Getting a head start with green manures

Summary
Green manures play an important part of soil care, but are often neglected by gardeners. Growing a green manure over the winter rather than leaving the soil bare is where they can have most benefit. They protect the soil, improve soil structure and prevent hard-earned nutrients from being washed out by rainfall. Winter green manures are ideally established in early September. The problem is, that at this time, we are often still harvesting from our food plants, so the space isn't ready for sowing a green manure.

We wanted to look at the possibility of sowing a green manure under the food plants whilst they are still growing. That way, you can get the green manure established for the winter whilst still continuing to take harvests from your crop in the autumn. This technique is known as 'undersowing'.

Here is a timeline for the process:

Late spring	Plant out French beans, sow green manure underneath
Summer	Green manure grows slowly underneath the beans
Autumn	Take down beans when they are finished, green manure is already established
Winter	Green manure is there to protect your soil
Spring	Cut down green manure and mix it with compost to break down and boost soil fertility
Spring	Plant next crop

The challenge is to get the green manure established without it competing against the main food crop. Yellow trefoil (*Medicago lupulina*) was chosen as a low-growing non-competitive green manure that is often used for this purpose. It was sown underneath climbing French Bean plants, at the same time as they were planted out, at the end of May.

The green manures became well established under the bean plants, and when the time came to remove the bean plants at the end of September, the green manures were covering 85% of the ground, enough to provide good ground cover to protect the soil over the winter. There was a small amount of competition, between the green manure plants and the bean plants, but on average, this only resulted in a small reduction in yield of 4%. This seems like a worthwhile price to pay to protect your soil over the winter. As trefoil is a legume, it will also fix nitrogen that will be released into the soil for the subsequent crops when you chop it down in the spring. The competitive effects of the green manure could be

reduced by cutting it back if it appears too vigorous, or sowing it later in the summer in future years.

The alternative to undersowing, would be to remove the bean crop at the beginning of September in order to sow the yellow trefoil to get it reliably established for the winter. However, removing the bean crop at this time would sacrifice 15% of the total yield. So undersowing really does seem like a viable option. Why not give it a go?

Background

One of the most important elements of organic growing is to care for the soil not just the plants you are growing. This ensures that you will continue to grow healthy food plants in future years. Green manures play an important part of soil care, but are often neglected by home gardeners. Growing a green manure over the winter rather than leaving the soil bare is where they can have most benefit. They protect the soil, improve soil structure and prevent nutrients from being leached out by rainfall.

Yellow trefoil

Winter green manures are ideally established in early September. The problem is, that at this time, we are often still harvesting from our food plants, so the space isn't ready for sowing a green manure. By the time we have cleared the plot, it is often well into October. This is usually too late to get a green manure to establish reliably.

Undersowing is a technique where green manures are sown underneath a food crop

We wanted to look at the possibility of sowing a green manure much earlier, under the food plants in the spring as an alternative method of getting a green manure going ready for the winter. The idea is simple:

1. Plant out the food crop
2. Sow the green manure underneath the food crop at a similar time
3. The green manure grows slowly underneath the food crop
4. In autumn, remove the food crop, allowing the green manure, which is already established, to grow over the winter.
5. The green manure will protect the soil over the winter.
6. The following year, in early spring, it will start to put on more leaf growth and also fix nitrogen.
7. In mid spring cut down and chop up the green manure and cover with compost. This will break down, to release the nitrogen that it has fixed for your next food crops.

Undersowing needs to strike a balance between the food crop and the green manure

This is not always as easy as it sounds. We wanted to get the green manure to establish well, but not so well that it competes against the food crop. Achieving this balance can depend on the timing of sowing of both the food crop and the green manure, the soil conditions and the vigour of both plants. It has been shown competitive effects are more

likely to occur when resources are scarce such as low soil fertility than when there are adequate resources (Tempesta *et al,* 2019). Techniques such as undercutting the roots can be used to reduce the competition of the clover between the crop rows, but this is resource intensive (Finch, Kienegger, 1997).

