Can companion planting reduce allium leaf miner?

Summary

- This experiment was developed with consultation through Garden Organic's citizen science action group. The topic, the pest and the plants were selected through suggestions from gardeners through an online workshop and virtual noticeboard.
- Allium leaf miner was selected as a topic as it is becoming an increasing challenge in the UK, but there are few effective non-chemical ways of managing it apart from covering the crop.
- Two companion plants were tested: chard as a taller plant and clover as lower growing plant. Growing crops next to other plants has been known to reduce infestation by pests. As the pest is searching where to lay eggs, if it lands on an alternative plant more than a few times, it will give up and go somewhere else. This theory ('inappropriate/appropriate landing') has been tested extensively in brassicas but not with alliums.
- The leeks, chard and clover all established well, but the chard was clearly competing against the leeks from July onwards.
- There were visible signs of damage from allium leaf miner from September onwards leading to extensive losses by November.
- There was a consistent trend for chard intercropping to reduce the infestation from allium leaf miner although this was not statistically significant. The low growing clover had very little effect.
- Using chard as a companion plant significantly reduced marketable yield by 69% - the competitive effects far outweighed any balance of reducing pest damage.
- Companion planting has the potential to reduce damage by allium leaf miner, but a balance must be sought between reducing pest damage and losing yield. Since allium leaf miner can cause extensive damage, growers would be likely to tolerate a moderate reduction in yield if companion planting could salvage their crop.

How the experiment was designed

The experiment was designed through a collaborative process where gardeners contributed their ideas in an online session and then they were encouraged to further add their ideas to an online noticeboard (Figure 1) after the session.

In the online session, people were first introduced to companion planting by Rosemary Collier, entomologist at Warwick University. When asked for suggestions for companion planting combinations, participants had already been experimenting with beans with coriander, tomatoes or nasturtiums, cabbages with fennel or quinoa, pumpkins and squash with borage. Suggestions for priority pests to research included aphids, carrot fly, cats, slugs and snails, cabbage white butterflies, allium leaf miner and pigeons. The allium leaf miner secured the most votes amongst participants as it was becoming an increasing problem in the UK, but there was a lack of information about managing the pest.

By the end of the discussion, it was decided to test growing leeks with one low growing species and one taller species to act as 'distraction plants' against the pest.

