Monitoring and control of the potato brown rot bacterium in irrigation water

BPC TACKLING PESTS & DISEASES

Potato brown rot poses a serious threat to GB potato production and vigilance is required to prevent its introduction and spread. Several isolated cases have occurred linked to the presence of the causative bacterium (*Ralstonia solanacearum*) in certain watercourses. Contaminated irrigation water is a potential source of infection, so this leaflet reports research on the monitoring and control of the bacterium in irrigation water.

Summary

- This pathogen has quarantine status in Europe
- Contaminated irrigation water could spread the disease
- A test for the brown rot baterium in river water is rapid, sensitive and specific. It detects, quantifies and determines the viability of the pathogen in a water sample. This leaflet explains the test and summarises when it should be used
- A number of water treatments have been validated for their ability to remove viable causative bacteria. These treatments are also summarised in this leaflet.

Infected plants may suffer from rapid wilting of potato foliage resembling water stress.

Brown rot symptoms

Typically, infected tubers show discolouration of tuber vascular ring from which creamy bacterial slime oozes.

Alternative host

Woody nightshade (*Solanum dulcamara*) growing in river water acts as a secondary host in which the pathogen can overwinter and multiply to further contaminate irrigation water supplies.

Introduction

Potato brown rot is caused by a bacterium (*Ralstonia solanacearum*) and can seriously damage potato production. This pathogen has quarantine status in Europe to restrict its spread. Isolated outbreaks in ware potatoes have recently occurred for the first time in the UK - two in the Thames valley (in 1992 and 1995), two in Northamptonshire in 1999 and one in Kent in 2000. The same organism has also caused bacterial wilt disease in tomato in Bedfordshire (1997 and 1998).

Similar sporadic outbreaks have also been recorded in most other EC countries since 1989 and have resulted in official controls on infected crops and restriction on further planting in affected areas. The bacterium appears to have entered the EC in infected ware potatoes imported from third countries. It has entered certain watercourses, possibly in industrial or municipal effluents containing potato washings, and become established in the weed host, woody nightshade (*Solanum dulcamara*), which commonly inhabits river banks.

Transmission to potatoes and tomatoes has then resulted from irrigation with contaminated river water. Irrigation and spraying with water from watercourses designated as contaminated has therefore been prohibited.

This three-year SAPPIO (Sustainable Arable Production through Precision Input Optimisation) LINK project aimed to provide the potato and water industries with practical tools for effective monitoring and control of the brown rot bacterium to prevent its further establishment in UK river systems, while protecting the reputation and sustainability of the UK potato industry.

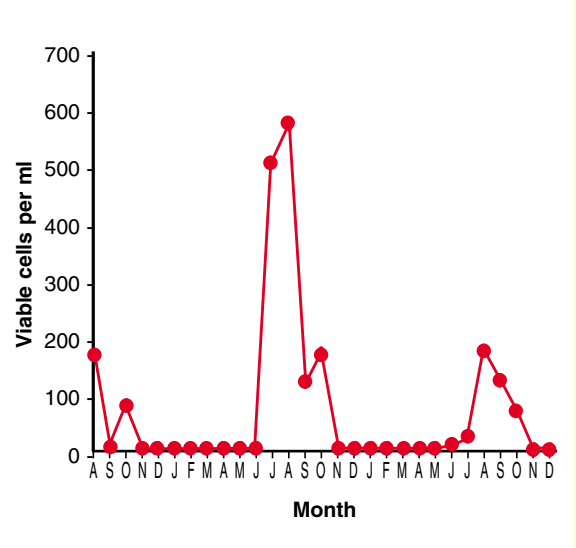

Fig. 1. Seasonal population dynamics of *R. solanacearum* in river water at a single point downstream from infected *Solanum dulcamara*.

The research involved collaboration between the Central Science Laboratory, ADAS Consulting Ltd, DEFRA (Department for Environment, Food and Rural Affairs) Plant Health and Seeds Inspectorate, the Potato Processors' Association, UK Water Industry Research Ltd, the British Potato Council, Greenvale AP plc, Wm. Morrison Supermarkets plc, McCain Foods (GB) Ltd and waste treatment specialists from Haith Industrial Ltd, Degussa Ltd, and AECS Ltd. Industry support was matched by DEFRA and Scottish Executive Environment and Rural Affairs Department.

Pathogen detection

River water is tested at the Central Science Laboratory (CSL) by culturing the brown rot bacterium on selective growth media. Results are obtained within three days and the test routinely detects as few as two viable pathogen cells per ml of river water. Populations of the bacteria in the water vary according to the time of year, being highest in the warm months between June and September and often falling below detectable levels in the winter (see Fig. 1). The bacteria can be detected all year round in aquatic roots of infected woody nightshade plants, in which they survive the winter.

Sampling of water for the detection of *Ralstonia solanacearum*

- Testing of river water can be arranged through your local PHSI or SEERAD office
- Samples of approximately 0.5 litres of water, collected at a depth of 30cm into sterile bottles, should be kept cool and dark and be tested within 24 hours of collection
- Sampling should follow a period of several days without rainfall to avoid dilution effects
- Sampling is most reliable when river water temperatures exceed 15°C
- Regular sampling at multiple sampling points increases the reliability of detection of low pathogen populations
- Collect samples in the vicinity of woody nightshade plants
- It may be useful to target small waterways/ ditches which receive high volumes of sewage effluent or stretches of river where water temperatures are maintained abnormally high, e.g. by power station outfalls or due to entry of warm sewage or industrial effluents.

