A winter green manure mix for gardeners

Summary

Over winter green manures are plants grown to protect the soil over winter. The standard mix of grazing rye and vetch that is frequently grown is very dependable but it can be tough to incorporate in the spring, especially for gardeners practising no dig methods. The aim of this experiment was to compare an alternative green manure mix ('Gardeners mix') containing 5 different species (Vetch, Forage Pea, Crimson Clover, Phacelia, Flax) with the standard grazing rye and vetch mix. The Gardeners mix established very well in the autumn and covered the ground well. However, the mild autumn resulted in a large amount of lush growth that was susceptible to the severe frosts in December that killed much of the growth off. There was some recovery of growth in early spring. Having a mix of species helped to promote adaptability: the phacelia grew well initially but was killed off, then the slower- growing but more resilient crimson clover started to fill out the gaps. Almost half (46%) of participants used a no dig 'chop and drop' technique to incorporate their green manure, demonstrating a strong interest in this method of growing. The Gardeners mix was also much easier to incorporate than the standard rye-vetch mix which contained a lot of tough material.

Background

Winter green manures are plants grown to protect the soil when it is not being used for growing food. They are grown over winter, then they are incorporated into the soil in the spring. They protect the soil in several ways. Firstly, they protect the surface from the action of heavy rain which reduces the chance that it will develop into an impermeable crust in drier weather (Williams & Doneen, 1960, McGuire, 2003). Secondly, the plants growing during the winter, help to retain nutrients by stopping them from being washed out of the soil by the rain (Tosti *et al*, 2014, Fowler *et al* 2004,).

Although most farmers and growers will grow a winter green manure whenever they can, gardeners are often less likely to do this. There are a few reasons that might put them off:

1. Many of the green manure mixes sold in gardening catalogues have been designed for more agricultural settings, where the green manures are mown and rotavated into the ground, so are less well-suited for gardeners.
2. Many gardeners focus their efforts on plants with immediate obvious rewards such as edible produce and flowers, rather than green manure plants to improve the soil.
3. In autumn, the ground is often still occupied by edible summer crops, and by the time these are removed, conditions are too cold for a green manure to reliably establish.

This trial aims to address some of these challenges by designing an over-winter green manure for gardeners. An over winter green manure mix should:

- ✓ Be vigorous to cover the ground and suppress weeds
- ✓ Be able to establish in cooler weather
- ✓ Remain lush into the following spring, so that the material is easy cut down and incorporate even in no dig systems.

Green manure mixes can provide a number of positive benefits over growing a single species alone. The Organic Research Centre carried out a large project from 2008 – 2013 examining the use of diverse species mixtures at a range of sites

(https://www.organicresearchcentre.com/manage/authincludes/article_uploads/PR513%20full%20report.pdf).

The key message from this study was that no species scored highly in all evaluation criteria but having a range of species provided 'complementarity' under a range of sites and conditions. The mixes also showed increased ground cover and biomass production and a reduction in weeds compared to growing single species. A number of reasons have been proposed for these effects. Legumes in the mix can transfer nitrogen into the soil when live roots produce exudates that leak out into the soil (Lesuffleur & Cliquet, 2010, Burity *et al*, 1989), when roots decompose (Fustec *et al*. 2010, Louram *et al*, 2015) or through mycorrhiza (Haystead *et al*, 1988, Johansen & Jensen 1996). This nitrogen feeds the non-legume and helps it to grow more quickly

A non-legume plant can also stimulate the legume to fix more nitrogen as the non-legume takes up nitrogen removing any soil build up that could suppress nitrogen-fixing bacteria (Schipanski & Drinkwater,2012, Hatch *et al*. 2007).

Gardeners green manure mix species

The green manure species chosen for this trial were selected for their complimentary properties. It consisted of 3 legumes and 2 non legume species. The information is compiled from experience at Garden Organic, seed companies such as Cotswold Seeds and commercial and amateur growers.

Vetch (*Vicia sativa*) – is an annual legume that can establish and cover the ground rapidly. However it requires warmer temperatures to guarantee good establishment, so may not perform well if it is sown later than the beginning of September, especially in cooler parts of the UK.