Undersowing is already practised on organic farms

Traditionally in organic systems, farmers sometimes undersow spring sown cereals to allow the green manure to become established so that, when the crop is harvested, the green manure crop is already established in the stubble, without the need for further cultivations. Usually less vigorous types of green manures are chosen such as yellow trefoil (*Medicago lupulina*), or small leafed varieties of white clover (*Trifolium repens*). These varieties are least likely to compete against the main crop (Hartl, 1989; Hollander *et al*, 2007). Examples of undersowing in vegetable crops is less common in everyday practice, although there have been examples of green manures being undersown under vegetable crops such as cauliflower (Tempesta *et* al., 2019).

Green manures bring benefits to subsequent crops

One point to note, is that although yellow trefoil is a nitrogen fixing legume plant, it will do little to boost soil fertility whilst it is growing. As with all legumes, most of the fixed nitrogen is taken up into the plant itself. It is only when it is cut down and incorporated, that the fixed nitrogen is released back into the soil where it will benefit the subsequent crop. This has been shown in a number of studies growing green manures under cereal crops (Amosse *et al*., 2014, Bergvist *et al*., 2011). So growing a green manure underneath a vegetable crop won't provide a nitrogen boost to that crop, as is commonly misconceived.

Sowing green manures amongst vegetable crops can bring about other benefits. Sometimes they have been used for weed suppression, although it is important to choose a species that is competitive enough to out compete the weeds, but not compete against the crop. A study of a range of species by Hollander *et al*. (2007) found that subterranean clover (*Trifolium subterraneum*) was not competitive enough against weeds, red clover (*T*. pratense) was too vigorous and competed against the crop, whilst white clover (*T*. *repens*) just about struck the right balance. Growing clover between brassica plants has also been shown to reduce pest damage from a number of key pests (Bjorkman *et al*, 2010), especially diamond back moth and small cabbage white butterfly (Finch and Collier, 2003).

We wanted to look at whether it is possible to establish an overwinter green manure of yellow trefoil by sowing it underneath a plot of climbing French beans. Yellow trefoil is a low-growing biennial legume that is often considered an ideal candidate for undersowing.

Methodology

1. A 2m^2 plot of land was prepared for growing climbing French beans.
2. The plot was divided into 2 x 1 m^2 plots each divided into the following treatments:

Undersown plot Green manure sown in mid-May, same time as the beans are planted out	**Autumn sown plot** Green manure sown in autumn after the beans have finished

3. In mid-April, 25 French beans seeds were sown into seed trays, one seed per large cell.
4. After the last frost (around mid-May) French beans were transplanted into both plots. In each plot place 10 plants were arranged around 1 wigwam of canes.
5. At the same time, 2g of yellow trefoil seed was sown into the undersown plot only.
6. The fresh bean pods were harvested regularly and counted and weighed.
7. The ground cover of the yellow trefoil was assessed in June, July, August and September.
8. In late September, all the bean plants were removed and 2 g of yellow trefoil was sown into the autumn green manure plot.
9. In October, the growth of the trefoil in both plots was assessed.

Results

Season

We experienced some very warm days in April, May and June with a long period without rain. This lack of rainfall made it difficult to apply sufficient water for optimum yields of vegetable crops. After mid-July, there were regular periods of rainfall interspersed with warm sunny weather, which made growing conditions easier.

Yellow trefoil covered the ground without competing against the main crop

The object of undersowing is to have a green manure that grows very slowly underneath the main crop, leaving a reasonable canopy of green manure to protect the soil over the winter, when the main crop is removed in the autumn. Yellow trefoil is a slow growing green manure, and is often chosen for undersowing, because it won't compete against the crop that it is growing underneath.

The ground cover of the trefoil increased slowly from June onwards and attained maximum cover of *c*. 80% towards the end of July. We observed that the trefoil remained less than 10 cm high, and did not compete significantly with the crop of beans.

The ground cover of weeds remained at around 15%, on average throughout the season, with the yellow trefoil providing some competition against the weeds. In commercial green manure crops, there isn't the labour to hand weed them, so they are often mown at an early stage, which suppresses the weeds but encourages the green manure to regrow more

vigorously. This often achieves very successful weed suppression if it is mown at the right time. This isn't often practiced by gardeners, but could be done with hand shears.

