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LATE BLIGHT of POTATO and TOMATO

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Late Blight of Potato and Tomato

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Late blight is one of the most destructive diseases of potato and is often very important on tomato. During seasons having cool temperatures, high humidity and abundant rainfall, the disease often causes a total loss of these crops unless control recommendations are carefully followed.

OCCURRENCE OF LATE BLIGHT IN WASHINGTON

This disease was recorded as a recent introduction into the State in 1893 and has been observed on potatoes west of the Cascade Mountains almost every year since identification records of diseases were started in the State in 1915. Late blight has been recorded on potatoes east of the Cascade Mountains only in 1941 in Kittitas, Benton, and Spokane Counties. The first identification record of late blight of tomato occurring in the State shows that the disease was present in San Juan, King, and Pierce Counties in 1937.

During the past few years losses from the disease have increased in Western Washington, and total loss of potato and tomato crops was observed in many fields in 1941.

SYMPTOMS

The disease is known as late blight because in most sections of the country it attacks the plants after blossoming. In some places, however, including Western Washington, the disease may appear when the plants are a few inches high.

1. **On Potatoes.** The disease usually shows first as purplish or brownish-black areas at the tips or margins of the lower leaves. The diseased areas have a water-soaked zone about their margin and spread more or less rapidly over the leaves and stems, depending upon the weather conditions. If moist weather prevails, entire leaves and plants may be blackened and killed in from one to four days. If dry

weather follows, the infection advances more slowly or becomes checked, but remains ready to become active again under conditions of high humidity.

The early blighting and death of the tops of potato plants will reduce the size and number of the tubers, but the greatest damage follows attacks on the tubers by spores washed into the soil from the diseased tops or by spores placed on tubers through contact with blighted foliage in harvesting. When late blight tuber-rot develops, it is primarily brown, and spreads irregularly from the surface through the flesh. The affected tubers may be completely decayed before harvest as a result of the activity of the blight fungus and secondary invasion by soil fungi and bacteria. Under less favorable conditions of moisture and temperature, the superficial, brown discolorations extends only 1/8 to 1/4 inch below the surface of the tubers. The affected portions of the tubers remain relatively firm, while the surface over the invaded tissues becomes slightly sunken and is darker in color than normal (Fig. 1). Under storage conditions, the disease is typically a dry rot, forming irregular, sunken, reddish-brown patches on the tubers. These patches are usually firm unless other fungi and bacteria invade the injured areas and cause a watery soft rot of the tubers. Affected tubers placed in large piles or bins with poor ventilation and high humidity often become a total loss because of the secondary invasion of the soft rot organism, *Erwinia carotovora* (Jones) Holland.

2. **On Tomatoes.** The effects on the foliage and stems of tomatoes are quite similar to those noted on potato. Fruits are susceptible to the disease in all stages of development and, most of the infections are found around the stem-end, or where fruits come in contact with each other or with the soil. It has been demonstrated that the fungus can enter through the unruptured epidermis of the fruit at any point. The early fruit symptoms consist of irregular brown patches which at first do not extend much beyond the epidermal layer. When conditions are more favorable, the spots spread rapidly, and form more or less concentric zones as they advance. The infected tissues are at first firm, but may soon become soft because of the invasion of other organisms.

THE CAUSE

Late blight is caused by a parasitic fungus, *Phytophthora infestans* (Mont.) De Bary (Fig. 2). If blighted leaves are examined while they are still moist and especially after humid conditions have prevailed for a few days, delicate, whitish or grayish bloom may be observed upon their under surfaces. This bloom consists of aerial fructifications of the parasite, which have grown out through the leaf pores. In this condition there is an abundant production of spores which may be spread to other leaves or other plants by insects, splashing of rain

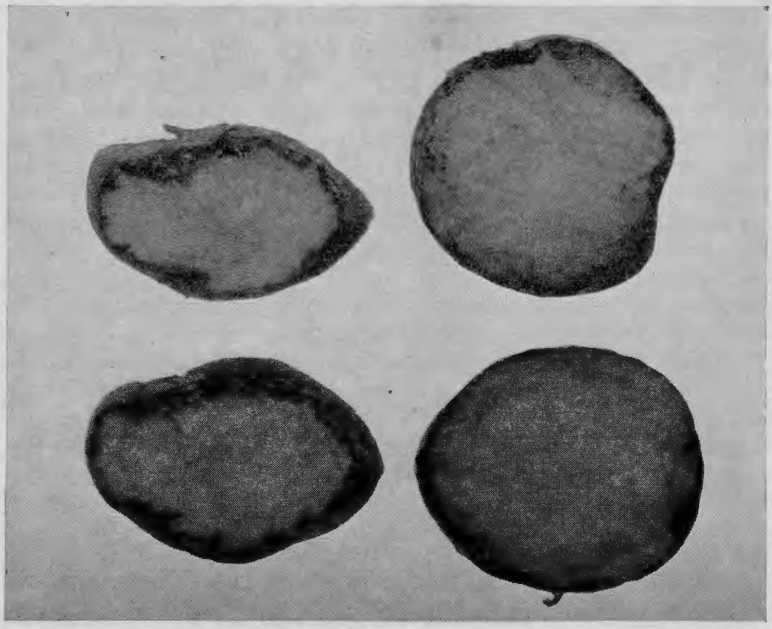

Fig. 1. Sections through tubers acected with late blight rot. (After Heald, Wash. Pop. Bul. 106).

or contact with tools and implements used in cultivation. The spores are responsible for new infections which may take place through any part of the epidermis of leaves, stems, fruit or tubers. The spores are short-lived and retain their vitality for about three weeks only, even under the best of conditions. The vegetative growth of the organism in the plant stems and tubers may remain alive for long periods and the presence of this vegetative growth in affected tubers accounts for the development of the disease in new fields and new localities.

