

Short-term green manures for intensively cultivated horticultural soils



Figure 1. Choose a green manure species or mix that suits the soil type, growing system (and available machinery) and the climate and length of the growing season

Introduction

Despite growing interest in green manures (crops grown to improve and protect the soil), using them in intensive vegetable rotations is particularly difficult. This has led to few large-scale vegetable and salad growers using them. This case study details the main green manure species suitable for use in high value vegetable and salad rotations, and summarises the benefits they can bring. It outlines demonstration trials undertaken at a large outdoor leafy salad-growing business and describes experiences gained by the grower.



Figure 2. Regular soil sampling is essential in intensively cultivated horticultural soils

Action points

- Consider trialling green manures in your vegetable rotations
- Read around the subject and learn about the species and mixtures that will suit your climate, site, soil and production system (Figure 1)
- Choose species or mixtures that are likely to bring benefits over the duration you plan to grow the green manure crop
- Find out whether growers local to you have had successes and/or failures with short-term green manures and learn from their experiences
- Take soil samples (Figure 2) and measure soil health parameters before and after growing green manure crops. Consider measuring soil organic matter and soil infiltration and assessing soil structure
- When counting the cost of green manures, be sure to consider potential long-term, as well as short-term, costs and benefits

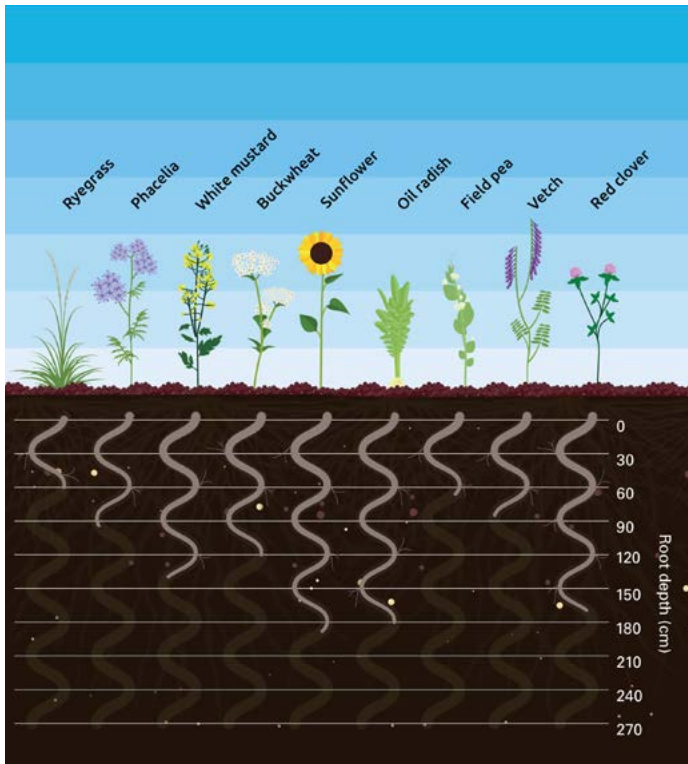


Figure 3. Green manure species have different attributes, eg deep-rooted species can bring up nutrients, including trace elements, from the deep

Background

Green manures are crops grown to improve and protect the soil. Depending on the species or species mix grown, they can bring a range of benefits not only to the soil, but also to the cash crops grown in the rotation and to the wider farm environment. Interest in green manures has grown recently, as farmers seek to minimise fertiliser costs and redress soil damage caused by years of cultivations with limited organic matter returns. However, incorporating green manures into intensive vegetable rotations is particularly challenging and has resulted in limited use of green manures by vegetable and salad growers.

Some green manures can bring immediate financial benefits, eg where the tops or roots are harvested as an energy crop for anaerobic digestion or where they provide grazing for animals. However, in most cases their purpose is to benefit subsequent crops and soils in the long term. There is a wide variety of green manure species from which to choose.

Legumes, such as clovers and vetches are popular because they fix nitrogen, but all green manures can offer other benefits, such as reducing nutrient losses over winter, weed suppression and improvements in soil structure. Some deep-rooted species are particularly good at bringing soil nutrients including trace elements up from deep within the soil profile (Figure 3) and some are thought to improve the availability of phosphate.

Green manure crops often have a positive impact on weed control and on the incidence and severity of pest and disease attacks. They can, however, become a weed problem in themselves and can compete with cash crops for both nutrients and water, so species choice and management is important.

Although green manures have the potential to make significant improvements to soil health, crop quality and yield, no single species will offer all of the benefits that green manures can bring. It is often beneficial to grow a mixture of species rather than a single species, but the choice of species or species mix will depend on the soil type, climate and latitude, as well as the crops grown in the rotation and the available machinery.

