in Idaho. Most damage has developed in orchards near infested pear orchards, or when pears are interplanted in the apple orchard.

Peculiar circumstances surround the fire-blight disease in that its behavior at one time and place may be quite different from what it does to the same variety at another time and place. Bartlett trees frequently are killed in one to three years in spite of efforts of the grower to handle the infection in the recommended way. On the other hand, we find cases where Bartletts with cankers in large scaffold branches continue the struggle on their own year after year and bear fruit. Whether the explanation for such behavior lies in differences in virulence of different strains of the bacterium, in factors in the environment or in some other factor we don't yet know.

The disease is caused by the bacterium *Erwinia amylovora,* which overwinters and oversummers in the edges of trunk and other stem cankers. The bacteria are spread rapidly through the orchard during the blossom period by insects, wind, rain and perhaps by other agencies. Rain-splashing of the bacteria usually results in more localized spread within the tree. Sprinkler irrigation is not advised where fire-blight is a problem.

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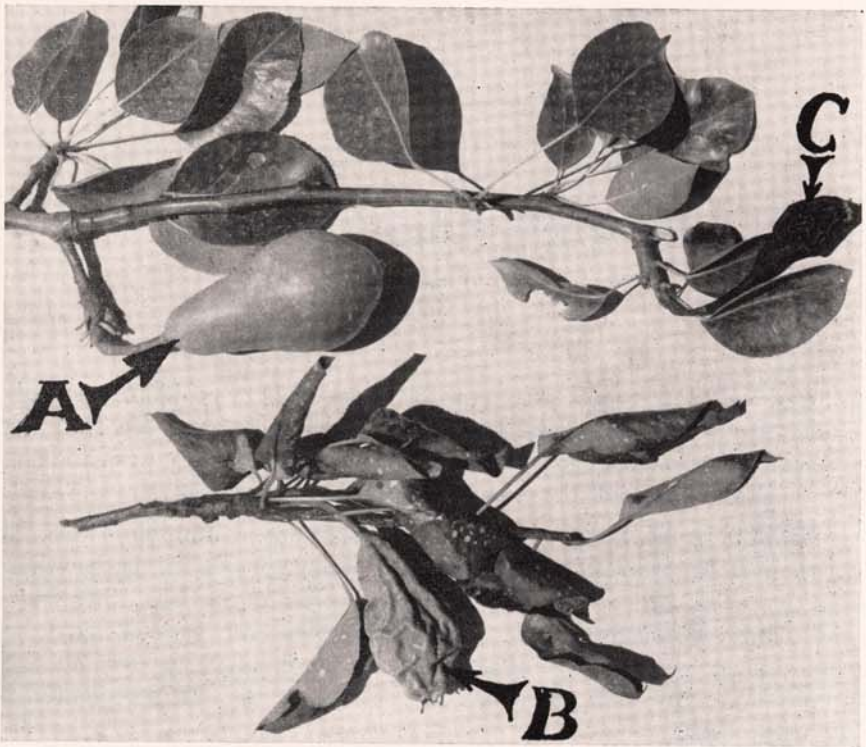

Figure 1.—Three fruits from an infected Bartlett tree. A is healthy, B is shriveled and hardened from being cut off by blight killing of the twig it was growing on, and C is blackened and shriveled from direct infection of the fruit parts. Most of the leaves on the B twig are blackened by fire-blight.

Symptoms

When fire-blight bacteria are present, flowers and leaves suddenly wilt, darken, shrivel and die. They remain attached to the twigs and develop prominent discolorations. This symptom often resembles fire scorching where brush or grass fires occur nearby. Individual leaves generally darken at the tips and margins first *(Figure 1)* unless the infection moves into them from the twig below. If the infection comes in from the twigs to which fruits are attached, the fruits retain their green color while hardening and shriveling *(Figure 1, B)*. If the infection begins directly in the flower or fruit parts, the fruit stops growing and becomes black and shriveled *(Figure 1, C.)*.