PREDISPOSING FACTORS

Temperature and humidity are determining factors in the development of late blight. The temperature best suited to the development of the disease is between 60° and 75°F., and the disease does not develop in areas having a mean temperature exceeding 77°F. A warm humid period followed by a drop to 60° F. is very liable to initiate an attack of the disease. Excessive amounts of rainfall and humidity are favorable to the germination of the spores. Under favorable conditions the fungus may become established in the plant in 2½ hours after spore germination and produce a new crop of spores inside of 4 days. Frequent periods of rainfall with low temperatures during the growing season are ordinarily associated with severe development of the disease.

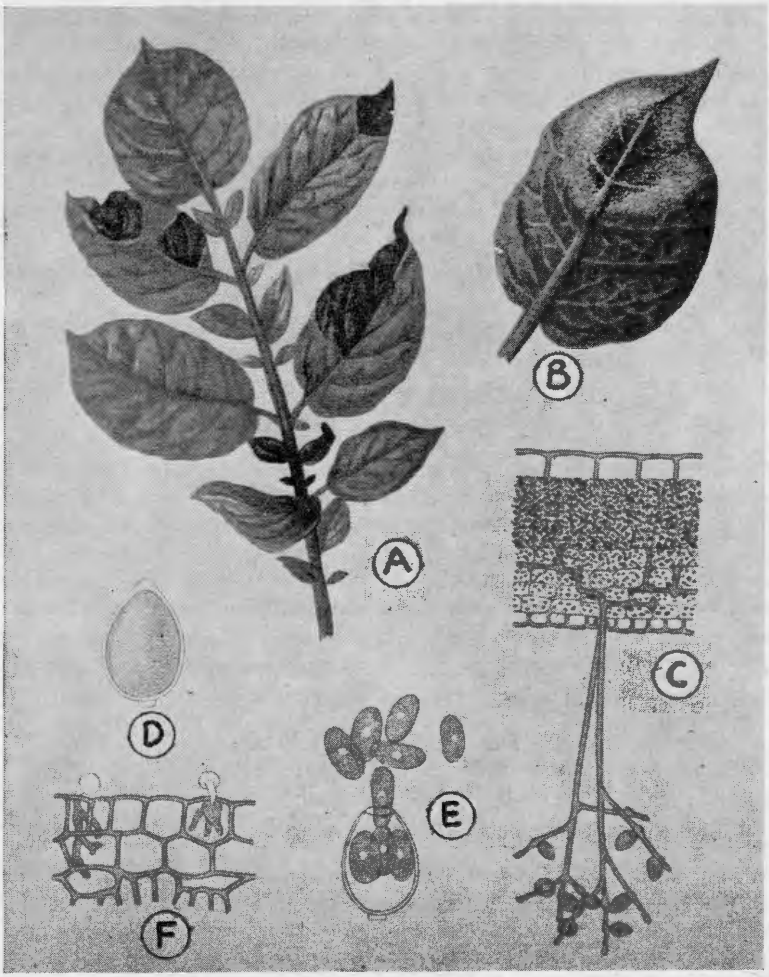

Fig. 2. Upper surface of potato leaf infected with the late blight fungus (A); whitish bloom on under surface of infected leaflet which consists of aerial stalks and spores of the fungus (B); cross section through infected leaf showing the fungus growing in the leaf and sending out fruiting stalks with spores of the fungus (C); the spore (D) may germinate directly into an infection thread or by producing numerous swarm spores (E) which produce infection threads that grow into the plant (F) to reinfect the host. (After v. Kirchner, Atlas der Krankheiten und Beschadigungen unserer Landw. Kulturspflanzen).

HOST RELATIONS AND VARIETAL RESISTANCE

It has been shown that there are a number of strains of the late blight organism, some of which may attack tomatoes and potatoes with equal severity, but others are somewhat limited to one of these host plants. Some species of plants closely related to potato and tomato have been shown to be immune or highly resistant to late blight. Crosses between these resistant species and potato have given very promising results in the breeding of resistant varieties. Different varieties of potatoes show varying degrees of resistance to the blight. The Sebago variety is quite resistant.

Tests of tomato varieties have failed to show any marked indication of resistance to at least two forms of the late blight organism, and for the time being, the prospects of breeding for immunity from late blight in tomatoes are not very encouraging.

