Blight and Insect Pests of Walnuts

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Figure 1. Appearance under the microscope of the walnut blight organism and its effect upon the tissues of the nut. A. Cross section through small portion of infected tissue showing disintegration of the cellular structure. The bacteria can be seen in the tissues near the arrow. B. Walnut blight bacterium greatly enlarged.
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WALNUT BLIGHT

Walnut blight is the most wide-spread and destructive disease of the Persian (English) walnut in Oregon. This malady causes greater annual loss to the walnut growers of the State than all other diseases of walnuts combined.

CAUSE

Walnut blight is caused by a specific bacterial organism¹ (Figure 1) which lives parasitically within the tissues, resulting in their death.

DESCRIPTION

This disease attacks the leaves, nuts, catkins, buds, and shoots of current growth. Blight first appears in the spring on the young leaves as reddish brown

Figure 2. Blight infections on walnut leaflets. A. Blight spots at the margins. B. Lesions on the midrib and veins of a leaflet. C. Lesions in the tissues between the veins. (Reproduced from U.S. Dept. of Agric. Cir. 331.)
Figure 3. Blight infections on walnut shoots. A. Lesions on a walnut shoot. B. A walnut shoot girdled by a blight infection showing dieback effect. (Figure 3 A reproduced from U.S. Dept. of Agric. Cir. 331.)

Dissemination. Blight is spread by rain. If prolonged and frequent rains occur during the critical period for infection, serious blight outbreaks follow.

Period of susceptibility. The nuts are susceptible to infection from the time the pistillate (female or nut-bearing) flowers first appear until the nuts are about seven-eighths grown. The blossoming period is the most critical part of this period of blight susceptibility. Nut infections occurring during blossoming almost always result in the destruction of the kernel and premature spots (Figure 2). On the shoots, the disease causes black, slightly depressed lesions (Figure 3, A) which oftentimes completely encircle the shoots causing dieback (Figure 3, B). Young leaf and catkin buds in the leaf axils are also susceptible to infection. Buds infected with blight turn dark brown or black and die (Figure 4). Walnut blight is most serious and destructive on the nuts, where it causes black spots of varying size (Figure 5). A nut that is infected at or shortly after the time of blossoming generally fails to mature, as the bacteria almost always gain access to the interior, where they cause the death of the developing kernel and premature dropping of the nut.

LIFE HISTORY OF THE DISEASE

Overwintering. Under Oregon conditions, the blight bacterium lives over from one year to the next primarily in diseased buds and to a lesser extent in hold-over infections on shoots of the previous year's growth.

Figure 4. Shoots with blighted buds. A, at (a) is an infected catkin bud. B, a diseased leaf bud at (a). (Figure 4, A reproduced from U.S. Dept. of Agric. Cir. 331.)
dropping of the nut. Infections occurring after the nuts are about one-half grown are of little, or no economic importance, since they seldom, if ever, reach the shell. After the nut is about seven-eighths grown it is no longer subject to blight infection.

CONTROL

Extensive experiments carried on over a period of seven years have shown that the application of a sufficient number of timely sprays of bordeaux mixture will keep walnut blight under control in orchards of a uniform, grafted variety.

In seedling orchards, however, satisfactory control of the disease is much more difficult than in grafted orchards. This situation appears to be due largely to variations in the blooming period of individual seedling trees, which makes it exceedingly difficult to time the sprays properly.

Nevertheless, results of studies carried on to date indicate that it is possible to reduce substantially the number of blight infections in seedling orchards as well as in grafted plantings by individual tree spraying—that is, by applying the spray treatments to the various trees as they reach the proper stage of development.

**Number and time of spray applications.** In an average Western Oregon season, two bordeaux mixture applications made (1) in the late prebloom period, just as the first pistillate blossoms can be seen, and (2) immediately after the majority of the female flowers have been pollinated, as indicated by the presence of tiny brown spots in the stigmas, will keep the disease under control in orchards of a grafted variety. In seasons when frequent and prolonged rains occur before blossoming, however, an additional spray applied in the early prebloom stage appears to be needed to control blight satisfactorily.

