Project title: Belowground carbon sequestration potential of apple trees

Project number: CTP_FCR_2019_5

Project leader: Prof Mark Tibbett and Prof Martin Lukac University of Reading and Dr Flora O'Brien NIAB EMR

Report: Annual report October 2020

Previous report: None

Key staff: Catherine Chapman

Location of project: NIAB EMR and the University of Reading

Industry Representative: National Association of Cider Makers

Worldwide fruits LTD

Date project commenced: October 2019

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.

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.

Catherine Chapman

PhD student

University of Reading and NIAB EMR

Signature Catherine Chapman Date 31/10/20

[Name]

[Position]

[Organisation]

Signature ..... Date .....

Report authorised by:

[Name]

[Position]

[Organisation]

Signature ..... Date .....

[Name]

[Position]

[Organisation]

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headline

A short-term (4 and a half months) trial looking at the difference in carbon sequestration of commercially used rootstocks in the UK.

Background

As climate change affects weather patterns globally, with predicted rises in temperature, and an increase in the occurrence of severe droughts and flooding episodes this is expected to have a major impact on global food production. Greenhouse gases (GHGs) in the atmosphere are still rising, in June 2019 the level of carbon dioxide (CO_2) in the atmosphere had risen to 413.92ppm, representing an increase of about 26% since June 1969 when it was 326.76ppm. The UK signed up to the Kyoto protocol (UNFCCC, 2014) where they agreed to reduce global carbon(C) emissions, this was followed in 2015 by the Paris agreement (*UNFCCC*, 2015) which 196 countries, agreeing to keep the global temperature rise below 2^{o}C and commit to further discussions on ways to achieve net zero carbon emissions by the second half of this century. In 2019 the UK became the first major economy to put in a legal frame work to achieve net zero GHG emission by 2050 (*GOV.UK*, 2019). Consequently, the UK government has put money aside to help mitigate and remove CO_2 from the atmosphere, with the industrial strategy Challenge fund representing a major part of the strategy to achieve this.

Perennial crops such as apple trees could help mitigate rising atmospheric CO_2 levels through sequestering carbon belowground via the roots into the soil. Soil is the second largest active carbon cycling pool after the oceans (Fry, De Long and Bardgett, 2018), and it is believed that soil is currently able to store more carbon as it is not at full capacity (Stewart *et al.*, 2007). Current rootstock breeding has promoted carbon uptake by the fruit, thereby limiting the amounts being sent to the roots and out in to the soil. Currently it is not known if any particular apple rootstock has a greater ability to store C below ground and this is what this study aims to determine. The amount of C that a tree can sequester varies dependent upon tree types (such as fruiting trees, other non-fruiting deciduous and evergreen trees) and where in the tree carbon is stored, such as above ground in stems, branches, and fruit, or belowground in roots or released in to the rhizosphere. This can also be affected by microbial (bacterial and fungal) communities in the rhizosphere, which can help promote nutrient uptake from the soil by the roots, in return for root exudates which feed these soil communities (Kell, 2012). Other factors that can affect C sequestration include abiotic stresses such as droughts and flooding, which can all have an impact on the rate of photosynthesis, growth, storage, and production.

In a climate experiment that is currently being carried out at the National Fruit Collection at Brogdale in Kent, UK (*Climate change could alter the face of apple growing in Britain*, 03/10/2018), 15 different dessert apple varieties grafted onto M9 337 rootstock, under six environmental conditions to see what affect increased temperature and changes in watering have on the growth, flowering, fruiting and fruit storage of the apples. Currently they have no plans to look at belowground carbon sequestration. Ledo et al (2020) found that approximately 30% of land is covered with perennial crops such as apple orchards, they suggest that perennial crops over their life time become carbon zero if not C negative as they continually absorb and store carbon as the soil is not being disturbed and releasing CO_2 back into the atmosphere. This PhD intends to investigate the factors which effect the ability of an apple to sequester carbon belowground, such as root system architecture via different rootstocks sizes, scion- rootstock interaction, temperature and irrigation and other factors.

Summary

In the first year of this PhD a small short-term glasshouse experiment was set up to investigate if there was a difference between three UK commercially used apple rootstocks (M9, M116 and MM106) in the amount of carbon they sequester both in the roots and the soil. The rootstocks were all grafted with Cox's Orange Pippin to avoid the influence of the scion-rootstock interaction and were grown in 1 meter high rhizotron boxes in fumigated soil. Soil samples and images were collected at monthly intervals and 12 trees were harvested every six weeks, with the final 18 trees being harvested at the end of September. Soil and root samples are still being processed in order to determine any differences in carbon levels using a variety of laboratory techniques

Financial Benefits

There are currently no financial benefits from this project at this early stage.

Action Points

There are currently no action points at this early stage in the project.

