Beet and Chard Microgreens Research

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Last Updated: February 11, 2024

1. Beet Trials

1.1. Feb. 12, 2023 Bull's Blood Beet Trial

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

It should be noted that some growers report effective seed hull shedding without an additional layer of soil, which may speak to the length of the germination/covering period as a factor in effective hull shedding as well.

This trial will compare beets ***covered with soil*** and ***not covered with soil*** at seeding time to assess the degree of hull shedding that occurs in each treatment. We will also explore sowing rates and corresponding yield to help determine optimum sowing rates for Bull's Blood beets.

An important thing to keep in mind with beet seed is that each seed can germinate multiple stems. These multi-germ seeds can produce 2 to 5 shoots each.

Results Summary

This trial was not fully completed due to disrupted and poor germination. However, it did demonstrate that covering the seed with soil helps the shoots shed their hulls. The original DTG of four days appears to not be sufficient as the beets seem to need more time to push through the soil covering. The sowing rate range was appropriate, though could be expanded both lower and higher.

Trial Goals

1. To test whether covering the seed with soil helps remove beet hulls.
2. To determine best Days to Germinate (DTG) and Days to Maturity (DTM) for Bull's Blood beets at the given temperature range.
3. To determine the potential yield for 4 different sowing rates of Bull's Blood beets.

Trial Overview and Methodology

This trial was conducted in 3.5 cm (1.5") tall, 13cm x 13cm (5" x 5") "trial" trays using Sunshine Mix #4 as a growing medium. The following sowing rates were used, in replicate, for each treatment and adjusted for sowing rates in 1020 and Paperpot trays:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
5.98	50	65.8
6.58	55	72.38
7.18	60	78.96
7.77	65	85.54

The Bull's Blood beet seed was sourced from Mumm's Sprouting seeds, Lot #BEB0G, from Italy.

Eight trial trays per treatment (4 sowing rates x 2) were placed in a Paperpot tray for the duration of the trial. After sowing,

the trial trays for each treatment were randomized within their respective Paperpot Trays. Treatment 1 was covered with just a Paperpot tray and a 14-lb paver while Treatment 2 was first covered with soil - about ½ cm deep (see image, previous page), then a Paperpot tray and 14-lb paver.

The seed was not soaked for this trial, although many growers report soaking their seed for 4 hours or more before sowing.

Temperature and relative humidity were recorded. These trials were grown at approximately 27C (81F) in the day and 25C (77F) at night, which would be considered on the warmer side for most microgreens production and will shorten the crop cycle.

Lighting consisted of ***4 x 13W fluorescent lights*** at ***6500K*** placed 10 inches from the soil surface. Lighting was on for ***15 hours each day***. A small oil heater was used under the trial to reach the desired temperature range and came on with the lights.

Sources of Error

There are several places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Care is taken at each stage to reduce margins of error.

Trial Hypotheses

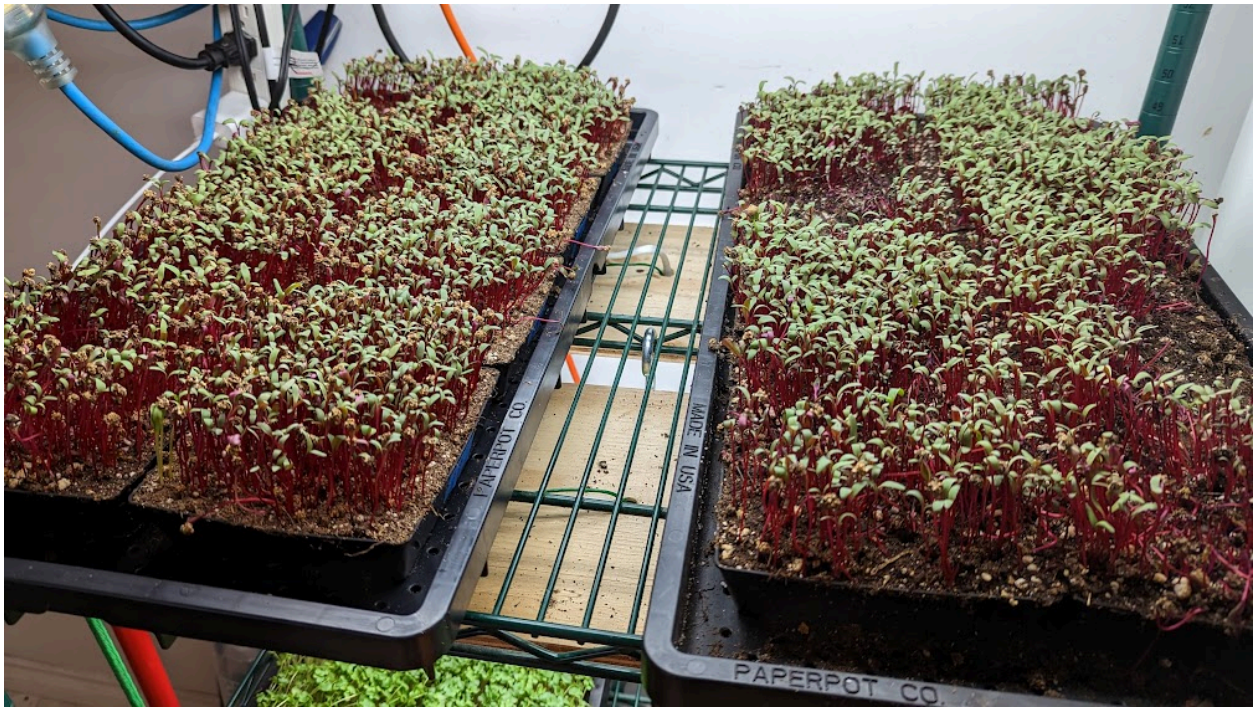
1. Covering the seeds with soil will help remove the hulls.
2. The yield to seed:ratio will be quite low.
3. Suitable DTG will be 4 days and suitable DTM will be 10 days

