

Green manures improve soil health in apple orchards



Figure 1. James Smith, Managing Director of Loddington Farms, evaluating soil structure

Action points

- Green manures have potential for use in modern orchard systems and they can bring benefits to beneficial insect populations as well as to soil health
- Growers are advised to regularly test soils using a range of techniques before and after making major changes, to enable them to measure the impact of soil management changes to the health of soils
- Demonstration trials in AHDB Horticulture Greatsoils project CP 107b concluded that the best soil tests for growers of perennial crops include soil structural evaluations (from simple compaction tests to more in-depth soil profile investigations using established methods), infiltration tests and earthworm counts

Background

There is increasing interest among UK growers in the potential for green manures to help improve the health of soils in intensive crop production systems. Evidence suggests that green manures can improve soil structure and soil organic matter content, which can lead to enhanced water infiltration, reduced plant water stress and, ultimately, improved crop quality and yields, in some cases. Most work relating to green manures has, to date, concerned crop rotations, rather than focus on perennial crops. There is, therefore, limited evidence to demonstrate the potential for different green manures species and mixtures in commercial orchards.

The Smith family have been growing fruit for five generations at Loddington Farm, near Maidstone in Kent and now produce apples, pears, cherries and apricots in around 60 hectares of orchards spread across three sites. The family are passionate about farming in ways that create and enhance a diverse range of habitats for a wide variety of plants, beneficial insects, birds and animals. Recently, they have been experiencing many challenges with establishing and maintaining productivity in new orchards.

James, Managing Director of Loddington Farm (Figure 1), and his brother Paul, are convinced that the key to improving tree establishment and productivity lies in a better understanding of their soils and appropriate soil management practices. They understand that soil plays a fundamental role in the profitability and long-term future of their whole business and are keen to learn more about soils – how to assess soil health and options for improving health over time. One option they have tested is to establish and maintain green manure strips between rows of orchard trees.

Approaches used

The brothers investigated the impact of two different green manure mixtures in a new apple plantation (Discovery, planted in April 2016) on a range of soil health parameters, including soil structure, soil organic matter content, soil fertility, soil respiration and earthworm counts. Apple trees were planted 1 m apart within the row, with the rows being 3.25 m apart. Standard orchard practice for managing soils between the trees at Loddington has been to sow grass/white clover strips (around 2 m wide) between the tree rows after planting, and mulch-mow three or four times a year. Herbicides are used twice each year to keep a 1 m wide strip under the trees free of weeds (Figure 2).



Figure 2. Standard ground cover mixture (grass and white clover) used in the strips between rows of orchard trees

James and Paul applied green manure treatments to three alleys (each alley lay between two rows of trees) over a row length of 100 m. The green manure treatments were sown full width between the tree rows after planting; they were not cut using a mulch mower and no herbicides were used to maintain a 1 m weed-free strip under the trees.

The green manure mixtures used in the demonstration trial were:

- A pollinator mix based on 14 species (Figure 3). There were five grass species in the mix (including several varieties of native grasses such as crested dogstail, sheeps fescue and smaller catstail), eight legume species including clovers and vetches, plus phacelia
- A soil improver mixture based on nine species (Figure 4). There were five grass species (including three species of fescue, a bent and a meadow grass) and four legume species including clovers and lucerne

The brothers compared the soil health from the traditionally managed alleys with soils from alleys with the two new green manure mixtures.

Soils were assessed and sampled for testing in April 2016, late October 2016, mid-April 2017 and late October 2017, which meant that results were available from before and after planting, which took place in April 2016.

Soil structure was evaluated in the field using the method published in the *Healthy grassland soils* factsheet. The speed of water infiltration into the soil was measured in the field using a simple test (see the *Soil structure and infiltration* factsheet). Earthworms were counted and identified to species level in the field, using the Opal method (Jones & Lowe, 2012). The soil was also sampled and tested using a new soil health test suite, offered by NRM.



Figure 3. Green manure mix 1 (pollinator mixture) growing between the tree rows

The NRM soil health test suite provides an overall soil health 'score' which is based on results of several chemical soil health tests (extractable P, K and Mg, soil pH and total soil organic matter), a physical indicator (texture) and a biological indicator (respiration rate). It also provides some soil management recommendations derived from the results.



