AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

Grower Summary

TF 223

Improving integrated pest and disease management in tree fruit

Annual report 2018

Project title:	Improving integrated pest and disease management in tree fruit
Project number:	TF223
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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.

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Project leader, Plant Pathologist
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Signature .... Date ....

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GROWER SUMMARY

Project TF 223 is a five year project which commenced in April 2015. The project is investigating solutions to the key tree fruit diseases and pests, namely: European apple canker, scab, powdery mildew, *Monilinia* species and bacterial canker affecting stone fruit, codling and tortrix moths including Blastobasis, pear sucker, apple fruit rhynchites weevil, apple sawfly, pear weevils and phytophagous mites. In the first year, work focused on European apple canker, powdery mildew, codling and tortrix moths and apple fruit rhynchites weevil. In the second year research focused on European apple canker, apple foliar diseases, bacterial canker of stone fruit, codling moth, tortirx moths, a weevil affecting pear buds, pear sucker and associated natural enemies. In the third year, reported herein, work continued on European apple canker and apple powdery mildew and we began trials for control of Monilinia diseases on stone fruit. Entomology work focused on blastobasis, a weevil affecting pear buds, pear sucker and their associated natural enemies (NE) and establishing trial sites to enhance NEs in newly established orchards. For ease of reading, this grower summary report is split into sections for each of the diseases and pests worked on in the third year. Full details of each objective are presented in the Science Section of the report.

Objective 1. Surveillance

Headlines

- Vf (scab resistance gene) breaking strains of scab have been observed in the UK.
- A new apple rot pathogen, *Neofabrae kienholzii,* has been reported for the first time in the UK.
- A new pest of pear, *Anthonomus spilotus,* has been reported for the first time in the UK.

Background and expected deliverables

The surveillance objective provides the opportunity for ongoing activities to continue and be reported. Such activities include the monitoring of scab virulence on indicator trees, undertaking an apple rot survey and horizon scanning for emerging and future pest and disease threats to the UK tree fruit industry. This objective aims to keep the industry up to date with the pest and disease threats which ultimately lead to yield losses and provides information for the industry to inform future research targets and priorities.

Summary of the project and main conclusions

Scab virulence: This task involves the monitoring of an indicator orchard, planted as part of a large pan-European project in which the same indicator cultivars are planted in 25 European countries. As in 2016 the severity of the disease epidemic on the *Vf* (scab resistance gene) containing cultivars was comparable to the disease incidence on Gala. This confirms that the local scab population has broken the resistance conferred by *Vf*.

Apple rot survey: Of the 52 samples assessed from the 16/17 storage season, overall average loss was 1.5%, lower than recent past surveys. Nectria rot was the most prevalent rot with an overall incidence of 33%, Brown rot (*Monililnia*) was the next most prevalent rot (19.3%) followed by *Gloeosporium* (12.4%), *Penicillium* (11.2%) and Botrytis (9.2%). *Phytophthora* was only found in a single sample.

Neofabraea kienholzii, a pathogen closely related to those which cause Gloeosporium rot has been reported for the first time in the UK. Gloeosporium rots (caused by *Neofabraea*) have been increasing in prevalence in recent apple rot surveys. *N. Kienholzii* adds to the list of *Neofabraea* known to occur in the UK (*N. perrenans* and *N. vegabunda*).

Drosophila suzukii (SWD) numbers were particularly high in April and late summer in 2017 compared to previous years. Despite this, fewer incidences of cherry damage were reported, probably due to the previous experience and revised management of cherry. In autumn 2017 trap catches were almost double the previous year, at least partly due to a mild October and November in 2017. However, in general numbers and damage increased in most monitored regions in 2017. Fruit damage in wild blackberry was recorded for the first time in Scotland and the pest is now present in Ireland.

Summer fruit tortrix was detected for the first time in the West Midlands during the 2015 growing season and it is recommended that growers now monitor for this pest in the region using pheromone traps alongside codling moth and fruit tree tortrix monitoring traps.

No monitoring traps for **Brown Marmarated Stink Bug** (BMSB) were in place in 2017. However, a new trap has become available which is more specific and works on the 2 main phases of the lifecycle. These have been ordered and will be deployed in amenity gardens from April 2018.

A weevil found in pear orchards which has been, over the last 2-3 years, damaging spring flower and leaf buds was identified as *Anthonomus spilotus* by the Natural History Museum and NIAB EMR in 2017 and is new to the UK. It has also recently been identified as an invasive pest in Belgium. More details are provided under Objective 10.

The RHS reported sightings of Pear Shoot sawfly (*Janus compressus*) in 2016. This has not been seen in commercial pear as far as we are aware.

