POTATO COUNCIL

growers' advice

***Dickeya* spp.** (*Erwinia chrysanthemi*)

What it is…and what you can do

The bacteria *Dickeya* spp. (formerly *Erwinia chrysanthemi*) and *Pectobacterium* spp. (formerly *Erwinia carotovora*) all cause tuber soft rots. *Pectobacterium atrosepticum* has traditionally been considered the main cause of blackleg in the UK, but in recent years certain ***Dickeya* species have been increasingly found to cause wilts and stem rots in warmer seasons, especially when the temperature rises above 25 ºC**.

Dickeya dianthicola was first discovered in England in 1990 in crops grown from seed of non-UK origin. An additional aggressive *Dickeya* strain (proposed to be named *Dickeya "solani"*) is also known to be spreading across Europe since at least 2005. In England, *D. "solani"* has been detected since 2007 on both seed and ware crops, again all grown from seed of non-UK origin. These bacteria are mostly spread via seed and can be controlled through good hygiene. The Safe Haven Certification Scheme, originally designed to protect against ring rot introduction, therefore also offers significant benefits for controlling the movement of *Dickeya spp.* on infected seed.

Dickeya species have the potential to cause high levels of wilting in potato crops. They are particularly suited to the warmer southerly potato growing regions of Europe and Mediterranean countries, but incidences of up to 30% are also being observed in Britain as we experience warmer spring and summer conditions. There is also some evidence that low tuber inoculum levels may cause significant disease. A number of other *Dickeya* species have been shown to infect potatoes worldwide, including *Dickeya zeae* (in Australia), *D. dadantii* (in South America) and *D. chrysanthemi* (in USA) but only *D. dianthicola* and *D. "solani"* have so far been isolated from potato in Europe. Surveys of UK seed stocks have shown both pathogens to be absent from Scottish seed whereas there have so far been 2 recorded findings of *D. dianthicola* in home-grown seed produced in England in 2001 and 2007.

Best practice

1. There is a major opportunity to reduce the risk of introducing *Dickeya* spp. into Britain through sourcing seed via the "**Safe Haven Certification Scheme**", which was originally introduced to protect British growers from ring rot (*Clavibacter michiganensis* subsp. *sepedonicus*). This voluntary scheme involves minimal bureaucracy and reduces risk through a series of best practice standards covering all of the infection points. Combined with existing seed classification schemes and phytosanitary controls, the Safe Haven Certification Scheme provides the best chance of achieving exclusion.

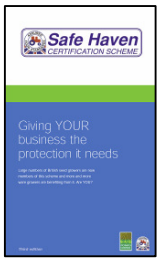
2. A disease risk assessment guide for blackleg and soft rot has been published which is also applicable to *Dickeya* spp. In summary:

   - Source seed carefully
   - Check varietal susceptibility
   - Remove rots and clean grader prior to grading
   - Avoid poorly-drained fields
   - Avoid short rotations
   - Use diagnostics to test seed stocks (but see cautionary note in guide)
   - Avoid de-sprouting at planting
   - Consider having irrigation water sources tested for *Dickeya* spp.
   - Do not over-irrigate
   - Harvest crop as early as possible
   - Minimise damage at harvest
   - During early storage ventilate using dry air

   See: **Managing the risk of blackleg and soft rot** published January 2007.

Action

- Read about the **Safe Haven Certification Scheme** – there is a guide available at www.potato.org.uk/safehaven, or contact: publications@potato.org.uk

  ! Seed growers: **consider joining the Safe Haven scheme**.
  ! Ware growers: **consider buying exclusively Safe Haven accredited seed.**

  See also: www.assuredproduce.co.uk/safehaven

- Obtain and read the risk guide: **Managing the risk of blackleg and soft rot** available from publications@potato.org.uk

- For further technical information contact Dr John Elphinstone of the Food and Environment Research Agency (John.Elphinstone@fera.gsi.gov.uk), Dr Gerry Saddler at SASA (Gerry.Saddler@sasa.gsi.gov.uk) or Dr Ian Toth of the Scottish Crop Research Institute (Ian.Toth@scri.ac.uk).

