Information

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Green Manure Crops

Background

Cover crops (green manures) are integral to field cropping systems. They can be used to break up pest lifecycles and are also grown to conserve, accumulate and recycle organic matter and plant nutrients, to improve soil fertility and structure and to assist in the control of weeds, pests and diseases. The use of green manures is particularly important in horticultural systems; tree crops are demanding on the soil in terms of both nutrient depletion and deterioration of soil structure. Grass leys, which are an important part of the fertility building phase, are frequently inappropriate (risk of build-up of pests such as wireworm) for horticultural regimes, so the correct use of green manures is vital.

The autumn and winter is the best time for some green manures to be grown since they may be fitted inbetween cash crops. Research has shown that nitrate leaching can be effectively reduced by the use of winter cover crops. For crops such as Sudan grass, Tagetes or Brassicas, planting should occur when the risk of frost has gone i.e. during the late spring and summer months. For land that is available prior to planting consider a green manure crop 6 months in advance of that planting.

1. Grazing Rye and Leguminous Plants

Of all the species investigated grazing rye is by far the most effective for preventing nitrate leaching since it becomes established so rapidly and continues to grow throughout the winter period. Legumes, particularly vetch, significantly increases the mineral N available to plants in the first season after their incorporation. The timing and quantity of nitrogen released can be manipulated by altering the incorporation date.

Crops grown after the incorporation of green manures tend to be higher yielding than those following bare soil; this effect is most evident in soil where available nitrogen levels are low.

The incorporation of both rye and vetch can cause inhibition of seed germination and this can have serious implications for the establishment of some crops of the Brassica family if they are sown too soon.

Mineralisation of the nitrogen in rye continues throughout the first autumn after its incorporation. If the land is kept bare this can result in considerable leaching (effectively postponed from the previous winter) but this excess nitrogen can be effectively utilised by winter agricultural and horticultural crops eg., winter cereals and tree crops. By the second winter after incorporation this extra leaching has declined to background levels. Green manures must therefore be carefully integrated into the rotation to maximise their benefits and to reduce the risk of loosing their nitrogen by leaching.

2. Phacelia

Phacelia has vigorous and highly branched roots which penetrate the soil and help to break it down. The structure of the soil is improved and its working made easier. Phacelia has roots which are much more developed than other green manure plants that may have been used in the past. Moreover, its roots quickly reach their maximum development which is reached when the plant is in flower, usually around two months after sowing. At that time, the oldest roots begin to die which allows the micro-organisms in the soil to start their job converting the organic matter.

Phacelia also has dense, abundant, thick foliage that can reach about 45cm in height. It protects the soil from the impact of rain and smothers weeds. This is very important for some of the capping soils and this protection is much better because Phacelia is sensitive to frost. At temperatures of around -5^0C the foliage and stems spread out over the soil and ensure an excellent cover.

In decomposing, *Phacelia* releases minerals, particularly phosphorus, calcium and magnesium in high proportions in an easily assimilated form for the following crop. The bright blue flowers attract hover flies, which lay eggs nearby and predate on surrounding crop aphids.

Through its foliage and roots, *Phacelia* gives each hectare more organic matter benefit than farmyard manure. *Phacelia* produces as much as 30 tonnes equivalent of farmyard manure and when buried, releases around 50 units of nitrogen for each tonne of dry matter produced. This calculation only includes the foliage and stems and not the roots. The nitrogen is released quickly in one or two months after decomposition begins. *Phacelia* also eliminates the leaching of nitrates in a mild winter and retains around 50% of the nitrogen produced by cultivation, which is around 20-30 units per hectare.

By using pelleted *Phacelia* seed you do not run the risk of re-seeding or a continual on-going volunteer *Phacelia* problem. It is a plant that needs warmth, and when sown from July onwards will not produce seed. The plant itself is very sensitive to the cold and will be killed by normal frost conditions. It has also been known to be a host to sugar beet nematodes.

