Soil Food Web School
Consultant Training Program

Final Report

# Biological soil management in a market garden showcase site -carrot experiment

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# Project Summary

Soil microorganisms are the primary drivers of all soil processes, including but not limited to nutrient cycling, building soil structure and biodiversity, carbon sequestration, water retention, and supporting healthy plant communities. In fact, plants and soil microorganisms form mutualistic relationships that create resilient, thriving ecosystems.

Bioactive compost is a valuable tool for bringing life back to soils and therefore, restoring soil functions. The process of making bioactive compost itself ensures that the result is a highly diverse soil amendment containing a wealth of soil microorganisms in balanced and desired proportions that can restore the nutrient cycles and soil structure in relationships with plants.

The experiment conducted on the carrot bed at our no-dig vegetable garden at the vocational school of AhlmanEdu in the 2023 season aimed to document the effects of bioactive soil amendments on soil biology and, in turn, soil structure, and carrot germination rate, growth, and yield. The carrot bed was divided into 6 plots: three trial plots and three control plots to ensure viability and consistency of results.

By applying the bioactive compost and/or liquids on the trial plots, the intent was to inoculate and enrich the soil with beneficial microorganisms that will drive nutrient cycling and help plants grow better. The main indicator of the change in soil quality was documenting the difference in soil microbiological quality through regular soil analyses.

The bioactive extract was applied to the seeds before sowing and four times during the growing season on the trial plots (the control plots received only water, and untreated seeds were sown). Two weeks after each application, soil samples were taken and tested for microbial content.

In addition to measuring the change in soil biology, the harvested carrots' Brix levels (sugar percentage) were measured, indicating the plant's photosynthetic efficiency. Compaction rates were regularly measured with a penetrometer to observe the changes in the soil structure. At harvest time, yield in kg and number of carrots was also measured, and average carrot weight was calculated from all six plots.

# Introduction

There is a permanent-bed market garden at the vocational school where I work (AhlmanEdu, Tampere, Finland). It was planted in 2021 on a previous turf lawn. For decades, the lawn was managed conventionally (mineral fertilizers, regular super-short mowing).  Before establishing the garden, some compaction was observed.

The garden has been managed biologically from the start (from 2021), using compost and compost extract, with some green manuring in places. The whole management hasn't been carefully followed up on assessing compost or extract quality.

The effects of compost and extract on carrot beds are documented, starting with soaking seeds for 3 minutes in compost extract before sowing on the trial plots. Carrots, along with potatoes and other root crops, are a staple vegetable crop in Finland. In that sense, it was an easy choice to make, as the results might have an impact on the region where I operate. Carrots were also chosen because they are an easy crop to see the difference in size and shape of the above and below-ground parts and to distinguish the difference in taste. Although there haven't been any major problems with the crop so far in this garden, the carrots can always grow bigger, better, and sweeter. The soil is clayey loam and a bit compacted, so the soil structure needed improvement, which carrots appreciate. On a more personal note, my first contact with gardening was when I was a little girl picking carrots from my grandmother's garden. It was a very impactful experience, which probably led me to gardening and finally to this career. In that sense, carrots were a natural and meaningful choice of crop. As I have accumulated practical experience in growing vegetables, I felt that my practical and observation skills would come in handy during the project rather than choosing a less familiar crop, such as pasture or wheat.

The trial is a part of the European Fusilli project, so the results will be published and disseminated to promote the Soil Food Web method of soil management to vegetable growers and urban gardeners alike throughout Europe.

## Project site and plot layout

The experiment site consisted of two 10 m long and 70 cm wide beds with a 35cm path between them. Both beds were divided into three smaller plots, each one marked and divided with a gap of 30 cm (Figure 1).

The region where the site is located had an average year rainfall of 598 mm/year, July being the wettest (75mm) and warmest (average max 22°C, record high 31.1°C, average mean 17°C) month. The last frost usually appears in mid-May, and the first frost in early October. Figure 2 shows the plots at the beginning of this project.


