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 ('Gardener's mix') containing 5 different species (Vetch, Forage Pea, Crimson Clover, Phacelia, Flax) with the standard grazing rye and vetch mix at a range of locations around the UK.

Around 80 people took part in the trial sowing small plots of each green manure mix in back gardens around the UK in September 2022 and 2023. They incorporated them the following spring and made observations to their growth and assessed how easy they were to incorporate.

In both 2022 and 2023, the Gardener's mix established very well in the autumn and covered the ground well. However in 2022, the mild autumn resulted in a large amount of lush growth that was then killed off by a sudden frost in December. 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. In 2023, there were less severe frosts, so the Gardener's mix showed better survival into the spring, although it was starting to break down by the spring at the time of incorporation.

In both 2022 and 2023, a high proportion of participants used a no dig 'chop and drop' technique respectively to incorporate their green manure, demonstrating a strong interest in "no dig" methods of growing. The Gardener's mix was also much easier to incorporate than the standard rye-vetch mix which contained a lot of tough material that many participants had to remove from the soil and add to the compost heap.

In conclusion, the Gardener's mix was definitely easier to incorporate but was killed off by heavy frosts so may not protect the soil all winter in colder areas of the country.

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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).

Gardener's 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.

Aim
The aim was to trial a green manure mix that is suitable for over-winter use in a garden setting and can be incorporated using no dig methods. A standard rye and vetch mix was compared with a 'Gardener's' mix' that contains a mixture of 5 species: vetch, forage pea, phacelia, linseed and crimson clover.

Methods

In 2022, a total of 104 people were sent out seed, for of which 76 returned results. In 2023, a total of 152 people were sent out seed, of which 84 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

Gardener's 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
In 2022 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.

In 2023, participants made an additional assessment in November to evaluate how well the various species had established. They also made the assessment in April to evaluate survival. They were given a key with pictures of the seedlings to help with the evaluation.

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.

2023 – 2024 Winter season weather

The autumn and winter were characterised by above average temperatures, and many months with significantly higher rainfall (20 - 30% more than average). Sunshine was generally lower than average. Although, the mean temperatures were above average, there were isolated frosts in some areas. The period from winter into spring (Mar – Apr) was also warm and wet but below average sunshine.

Sowing date

We advised participants to sow seed in the first few weeks of September. This timeframe was chosen as it is a typical period that a green manure might be sown, after harvesting vegetables, although ideally green manures establish more reliably if sown in August. In 2022, the range of sowing dates ranged from 12th September to 12th October with a median sowing date of 17th September. In 2023 the range of sowing dates ranged from 3rd September to 1st November with a median sowing date of 9th September.

