**Blackleg Decision support tool**

**BBSRC project summary Anne Stone April 2020**

**Background**

Blackleg is a major disease with losses estimated at £50 million annually in the UK. The main genera are Pectobacterium and Dickeya. *Pectobacterium atrosepticum* (Pba) is by far the most important species in the UK, and will be tackled by this project. Disease is caused when these bacteria from infected tubers enter growing stems. >50% of seed of all classes has some level of blackleg infection; the main cause of seed downgrading and failure by a factor of 10. Blackleg has become more common in the UK over the last 8-10 years, for unknown reasons.

Unpublished work provides evidence to support this project:

* Pba can enter plants directly from the soil (environmental) and not just via infected tubers
* Irrigation exacerbates environmental blackleg
* Free Living Nematodes enable blackleg organisms to enter potato plants

The project aims to develop new methods to control Pba and to make a major impact on the potato industry through uptake of these methods and of a new decision support tool.

The project, ‘**Building a Decision Support Tool for Blackleg Disease (DeS-BL),** which secured funding via the BBSRC call for work on Bacterial Diseases, began in early 2020. AHDB supported the application and will provide a ‘in-kind’ contribution to deliver Knowledge Exchange through our Farm Excellence Platform.

**WP1 Vectors and transmission (WP Lead: Roy Nielson, JHI)**

FLN species and insects will be tested as vectors of Pba in glasshouse trials. Diagnostics for the key FLN species will be developed and used as risk indicators.

FLN feed on roots and root hairs. Trichodorids, Pratylenchus and Meloidogyne are all implicated. A mixed population can lead to a 100 fold increase in Pba in stems.

Gerry Saddler, Head of SASA will contribute work on the potential role of aerosols and insect transmission. 20% of seed grown from mini tubers had Pba at harvest. A further 6.5% were Pba free, yet subsequent ware crops developed blackleg. The infection may be coming from soil/FLN, but also maybe from insects or aerosols. Plots of healthy plants will be close to plots of bait plants with Pba marked with Streptomycin. Some healthy plants will be protected from insects by mesh and from aerosols by polytunnels. At the end of the season the bait plants will be tested for the marker, to show how much Pba was transmitted. Air and insects will be tested.

Separately, aerosols containing marked Pba will be watered onto healthy plants.

Separately, bean seed fly will be tested as the most likely vector.

**WP2 Current management practices (WP Lead: Mark Stalham, NIAB CUF)**

The team will investigate the effects of irrigation on Pba An irrigation regime will be developed to control both blackleg and common scab, which require opposing water regimes. At the same time the effect of irrigation regimes on FLN will be measured.

* Unpublished work by Stalham showed irrigated crops had 14-27% blackleg compared with <2% from unirrigated. FLN may be a mediating factor since they move with water movements in soil. Investigated by 3 field trials over 3 years
* 4 levels of Pba, 4 levels of irrigation
* High infected stock irrigated till blackleg symptoms appear then treated with different levels of irrigation to see which controls the disease development
* High FLN fields, 2 irrigation regimes, 2 Vellum treatments (+/-) to see when FLN control has most effect.

Ian Toth will lead work to investigate the possible role of cover crops on Pba multiplication and spread. Use of cover crops is increasing. JHI have evidence of Pba infecting roots of crops and weeds with preferences e.g. cover crops more infected than cereals. In pot and 2 years of field trials crops of the 4 main cover crop classes: (legume, cereal, brassica, other broad-leaved plants) will be infected by watering on streptomycin marked Pba. Infection in the roots will be measured, and also the effect on susceptible potato varieties grown the following year.

**WP3 The rhizosphere environment (WP Lead: Barbara Mable UoG)**

Cover crops will be compared for their ability of Pba to colonise their rhizospheres, investigating their root exudates.

The microbial context in which pathogens work affect their ability to be pathogenic. Root exudates such as glucosinolates affect this context. Genomics and GC-MS will be used to see how irrigation and cover crops change the microbiome of the rhizosphere, specifically the proportion of the proteobacteria (includes pectobacteria such as Pba) and the other types of bacteria which might compete with them.

Anti-microbials (bacteriocins) from closely related bacteria will be identified and the effect of irrigation and cover crops on these bacteriocins will be identified.

Ari Sadanandom. Durham Crop Centre will examine how root systems architecture (RSA) is mediated by hormones. RSA affects not just the distribution of roots and uptake of water/nutrients but also root exudates and the microbial interactions dependent on these; including mycorrhizae. Will test whether irrigation and different cover crops affect root exudates, which are either phytohormones or influence them. These will be analysed by GC-MS. Identify markers of root exudates which favour colonisation by Pba.

Joel Milner UoG work will investigate the role of Bacteriocins. Nearly all bacteria produce bacteriocins, protein anti-microbials which kill closely related species. Two that kill certain Pba isolates have already been identified, and multiplied in *E.coli*; Pectocin M1 and M2.These will be purified and applied, preferably as a seed treatment. More will be identified, multiplied and tested against a set of 24 isolates.

**WP4 Modelling and decision support (WP Lead: Pete Skelsey, JHI)**

This work-package aims to describe trends and drivers of Pba incidence to produce predictive models for to use in decision support tools.



Climate change risk assessment. Suitable climate for Pba will be inferred from current distribution and provide models for Pba and FLN under current and potential future climates.

Machine learning. Objective is to forecast risk associated with any stock and planting location. A range of machine learning techniques will be applied to the data to identify the relative importance of all the pre-disposing characters for Pba occurrence.

Decision support. Finally all the aspects of this and the other WP will be combined into a decision support system based on presence or absence of FLN, irrigation, previous crop history; together with soil, climate, crop, cultivation and landscape factors.

**WP 5 Implementation and practical application (WP Lead: Adam Kleczkowski, U of Strathclyde)**

 A key part of this WP is a role for the AHDB SPot programme. However the KE side of the project has not been as tightly defined as the other WPs.

KE and uptake of the DST will be implemented via the AHDB Farm Excellence programme, Scottish Agronomy, SASA, Bayer conference, Soil Essentials and other industry opportunities to co-construct ideas with policy and industry.

Modelling the impact of implementing the use of the DST will be undertaken using tools such as game theory. Bioeconomic modelling with input from social science will be used to model the willingness of the end users to engage with the DST. Several factors are involved such as cover crop choice, willingness to thoroughly test for FLN and to alter irrigation regimes. Determinants of uptake of the DST will be identified, such as land tenure.

**Further details.** Others are involved in this large project. The full project proposal is available from Cathryn Lambourne, Graham or Anne.