*Figure 1 Design of Stage 3 project. RED indicates trial plots. BLUE indicates control plots.*

*Figure 2 Carrot beds at the beginning of the experiment.*

# Methods

## Agricultural practices

- Carrots were sown with a mechanical seed sower (Figure 3)
- Watering regime using a sprinkler system:
    - During germination: every second morning
    - When they sprouted, they were watered twice in the morning (for 45 minutes).
    - For the rest of the time, the garden relied on rainfall. The season 2023 was a fairly good season in terms of rainfall. There was a short drought at the end of June/beginning of July for 2-3 weeks.

*Figure 3 Sowing the seeds.*

# Application

## Treatment

- Thin layer (1 cm) of one-year-old bioactive compost was added to the trial plots (Figure 4).
- Seeds meant for the trial plots were soaked in the bioactive extract for 3 min and air-dried in the greenhouse (in the shade) before sowing.
- bioactive extract (150l/Ha) was applied 4 times during the growing season, as a soil drench, two times by using a simple watering can, and two times using a sprayer (due to the thickness of the canopy).
- Microbiological analyses of compost and extracts used during the trial are shown in Appendix 1.

*Figure 4 Thin layer of compost applied on the trial plots.*

## Control

- Same amount of water was applied to the control plots while the extract was applied to the trial plots. Nothing else was added during the trial.

## Harvest

Harvest took place in two phases: both before the scheduled time (2 weeks and 1 week earlier) as rodent damage had been observed, and the harvest appeared to be at risk (Figure 5 a, b). After four plots had been harvested (A+B), a conclusion was made that there hadn't been any significant damage, just a few nibbles here and there. As there wasn't enough space to store the carrots, and we wanted them to reach their peak growth (*St. Valery* variety of carrots can grow up to 30cm in length), we decided to postpone the harvest of the last pair of plots. That was a mistake, as rodents had caused more significant damage on the third trial plot (Figure 6) to the carrots, as observed upon the second harvest (6 days later), with some carrots being eaten almost completely, leaving only the stems (the trial plot was close to the parsnip bed where their nest was later found).

*Figure 5 a, b Rodent damage observed before the harvest.*

*Figure 6 Rodent damage observed at second harvest.*

# Response variables

According to the background information on the site, such as compaction and initial microbiological assessments, a thin layer of compost as an organic matter addition, seed treatment with compost extract, and regular applications of extract were chosen as the treatment strategy. It was decided to monitor the experiment by measuring the four variables discussed below.

## Soil biology

The change in soil biology assessed with a microscope (microscope model used: BRESSER Science TFM-301 Trino) according to the Soil Food Web method shows the quantity and quality of all the functional groups of soil organisms and assesses the F:B biomass ratio. By adding the bioactive compost and extracts, the aim was to inoculate and enrich the soil in question with beneficial microorganisms that would generate positive effects on the soil structure and plant health and growth, as well as shift the F:B ratio closer to the one required for carrots, which is 0.5.

Microscope assessments were used to monitor the change in microorganisms' quantity and diversity and estimate the current successional stage according to the bacterial and fungal biomass ratio (F:B ratio). Soil samples were taken and assessed at the beginning of the trial, before the sowing, and two weeks after each extract application using bright field microscopy with shadowing technique, a method developed by Dr. Elaine Ingham and the Soil Food Web School.

## Compaction rate

Soil structure depends on the balanced soil food web as the soil microorganisms' activity helps form soil aggregates. For example, adding them via bioactive soil amendments improves the soil structure as they become more abundant. As the soil structure improves, it generates the so-called positive feedback loop of enhanced air and water permeability. It also helps plants photosynthesize better, which means more food for the soil microorganisms to grow, which builds even better soil structure.