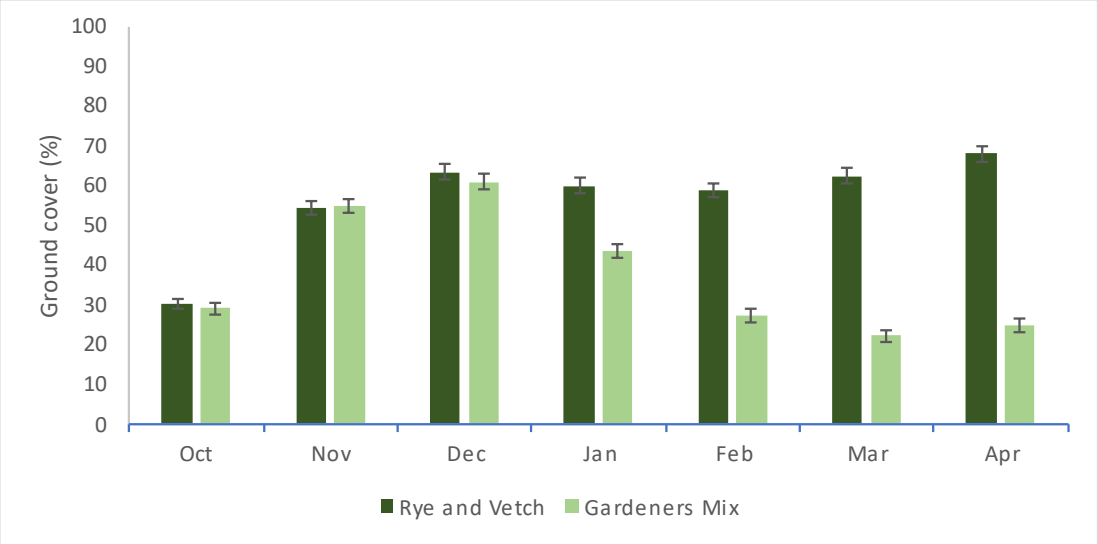
Ground cover

2022

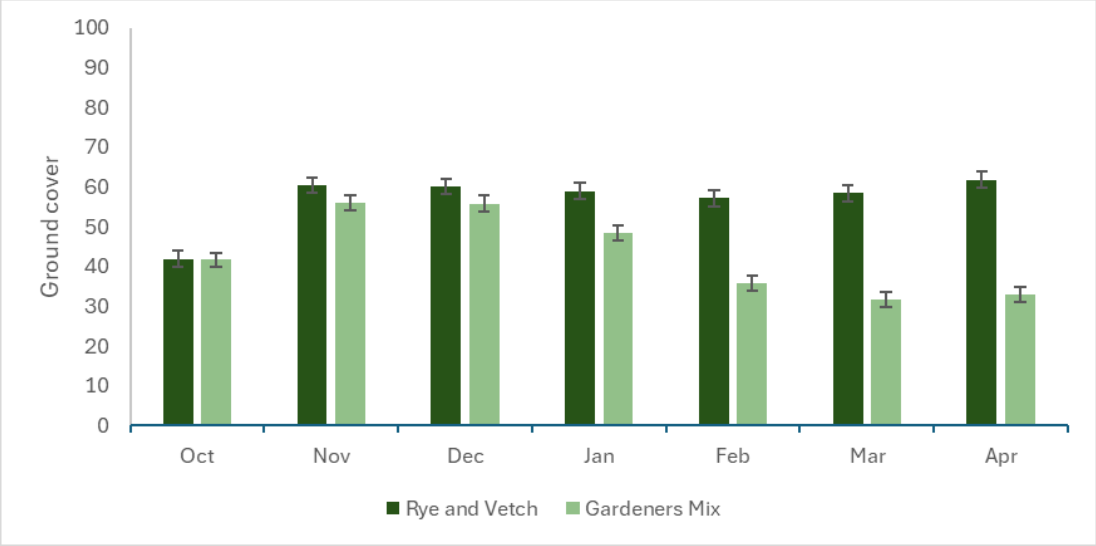
Participants estimated the ground cover, visually by eye. Through the months of October, November and December, ground cover of rye and vetch and gardeners mix were very similar: establishing 30% ground cover in October and rising to a maximum of 60% in December. The mild weather led to very lush growth 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.

2023

In 2023, the average ground cover showed a similar pattern to 2022, increasing to a maximum of 60% by November in both the vetch and rye and the Gardener's mix. There was not such a hard frost in 2023, so there was not the sharp decline in the Gardener's mix observed in 2022. However, beyond January, the Gardener's mix still started to show a more gradual decline to a ground cover of 30% in March.



2022



*the ground cover of the mixes were significantly different in January, February, March, April ($P<0.001$, using Pearson t test) in both 2022 and 2023.

Bars show standard error of the mean

2023

Figure 1 Ground cover of rye and vetch mix and Gardener's mix from October to April

Grazing rye and vetch November 2022

Gardener's mix November 2022

Grazing rye and vetch January 2023

Gardener's mix January 2023

Species present at establishment

In October 2022, at Ryton, seedlings of all species sown in the Gardener's mix emerged:

Phacelia

Vetch

Forage pea

Flax / linseed

Crimson clover

In 2022, visual observation at Ryton showed that the rye dominated in the rye/vetch mix for most of the season. In the Gardener's 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.

In 2023, participants also made an assessment of the species present in November, in order to evaluate how well they established:

