Project title:	Understanding Resilience of Soil Beneficials to Combat Apple Replant Disease
Project number:	CTP_FCR_2018_5
Project leader:	Louisa Robinson-Boyer, NIAB EMR., Naresh Magan, Cranfield University., Xiangming Xu, NIAB EMR.
Report:	Annual report, October 2019
Previous report:	None
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Location of project:	NIAB EMR, Kent and Cranfield University, Bedfordshire
Industry Representative:	N/A
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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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GROWER SUMMARY

Headline

Long-term trial established assessing the effect of pre-plant soil amendment with specific microorganisms for Apple Replant Disease (ARD) prevention.

Background

The phenomenon of previously high yielding perennial fruit orchards producing unsatisfactory growth and yield in replanted trees, termed apple replant disease or ARD (Mai & Abawi, 1981), has become an increasing problem as virgin land to establish new plantings becomes increasingly difficult to locate in both nurseries and newly established orchards. Modern, intensive systems of apple production require high yields throughout the orchards life to get a good return on investment however a reduction in yield caused by ARD can limit yield potential. ARD symptoms may decrease profitability by up to 50% during the orchards life (van Schoor *et al.*, 2009). ARD symptoms include stunted growth, discolouration of apple skin, reduced yield, reduced fruit size/weight, altered fruit aroma and tree death (Mazzola & Manici, 2012; Zhu *et al.*, 2014; LIU *et al.*, 2014). The aetiology of ARD is disputed within the scientific community but is likely caused by a consortium of soil pathogenic microorganisms, the main causative agents of which change depending on local conditions.

Current treatments for ARD include pre-plant fumigation of the soils by applying volatile chemical compounds (eg. Chloropicirin & Dazomet) to sterilise the soils (Mazzola & Manici, 2012). These products however are under pressure from government legislation regarding safe chemical use as well as being harmful to the environment. Chemical treatments are therefore not sustainable in the medium to long term. Brassica seed meal (BSM) is a newly developed bio-fumigation treatment that has been extensively studied and used to alleviate ARD symptoms but is yet to be trialled in long term trials in the UK. BSM has been shown to increase apple tree growth over a period of 3 years higher than those observed using conventional fumigation techniques (Mazzola *et al.*, 2015). Specific plant growth promoting microbes are yet to be widely recognised as a treatment for ARD despite the use of arbuscular mychorrizal fungi (AMF) significantly increasing fresh weight of apple seedlings in AMF inoculated soils (Mehta & Bharat, 2013) and improving drought stress tolerance in strawberry (Boyer *et al.*, 2015).

The present research project aims to understand how various soil management practices, including amending soils with specific microbes (Nicola *et al.*, 2017), will impact soil quality in terms of ARD and other apple diseases will be observed such as apple canker development. In addition, we are studying the dynamics of soil microbial communities under climate change scenarios: combinations of elevated CO_2 x temperature x water potential stress.

Summary

In the first year of this study, long term trials were established evaluating beneficial biological soil amendments in ARD predisposed soils. Trials were measured to determine whether treatments have beneficial effects on tree development in the presence of ARD. The growth parameters chosen were height, girth and yield of the tree throughout the first growing season. Further work will include microbiome population analysis of inoculated trees using next generation sequencing and functionality difference tested using carbon utilisation assays. Once population and functionality variation are established, these can be cross-referenced with the long-term growth data to demonstrate a comprehensive assessment of the effectiveness and potentiality of standardising biological soil amendments to mitigate the effects of ARD.

Financial Benefits

It is too early to calculate the financial benefits of this work from the first-year data. As ARD is a prevalent disease in both nurseries and in fruit production and ARD onset can be 1-2 years after planting, significant economic losses can occur for growers from both management and prevention of ARD. Fumigation is an expensive pre-plant option, so a transition to using non-chemical soil amendments applied at planting would save growers both money and time managing ARD. This work aims to identify candidate amendments and optimise their use to reduce ARD in long term field trials, benefiting growers by offering alternatives to chemical treatments.

Action Points

There are no action points for growers as the project is still at an early stage of a 4-year project.