Trials Results and Discussion

The crop was uncovered after four full days in germination as expected. The soil-covered treatment looked poorly germinated in spots, but only because the seeds had not yet pushed through the soil. In the image below, the treatment on the left is the one ***without*** the soil covering and the treatment on the right is ***with*** the soil covering. Both germinated well overall. In the second image (following page) you can see both treatments after a watering and a full day of growth in the light.

The seed not pushing up through the soil suggests *at least* another day of germination may have been beneficial for the soil-covered treatment. Some growers report up to six days in the germination stage for beet microgreens. However, longer stages in the germination stage can have a few negative outcomes:

1. Increased risk of disease
2. Bent stems which may not recover and fully straighten out, which makes harvest more difficult and thus reduce yield



Right out of the germination stage, it appeared the soil-covered treatment is ***shedding its hulls better*** than the non-soil-covered treatment. The soil-covered treatment also appears ***taller*** at this stage. This held true as the crop matured, with the soil-covered treatment shedding most of its hulls. The image below on the left is the treatment which was not covered with soil - showing many hulls still attached. The treatment on the right is the soil-covered treatment, which shows most of the hulls have been shed. This supports our hypothesis that covering the seeds with soil will help them shed their hulls.

We did not collect any yield data due to multiple crop failures, so this trial will be repeated to get proper sowing and yield data and to get a yield:seed ratio. But this short trial did make clear that covering the seed with soil is very effective in hull removal.

Temperature and Humidity Data

Not included.

General Crop Observations

- You can see the root hairs on a few of the shoots, which may make for interesting viewing, but is not a good sign. If you can see root hairs this prominently, then it means the shoot is not properly rooted into the soil. This often occurs when overseeding. This seed looks like it was on the edge of the tray and may have been reaching to find the soil.
- This trial had reasonably good results in the early part but failed as it matured (aaaaand may have been slightly neglected). In our next trial we will leave the crop covered for at least one or two more days in the germination stage. At this point, we see no need to test the “plastic wrap” method for germination since hull shedding on the soil-covered treatment appeared to be effective.
- Future trials should explore some higher seeding rates.
- Because the mature beet plant has an edible leaf, beet microgreens may be a good candidate for growing to the true leaf stage which would make better use of the seed and improve the yield to seed ratio. This would require a lower seeding rate than for true microgreens.
- Getting the DTG right is important to ensure the crop germinates properly and fully pushes up through the soil.

Recommendations

- We have no strong recommendations after this trial.

1.2. Feb. 23, 2023 Bulls' Blood Beet Trial

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

In our last trial we uncovered the crop after 4 days and had a few spots where the seeds did not emerge through the soil. In this trial, we are aiming to leave the trays covered for six days to see if we get better hull shedding. Leaving germinating seeds covered for too long can be problematic as it increases disease pressure and can result in bent stems which often do not recover and are thus harder to harvest.

Results Summary

This trial ended early because the seed did not successfully emerge through the soil in most trays, suggesting the soil covering method or thickness was inadequate. There was also mold starting on the surface of the soil.

Trial Goals

1. To determine best Days to Germinate (DTG) and Days to Maturity (DTM) rate for Bull's Blood beets at the given temperature profile.
2. To determine the potential yield for ***8 different sowing rates*** of Bull's Blood beets.
3. To explore an effective soil-covering method for beets to help with seed hull removal.

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using Sunshine Mix #4 as a growing medium. The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
5.4	45.0	59.2
6.0	50.0	65.8
6.6	55.0	72.4
7.2	60.0	79.0
7.8	65.0	85.5
8.4	70.0	92.1
9.0	75.0	98.7
9.6	80.0	105.3

Bulls Blood beet seed was from Mumm's Sprouting seeds.

The eight 5 x 5 trial trays per replicate were placed in two 23" x 11" Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were watered then randomized within their respective Paperpot trays. Both replicates were then covered with soil - about ½ cm deep then a Paperpot tray and 14-lb paver. The soil was manually spread over the seeds and evened out then watered again.

Temperature and relative humidity were recorded and leaf vapor pressure deficit (VPD) calculated from the results. These trials were grown at approximately **TBD in the day TBD at night,** which would be considered fairly standard for most microgreens production.

Lighting consisted of 4 x ***13W fluorescent lights*** at ***6500K*** placed 10 inches from the soil surface. Lighting was on for ***15 hours each day***. A small oil heater was used under the trial to reach the desired temperature range.

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. Keeping the trial covered for four days instead of six days for germination will improve germination and seed hull removal.
2. The lower sowing rates will be too low, and may be good to take to the first leaf stage.
3. The higher sowing rates will result in a higher yield and be close to peak yield

Trial Results and Discussion

After four days in germination we could see that germination was progressing well and it was tempting to uncover the trays! On the image to the right you can see the germinated shoots popping up through the drainage holes in the covering tray.

In the image on the next page, you can see the shoots working their way out the sides of the trays. In most crops, this is a clear

indicator it is time to uncover your crops. But with the need for beets to shed their hulls, we left the crop covered to try and achieve this.