A table of additional pest and disease threats relevant to tree fruit growers is presented in the science section of this report with links to useful resources.

Financial benefits

Current, emerging and newly introduced pests and disease can have a devastating effect on yield and economic return to your business. This objective enables the ongoing monitoring of these threats helping to inform future research priorities.

Action points for growers

- Continue to use the rot risk survey available in the AHDB/DEFRA apple best practice guide to limit loss of apples in store.
- Keep an eye on trade press for important announcements from the animal and plant health agency (APHA) about invasive pests and diseases which will affect your business such as *Xylella fastidiosa.*

Objective 2. Neonectria

Headlines

- Long-term trials have been established to determine the effects of rootstock/interstock choice and biological soil amendments on susceptibility/tolerance to European apple canker.
- The first year of trials have identified treatments which reduce pruning wound infection by the canker pathogen.

Background and expected deliverables

European apple canker caused by *Neonectria ditissima*, is a devastating disease of apple which has been increasing in significance over the past 10-15 years as the industry has changed agronomic practices and cultivar choice. This objective looks at various factors including developing diagnostic tools, rootstock/interstock choice, biological soil amendments and novel delivery systems which, together with other projects will contribute to the development of a systems approach for canker control from nursery to orchard.

Summary of the project and main conclusions

A diagnostic tool has been developed and is currently being utilised in AHDB PhD studentship (CP161) to increase our understanding of latent non-symptomatic canker infections with the ultimate goal of developing a sampling strategy to deploy the diagnostic tool in the nursery.

Long-term trials have been established on multiple sites to determine the effect of rootstock/interstock and biological soil amendments on canker resistance/tolerance. The rootstock trials are evaluating a panel of rootstocks commonly used today alongside several advanced selections from the NIAB EMR and Geneva rootstock breeding programmes. The amendment trials are evaluating the effect of arbuscular mycorrhizae fungi (AMF), plant growth promoting rhizobacteria (PGPR), Trichoderma and Biochar in both newly planted orchards and stool beds. These trials are now established but their long term nature means that we need to collect data over the remaining two years of the project before conclusions can be drawn.

Two treatment delivery systems have been evaluated in this project; a pruning wound protection device (the Felco19 system) and a tree injection system (fertiyect) with the aim of better targeting treatments to the vulnerable areas of the plant such as pruning wounds and eradicating systemic infection respectively. Using the Felco19 device, five treatments (Folicur (tebuconazole), blocade (a physical barrier), T34 (a Trichoderma strain) and combinations thereof) were evaluated against an untreated control. Folicur alone and Blocade in addition to Folicur or T34 all reduced infection significantly compared to the untreated control. Another year of trials will be carried out to confirm the benefits of these products and a Trichoderma species better adapted to aerial environments will be tested instead of T34. Fertinject devices provide an inexpensive and easy to use system for tree injection which effectively distributes treatments through the tree. Products evaluated to date (including conventional plant protection products, defence elicitors and biological based products) have not shown sufficient efficacy to recommend tree injection as part of an integrated programme. Next season's trials will develop a screening method to evaluate differerent actives with varying modes of action in controlled environment facilities.

Financial benefits

European apple canker is a devastating disease that has an economic impact through the chain from plants in the nursery to fruit in the store. This project endeavours to focus on key areas within the chain to develop an integrated approach to canker control and reduce financial losses caused by this disease. Currently these approaches are still being evaluated and will be summarised in subsequent reports.

Action points for growers

- It is hoped to develop a commercially available diagnostic tool to determine disease risk in the nursery.

- Results from the rootstock and soil amendment trials will inform best practice planting guidelines which mitigate against canker expression in the field. These will not be available until the end of the project.
- In the meantime it is important to be vigilant with visual inspection, roguing out any trees which are showing symptoms and limiting abiotic stress as far as possible when planting out and establishing new orchards.

Objective 3. Apple foliar diseases

Headline

- Alternatives to conventional fungicides are showing promise for in-season mildew control as part of a reduced fungicide programme.

Background and expected deliverables

Foliar diseases of apple require season-long control. For scab and mildew control, susceptible cultivars require season long programmes of fungicides (~10-15 sprays) to protect shoots and buds and prevent high levels of over-wintering inoculum. Routine sprays of fungicides cost around £700/ha/annum with a large proportion spent on scab and mildew control. Despite such stringent measures, scab and mildew control can break down during the growing season resulting in disease epidemics. Mildew epidemics, in extreme cases, can defoliate affected trees reducing yield and causing russeting of the fruit. Scab infection of fruit renders it unmarketable and can lead to cracking which serves as entry points for rot fungi which subsequently develop in store. With a reduction in the availability of effective products against powdery mildew, due to changing regulations and fungicide insensitivity, new approaches to disease control need to be developed which are less dependent on conventional fungicides. This project aims to develop an integrated programme focused on reducing inoculum, promoting tree health/resistance and evaluating alternative treatments based on physical and biological properties with the aim of reducing fungicide applications whilst maintaining acceptable disease control.