Figure 4. Green manure mix 2 (soil improver mixture) growing between the tree rows

Findings

James felt that one of the best things to come out of the trial was that he spent an increased amount of time focusing on assessing the condition of the orchard soils, and possible options for improving soil health.

“So much of the day-to-day assessment of orchard health looks at what is going on above the soil surface,” he said. “This project got us looking at what is going on under the soil surface, including worm activity, soil structure and infiltration.”

Several soil tests over and above standard soil nutrient and soil organic matter testing proved useful at Loddington farm. James was impressed with the testing and, in particular, the speed at which soil structure improved (as measured by the test) under the alleys, which had been sown with either of the two green manure mixtures, in comparison with the standard orchard mix of grass and white clover). Soil structure was markedly better under the green manure treatments in the second and third assessments but by the final assessment, soil structure had improved in the standard orchard mix and similarly good structural scores were obtained in all three alley treatments.

James found the water infiltration test to be a quick, useful indicator of the amount of compaction present in orchard soils. There were clear differences in the speed of water infiltration between soils, which were more or less compact in nature.

Counting earthworms properly, with species identification, is a time-consuming business, and few growers would have the time to do sufficient assessments once or twice a year, as required, to be confident of differences between treatments. The trial at Loddington was relatively short term, and the treatments were not replicated. However, early indications were that earthworm numbers increased over the 18-month trial, which might be expected under an establishing perennial crop. On the final earthworm count earthworm numbers were considerably higher in soils under the two green manure treatments than they were under the grass/clover control. There could be many factors at work though, given that the management regime differed between the three alley treatments. However, given the importance of healthy earthworm populations in soils under perennial crops, the results suggest that it may be worth reviewing the impact of green manures and management options on earthworm populations in orchards.

The NRM soil health test suite contains several useful individual pieces of information that can easily be interpreted to obtain recommendations for improving aspects of soil health (e.g. soil pH and extractable nutrients). However, one of the tests done as part of this suite measures soil respiration, which is more difficult to interpret accurately. Until more data is available for comparison, the value of producing a single score from the results of all the tests in the suite, which represents the health of a soil, is debatable. In this case, the health of the soils, as measured by soil respiration (which is a recognised indicator of soil health), under the standard orchard mix remained similar over the course of the trial, whereas that of soils under the two green manure treatments appeared to improve throughout the trial.

Growers involved in the field trial felt that the most useful soil health tests for top fruit included visual soil health assessment, water infiltration and earthworm counts. They felt that some tests within the NRM soil health test suite were useful, but were undecided as to whether they would pay for the whole test suite in future.

James and Paul also felt that the green manures could be attracting and providing homes for greater numbers of beneficial insects and have obtained some evidence that topsoil health was improving more quickly under the green manures than under their standard orchard alley mix of grass and white clover. They acknowledge that both their standard orchard mix and the more novel green manure mixtures can compete with the developing young trees and, for this reason, they are considering looking further at options for managing green manures organically, using mulch mowers rather than herbicides. Both are convinced that, despite some challenges, green manures have sufficient potential to merit further investigation for use in fruit orchards.

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References

Jones, DT & Lowe, CN (2012) Opal Key to common British earthworms (<https://www.opalexplornature.org/sites/default/files/7/file/soil-survey-field-guide-2014.pdf>)

Rosenfeld, A & Rayns, F (2012) Sort out your soil: a practical guide to green manures. Editors: Wilkinson, I., and Milner, I. (Costwold Seeds).

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Further information

A range of resources for soil health assessment and soil management, including the publications below, are available on the AHDB Greatsoils web page www.ahdb.org.uk/greatsoils

- **Healthy grassland soils** factsheet
- **Soil structure and infiltration** factsheet
- 24/10 **Green manures – effects on soil nutrient management and soil physical and biological properties** factsheet
- 25/10 **Green manures – species selection** factsheet
- 26/10 **Green manures – implications of economic and environmental benefits on rotational management** factsheet

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