At the end of Day four we could see that the seed in most spots in both replicates were not pushing through the soil.

Upon uncovering on Day 5 it was clear the trial would not run its full course to determine yield (see image below). Most of the seed did not emerge through the soil covering. I have two theories on why this happened:

1. The soil covering was too thick.
    a. This is suggested by the better emergence on the edges
2. The weight on the trays was too much
    a. This is a possibility, but I do know of growers who use this method and stack their trays six high with good germination

Temperature and Humidity Data

General Crop Observations

- See above

Recommendations

- Conduct further trials to best determine soil covering methods

1.3. March 4, 2023 Bull's Blood Beet Trial

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

This trial is a follow up to previous trials to determine a reliable method of growing beets while getting the seeds to shed their hulls as well as determining optimum sowing rates. Our last beet trial was cut short as the seeds did not emerge successfully through the soil.

Results Summary

Damping off prevented us from collecting useful yield data, but our method of covering the seed with soil has shown to be effective.

Trial Goals

1. To determine best Days to Germinate (DTG) and Days to Maturity (DTM) rate for Bull's Blood beets at the given temperature profile.
2. To determine the potential yield for ***8 different sowing rates*** of Bull's Blood beets.
3. To explore an effective soil-covering method for beets to help with seed hull removal.

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using a Modified Sunshine Mix #4 as a growing medium. The growing medium had a small amount of compost (5 - 8%) and a moderate amount of perlite (20 - 30%) added to the base Sunshine Mix. It is possible a lighter soil mix will also help the seed more easily emerge from covering.

The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
5.4	45.0	59.2
6.0	50.0	65.8
6.6	55.0	72.4
7.2	60.0	79.0
7.8	65.0	85.5
8.4	70.0	92.1
9.0	75.0	98.7
9.6	80.0	105.3

The Bull's Blood beet seed was from Mumm's Sprouting seeds.

The eight 5 x 5 trial trays per replicate were placed in two 23" x 11" Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were randomized within their respective Paperpot trays then watered. Both replicates were then covered with soil - about ½ cm deep then a Paperpot tray and 14-lb paver (see method details below).

Covering the Sowed Seed with Soil

In the previous two trials, the soil covering had variable results - possibly from being too thick in spots. In this trial we are trying a new method of spreading the covering soil using a wide-screened colander to ensure an even spread to just barely cover the seed. See a video of the method here.

The overall method was as follows:

1. A light sprinkling of soil *before* sowing to even out the soil
2. A light sprinkling of soil after sowing to cover the seed
3. A light misting of water to get the cover soil moist
4. A final very light sprinkling of soil which was *not* watered
5. Paperpot covering tray placed over trays
6. 14-lb paver placed over Paperpot tray

Temperature and relative humidity were recorded and leaf vapor pressure deficit (VPD) calculated from the results. These trials were grown at approximately **23Cin the day and 20C at night,** which would be considered fairly standard for most microgreens production.

Lighting consisted of 4 x ***13W fluorescent lights*** at ***6500K*** placed 30 cm from the soil surface. Lighting was on for ***15 hours each day***. A small oil heater was used under the trial to reach the desired temperature range.

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space

3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. A lighter covering of soil relative to the previous trial will result in better seed emergence and still maintain effective hull removal.
2. The lower sowing rates will be too low, and may be good to take to the first leaf stage.
3. The higher sowing rates will result in a higher yield and be close to peak yield

Trial Results and Discussion

We saw the first signs of emergence after three days in germination and after four days in germination we saw emergence was looking healthy, though not complete (see image to right). This was a big improvement over the last trial.

With the paperpot trays, we do see the shoots poking up through the drainage holes which can damage them upon uncovering. We will explore an intermediary cover to prevent this in the future if it becomes a problem.

With the degree of germination we saw after four days of growth, we decided to uncover this crop after five days (instead of the projected six days) to prevent any issues that may occur from keeping a crop covered for too long. Overall, germination on this trial was superb at the five-day mark (see image to right) and hull shedding was very successful. The only place where we saw a few hulls still attached to the cotyledons was on shoots growing out the edges of the tray.

We were also able to somewhat successfully remove the covering tray without damaging all the shoots that were poking through the drainage holes, which may not have been possible with another day of germination.

After six days of growth we see the leaves starting to open up. The Bull's Blood beet has a red underside so stays very red looking for a full day after uncovering.

The five-day germination period is interesting because after four days the crop was not quite ready for uncovering, whereas after five days it almost feels overmature. The crop puts on rapid growth on the fourth day and this results in significant bending in the stems, which can make the crop harder to harvest. However, after one full day in the light the stems were doing a good job of straightening out, so we were carefully watching the stems carefully as the crop matured.

The first watering for this crop was after six days of growth, which may have been one day too late, though the crop still looked good. There were some signs of damping off in one of the trays at this point. This trial was only bottom watered.

By Day 10 we were seeing a lot of damage from damping off. We will still be able to harvest many trays, but will not have a full data set. So far, the March 5 trial, sowed one day after this trial, is showing much less damping off. We will really need to stay on top of our sanitation program to try and control this issue.

We did a bottom watering after ten full days of growth to prepare for harvest after 11 days of growth (one more than anticipated).

At harvest time, most of the trial trays had some or a lot of damping off. Trays 3, 6, 7, 9 ,12, 13, 14, and 15 all had severe damping off, so it does not appear to correlate too strongly to sowing rate. We only harvested trays that showed no or very little damping off. See image on right.

We were not able to generate any relevant yield data from this trial.

