# Molecular diagnostics: quantitative tools for investigating potato pathogens

## Alison K. Lees, Jennie L. Brierley, Jenny A. Stewart, Louise Sullivan & Danny W. Cullen

Potatoes are subject to attack from a wide range of seed- and soil-borne pathogens. In order to develop effective strategies for minimising disease risk in potato production, it is first necessary to understand the factors governing the incidence and severity of diseases caused by these pathogens: for example, the method of transmission of the pathogen, the relative importance of different sources of inoculum and factors influencing infection and the subsequent development of disease symptoms.

Current knowledge of the epidemiology of individual potato diseases varies according to both their historical and perceived importance and also to ongoing changes in the pathogen population such as increased levels of fungicide resistance, or selection for pathogenic strains. There are many remaining epidemiological questions and work has, in some cases, been hindered by the inability to detect the pathogen at an early, or symptomless, stage of host infection. Accurate quantification of the pathogens on tubers, by methods other than visual assessment, which can be subjective, and also in soil is

Potato showing symptoms of a range of blemish diseases.

important. At SCRI, the development of reliable, specific, real-time PCR assays for the detection and quantification of potato pathogens (Table 1) has provided the tools needed to investigate these questions and new studies have therefore been instigated.

By using the PCR based quantitative diagnostic assays in combination with conventional measurements of infection and disease symptom expression, BPC and SEERAD funded work has allowed us to accurately measure the effect of soil inoculum level, environmental factors (e.g. soil type, soil moisture regime and temperature) and disease control measures on the incidence and severity of diseases such as powdery scab (Spongospora subterranea), black scurf (Rhizoctonia solani) and black dot (Colletotrichum coccodes) under controlled environmental conditions and in field trials. As would be expected, these effects vary according to the pathogen; for example, the level of S. subterranea soil inoculum did not significantly affect the incidence and severity of either tuber infection or powdery scab symptoms at maturity, whereas a relationship between soil inoculum level and black dot disease symptoms

Cullen, D.W. et al., 2001. European Journal of Plant Pathology 107, 387-398.
Cullen, D.W. et al., 2002. Plant Pathology, 51, 281-292
Lees, A.K. et al., 2002. Plant Pathology 51, 293-302.
van de Graaf., P. et al., 2003. European Journal of Plant Pathology 109, 589-597.
Cullen, D.W. et al., 2005. Phytopathology 95, 1462-1471.
Cullen, D.W. & Lees, A.K. 2007. Journal of Applied Microbiology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).
Cullen, D.W. et al., 2007. Journal of Phytopathology (in press).

Table 1 Real-time PCR assays developed at SCRI for the quantification of seed and soil-borne potato pathogens.

Reference

Silver scurf Black dot Black scurf Powdery scab Dry rot Common scab Gangrene Watery wound rot Pink rot Late Blight

### Pathogen

Helminthosporium solani Colletotrichum coccodes Rhizoctonia solani AG3 Spongospora subterranea Fusarium spp. Streptomyces spp. Phoma foveata Pythium ultimum Phytophthora erythroseptica Phytophthora infestans



has been described. Additionally, it was demonstrated that root galling caused by *S. subterranea* increased significantly at 17°C compared to 12°C and this has implications for increasing soil contamination where root gall susceptible cultivars are grown (van de Graaf *et al.*, 2005).

Molecular diagnostic assays are an invaluable research tool, but are also being used on a larger scale in an industry driven BPC funded project led by SCRI. It is apparent that investigating seed stocks and soils for pathogens on a commercial scale and relating this to crop information is the most effective approach for validating diagnostic tests and interpreting their findings in relation to disease risk. This work therefore combines diagnostic assays for several pathogens with appropriate soil sampling strategies and monitoring trials that encompass a wide range of cropping and environmental variables, in order to make the link between seed and soil contamination and the incidence and severity of disease outbreaks in commercially grown crops. Results are being collated in a database and interpreted in association with our knowledge of the epidemiology of the diseases. The assays and an interpretation of the results will be made available to the potato industry for disease risk assessment and decision making purposes, in conjunction with disease control advice.

### References

van de Graaf, P., Lees, A.K., Wale, S.J. & Duncan, J.M. 2005. Effect of soil inoculum level and environmental factors on potato powdery scab caused by *Spongospora subterranea*. *Plant Pathology* **54**, 22–28.



