Grower Summary

SF 157

Improving integrated disease management in strawberry

Annual 2016

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Project title:	Improving integrated disease management in strawberry
Project number:	SF157
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Report:	Annual, 02/2016
Previous report:	N/A
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Location of project:	East Malling; Cambridge; Wisbech
Industry Representative:	Marion Regan
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

- The level of bare-root runners with *Phytophthora fragariae* (red-core) DNA detected is very low; however the level of *P. cactorum* DNA detected could reach 30%.

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 materials. 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. Currently, NIAB EMR is testing fungicides and alternatives (in the SCEPTRE project) against crown rot and has identified effective products against this disease. 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 investigate 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 materials and identify treatments to reduce plant losses due to these hidden infections.

Summary of the project and main conclusions in Year 1

A survey was conducted along with a molecular screening of bare-rooted runners for the presence of *Phytophthora* spp. Results suggested that the level of runners with contamination of *P. fragariae* (causal agent of red core) is very low; however, the level of contamination of *P. cactorum* (causal agent of crown rot) could reach 25-30% (although only up to 5% of runners may have symptoms of crown rot at the time of plantings). Further sampling and screening is needed, focusing on *P. cactorum*.

Small-scale experiments (as constrained by the nature of *Phytophthora* spp. as quarantine pathogens) 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 can reduce severity of red-core development. Further experiments will be conducted to test the effect of AMF and PGPR on Phytophthora development, particularly with crown rot.

Financial benefits

The results are from only the first year and hence it is too early to quantify benefits to growers.

Action points for growers

- At this stage of the project, there are no action points to recommend to growers.

Powdery mildew

Headline

- Weekly application of silicon through fertigation can lead to reduced mildew development and higher pollen viability.

Background and expected deliverables

Projects SF 62, SF 62a and SF 94 (Defra Horticulture LINK HL0191) focussed on development, implementation and use of a strawberry powdery mildew prediction system. The prediction system was based on the one developed at the University of Hertfordshire. The project clearly demonstrated the benefit of using the system for early crops where initial mildew inoculum is low. Recent research in UK and Norway showed the importance of chasmothecia as a source inoculum, particularly for perennial cropping systems, and indicated the importance of removing debris from previous crops. Recent research in Norway also suggested young leaves and fruit are most susceptible to mildew infection. An EU-interreg funded project at NIAB EMR demonstrated a small reduction of powdery mildew under a deficit

irrigation regime. A pilot study at the University of Hertfordshire showed that application of silicon nutrients changed plant morphology and delayed mildew development by 8-10 days on several cultivars. A TSB-funded project at NIAB EMR identified several QTL for resistance to powdery mildew. Another TSB project at EMR is investigating whether we could develop imaging tools to detect mildew infection before visual symptoms.

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

Summary of the project and main conclusions in Year 1

Two trials were conducted (one at NIAB EMR and one at ADAS, Cambridge) to study the effects of combining alternative products with reduced fungicide input on powdery mildew development. At both sites, the level of pre-harvest powdery mildew was low. Subsequently, at NIAB EMR the trial continued on the post-harvest regrowth for which severe mildew epidemics developed. Results suggested that combining certain alternative products with reduced fungicide input could be effective in controlling mildew, particularly when the level of inoculum is relatively low. In the coming season, further trials will be conducted, focusing on a few specific combinations of alternative products and fungicides.

A trial was conducted at a grower's site to investigate the effect of applying silicon through fertigation on strawberry powdery mildew [note - this work was funded by a private company who kindly agreed to share the results]. Results showed that applying the concentration of silicon (0.017%) once a week to the plants led to reduced development of powdery mildew, a lower level of two-spotted spider mite infestation and a higher level of pollen viability. It demonstrated that the silicon nutrient needs to be applied via the fertigation system on a weekly basis throughout the life of the plant. Brix levels in petioles in a commercial crop using Si nutrient were consistently higher than those in petioles from plants not receiving Si nutrient. There were no adverse effects at the Silicon concentration used. Full details of the rates used are included the Science Section of this report.

