Managing the risk of blackleg and soft rot
Blackleg is one of the key diseases across all sectors of the potato industry in Great Britain. The disease is caused by a number of bacteria that have the ability to breakdown plant cell walls. They are referred to as pectolytic bacteria and include *Pectobacterium* and *Dickeya* species.

*Pectobacterium atrosepticum* is the major cause of blackleg in GB, although *Pectobacterium carotovorum* can also cause symptoms in the growing plant. Both bacteria cause tuber soft rot (decay in the field or during storage). These two species respond similarly under different environmental conditions and they are more common in cooler and wet conditions. In addition, *‘Dickeya solani’* and *Dickeya dianthicola* can also cause stem rots, though they are associated with non-GB seed and are more damaging in warmer seasons.

Control measures which reduce bacterial contamination on seed tubers also reduce the risk of soft rot and blackleg, although disease development is very dependent on the temperature and moisture levels in both field and store.

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**Summary**

- Check varietal susceptibility
- Check seed quality
- Store seed carefully before planting
- Avoid de-sprouting at planting
- Do not over-irrigate
- Control ground keepers
- Avoid poorly drained fields
- Harvest crop as early as possible and under dry conditions
- Minimise damage at harvest and during all subsequent handling
- Remove rots and clean grader prior to grading
- Dry quickly during early storage and ventilate using dry air
- Avoid condensation during storage.

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**Bacterial species:** *Pectobacterium atrosepticum (Pba)* (Blackleg, soft rot)
**Host range:** Potato

**Bacterial species:** *Pectobacterium carotovorum (Pbc)* (Blackleg, soft rot)
**Host range:** Potato and a wide range of other crops

**Bacterial species:** *Dickeya spp. D. dianthicola ’D. solani’* (Blackleg, wilt, vascular browning, soft rot)
**Host range:** Potato, *Dianthus ssp*, tomato, maize, chrysanthemum, etc.
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Blackleg caused by *P. atrosepticum* is more likely to occur in wet cool seasons especially when contamination levels on seed are high.

![Graph showing Pba contamination, weather and blackleg](image)

### Diagnostic testing

**Cautionary Note**

Diagnostic techniques can be used to determine the level of contamination by specific bacteria on tuber stocks but are only indicative of levels on tubers at the time of testing. Bacterial numbers can fluctuate when stocks are in store or in transit and extensive bacterial spread from rotting to healthy tubers can occur during handling.

Blackleg and soft rot bacteria levels are often reported as cells per tuber (or cells per ml peel extract) and relate to risk when conditions are favourable for diseases development.

These numbers are only an indication of potential disease development and should be considered along with other factors outlined in Managing the Risk of Blackleg and Soft Rot.

*Pectobacterium* and *Dickeya* spp. diagnostically digest the pectin in CVP agar plates and, in combination with DNA-based methods, this provides an accurate test for both bacterial species and bacterial number.
## Managing the risk of Blackleg

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>HIGH RISK</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variety</strong></td>
<td>Growing susceptible varieties</td>
<td>Check varietal susceptibility to blackleg at <a href="http://www.potato.org.uk/varieties">www.potato.org.uk/varieties</a>, in the NIAB Pocket Guide or contact your seed supplier.</td>
</tr>
<tr>
<td><strong>Grading</strong></td>
<td>Little or no grading&lt;br&gt;Contamination and damage during grading on poorly maintained equipment</td>
<td>To avoid spreading bacteria, attempt to remove rots early when grading seed.&lt;br&gt;Clean grader if obvious signs of rots in a previous stock.</td>
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<tr>
<td><strong>Field</strong></td>
<td>Recent history of soft rots in seed stock&lt;br&gt;Volunteer problem&lt;br&gt;Poor drainage</td>
<td>Avoid short rotations.&lt;br&gt;Address water-logging/compacted areas.&lt;br&gt;Avoid poorly drained fields and areas prone to flooding.</td>
</tr>
<tr>
<td><strong>Seed health</strong></td>
<td>Moderate/high pectolytic bacterial count&lt;br&gt;Blackleg in parent crop</td>
<td>Avoid de-sprouting seed at planting.&lt;br&gt;Consider having pectolytic bacterial levels assessed on seed prior to planting (see cautionary note under Diagnostic testing).</td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td>Excessive irrigation applied&lt;br&gt;Poor crop monitoring&lt;br&gt;Full skin set not achieved</td>
<td>If irrigating, ensure cautious use of water.&lt;br&gt;Carry out regular inspections for blackleg.</td>
</tr>
<tr>
<td><strong>Harvest</strong></td>
<td>Crop harvested after mid October&lt;br&gt;Lifting in wet conditions</td>
<td>Aim to harvest crops as early as possible.&lt;br&gt;Minimise damage at harvest. Kill haulm in crops well in advance of harvest to allow complete skin set – continue to check for skinning at harvest.</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Poor ventilation during store loading and pull-down</td>
<td>Aim to ventilate crop during early storage using dry air.&lt;br&gt;Avoid condensation throughout storage.&lt;br&gt;Store crop as cool as possible.</td>
</tr>
<tr>
<td><strong>Post storage handling &amp; care</strong></td>
<td>Damage during store, unloading, grading and transit&lt;br&gt;Seed left in bags uninspected, with no temperature control or ventilation</td>
<td>Avoid mechanical damage, excessive falls and abrasions.&lt;br&gt;Inspect seed immediately on delivery, contact supplier if any quality concerns.&lt;br&gt;If seed is not to be planted immediately, decant into boxes and store dry and preferably cool. See – PCL technical note TN03 for best practice seed handling and storage.</td>
</tr>
<tr>
<td><strong>Washing</strong></td>
<td>Crops with history of blackleg and/or soft rots&lt;br&gt;Crops at high temperature&lt;br&gt;Infrequent wash water changes</td>
<td>Be aware of increased risk of bacterial breakdown after washing (in particular fresh lifted tubers).</td>
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</tbody>
</table>
Some varieties are consistently found to be more susceptible than others. Knowing your variety’s susceptibility rating for blackleg can help you apply the correct agronomy.

