

INTRODUCTION

Green manures are specific plants grown when land is not being used for crop production. They are incorporated into the soil to enrich it. There is no short term economic gain: they are not produced for sale, but rather for the benefits they provide for the production of subsequent cash crops.

WHY GROWN THEM

The use of green manures is particularly important in horticultural systems where vegetable growing is demanding on the soil in terms of both nutrient depletion and deterioration of soil structure. Although often used in conventional production as part of an integrated crop management programme they are always used in organic production and if a stockless system is being operated, they are vital.

BENEFITS

Green manures have different attributes, but some of the following benefits could be achieved by their use:



Buckwheat – fast growing, deep rooting



Phacelia – quick to establish, attractive to insects

- **Improving soil structure**

Organic matter in the form of humus is the key to soil improvement. It needs to be replenished after every cultivation if levels are to be maintained and this can be achieved by the addition of green manure. Also extensive root systems open up compacted soil and improve drainage.

- **Erosion protection and nutrient conservation**

Quick growing green manures hold soil in place, reduce crusting and protecting against erosion from wind and rain. The above ground plant material also helps reduce the impact of raindrops, reducing soil capping. Long term use also increases water infiltration and reduces runoff. In addition, winter green manures take up and retain nutrients in their leaf and stem structures, which might otherwise be washed into the subsoil by winter rain.

- **Suppress weeds**

Green manures take up space and light, thereby shading the soil and reducing the opportunity for weeds to establish. The aim is for them to 'out compete' weeds for water and nutrients.

- **Pest and diseases**

Some green manures host beneficial microbial life that discourages disease and create an inhospitable soil environment for many soil borne diseases. They encourage beneficial insect predators that can reduce insect damage, some produce compounds that reduce nematode pest populations.

A sudden change of plant species, growing on the same piece of land goes a long way towards controlling certain pest and diseases. By disturbing and quickly altering the surrounding habitat or food supply it is possible to break their life cycle and reduce numbers. They also provide habitats for pollinators and other beneficial insects.

- **Increasing microbial activity**

After incorporation, the breakdown of green manures releases nutrients held within the plant tissues, making them available to the following crop. A fresh influx of organic matter stimulates a rise in soil micro-organisms. This will provide a valuable source of plant food as they consume the decomposing green manure

- **Nitrogen fixation**

Nitrogen fixation is often the main reason for growing green manures. The nitrogen fixing ability of legumes represents a true import of Nitrogen and is therefore invaluable. Traditionally this has been achieved by the use of leys or fertility breaks.

WHAT VARIETY TO CHOOSE

The choice of green manure will depend on a number of factors including: the desired outcome, season, site characteristics, duration of ground occupation required etc. Table 1 (below) lists some of the key characteristics of the most commonly used green manures.

Table 1: Key characteristics of commonly used green manures

Common name	Latin name	Characteristics
Alfalfa	<i>Medicago sativa</i>	Deep rooting retrieves trace elements and improves the structure of the subsoil. Rich in calcium. Cut foliage as mulch or dig in when still green. N fixer.
Buckwheat	<i>Fagopyrum esculentum</i>	Fast growing. Deep rooting, accumulates calcium. Weed smothering. Pink flowers attract insects.
Clover white	<i>Trifolium repens</i>	N fixer. Good weed suppressor. Drought tolerant.
Clover red	<i>Trifolium pratense</i>	N fixer. Penetrating root structure. Competitive against weeds.
Clover crimson	<i>Trifolium incarnatum</i>	Vigorous, quick growing. Attractive to bees. N fixer.
Fenugreek	<i>Trigonella foenum graecum</i>	Quick growing. Good for catch cropping in summer. Useful for increasing humus content of the soil.
Italian ryegrass	<i>Lolium multiflorum</i>	Quick and abundant growth, extensive fibrous roots.
Fodder radish	<i>Raphanus sativus</i>	Rapid growth. Weed smotherer
Mustard	<i>Sinapsis alba</i>	Very rapid growth. Excellent between summer crops. Dig in before flowering. May act as a decoy crop for wireworm. Weed smotherer
Phacelia	<i>Phacelia tanacetifolia</i>	Flowers attract insects. Good ground cover, weed smother and establishes quickly.
Lupin	<i>Lupinus angustifolius</i>	Deep rooting, good for breaking up and aerating soil, and retrieving trace elements from the subsoil. Most varieties are poisonous. N fixer.
Yellow trefoil	<i>Medicago lupulina</i>	Good for undersowing. Will stand through winter into the following season. Dig in while still fresh and green, or in Spring from later sowings. N fixer.
Winter beans Or field beans	<i>Vicia faba</i>	Deep rooting. Grow to about 45cm. Sow with grazing rye to improve weed control. N fixer.
Winter grazing rye.	<i>Secale cereale</i>	Extensive roots. Really good for soil improvement, especially on clay. Inhibits seed germination.
Winter tares	<i>Vicia sativa</i>	Also known as vetches. Produces a large quantity of foliage. Inhibits seed germination. N fixer.