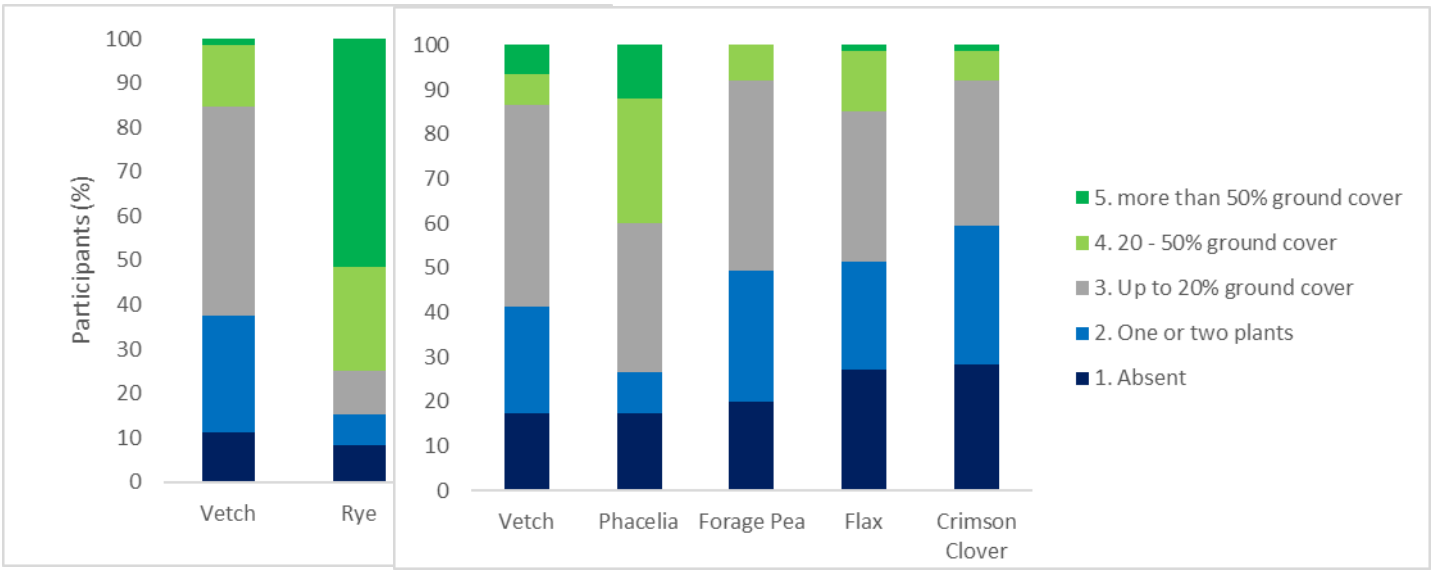


Figure 2 Species composition of the mixes shortly after establishment in November 2023

In the vetch and rye mix, the rye dominated reaching more than 50% ground cover at more than 50% of participant sites. In the Gardener's mix, the phacelia dominated, attaining more than 20 – 50% ground at 40% of the participant sites. The other species (vetch, forage pea, flax and crimson clover) also showed a presence albeit at low levels, reaching up to 20% at least 50% of sites .

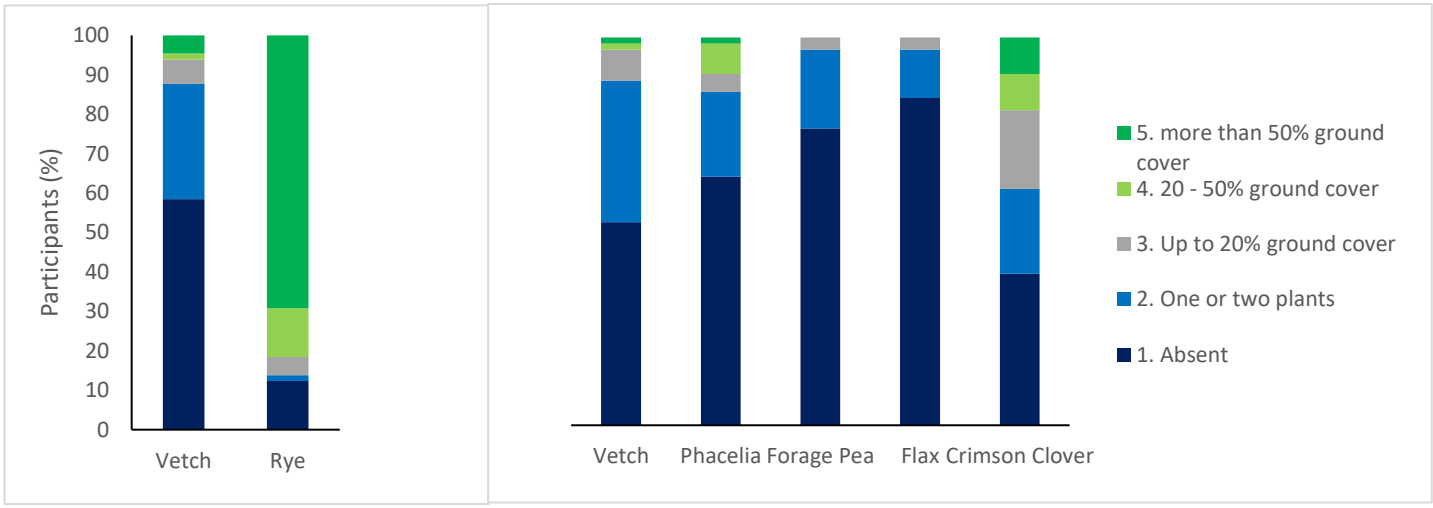
Some people commented that in the more northerly areas of the country, the sowing date was on the late side for reliable establishment of green manures, and they needed to be sown in August.

