

ORIGIN OF INITIAL INOCULUM OF *PHYTOPHTHORA INFESTANS* (LATE BLIGHT) IN THE COLUMBIA BASIN

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Late blight of potato, caused by *Phytophthora infestans*, was first reported in the Columbia Basin of Washington and Oregon in 1947 when weather was cool and cloudy. It was reported next during 1974 and occurred in fields during 7 of 16 years between 1974 and 1989 (7). Outbreaks have occurred every year since 1990 with an especially severe epidemic in 1995. The persistence of the disease is likely due to several factors including an aggressive population of *P. infestans* that is insensitive to the fungicide metalaxyl (Ridomil) (10,11), higher than normal precipitation during the growing season (6), widespread use of overhead sprinkler irrigation in this semiarid environment (7), and early planting of very susceptible cultivars such as Shepody and Russet Norkotah (5).

Late blight is very explosive and the cost of managing the disease is high. Total cost of managing the epidemic in the Columbia Basin in 1995 approached \$30 million (9). In 1998, cost of managing late blight was \$22.3 million. The 1998 cost included \$19.8 million for fungicide applications and materials, \$1.1 million for canopy desiccation, and \$1.4 million loss due to tuber rot in storage. Average cost per acre of fungicides and application on late-season potatoes in 1998 was \$128 in the north basin and \$191 in the south basin of Washington (8).

Reducing or eliminating the initial source of inoculum from which outbreaks arise during the growing season is important in managing late blight in the Columbia Basin. Sources of initial inoculum can be infected tubers that are used as seed tubers, disposed as tuber refuse, or result as volunteer potato plants. Oospores of *P. infestans* in soil and infected tomato plants transported into the region or grown in greenhouses may also function as sources of inoculum. Disease management efforts can be more efficiently concentrated on reducing a particular inoculum source when its relative importance is known.

Infected seed tubers were identified as the most likely source of initial inoculum in the Columbia Basin in 1993, 1994 and 1998. In 1998, late blight was first observed in a field north of Pasco on 15 June. Within two days the disease was found in three additional fields within 300 yards to three miles of the first field. Two weeks later the first observance of late blight was reported approximately 35 miles away near Hermiston. All five infected fields were of the cultivar Norkotah, seed tubers had originated from the same farm, and late blight was present in the seed fields in 1997. Patterns of infected plants within the five Columbia Basin fields were in foci with no gradations of infected plants from the outer edge. Refused tubers were not evident in the two areas and late blight was not observed on volunteer plants or in surrounding fields grown from other sources of seed tubers for at least two weeks. Evidence is circumstantial, but transmission of *P. infestans* by infected seed-tuber is the most likely explanation for the early appearance of late blight in these two distant areas of the basin in 1998.

The first A2 mating type in the Columbia Basin was found in 1993 and the US-8 strain was identified in the region in 1994 (10). Prior to 1993 and 1994 in northern North America, the A2 mating type was only found in western Canada and the eastern US (1,4), and the US-8 strain was only reported in Maine and New York (3,4), respectively. The US-8 strain infects potato tubers very efficiently and interstate shipment of potato seed tubers is an effective method

of long-distance movement of *P. infestans*. It is highly likely that A2 and US-8 isolates of *P. infestans* were first carried into the basin on infected seed tubers. Not only was inoculum introduced into the region that contributed to an outbreak, but also new, aggressive strains of the pathogen were introduced.

A pile of refuse potato tubers disposed in early spring from a potato storage was the initial source of inoculum for potatoes grown in an isolated mountain valley north of Spokane in 1999. Infected tubers were found both in the storage and in the cull pile adjacent to the storage. The south side of the cull pile had no growth of potato foliage because of direct exposure to the sun, but the north side of the pile had lush potato foliage with stems and leaf lesions, and sporangia of *P. infestans*. South of the pile about 400 yards was a field of cultivar, Red Chieftain. A gradient in severity of late blight began on the side of the field closest to the cull pile and progressed into the field. This was on 12 July and was the first observance of late blight in eastern Washington in 1999. Few volunteers were in the area because of cold temperatures in early winter. All volunteers were checked and none were infected with *P. infestans*. A direct role of cull piles as an inoculum source in the major potato region of the Columbia Basin has not been documented. However, it is likely that they can be a factor during cool, wet weather during the growing season. Such conditions favor sporulation on infected tubers and foliage, spread of spores to adjacent plants and fields, and plant infection.

Volunteer potatoes have been collected during the early phases of late blight outbreaks in the Columbia Basin and have likely play a major role in the early development of late blight outbreaks. Volunteer potatoes often grow within other crops where the microclimate is humid and late blight is favored. Volunteer potatoes are usually not treated with fungicides so they can also increase the quantity of late blight inoculum during an outbreak.

Oospores are a result sexual reproduction. They have not been found in plant tissue or soil in the Columbia Basin but there is evidence that sexual reproduction of *P. infestans* has occurred in the basin. In 1993 and 1995 isolates of *P. infestans* were collected with new combinations of compatibility type and allozyme genotypes, which most likely arose from sexual reproduction (10). Formation of oospores is possible when both the A1 and A2 mating types are present in an area. Oospores have survived over winter in the Netherlands (2) and Prince Edward Island (12), and will likely survive winters in the Columbia Basin.

Phytophthora infestans is an aggressive pathogen of potato and survives winter conditions in infected tubers. Infected seed tubers have been found to be an important source of initial inoculum of the late blight pathogen in the Columbia Basin. *P. infestans* can spread from infected to additional seed tubers during cutting and handling. Two experiments in Pullman demonstrated that temperature and moisture condition in cut lots of seed tubers favor sporulation and infection of *P. infestans* and that spread is likely to occur within a seed lot with an infected tuber. Seed treatments with mancozeb and cymoxanil (Curzate) reduce spread during cutting and handling. However, reliance should not be place solely on the fungicide and it is important to obtain seed tubers from areas where pressure from late blight is low and the disease is effectively managed. Seed should also be planted within 24 hours of cutting.

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