The early prebloom spray. This spray should be applied when the terminal leaves have sufficiently parted just barely to expose the pistillate flowers. The pistils at this stage will average about 1/16 of an inch in diameter (Figure 6, A). The stigmas (blossom ends) will not be visible at this time.
The late prebloom spray. This spray treatment should be applied just as the first few pistillate flowers come into bloom but before the stigmas of most of the female flowers open. At this time the unopened blossom ends of many pistillate flowers will be pink or red. The pistils at this stage of development will average about \( \frac{1}{8} \) of an inch in diameter or about the size of a grain of wheat (Figure 6, B).

The postbloom spray. This application should be given just as soon as it is reasonably certain that a majority of the pistillate flowers have been pollinated, as indicated by the presence of tiny brown spots in the stigmas. At this time the young nuts will average about \( \frac{3}{16} \) of an inch in diameter or about the size of a sweet pea seed (Figure 6, C). In an average season there will be about a two-week interval between the late prebloom and postbloom applications.

Three spray applications the safest procedure. It is impossible to predict at the beginning of the season the amount and frequency of rain that will occur during the infection period. The safest policy to pursue, therefore, is to make all three applications. This is particularly advisable in orchards that have never been sprayed before. If economic conditions or other circumstances should dictate fewer than three applications, omit the postbloom spray. The late prebloom spray has proved, in the past, to be the most important single application and should never be omitted from the spray program.

Proper timing of sprays essential. It is extremely important that the sprays be applied at the designated times, as the success of the spray program depends more on the proper timing of the applications than on any other one factor. Deferring the applications even for a few days after the proper stage of blossom or nut development has been reached may mean the difference between success and failure of the spray program. Every detail connected with spraying should be attended to, therefore, before the time comes to begin spraying operations so as not to delay the application of the spray when the proper time arrives.

The proper concentration of the spray mixture. Results of studies carried on over a seven-year period indicate that under average Western Oregon conditions 2-2-50 bordeaux mixture will give essentially as good control of blight as stronger concentrations, provided a sufficient number of properly timed applications are made.

Thoroughness of application essential. If satisfactory control is to be obtained the sprays should not only be properly timed but also thoroughly ap-
plied. Spraying is not a cure for walnut blight; it serves only as a protection against infection. The degree of protection obtained by spraying will be in proportion to the thoroughness of spray coverage. For maximum protection a film of spray should completely cover the nuts throughout the infection period. The use of modern spray machinery will facilitate the achievement of thoroughness of spray coverage without an undue waste of time and material. Modern power spray machines capable of developing from 500 to 600 pounds pressure per square inch and having a capacity of 20 to 26 gallons of spray per minute are much more efficient than the older types of spray machines having only limited power and capacity. There is also quite a difference in the efficiency of the various types of spray guns and rods on the market. One of the most efficient types is the so-called "fog drive" gun, which consists of three or more spray nozzles mounted abreast on a crossbar which is fastened to an aluminum rod or lance with the cut-off in the basal casting (Figure 7). The power developed by the spray machine and the size of the openings in the disks of the spray nozzles will determine the fineness of the spray particles. The height of the trees to be sprayed will determine the length of the lance. A four-nozzle "fog drive" gun with a 10-foot lance can throw a cloud of spray 30 to 40 feet high on a relatively calm day provided there is sufficient power and capacity back of the gun. The number of nozzles that can be efficiently used on this gun will depend on the power and capacity of the spray machine. Two four-nozzle guns can be efficiently operated if the spray machine can develop at least 500 pounds pressure per square inch and if it has a capacity of 20 gallons per minute. The use of this spray gun not only results in better coverage but also reduces the time required thoroughly to spray the trees. Furthermore, with this gun faulty spraying due to inexperienced help is reduced to a minimum, since the operator cannot wrongly adjust the type of spray coming from the nozzle.

Figure 7. A type of spray gun that has been found to be very efficient in spraying walnuts.