Forage pea (*Pisum sativum*) – this was chosen as an alternative legume to vetch. It is capable of germinating and establishing at cooler temperatures, so may do better than vetch if the mix is sown later or under cooler conditions.

Crimson clover (*Trifolium incarnatum*) – this is an annual clover that can produce a reasonable covering in biomass. It has a lower growing habit than the other legumes in the mix, so may be able to fill in any gaps. It has reasonable frost tolerance so may continue to grow after other species have been killed off.

Phacelia (*Phacelia tanacetifolia*) – this non legume can produce large amounts of ground to cover the ground, but it has less good frost tolerance, especially if it has been allowed to grow large early on.

Linseed / flax (*Linum usitatissimum*) – is increasingly been grown as an autumn sown crop in the UK, so can provide some non-legume biomass in the mix. It has a more upright habit that may compliment the sprawling habit of the other plants.

Aims of this experiment
To trial a green manure mix that is suitable for over-winter use in a garden setting. A standard rye and vetch mix was compared with a 'Gardeners' mix' that contains a mixture of 5 species: vetch, forage pea, phacelia, linseed and crimson clover.

Methods
A total of 104 people were sent out seed, for of which 76 returned results. Each person received two packets of seed mix:

Standard rye and vetch mix:
70% Protector rye (*Secale cereale*)
30% Miluka vetch (*Vicia sativa*) - Organic

Gardeners mix:
40% Miluka vetch (*Vicia sativa*) – Organic
40% Livioletta forage pea (*Pisum sativum*)
2% Nectar phacelia – Organic (*Phacelia tanacetifolia*)
8% Ineke linseed / flax (*Linum usitatissimum*)
10% Red crimson clover – Organic (*Trifolium incarnatum*)

Seeds were sown in mid-September at a rate of 30g m^2 into 1 m^2 plots. The following assessments were made from September to April:

Ground cover
The percentage ground cover of green manure mix, bare ground and weeds in each plot was estimated visually at the beginning of each month.

Species survival
At the end of the trial in April participants assessed which species were present using a visual key supplied:

1 = absent, 2 = one or two plants present, 3 = up to 20% ground cover, 4 = 20 – 50% ground cover, 5 = more than 50% ground cover.

Ease of incorporation
Participants either dug in the green manures or used a no dig 'chop and drop' method. They were asked to judge the ease of incorporation using the following scale:

1 = Extremely tough and almost impossible to incorporate, 2 = A lot of tough material, difficult to incorporate, 3 = Some tough material, but some softer material that will easily break down,

4 = Mostly soft material that will easily break down, 5 = All soft material, much of it has broken down already

Participants were also asked to assess flowering in April, but there was very little to observe.