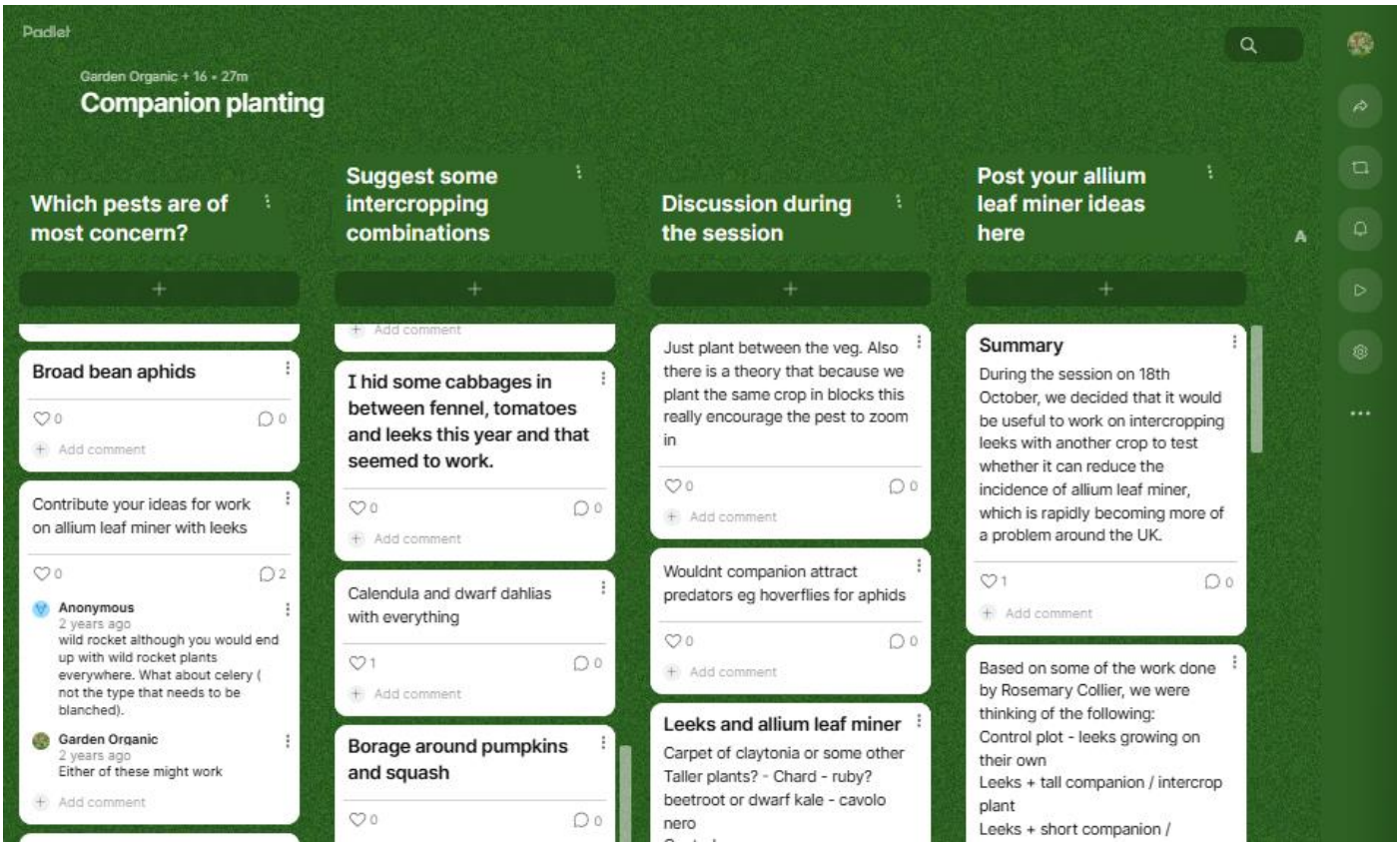

Figure 1 Example of padlet board used for online discussion.

We asked for suggestions for lower growing and tall plants. The suggestions for lower growing plants included claytonia, carrots, mizuna, American land cress, marigolds and clover. For taller plants: zinnias, chard, phacelia and purple sprouting broccoli. Taking these suggestions into account, and the need for companion plants that would stand the period from April to December, we decided on white clover for the shorter plant and chard for the taller plant.

Background to allium leaf miner

Allium leaf miner (*Phytomyza gymnostoma*) is a small fly that lays its eggs in allium plants during spring and autumn time. The maggots hatch out and burrow through the plant, often causing it to collapse and rot (*Figure 2*). It can cause extensive damage especially to leeks [1]. Even mild infestations leave maggots and pupae in large enough numbers to render much of the crop inedible. Most infestations will result in significant losses and it's possible to lose the entire crop.

Figure 2 Allium leaf miner damage, showing characteristic distortion of the leaves

The pest was first sited in Europe as early as 1988, on some leek crops on the outskirts of Budapest [2]. It later made its way to the UK, when it was found on allotment in Wolverhampton [3].

The most common non-chemical means way of controlling it is to cover the crop with fine mesh at the times of egg laying. When growing leeks, it may be necessary to cover the transplants in the trays as eggs can be laid in them, which means the crop is infected as it 's being planted into the ground. It 's important to grow alliums in a different place each year, as pupae can remain in the soil over winter and carry over into the next crop.

More recently, there's been a number of studies to investigate alternative methods of control. One study [4] searched for species that would attract the allium leaf miner away from leeks. Its work demonstrated the pest showed a preference for chives, and from this observation they claimed this would make a suitable trap crop. However, when tested in the field in another study [5], the study found this was not sufficient to reduce allium leaf miner damage. A number of other studies have also tested the use of reflective mulches [5,6] to deter the pest, managing to achieve a reduction in the pest by 40% in one case [6] Another field trial study in Slovenia [4] attempted to test the effects of intercropping on the pest with three different herbs:rosemary, oregano and lavender grown among the leeks. Unfortunately, the results were inconclusive, as there were only low levels of the pest during the field trials.