Figure 8. Walnut leaves showing bordeaux spray injury. (Reproduced from U.S. Dept. of Agric. Cir. 331.)
Cost of spraying. Cost records kept over a period of several years show that the approximate cost of spraying walnut trees, from 15 to 20 years old, with 2-2-50 bordeaux is about 15 cents per tree per application or about $3 per acre on the basis of 20 trees per acre. This cost includes not only the cost of labor and materials but also overhead, such as interest and depreciation on spraying equipment. The cost of spraying will vary, within limits, with the size of the trees, the price of spray materials and the local cost of labor. The above figure may be generally accepted, however, as approximating the cost of applying one spray of 2-2-50 bordeaux mixture to walnut trees from 15 to 20 years old under prevailing market conditions.

Spray damage and how to reduce it. Spray burn may and often does follow the application of bordeaux mixture to walnut leaves that are not full grown. The margins or tips of the young, developing leaflets are the parts most generally affected. The injured areas die and often drop out of the tissues, leaving the affected leaflets very ragged in appearance. Subsequent growth may cause the injured leaflets to assume abnormal shapes (Figure 8).

The severity of bordeaux spray injury to the foliage has been appreciably reduced, in experiments carried on over a three-year period, by adding to all prebloom applications of bordeaux mixture either fish (salmon) oil or a mineral spray oil having a viscosity of 100 to 120 seconds Saybolt and a sulfonation test of between 50 and 70, the addition being at the rate of 1 pint of oil to 100 gallons of spray material. The oil should be poured slowly into the bordeaux mixture while stirring vigorously. Freshly prepared bordeaux mixture will emulsify the oil if mixed properly. With the postbloom application of bordeaux mixture it is not necessary to use oil, as by this time walnut leaves are quite resistant to spray burn.

DUSTING NOT ADVISED

The dusts that have so far been used in blight control experiments have not given results sufficiently good to warrant recommending them for general use. The following dusts have been subjected to trial: copper-lime, dehydrated commercial bordeaux, red copper oxide, copper hydroxide, copper ammonium silicate, basic copper sulphate, copper phosphate, three types of flotation sulphurs and a gas house sulphur dust. Of the dusts tested, a 30 per cent copper-lime dust (30 per cent monohydrated copper sulphate and 67 per cent hydrated lime and 3 per cent “gludust”) gave the best results. If a dust is used at all, it should be used only in case of an emergency when it is apparent that a liquid bordeaux spray application cannot be completed before an impending period of rain.

WALNUT INSECTS

THE COMMON WALNUT APHID

Chromaphis juglandicola (Kalt.)

The common walnut aphid is a pale yellow insect found on the under side of Persian (English) walnut leaves. It is quite often a serious pest.

Control. Nicotine sulphate 40 per cent, 1 pint to 100 gallons of water, is recommended for the control of this aphid. Nicotine dust under favorable conditions (see control of midrib aphid) may also prove effective. Control measures should be applied soon after aphids first appear. Nicotine sulphate sprays and dusts are more effective when temperatures are high, preferably about 70° F.
THE DUSKY-VEINED OR MIDRIB WALNUT APHID

Callipteris juglandis (Frisch)

The dusky-veined or midrib walnut aphid is a large species, and unlike most aphids works on the upper surface of the leaves along the midribs (Figure 9). It is a European species, first found in Oregon in 1928. It is now generally distributed throughout Western Oregon.

Control. This species is quite effectively controlled with 2 per cent nicotine dust. A 2 per cent nicotine dust may be made by thoroughly mixing 5 pounds of nicotine sulphate with 95 pounds of hydrated lime. A home-made dust mixer may be constructed as follows: A 50-gallon barrel or oil drum is mounted on an eccentric shaft with a crank on one end of the shaft. A door is cut in the side of the barrel and the edges of the door felting to prevent leakage. The hydrated lime and nicotine sulphate are placed in the barrel and turned for about three minutes. If a half dozen pebbles or pieces of river gravel three or four inches in diameter are placed in the barrel with the lime and nicotine sulphate, a better mixture is obtained, as the gravel tends to break up the lumps. After thoroughly mixing, the dust is passed through a screen to remove the gravel and any remaining lumps. The dust should be kept in an air-tight container and used as soon as possible after mixing. Control measures should be applied as soon as possible after the aphids first appear. The most favorable conditions for the application of dust are usually found between midnight and sunrise. Nights when there is little or no wind and when the humidity is high are most favorable.