[Raw Data Here]

Seed/Tray (g)	Yield (g)	1020 Equivalent (g)	Paperpot Equivalent (g)	Average Yield, Each Replicate (g)	Average Yield, Both Replicates (g)	Average 1020 Equivalent (g)	Average Paperpot Equivalent (g)	STDEV, both replicates (g)	Yield to Seed Ratio	Average Yield to Seed Ratio	STDEV as %
4.78	11.4	95.3	125.4	12.1	11.4	95.3	125.4		2.4	1.2	**0.00%**
5.38	11.1	92.8	122.1		11.1	92.8	122.1	0.0	2.1	2.1	**0.00%**
5.98		0.0	0.0		9.8	81.9	107.8		0.0	0.8	
6.58	13.9	116.2	152.9		13.9	116.2	152.9		2.1	1.1	**0.00%**
7.18		0.0	0.0			0.0	0.0		0.0	0.0	
7.77		0.0	0.0			0.0	0.0		0.0	0.0	
8.37		0.0	0.0		16	133.7	176.0		0.0	1.0	
8.97		0.0	0.0		16.1	134.6	177.1		0.0	0.9	
4.78		0.0	0.0	13.3					0.0		
5.38	11.1	92.8	122.1						2.1		0.00%
5.98	9.8	81.9	107.8						1.6		0.00%
6.58		0.0	0.0						0.0		
7.18		0.0	0.0						0.0		
7.77		0.0	0.0						0.0		
8.37	16	133.7	176.0						1.9		
8.97	16.1	134.6	177.1						1.8		

Temperature and Humidity Data

[Raw data here]

Average Temperature: 22.9 C

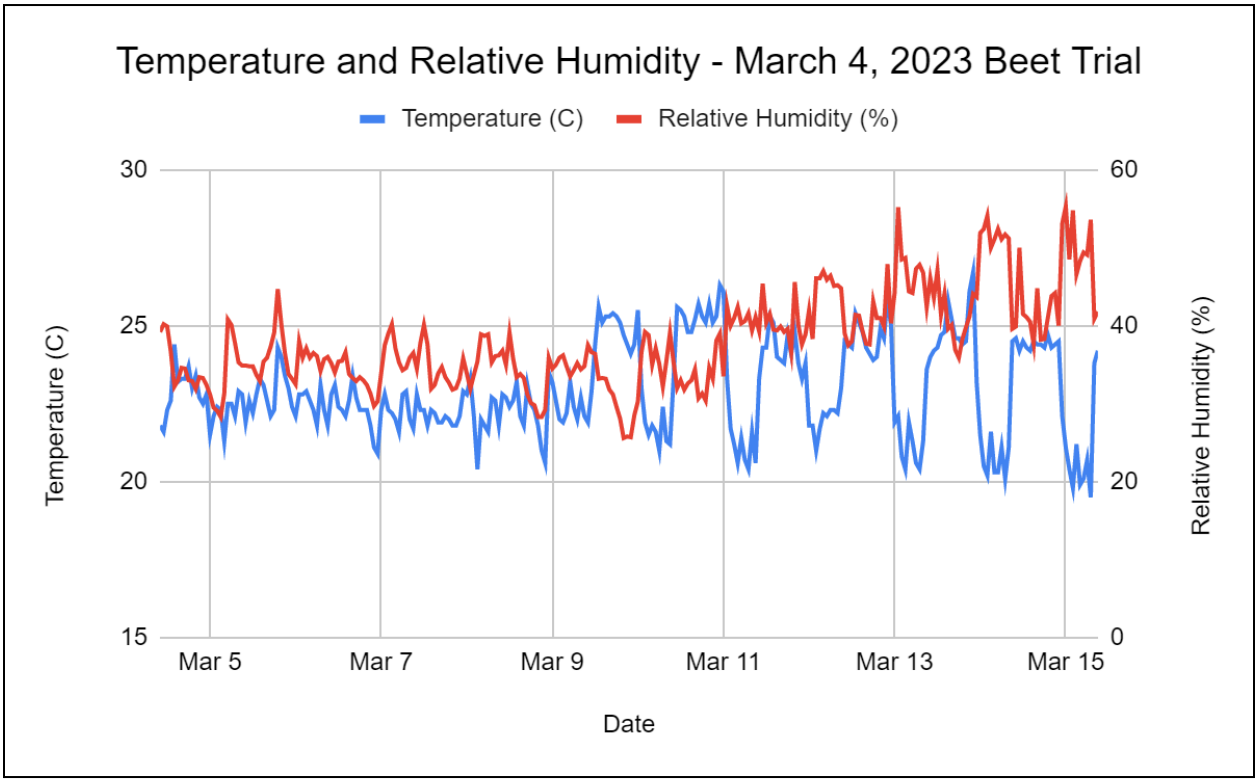
Maximum Temperature: 26.7 C

Minimum Temperature: 19.5 C

Average Relative Humidity: 38.1%

Maximum Relative Humidity: 55.3%

Minimum Relative Humidity: 25.6%



General Crop Observations

- The soil covering method we used seems to have been effective and is easy to replicate. This is after the previous trial in which the seed did not emerge well through the soil covering.
- The soil covering method was effective for hull removal and germination, but did result in a rough soil surface which made harvest a bit more challenging to ensure no soil got mixed in with the shoots. See image to the right.

- Damping off continues to be an issue with beets, even with bottom watering. We may be able to control damping off by adjusting the growing method for this crop, but how to do so is yet to be determined. We will also improve our hygiene and sanitation measures.