An alternative approach that has been trialled in brassica is 'inappropriate/appropriate landing'. There's been extensive work to showcrops grown among other plants are attacked less frequently by pests [7–9]. It has been shown that when a pest is seeking a place to lay eggs, the nearby companion plants reduce the chance of the pest landing on a crop plant leaf, so it's more likely to abandon egg laying and fly off somewhere else. Contrary to popular belief, both unscented and scented plants are just as effective and even cardboard cut-out plants work – it's having a green surface that is important [10]. The size and shape of the companion plants has also been shown to have an influence [11] with larger, taller plants such as fat hen being more effective at preventing pest damage than smaller lower growing plants such as scentless mayweed. The challenge is achieving a balance of growth of the companion plants that will deter the pests without competing against the crop and compromising yield.

Much of this work has been done on brassica pests, and there's been little or no work to see if such approaches could deter allium leaf miner. We wanted to test the effects of growing two different shaped plants amongst leeks to see if they could control leaf miner. Plots were set up with three different treatments comprising of: 1) leeks alone (control), 2) leeks mixed with low growing white clover and 3) leeks mixed with tall growing chard. Plots were assessed at harvest to see whether the treatments had any significant effect. We were hoping to improve our understanding of companion planting and give gardeners new options for pest control.

Aim

We wanted to see if we could reduce the damage from allium leaf miner in leeks by interplanting them with low growing (clover) or taller growing (chard) crops.

Plot layout and care

Sowing

Leeks and chard were sown into modules in early March.

Plot preparation

An area with three 1m x 1m plots close to each other were set aside. The soil had compost or manure applied and were weeded before the trial.

Plot layout

The three plots were laid out as follows:
Plot 1 - Control plot: two rows of leeks.
Plot 2 – Leek/chard intercrop: alternate rows of leeks and chard.
Plot 3 – Leek/clover intercrop: two rows of leeks planted into bed of clover.

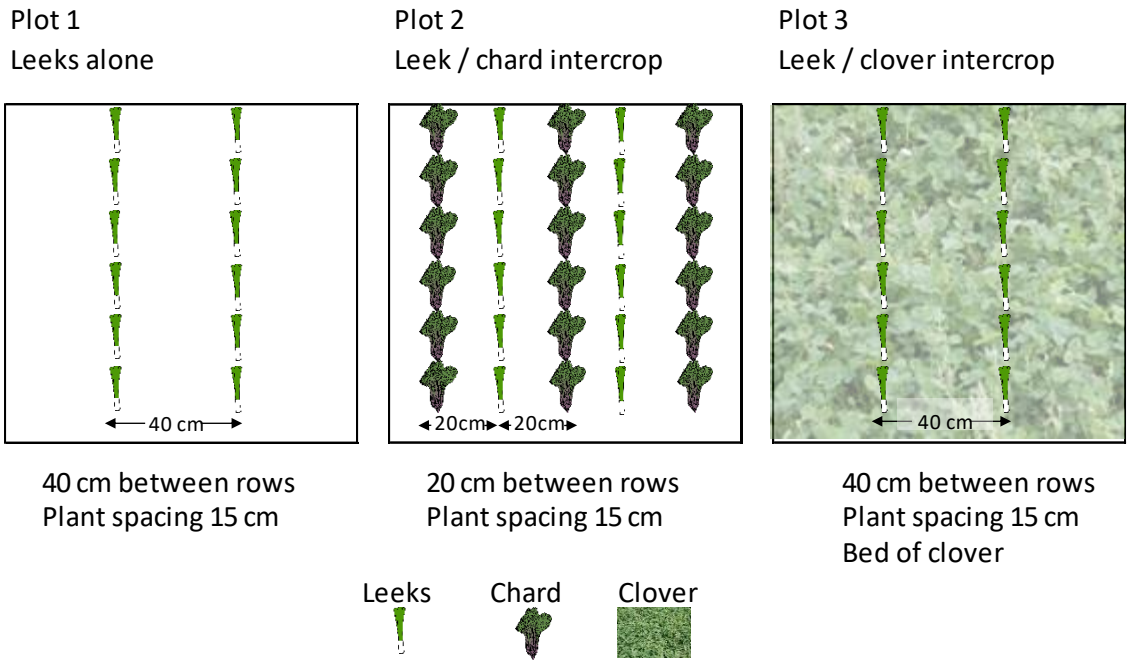

Figure 3 Plot layout

Subsequent plot care

Plants were watered and hand weeded as necessary.

Chard:
Harvests were taken from the chard to encourage fresh leaves to continue growing and maintain a canopy of tall growing leaves next to the leek plants. If the plants went to flower, the flower stem was cut off to maintain leafy growth.