A penetrometer was used to measure the compaction and possible changes in compaction rates on all six plots. It was done at the same time the soil analyses were taken, so at the beginning of the trial and two weeks after each extract application. Readings were taken from three different places from each of the six plots. The expected result is a soft crumbly aggregated soil structure with no or reduced compaction on the trial plot instead of the control plot.

## Brix levels

Carrot is supposed to be a sweet and succulent vegetable. That is not always the case, though, as carrots can also be hard, bitter, and chewy. The taste of the vegetable says a lot about its nutrient quality. The Brix levels show sugar content in the plant, which results from the efficiency of the plant's photosynthesis. The more balanced the soil food web is, the more supported a plant is to optimally function and photosynthesize, which also translates into nutrient richness.

Brix levels were measured with a refractometer from three carrot roots per plot at harvest time.

## Yield/average carrot weight

The more balanced the soil food web is in a soil system, the better the plants grow, as they get all the “ecosystem services” that it provides; primarily optimal nutrient and water intake, which should result in optimal plant growth. An increase in yield is what growers want to see, so measuring that trait could be the final motivation in farmers choosing biological plant and soil management. Carrots from all six plots were weighed and counted. Finally, the harvest weight from all six plots was divided by the total number of carrots harvested, thus calculating the average weight from both plots.

# Timeline

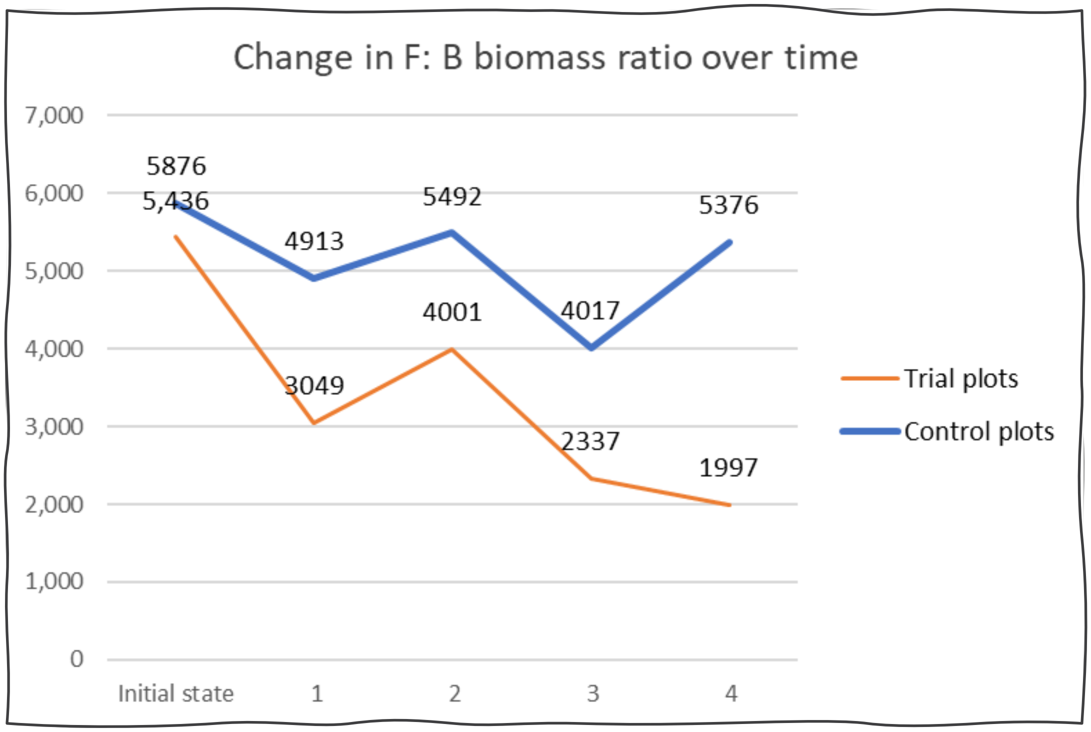
| Date | Action |
|---|---|
| 03/05/2023 | Marking the plot |
| 09/05/2023 | Initial biological assessments, soaking the seeds in the extract |
| 10/05/2023 | applying compost, sowing the seeds |
| 08/06/2023 | 1st microbiological assessment and application of extract (trial plots) and water (control plots) |
| 22/06/2023 | microbiological assessment, compaction measurement |
| 23/06/2023 | 2nd microbiological assessment and application of extract (trial plots) and water (control plots) |
| 06/07/2023 | microbiological assessment, compaction measurement |
| 07/07/2023 | 3rd microbiological assessment and application of extract (trial plots) and water (control plots) |
| 24/07/2023 | microbiological assessment, compaction measurement |
| 25/07/2023 | 4th microbiological assessment and application of extract (trial plots) and water (control plots) |
| 09/08/2023 | microbiological assessment, compaction measurement |
| 17/08/2023 | Harvest (A+B plots), weighing, counting, brix measurements |
| 23/08/2023 | Harvest (C plots), weighing, counting, brix measurements |