Recommendations

- While we can see that covering the crop with soil is helping with hull removal, we do not yet have an official recommendation.
- For future trials we look at using a thinner soil layer and trying perlite as a covering medium instead of soil. This might help reduce damping off.
- We are still exploring the best way to record and report vapor pressure deficit (VPD) over the crop's life cycle.

1.4. March 5, 2023 Bull's Blood Beet Trial

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

This trial is a follow up to previous trials to determine a reliable method of growing beets while getting the seeds to shed their hulls as well as determining optimum sowing rates. Our last beet trial was cut short as the seeds did not emerge successfully through the soil.

Results Summary

This trial demonstrated for a second time that our method of covering the seed with soil was effective. From this trial and the previous trial, 5 days in germination appears to be a good germination time at the given temperature range.

Trial Goals

This trial is an almost exact replicate of our March 4, 2023 trial, with the key difference being the seed is being soaked before sowing. The goals are as follows:

1. To test the efficacy of ***soaking seed*** in contributing to hull removal and germination
2. To determine ***best Days to Germinate (DTG) and Days to Maturity (DTM)*** rate for Bull's Blood beets at the given temperature profile.
3. To determine the potential yield for ***8 different sowing rates*** of Bull's Blood beets.
4. To explore an effective ***soil-covering method*** for beets to help with seed hull removal.

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using a Modified Sunshine Mix #4 as a growing medium. The growing medium had a small amount of compost (5 - 8%) and a moderate amount of perlite (20 - 30%) added to the base Sunshine Mix. It is possible a lighter soil mix will also help the seed more easily emerge from covering.

The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
5.4	45.0	59.2
6.0	50.0	65.8
6.6	55.0	72.4
7.2	60.0	79.0
7.8	65.0	85.5
8.4	70.0	92.1
9.0	75.0	98.7
9.6	80.0	105.3

The Bull's Blood beet seed was from Mumm's Sprouting seeds.

The eight 5 x 5 trial trays per replicate were placed in two 23" x 11" Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were randomized within their respective Paperpot trays then watered. Both replicates were then covered with soil - about ½ cm deep then a Paperpot tray and 14-lb paver (see method details below).

Soaking Seeds

Seeds were soaked at 9:30 am on March 5 using hot tap water (see image to right). Each individual cup holding seeds was filled halfway with water then stirred immediately afterward. Initial soak time goal was six hours, which several growers have stated has been a good soak time for them. Beet is a soft seed, so should imbibe water very quickly to induce germination, thus, the longer soak time might be more important for further softening seed hulls for more effective shedding upon germination. After soaking, the seeds were strained through a fine meshed sieve and then sowed immediately.

Over time, there are four key questions to answer about any crop where the seed is soaked:

1. What is the ***optimum*** soak time for this seed?
2. What is the ***minimum*** soak time for this seed?
3. What is the ***maximum*** soak time for this seed?
4. How does soak time ***affect performance***?

These questions are important to answer because they help you schedule when you soak your seeds and determine how long they can stay soaked for - which may affect the flexibility of your schedule.

Covering the Sowed Seed with Soil

In the previous two trials, the soil covering had variable results - possibly from being too thick in spots. In this trial we are trying a new method of spreading the covering soil using a wide-screened colander to ensure an even spread to just barely cover the seed. See a video of the method here.

The overall method was used for this trial:

1. A light sprinkling of soil *after* sowing to cover the seed
2. A light misting of water to get the cover soil moist
3. Paperpot covering tray placed over trays
4. 14-lb paver placed over Paperpot tray

Temperature and relative humidity were recorded. These trials were grown at approximately **24C in the day and 22C at night,** which would be considered fairly standard or even a little warm for most microgreens production.

Lighting consisted of 4 x ***13W fluorescent lights*** at ***6500K*** placed 10 inches from the soil surface. Lighting was on for ***15 hours each day***. A small oil heater was used under the trial to reach the desired temperature range.

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. A lighter covering of soil relative to the previous trial will result in better seed emergence and hull removal.
2. The lower sowing rates will be too low for a true microgreen, but may be good to take to the first leaf stage.
3. The higher sowing rates will result in a higher yield and be close to peak yield.

Trial Results and Discussion

This trial was uncovered on Day 5 and showed effective hull loss. Relative to the March 4, 2023 trial, we do not see any indication that soaking the seed in this trial has improved germination or hull shedding. Most hulls have been shed with just a few still clinging to the cotyledons on the shoots growing out the side of the tray, which is what we also saw in our March 4 trial.

The first watering for this crop was after five days of growth and the crop was looking healthy. There are one or two sections where soil crusting has restricted seed emergence. In our Feb, 23, 2023 trial we had watered the crop from above and this worsened the crusting in some areas, so we were careful not to do this again. This is one of the main things we were trying to avoid with our soil-covering method in this trial with the thought that the correct method plus the right depth of soil would be key to preventing soil crusting.

One way to avoid soil crusting is to use *perlite* as a covering option, which some vegetable farmers do with certain crops for transplanting (e.g., leeks and onions). This is still an option, but can pose a couple of challenges:

1. Perlite can be easily “dislodged” and become a contaminant at harvest time
2. Requires a source of perlite, which is not always readily available

Perlite comes in different particle sizes, so it would also need to be determined whether a fine, medium, or coarse perlite would work best. Our guess would be a fine perlite would be best as it would provide more uniform coverage. It would only take a thin layer, so a little perlite could go a long way. Also, with the right harvest set up and method, the risk of perlite contamination could be reduced. Growers report effective hull removal with perlite. Further, after germination, we may be able to effectively "dump" loose perlite from the top of the tray (method pending!) at uncovering time.