There is the potential for bacterial and fungal contamination from infected soil or rotted tuber material during grading. Prevention of cross-contamination between low and high grade stocks is achieved by cleaning or power-washing grading lines. Additional benefits may be achieved by using a disinfectant.

The level of blackleg developing is related to soil water retention and/or poor drainage. Short rotation may lead to carry-over on ground keepers or alternative hosts.

Blackleg and soft rot bacteria can invade and multiply in damaged sprouts and increase the risk of blackleg.

Blackleg disease development is directly related to the level of seed tuber contamination by *P. atrosepticum* (provided environmental conditions are suitable). The risk of blackleg is highest when levels are above a threshold of 1000 Pba/tuber. There are currently no thresholds known for Pbc or *Dickeya* sp. In warm conditions, *’Dickeya solani’* is more aggressive than Pba and can cause infection at lower thresholds.

Late blackleg development, even at a relatively low level, can lead to high levels of tuber contamination. In such cases, harvest early, avoid over-irrigation and test progeny for Pba loadings if seed.

Schedule your irrigation to minimise risk of waterlogging.

Ventilating crops with dry air (at 0.02 – 0.06 m³/s/t) during curing and pull-down reduces build up of soft rots.

During the early stages of storage, the risk of bacterial multiplication and soft rots developing in store will be minimised by cooling the crop to below 10°C and avoiding condensation.

Desiccation should take the minimum amount of time as a protracted kill will increase the risk of blackleg.

In this experiment, seed stocks were artificially inoculated with *Pba*. This resulted in stocks with uniform bacterial contamination at low, intermediate and high levels of *Pba*. This may differ from normal field conditions where bacterial numbers vary considerably from tuber to tuber. (Note: the crop was irrigated to encourage disease development).

**Initial seed loading interacts with harvest date**

- **Low seed loading**
  - Infection of progeny was similar, regardless of harvest date. Note small increases in infection as harvest is delayed.

- **Intermediate seed loading**
  - While infection of progeny was low if harvested early, any delay in lifting resulted in large increases in infection. This increases further for a very late harvest.

- **High seed loading**
  - Infection of progeny tubers was greater than 60%, even when harvested early. Any delay in lifting resulted in almost complete infection of progeny.

Be aware that risk of blackleg and soft rot bacteria infections will increase after excessive rainfall.

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Earlier harvest (preferably before mid-October) for generally reduced disease levels and drier soils.

Careful planning is essential during periods of wet weather to minimise lifting wet crops. Where possible avoid heavier fields or areas until conditions improve.

Desiccation should take the minimum amount of time as a protracted kill will increase the risk of blackleg.

Damage on the tuber allows bacteria into these stress points.

Know your tolerances for the grade and origin of seed being inspected.

Breakdown of washed, bagged potatoes can occur even though no rots were evident on the crop before washing. Change water regularly (at least daily), use a clean water rinse and dry tubers before packing. Specialist advice should be sought before use of disinfectants.

It is essential to follow the instructions given on the approved label before handling, storing or using any fungicides or other crop protection product. USE PESTICIDES SAFELY, ALWAYS READ THE LABEL. Always consult your buyer protocols before using any pesticide.

References:

BUCKLEY et al., 2005 Irrigation Best Practice Delta guide.

CLAYTON et al., 2001 Potato store hygiene and disinfection to improve seed health and ware quality. BPC project report number 2001/5.


TOTH et al., 2003 Plant Pathology (52) pp. 119-136.
Blackleg and soft rot field disease identification

(Note that visual symptoms alone do not necessarily identify a pathogen accurately.)

**Pectobacterium atrosepticum**
Plants with blackleg caused by *P. atrosepticum* often have yellowish foliage and have a wilted appearance. Stems become blackened and sticky at ground level.

**Pectobacterium carotovorum**
*P. carotovorum* is not as frequently associated with blackleg as *P. atrosepticum* or *Dickeya*. However, when it enters the haulm through wounds and natural openings in leaves and stems it can result in above ground blackleg symptoms (aerial blackleg). Visible symptoms appear above soil level as a slimy green-brown rot (less dark than *Pba*) which in time can result in the collapse of a stem.

**Dickeya species**
*Dickeya* species produce symptoms similar to blackleg. *Dickeya* can cause a wilt, the plant often taking on a bluish appearance. The stems have a brownish, sticky discolouration and the vascular tissues are stained light brown.