Results

2022- 2023 Winter season weather

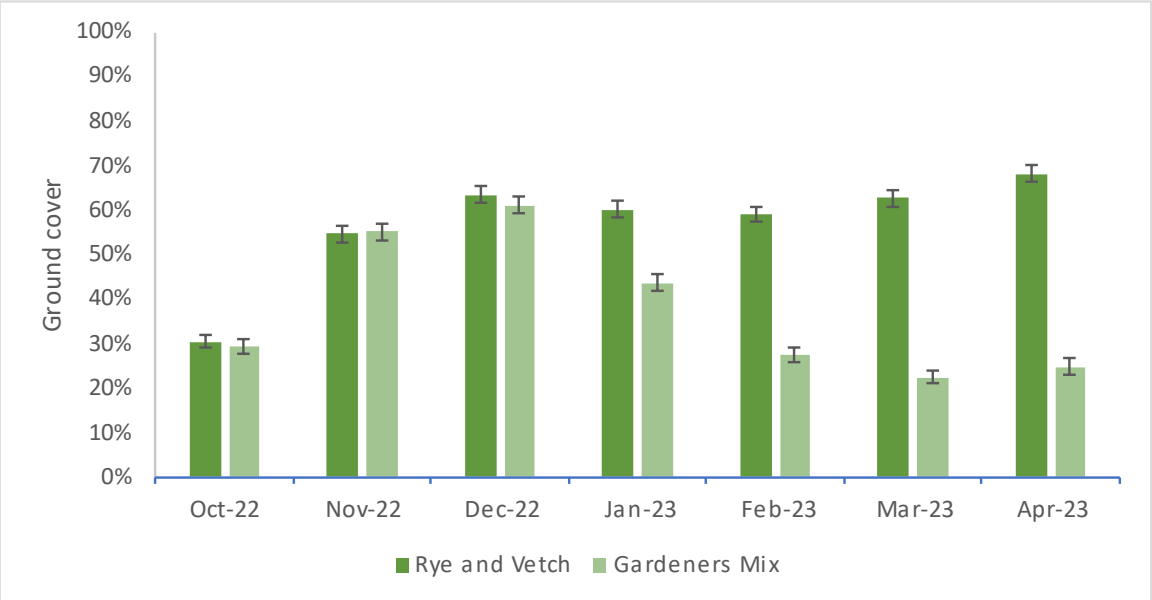
September to November was very mild with above average temperatures, above average sunshine and plentiful rainfall. The 2nd and 3rd weeks of December brought about an abrupt change with heavy snowfall, frosts and freezing rain in many places for about 10 days. The mild and damp weather resumed in January and continued into April with few of the heavy frosts and extreme cold experienced in December.

Sowing date

The range of sowing dates ranged from12th September to 12th October with a median sowing date of 17th September.

Ground cover

Participants estimated the ground cover, visually by eye. Through the months of October, November and December, ground cover of rye and vetch and gardeners mix were very similar: establishing 30% ground cover in October and rising to a maximum of 60% in December. The mild weather led to very lush growth especially of the phacelia plants in the gardeners mix. A prolonged period of frost and snowfall in December killed off much of this growth in the gardeners mix, greatly reducing the ground cover to an average of 45%. Much of this ground cover was dying material that declined further during the following months leaving a ground cover of less than 20% in March. Conversely, the rye and vetch mix maintained a ground cover of 60% through January to April. Most of this ground cover consisted of grazing rye.



*the ground cover of the mixes were significantly different in January, February, March, April ($P<0.001$, using students t test)

Bars show standard error of the mean

Figure 1 Ground cover of rye and vetch mix and gardeners mix from October to April.

Grazing rye and vetch November 2022

Gardeners mix November 2022

Grazing rye and vetch January 2023

Gardeners mix January 2023

Species present

In October, at Ryton, seedlings of all species sown in the Gardeners mix emerged:

Phacelia

Vetch

Forage pea

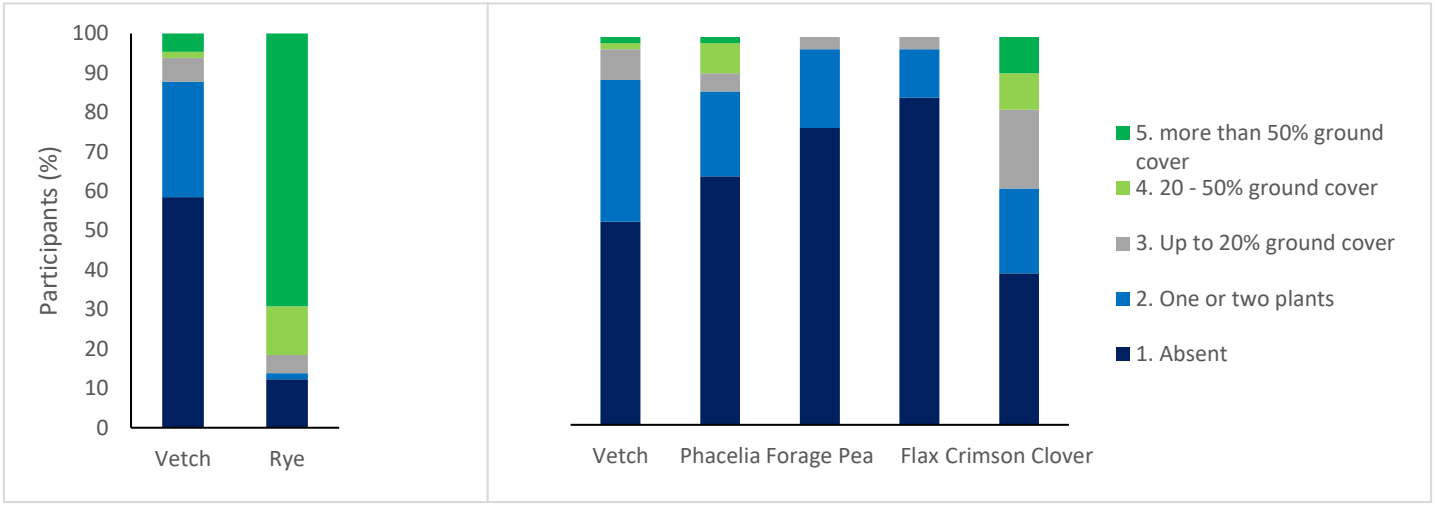
Flax / linseed

Crimson clover

Visual observation at Ryton showed that the rye dominated in the rye/vetch mix for most of the season. In the gardeners mix, the phacelia dominated early in the season until it was killed off by frost. Of the remaining plants, the crimson clover in the mix showed the best survival into the spring, although this was at low levels.

Participants were asked to assess which species were still present in the mix in April. In the vetch/rye mix, by April, the rye grass was dominating most plots, covering more than 50% of the ground at 69% of sites. Vetch survival was poor and was absent or only showing a few plants at 87% of sites. The gardeners mix had poor level of survival for all plants. The crimson clover showed relatively better survival, having at least 20% ground cover at 38% of the sites. One person commented that the thick canopy of phacelia may have provided some frost

protection to the crimson clover, as it had been killed by frost elsewhere on the site when it was grown on its own. The flax and the forage pea had the poorest survival, with no plants present at 77% and 84% of the sites respectively. One person noticed that there some forage peas germinating initially, but they were smothered out and rotted under the thick canopy of phacelia.



Rye and vetch mix Gardeners mix

Figure 2 Species composition of the mixes remaining before incorporation in April.

Incorporation

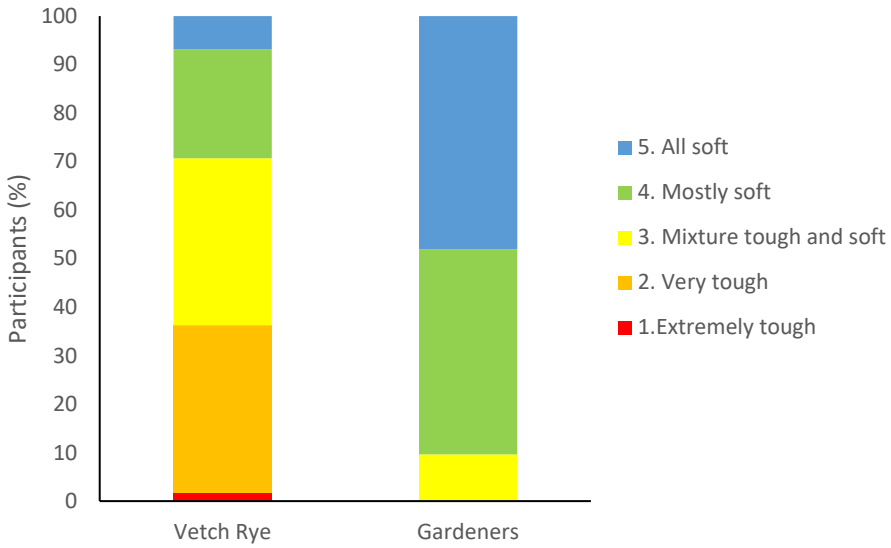
Winter green manures are usually terminated and incorporated into the soil in the spring so that they can break down, adding organic matter and nutrients to the soil for the following crops.