Summary of the project and main conclusions

The 7 and 14 day programmes used as the main block treatments successfully established high (50%- almost 100% mildewed leaves) and low (40-60% mildewed leaves) mildew plots in which to evaluate the test products. It was important to have these blocks differing in mildew incidence as the largest differences in mildew between the test products was in the high mildew plots. Most of the test products over the whole season significantly reduced mildew incidence compared to the fungicide only plots. SB Invigorator was the most consistent in reducing mildew, confirming results from 2015 and 2016. AHDB9910 2 years, AHDB9910 + AHDB9904 and AHDB9904 only were almost as effective. AHDB9910 2 years had almost significantly less mildew than plots receiving AHDB9910 for the first year, indicating a possible cumulative effect of this product. Including AHDB9904 with AHDB9910 also improved performance, but this may have been due to the AHDB9904 only. AHDB9908 performed as well as in 2016 but did not cause leaf spotting or russeted fruit as in 2016. This is most likely due to a change in the wetter included in the formulation.

Financial benefits

- No financial benefits have been identified at this stage in the project.

Action points for growers

- Careful monitoring of the mildew epidemic is essential to rationalise fungicide use.
- Where primary mildew levels are high, prompt physical removal of mildewed blosoms and shoots is necessary. Alternative control strategies based on biological control products are being investigated.
- Alternative products for in-season control to supplement a reduced fungicide programme have been identified, but further evaluation needs to be conducted before programmes can be recommended.

Objective 4. Stone fruit diseases

Headline

- Evaluation of alternative treatments for Monilinia diseases commenced in the 2017 season but due to severe frosts and SWD damage the results were not possible to interpret – Trials will be repeated in 2018

Background and expected deliverables

Losses resulting from Monilinia sp. in stone fruit are hard to quantify because infection occurs throughout the season (blossom and fruit both pre- and post-harvest). Post-harvest development of brown rot limits the storage potential of UK stone fruit and a few rotten fruit in one punnet can lead to food retailers rejecting whole consignments. Two *Monilinia* species are present in the UK; *Monilinia laxa* and *Monilinia fructigena*. Currently diseases associated with Monilinia are controlled by 1) inoculum removal and 2) fungicides. The former is seldom practiced due to the associated increase in cost. Fungicides are applied at blossom and pre-harvest including Bellis, Signum, Switch, Systhane (and other myclobutanil containing products) but are not totally effective and pre-harvest applications present a residue risk. This project will evaluate newly available products including plant health promotors, biological control agents and fungicides, which in combination, could provide a more effective programme for brown rot control.

Summary of the project and main conclusions

Due to the late frosts during the 2017 growing season which coincided with blossom and early fruitlet development, the yield within the trial orchard was significantly affected. In addition to the frost, the trial was severely affected by SWD prior to harvest, despite weekly application of control products. Together the frost and the SWD damage meant that very little fruit was available for picking by harvest and it was impossible to draw any meaningful conclusions.

Financial benefits

- No financial benefits have been identified at this stage in the project.

Action points for growers

- Orchard sanitation is important for brown rot control, removing all mummies and wood showing cankers from the orchard.
- Blossom and pre harvest application of fungicides are required dependent on risk. Trials in 2018 will evaluate new fungicide based and fungicide alternative treatments to add to the current registered products.

Objective 6. Codling and tortrix moth – Blastobasis monitoring

Headline

- This objective aimed to validate and optimise a pheromone trap for Blastobasis as part of an integrated programme for Codling and Tortrix control as more growers use the RAK 3+4 MD system.

