Grower Summary

TF 223a

Improving integrated pest and disease management in tree fruit

Additional Work Report 2021

Project title:	Improving integrated pest and disease management in tree fruit
Project number:	TF 223a
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Report:	Annual report, March 2021 (Year 1)
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DISCLAIMER

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.

Michelle Fountain

Project leader, Deputy Head of Pest and Pathogen Ecology

NIAB EMR

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Industry Representative

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GROWER SUMMARY

Objective 2. Neonetria canker of apple

Headline

- A combined approach of site-specific rootstock selection and the addition of specific soil amendments at planting time can help reduce Neonectria canker in newly planted orchards as part of an integrated disease management programme.

Background and expected deliverables

Neonectria canker caused by *Neonectria ditissima* is a devastating disease of apple which has been increasing in significance over the past 10-15 years as the industry has changed agronomic practices and cultivar choice. This objective of Project TF 223a is to extend the experiments done in Project TF 223 that examined the effect of rootstock selection and the addition of soil amendments on canker number.

In the rootstock experiments, two sites in the UK were selected (Kent, Gloucestershire), while in the soil amendments experiments three sites were selected (two in Kent, one in Gloucestershire). The rootstock experiments evaluated a panel of six industry standard rootstocks alongside six advanced selections from the NIAB EMR rootstock breeding programme and two Geneva breeding programme selections (14 selections in total).

The amendment experiments evaluated the effect of arbuscular mycorrhizal fungi (AMF), plant growth promoting rhizobacteria (PGPR), Trichoderma and Biochar (at one of the sites) on reducing canker in newly planted orchards.

Summary of the project and main conclusions

Rootstock experiments

Canker numbers were assessed in 2020 in Spring (13-19 May in Kent, 21 May in Gloucestershire). For each tree, cankers were recorded according to their position on the tree where A = rootstock, B = mainstem or trunk of the tree and C, D, E = peripheral branches.

Mainstem cankers (A+B), peripheral cankers (C+D+E) and total cankers (A+B+C+D+E) were recorded. The number of dead trees per rootstock was also recorded.

By the 2020 assessment, across all rootstocks, site 1 (Kent) had a 20.7 times higher total A+B+C+D+E canker number than site 2 (Gloucestershire) (Kent: 4803, Gloucestershire: 232).

Mean A+B+C+D+E canker number for Kent and Gloucestershire increased for most of the rootstocks between 2017-2020. G41 at Kent for example, had mean A+B+C+D+E canker of 0.03, but by 2020 this had increased to 27.29. G41 at Gloucestershire had a mean A+B+C+D+E canker in 2017 of 0.13 and in 2020 of 0.82.

At the Kent site, the highest mean A+B+C+D+E canker number and peripheral C+D+E canker number was lowest for M116 (7.10, 6.34) and MM106 (7.65, 6.46) while it was highest for the Geneva rootstocks G41 (27.29, 25.13) and G11 (21.54, 19.71).

At Gloucestershire, the lowest mean A+B+C+D+E canker number and peripheral C+D+E canker number was for M9 (337) with Golden Delicious interstock (0.11, 0) and EMR-004 (0.19, 0.19), while it was highest for G41 (0.82, 0.64) and M9 (EMLA) (0.81, 0.55).

By the 2020 assessment, at site 1 (Kent), 104 of the 448 trees (23.21%) had died, while at site 2 (Gloucestershire) 100 out of 560 trees (17.85%) had died.

Many of the NIAB EMR elite selections look promising for reduced canker, such as EMR-004 and EMR-003, while EMR-005 and EMR-006 are promising for reduced number of dead trees.

EMR-001 generally did not perform well, with the highest mainstem canker number and third highest peripheral canker number at Kent, and the fourth highest dead tree number for Gloucestershire and the sixth highest dead tree number at Kent.

Analysing data from both sites showed there is little relationship between tree vigour and canker number (R^2=0.0015).

Canker number is likely affected by site factors such as weather, orchard management and soil properties.

Soil amendment experiments

In 2020 (unlike 2019) there was no statistical difference between the unamended control and amended trees at any of the three sites.

There were slight decreases in mean tree vigour observed at all sites compared to the unamended control, except for AMF at site 1 which had an increase in vigour. It isn't clear if this affected yield or other tree performance measures in 2020.

