

Studentship Project: Annual Progress Report 10/2021 to 10/2022

Student Name:	Lauren Farwell	AHDB Project Number:	SF/TF 170/a
Project Title:	The Epidemiology and Management of <i>Cladosporium</i> on Raspberry		
Lead Partner:	Cranfield University		
Supervisor:	Prof. Xiangming Xu & Prof. Naresh Magan		
Start Date:	Oct 2019	End Date:	Oct 2023

1. Project aims and objectives

- a) To determine which *Cladosporium* species predominantly grow on UK raspberries, and to determine which stages of fruit development are susceptible to skin lesions and stigmata infections.
- b) To investigate if the microbiome of raspberries varies across fruit age, location within the polytunnel (fruit nearer the edge vs fruit in the centre) and across polytunnels. This will indicate if potentially pathogenic species, including *Cladosporium*, vary in their presence within polytunnels due to climatic differences.
- c) To ascertain if *Cladosporium* spores in the air are affected by polytunnel infrastructure, by people picking fruit within a raspberry canopy and at different time points across a day.
- d) To elucidate if the susceptibility to *Cladosporium* skin lesions and stigmata infections vary across varieties, indicating that breeding may provide a potential mechanism of control.
- e) To find out if biocontrol products can provide preventative or curative protection from *Cladosporium* skin lesions.

2. Key messages emerging from the project

- We have confirmed that the most susceptible stages of raspberry development to *Cladosporium* skin lesions is at the ripe fruit stage. This is when visible lesions are most likely to be present, and the time frame when we should be looking at control methods.
- The stigmata are susceptible from earlier in development, however it appears that *Cladosporium* predominantly colonises the outer surface. Dead/senescent material on the fruit such as petals, anthers and stigmata likely provide a source of food earlier in development that *Cladosporium* can colonise and subsequently cause skin lesions when fruit are susceptible. Whether this is economically important is unknown. It does however demonstrate the importance of good hygiene, e.g., removing dead branches in the canopy, that will help reduce material for *Cladosporium* to colonise and sporulate on. Ideally, it would best to remove snapped branches to reduce sources for *Cladosporium* for colonisation of the ripening fruit.
- *Cladosporium cladosporioides* appears to be one of the most frequently found species on raspberries, indicating airborne spores are likely to be an important inoculum source. Venting practices are likely to impact on the spore load inside the tunnels.

The results described in this summary report are interim and relate to one year. In all cases, the reports refer to projects that extend over a number of years.

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. Reference herein to trade names and proprietary products without stating that they are protected does not imply that they may be regarded as unprotected and thus free for general use. No endorsement of named products is intended, nor is any criticism implied of other alternative, but unnamed, products.

- *Cladosporium* can also grow on the honeydew produced by aphid outbreaks. Thus, good control of aphids will also help prevent outbreaks on both the leaves and fruit. If an outbreak of aphid infestation occurs on plants that will be used in the next growing season, an application of pesticide in the autumn will help prevent a subsequent outbreak of aphids (and potentially *Cladosporium*) in the next growing season.

3. Summary of results from the reporting year

- Raspberries are susceptible to skin lesions from the ripening stage onwards, hence applications of control measures should focus from this stage onwards.
- Raspberries are susceptible to stigmata infections earlier in development (green stage of fruiting onwards). It is currently unclear if these infections are economically important. However, reducing the potential inoculum load within polytunnels may help decrease the likelihood of these infections.
- We have been able to detect *Cladosporium* in our microbiome samples, which means we can begin analysing our results to determine which factors impact the absence/presence of *Cladosporium* and how much is present.
- The biocontrol products screened reduced the growth of *Cladosporium* under laboratory conditions and reduced the incidence of *Cladosporium* in one field trial (Figure 1). The field experiment will be repeated next year to obtain statistically robust information on the best biological products. This would be closer to the industry standards and would be beneficial in making more effective recommendations for growers.

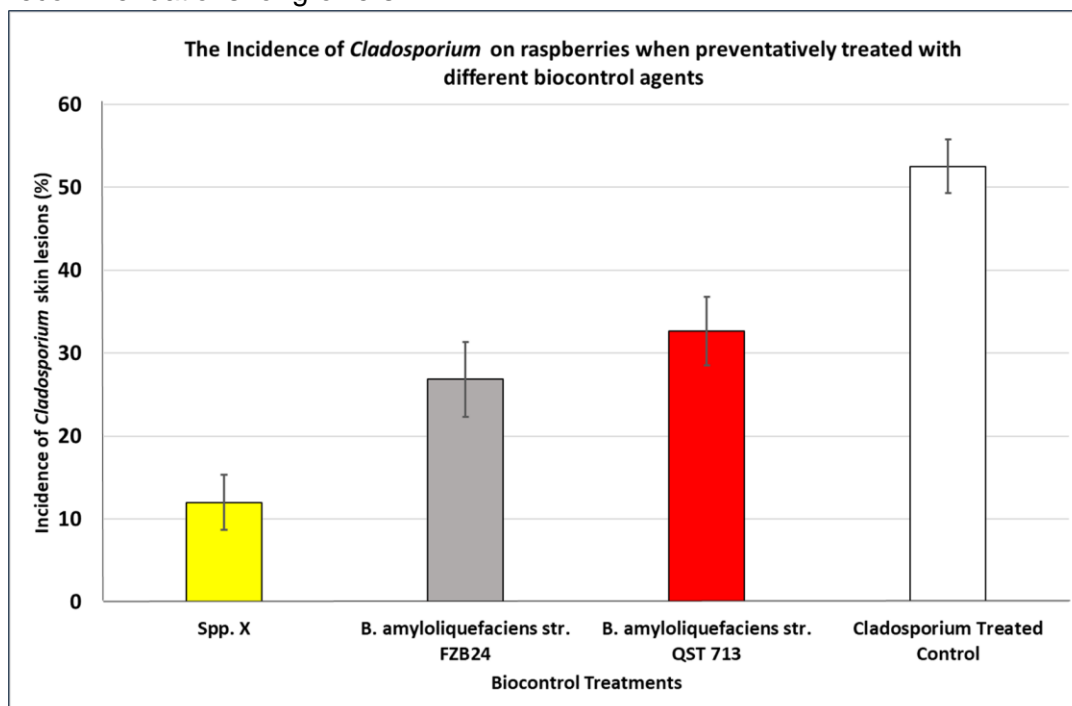


Figure 1. The incidence of *Cladosporium* on raspberries that has received a preventative application of bio-control.

4. Key issues to be addressed in the next year

The majority of field work has now been completed, laboratory work to quantify the amount of DNA for both the microbiome experiment and the *Cladosporium* spores (inoculum load) in the air are currently underway. All other experiments are now being statistically analysed.

5. Outputs relating to the project

(events, press articles, conference posters or presentations, scientific papers):

Output	Detail
BCPC Disease Review 2022	A short presentation and poster detailing the biocontrol work performed.
BMS conference 2022	A presentation and poster on the phylogenetic work and susceptibility work performed.
The National Fruit Show	A presentation on the bio-control work performed.
DTP Students	A poster and brief talk on the susceptibility and phylogenetic work I have performed to visiting students.
East Kent Growers Grower Walk	A brief discussion of the biocontrol laboratory studies and susceptibility work.

6. Partners (if applicable)

Scientific partners	Cranfield University, AHDB & NIAB.
Industry partners	Berry Gardens and Worshipful Company of Fruiterers.
Government sponsor	BBSRC.