Grower Summary

SF 157

Improving integrated disease management in strawberry

Annual 2017

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 may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.
Before using all pesticides check the approval status and conditions of use.
Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

AHDB Horticulture,
AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

Project title:	Improving integrated disease management in strawberry
Project number:	SF 157
Project leader:	Prof Xiangming Xu NIAB EMR
Report:	Annual, 2016/2017
Previous report:	Year 1
Key staff:	Erika Wedgwood (ADAS) Angela Berrie (NIAB EMR) Avice Hall (UoH) Tom Passey (NIAB EMR)
Location of project:	East Malling; Cambridge; Wisbech
Industry Representative:	Louise Sutherland
Date project commenced:	1 March 2015
Date project completed (or expected completion date):	31 March 2020

GROWER SUMMARY

For ease of reading, this Grower Summary report is split into sections for each of the diseases being worked upon in the project.

Crown rot and red-core caused by *Phytophthora* spp.

Headline

- Contamination of *P. cactorum* in asymptomatic runners could cause considerable losses to growers.

Background and expected deliverables

Adopting a clean propagation system is the first line of defence against crown rot and red-core diseases. This strategy has been working for many years until recent times. Currently, crown rot and red-core can cause significant damage in strawberry even in substrate production. The most likely cause is asymptomatic infection in planting material. Frequent application of fungicides, alleged to have occurred in overseas nurseries, may delay the onset of symptom development until post-transplanting. Subsequent disease spread is likely to occur because of over-irrigation or rain-splash. Alternative products for control of crown rot (both fungicides and biocontrols) were identified in trials conducted by NIAB EMR as part of the SCEPTRE project. Recent research on *Phytophthora* spp. has concentrated on detecting the pathogens and seeking products to reduce root rotting. Two AHDB Horticulture projects have just been completed; SF 130 focussed on fungal molecular quantification and an assay was developed that detected *Phytophthora rubi*, although it was not as sensitive as the *Phytophthora fragariae* assay (which however detects both pathogens); SF 123 investigated alternative products against *P. rubi* on raspberry where one novel chemical product gave reduction. Red-core is more difficult to control and currently there is no work on controlling this disease. Note that BBSRC is funding NIAB EMR to manage a five-year project to identify Phytophthora virulence factors against strawberry. More research is required to assist growers to be able to plant disease-free propagation material in order to reduce crop protection product use and crop losses.

The aim of this project on Phytophthora is to quantify the extent of hidden infection in initial planting material and identify treatments to reduce plant losses due to these hidden infections.

Summary of the project and main conclusions in Year 2

Year 1 results suggested that the incidence of contamination by *P. fragariae* (causal agent of red core) in runners is very low; however, the level of contamination of *P. cactorum* (causal agent of crown rot) could reach 25-30%. Year 2 sampling and screening therefore focussed

on *P. cactorum*. The survey results in Year 2 agreed with those from Year 1. The level of *P. cactorum* in runners varied greatly from sample to sample, and could be as high as 20%, detected mostly in asymptomatic crowns. In addition, it appears that the level of *P. cactorum* is not associated with particular cultivars.

Small-scale experiments were conducted at NIAB EMR to determine whether separate or joint use of AMF (arbuscular mycorrhizal fungi) and PGPR (Plant growth promoting bacteria) could reduce *Phytophthora* development. Results suggested that amendment of compost with both AMF and PGPR together could reduce severity of red-core development. However, these treatments failed to achieve significant reduction in the development of *P. cactorum* in inoculated crowns; further experiments are needed to confirm this result.

Financial benefits

Potential loss of plants due to *P. cactorum* could reach 20-30%. In 2016, 90,000 tonnes of strawberries were sold in the UK season with the market valued at £386 million (Data from Kantar). Should 25% of plant losses occur in the UK as a result of crown rot, the volume of fruit sold could be reduced by up to 22,500 tonnes, representing a value of £96 million. Techniques and measures to control *P. cactorum* could therefor save such potential losses.

Action points for growers

- As this project is still in its infancy, growers should continue their current commercial practice of treating runners with an approved fungicide soon after planting to suppress and control *P. cactorum* and *P. fragariae*.

Strawberry powdery mildew (SPM)

Headline

- The two biocontrol substances, Ampelomyces quisqualis (approved on protected strawberry) and Bacillus pumilus (not currently an approved plant protection product), when applied with Silwet, achieved a similar level of control of powdery mildew to that achieved by a standard 7-day fungicide programme.