Clover:
If the white clover grew taller than 10 cm, it was trimmed with shears to encourage vigorous growth and keep down weeds.

Assessments

Damage assessment

At the end of December, leeks were harvested from the three plots. Leeks from each plot were kept separate. The roots were cut off and excess soil from the base was removed.

For each plot the leeks were divided into three categories:
1 – No damage.
2 – Moderate damage: twisting of leaves, distorted growth.
3 – Severe damage: base of plant starting to collapse and rot.

For each plot the number and weight of plants in each category was recorded.

Number of larvae and pupae

For each plot, five leek plants were taken. The leaves were peeled back and the total number of allium leaf miner pupae and larvae on the five plants taken from that plot were counted (Figure 4).

Pupae

Larva

Figure 4 Pupae and larvae

Analysis

Results were collated, then analysed using analysis of variance as an unreplicated randomised block design. Each garden site was considered as a block, and the different methods of companion planting considered a treatment. As it was not practical to replicate the plots within people's gardens, we were not able to statistically analyse the interaction between the treatments and the garden sites. Treatments are marked with letters on the bar charts and those with different letters are considered significantly different ($p<0.05$).

Results

Response

Fifty people signed up to the experiment with 25 returning results, giving a 50% return rate. The sign-up rate was lower than for other experiments where we typically get 100–200 people meaning that our results are not as robust as we would like. It's likely the commitment required for the experiment discouraged people from signing up or later abandoning the trial. Additionally, we created a demonstration plot at Ryton Gardens in Warwickshire to keep our own records and record photographs.

Historical levels of damage at sites

We asked participants about the history of damage from allium leaf miner at their site. The responses suggested that allium leaf miner is a significant problem for many of the growers with 69% citing regular moderate or severe damage (Figure 5). These figures are quite similar to our survey carried out in 2017 [12], which also found that 69% of participants suffered from severe crop damage from the pest. Only 23% stated they never experienced damage from the pests. Unfortunately, surveys such as these tend to overestimate the incidence of pests, as people are more likely to respond if they have a problem.

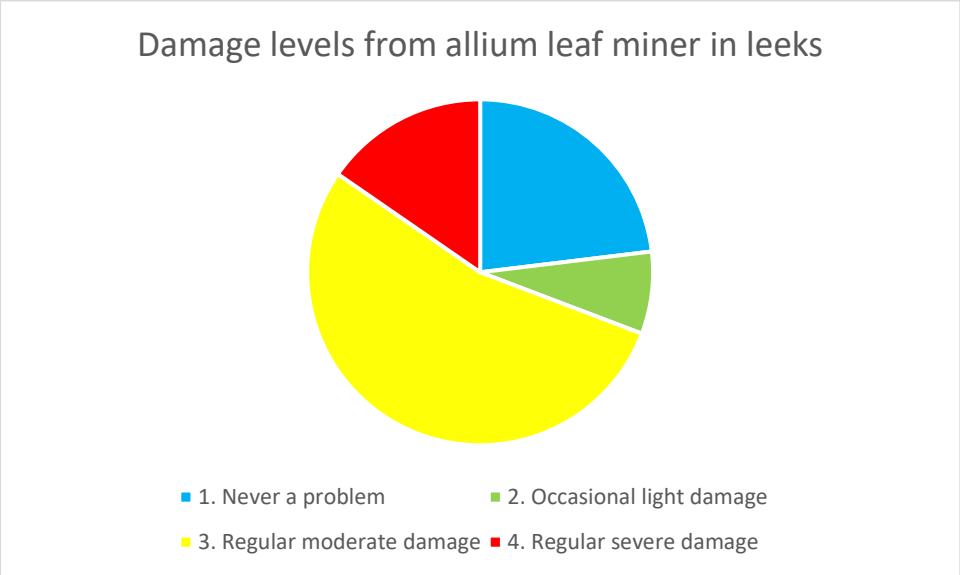

Figure 5 Participants experiencing problems with allium leaf miner

We asked growers which crops were affected by allium leaf miner (Figure 6). Leek growers were most affected with 80% reporting problems, followed by onions at 32%. This is in accordance with other work that shows that leeks are the most commonly affected crop [6,13]. One piece of work [6] showed the pest had a slight preference for chives over leeks and suggested they might be a suitable sacrificial trap crop.