Main conclusions

Rootstock selection:

- Many of the NIAB EMR elite selections look promising for reduced canker, such as EMR-004 and EMR-003, while EMR-005 and EMR-006 are promising for reduced number of dead trees.
- At both sites, G41 had the highest mean number of A+B+C+D+E cankers.
- At both sites, tree death was higher with the M9 rootstocks [M9 (337) Golden Delicious interstock, M9 (337), M9 (EMLA)] and EMR-001.
- Analysing data from both sites showed there is little relationship between tree vigour and canker number (R^2=0.0015).
- Factors such as climate (temperature, rainfall, relative humidity), soil factors (organic matter content, waterlogging during autumn/winter, replant sites) and management factors (groundcover/mowing, tree spacing and scion cultivar selection) are likely to be having greater effects on canker number than the rootstock selection.

Soil amendments:

- There was no statistical difference between canker of the unamended control and the amended trees.
- There was a significant effect on vigour (trunk circumference) at sites 2 and 3, with decreases in mean tree vigour observed at all sites compared to the unamended control. It is not clear if this affected yield or other tree performance measures.

Financial benefits

This work has established practical approaches growers can use to reduce losses to canker in their orchards including rootstock selection and the addition of soil amendments. Growers commonly remove trees with main stem cankers in the first five years of orchard establishment and canker is known to cause tree death of ≥10% of newly planted trees each year. This results in the financial burden for growers of replacing diseased/dead trees and years of delayed fruit production. Employing a range of canker reducing methods is recommended, as using single methods in isolation may not have as much of an effect on reducing canker.

Action points for growers

- It is important for growers to remain vigilant for cankers, identifying trees which are showing symptoms, pruning out cankers or removing heavily infected trees to prevent transmission to other trees and limiting abiotic stress of trees e.g. water stress, when planting out and establishing new orchards.
- Employing a range of canker reducing methods is recommended, as using a single method in isolation is unlikely to have as much benefit as a combined approach.

Objective 7.1 Improving the reliability of natural predation of pests

Headlines

- The use of wildflower mixes, earwig refuges and hoverfly attractants hastened the influx of natural enemies and reduced pest damage in newly established orchards.
- Effects on pests and natural enemies fluctuate between years and 2020 was the first year a rise in woolly apple aphid might have been detected in two of the six treated plots.

Background and expected deliverables

Establishing new crops requires substantial investment (~£35k/ha for apple). Growers need confidence that their orchards will crop reliably and that fruit will find a profitable market. Ecological succession is the observed process of change in the species structure of an ecological community over time. The community begins with relatively few pioneering plants and animals and develops through increasing complexity until it becomes stable or self-perpetuating, as a climax community.

Newly planted orchards have an un-established ecosystem. The recently tilled ground in newly planted orchards often has minimal, simplified or absent vegetation cover with a low diversity of annual plant species resulting in low pollen and nectar provision and low refugia and structure. The tree bark and canopy are simple compared to older established trees affording little availability for predatory arthropods to gain refuge. Hence, local, populations of natural predators and pollinators have not built up and established in new orchards, leading to random, sporadic attacks from several pest species which can then be difficult to control.

The aim of this work was to apply interventions to newly planted orchards to hasten the establishment of beneficial ecology.

Summary of the project and main conclusions

Six replicate commercial apple orchards were chosen in 2017 and secured for experimental purposes through help from Caroline Ashdown at Worldwide Fruit Ltd. In each orchard, 0.25 ha was treated with ecological enhancement interventions.

In each treated area, interventions included the sowing of alleyway seed mixes (including yarrow, ox-eye daisy, bird's foot trefoil, self-heal, red campion and red clover), and the provision of earwig refuges (Wignests) and hoverfly attractants. Each treated area was assessed and compared to an untreated area of the same orchard throughout 2018 and 2019.