WHEN TO GROW

Although traditionally used as a winter cover there are many options for their use, the skill is in managing their usage at every available opportunity to gain maximum benefit.



Yellow trefoil – nitrogen fixing

- **Winter cover** A winter green manure is sown in late summer or autumn to provide soil cover during the winter. It needs to possess enough cold tolerance to survive hard winters'. Hairy vetch and rye are among the few selections that meet this need. Specific varieties will also scavenge excess nitrogen from previous crops and prevent leaching. The nitrogen held within the green manure crop is released once the green manure is incorporated in the spring.
- **Summer cover** A summer green manure only occupies the ground for a portion of the summer growing season, but can add organic matter to the

soil. They can be used to fill a niche in crop rotations or simply to fill a gap before a late sowing of crops. If a legume is used, it will add nitrogen along with organic matter; non-legumes will provide biomass, smother weeds and improve soil tilth. Normally planted from spring onwards and in the ground for 8 – 10 weeks, examples are; Phacelia, Buckwheat and Mustard.

- **Interplanting / Living mulch** An interplanting system is where the green manure and vegetable grow together in the field for all or part of the growing season in order to extend weed control and other green manure benefits. They can compete for moisture and nutrients, so they are not recommended for low growing, shallow rooted or drought susceptible vegetable crops. They may be planted before or after the vegetable crop. The most likely green manures for this system are clover and yellow trefoil.
- **Fallow period** Fallow green manures provide the best rotation benefit in terms of resting the land from cultivation, avoiding crop families likely to host vegetable diseases, and adding biomass to the soil to help maintain its structure and the supply of organic carbon and nitrogen. However, they can be the most costly in terms of lost production because they are grown *in lieu* of a cash crop. Fallow green manures are used over a one to three year period. This means that they can add large amounts of organic matter to the soil and leave the structure of the soil in excellent condition for subsequent crops. Sweet clover and specific fertility building mixes of clover, rye and cocksfoot are very good.
- **Undersowing** Undersowing / Interseeding green manure into an already established crop is a way of getting ahead of the traditional winter green manure. This can lead to an increase in biomass production, erosion control and soil organic matter enhancement. It is important that the timing is right, sowing must be delayed enough to minimize competition with the vegetable crop but early enough so the green manure can survive competition with the vegetable. The usual green manures for this are clovers.

MANAGEMENT

Green manures are not generally difficult to manage, they can be seeded by drilling or broadcast. Once they have grown then they can be incorporated into the soil by digging or mechanical methods. If on a mixed farm they can be grazed. In some instances they can simply be topped and left on the ground as a mulch or recovered and composted.

ECONOMICS

It is hard to quantify the value of green manures, as their worth lies in the improvements they make to soil structure and fertility and the consequent improvements to cash crop yields. On mixed holdings where there is livestock to utilise grass / clover and forage legume crops, there is no opportunity cost incurred by having unused land.

The cost of seed is obviously variable year on year. Table 2 shows seed prices which were current at the time of writing, along with the seed rate per hectare. Over and above the seed costs, labour and equipment use must also be taken into account to give a true indication of the cost of producing green manures.

Table 2: seed costs for selected green manure crops

Variety	Price	Requirement per ha	Cost per ha
Phacelia	£9.60 per Kg	10 Kg	£ 96.00
Buckwheat	£1.80 per Kg	80 Kg	£ 144.00
Mustard	£1.90 per Kg	25 Kg	£ 47.50
Sweet clover	£2.90 per Kg	15 Kg	£ 43.50
Rye	£0.68 per Kg	180 Kg	£ 122.40
Vetch	£1.55 per Kg	65 - 100Kg	£ 100.75 - £155.00
Crimson clover	£6.90 per Kg	15 Kg	£ 103.5
White clover	£9.80 per Kg	5 Kg	£ 49.00
Yellow trefoil	£3.70 per Kg	8 Kg	£ 29.60
Red clover	£7.80 per Kg	15 Kg	£ 117.00