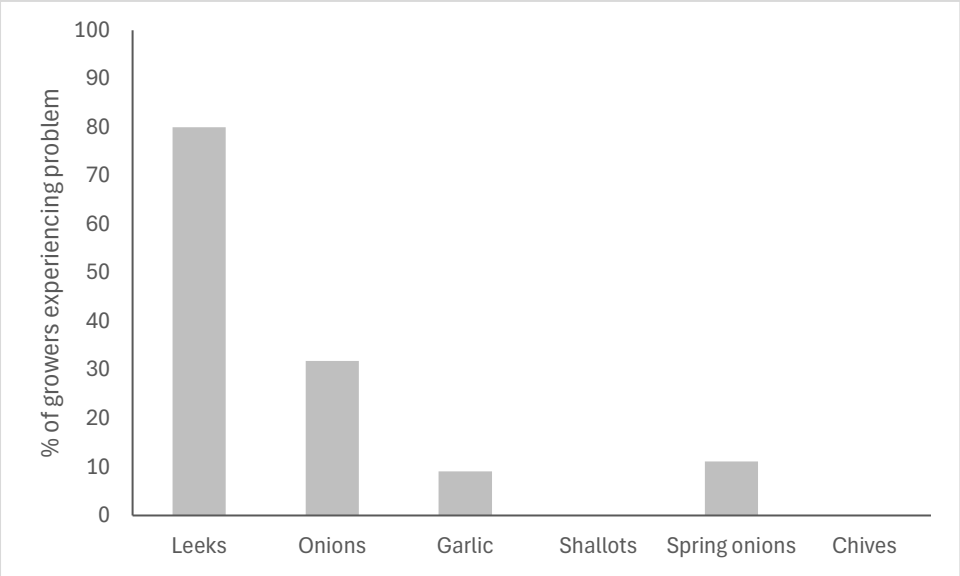

Figure 6 Crops experiencing problems with allium leaf miner

We asked participants which methods of control they used (Figure 7). Mesh or fleece was by far the most common with 50% using it compared to 45% not using any control measure. This is much increased from a previous study done by Garden Organic [12], when only 28% of participants covered crops, and suggests there's a better level of knowledge about the pest. The measures need to be applied at a time to take account of the egg laying period. Allium leaf miner has two generations of egg laying, one in March and a second more extensive period from September to November [14]. Leeks are particularly susceptible to the pest as they have a long growing period so it's difficult to avoid both generations of egg laying. Plants can be attacked by the first generation in March at the seedling stage and also at shortly before harvest by the second generation in autumn. Therefore, it's most important that any mesh or fleece is covering the crop during these times when the pest is actively egg laying in spring or autumn.

Figure 7 Methods used against allium leaf miner

In the study at Ryton, leeks, chard and clover all established well (Figure 8). However, by July the chard was causing a noticeable reduction in yield in the leek crops through competition.

Figure 8 July 2024 Leeks with chard

Leeks with clover

The initial symptoms of allium leaf miner were first noticed in October with scarring and twisting of the leaves. By November, the infestation of allium leaf miner was so severe (Figure 9), that, at Ryton we decided to harvest the crop so that it could be assessed before it rotted.

Figure 9 Allium leaf miner damage in November 2024

Participants selected five leeks at random from the plot and counted the number of pupae and maggots to assess the immediate damage done by the allium leaf miner (Figure 10). The chard, (which has a taller architecture) almost halved the number of pupae found in the leeks. This difference was not quite statistically significant (p=0.0978) but was a consistent trend. The clover undersowing, which was much shorter than the chard only resulted in a small reduction in the number of pupae. These results are similar to those found in a study of interaction of brassica pests and weeds in crops [11] where taller weeds were more effective at reducing pests than shorter plants. No work has previously looked at the effects of the size and architecture of companion plants on infestation by allium leaf miner.