One of the main objectives of using an alternative to the tried and tested grazing rye and vetch mix was to find a mix that is softer and easier to incorporate. Although very reliable, grazing rye and vetch can become tough and difficult to dig in. If growing in a no dig system where it is just chopped up, it can leave a lot of tough material that takes some time to break down.

Slightly more people dug (54%) in their green manures than used the 'chop and drop' technique (46%) that is often used for no dig growing. However, the fact that there almost half the people used a no dig method for incorporation shows that there is considerable interest in using this

technique. Some growers commented that they used cardboard and compost to cover the green manures and prevent regrowth.

Although the rye and vetch was reliable, 70% of the participants found it contained some tough material, with 36% saying it had a lot of tough material. Conversely 90% found that the gardeners mix contained mostly soft material, especially as much of the material had died off, making it easier to incorporate.



** difference between mixes was highly significantly different (P<0.001) using Pearsons Chi Squared Test

Figure 3 Participants rating of how easy the crops were to dig in.

Conclusion

The gardeners mix achieved some its aims in that it was rapid to establish in the autumn and was easy to incorporate in the spring. However, due to the unusual combination of a mild autumn followed by a very hard frost, it was killed off in December so did not protect the soil all winter. In a milder winter, with less extreme fluctuations in temperature, it would have covered the ground for longer. In many cases, there was a good demonstration of the complementarity of the species, with the phacelia providing a good initial burst of growth, then the crimson clover providing some back up once the phacelia was killed off by the frost.

References

Burity HA, Ta TC, FarisMA, Coulman BE (1989) Estimation of nitrogen fixation and transfer from alfalfa to associated grasses in mixed swards under field conditions. Plant Soil 114:249–255.

Dubach, Markus, and Michael P. Russelle. "Forage legume roots and nodules and their role in nitrogen transfer." *Agronomy Journal* 86.2 (1994): 259-266.

Fowler, C. J. E., Condron, L. M., & McLenaghen, R. D. (2004). Effects of green manures on nitrogen loss and availability in an organic cropping system.

Fustec J, Lesuffleur F, Mahieu S, Cliquet JB (2010) Nitrogen rhizodeposition of legumes. A review. Agron Sustain Dev 30:57– 66.

Hatch, D. J., Goodlass, G., Joynes, A., & Shepherd, M. A. (2007). The effect of cutting, mulching and applications of farmyard manure on nitrogen fixation in a red clover/grass sward. *Bioresource Technology*, *98*(17), 3243-3248.

Haystead A, Malajczuk N, Grove T (1988) Underground transfer of nitrogen between pasture plants infected with vesicular-arbuscular mycorrhizal fungi. New Phytol 108:417–423.

Johansen A, Jensen ES (1996) Transfer of N and P from intact or decomposing roots of pea to barley interconnected by an arbuscular mycorrhizal fungus. Soil Biol Biochem 28:73–81.

Lesuffleur F, Cliquet JB (2010) Characterisation of root amino acid exudation in white clover (Trifolium repens L.). Plant Soil 333:191– 201. doi:10.1007/s11104-010-0334-1

Louarn G, Pereira-lopès E, Fustec J et al (2015) The amounts and dynamics of nitrogen transfer to grasses differ in alfalfa and white clover-based grass-legume mixtures as a result of rooting strategies and rhizodeposit quality. Plant Soil 389:289–305.

McGuire, A. M. (2003). Mustard green manures replace fumigant and improve infiltration in potato cropping system. *Crop Management*, *2*(1), 1-6.

Schipanski, M. E., & Drinkwater, L. E. (2012). Nitrogen fixation in annual and perennial legume-grass mixtures across a fertility gradient. *Plant and Soil*, *357*, 147-159.

Tosti, G., Benincasa, P., Farneselli, M., Tei, F., & Guiducci, M. (2014). Barley–hairy vetch mixture as cover crop for green manuring and the mitigation of N leaching risk. *European Journal of Agronomy*, *54*, 34-39.

Williams, W. A., & Doneen, L. D. (1960). Field infiltration studies with green manures and crop residues on irrigated soils. *Soil Science Society of America Journal*, *24*(1), 58-61.