

Deciduous Orchard Diseases—Biological Control

Apple Replant Disease

Raj Utkhede

Agriculture Canada Research Station, Summerland, B.C., Canada

*Keywords:* replant disease, apple

Apple replant disease (ARD) is not lethal but may result in very poor tree growth during the first few years after planting, frequent delays in cropping and reduced yields. Various fungi, bacteria, and nematodes have been associated with this disease. In British Columbia, two strains of *Penicillium janthinellum*, one strain each of *Constantinella terrestris* and *Trichoderma* species and two strains of *Bacillus subtilis* have been associated with this disease. Recently it was shown that fungi, bacteria, and nematode (*Pratylenchus penetrans*) interactions contribute toward the occurrence of ARD in orchard soils of British Columbia. Chemical control of ARD with soil fumigants and monoammonium phosphate has been a popular method with growers to control ARD. Soil fumigation is believed to destroy the natural equilibrium between pathogens and antagonistic organisms and also mycorrhizal fungi. The objective of this investigation was to develop a biological treatment to increase apple tree growth and fruit yield in ARD soils of the Okanagan Valley of British Columbia.

Three bacterial strains of *Bacillus subtilis*, one strain of *Enterobacter aerogenes*, and formalin alone and in combinations were tested in sandy loam soil (pH 6.0, organic matter 2.5%). Thirty-year-old apple trees, including roots, were removed from their sites in the fall of 1985. The ground was cultivated twice. Formalin mixed with 6 L of water was drenched on each planting site in the spring of 1986. One month later, one-year-old McIntosh apple trees on M.26 rootstock were planted. Tree spacing was 4.5 m between roots and 1 m between trees. Treatments were replicated 4 times 10 trees per plot in a randomized complete block design. Initial trunk diameter was measured 10 cm above the soil line immediately after planting trees. Subsequent trunk diameter of rootstock was measured in the fall of 1987, 1988, 1989, 1990 and 1991. Total shoot growth was measured in late September of 1986, 1987, 1988, and 1989 only. Fruit yield was measured for each tree in mid-September for 1989, 1990, and 1991.

The post-planting drench application of strain EBW4 of *Bacillus subtilis* alone was consistently effective in increasing cross-sectional trunk area for 5 years, total shoot growth for 4 years, and fruit yield for 3 years. The biological agent EBW4 of *B. subtilis* in combination with formalin fumigation was also effective in promoting total shoot growth and cross-sectional trunk area. The application of formalin fumigation alone was effective in increasing shoot growth for 2 years and cross-sectional trunk area for one year only. This treatment did not increase fruit yield for 3 years. The consistent performance of strain EBW4 of *B. subtilis* during 1986-1991 indicates that this bacterium has the potential for biological control of replant disease under orchard conditions in the Okanagan Valley of British Columbia.