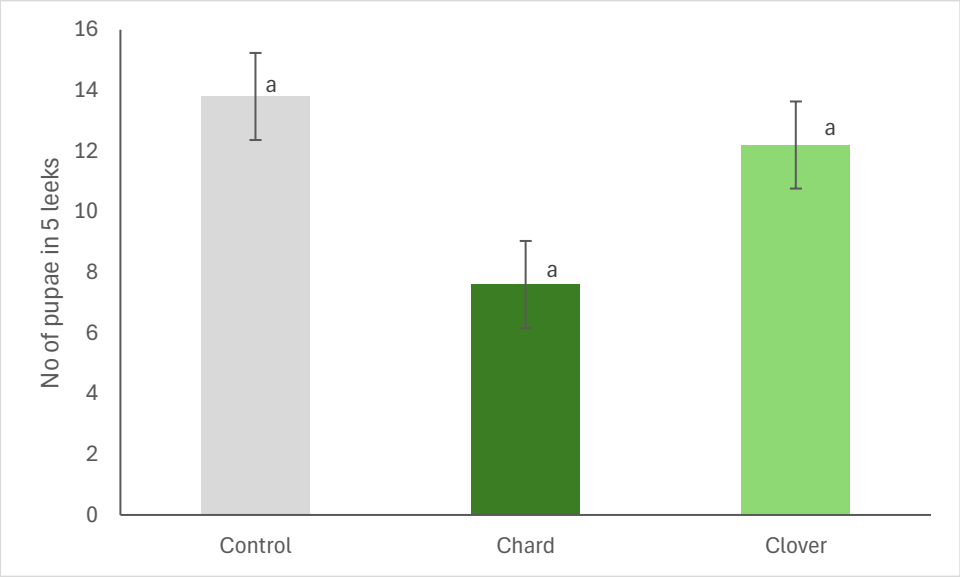

Figure 10 Effects of companion planting on number of allium leaf miner pupae found in harvested leeks Bars show Standard Error of the Mean. Results with different letters are significantly different (p<0.05)

Chard significantly (p=0.0031) reduced total yield from 870 g / m2 to 278 g/m2 (Figure 11), a 68% reduction in yield. This was due to the chard competing against the leek plants which was evident from just looking the plots. The chard plants swamped the leeks, and the leeks grew very slowly consequently.

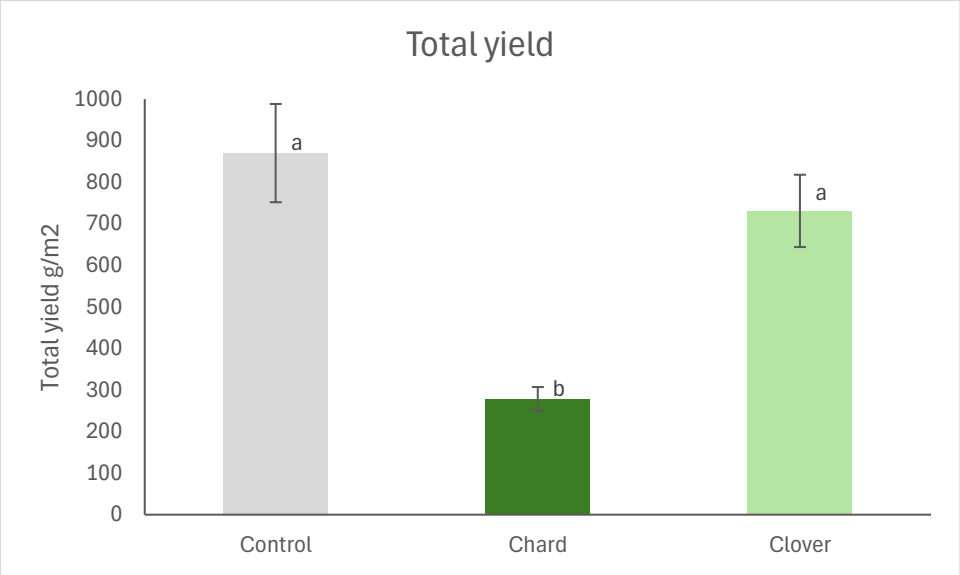

Figure 11 Effects of companion planting on total yield.

Marketable yields were typically half of the total yield as the allium leaf miner rendered about half of the crop unmarketable (Figure 12). Companion planting with chard reduced the percentage damage from 60 to 50% although this was not a significant reduction (Figure 13).