First published 2007; republished April 2009 and November 2009
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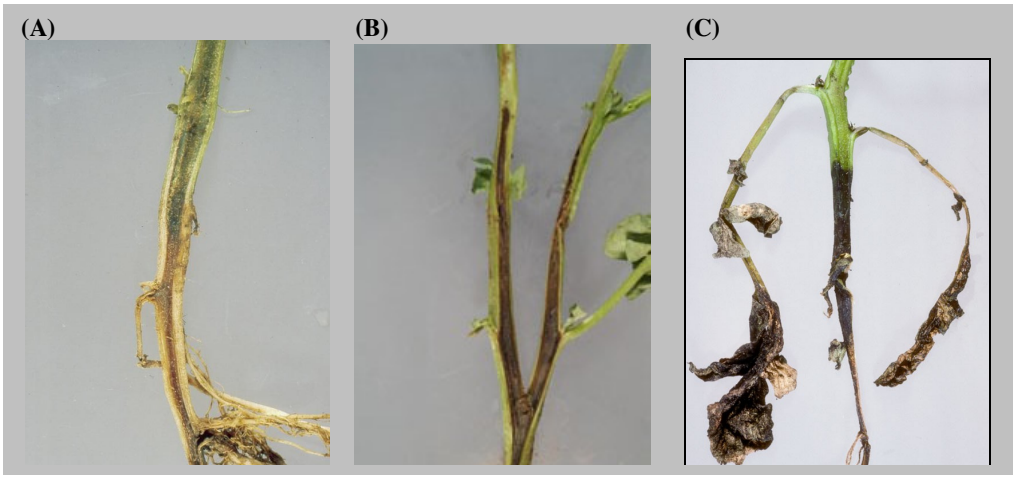
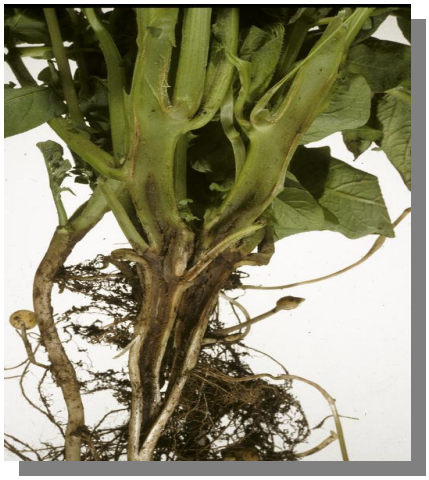
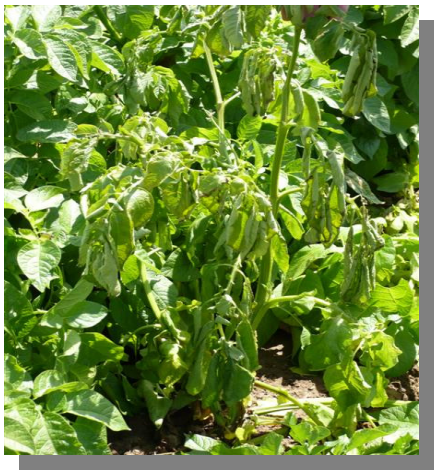
Potato stems showing symptoms of (A) *Dickeya dianthicola* internal stem necrosis, (B) *Dickeya "solani"* internal soft rot and (C) *Pectobacterium atrosepticum* typical blackleg.



Dickeya dianthicola infection, 1996



Wilting due to *Dickeya "solani*", Norfolk 2009



Typical tuber soft rot symptoms caused by *Dickeya* sp.
(indistinguishable from soft rot caused by *Pectobacterium* spp.)

First published 2007; republished April 2009 and November 2009
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The pathogens

A number of *Dickeya* species now comprise the complex of bacteria formerly known as *Erwinia chrysanthemi*. A number of *Dickeya* species have been shown to infect potatoes worldwide, including *Dickeya zeae* (in Australia), *D. dadantii* (in South America) and *D. chrysanthemi* (in USA) but only *D. dianthicola* and a newly identified strain, currently proposed as *D. "solani"*, have so far been isolated from potato in Europe. The revised nomenclature of these pathogens has distinguished them from the other potato soft rot bacteria (including *P. atrosepticum* and *P. carotovorum*).

Symptoms

Symptoms of soft rot disease on potato tubers are similar whether caused by *Dickeya* or *Pectobacterium* spp. In the field, disease develops following movement of either pathogen from the seed tuber to the stem base. Whereas *P. atrosepticum* typically causes blackleg symptoms under cool wet conditions, symptoms due to *Dickeya* spp. have been more commonly observed to occur under warm conditions (especially when temperatures exceed 25 ºC). The foliar symptoms most commonly associated with *D. dianthicola* in warm dry growing conditions include brown staining of the vascular tissues and occasional necrosis and hollowing of the stem, which usually remains green until leaf desiccation is complete. Symptoms due to *D. dianthicola* often occur late in the season. *D. "solani"*, appears to be highly pectolytic causing a rapidly spreading internal soft rot of the stem leading to rapid wilting and eventual blackleg-like symptoms, starting either at the stem base or sometimes higher up the stem or in leaf petioles. Soft rotting of progeny tubers before harvest is especially common in plants infected with *D. "solani"*. There is some dispute as to whether disease symptoms and timing alone can differentiate the various pathogens. Symptoms caused by *Dickeya species* under warm dry conditions can be confused with those of other wilting diseases.