Very early infection of young twigs is difficult to detect. But soon faint streaks of dark color become visible in the bark *(Figure 2, left)*. Such symptoms generally arise where the bacteria move into the twigs from spurs *(Figure 2, center)*. The same thing happens when only a

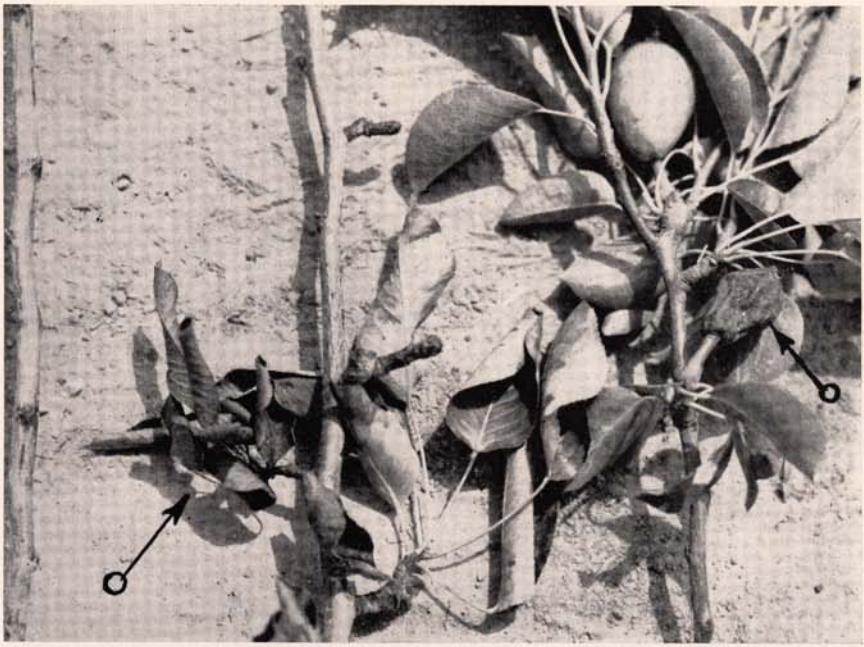

Figure 2.—Three stages of twig infection. On one (left) all the leaves and spurs are blackened and dead. These were removed to show the dark streaking in the bark of the twig itself. Another (center) has some completely blackened spurs (arrow) and others partially blackened. The third twig (right) is of normal appearance except for one infected fruit that is beginning to blacken (arrow).

single fruit on the twig becomes infected *(Figure 2, right)*, because the bacteria move through the fruit stem and into the twig as easily as through leaf stems and non-fruiting spurs.

The bacteria responsible for fire-blight are most active in the spring when the tree tissue is growing rapidly and there is plenty of moisture. At such times long wet streaks of bacterial slime run down the lower sides of branches and down the trunks from the cankers. When such vigorous activity ceases, the cankers tend to become inactive and small cracks develop at the margins. This crack is a characteristic symptom of the disease *(Figure 3)*. Such cracks do not develop in the dead areas, but may be found there after conditions have become favorable again and the necrotic margin of the canker has advanced farther along the branch or trunk.

In most cases canker development on the trunk or scaffold branches results in death of the parts above. We often find a similar condition of severe die-back caused by current season infection of most of the leaves and spurs on major branches. This is a common sight in heavily infested orchards *(Figure 4)*. Where so many small infection sites develop it is

Figure 3.—Fire-blight damage in the scaffold of a Bartlett tree. The lower branches to right and left have spots of bark shaved away to reveal the dead brown tissue beneath. On the upper part of the leader is shown the typical crack (arrow) that develops at the margins of cankers formed the previous season.

virtually impossible for the grower to prune out all the diseased parts. The likelihood that this condition will develop greatly emphasizes the need for preventive measures such as sprays before it becomes necessary to apply corrective surgery. Where neither prevention nor correction is practiced—and often where the practice is applied late—tree death is common and rapid *(Figure 5)*.

During the period of normal foliage coloration in the fall, parts directly above fire-blight cankers tend to develop brighter colors. These colored parts serve as "flags" that can guide the grower to the infection sites he may have missed previously.