The longer the green manure crop is in the ground, the greater the benefits that it will bring, eg increases in soil nitrogen fertility and improvements in soil structure. For example, grass/clover leys are a mainstay of organic farming systems and there are proven benefits to both soil structure and fertility of leaving them in the ground for one, two or more years. Where soil structural problems are severe, eg following enforced harvest in wet conditions, it may be beneficial to consider sowing a long-term green manure ley for a full year or more. However, there is growing evidence that it is possible to gain benefits in intensive rotations by growing green manures for relatively short periods. While some growers are able to sow overwintering green manures, others are trying short-term green manures during the growing season, either in the beds with the crop (intercropping or companion-cropping), in strips between the cash crop beds/rows or as very short break crops between multiple crops within the growing season. Table 1 summarises the key characteristics and benefits of the most commonly grown species which have potential for use as short-term green manures.

There is little doubt that every farm is different when it comes to realising the benefits of green manures. Farmers growing in northern latitudes have a particular problem because their growing seasons are short and there is often little or no time to establish green manure crops after cash crops, particularly when weather and soil conditions are poor at harvest. Those growing multiple crops each season also have difficult decisions to make on how best to use green manures during short periods, while still maintaining a profitable rotation. Although the advice from independent experts on green manures and seed companies selling green manure seed (and from growers local to you who have tried green manures) will be invaluable, there is no substitute for trying green manures yourself, on your own holding.

The GREATsoils project aimed to work with vegetable, salad and fruit growers to evaluate a range of methods for measuring soil health. Several fruit and vegetable growers involved in the project chose to evaluate soil health before and after trialling green manures on their holdings.

Table 1. Overview of the main green species and mixtures which have potential as short-term green manures in UK vegetable and salad production

Benefit									
Species	Plant type	Annual/perennial/biennial	Approximate ideal duration	N fixer	Speed of N release on cultivation	Good nutrient lifter	Best for soil structure improvement	Good for organic matter	Good for very short summer terms (<2 months)
Red clover	legume	perennial	1–4 years	✓	fast	✓	✓	✓	
Crimson clover	legume	annual	6–9 months	✓	fast	✓	✓	✓	
Persian clover	legume	annual	5–12 months	✓	fast	✓	✓	✓	
Sweet clover	legume	biennial	6–18 months	✓	fast	✓	✓	✓	✓
Yellow trefoil	legume	annual	6–18 months	✓	fast	✓	✓		
Vetch	legume	annual	6–10 months	✓	fast			✓	
Grazing rye	cereal	annual	6 months	✗	slow	✓		✓	
Mustard	brassica	annual	2–4 months	✗	slow			✓	
Tillage radish	brassica	annual	3–6 months	✗	slow	✓	✓	✓	✓
Buckwheat	polygonaceae	annual	4–6 months	✗	moderate	✓			✓
Phacelia	borage	annual	4–6 months	✗	slow				
Chicory	composite	perennial	1–5 years	✗	moderate		✓	✓	
Perennial ryegrass	grass	perennial	1–5 years	✗	slow			✓	
Cocksfoot	grass	perennial	2–5 years	✗	slow			✓	
Italian ryegrass	grass	perennial	1–2 years	✗	slow			✓	
Westerwolds	grass	annual	6–12 months	✗	slow			✓	
Red clover & ryegrass	mixture	perennial	1–3 years	✓	slow			✓	
Rye & vetch	mixture	perennial	6 months	✓	slow	✓		✓	
Ryegrass & vetch	mixture	perennial	6 months	✓	slow			✓	
Mustard & mixed clovers	mixture	perennial	4–6 months	✓	fast			✓	
Oats, peas and vetch	mixture	annual	3–6 months	✓	fast			✓	
Yellow trefoil & white clover	mixture	perennial	6–18 months	✓	fast			✓	

All green manures help to retain nutrients in the topsoil while they are growing well. They also protect soil structure and help prevent soil erosion (the extent to which they do this depends on the species grown and the extent to which the soil is covered). Green manure crops often have a positive impact on weed control and on the incidence and severity of pest and disease attacks but they can become a weed problem in themselves and can compete with cash crops for both nutrients and water, so species choice and management is important. Although all green manures have the potential to deliver organic matter returns when they are incorporated, those that produce the most biomass generally contribute the most: overwintering and full growing season mixtures are generally best.



Figure 4. Phillip Hubbert, JEPCO

Phillip Hubbert (Figure 4) is Production Director at JEPCO. The business produces a wide range of conventional and organic leafy salads and salad onions. The crops are grown over around 650ha in Lincolnshire, Norfolk and Essex. Phillip knows that mechanical cultivation techniques are detrimental to soil health. He is aware that the organic matter content in some fields is lower than it could be and feels that green manures could be part of the solution.