Geographic distribution

Dickeya dianthicola was first found to have infected potato in Europe in the Netherlands in the 1970s and has since been discovered to have occurred on potato in a number of other European countries, including Austria, Belgium, Denmark, Finland, France, Greece, Hungary, Romania, Spain, Switzerland and the UK. *D. dianthicola* has been detected during voluntary testing of potato plants with wilting symptoms on more than 50 occasions in England and Wales since 1990 (and since 1987 in ware potato grown on Jersey). Affected crops were found in 16 counties of England and Wales. Wilt incidence was reported to vary between 1-30%. Since there are no official surveys for *Dickeya*, it has probably occurred more widely than records suggest. Although most infected crops had been grown from seed of non-UK origin, the pathogen was also found, in a single seed crop (cv. Maris Piper) grown from home-grown seed in 2001. Further testing of over 250 seed stocks produced in England and Wales from home-grown seed in 2007 indicated that all but one additional seed stock (cv. Maris Bard) was free from infecton with *D. dianthicola*. In contrast, *P. carotovorum* was detected in 68% of the same stocks, although is unlikely to contribute to disease in the field. To date there have been no findings of *Dickeya* spp. on seed potatoes in Scotland.

The newly emerging *Dickeya "solani"* strain was first recognised in Israel around 2005 in crops grown from imported seed. It has since been reported on potato in Belgium, Finland, the Netherlands, Poland and GB. It was first found in GB in 2007 in a seed potato crop grown in North Yorkshire from seed of non-UK origin. *Dickeya* was not detected during voluntary potato testing in 2008 but *D."solani"* was again found in wilted plants with blackleg-like symptoms from 10 seed and ware crops sampled in Lincolnshire, Norfolk, North Yorkshire and Shropshire in June and July 2009. All infected crops had again been grown from seed of non-UK origin. Wilt incidence was reported to vary from 1-25% between crops.

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Biology, survival and dissemination of the pathogen

Factors influencing disease development on potato caused by *Dickeya* spp. are similar as for *P. atrosepticum*, with the exception of temperature, where a warmer spring and summer favours disease development by *Dickeya* spp. Inoculation experiments under glasshouse conditions at Fera and SCRI have shown the *Dickeya "solani"* strain to be highly aggressive. At Fera, disease developed within 3 days after artificial inoculation at 22 and 27 ºC, even at low inoculum levels, with total plant collapse at the upper temperature. In contrast, *Pectobacterium atrosepticum* caused typical blackleg symptoms at 22 ºC but did not cause disease at 27 ºC. It may also be the case that *Dickeya* spp. may cause significant disease from lower inoculum levels than required for *P. atrosepticum*. At SCRI, strains of *D. dianthicola* have been shown to vary considerably in their aggressiveness and optimal temperature. Some strains show similar optimal temperatures (21ºC) and levels of disease to *P. atrosepticum*, while others are more similar to *D. "solani",* causing considerably higher levels of disease at optimal temperatures of 27-30ºC.

The most important means of dissemination for potato is movement of latently infected seed tubers. However, the high host diversity across the *Dickeya* species has probably contributed to spread over long distances and across borders, in a variety of infected vegetative material. *D. dianthicola* is known to have been previously disseminated around Europe in the *Dianthus* (carnation) trade but it also infects other hosts, including tomato, chicory, artichoke, hyacinth, *Dahlia, Iris & Kalanchoe*. *D. "solani"* is also known to have occurred on field-grown flower bulbs such as hyacinth in the Netherlands. In plant-free soil, survival of *Dickeya* spp. is less than 6 months and over-wintering is therefore unlikely, although wild host plants could potentially play an important role in survival.

Dickeya spp. have been identified in watercourses in several countries and in one case in Sweden on the riparian weed *Solanum dulcamara*. *Dickeya* spp. were detected in some 35% of rivers sampled in South-East England in 2007 but none were identified as *D. dianthicola* or *D. "solani"*. Two species were identified; (1) *D. zeae* which has been previously found in river water and infected potatoes in Australia and in maize in Italy, and (2) an as yet unclassified *Dickeya* species. Surface water samples in the vicinity of *D. "solani"* infected fields in Norfolk in 2009 was found to contain high populations of *P. carotovorum* but *Dickeya* spp. were not detected. *D. "solani"* has, however, been recently detected in river water in South-East Scotland and Finland.

