Phytophthora root rot - A continuous problem in raspberries

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Pathogen and disease

With over 140 different species the genus *Phytophthora* contains some of the most aggressive plant pathogens in agriculture, horticulture and forestry. At least ten of these species have been reported to affect raspberry plantations worldwide, causing various degrees of root rot, wilting and cane death.

Phytophthora species were first associated with dieback in raspberry plantations in 1937 by J.M. Waterston. However, it was not before the 1980s that *Phytophthora* root rot started to cause a major problem with outbreaks in the UK (Duncan *et al*., 1987), Scandinavia and Germany (Seemüller *et al*., 1986). The identity of the involved *Phytophthora* species was widely debated but after comparing isolates and results from North America and Europe it was concluded the most widespread and damaging of the species was a variety of the strawberry pathogen *Phytophthora fragariae* (Wilcox *et al*., 1993). Named initially *P. fragariae* var. *rubi* genetic analysis confirmed that it is a separate species and it was re-named *P. rubi* (Man in 't Veld, 2007). The pathogen is present in raspberry growing areas of Europe, North and South America and Australia and is particularly damaging in temperate climates. Fruiting canes fail to break bud in spring or the fruiting laterals wilt and dry out prematurely. Primocanes wilt and die. Red- purple discolorations can frequently be found on the lower parts of the canes. If the plant is removed from the soil, the lack of fine roots is obvious. The disease severely reduces the life time of a plantation and resting spores (oospores) contaminate the soil leaving it unsuitable for raspberry cultivation for about a decade. The spores can inadvertently be spread to other fields through the movement of soil, for example, in mud attached to machinery tyres or shoes. Long distance spread however, is mainly caused by the movement of infected planting material.

Oospores germinate to form sporangia which, in the presence of water, release the highly mobile zoospores. These zoospores swim and attach themselves to the root tips where they encyst and infect the raspberry plants. Hyphae invade the roots and produce more sporangia on the surface which release zoospores for secondary infections. Apart from resting spores the pathogen also persists as mycelium within the infected raspberry stocks. Optimum growth temperature for the pathogen is 15-21 °C, but growth is possible between 3-27 °C.

Control

An integrated approach of cultivation methods, resistant varieties and healthy planting material is necessary to manage *Phytophthora* in raspberries. These measures can be supported by biological (e.g. *Gliocladium, Trichoderma*) or chemical plant protection products.

Healthy planting material as delivered by certification schemes provide less benefit for widespread *Phytophthora* species with a wide host range such as *P. cactorum* because they might already be present in soil even if it has not been used before for raspberry cultivation. However, for the host specific *P. rubi* though,

certification schemes are an invaluable tool in the fight against the disease. Raspberry certification in Scotland goes back as far as 1930. In response to the high incidence and the devastating effects of *Phytophthora rubi*, the Scottish Government made raspberry certification mandatory in 1991 ('The Soft Fruit Plants (Scotland) Order 1991) but in 1995 when the Order was replaced with the EC Marketing of Fruit Plant Material Regulation this turned the certification back to a voluntary scheme.

The origin of all certified planting material in Scotland is the Nuclear Stock which is held at the James Hutton Institute in Dundee under strict containment. The following stages of propagation are Foundation Grade, Super Elite, Elite, and Standard. All stages are subject to regular strict health screening. The latter three grades are field grown in so called 'spawn beds' with Elite or Standard usually the grades used by growers to set up fruit plantations. Tolerances for certain diseases apply for the lower grades of the certification scheme but for *Phytophthora rubi* nil-tolerance applies throughout all stages.

Most cultivation methods to control *Phytophthora* aim to reduce the amount of water available for the movement of the motile zoospores. Good drainage and measured, targeted irrigation to avoid flooding are essential. Raised beds have also proved to substantially reduce the level of raspberry root rot (Maloney *et al*., 1993, Heiberg, 1999) and the planting on ridges is now standard in raspberry plantations. Covering the ridges with mulch appears to have a negative effect as the layer of mulch increases the moisture within the ridge. The benefits of incorporating compost are contested (Brunner-Keinath and Seemüller, 1993; Maloney *et al*., 2005) and appear to depend on the composted material. The addition of gypsum ($CaSO_4$) was found to suppress *Phytophthora* and increase the survival, growth and yield of infected fields (Maloney *et al*., 2005).

With decreasing numbers of available pesticides growers urgently require resistant varieties in their fight against the disease. A small number of North-American varieties such as 'Latham' or 'Newburgh' are fairly resistant but European raspberry varieties so far are all more or less susceptible. Graham *et al*. (2004 and 2006) were able to construct a genetic linkage map and identified genetic markers linked to raspberry root rot resistance from a segregation population crossing 'Latham' and the susceptible 'Glen Moy'. Such markers are able to identify resistance and other traits early in a breeding programme using a simple molecular test instead of glasshouse and field tests and will significantly shorten the time required for breeding new varieties.

The most effective control strategy is to apply as many of the above control practices together as possible.

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