Species present at incorporation in April

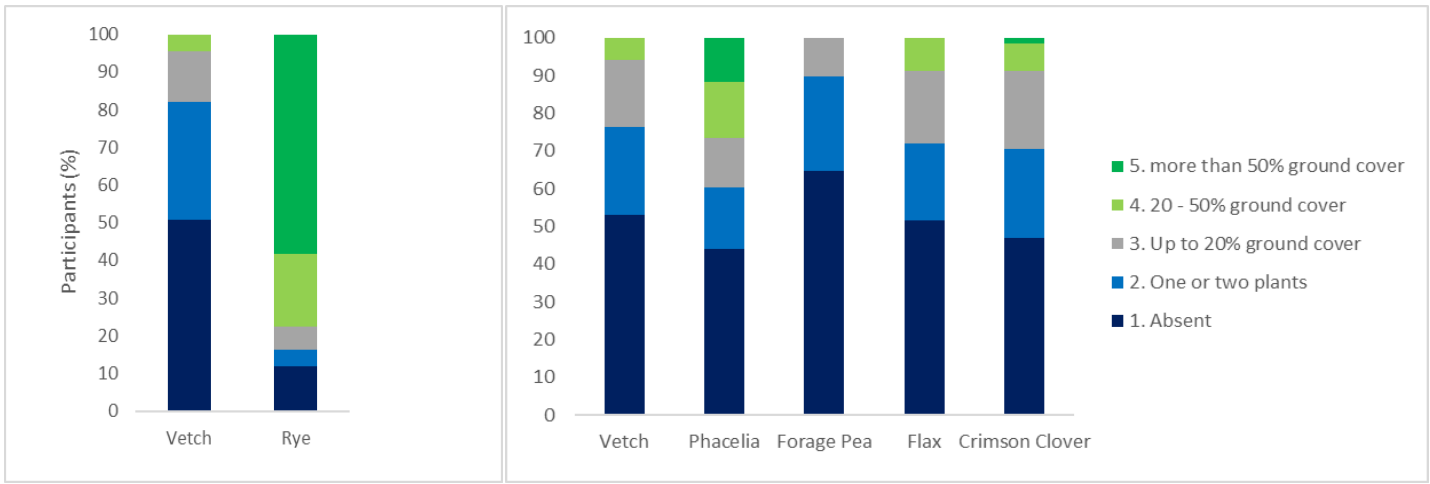
Participants were also asked to assess which species were still present in the mix in April.

In 2022, in the vetch/rye mix, by April, the rye was dominating most plots, covering more than 50% of the ground at 69% of participant sites. Vetch survival was poor and was absent or only showing a few plants at 87% of sites. The Gardener's mix had poor level of survival for all plants. The crimson clover in the mix 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.

In 2023, the rye also dominated the rye / vetch mix attaining more than 50% cover at over 50% of participant sites. In the Gardener's mix in 2023, the survival rate was better than in 2022 as the weather was less harsh, although it was still considerably less than the rye and vetch mx. Phacelia was the dominant species attaining 20 – 50% at 27% sites. The survival of the flax was better in 2023 than in 2022 but still at low levels. The performance of the forage pea was disappointing in both years, as it is a legume that is claimed to germinate at lower temperatures. Larger seed sizes benefit from being drilled at a deeper depth than the smaller seed which can be broadcast, so this may cause problems with establishment in a mix containing different sizes of seeds.