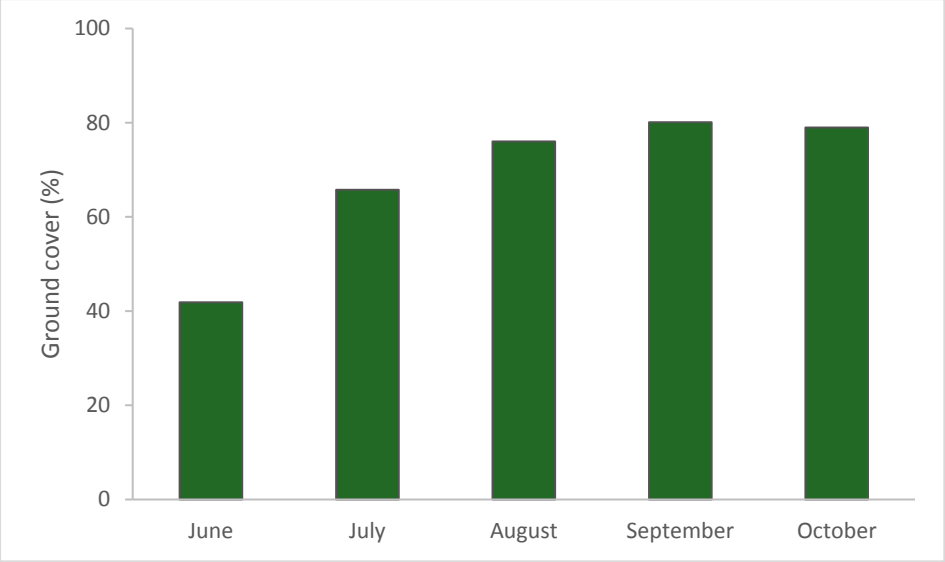

Figure 1. Ground cover of trefoil

Trefoil growing underneath the climbing French beans.

Undersowing in spring was more effective than autumn sowing at establishing a winter green manure

In late September, the bean crop was cleared to allow space for the autumn sown green manure. The average date that the autumn yellow trefoil was the 26 September, which is considerably later than the recommended date for sowing at the end of August / beginning of September. As a consequence, establishment of the yellow trefoil in late September was poor, resulting in a ground cover of only 26% by mid-October. The small plants never got a chance to develop, and much of the ground remained unprotected over the winter.

In contrast, the undersown plot had a good covering of low growing yellow trefoil, with an average ground cover of 79% in mid-October. Observations of our own plots showed that the yellow trefoil that was undersown, maintained a cover over the winter to protect the soil, and then started to produce more leaf growth in early March. This extra leaf growth could be chopped down in late April/early May to break down and boost the fertility of the soil for the subsequent crop.

Autumn sown green manure and undersown green manure, the following spring.

Undersowing only reduced yields of the beans very slightly

One of the main challenges of undersowing crops, is to ensure that the undersown green manure does not compete against the main crop. This is why a non-vigorous species such as yellow trefoil or small-leaved varieties of white clover are generally used.
In this trial, on average, there was a slight reduction in yield of 4% caused by undersowing trefoil. This reduction was not significant, as the variation between the different sites was far greater than this small difference in yields.

