Project title:	Improving integrated pest and disease management in tree fruit
Project number:	TF223
Project leader:	Dr Robert Saville East Malling Research
Report:	Annual report, March 2017 (Year 2)
Previous report:	Annual report, March 2016 (Year 1)
Key staff:	Dr Robert Saville (EMR) Dr Michelle Fountain (EMR) Dr Angela Berrie (EMR) Mr Chris Nicholson (ADAS) Prof David Hall (NRI) Dr Rob Jackson (UoR)
Location of project:	NIAB EMR (Lead), RSK ADAS, Natural Resources Institute, University of Reading.
Industry Representative:	The programme management group (PMG) Nigel Kitney, Jeremy Linsell, Nigel Jenner and Tom Hulme
Date project commenced:	01/04/2015
Date project completed:	31/03/2020

DISCLAIMER

While the Agriculture and Horticulture Development Board seeks to ensure that the information contained within this document is accurate at the time of printing, no warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Robert Saville
Project leader, Plant Pathologist
NIAB EMR
Signature ..... Date .....

Michelle Fountain
Entomologist
NIAB EMR
Signature ..... Date .....

Report authorised by:
Rachel Lockley
Fruit Technical Manager
AHDB
Signature ..... Date .....

Signature ..... Date .....

GROWER SUMMARY

Objective 2 – Neonectria ditissima

Project TF 223 is a five year project which was commissioned to tackle a number of current pests and diseases affecting tree fruit crops. Objective 2 deals with the surveillance of existing and potential new invasive pests and diseases. This Grower Summary reports separately on four different approaches to management and control of *Neonectria ditissima* being investigated in this project. They include work on:

1. Detection of *N. ditissima*
2. Rootstocks/interstocks
3. Soil amendments
4. Novel application methods

Detection

Headline

- An antibody has been selected that can detect *Neonectria ditissima* antigens in plant material.

Background and expected deliverables

Virus detection and elimination in industry base material has advanced hugely in the last 40 years whilst Nectria canker detection has got significantly worse. Propagation nurseries know that latent canker exists in trees but it rarely expresses itself either in the rootstock or the young tree on the nursery. Without better detection methods in rootstock stoolbeds, budwood and graftwood mother stock or indeed in the orchard, this situation will not improve. Understanding how the pathogen is transferred between the stages of tree and fruit production will be vital to develop management strategies to disrupt the disease cycle. The development of a detection tool will not only be invaluable for basic biological understanding of the pathogen but also has the potential to be developed for use by the industry.

Summary of the project and main conclusions

A short list of seven antibodies was selected from year 1. Cross reactivity tests were carried out with a panel of commonly occurring fungi in UK apple orchards to determine which antibodies were the most specific to the target species (*Neonectria ditissima*). *Botryosphaeria*

obtusa was consistently giving a stronger signal (colour change) relative to the other negative antigens for all of the antibodies. The cross reactivity of the antibodies with *Botryosphaeria* and *Neonectria* is of concern because both share a niche in apple as wood canker forming pathogens. Modifications to the ELISA protocol reduced the cross reactivity to *Botryosphaeria* improving the resolution between positive and negative antigens. A validation experiment demonstrated that the selected antibody could detect the presence of the canker pathogen in plant material.

Main conclusions

- An antibody (1B10) has been selected which gives good resolution in cross reactivity tests between Neonectria ditisima antigens and antigens from other fungi commonly found in UK apple orchards. An Enzyme Linked Immunosorbant Assay (ELISA) protocol has been optimised to provide maximum resoulution
- The antibody can detect *Neonectria ditissima* antigens in plant material.
- This work forms the basis of the development of a detection tool.

Financial benefits

With further refinement, outside of this project, this assay can be used to improve our understanding of the biology of *N. ditissima* and potentially developed as a detection tool for the industry. This tool will be used as part of various AHDB projects to increase our understanding of the spread of the disease in the host, from which it is hoped new control strategies can be developed. If developed for use by the industry, it could help propagation nurseries to remove any infected material within stock plants and significantly reduce incidence of the disease in fruiting trees.

Action points for growers

- At this stage of the project, no action points have been developed for growers.

Rootstocks/interstocks

Headline

- Two advanced selections from the NIAB EMR Rootstock Club show promise in conferring resistance to *N. ditissima*.

Background and expected deliverables

Rootstocks are known to confer resistance/tolerance traits to various pests and diseases such as woolly apple aphid, Phytophthora and Neonectria. Interstocks are being increasingly used to confer resistance to the particularly canker susceptible scion cultivars. This work on rootstocks and interstocks will evaluate the relative resistance conferred by a panel of rootstocks commonly used today alongside several advanced selections from the NIAB EMR and Geneva rootstock breeding programmes. The trials are being conducted in two phases; the first phase has evaluated relative resistance of the rootstocks alone using an artificial pathogenicity test and the second will evaluate relative resistance of a panel of rootstocks grafted with a common scion (cv. Gala) planted in the field. The material for the latter phase of this objective was grafted during the winter of 2015/16 and has been planted out during the winter of 2016/17. The purpose of this work is to provide evidence based information to nurserymen and growers to inform choice of rootstock and interstock in the context of European apple canker control.