Background and expected deliverables

Work in a recent AHDB project on edible crops highlighted the efficacy of at least three biological plant protection products against powdery mildews on crops other than strawberries. These biofungicides could gain approval for use on strawberry; however work was required to determine how these might be integrated into crop protection programmes currently used against strawberry powdery mildew (SPM).

Projects SF 62, SF 62a and SF 94 (Defra Horticulture LINK HL0191) focussed on development, implementation and use of an SPM prediction system developed at the

University of Hertfordshire. The project clearly demonstrated the benefit of using the system for early crops where initial SPM inoculum is low. Recent research in the UK and Norway showed the importance of chasmothecia as a source of inoculum, particularly for perennial cropping systems, and indicated the importance of removing debris from previous crops. Research in Norway also suggested young leaves and fruit are most susceptible to SPM infection.

An EU-interreg funded project at NIAB EMR demonstrated a small reduction of SPM under a deficit irrigation regime.

A pilot study at the University of Hertfordshire showed that application of silicon nutrients changed plant morphology and delayed SPM development by 8-10 days on several cultivars.

The central aim of this project is to optimise and integrate non-fungicide alternatives with conventional fungicides in the control of SPM, particularly integrating nutrients and resistance inducers.

Summary of the project and main conclusions in Year 2

In a replicated small plot field trial on strawberries (cv. Elsanta), grown under Spanish tunnels at NIAB EMR and in coir bags under a tunnel at ADAS Boxworth, the efficacy of programmes combining biocontrol agents (BCA) and elicitors, with and without fungicides at 14 day intervals, was compared to a 7 or 14 day interval standard fungicide programme and untreated plots for control of SPM on leaves and fruits. Conditions at NIAB EMR were exceptionally favourable for SPM (average 60% leaf area with SPM in untreated control), indicating that the trial gave a good test of efficacy of management programmes. Significant treatment effects on SPM were only detected at the NIAB EMR site.

At NIAB EMR, all spray treatments significantly reduced SPM incidence on both leaves and flowers/fruit. The lowest SPM incidence was on plots treated with the standard 7-day fungicide programme. However the efficacy of two BCA only programmes (in admixture with Silwet) were as effective as the standard 7-day fungicide programme. These BCA programmes included *Ampelomyces quisqualis* (AQ10 – currently approved on protected strawberries) and *Bacillus pumilus* QRD2808 (Sonata – not currently approved as a plant protection product). Surprisingly, when applied alone, the two BCAs provided better control than when used with other products. A crop ‘strengthener only’ programme offered the least effective control. Because conditions were so conducive to SPM, around 25% of leaf area was infected with SPM on the best treatment (standard 7-day fungicide programme).

There were obvious visual differences in plant vigour in the plots receiving the different programmes. All treated plots had a higher vigour score than the untreated control which was obviously stunted, but only the plants in the plots receiving 7 day fungicide programme were

significantly better, despite the similar incidence of foliar SPM in plots receiving biocontrol products. There was a negative relationship between yield (fruit number) and the level of SPM.

The incidence of fungal rots (*Botrytis* and *Mucor*) at harvest was low and sporadic. However, there was a much higher post-harvest rot incidence, particularly *Botrytis*. Although there were significant differences in the *Botrytis* incidence between treatments, none of the programmes were effective in reducing rots to acceptable levels. The incidence of other rots (e.g. *Mucor*, *Penicillium*) was very low and none of the programmes were effective in controlling the other rots.

Results from independent trials at a commercial farm over the last few years (conducted by University of Hertfordshire) showed that weekly application of silicon through drip fertigation can lead to reduced SPM development.

Financial benefits

Powdery mildew can result in yield losses of between 20-70% of crop potential. In 2016, 90,000 tonnes of strawberries were sold in the UK season with the market valued at £386 million (Data from Kantar). At 20% losses, using these figures, this could contribute to an industry volume of 18,000 tonnes at a value of £77.2 million. Providing effective control can therefore offer enormous financial benefits.

Action points for growers

- At low/moderate SPM levels (< 15% leaf area with SPM), programmes using biofungicides alone (with Silwet) are as effective as weekly standard fungicide applications. However, it is important to ensure early control of SPM.
- This work identified *Ampelomyces quisqualis* (AQ10) as one biofungicide which gave comparable control to standard fungicide programmes and this is currently approved for use on protected strawberry.
- Weekly application of silicon through drip fertigation can also lead to reduced SPM development.