Background and expected deliverables

Larvae of the moth Blastobasis lacticolella, Rebel, 1940 (Synonym:decolorella) (Lepidoptera: Blastobasidae) (Figure 10.1) feed on the surface of the pear and apple fruits in mid- and late-summer, often where clusters are touching, causing large open, scallop-shaped, wounds in the flesh and making attacked apples un-saleable. Very severe damage can result if the pest is allowed to increase over a number of years unchecked, especially on short stalked varieties such as Bramley and Egremont Russet which are very susceptible. Growers currently have no means of identifying whether they have a problem other than the occurrence of damage the previous year, which is often confused with damage caused by other apple moth pests. It is also difficult to time sprays accurately against Blastobasis. Sprays are likely to be most effective when they are applied against hatching eggs. Pheromone traps are the easiest way of monitoring the flight activity and egg laying period of moth pests. Increased use of pheromone mating disruption and granulovirus, the move towards reducing the occurrence of product residues on fruits and the loss of crop protection products have meant that the products that control Blastobasis are not always used. This has led to the occurrence of occasional but severe outbreaks of damage. In particular, in recent trials, growers using RAK3+4 for mating disruption of codling moth and tortrix moths experienced outbreaks of Blastobasis, requiring application of products which negated the advantages of using mating disruption. There is a clear commercial need to develop a pheromone monitoring trap for Blastobasis so that growers can determine whether they have a problem and can time product applications accordingly.

Summary of the project and main conclusions

Field trapping experiments with three potential pheromone blends based on previous work were carried out in Northern Ireland, Hereford and Kent. A number of moths were caught, but analysis of sample moths by DNA barcoding of COI gene locus and comparison with NCBI Database indicated that in all probability, none were *Blastobasis lacticollela* (Synonym decolorella). The majority identified were *Rhigognostis incarnatella* and six out of eight were from traps baited with blend C, 1:10 Z11-16:Ac : Z11-16:Ald. This species is related to the diamondback moth, Plutella xylostella, the pheromone of which is a 1:1 blend of Z11-16:Ac and Z11-16:Ald. These results confirmed that the lures were working as intended and would have trapped *B. laticollela* if the pheromone blend was correct and this species was present. In 2018 work will focus on obtaining virgin adults of Blastobasis laticollela for pheromone and molecular analysis, rather than further testing of candidate pheromone blends. Attempts will be made to rear larvae collected during 2017 and to collect pupae or adults from sites in Northern Ireland during 2018.

Financial benefits

- No financial benefits have been identified at this stage of the project.

Action points for growers

- Not action points have been identified at this stage of the project.

Objective 7.1 Improving the reliability of natural predation of pests

Headline

- Six trial orchards have been set up to monitor the benefits of speeding up the ecology of newly planted orchards in establishing beneficial arthropods more quickly to mitigate losses due to pests.

Background and expected deliverables

Establishing new crops requires substantial investment (~£30k/ha for apple) and growers need confidence that their orchards will crop reliably and that their fruit will find a profitable market. Ecological succession is the observed process of change in the species structure of an ecological community over time. The community begins with relatively few pioneering plants and animals and develops through increasing complexity until it becomes stable or self-perpetuating, as a climax community. Newly planted orchards have an un-established ecosystem. The recently tilled ground in newly planted orchards often has minimal, simplified or absent vegetation cover with a low diversity of plant species resulting in low pollen and nectar provision and low refugia and structure. The tree bark and canopy are simple compared to older established trees, affording little availability for predatory arthropods to gain refuge. Hence, local, natural predators and pollinators have not built up and established in new orchards leading to random, sporadic attacks from a number of pest species which can then be difficult to control.

Summary of the project and main conclusions

We applied interventions to newly planted orchards in order to establish more rapidly the beneficial ecology. The alleyway sowings are completed at all sites and most orchards have now established. Earwig refuges were deployed in autumn 2017. Monitoring in 2018 will provide detailed data on the establishment of orchards with and without interventions.

Financial benefits

- No financial benefits have been identified at this stage of the project.

Action points for growers

- No action points have been identified at this stage of the project.

Objective 7.2 Dynamic pear sucker/ predator chart

Headline

- A study of pear sucker and its natural enemies has been set up on six commercial pear farms.

Background and expected deliverables

Pear sucker (*Cacopsylla pyri*) is still the major pest on pear with sporadic population growth in relation to warm dry weather and in orchards where the numbers of earwigs and anthocorids is not sustained. Emerging evidence from other AHDB and Innovate UK projects is showing that earwigs are important control agents for aphids and pear sucker. Additional research in the USA also demonstrates predation of codling moth eggs. Earwigs, hoverfly larvae, lacewing larvae, spiders and ladybirds are able to penetrate the leaf rolls (galls) caused by the various apple aphid species.

There are large differences, between orchards, in earwig populations and AHDB Project TF 196 has demonstrated that the use and timing of crop protection products may be, at least partly responsible. However, anecdotal evidence is showing that earwigs can be distributed in patches within an individual orchard.

The aim of this study is to enable more effective monitoring, crop protection use and natural enemy build-up in pear orchards. It is expected that the application of control product interventions will be better timed.

