AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

Grower Summary

Understanding Resilience of Soil Beneficials to Combat Apple Replant Disease

CTP_FCR_2018_5

Annual report 2021

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 2021
Previous report:	Annual report, October 2020
Key staff:	Chris Cook
Location of project:	NIAB EMR, Kent and Cranfield University, Bedfordshire
Industry Representative:	Charnee Butcher, Worldwide Fruit., Loraine Boddington, NACM
Date project commenced:	October 2018

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 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.

Chris Cook

PhD Student

NIAB EMR

Signature .... Date ....

Louisa Robinson-Boyer

Researcher in Pest & Pathogen Ecology

NIAB EMR

Signature .... Date ....

Report authorised by:

[Name]

[Position]

[Organisation]

Signature .... Date ....

[Name]

[Position]

[Organisation]

Signature .... Date ....

GROWER SUMMARY

Headline

Planting genetically different rootstocks and inter-row cropping can both reduce severity of Apple Replant Disease.

Background

Successive planting of apples on the same location can lead previously high yielding orchards to produce reduced establishment of young trees, unsatisfactory yields and ultimate loss or removal of the tree (Mazzola and Manici, 2012). This disorder has been termed Apple Replant Disease (ARD). ARD has previously been managed using chemical fumigation of the soils to remove any pathogenic causal agents present at replanting. Legislation against many active ingredients have made us look for alternative management strategies for treatment of ARD.

Multiple non-chemical proposals have been put forward to manage ARD including anaerobic soil disinfestation and applications of beneficial microbes. These include plant growth promoting rhizobacteria (PGPR) and arbuscular mycorrhizal fungi (AMF). Both can be beneficial to the tree and increase yield, growth, and disease suppression but may not be effective at treating oomycete pathogens implicated with ARD (Xu and Berrie, 2018; Shuttleworth, 2021).

Orchard management practices are also important to prevent ARD onset. Crop rotation for a period of 5 years with a non-woody cover crop can reduce ARD pressure. Often growers do not have the land, time or resources to leave their orchards fallow or cover cropped, particularly in cider orchards. Inter-row cropping is an alternative strategy previously shown to reduce the severity of ARD, with distinctly different populations between the tree rows and grass alleyways (Rumberger *et al.*, 2004; Leinfelder and Merwin, 2006; Deakin *et al.*, 2018).

Rootstock selection is important due to different relative resistance between rootstocks (Rumberger *et al.*, 2004; Leinfelder and Merwin, 2006; Fazio *et al.*, 2012). Each rootstock will have a different level of vigour and ARD tolerance. Crop rotation with a different crop such as wheat can alleviate ARD but financial restrictions and land availability make using a different crop a large obstacle for many growers (Mazzola and Gu, 2007; Winkelmann *et al.*, 2018). Alternatively replanting an orchard with a rootstock different to the previous one can be effective in reducing ARD but the genetic resistance of the rotated rootstock and its genetic relationship to the previous rootstock are also important when deciding which rootstock to choose for rotation (Xu and Berrie, 2018; Deakin *et al.*, 2019; Shuttleworth, 2021).

In this study we present a continuation of the work from Deakin *et al* (2019) and report the results of rotating successive generation of rootstocks and different planting position. Here we report on (i) whether growth in the first 5 years after replant is greater in the alleyway then the corresponding tree station (hence ARD), and (ii) whether ARD severity was worse if the same or closely related rootstock genotypes were planted as those previously planted.

Summary

In this study we present the effect of planting rootstocks in the alleyway beside the previous tree station on ARD severity. Our results suggest that planting rootstocks closely related to the previous planted genotype can increase ARD severity. M.116 (derived from MM.106 in parental cross) and MM.106 both had greater initial growth in both girth and height compared the their paired trees in the previous tree stations. Other rootstocks more genetically different to the previously planted rootstock had similar growth in both the alleyway and the tree station. The effects of ARD were also apparent by Year 1/2 for both M.116 and MM.106.

Fruit number was higher in the alleyway trees compared to the tree station trees but fruit number was low across trees. The increased fruit in the alley could be due to larger more vigorous trees but could also be interpreted as more nutritious soils allowing energy flow into fruit production. M.116 and MM.106 had the largest disparity between the number of fruit in the alley and in the tree station, again highlighting the most severe ARD in those genotypes.

This report has focused on just one aspect of the experiment whilst I concurrently conduct the following tests:

- Metabarcoding of ITS and 16S regions to compare microbial populations in soils between alley and tree station as well as between rootstock genotypes.
- Soil functional assessment to see differences in soil carbon utilisation and bacterial enzyme activity between planting positions and rootstock genotypes.

Financial Benefits

It is difficult to identify the financial impact of ARD in orchards. Our data shows that tree establishment of common genotypes used in the cider industry may be hindered by a genetic link to the previously planted genotype. In the long-term if the tree is larger and has a healthier canopy it will both produce more fruit and create a more desirable bush shape for spray applications. Planting in the alleyway is financially difficult for growers due to existing alleys and compaction in those alleyways. Growers may also have existing irrigation lines or stakes that cannot be moved without significant financial investment.

Action Points

Growers should aim to plant a genetically different rootstock to the previous planted rootstock to maximise growth in the early years following planting. This will lead to the healthiest and largest tree and best financial reward long term for the orchard. If possible, alleyway rotation should also be considered if rootstock rotation is unviable.