- Seeded floral alleyway establishment was successful in most orchards and the percentage coverage from the seed mix generally increased from 2018 to 2020.
- Not all species in the seed mix established. Red clover, yarrow and knapweed were the most abundant flowering species.
- In the early years, fewer aphids were observed in the treated plots in spring but not in summer. However, in 2020 there were more aphids overall in the treated plots and in at least two of the six treated plots, woolly apple aphids were higher in number. This should be a focus of future observations.
- More predatory spiders were found than earwigs in Wignests that had been deployed in treated plots, but anthocorids ladybirds and earwigs have also been observed. Some orchards still have relatively few earwigs even though they are in their third year.
- Predatory spiders were the most common arthropod recorded in apple trees in all seasons in both years. In 2019 most belonged to the Araneidae and Philodromidae families. Some species of the Philodromidae, like *Tibellus macellus*, primarily feed on aphids, accounting for over half the total prey they ingest when available (Huseynov 2008).
- Linyphiidae was the only family with significantly higher numbers of individuals in the treated plots compared to untreated. A subfamily of Linyphiidae, Erigoninae (also known as Micryphantids), are reported preying on soft-bodied pests, like aphids (Nyffeler & Benz 1988; Mansour & Heimbach 1993).
- In 2018, no apple leaf curling midge damage occurred in treated plots compared to untreated. Apple leaf curling midge was not assessed in 2019 or 2020.
- In 2018, fewer predatory mites and fruit tree red spider mites were found in treated plots compared to untreated. However, the opposite was observed for rust mites and spider mites. In 2019 only predatory mites were found, with higher numbers recorded in treated plots. Mites were not assessed in 2020.
- In 2018, significantly fewer codling moth deep entry damage was recorded on treated plots in summer and significantly fewer codling moth stings were recorded on treated plots in the dropped apple assessment. In 2019, codling moth stings were significantly less frequent in the treated plots in autumn. Codling moth damage was too low to analyse in 2020 but there were significantly fewer tortrix damaged apples in treated plots.

- There were significantly more hoverfly adults in the treated plots in autumn 2018. It is not known if this is the consequence of the attractant sachet and/or the floral alleyways. This effect was not observed in summer 2019. Statistical analysis on all data has to be interpreted with caution since numbers of arthropods were low in the orchards.

Main conclusions

- Positive benefits have been shown over two seasons following sowing wildflowers in alleyways in newly planted orchards, although it is important to observe effects on woolly apple aphid over the long term.
- Positive effects recorded included reduced numbers of pests including damage by codling moth, and higher numbers of natural enemies including hoverflies, spiders, and lacewings.
- Pest and natural enemy numbers need to be monitored in the long term.
- Perennial wildflower mixes in orchard alleyways also have the potential to outcompete undesirable weed species.

Financial benefits

The costs of implementing this system of management incorporating wildflower mixes, earwig refuges and hoverfly attractants are listed in the table below (calculated in 2019).

	Per unit	Per ha	Time (hours)
Seed Mix for 1 ha; every other row	-	~£152-310	-
Sowing/Drilling and Rolling over large area (Minimal ground prep because new orchard)	Large areas	New orchard £28	8 hours for 10 ha
Hoverfly attractant (7x7 m spacing)	£2.70/device 196/ha	£529.20 (£265 – half rate)	-
Cost of Labour (2019) Inc. NA + PEN	£8.77/hr	-	1
Deploying hoverfly attractant	-	£35.08	4
Reduced cost due to less mowing through labour and fuel		£ ?	Faster moving sprayer
OPTIONAL: Wignest, marketed by AgroVista		~50/pack @ £43.87/50 for 1-19 packs or 40.62/50 for 20 packs+	
Total		**~£480-902**	

Action points for growers

- New and existing orchards should be provisioned with pollen, nectar and structural resources to provide pollinators and natural enemies with habitat and food to increase their numbers.
- The selection of perennial wildflower seed mix should be largely driven by soil type.
- It is recommended to use a perennial mix which should be regularly cut to 6-10 cm in the first year to encourage establishment. The plants will flower from Year 2.
- In preparation for sowing, soil should be weed free and have a fine tilth. Once the wildflower seeds are broadcast (not drilled) they should be rolled to help seeds contact the soil. Following this, a period of rain or irrigation is desirable to encourage germination.
- The best time to sow in in the autumn.
- Seed mixes should contain a range of native open, legume and complex flower types with non-competitive grass species making up a high percentage of the mix.
- From Year 2, in general, one cut before fruit harvest is recommended or maybe an additional midsummer higher cut – depending on weather conditions.
- Our orchards were also amended with earwig refuges (Wignests, Russell IPM) in each tree and hoverfly pheromone attractant. A similar hoverfly attractant product, MagiPal, is now available from Russell IPM.