

Work Package 1.4: Barley Pathology

- **Required Output 1: Research which improves the control of key diseases which limit barley production.**

Summary

This research examines the relative importance of seed infection over other infection sources. We have demonstrated that barley seed is a major source of inoculum for both the fungal diseases rhynchosporium and ramularia. For ramularia, seed infection is the main source of infection and airborne spores only appear once symptoms have developed. For rhynchosporium seed infection is one of many sources of infection and weather conditions, for example, rainfall can exert a considerable influence on disease epidemics. Populations of these fungal pathogens show great diversity and by characterising this we are gaining understanding why certain geographic regions may be affected more than others, and why a variety may be resistant in one region but not another.

Fungi compete on a leaf surface with other fungi and bacteria and a better understanding of these organisms and how they compete with major disease-causing micro organisms on leaf surfaces is important to effectively manage disease. We have identified yeasts and bacteria from leaf surfaces and have shown that they compete with rhynchosporium and that fungicides affect the balance between leaf surface microbes and compromise our ability to control rhynchosporium and other pathogens. Other yeasts have a negative impact leading to an increase in disease. New methods to characterise important but unculturable microorganisms will be developed and applied to enhance our understanding.

- **Required Output 2: Development of crop protection strategies for key pests and diseases affecting Scottish crops, which will lead to a reduction in pesticide use.**

Summary

Diversifying the range of resistance mechanisms operating in plants, and improving the ability of crops to avoid infection and tolerate disease if infection occurs should lead to a more durable protection of yield and quality, paving the way for a reduction in pesticide use. The aim of this work is to understand the mechanisms of disease avoidance, induced resistance and tolerance so that they can be exploited in disease management. This research has shown that the characteristics of plant height and leaf angle can influence the severity of rhynchosporium infection and yield loss. Natural chemicals which enhance the response of a crop to disease (elicitors), increased the resistance of varieties to a

range of pathogens under low disease pressure. We have shown that elicitors offer the prospect of using less fungicide in a season, while maintaining yield.

Another approach to minimise disease is the use of mixtures of varieties that differ in resistance. Our modelling has shown that this may also have significant effects on the evolution of pathogen populations and their ability to overcome the crop's resistance mechanisms. Experimental work has demonstrated that the varieties used in the mixture do not have to be blended well for benefits to occur implying that seed mixing can be easily achieved on farm. Currently, most markets for barley require grain comprising a single variety to meet strict market requirements on uniformity of quality. We are engaging in a dialogue with end users to encourage the use of variety mixtures.

- **Required Output 3: Information on host resistance and susceptibility to key diseases affecting Scottish crops which lead to the development of durable resistance in the field.**

Summary

When pathogenic fungi infect a crop, they can kill plant tissue, causing a loss in yield and quality. Plants recognise when they are under attack from fungi and can react to the attack by causing a hypersensitive reaction which can lead to extensive leaf death. We have studied several plant genes which are important for varietal disease resistance response, particularly those which stop leaf death. We have developed an assay to allow barley varieties to be screened for activity of this type of disease resistance. This work will be enhanced with the appointment of new researchers to develop and integrate our understanding of pathogen-host molecular interactions with our epidemiology research

- **Required Output 4: Development of appropriate sampling strategies, of field-based diagnostics and of validated multiplexed diagnostics for key pests and diseases, for use by industry and/or government (in association with external funding).**

Summary

Knowledge about the movement of fungal spores in the air can provide an early warning of disease in crops in a similar way that pollen counts provide an early warning of the risk of hay fever. We have quantified the two key fungal pathogens rhynchosporium and ramularia by extracting DNA from leaf and air samples and using DNA detection systems specific for these fungi. We have made further advances in the diagnostic for ramularia by increasing the sensitivity of the test and modifying it to identify populations resistant to strobilurin fungicides. The test has been used on plant material collected from crops grown in Scotland since 1990 and also from leaf and seed archive material

from the Rothamsted Institute archive (1850 onwards). We have found that fungicide resistance to ramularia is now widespread in Scotland, but was absent in 2000. Analysis of the historical samples shows that ramularia was present in the 1850s, 1960s and 1980s, but has increased markedly on leaves and seed in the last 10 years. It is therefore a relatively new disease in Scotland. We plan to associate the historical presence with historical weather patterns and changes in farm practice (e.g. varieties and fungicide applications).

- **Required Output 5: Consideration of the impact of climate change on crop health in Scotland and identification of future plant health risks.**

Summary

Making best use of historical information provides a baseline which helps us to understand how disease epidemics may change in the future. The crop disease information database known as Adopt-A-Crop, which uses information collected since 1983 is being modified to incorporate additional cropping information from field trials. This information will be used alongside new data coming from the work package and climate change models to study the impact of climate change on crop disease, particularly the importance of biodiversity and diversification at the field scale.

- **Required Output 6: Knowledge transfer on best practice for crop health (in association with external funding).**

Summary

A series of knowledge transfer events have been held as part of the Success Through Knowledge Campaign organised by the Scottish Agricultural College (SAC). A paper-based technical note on Barley Disease Control has been updated twice and places the results of the research from the work package alongside Home-Grown Cereals Authority (HGCA) funded research into a practical context. Agreement has been reached with HGCA to incorporate decision tools into their web based "RL plus" tool which selects the best variety for a grower based on disease pressures and the target market.