CONTROL

Late blight has been of such infrequent occurrence east of the Cascade Mountains that spraying or dusting for control should not be adopted as a regular practice, but the selection of blight-free tubers for planting, storage at low temperatures with good aeration and the adoption of special harvesting practices designed to reduce losses should be given consideration. In Western Washington, however, spraying or dusting and other control measures should be practiced every year as crop insurance.

Late blight can be effectively controlled by spraying or dusting. Other measures are also of value in reducing losses.

1. **Sprays.** Bordeaux mixture has given the best results in controlling late blight and its application to potato plants has been shown to increase yields even in the absence of the late blight disease. Bordeaux mixture, 5-5-50, is usually recommended, which means that five pounds of copper sulphate are to be mixed with five pounds of lime in each 50 gallons of spray. Penetrol, at the rate of one gallon in 300 gallons of spray, is added to increase the effectiveness of the spray. Calcium arsenate at the rate of two pounds in 50 gallons of spray may be added for the control of Colorado potato beetle and flea beetles. The spray mixture should be freshly prepared just before being used as follows:

A stock solution of copper sulphate is prepared with water so that each gallon will contain one pound of copper sulphate. The copper sulphate should be dissolved in hot water or suspended from the top of a wooden barrel in a burlap sack so that it is immersed in the top portion of the water. A high grade hydrated lime should be used and may be added by washing it through a screen into the spray tank. When the spray tank is about half full of water containing the lime,

the copper sulphate, followed by the penetrol, may be poured into the tank, while the additional water to make the required amount of spray is being added. The mixture should be thoroughly agitated during preparation and use.

Bordeaux mixture may be made in other ways, but it should be remembered that the best product is made by having the lime and copper sulphate solutions considerably diluted before they are mixed together.

There are several ready mixed Bordeaux pastes or powders on the market, but in general, they are not considered as effective as freshly prepared Bordeaux mixture. In the home garden and when only small amounts of spray are needed, it would be advisable to use the ready mixed pastes or powders rather than attempt to make the freshly prepared material. To give the vines a good protective coating on both sides of the leaves, an application of from 60 to 75 gallons to the acre is required when the plants are small and from 100 to 125 gallons when they are large.

2. **Dusts.** Many growers prefer to apply copper-lime dust rather than Bordeaux mixture because of greater ease of application, the difficulty of operating heavy spray equipment in the fields, and greater efficiency in the control of potato flea beetles. Experimental work in many states has shown that dust, properly applied, will give nearly as good late blight control as the spray. A very satisfactory dust for use on potatoes or tomatoes is a mixture of monohydrated copper sulphate and hydrated lime with powdered calcium arsenate added when an insecticide is necessary. Twenty per cent copper sulphate and eighty per cent lime is ordinarily used except that calcium arsenate 20 to 25 per cent may replace an equal amount of lime when the insecticide is used. It is also possible to purchase dusts already mixed. If the dust is applied when the leaves are dry, it is likely to be blown off. It is, therefore, desirable to apply the dust early in the morning when the leaves are covered with dew.

3. **Time of Application of Sprays and Dusts.** Spraying or dusting is a protection against infection and the number of applications made each season depends upon the number and frequency of rainy periods and the number of applications necessary to control the flea beetles. In Western Washington, the disease may appear when the plants are small in early July. Accordingly applications of protecting chemicals should be made early in July, and continued at about ten-day intervals during the growing season if the maximum degree of protection is to be obtained. It is recommended that the copper fungicide be incorporated into all dust applications made for flea beetle control and that the Bordeaux mixture spray be used in preference to dusts in the regular ten-day applications that are less essential to flea beetle control.

4. **The Selection of Tubers for Planting.** Tubers from infected fields should not be used for seed purposes. Even with the most careful selection some infected tubers will not be observed and will accordingly carry the organism into the new planting. Since the fungus is internal in the tubers, the chemical dips effective in the control of other tuber-borne diseases are without value in controlling late blight.

5. **Aeration and Low Temperature in Storage.** The spread of rot in affected tubers can be greatly retarded by drying the tubers before storage and storing in a cool, dry cellar. Affected tubers should not be placed in large piles or bins, but stored in such a manner as to allow for free ventilation under and around the sacked or crated tubers.

6. **Special Harvesting Practices.** A number of special practices have proven of value in reducing losses in fields where the disease has not been controlled by spraying or dusting:

Delay in harvesting the tubers for a week or more after frosts have killed the vines.

The removal of diseased vines that have been killed by frosts from the field at least three days before harvesting the tubers.

Scorching the vines with calcium cyanamid dust or an acid spray at least three days before harvesting the tubers. Commercial pulverized and oiled calcium cyanamid applied at the rate of 40-50 pounds per acre has proven more satisfactory than the liquid treatments in Western Washington. Twelve pounds of copper sulphate plus ¼ pound of caustic soda in 40 gallons of water or a dilution of three to four gallons of commercial sulphuric acid in 40 gallons of water may be used if the acid spray treatment is desired.

Washing the tubers upon removal from the field immediately after digging and sorting out the blighted tubers as they pass over the belt.

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