The cankers themselves are dark and slightly sunken in advanced cases, and almost always have the narrow border cracks. In moist weather droplets of the bacterial ooze (or exudate) appear on the canker surfaces. This ooze is heavily loaded with fire-blight bacteria, which soon are spread about by wind, rain, insects, pruning tools, etc.

Figure 4.—Rapid die-back in a Bartlett tree due to fire-blight infection.

Figure 5.—This young Bartlett is being killed by fire-blight. Life remains only in the lower right portion.

As new infections take place, tiny water soaked spots appear. As these spots develop, they change in appearance from reddish colors to larger brown and black streaks and lesions. These develop into cankers and the cycle begins again.

Varietal Reaction

Bartlett pear is one of the most susceptible and heavily damaged of our popular varieties. Jonathan is one of the most susceptible of the apple varieties, but apples generally are much less damaged than pears. However, apple orchards should not be set adjacent to pear orchards because of the increased likelihood that they will contract the disease repeatedly from the pears. The problem is worse where apple orchards are interplanted with pears.

When setting new orchards varietal susceptibility should be considered as much as environmental requirements and information now available will permit. The pear varieties Old Home and Orient and the apple varieties Baldwin, Delicious, Duchess, Golden Delicious, McIntosh, Northern Spy, Stayman and Winter Banana have some resistance. However, the resistance of these varieties is not really good. They are not immune to infection, but they are much more resistant than the pear varieties Bartlett, Flemish Beauty, Bosc, Howell and Clapp Favorite, and the apple varieties Jonathan, Wealthy, Yellow Transparent and Transcendent Crab.

Sometimes resistant types are used by the nurseryman in certain rootstock and scaffold build-up combinations. Some French and Asiatic understocks are helpful too. Thus, some protection for susceptible orchard varieties can be obtained; either in a resistence-or tolerance-contributing root, or in a build-up arrangement in which the susceptible variety is top-worked on a resistant root or scaffold stock.

We must remember, however, that fire-blight is a versatile disease. It has been known to infect almost all kinds of fruit plants at one time or another.

Control

Only in rare cases is fire-blight relatively easy to control. The disease generally is present somewhere in the fruit-growing environment every year, and even with good precautions it continuously causes damage. Wet weather is a major factor in bringing this about. Heavy pruning and fertilization stimulate succulent growth which is very susceptible to infection.

SURGERY—

Ever more effective spray programs are being developed for the control of fire-blight. But, until a material and a program for its use are

developed in which the bactericide works from within the tree itself, it is not likely that any program will be satisfactorily effective without surgery. Recent investigations of some of the antibiotics suggest that they may in some cases act from within. Preliminary tests in Idaho have not indicated that such action is adequate for killing existing cankers in Bartlett pear trees. We still have to rely on corrective pruning.

Cut out the infected parts. Carry them out of the orchard and destroy them. Allow several inches of live tissue between cut and canker where possible. No disinfection is necessary in good dormancy, but if cuts are made at other times wounds should be treated with a mixture of 1 ounce mercuric chloride plus 1 ounce mercuric cyanide plus 3½ gallons of water and ½ gallon of glycerin. THIS IS A POISONOUS MIXTURE and should be handled accordingly. These chemicals can be obtained at drug stores.

If cankers are removed during the growing season, cut at least one foot below the canker. Patrol the orchard weekly during the bloom period (look for "ooze" running down branches on the lower sides) and in the fall (look for bright colored "flags") so that new infections can be found and destroyed as soon as possible. When they are removed, the cut surfaces should be disinfected with the mercury mixture. If there are too many to handle in this way, they may be held over for removal in dormancy. To do this, scrape the cankers free of all discolored bark and paint the canker and a few inches of the surrounding tissue with the mercury mixture. Remove these cankers when pruning, and at the same time remove all shoots from the ground line and trunk. These succulent sprouts are ideal places for infection to take place and for the bacteria to multiply—and move into the trunk and kill the tree.

When doing surgery connected with fire-blight, tools also should be disinfected between cuts with the mercury mixture to prevent carrying the bacteria from one place to another. Other materials may be used, such as formaldehyde or strong alcohol solutions, but they are not as effective.