Summary of the project and main conclusions

Six farms were involved in the study in 2016 and 2017. All participants were trained in the monitoring technique at the start of the growing season. Each grower selected three orchards (high, medium and low pear sucker infested) on each farm and allowed time for a worker to systematically assess the chosen orchards each week. The results were collated at least fortnightly by NIAB EMR and then shared with all participants.

Records of pear sucker eggs, nymphs and adults, and ladybirds, earwigs and anthocorids in the perceived low, medium and high pear sucker pressure orchards were made from March to September.

Financial benefits

Close monitoring of pear sucker and its natural enemies can prevent the application of unnecessary sprays and conserve natural enemies which control pear sucker. This will reduce the need for applications of products needed to control honey dew on trees. The reduction of pear sucker in the crop reduces crop loss through the maintenance of high fruit quality and prevents damage to overwintering bud and tree health.

Action points for growers

- Monitor pear sucker stages in the crop to accurately time Envidor applications and avoid sprays where unnecessary.
- Monitor natural enemies such as earwigs, anthocorids and ladybirds alongside pear sucker populations to track the likely future control by these predators in the absence of sprays.
- Enter numbers and information into a spreadsheet to get an overall picture of when natural enemies are detected and how this relates to the life stages of pear sucker.
- Remember earwigs are nocturnal so you may underestimate them early in the spring.
- Consider releases of anthocorids early on if numbers of natural enemies are low, but think about the surrounding habitat to encourage long term resilience in populations.
- Be careful with spray application. Think about spray frequency and its impact on natural enemies
- Aim to achieve;

  <1,000 pear sucker eggs per 30 shoots per week

  >10 natural enemies per 30 shoots per week

Objective 8. Apple sawfly

Headline

Work has begun to discover the sex pheromone of apple sawfly for future monitoring.

Background and expected deliverables

Apple sawfly is a locally common and problem pest, particularly in organic orchards where products for effective control are not available. However, timing of application relies on knowing when the first flight is occurring and when females are laying eggs. The aim of this project is to identify the sex pheromone of the apple sawfly for use in future monitoring and mating disruption studies.

Summary of the project and main conclusions

Apple sawfly larval infected apples were collected in spring 2015 and 2016 from an unsprayed orchard at NIAB EMR. The apples were placed onto compost in mesh covered bins. Larvae were allowed to crawl out from the fruits and enter the compost. As apple sawfly has only one generation per year, these were maintained outside until spring 2016 and spring 2017. However, no apple sawfly adults emerged and pupae were found to be infected with either bacteria or fungus, even when in 2017 bins were maintained with lids to prevent over wetting from rain. The previous winter had been very wet and it was speculated that the soil may have become too wet outside.

In spring 2017 apple sawfly infected apples were collected again and kept in Bugdorm cages under cover. As the larvae emerged from the apples and began to 'wander' they were transferred into smaller plant pots of compost. Six were kept at ambient conditions in an outside area under cover and two were stored at 6°C for two months to attempt to simulate a cold period. To date, no adults have emerged, but pots will be brought into room conditions in spring 2018 for emergence of adults and headspace volatile collection for pheromone identification.

Financial benefits

- No financial benefits have been identified at this stage of the project.

Action points for growers

- No action points have been identified at this stage of the project.

Objective 9. *Anthonomus spilotus* in pear

Headline

- A new damaging weevil pest of pear blossom has been identified as *Anthonomus spilotus* and is new to the UK.

Background and expected deliverables

A new pest of pear was identified. The weevil is from the *Anthonomus* family of weevils known to feed and develop in buds and fruits of plants. Unlike *Anthonomus piri* (pear bud weevil), *A. spilotus* feeds and lays eggs in spring blossom and leaf buds. In order to control the weevil, it is likely to be necessary to target sprays in the spring, before the flower clusters open. This objective aimed to establish the activity period, lifecycle and toxicity of commonly used insecticides. More research is needed to establish thresholds and to target spray timing more precisely.

Financial benefits

Larvae in flower buds feed on flowers, but then also feed on emerging leaf shoots. This could affect yield but also the health of trees over the long term. It is essential to calculate thresholds for spraying and spray timing. It is estimated that a female weevil in the *Anthonomus* family can lay around 25 eggs in her lifetime.

Action points for growers

- Monitor pear orchards weekly from February by tap sampling tree branches to check for the presence of *Anthonomus spilotus*.
- Check for feeding holes in flower and leaf buds.
- Continue to monitor until May.
- Make a careful decision over the need to use control measures and the choice of product.
- Continue to monitor for the pest after control methods have been used.