Financial benefits

The results are from only the first year and hence it is too early to quantify benefits to growers.

Action points for growers

- At low mildew levels, preventative fungicide programmes using biofungicides alone or alternated with standard fungicides are as effective as weekly standard applications, without increasing post-harvest rot incidence.
- Weekly application of silicon through fertigation can lead to reduced mildew development

and higher pollen viability.

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 rot. Previous work (Project SF 94, Defra Horticulture LINK HL0191) has shown that it is possible not to use 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 on using bees to deliver biocontrol agents to strawberry flowers. However, it should be noted that using bees to deliver biocontrol products may face registration hurdles or even negative public responses. Because of the 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 may help to reduce Botrytis risk in late season crops.

Projects SF 74 (Defra Horticulture LINK HL0175) and SF 94 (Defra Horticulture LINK HL0191) suggested that in raspberry and strawberry, rapid post-harvest cooling to storage at 2°C is effective in delaying Botrytis development. However, such cooling treatment is not effective against Mucor as it can develop in cold conditions. In Project SF 98, NIAB EMR identified a few fungicides that can control Mucor effectively. Currently, Berry Gardens Growers is funding a PhD project at NIAB EMR on the epidemiology and management of Mucor *and* Rhizopus rot in strawberry. We have made Significant progress has been made in this project but due to commercial confidentiality the findings cannot be disclosed in this report.

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 3 of the project.

Verticillium wilt

Headline

- Alternative biofumigation-derived products can significantly reduce the level of *Verticillium dahliae* inoculum in the field.

Background and expected deliverables

Recent withdrawal of methyl bromide and other soil fumigants has instigated new research seeking alternative soil treatments against Verticillium. Disappointingly, a new microencapsulated product did not have sufficient efficacy to have any commercial future (a TSB funded project which ended in December 2014). AHDB Horticulture is funding a PhD studentship project on pre-colonising strawberry runners or tipping plants to manage wilt. With AHDB funding, Fera developed a molecular diagnostic tool to quantify soil inoculum and currently ADAS is using this tool to investigate the relationship of wilt development in relation to nematodes. Separately, 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 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 by *Bacillus* and *Pseudomonas* species. A new AgriTech proposal is currently under development to tackle these issues related to the *Ilyonectria* pathogens.

For wilt control, the emphasis in this project is on the use of anaerobic soil disinfestation and addition of beneficial bacteria to improve soil health.

Summary of the project and main conclusions in Year 1

Combined use of three alternative products (microencapsulated terpenes, liquid BioFence^{TM} and digestate [by product of anaerobic process]) have been tested in small-plot filed trials at NIAB EMR against wilt. The three tested alternative products can reduce *V. dahliae* inoculum by more than 50% when used individually. However, the combined use of these products in most cases did not result in efficacies as great as expected on the assumption of independent actions. Whether these products can be used in commercial agriculture depends on the level of inoculum and the inoculum threshold for causing economic damage. For crops like strawberry with a very low wilt threshold (0.5 – 1.0 CFU g^{-1} of soil (Harris and Yang, 1996),

their use is not likely to be commercially viable for highly susceptible cultivars in fields with moderate to high inoculum levels. The value of combining these treatments is also questionable and needs to be further studied in different types of soils and cropping systems.

Anaerobic soil disinfestation was carried out on soil collected from a soft fruit farm that had a natural infestation of 2.3 microsclerotia of Verticillium per gram of soil. The soil was collected into replicated pots treated with either one or two products that provided nutrition to encourage the activity of the anaerobic bacteria present in the soil. The pots were sealed for eight weeks and the metabolites were anticipated to reduce the viability of the microsclerotia. Significant reduction in propagule viability occurred after the incorporation of Herbie 82 in four treatments, to give a mean 0.28 microsclerotia/g of soil, with four out of sixteen pots having zero.

Financial benefits

The results are from only the first year and hence it is too early to quantify benefits to growers.

Action points for growers

- If the level of wilt inoculum is not two high < 1.5 CFU per gram of soil, treating soils with alternative products can be effective in suppressing wilt development