SPRAYING—

Sprays for the control of fire-blight generally are recommended for use during the bloom period in the spring. Whatever the material used, applications should be made more frequently during rainy periods. This applies to dusts also. The grower must be very careful about application of spray or dust materials near harvest time in view of the "Miller Amendment." This is an amendment to the U. S. Pure Food, Drug and Cosmetic Act. It limits acceptable spray residues on marketed products. Reliance on the blossom period schedule will minimize the danger of building up too much residue.

The "Miller Amendment" was enacted to insure that the consumer will not be able to purchase edible materials or products that have in or on them a harmful chemical deposit or residue. In order to accomplish this, residue tolerance limits for pest control materials have been set up on each crop on which they are to be used. The law is enforced through confiscation of produce bearing residues in excess of the established

minimum tolerances for the chemicals used on them. Some recommended materials may leave objectionable residues if used later in the growing season than the usual spring fire-blight spraying season, especially near harvest time. This being the case, the grower is urged to rely on the recommendations of the manufacturer set forth on the label of the package. Follow these label instructions and excess residue problems should not arise.

Whatever the spray program selected by the grower, use of insecticides with fire-blight sprays is not recommended because of danger to bees.

In Idaho we do not recommend spraying for fire-blight during the summer period. Spraying sometimes is necessary during rainy fall periods, and it is then that the residue problem must be kept in mind. If it is necessary to use a material that may leave an objectionable residue before harvest operations are completed, the weather factor should be considered when deciding whether to risk using it.

If either the fall or spring seasons are unusually wet, cool and prolonged, more than the recommended amount of a spray material may be necessary to accomplish the same degree of disease control. But, there is always danger of injury when dosages are increased, and this should not be done except on competent advice or in a very small experimental way.

None of the spray materials available for fire-blight control will eradicate the disease unless good surgery goes with it. Spraying is effective in the long run only if used as a preventive measure after the cure has been effected by surgery and sprays used together.

Bear all the above in mind in considering the following information on spray treatments. Choose the program that best suits your needs and your environment.

Copper—Twigs and blossoms can be protected to some extent by spraying every 8 to 10 days during the bloom period with 1-3-100 Bordeaux mixture (1 pound copper sulfate plus 3 pounds freshly slaked lime in 100 gallons of water) or by dusting with 20-80 copper-lime dust (20 parts copper sulfate and 80 parts hydrated lime). Begin when about 15 percent of the flowers are open and continue till all petals have fallen. Make another application shortly after harvest.

If dusted, apply at a rate of about 60 pounds per acre.

Fixed coppers are satisfactory at about 1-100 (1 pound in 100 gallons of spray). However, copper sprays tend to cause russeting on Anjou and some other pears and apples. Bordeaux will do this also under slow drying conditions.

Dithiocarbamates.— The commercial zinc carbamate preparation Zineb, is effective when applied at a rate of 1½ pounds per 100 gallons of spray. It rarely causes any injury.

There are numerous dithiocarbamates on the market now, most of which have not been thoroughly investigated for their effectiveness in controlling fire-blight. Some of the same active ingredients are marketed under different trade names and often in different concentrations.

Antibiotics.—Excellent results have been obtained with the antibiotic streptomycin applied from three to five times during the bloom period, beginning when about 20 percent of the flowers are open. Aside from good control of fire-blight, streptomycin is reported to have an additional advantage over many materials in that spray injury is virtually eliminated.

The antibiotic approach to control of bacterial diseases of plants is new and such products have not been thoroughly tested. However, results generally are reported to be superior to those obtained with other types of spray or dust products.

A few products containing antibiotics are on the market. Directions are supplied by the manufacturer with each product. These are based on the best information available to the manufacturer but have not thus far been tested for Idaho conditions. In the meantime, they should be used cautiously as should any other material marketed for similar purposes. Use them as the manufacturers recommend. Be careful of washoff due to rain, and of other complicating conditions peculiar to the locality.

Materials Referred to in this Bulletin

ANTIBIOTICS—

The antibiotics of primary concern in the control of fire-blight are streptomycin and oxytetracycline (terramycin). As yet few commercial products containing these ingredients in agricultural form have been marketed. Among those that have are Agri-mycin, Agristrep, Phytomycin, and Ortho Streptomycin.

