# ROLE OF INSECTS IN POTATO DISEASE PROBLEMS

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Several diseases spread by insects may affect potatoes grown for seed or for food. Four virus diseases and one bacterial disease are of most importance in Washington. The distribution and damage caused by these diseases varies from one part of the State to another and also from year to year. Leaf roll and mosaic are spread only by aphids and chiefly by the green peach aphid (Myzus persicae (Sulzer)) and the potato aphid (Macrosiphum euphorbiae (Thomas)). Usually leaf roll is most prevalent in eastern Washington and mosaic in western Washington. Aster yellows, or purple-top wilt, can be spread by several kinds of leafhoppers, of which the six-spotted leafhopper (Macrosteles fascifrons (Stol)) is most abundant. The disease is present throughout the State, but most prevalent in eastern Washington. Curly top is spread only by the beet leafhopper (Circulifer tenellus (Baker)). It is of no importance in western Washington because the humid climate is unfavorable for the leafhopper vector. Blackleg, a bacterial disease, may overwinter in seed potatoes, in the soil, or in the pupal stage of a fly commonly known as the seed-corn maggot (Hylemya cilicrura (Rondani)). Other less important potato diseases transmitted or in part by insects include calico, witches'-broom, and spindle tuber.

Insects cannot transmit potato virus diseases acquired during their lifetime to their young, nor can the insects infected during one season live until the following season in Washington. Therefore, if the diseases were not carried through the winter in potato tubers or hardy plants, they would soon disappear.

Before any virus disease can spread in the spring, a certain kind of insect must feed for a definite period of time on a diseased plant and become infected or viruliferous. Mosaic virus is acquired rapidly by aphids during feeding but is also lost a few days later, which is why this virus is called a semipersistent one. On the other hand aster yellows is acquired more slowly; from 10 to 30 days from the time of infection may be required before leafhoppers can successfully transmit aster yellows. But having once acquired the virus, leafhoppers do not lose it. Viruliferous insects can transmit leaf roll or aster yellows viruses for the rest of their lives. Such viruses are called persistent ones.

The time required for acquisition, transmission, and retention of viruses in their insect hosts can be used to advantage in developing control measures, as will be noted in the discussion of leaf roll that follows later.

The best time to start controlling insect-transmitted potato diseases is early in the spring when the insect populations are at the low point for the year and before the aphids and leafhoppers have become infected with viruses. Also at that time the fewest plants infected with virus diseases are present; thus, growers can plant healthy seed and follow through with the roguing out of all diseased plants in their crops.

Potential insect vectors of the virus diseases overwinter on only a few plants; but even in restricted areas where these vectors can be controlled reasonably well, they probably cannot be eliminated entirely. They can fly long distances and each spring some migrate north in considerable numbers. After winged forms develop in the spring, they spread to a large number of crops and weeds; thereafter, control becomes more difficult. The green peach aphid has been reported as reproducing on 321 different plants (Patch, 1938), the potato aphid on 61 (Smith, 1919), the six-spotted leafhopper on 319 (Wallis, 1960), the beet leafhopper on 45 (Severin, 1934), and the seed-corn maggot on 15 (Essig, 1926).

The aphid vectors of leaf roll and mosaic enter the winter period as either eggs or summer forms, or both, depending upon the climate and kind of host plants present. Eggs, if produced and deposited on the appropriate woody plants, can survive the coldest winter. The summer forms of the aphids may or may not survive the winter, depending on the temperature and other factors. Thus, in eastern Washington, potatoes planted within a few miles of peach orchards are always heavily infested with green peach aphids; but this condition is not necessarily present in western Washington. Potato fields in the central and eastern parts of the Columbia River Basin have been less heavily infested than those in the northeastern part, particularly following cold winters. In general, conditions favor the rapid development of the green peach aphid in eastern Washington, where more than 90 percent of all aphids on potatoes are of this species. Not only are aphids less abundant on potatoes in western Washington, but also, of the potato aphids present in this area, only a small percentage may be the green peach aphid.

Leaf roll, aster yellows, and curly top diseases primarily affect the vascular tissues of the potato plant and thus food manufactured in the form of starch, accumulates in the leaves. Disease symptoms such as the following may appear: Leaf rolling; abnormal amounts of yellow, red, or purple pigments in leaves or stems; axillary stem and leaf growth; aerial tubers; and necrotic flecks or strands in roots and tubers. These symptoms appear well after the plants have been infected by insects and much too late for corrective measures.

Many Washington farmers can recall when it was customary to plant all Russet Burbank potatoes after mid-May for a fall, storage crop. Later it was found that when this variety was planted from mid-March to May 1, the tubers harvested before August 15 were usually free of net necrosis, although leaf roll symptoms may have been severe for several weeks before the harvest. That net necrosis did not become a factor in production of high-quality early-crop potatoes can be attributed to the scarcity of aphids when spring planting was done and the slow rate at which the aphids acquired and transmitted the leaf roll virus during the early period of plant growth.

Various workers have shown that potato plants are most susceptible to leaf-roll infection when small, that the virus may move downward from the leaf to the tuber within 10 to 14 days after infection (Beemster, 1960), but that the older plants are at the time of infection the less chance they have of developing net necrosis in the tubers (Rich, 1951). Although green peach aphids start infesting potato fields early in May in eastern Washington, these aphids do not ordinarily bring leaf roll with them. Assuming the grower has planted good stock with 1% or less, of the plants containing tuber-transmitted leaf roll, the odds are strongly against many of the relatively few winged aphids entering the fields becoming infected with leaf roll. Aphid colonization of

the potato plants continues, however, and usually by June 15 to 25 some winged, summer migrant aphids are produced on early potatoes. All winged aphids produced on leaf-roll infected plants are potential vectors. The greatest spread of leaf roll ordinarily takes place from June 15 to 25 through about August 1, or the time when very hot weather kills most of the aphids. By the time the first winged, summer migrants leave diseased potato plants, the early crop may be nearly half grown and the large plants quite resistant to further infection. As the planting date is brought closer to the time when the summer flight normally occurs, the plants become more and more susceptible to infection and damage from leaf roll. Late-planted crops require careful planning and treatment with insecticides to retard leaf-roll spread.

Much confusion exists in the separation of leaf roll and aster yellows diseases on the basis of foliage and tuber symptoms. Nevertheless, aster yellows is undoubtedly quite common in potatoes and under certain conditions may cause a necrosis in the tubers similar to that caused by leaf roll. Numbers and time of appearance of the six-spotted leafhopper vector vary annually. Several common weeds, including mare's-tail (Erigeron canadensis), provide a considerable reservoir for the aster yellows virus. Most infection of potatoes seems to take place about the same time as the start of the summer migration of the green peach aphid.

Curly top attacks and damages a large number of crops. The amount of damage caused to potatoes in Washington has not been fully determined.

Blackleg is most common on red-skinned varieties, but occasionally damages white-skinned and russet potatoes as well. The organism thrives best during cool, wet weather. Seed-corn maggot flies are usually present in most potato fields in the spring; larvae of this species and similar flies develop in the seed pieces and decaying plant stalks. The winged insects can spread the bacteria from plant to plant.

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