Summary of the project and main conclusions

Rootstocks have been sourced from various nurseries and breeding programmes as described in the science section of Project TF 223. Rootstocks were bench grafted on to a common scion (cv. Gala) in February 2016. The trees were grown on in preparation for planting in field trials in winter 2016/17. In the meantime rootstock offcuts were retained and used to determine *N. ditissima* susceptibility of the rootstock cultivar in a detached stem pathogenicity test. Although disease progression is highly variable within experiments and across experiments, rootstocks have broadly differing susceptibility to *Neonectria ditissima.* The NIAB EMR advanced selections, EMR-004 and EMR-002, look promising canker resistant cultivars sharing the same significance grouping as MM106 as the least susceptible cultivars in the panel. All other cultivars are not significantly different from the most susceptible cultivar in this test, EMLA M9. The field trials which have now been planted will provide further information on rootstock and interstock influences on scion susceptibility.

Financial benefits

Planting a new orchard is a large, long-term investment. By conducting objective, controlled trials, the outputs from this task will help inform growers of decisions on rootstock choice in the context of canker susceptibility for future plantings.

Action points for growers

- Choice of rootstock/interstock is an important consideration when ordering trees for new plantings.
- Early results suggest that M9 rootstocks are conferring higher susceptibility to other rootstocks available on the market.
- New advanced selections from the NIAB EMR rootstock breeding programme are showing promise in terms of reduced canker susceptibility.

Soil amendments

Headline

- Long-term trials have been established to assess the benefit of biological soil amendments with respect to canker control at both the nursery phase and in newly established orchards.

Background and expected deliverables

This study aims to evaluate biological soil amendments:

- Arbuscular mycorrhizal fungi (AMF)
- Plant growth promoting rhizobacteria (PGPR)
- Trichoderma and Biochar (newly established orchard only)

The aim is to improve tree health and establishment in the context of canker expression. The work is to be conducted in two parts:

1. A stool bed trial will simulate the nursery phase of tree fruit production.
2. A replicated trial on newly planted orchards to simulate the establishment of new orchards on the production site.

These are long term trials, requiring establishment and monitoring over time. The stool bed was planted in May 2015 and in 2017 will have reached the production phase so that rootstocks will be harvested from the stool bed for assessment in December 2017. Two newly planted orchard trials have been planted in 2016 and will be assessed through the remainder of the project. This task is expected to determine the value of biological soil amendments to reduce the impact of *N. ditissima* based on the hypothesis that the interaction with the beneficial microbes will provide the host with more water and nutrients and thus reduce the stress factors which can lead to the expression of a latent infection.

Financial benefits

The loss of trees to canker in the early stages of orchard establishment has financial consequences for both nurserymen and growers. The current cost of establishing an intensive orchard is in the region of £28K per hectare (FAST Ltd, 2017). In commercial practice, with cultivars susceptible to *N. ditissima*, it is not uncommon for 10% of the trees to be lost each season in the first year or two after establishment. This incurs significant extra costs in replacing lost trees and results in years delay in repaying the outlay of establishing a new intensive orchard.

As part of an integrated approach this project is evaluating the benefit of biological amendments to increase the plant's resilience to transplanting and reduce the expression of the disease during the crucial early stages of orchard establishment. Reducing the incidence of the disease in the early years after establishment will reduce the time taken to repay the establishment costs.

Action points for growers

- The research into soil amendments has not yet reached a stage where action points can be recommended to growers.

Novel application methods

Headline

- Some control products show promise when applied for canker control through an inexpensive injection system.

Background and expected deliverables

Targeted treatment application has the potential to increase efficacy whilst reducing cost and environmental exposure. This study explores novel application methods for treatments targeting *Neonectria ditissima*. Tree injection systems are widely used in forestry and amenity sectors, have been trialled for apple foliar disease, fireblight and pest control in the USA (VanWoerkom *et al.* 2014) and have great potential to be used for European apple canker control. A collaboration has been established between Fertinyect, Bayer and NIAB EMR to conduct proof of concept trials. This task will evaluate and demonstrate the benefits of targeting treatment application.

Summary of the project and main conclusions

Three trials were conducted. The first evaluated the uptake of a dye from the injection devices to assess the dynamics of product dispersal within the tree. The second and third trials evaluated the curative and protective effects of the treatments in field trials. The treatments fell into one or more of the following categories; chemical, biological, defence eliciting and plant health promoting. The uptake and phytotoxicity of each of the treatments was recorded.

Despite high variability of the results, a synthetic fungicide product (HDC F199), a biological based product (HDC F200) and a defence eliciting product (Fertinyect protect), all performed well in the trials which assessed curative effects. Uptake issues were identified with certain products such as Cercobin, HDC F200 and HDC F197, which had over 75% of the product left in the devices after 3 days. The products which had poor uptake were available in forms known to be less amenable to injection systems. Some phytotoxic effects were observed, particularly in HDC F206 which caused necrosis of the leaves and the retardation of fruit development. Tests will continue in 2017 with the aim of reducing variability and taking forward the more promising products. Researchers in New Zealand are also working on tree injection for canker control. Results will be exchanged between NZ and UK enabling protocol and treatment list improvements.

Financial benefits

It is envisaged that once refined, an injection system will be available for use as part of an integrated programme to clean up mother trees in the nursery or to spot treat trees in young orchards to prevent trunk cankers girdling the stem.

Action points for growers

- At this stage in the project, no action points can be recommended to growers.