Agri-mycin contains both streptomycin and terramycin and is available in two forms. Agri-mycin 100 is a wettable powder containing approximately 15 percent streptomycin. Agri-mycin 200 is a liquid concentrate containing 35 percent streptomycin.

Streptomycin products should not be mixed with oils or with the safeners zinc sulfate and lime.

BORDEAUX MIXTURE—

Home-made Bordeaux is recommended rather than commercial types because tests conducted in Idaho have shown it to be superior in terms of control obtained. Bordeaux mixture is one of the oldest—and still best—of our general disease control materials. Directions for home preparation are contained in the Idaho Agr. Exp. Sta. Mimeo-Leaflet No. 128.

Do not mix Bordeaux with Aldrin, Aramite, Toxaphene, TEPP, Captan, Parathion, Malathion, EPN, Metacide, SR-406, Karathane, DN-111,

Dimite, Dieldrin, Chlordane, Chlorobenzilate, Heptachlor, BHC (Lindane), Cryolite, Systox, Pyrethrum, Rotenone, Lime-sulfur, dinitro compounds (Elgetol or Krenite), quarternary ammonium compounds (Hyamines), quinones (Phygon; Chloronil; Dichlone), organic mercuries (Puratized Agricultural Spray), or dithiocarbamates (Ferbam; Zineb; Ziram).

Bordeaux has been known to cause red spotting, yellowing, defoliation and russeting when used in apple orchards. Peaches occasionally are affected. This generally happens when drying is slow.

COPPER-LIME DUSTS—

Copper-lime dusting products are available in several concentrations of copper. The 10 percent and 20 percent preparations seem to be most used. Twice the poundage per acre of the 10 percent is required when substituting it for the 20 percent.

Copper-lime dusts should not be mixed with Aramite, Captan, Cryolite, Karathane, Chlorobenzilate, Rotenone, Allethrin, Pyrethrum, or with products that cannot be mixed with fixed coppers.

FIXED COPPERS—

Copper is one of the oldest and most effective fungicides. There are proprietary, or trade name, products on the market in great numbers. Whether one is more effective than another is governed largely by the percent content of metallic copper. Other ingredients have a bearing also. Poundage recommendations when given in terms of one of these fixed coppers will not be correct for another unless the copper contents are comparable. These products generally serve as substitutes for Bordeaux mixture and seem to be about as effective as commercial Bordeaux products.

Fixed coppers should not be mixed with DN-111, TEPP, dithiocarbamates (Ferbam; Zineb; Ziram), or lime-sulfur.

Cold weather, cloudiness, rain and high humidity can result in slow drying conditions under which any of the fixed coppers may be injurious. Injury to apple leaves resembles Bordeaux injury. Reddish spots sometimes develop on peach leaves, the centers of which may drop out. This results in an effect of shot-holing similar to that caused by *Coryneum* blight.

MERCURY DISINFECTANTS—

Disinfectants containing mercury are poisonous and should be handled with care. They are useful, and often recommended, for disinfesting tools and painting wounds that are, or may become, infected. Many products are on the market which have mercury compounds as their active ingredients. Among these are Calo-Chlor, Corrosive Sublimate (mercuric chloride), Mercurnol, Calogreen, and Calomel (mercurous chloride).

Tablets of mercuric chloride can be purchased at drug stores and used to prepare small quantities of disinfectant. One 7-grain tablet in a pint of water gives a concentration of approximately 1-1000, which is adequate. This is corrosive to metal and should be handled in glass or enamel containers.

Another common disinfecting mixture consists of equal parts of mercury bichloride and mercury cyanide in water. To 3½ gallons of water add 1 ounce of each, plus ½ gallon of glycerin. The glycerin prolongs the life, or usefulness of the mixture. This is a useful preparation for tool disinfestation.

STREPTOMYCIN—

See section on ANTIBIOTICS.