After 10 full days of growth, this trial was looking better than the previous trial with much less damping off.

Raw Trial Data Here

Seed/Tray (g)	Yield (g)	1020 Equivalent (g)	Paperpot Equivalent (g)	Average Yield, Each Replicate (g)	Average Yield, Both Replicates (g)	Average 1020 Equivalent (g)	Average Paperpot Equivalent (g)	STDEV, both replicates (g)	Yield to Seed Ratio	Average Yield to Seed Ratio	STDEV as %
4.78	11.1	92.8	122.1	13.2	11.2	93.6	123.2	0.1	2.32	2.3	**1.3%**
5.38	12.7	106.2	139.7		13.7	114.5	150.7	1.4	2.36	2.5	**11.1%**
5.98	13.8	115.4	151.8		15.3	127.9	168.3	2.1	2.31	2.6	**15.4%**
6.58	16.3	136.3	179.3		16.05	134.2	176.6	0.4	2.48	2.4	**2.2%**
7.18	0	0.0	0.0		6.65	55.6	73.2	9.4	0.00	0.9	
7.77	14.1	117.9	155.1		17.1	142.9	188.1	4.2	1.81	2.2	**30.1%**
8.37	18	150.5	198.0		18.05	150.9	198.6	0.1	2.15	2.2	**0.4%**
8.97	19.2	160.5	211.2		19.3	161.3	212.3	0.1	2.14	2.2	**0.7%**
4.78	11.3	94.5	124.3	16.2	12.3	16.1875	12.3	16.1875	2.36	16.2	143.3%
5.38	14.7	122.9	161.7		17.4		17.4		2.73		0.0%
5.98	16.8	140.4	184.8		17.45		17.45		2.81		0.0%
6.58	15.8	132.1	173.8		17.6		17.6		2.40		0.0%
7.18	13.3	111.2	146.3						1.85		
7.77	20.1	168.0	221.1						2.59		
8.37	18.1	151.3	199.1						2.16		

Yield data was inconsistent across the replicates, but peaked similarly in both replicates between 150 g and 162 g per 1020 tray and 198 g to 213 g per Paperpot Tray at sowing rates of 70 g and 75 g respectively. This is similar to the results of Johnny's Selected Seeds' Bull's Blood Beet Trial in 2017 on a 17-day cycle and a sowing rate of 23 g/1020 tray (Johnny's, 2017). On the Grow reported a yield of 128 g with a sowing rate of 25 grams (On the Grow, n.d.)

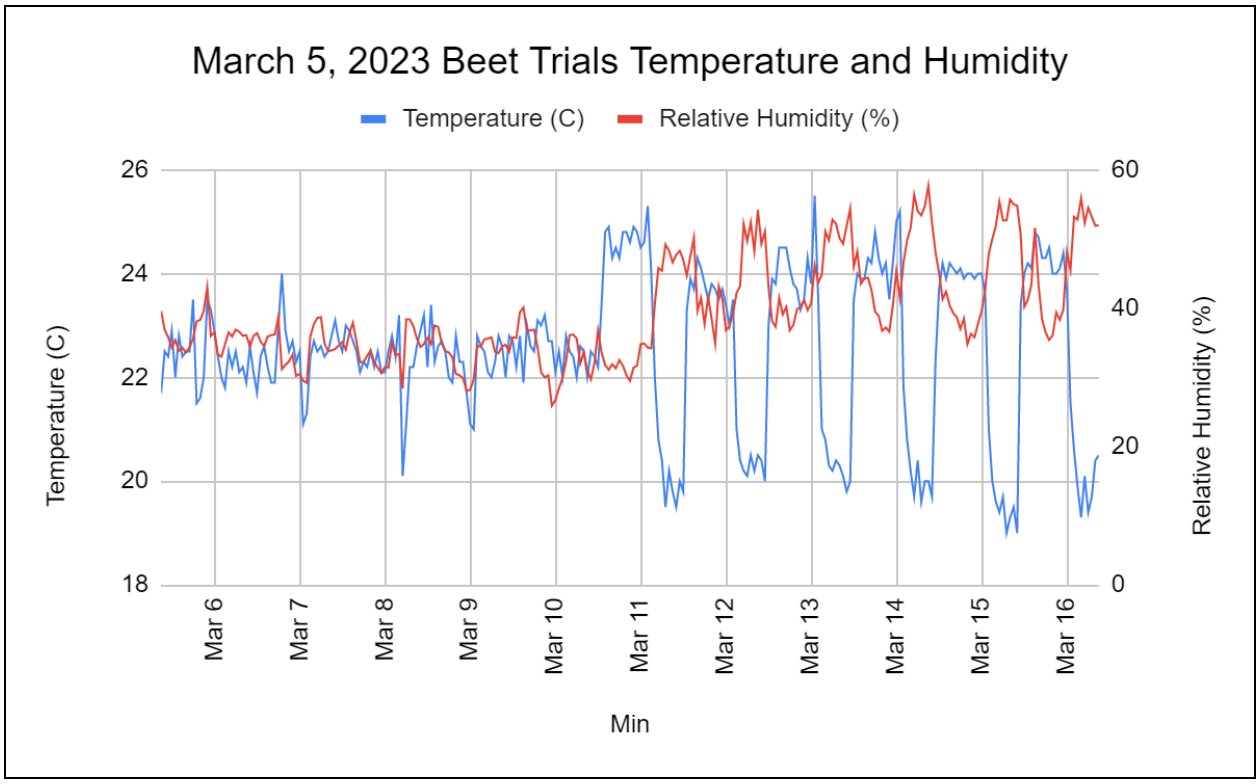
None of our trial sowing rates were as low as the sowing rates from On the Grow and Johnny's, Our lowest sowing rate was at 40g/1020 tray which yielded between 93 and 95 g after 11 days.