Phacelia is adaptable to all types of soil and grows in all climates. It is happy with a weak nitrogen fertiliser of around 40-60 kgs/hectare according to the richness of the soil. There is usually sufficient phosphorus and potash for it from the previous crop. *Phacelia* is sown at around 8-12kg/ha in a finely prepared seedbed placed at around 1-2cm deep. It should be ploughed in before or after the winter, depending on the soil type. It is very easy to prepare for ploughing by rolling, discing or rotavating.

3. Sudan grass (*Sorghum* spp.)

This is a crop similar to *Phacelia* in its growth characteristics. It is heat tolerant, drought resistant and can grow in a wide range of soils. It produces a deep, penetrating network of roots throughout its life and this can be increased further by cutting the top growth part-way through the growing season. It does not produce flowers but forms a large, dense canopy layer that suppresses weed growth and prevents erosion successfully. Work with this crop is limited in the UK but some initial results have shown that both nematode populations and *Verticillium* wilt propagules have been significantly reduced in an infested soil after one application of this crop. The plant produces a harmless glucoside called dhurrin, which when the plant is damaged by cutting, frost or drought, is converted into hydrogen cyanide (HCN).

German research has found that during growth, the roots can start to exude some of this chemical, thus giving some initial control. Young tissue produces a greater amount of HCN, which requires incorporation and sealing immediately after a flail cut to gain maximum effect. The limited work on this crop means that further research is required to identify the variety that produces the most HCN, at what growth stage this occurs and an appropriate approach to growing in the UK.

If seed is broadcast, 60kg/ha is required but if the seed is drilled, 45kg/ha is recommended. Fertiliser application is required but as experience with this crop is limited, it is not known for sure whether adding a basic nutrient mix is going to be the only requirement to achieve optimum crop growth.

4. Marigolds (*Tagetes* spp.)

Tagetes is an important green manure crop because, like *Phacelia*, it has the added benefit of being able to produce flowers during its growing season. It can also be used successfully as an inter-crop between such crops as field-grown ornamental trees. The plant roots contain naturally-occurring broad-spectrum biocides that act as nematicides, fungicides and bacteriocides. After incorporation, at the end of flowering, a breakdown of organic matter occurs, which encourages a range of beneficial, disease-fighting micro-organisms. The amount of organic matter produced depends on the variety used but can be substantial. As with Sudan grass, the amount of public research that has been carried out in the UK is limited but initial results on some nurseries show that a good amount of organic matter can be produced. Pest and disease suppression is also an area that needs further research, as far as the range of problems controlled is concerned and its period of efficacy. Usual application rates are 3-4kg/ha.

5. Mustards

There are several varieties on the market but the Caliente brand from Plant Solutions division of Tozer Seeds has shown significant promise abroad and in the UK. A wide range of soil diseases can be reduced including Verticillium wilt, silver scurf, *Sclerotinia* and nematode damage, onion pink root, *Sclerotinia minor* in lettuce, *Pythium* in carrots, *Fusarium* in tomatoes and *Sclerotinia*, *Pythium* and *Fusarium* in beans. A significant amount of organic matter is also produced which can be incorporated into the soil to release a similar product to the Sudan grass. Successful biofumigation and green manuring from Caliente Mustards requires a number of inputs, which will be repaid in following crops. Failure to treat Caliente Mustards as a 'crop' may result in disappointment.

Flowering time and incorporation depends on variety and sowing date. A period of 21 days after incorporation is recommended prior to planting a new crop to prevent the risk of poor seed germination.

Caliente Mustard 199

- Hottest variety, giving the best biofumigant action due to very high levels of glucosinolates (30% more ITC than the previous basis Blend 119).
- Requires good growing conditions.
- Fertiliser inputs and irrigation are essential for best results from this variety.
- Recommended seeding rate: 8-10 kg/ha.*

Caliente Mustard 61

Large leaved variety producing high levels of biomass under ideal conditions. Longer season and slowest to flower out of the varieties.

Requires warmth so suitable for mid-summer UK growing and needs irrigation where soil moisture is low. Best variety for warmer climates (Spain, Portugal etc.) Sowing rate is 6.5-8kg/ha.