2022



2023

Rye and vetch mix Gardener's mix

Figure 3 Species composition of the mixes remaining before incorporation in April.

Incorporation

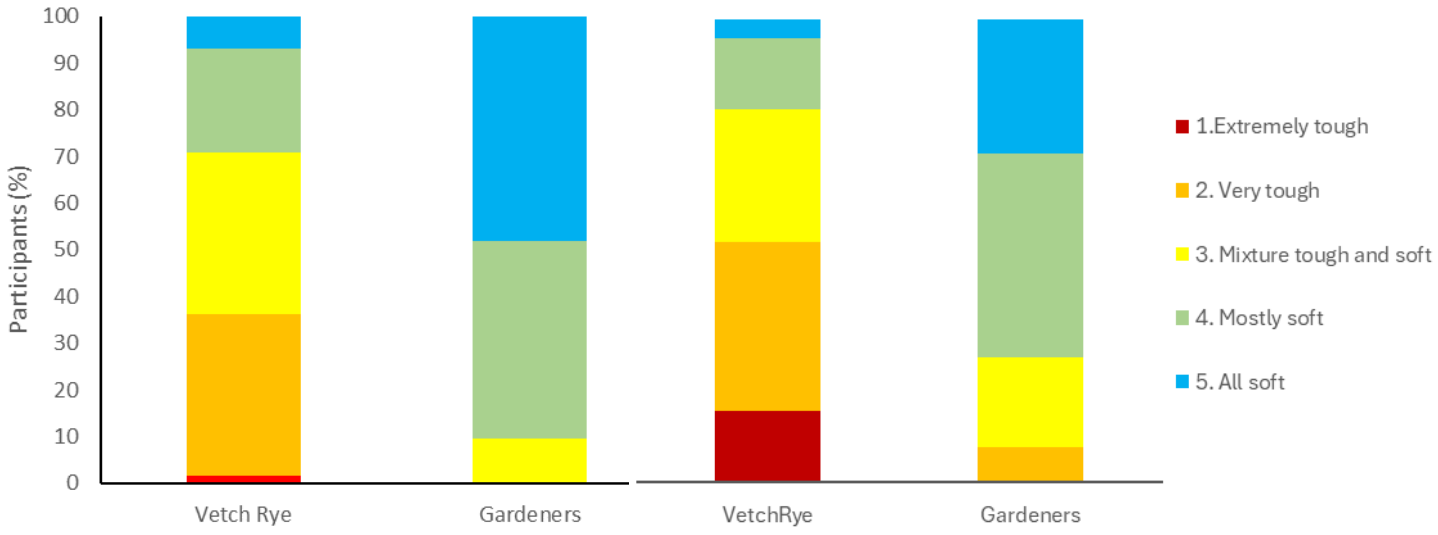
Winter green manures are usually terminated and incorporated into the soil in the spring so that they can break down, adding organic matter and nutrients to the soil for the following crops.

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.

In 2022, 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. In 2023 there was a considerably higher proportion of no diggers with 68% using the 'chop and drop method'. This shows that there is considerable interest in using no dig methods to incorporate green manures. Some growers commented that they used cardboard and compost to cover the green manures and prevent regrowth.

Although the rye and vetch was reliable, in 2022, 70% of the participants found it contained some tough material, with 36% saying it had a lot of tough material. In 2023, this was even more, with 81% finding it contained some tough material and 52% finding in contained a lot. Some people commented that they had to remove the material from the soil and add it to the compost heap because it was too tough.

Conversely, in 2022 90% found that the Gardener's mix contained mostly soft material, especially as much of the material had died off, making it easier to incorporate. In 2023, even after a milder winter and less of the material having died off still 73% found that it contained mostly soft material.



** difference between mixes was highly significantly different (P<0.001) using Pearsons Chi Squared Test in both 2022 and 2023

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

Conclusion

In 2022, the Gardener's 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 2023, there was a milder winter, and the Gardener's mix showed better survival into the spring. This was a better balance, on average with the mix covering the ground enough to protect the soil but starting to break down in early spring to make it easier to incorporate. This suggests that the Gardener's mix might be more useful in areas that experience a milder climate, but not so useful for places that are likely to get a heavy frost early in the winter.

The Gardener's mix was dominated by the phacelia in both years, although the crimson clover proved useful for filling in gaps when the phacelia was killed off by frost in 2022.

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