SCALE INSECTS

Several species of large, soft-bodied scale insects are often found in walnuts in Oregon. Among these are the brown elm scale, Lecanium canadense (Coc.); the frosted scale, L. pruinotum (Coq.) and the excrescent scale, L. excrescent, (Ferris.)

The excrescent scale is the largest of the scale insects attacking walnuts. It is globular in shape and when full grown is about ¼ inch in diameter. The brown elm scale is about half the diameter of the excrescent scale in size, oval in shape and having a surface as wrinkled as a dried prune. The frosted scale is nearly as large as the excrescent scale but is covered with a frost-like wax. All three species are brown in color.

Control. A dormant spray of winter strength lime sulphur should control the scale insects. To avoid injury this should be applied before the buds open.
THE FALL WEB-WORM

*Hyphantria cunea* (Drury)

Fall web-worms feed on a great many forest, shade, and fruit trees. Both the English and black walnut are often badly damaged by this insect. The adult moths are pure white in color, clothed with long hairs. The abdomen is yellow with black spots on the back and sides. The eggs are white to yellow in color and are laid in large clusters on the undersides of the leaves, usually during July and August. The eggs hatch in about two weeks. The caterpillars hatching from one egg-cluster remain together in a colony. They build a “nest” by spinning webs within which they feed (Figure 10). As more food is needed the web is enlarged. These webs are not to be confused with the webs of the tent caterpillars which appear in early spring; they are larger and more gauze-like than those of the tent caterpillar.

The caterpillars when full grown are usually about one inch long. They are gray or yellowish brown in color and are sparsely covered with long, white hairs. Winter is passed as pupae within cocoons attached to the tree trunks and other convenient places.

**Control.** Same as for the red-humped caterpillar, or by cutting out or burning the nests.

THE RED-HUMPED APPLE TREE CATERPILLAR

*Schizura concinna*, (A. & S.)

This insect sometimes attacks walnuts. Due to its gregarious nature it occasionally completely defoliates individual trees.

The adult moths are of a mixed brown and gray color. The body and the inner portion of the forewings are brown. The outer margins of the fore and hind wings are gray. The adult moths appear in early summer and lay small, pearly white eggs in large clusters on the under surfaces of the leaves. From these eggs soon hatch the larvae, which for a time feed on the surface of the leaves. Later as they grow larger they devour the entire leaf, excepting the midrib. The fullgrown caterpillar is about 1 ½ inches long. It is marked with fine longitudinal stripes of black, white, and yellow, has a bright red head, and the fourth body segment is raised on the back to form an oval, bright red hump (Figure 11). In October the larvae become full grown, de-
scend to the ground and crawl under leaves and rubbish where they spin a cocoon in which they pass the winter.

**Control.** Spraying the infested trees with lead arsenate at the rate of 3 pounds to 100 gallons gives good control. Spraying is done as soon as the injury is first noticed. The caterpillars mature rapidly, and the trees, especially young ones, are soon defoliated.

**THE YELLOW-NECKED APPLE CATERPILLAR**

*Datana ministra* (Drury)

The yellow-necked caterpillar sometimes attacks walnuts. It works very much as does the red-humped caterpillar. Although usually of very minor importance, this caterpillar at times completely defoliates entire trees. The winter is passed in the pupal stage, in the soil. Adult moths, which are brown in color with a few dark lines across the forewings, appear in June and July. The eggs are laid in clusters on the undersides of the leaves. Larvae begin to appear in late July. All the caterpillars hatching from an egg mass remain close together, eating all the foliage on the branch on which they hatch before moving to other branches.

**Control.** When the caterpillars are numerous enough to warrant control, lead arsenate 3 pounds to 100 gallons is quite effective against this pest.

**THE WALNUT SPAN WORM**

*Coniodes plumogeraria* (Hulst.)