Table 1 Yield of undersown and control plots of climbing French beans

	Control yield (g/m^2)	Undersown yield (g/m^2)
Average yield	2762	2650

The majority of yield is produced in July and August

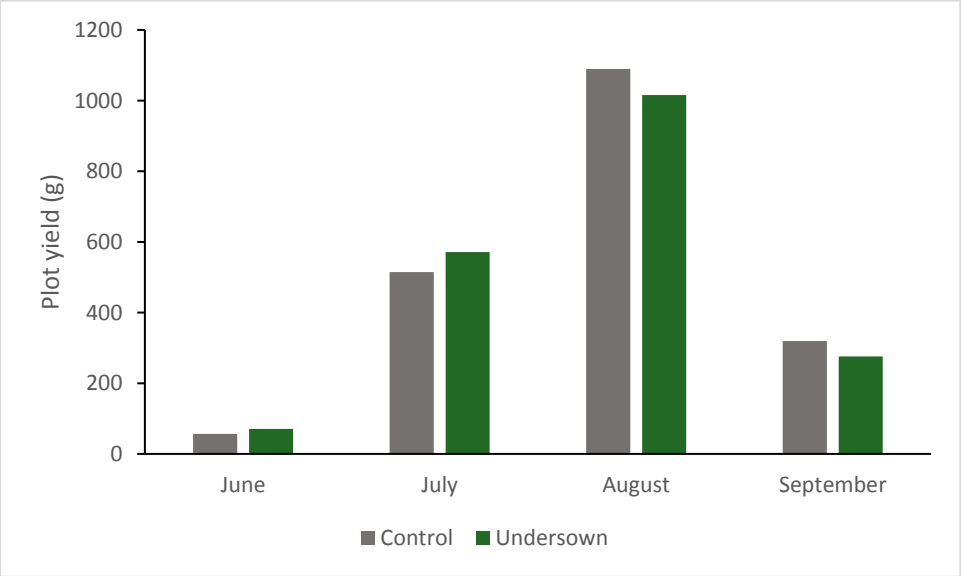

Figure 2 Yields of control and undersown crops in different months

The majority of the yield was produced in July and August, with 30% of the total yield being produced in July, and 50% in August. Only 15% of the yield was produced in September, but this is still a reasonable amount to sacrifice if you were to take down the beans at the beginning of September to accommodate the ideal sowing date for yellow trefoil. Therefore if undersowing results in a yield loss of only 4%, this could be a preferable option to terminating the bean crop early in September. It also ensures good establishment of the green manure to protect your soil over the winter.

Practical recommendations

- This experiment showed that it is possible to achieve good establishment of yellow trefoil under a crop of climbing French beans, by sowing the yellow trefoil around your beans at the same time as you plant them out, at the end of May.
- There was some competition between the undersown green manure and the beans, but this effect was very small. If you do notice competition, then you could chop down the yellow trefoil with shears to curb its growth.
- If the green manure consistently competes against the main crop, at your site then experiment with sowing it later in the season, such as June or July, to give it less of an opportunity to compete.

References

Amossé, C., Jeuffroy, M. H., Mary, B., & David, C. (2014). Contribution of relay intercropping with legume cover crops on nitrogen dynamics in organic grain systems. *Nutrient Cycling in Agroecosystems*, *98*(1), 1-14.

Bergkvist, G., Stenberg, M., Wetterlind, J., Båth, B., & Elfstrand, S. (2011). Clover cover crops under-sown in winter wheat increase yield of subsequent spring barley—Effect of N dose and companion grass. *Field Crops Research*, *120*(2), 292-298.

Björkman, M., Hambäck, P. A., Hopkins, R. J., & Rämert, B. (2010). Evaluating the enemies hypothesis in a clover-cabbage intercrop: effects of generalist and specialist natural enemies on the turnip root fly (Delia floralis). *Agricultural and Forest Entomology*, *12*(2), 123-132.

Den Hollander, N. G., Bastiaans, L., & Kropff, M. J. (2007). Clover as a cover crop for weed suppression in an intercropping design: II. Competitive ability of several clover species. *European journal of Agronomy*, *26*(2), 104-112.

Finch, S., & Collier, R. (2003). Insects can see clearly now the weeds have gone. *Biologist*, *50*(3), 132-135.

Finch, S., & Kienegger, M. (1997). A behavioural study to help clarify how undersowing with clover affects host-plant selection by pest insects of brassica crops. *Entomologia experimentalis et applicata*, *84*(2), 165-172.

Hartl, W. (1989). Influence of undersown clovers on weeds and on the yield of winter wheat in organic farming. *Agriculture, ecosystems & environment*, *27*(1-4), 389-396.

Tempesta, M., Gianquinto, G., Hauser, M., & Tagliavini, M. (2019). Optimization of nitrogen nutrition of cauliflower intercropped with clover and in rotation with lettuce. *Scientia Horticulturae*, *246*, 734-740.