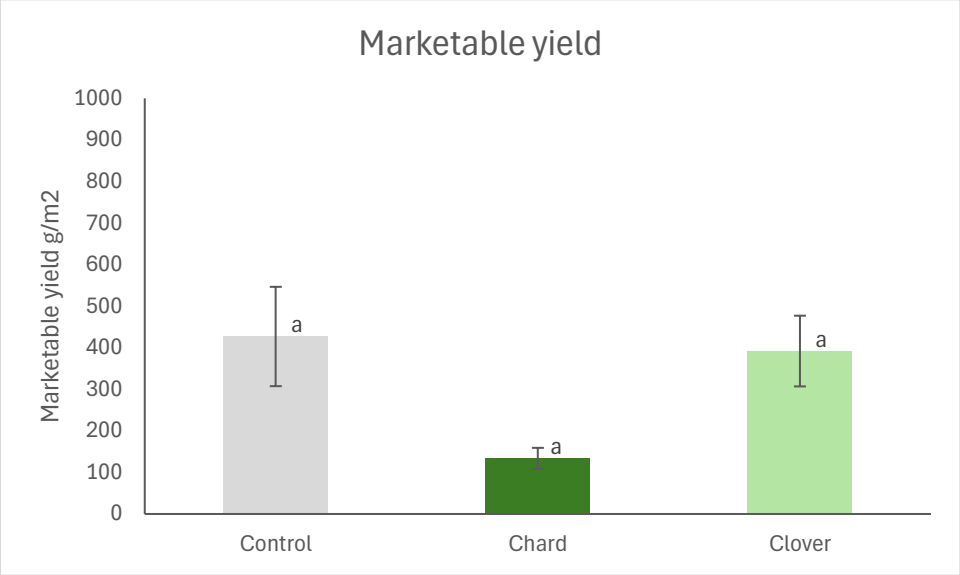

Figure 12 Effects of companion planting on marketable yield

Marketable yield was reduced by 69% companion planting with chard. Although the chard reduced the percentage of damage by the pest, this benefit was far outweighed by the reduction in total yield.

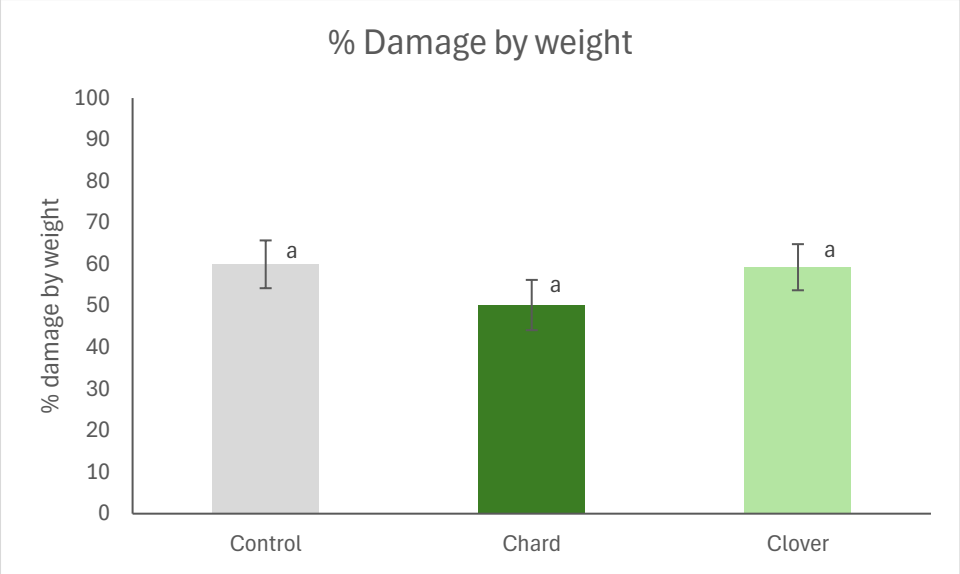

Figure 13 Effects of companion planting on percentage damage by weight

Conclusion

This trial suggests that there was a trend for the chard to reduce the attack by allium leaf miner, even though the effect was not significant. This is consistent with previous work that showed that taller companion plants were more effective at reducing pest damage.

However, in this instance the chard significantly reduced total yield of leeks through competition, far outweighing any benefit from reducing pest damage. This technique would need to be refined to make it worthwhile in practical use. The challenge is balancing the benefit of reduced pest damage against the reduction in yield through competition. Since allium leaf miner can cause quite extensive damage resulting in complete crop loss, growers might be willing to tolerate a moderate yield penalty from companion planting. This would be preferable to losing a large proportion of the crop to pest damage.

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