Published sowing rates for beets tend to be on the low side, as are the yields, so it appears there could be a lot of work to do to better understand this crop as a microgreen.

Temperature and Humidity Data

Raw Temperature and Humidity Data Here

	Temp (C)	Relative Humidity (%)
Min	19	25.9
Max	25.5	57.7
Average	22.5	39.3



General Crop Observations

- Our soil-covering method once again proved effective.
- Sowed just one day after our previous trial this trial experienced much less damping off.
- The rough soil surface from covering the seeds with soil makes harvesting a clean crop much more difficult.

Recommendations

- We could explore leaving the crop covered for an additional day to see results
- We can try using perlite as a covering material instead of soil and further look at ways to “remove” it from the soil surface at uncovering time.

1.5. March 24, 2023 Bull's Blood Beet Trial

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

This trial is a follow up on previous trials to determine optimum sowing rates and corresponding yields along with the best method of covering the seeds to get effective hull shedding during germination.

Results Summary

Both treatments suffered severe damping off, so no yield measurements were made. The soil-covered treatment seemed to have better results in hull shedding. The perlite covered treatment did not look great aesthetically.

Trial Goals

This trial has multiple goals:

1. To determine ***best Days to Germinate (DTG) and Days to Maturity (DTM)*** rate for Bull's Blood beets at the given temperature profile in the shortest crop cycle possible.
2. To determine the potential yield for 4 ***different sowing rates*** of Bull's Blood beets.
3. To compare two ***soil covering methods*** for beet seeds to help with seed hull shedding
    a. Seed covered with soil
    b. Seed covered with perlite

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using a Modified Sunshine Mix #4 as a growing medium. The growing medium had a small amount of compost (5 - 8%) and a moderate amount of perlite (20 - 30%) added to the base Sunshine Mix. It is possible a lighter soil mix will also help the seed more easily emerge from covering.

The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
7.18	60.0	79.0
7.77	65.0	85.5
8.37	70.0	92.1
8.97	75.0	98.7

These are the top four sowing rates used in our previous trials and are much higher than published rates for beet microgreens.

The Bull's Blood beet seed was from Mumm's Sprouting seeds.

The eight 5 x 5 trial trays per replicate were placed in two 23" x 11" Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were randomized within their respective Paperpot trays then watered.

After sowing, one replicate was covered with soil - about ½ cm deep then a Paperpot tray and 14-lb paver. The other replicate was covered with perlite - about ½ cm deep then a Paperpot tray and 14-lb paver (see method details below).

Covering the Sowed Seed with Soil

In this trial we are trying the same method of spreading the covering soil using a wide-screened colander to ensure an even spread to just barely cover the seed. See a video of the method here.

The overall method was used for this trial:

1. A light sprinkling of soil *after* sowing to cover the seed
2. A light misting of water to get the cover soil moist
3. Paperpot covering tray placed over trays
4. 14-lb paver placed over Paperpot tray

Covering the Sowed Seed with Perlite

We used the same method as we use with the soil for covering the seed with perlite.

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. Current DTG (5) and DTM (11) will prove sufficient
2. The higher sowing rates will show the highest yields
3. There will be no difference in hull shedding between the soil covering methods

Trial Results and Discussion

This trial was uncovered after 5 days. A few spots had not germinated well in both trays. And the soil-covered tray clearly germinated better.

Crop growth did not improve as the crop matured (see image next page). The perlite-covered tray does not look nice at this point - the perlite is stained from the soil.

Even following the effective soil covering method from our last trial we still had germination issues. It is likely the coverings on both treatments were too thick.

Temperature and Humidity Data

General Crop Observations

- Both treatments had bare posts at germination and damping off spread quickly through both treatments.

Recommendations

- In a follow-up trial, we will continue with the same method and be sure to have a lighter covering of soil.
- We will consider leaving the crop for one extra day of germination to see how it affects hull shedding and overall crop growth.

1.6. April 23, 2023 Bull's Blood Beet Trials

Introduction

Beets are a popular microgreen for their vivid color and sweet, earthy flavor profile. One of the biggest challenges with beets is separating the seed hulls from the shoots. Many growers report covering the seeds with soil after sowing helps with hull removal while others have reported using a layer of plastic wrap over the seeds during the germination process is effective. The idea behind the extra soil covering would be that there is increased friction between the emerging shoots, the seed hulls, and the additional soil which work together to help loosen the hulls - which is crucial for making the product quick to harvest and marketable.

This trial is a follow up to previous trials to determine a reliable method of growing beets while getting the seeds to shed their hulls as well as determining optimum sowing rates.

Results Summary

While both trays showed substantial disease, we did see that with a six-day germination period:

1. The non-soil-covered treatment shed hulls as well as the soil-covered treatment
2. The non-soil-covered treatment had less disease than the soil-covered treatment

Trial Goals

1. To further determine sowing rates and corresponding yields
2. To test soil covering as a hull shedding strategy vs no soil covering

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using a Modified Sunshine Mix #4 as a growing medium. The growing medium had a small amount of compost (5 - 8%) and a moderate amount of perlite (20 - 30%) added to the base Sunshine Mix. It is possible a lighter soil mix will also help the seed more easily emerge from covering.