Fruit rot complex

Recent evidence in the UK and New Zealand has shown that *Botrytis* is not the only pathogen causing fruit rot, and that the importance of *B. cinerea* in strawberry may have been over-stated because of similar morphological characteristics of *Botrytis* fungal morphology with two other rotting fungi – *Mucor* and *Rhizopus* spp. The relative importance of these three pathogens may vary greatly with time and location. Although the overall direct loss to these pathogens may be relatively small compared with other diseases, the consequence (e.g. rejection of a consignment by retailers) of fruit rot is much more serious.

Botrytis cinerea, causing grey mould, is the most-studied disease in strawberry worldwide. Infection at flowering stages leads to the establishment of latent infection, which becomes active during fruit ripening. Direct infection of fruit by conidia during ripening is also possible, which may account for a high proportion of post-harvest rots. Previous work (Project SF 94, Defra Horticulture LINK HL0191) has shown that it is possible to avoid using fungicides against *Botrytis* for early-covered June-bearers. Controlling *Botrytis* in late season strawberry, particularly ever-bearers, is problematic. Use of bees to deliver biocontrol agents to flowers gave the same level of *Botrytis* control as a fungicide programme on one strawberry farm. There is an on-going European core organic project which is assessing the use of bees to deliver biocontrol agents to strawberry flowers. However, it may face registration hurdles or even negative public responses. To manage spotted wing drosophila (SWD) risk, growers are now implementing strict hygiene measures by removing all old, damaged or diseased fruit from the plantation during and after harvest. This will also help to reduce *Botrytis* risk in late season crops.

Projects SF 74 (Defra Horticulture LINK HL0175) and SF 94 (Defra Horticulture LINK HL0191) demonstrated that rapid post-harvest cooling to 2°C is effective in delaying *Botrytis* development in raspberry and strawberry. However, such cooling treatment is not effective against *Mucor* which can develop in cold conditions. In Project SF 98, NIAB EMR identified a few fungicides that can give partial control of *Mucor*. Berry Gardens Growers (BGG) recently funded a PhD project at NIAB EMR on the epidemiology and management of *Mucor* and *Rhizopus* rot in strawberry; significant progress has been made in this project but due to commercial confidentiality the findings cannot be disclosed in this report. BGG continues to fund work on the control of fruit rotting at NIAB EMR.

For fruit rot complex in this project, the integration of biocontrol products with reduced fungicides will be investigated, along with post-harvest handling to reduce fruit rot and/or delay rot development. Work to understand the epidemiology of fruit rot complex and to develop management strategies will start in Year 4 of the project.

Verticillium wilt

Background and expected deliverables

Recent withdrawal of methyl bromide and other soil fumigants has instigated new research to find alternative soil treatments for *Verticillium*. Disappointingly, a new microencapsulated product did not have sufficient efficacy to offer any commercial future (a TSB funded project which ended in December 2014). AHDB Horticulture funded a PhD studentship project to assess the use of pre-colonisation of strawberry runners with arbuscular mycorrhizal fungi (AMF) to manage wilt.

With AHDB funding, Fera developed a molecular diagnostic tool to quantify soil inoculum and ADAS is currently using this tool to investigate wilt development in relation to nematodes. Separately, NIAB EMR (in collaboration with Chinese researchers) has developed a more sensitive qPCR tool for quantifying *Verticillium* inoculum in soils. In an on-going TSB project, significant yield reduction associated with stunted strawberry growth has been observed that is apparently not associated with *Verticillium*. Further metagenomics research suggested that several candidate organisms are responsible for this stunted growth (though further research is needed to confirm this), including two fungal pathogens *Ilyonectria robusta* and *I. coprosmae* (former *Cylindrocarpon* spp.) and the suppressive effects of *Bacillus* and *Pseudomonas* species.

Summary of the project and main conclusions in Year 2

Originally, we planned to conduct an experiment to study the use of anaerobic soil disinfestation (ASD) on wilt development in Year 2. Unfortunately, CRD informed us that ASD requires registration as a plant protection product (PPP). As the Dutch manufacturer is was unwilling to do this, we had to cancel this experiment.

Financial benefits

No financial benefits are relevant to this part of the project so far.

Action points for growers

- No action points have been developed from the work on Verticillium wilt to date.