ZINEB—

Zineb is a zinc dithiocarbamate. Other names of commercial products with zinc carbamate as the active ingredient are Corozate, Ortho Zineb, Stauffer Zineb, Thiodow, Opalate, Orchard Brand Ziram, Ziram, Dithane Z-78, D & P Fruit Spray, Stauffer Ziram, Z-C Spray, Good-Rite Z.A.C., Karbam White, Methasan, Parzate, Zerlate, and Zincate. Parzate, Ortho Zineb, Stauffer Zineb, Thiodow, and Dithane Z-78 have the Zineb formulation.

In the Northwest, where zinc deficiency is common, these products seem to serve the dual purpose of disease control and supplying needed zinc. They are mild fungicides from the plant injury standpoint.

Zineb should not be mixed with Paris Green, TEPP, SR-406, Bordeaux, Polysulfide Compound, calcium arsenate, quaternary ammonium compounds (Hyamines), glyoxalidines (Crag 341), quinones (Phygon; Chloronil; Dichlone), organic mercuries (Puratized Agricultural Spray), fixed coppers, lime-sulfur, zinc sulfate, zinc sulfate and lime, or lime.

Things to Remember

Keep Equipment Clean

Do not allow spray materials to stand in tanks or pipes. Many are corrosive. Many settle out on standings, which results in plugging of screens and nozzles by the residue. Use the spray when it is prepared and keep the agitator running until the tank is drained and flushed out. Do not use equipment for disease or insect control sprays that has been used for application of weed killers. If it is necessary to do so, wash out the equipment with extreme thoroughness. Even then there may be damage to the trees.

Mixing the Spray Materials

Do not mix pesticidal materials unless they are compatible. If the information is not on the packages, ask your county extension agent or supplier. Idaho Agricultural Experiment Station Mimeo-Leaflet 128 will

be useful and can be obtained from or through your Extension Service.

Spraying Practices

Apply sprays with discretion. Narrow nozzle streams at high pressures can damage foliage. Fine mists at distances of four feet or more should be safe enough.

Spray Method vs. Quantity

Whether it be concentrated, semi-concentrated, or diluted, the method of application has little bearing on the needed quantity of the effective part of the product.

Dusts vs. Sprays

Dusts must be applied thoroughly at the proper time. They should contain quantities of active ingredients at least equal to sprays used for the same purposes. For example, if a product containing 5 percent copper is being applied as a spray at a certain poundage per acre and the operator wishes to switch to a dust, he should choose a product and per acre rate that will deliver the same copper poundage per acre. More frequent applications of the dusts may be necessary because they do not stick and retain their effectiveness as long as sprays.

Pruning and Spacing

Pest control programs are more effective in orchards where the trees are properly spaced and pruned. This aids air circulation, which reduces disease damage.

Spray Concentration Numbers

The first figure means pounds or gallons of the pesticide. The last means gallons of water. For example, 1½-100 Ferbam means 1½ pounds of Ferbam in 100 gallons of water. Where there is a middle number it refers to the second ingredient, i.e. 3-4-100 Bordeaux means 3 pounds of copper sulfate and 4 pounds of freshly slaked lime (one third more if hydrated—never use air slaked) in 100 gallons of water.

Useful Idaho Publications For Tree Fruit Growers

Idaho Recommendations for Insect Control.
Extension Bulletin No. 216.

Cytospora Canker of Prunes.
Experiment Station Bulletin No. 254.

Powdery Mildew Control in Idaho Orchards.
Experiment Station Bulletin No. 221.

Little Cherry and Western X-Disease in Cherries and Peaches.
Extension Bulletin 259.

Latent Viruses in Stone Fruit Trees.
Experiment Station Bulletin No. 260.

Curative & Preventive Methods in Controlling Fruit Diseases.
IV. Pome Fruits. Mimeo-Leaflet No. 125.
V. Stone Fruits. Mimeo-Leaflet No. 126.
VII. A Preliminary Survey of Preparation, Use and Injury Factors for Pesticides. Mimeo-Leaflet No. 128.

Copies of these and other Idaho Agricultural publications may be secured from County Agents or by writing the Director, Idaho Agricultural Extension Service, Moscow or Boise.