The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
7.18	60.0	79.0
7.77	65.0	85.5
8.37	70.0	92.1
8.97	75.0	98.7

These are the top four sowing rates used in our previous trials and are much higher than published rates for beet microgreens.

The Bull's Blood beet seed was from Mumm's Sprouting Seeds, Lot #BEB0G

The eight 5 x 5 trial trays per replicate were placed in two 23" x 11" Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were ***not*** randomized within their respective Paperpot trays then watered. Lighting consisted of ***2 x 10W LED lights*** at ***6500K*** placed 12 inches from the soil surface. Lighting was on for ***14 hours each day***.

After sowing, one treatment was covered lightly with soil - about ½ cm deep then a Paperpot tray and 14-lb paver.

Covering the Sowed Seed with Soil

In this trial we are trying the same method of spreading the covering soil using a wide-screened colander to ensure an even spread to just barely cover the seed. See a video of the method here.

The overall method was used for this trial:

1. A light sprinkling of soil *before* sowing to cover the base (wet) soil and make it uniform.
2. A light sprinkling of soil *after* sowing to cover the seed

3. Paperpot covering tray placed over trays
4. Plastic divider inserted into Paperpot tray (to prevent beets from growing up through Paperpot tray drainage holes).
5. 14-lb paver placed over Paperpot tray

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. Our highest sowing rate will give the highest yield
2. The soil-covered treatment will shed hulls better than the treatment not covered with soil

Despite the soil covering method showing the best hull shedding in a previous trial, we are trying a non-soil covered treatment again and leaving it in germination for a longer period to see if we can get suitable hull shedding without covering with soil. The idea here is see if we can find the simplest method of growing beets.

Trial Results and Discussion

Raw Data Here.

This trial was not taken to completion due to excessive mold after germination, but still provided some valuable insights.

Trays were left for a full six days before uncovering - one day longer than in previous trials.

Both treatments experienced mold, but the mold on the soil-covered treatment (on left, below) was much worse and the treatment was discarded. The non-soil covered treatment was left to grow (on right, below).

Both treatments showed almost complete hull shedding, demonstrating that beets can effectively shed their hulls without a soil covering. This is the preferred method because it requires less steps in the sowing process.

Seeing mold after the germination stage has been quite frequent in our trials and we have had only one trial out of six that has not experienced excessive mold and was able to produce a measurable yield. This inconsistency is a challenge to deal with!

One possible factor in the soil surface mold could be the compost complacent of our soil mix. In some trials we did years ago, we noticed an increase in soil mold with an increase in the compost portion of our soil mix.

Taking this into consideration, for our follow-up trial we will be creating a custom soil mix for our beets which will not contain any compost and will contain our Sunshine Mix # 4 and some additional perlite to improve air movement in the soil.

Temperature and Humidity Data

Not added.

General Crop Observations

- Both treatments had almost perfect hull shedding
- The soil-covered treatment experienced much more mold than the non-soil-covered treatment

Recommendations

Conduct the trial with a soil mix that has a higher percent of perlite and no compost.

1.7. May 7, 2023 Bull's Blood Beet Trials

Introduction

We continue our quest to get a consistently decent beet crop!

Results Summary

Pending trial results

Trial Goals

- To grow beet microgreens without experiencing damping off

Trial Overview and Methodology

This trial was conducted in 5 x 5 trial trays using a Modified Sunshine Mix #4 as a growing medium. The growing medium had a moderate amount of perlite (20 - 30%) added to the base Sunshine Mix. We are hoping by eliminating the compost and increasing porosity with the perlite we can have a more successful grow

The following sowing rates were used, in replicate:

Seed/Tray (g)	1020 Equiv. (g)	Paperpot Equiv. (g)
7.18	60.0	79.0
7.77	65.0	85.5
8.37	70.0	92.1
8.97	75.0	98.7

These are the top four sowing rates used in our previous trials and are much higher than published rates for beet microgreens.

The Bull's Blood beet seed was from Mumm's Sprouting Seeds, Lot #BEB0G

The eight 5 x 5 trial trays per replicate were placed in two 23” x 11” Paperpot trays for the duration of the trial. After sowing, the 5 x 5 trial trays were ***not*** randomized within their respective Paperpot trays then watered.

Lighting consisted of 4 x ***13W fluorescent lights*** at ***6500K*** placed about 30 cm from the soil surface with a PPFD at this distance of 25 to 57 µmol m^{-2} s^{-1} depending on location relative to the light. This PPFD is lower than rates published in microgreens research, which is potentially beneficial (if we are getting suitable results) as lower PPFD values will require less energy to achieve. Lighting was on for ***14 hours each day***.

Sources of Error

There are a few places in the trial process where errors may take place that will affect the trial results:

1. Seeding: During seeding, some seeds tend to bounce off the soil and thus off the tray. After each sowing we tried to gather each seed that had been displaced to keep the sowing rates consistent.
2. Growing: Our small trial space may have some inconsistencies in temperature, humidity, and light quality, so we rotate the trays regularly to change their positions in the growing space
3. Harvesting: It is very difficult to get an exact consistent cut with each tray. With such small seeding areas, a small yield difference can change results significantly. We make an effort to keep the cutting position consistent, close to the soil, and pick up any shoots that fall from the tray during harvest.

Trial Hypotheses

1. We will see less damping off and achieve a recordable harvest

Trial Results and Discussion

Temperature and Humidity Data

General Crop Observations

Recommendations