JEPCO has been trialling green manures for the past four years and got involved in the GREATsoils project in 2015. It has had positive results with various short-term green manure types, including winter oats, a grass/vetch mix and oilseed radish. Phillip chooses green manure crops for their key benefits: the oats are relatively inexpensive, the grass/vetch mix persists well into the spring when a later start is planned for the following crop and the radish is especially good at producing fast-growing, deep roots, which are beneficial for soil structure. In some trials, Phillip has measured the biomass/ha of cover crop returned to the soil and he feels this may become standard practice at JEPCO, since it helps with nutrient input planning.

All of the green manure crops at JEPCO are sown in autumn, after the previous rotational crop (usually winter wheat; occasionally vining peas or sugar beet), which precedes salad crops in the rotation. The green manures are overwintered, then cultivated in before the salad crops are sown in spring.

At present, food safety standards do not allow cover crops to be grazed off immediately prior to growing leafy salads, so the green manures are currently flail-mown prior to being cultivated in.

Few earthworms were found in this intensively managed soil but Phillip felt there were clear improvements in soil structure both during and following the green manure crop. Water infiltration downwards through the soil profile improved in soils growing buckwheat in comparison to control plots of bare soil.

From a business point of view, Phillip has found that flexibility in the planting programme and the ability to work around bad weather is much improved where there are green manures in the rotation. As he ploughs in front of planting, the improved soil structure following green manure crops tends to provide better drainage, allowing for earlier entry than on land ploughed during the winter. Phillip is also finding that cultivation costs are lower following green manure crops, due to the soils being in better condition. He also found out that the soil's ability to cope with high rainfall events is much improved in cropped areas which follow green manure crops.

Using green manures fits with the need to maintain and improve environmental performance of high-value cropping systems.

JEPCO took part in a GREATsoils field demonstration trial during 2016 which investigated the impact of a short-term (six-week) green manure crop (buckwheat) in an intensive salad rotation. Beds were formed in the spring (after winter wheat) and a wholehead lettuce crop was grown. Following harvest of the first 2016 crop, the soil was either rested (left bare) or sown with buckwheat, which was left to grow for six weeks. Buckwheat was grown on 20 metre lengths of alternate beds (Figure 5). The buckwheat was flail-mown and cultivated in prior to sowing the second 2016 wholehead lettuce crop across beds on the whole field in late summer. Earthworms were counted, soil structure was assessed using visual soil assessment, water infiltration rate was recorded and the NRM soil health test was conducted before, during and after the green manure and salad crops.



Figure 5. JEPCO buckwheat green manure demonstration trial

In 2017, JEPCO also took part in a GREATsoils Field Lab, part-sponsored by Innovative Farmers (www.innovativefarmers.org). The trial aimed to look at the impact on agronomy of growing wholehead lettuce crops following an overwintered green manure (King's Italian ryegrass mix).

Phillip felt that cultivations were easier and that JEPCO had used less diesel, particularly with its triple bed tiller, where around 10 litres per hour were saved. He also found that water infiltration into the soil was improved where the lettuce crops had followed green manures. For example, in late Summer 2017, following a wet spell when around 75mm of rain fell in just over 24 hours, Phillip noticed that water disappeared off the beds a lot quicker where the lettuce had followed a green manure crop.

There was a 7.9 per cent increase in lettuce head weights where the crop was grown following the overwintering green manure. It is important to note that only a small trial area was planted and the trial was not replicated. The increased weights were down to both bigger heads and improved integrity of leaf structure. Phillip felt that the improved leaf structure would potentially give a longer shelf life and that since the crop was more consistent in size and shape, harvesting was easier, which was likely to further reduce costs.

Phillip admitted that the incorporation of the cover crop was challenging. However, he felt there were clear indications of benefits to both soils and cash crops from growing the cover crop.

Phillip Hubbert is convinced there is a future for short-term green manures at JEPCO, to the extent that they are now being grown before all salad crops, but the company is committed to further work to determine the best species and mixtures to use and to improve the ways in which green manures are used within its cropping systems.

Conclusions

There is clear and growing evidence that green manures, eg phacelia (Figure 6) have considerable potential to improve the health of soils in intensive vegetable rotations

without being a drain on profitability. The choice of species or mixture, and the most appropriate techniques for using green manures will differ depending on the soil type, growing system, available machinery and on the climate and length of the growing season. For that reason, growers are advised to read around the subject, talk to farmers who have tried green manures locally, and then try them on a small scale in the first instance. It's a good idea to conduct simple farm trials to develop methods that work on your holding, in your own rotations.



Figure 6. Phacelia is suited to most soil types. It flowers 6–8 weeks after sowing and so it must be dug in before it seeds

Authors

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Figures 4 & 5 – JEPCO

Further information

A range of resources to help you with soil health assessment and soil management are available on the AHDB GREATsoils webpage at ahdb.org.uk/greatsoils

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