Probability of infection

Strengthening of official controls and testing programmes in recent years has significantly reduced the risk of finding the potato brown rot bacterium in imported and EU-produced potatoes intended for packing or processing. Legislation (Council Directive 98/57/EC on the control of *Ralstonia solanacearum*. Commission Decision 96/301/EC and amendments. Potatoes originating in Egypt Regulations 1998 and amendments) has ensured that potatoes imported from certain third countries are grown only in areas recognised as free from the pathogen, that produce is appropriately inspected and tested, that traders are registered and that packing houses approved to handle certain imported produce.

Official measures also ensure that regular surveys identify the limits of pathogen distribution within the EU and that irrigation of potatoes and other host crops (e.g. tomato and aubergine) with infested surface water is prohibited. The brown rot bacterium has been detected in only a small number of the many surveyed river systems in England and Scotland. Furthermore, additional measures have been taken to remove infected *Solanum dulcamara* from waterways in which it has been found with a view to eradicating the pathogen altogether. Testing during the course of this project has shown no evidence that the bacterium is currently entering watercourses in treated effluents from industrial or domestic sources.

The probability of infection of potatoes through use of contaminated river water is thought to be generally low since there have been few outbreaks of the disease, even in areas where watercourses were found to be contaminated. Outbreaks of the disease in the UK have mostly been associated with over-irrigation, flooding and/or poor drainage.

Infection is more likely at an early growth stage, particularly if soil temperatures are warm (18-25°C). It is important to note that latent (symptomless) infections can occur, particularly in cool growing seasons. In this way the pathogen can be unwittingly transported in harvested produce. This mode of spread is particularly dangerous for latently infected seed potato crops in which the disease can develop in the following generation.

Potential water treatment methods

A number of measures could reduce the risk of transmission of the brown rot bacterium during irrigation. Irrigation with surface water designated as contaminated with the organism is currently prohibited. Consideration of potential measures for decontamination of irrigation water sources must involve local PHSI or SEERAD as well as EA or SEPA officials. In cases where watercourses have been designated as contaminated with the organism, such water may only be used with the written authority of an inspector of DEFRA or SEERAD, who must be satisfied with the water treatment process. Any permission to irrigate would be subject to sampling and testing of the water and of the irrigated crop prior to harvesting and marketing. Regardless of any measures taken, irrigation of seed potato crops would not be allowed. In some cases it may also be necessary to continue to prohibit the irrigation of ware crops, if seed production is carried out on the same unit or nearby.

Winter abstraction and storage

Water abstracted during the winter months (when pathogen populations fall below detectable levels) can be used for irrigation the following season subject to testing to confirm absence of the bacterium. The pathogen has been shown not to survive in storage lagoons provide they are kept free from host plants such as *Solanum dulcamara*. Care must be taken to avoid contact with contaminated water sources during transport from the lagoon to the crop.

Assessing risks

To assess the risks of spreading potato brown rot through irrigation of potatoes or other host crops:

- Contact your local office of the PHSI or SEERAD, or check the DEFRA website (***www.defra.gov.uk/planth/ph.htm***), for current information on contaminated watercourses from which irrigation is banned
- Be especially vigilant during field and storage inspections for symptoms of potato brown rot and report suspect findings immediately to your local PHSI or SEERAD office. Test kits are available which can be used for rapid on-site preliminary diagnosis of suspected cases
- Consider having watercourses tested for the pathogen through your local PHSI or SEERAD office
- Where irrigation is critical and surface water sources are known to be contaminated, seek advice from your local PHSI or SEERAD and Environment Agency or Scottish Environment Protection Agency (SEPA) offices on possible alternative means of obtaining pathogen-free water for irrigation.

Filtration

Ground water sources are likely to be pathogen-free due to the removal of bacteria during percolation through the soil. Filtration of water through reed-bed systems and slow sand filters has also been shown to remove contaminating bacteria. For reliable control of the brown rot bacterium by filtration, all particles larger than 0.45μm must be removed.

Chemical disinfection

Two chemical treatments have been shown to effectively kill the brown rot bacterium due to rapid oxidation of organic material following injection into contaminated surface water during irrigation. Dosing should ensure a critical residual level is maintained over a minimum reaction time throughout the volume of water being treated.

Peroxygen products - Complete control of the potato brown rot bacterium requires a residual level of at least 4mg/litre of peracetic acid, measurable for a minimum of two minutes. Under commercial conditions, this was achieved by injecting irrigation water during pumping (at 15-35m^3/hour) with a commercial formulation (Clarmarin 150 from Degussa Ltd) at 50-100ml/m^3. In trials, no phytotoxic effects on potato (cv Maris Piper) yield or quality were observed when these rates were used.

Chlorine dioxide - Similar levels of control were observed by dosing naturally contaminated river water with at least 0.1mg/litre of residual chlorine dioxide, measurable over a two minute minimum reaction time. This was achieved under commercial conditions by injecting irrigation water with 5mg/litre using a chlorine dioxide generator from Prominent Fluid Controls (UK) Ltd. No adverse effects on plant growth, tuber yield or quality were observed when potato (cv. Maris Piper) was irrigated three-times weekly with water containing residual chlorine dioxide at this rate.

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For further information and general advice please contact your local offices of **PHSI** (in England), **DARDNI** (in Northern Ireland), **SEERAD** (in Scotland) or the **Welsh Assembly** (in Wales).

For further information on water discharge consents and regulations regarding waste treatment and disposal, please contact your local **Environment Agency** or **SEPA office**
W *www.environment-agency.gov.uk*
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