Assessment of risk and economic loss

In recent meetings of *Dickeya* researchers it was reported that direct losses in Dutch seed reached €25m in 2007 due to downgrading and rejection of over 20% of stocks during certification. Certification field tolerances for plants showing symptoms such as wilting caused by soft rot and blackleg pathogens are currently stricter in the Netherlands than in the UK. The Dutch bulb industry also recorded losses of €15m in 2007. The reported losses in potato were almost entirely due to the new *D. "solani"* strain with few findings of *D. dianthicola* or *P. atrosepticum*. Losses were lower in 2008 when the season was cooler and wetter and *P. atrosepticum* was also present. Losses in the current 2009 season due to *D. "solani"* are again high in the Netherlands and a number of findings have again been detected at Fera in seed and ware potato samples grown in England and Wales from seed of non-UK origin. Unpublished UK studies found that *D. dianthicola* was highly contagious and aggressive with low tuber inoculum levels leading to high wilting incidence under experimental conditions. Similar preliminary results have been obtained with low *D. "solani"* inoculum concentrations. Under UK growing conditions, seed infections could be expected to result in significant disease levels, particularly in warm growing seasons or if infected seed is exported to warmer climates. Government and industry sponsors have initiated a significant research programme in the Netherlands and grower levies have been increased to cover the extra cost of this research.

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Previous Potato Council-funded R&D led to the development of new diagnostic methods to detect *Dickeya* species and Scottish Government funded R&D is currently studying the survival and spread of *Dickeya* species under UK conditions in relation to disease epidemiology. An informal partnership between researchers is also fostering international R&D collaboration in Europe to tackle the problem.

Control and diagnostics

Dickeya, like *P. atrosepticum,* is regarded as a seed-borne pathogen and is controlled largely through seed classification in line with domestic and EU legislation. In the UK, as in other European countries, the seed potato classification schemes set tolerances for diseases encountered during visual inspections of growing crops and harvested tubers. There is no official post-harvest testing programme, although voluntary testing services can provide useful decision support. On-farm control measures for *Dickeya* spp. are currently the same as for *P. atrosepticum*, largely because there is insufficient data available to support alternative *Dickeya*-specific measures. However, where information is available, it suggests that the use of diagnostics, avoiding over-irrigation and controlling secondary hosts may be a way to avoid disease caused by *Dickeya* spp. Above all, tThe Safe Haven Certification Scheme presents a major opportunity for growers to reduce the risk of introducing *Dickeya* spp. into the UK.

In other European countries, as in the UK, there are no *Dickeya* spp.-specific control measures and no compulsory testing in operation. Some countries attempt to differentiate *Dickeya* spp. and *P. atrosepticum* based on visual inspection, while others also use diagnostics but on a voluntary basis. There are media-, antibody- and PCR-based diagnostics available for *Dickeya* spp. and in some cases for the soft rot bacteria as a group. Most countries do not differentiate between these pathogens but consider disease as caused by "soft rot bacteria" and use general control measures accordingly. New R&D will attempt to provide pathogen-specific detection methods to allow independent monitoring of the various *Dickeya* species.

Threats

Dickeya now appears, in some seasons, to be as important on potato as *P. atrosepticum* in several Northern European countries, and experts consider it to be increasing in importance. In some countries and seasons, *Dickeya* is now considered more important than *P. atrosepticum* as the major cause of disease in the field. It is very likely to pose a threat to UK potato production and *D. dianthicola* has already been detected in English home-grown seed. The range of wilting symptoms estimated in English crops due to *D. dianthicola* or *D. "solani"* has varied from <1% to 20-30%. Currently, the protected Scottish seed potato regions appear to be clear of this pathogen but for how long remains to be seen. Effective control measures implemented now are our best, and possibly only, chance of preventing economic losses caused by this pathogen as it gains a foothold in the UK. In this respect, the Scottish Government is about to consult the industry on possible amendments to its Classification Scheme and Plant Health order to counteract the threat from *Dickeya*, particularly to the seed industry.

Opportunities

Demonstrating that seed-growing areas in the UK are free from *Dickeya* would provide a competitive advantage for GB seed exports. There may also be added advantages to GB ware potato growers, particularly in warm growing seasons, in having access to *Dickeya*-free seed supplies (e.g. through safe-havens accredited seed stocks).

Further reading: Investigation of *Erwinia chrysanthemi* (*Dickeya dianthicola* and other *Dickeya* spp.) able to infect potatoes. Potato Council Project Report No. 2008/7.

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