The native host of this insect is live oak, but it has been reported to have completely defoliated a large English walnut orchard in California. This insect has been found in Oregon but so far has not been reported doing damage to walnuts. Should it be found attacking walnuts, the control recommended for the red-humped caterpillar would probably be effective.

**CODLING MOTH**

*Carpocapsa pomonella* (Linn.)

The codling moth, so destructive to apples and pears, at times attacks walnuts. In some sections of the world it is a major walnut pest. It has not yet occurred in epidemic numbers on walnut in Oregon, although from year to year occasional specimens have been taken on walnuts in this state. Should it occur in sufficient numbers on walnut to warrant control, the same spray program recommended for apples is suggested. This will be found in Oregon Extension Bulletin 483.

**THE WALNUT TINGID**

*Corythucha juglandis* (Fitch)

The walnut tingid has been taken in Oregon. This is a small, very flat bug with peculiar lace-like wings held close to the body. The adults are somewhat rectangular in shape about 1/10 of an inch wide by a little more than 1/8 inch long. They feed on a number of trees besides walnut. These include linden, basswood and butternut.

Tingids are sucking insects, feeding on the undersides of the leaves. Injured leaves appear yellow or brown. The undersides of the infested
leaves are spotted with black, pimple-like specks of excrement and the cast skins of the nymphs. The adults pass the winter by hibernating in moss, debris, etc. On heavily infested trees the leaves turn brown and die prematurely.

**Control.** No experimental work has been done on the control of this insect in Oregon, but the control measures recommended for a closely related species on apples might prove effective. This consists of a spray of nicotine sulphate 40 per cent, 1 pint; fish oil soap, 5 pounds, and 100 gallons of water. The spray is directed at the undersides of the leaves. The insects must be thoroughly wet with the spray to insure control.

### A SHOT-HOLE BORER

*Anisandrus dispar* (Fabr.)

This shot-hole borer is a small beetle that sometimes attacks filberts and walnuts. The injury is recognized by the small "shot-hole" entrances of the beetles (Figure 12) into the trunk and branches of the tree. This insect belongs to a group known as ambrosia beetles, and the larvae feed only on a fungus which the beetles "plant" in the tunnels. This fungus will grow only in trees that have a sour-sap condition. There are various causes of sour sap such as winter injury, drought, lack of drainage, lack of cultivation, and other conditions that lower the vigor of the trees.

**Control.** Since the beetles attack only trees of very low vigor or those in a sour-sap condition, every possible means should be used to revitalize the trees. Cultivation, drainage, fertilization and pruning are practices that are suggested.

Heavily infested limbs and trees should be cut out and burned. The slightly infested portions of a tree may be painted with the following wash:

- Water .................................................. 3 gallons
- Soft soap or liquid fish-oil soap .................. 1 gallon
- Crude carbolic acid .................................. ½ pint

### GRASSHOPPERS

A few years ago grasshoppers were found doing serious damage to young walnut trees in the foothills of the Coast Range west of McMinnville. The trees were defoliated, and in many cases the bark was eaten from the new growth. Trees thus injured died. Several species of grasshoppers were present but *Melanoplus femur-rubrum* and *M. mexicanus* predominated.

**Control.** Poison bran bait made up according to the following formula gave control: Wheat bran, 100 pounds; white arsenic or paris green, 4 pounds; stock molasses, 2 gallons; water to make crumbly mash. The poison mash is spread sparsely about the trees.

### THE COMMON RED SPIDER

*Tetranychus telarius* (Linn)

The common red spider often attacks walnuts. It works on the undersides of the leaves puncturing the epidermal cells. Infested leaves first turn
yellow, then brown, and finally drop. Injury is more severe during hot, dry weather.

The mites are quite small, being about 1/20 of an inch long. They vary in color from pale yellow to red. Some have a greenish hue and often have two dark colored spots on their backs.

**Control.** This mite spends the winter in the adult stage. It hibernates in the soil, rubbish, debris, etc. Winter spraying is therefore of no avail against this species. An oil emulsion spray of a medium-light oil applied at the rate of 2 gallons of oil to 100 gallons of water gives control of this mite on apples and would probably control it on walnuts, although we have no experimental data relative to its use on walnuts.