Nemat (*Eruca sativa*)

- Not mustard but a white flowered rocket with biofumigant properties
- Trap crop for various nematodes, including some root knot and cyst species
- Plant roots contain highest levels of glucosinolates
- Dense foliage produces good biomass although crop is shorter in height than the mustards
- Mowing before flowering can extend the crops growing (and trapping) period
- Tolerant to a range of temperatures, frost tolerant, and relatively drought tolerant once established.
- Sowing rate is 6.5-8kg/ha.

Seed placement

A reasonable seed bed is required, maximum seeding depth 5-10 mm.

Seed should be shallow drilled and rolled, or broadcast (shallow harrowed) and rolled.

Seed can be broadcast into cereal stubbles, rolling will improve germination.

Fixed beds - reduce seeding rate/ha to take account for wheelings.

Timing

Crops grown on non-irrigated land should be timed to coincide with normal weather patterns, sow early or late in the year (UK) to take advantage of residual soil moisture, although crops will respond to irrigation during dry periods.

Summer sown crops (May, June, and July in UK) will require irrigation throughout all crop stages to supplement rainfall.

Overwintering of crops is possible, especially in south UK and warmer climates. Successful crops must be sown late, no earlier than early-mid October (UK) depending on conditions.

Irrigation

Soil moisture is essential at sowing and to establish the crop; lack of water will lead to premature flowering and reduced biomass production. The biofumigation reaction will only occur in the presence of water.

Where irrigation is available, ensure crop is watered throughout germination and establishment, and as required to keep soil moist.

Fertilizer

For maximum biomass production Caliente Mustard crops require 120-140 kg/ha nitrogen, depending on soil type and previous cropping. Up to 90% of this nitrogen will be recycled and made available to following crops.

Apply entire quantity of N at or immediately after sowing, except for overwintered crops where applications should be split into two; at sowing, and once growth restarts in early spring.

Sulphur levels vary greatly by soil and geography, but as a guide Caliente Mustard crops require 20 kg S, for maximum glucosinolate production.

Organic growers may experience reduced biomass due to restricted fertilizer inputs, however good crops can still be achieved on fertile soil.

Incorporation

Time to crop maturity will vary with time of year and climatic conditions, but generally ranges from 60-100 days for a spring to late summer sown crop. Overwintered crops will take significantly longer.

At maturity vertical growth will stop, and if grown to full potential will achieve a height of approx 100-150 cm, producing 50-100 t/ha biomass (fresh weight), of which 15¬20% constitutes dry matter.

Aim to incorporate crop up to 2 weeks after first bloom for maximum biofumigation effect.

Chop the crop using a flail mower with hammer blades for maximum cell destruction, immediately followed by cultivation equipment to incorporate to a depth no greater than 15cm, producing a fine tilth and rolled to seal the surface, trapping the ITC gas.

In 20 minutes 80% of the ITC gas will be lost – it is therefore essential to incorporate the crop as quickly as possible after chopping. Use two pieces of equipment that closely follow each other, or large machinery that allows for one pass.

Soil moisture at incorporation is essential for biofumigation, either irrigate or incorporate after rain.

Beds can be formed at incorporation if required, and polythene laid if necessary for the following crop.

Post Incorporation

Leave for 14 days, and ideally perform a cress test before drilling or planting subsequent crop.

Crops grown as soon as possible after 14 day period will gain greatest benefit from the weed suppression effect.

Avoid ploughing and excessive cultivation before the following crop, subsequent cultivations should remain within the incorporated depth.

All varieties are soft seeded and should not pose a volunteer problem providing seed is not allowed to ripen.

As a guide, after first bloom, seed ripening takes 28-42 days. Any ripened seeds that do self-sow will germinate in one flush, enabling easy control by mechanical or chemical methods.

If you would like to use a green manure on your land, please give us a call and we can help in taking soil samples (prior to seeding, throughout the growing period and after incorporation) as well as giving further advice on preparing the land.

Parts of this information sheet on *Phacelia* have been extracted from a “Winter Cover Crops” leaflet produced by The Henry Doubleday Research Association.

For details of seed suppliers please contact the office.