**WALNUT BLISTER MITE**

*Eriophyes tristriatus erineus* (Nal.)

The walnut blister mite attacks the lower surface of the leaves of Persian (English) walnut. It causes a large blister-like swelling on the upper surface and a concave area on the under surface of the leaves (Figure 13). The concave area has a yellow velvety appearance. This mite, though common in Oregon, has never proved serious enough to warrant control.

**PREPARATION OF BORDEAUX MIXTURE**

Home-made bordeaux mixture is prepared by mixing together very dilute solution of copper sulphate (bluestone or blue vitriol) and lime. Formulae of bordeaux mixture are generally designated by the proportions of the materials used. Thus, a 2-2-50 bordeaux mixture would contain:

- Copper sulphate (bluestone) .................. 3 pounds
- Quicklime (stone lime or caustic lime) .... 2 pounds
- Water ............................................ 50 gallons

If any considerable quantity of bordeaux mixture is to be made, it is advisable to prepare separately concentrated stock solutions of copper sulphate
and of lime from which the bordeaux mixture may be made as needed. A convenient concentration of each is 1 pound to a gallon of water. These are prepared as follows:

(A) Copper sulphate solution may be made by suspending in a fifty gallon barrel of water near the surface, 50 pounds of bluestone in a burlap sack. Wooden barrels must be used.

(B) Lime solution may be made by slaking 50 pounds of high-grade quicklime (stone or caustic lime) and then adding water to make 50 gallons of the milk of lime.

**PREPARATION**

To prepare 50 gallons of the 2-2-50 formula, proceed as follows:

1. Put into the spray tank about 25 gallons of water and start the agitator.
2. Stir up stock solution B thoroughly and dip out 2 gallons of the milk of lime. Pour through strainer into spray tank.
3. Arrange a water inlet to the tank so that the water runs down a trough into the tank. Turn on water full force and pour slowly into the running water, 2 gallons of stock solution A, copper sulphate, so that it will be diluted as much as possible.
4. As the last portion of bluestone solution is being poured into the spray tank, the last of the water should have been added and the tank be full.

For more detailed information regarding the preparation of bordeaux mixture, see Oregon Experiment Station Bulletin 259.

**PRECAUTIONS**

1. Use fresh quicklime of highest purity and avoid burning or drowning during the slaking process by adding just the right amount of water—not too little or too much.
2. Do not mix the concentrated solutions together at any time.
3. Bordeaux mixture should be used immediately after preparation. If, for some reason, the bordeaux can not be used the day it is made, 1/2 of an ounce of sugar may be added for each pound of copper sulphate used in making the spray mixture. Thus, for fifty gallons of 2-2-50 bordeaux, one teaspoonful of sugar should be dissolved and added.
4. Clean water should be forced through the spray machine at the end of each day's spraying to avoid corrosion of metal parts by the bordeaux.
SUMMARY OF CONTROL PROGRAM
FOR WALNUT BLIGHT

Spray material to use and concentration: bordeaux 2-2-50

Number and time of spray applications:

(1) *Early prebloom*. When terminal leaves of the new shoots have sufficiently parted just barely to expose the young pistillate (female or nut-bearing) flowers. Pistils average about 1/16 of an inch in diameter (Figure 6, A). Either fish (salmon) oil or a heavy mineral spray oil at rate of 1 pint of oil to 100 gallons of spray should be used in this application to reduce severity of foliage injury.

(2) *Late prebloom*. Just as the first few pistillate flowers come into bloom but before the stigmas (blossom ends) of most of the female flowers open (Figure 6, B). Fish (salmon) oil or a heavy mineral spray oil should be used in this application at the rate of 1 pint of oil to 100 gallons of spray.

(3) *Postbloom*. After majority of pistillate flowers have been pollinated, as indicated by presence of tiny brown spots in stigmas. At this time the young nuts will average about 3/16 of an inch in diameter (about 2 weeks after late prebloom application in an average season) (Figure 6, C).

*Note*: If little, or no rain falls before bloom, the early prebloom application can be omitted. Never omit the late prebloom spray, as this is the most important application of all.