# Results

## Soil biology

The initial soil assessment showed the soil to be extremely bacterially dominated ( F:B biomass ratio of 0.01) with very little soil protozoa and no nematodes (Table 1). This indicates that the nutrient cycling was underperforming in this soil as there weren't enough predators to power the nutrient cycling.

A final analysis of trial plots shows significant change in bacterial and fungal biomass, and the introduction of nematodes and greater numbers of active protozoa in the trial plots. Due to the greater number of protozoa and nematodes in trial plots, bacterial biomass decreased after every extract application. At the same time, fungal biomass increased, resulting in a more favorable F:B biomass ratio (Graph 1), closer to the desired F:B ratio required for carrots, which is 0.5. F:B ratios at the beginning of the experiment showed the soil being predominantly bacterial on both trial and control plots, and by the end of the experiment, the F:B ratio increased tenfold in the trial plots, while on the control plots, it stayed the same.




*Graph 1 Changes in fungal to bacterial biomass ratio (F:B) after each extract application in trial and control groups. Assessments were conducted 2 weeks after each application (numbers on the x-axis indicating extract application).*

Table 1 shows the average values (calculated from the three trials and three control plots) of the biological state of the soil at the beginning of the experiment and at the end of it, before the harvest.

| **Beneficial Microorganisms** | **trial plot beginning** | **control plot beginning** | **trial plot final stage** | **control plot final stage** | **Desired range for successional stage for root vegetables** |
|---|---|---|---|---|---|
| Bacterial Biomass ( µg/g ) | 5473 | 5876 | 1997 | 5375 | 135 - 450 µg/g |
| Fungal Biomass ( µg/g ) | 131 | 85 | 305 | 68 | 68 - 225 µg/g |
| Fungal Standard Deviation (%) | 81% | 26% | 69% | 59% | |
| F:B Ratio | **0,024** | **0.015** | **0.15** | **0.014** | **F:B ≈0.5** |
| Beneficial Protozoa (number/g) | 29535 (100% deviation) | 26988 (84% deviation) | 57418 (50% deviation) | 7066 (165% deviation) | 10 - 50,000 /g |
| Bacterial-feeding Nematodes (number/g) | 0 | 0 | 57 | 0 | |
| Fungal-feeding Nematodes (number/g ) | 0 | 0 | 57 | 0 | Bacterial feeders, fungal feeders and predatory nematodes present |
| Predatory Nematodes (number/g) | 0 | 0 | 0 | 0 | |
| **Detrimental Microorganisms** | | | | | |
| Oomycetes Biomass ( µg/g ) | 0 | 0 | 0 | 0 | / |
| Ciliates ( number/g ) | 0 | 0 | 0 | 0 | / |
| Root-feeding Nematodes (numberr/g ) | 0 | 0 | 0 | 57 | / |

*Table 1 Summary of the soil analyses.*

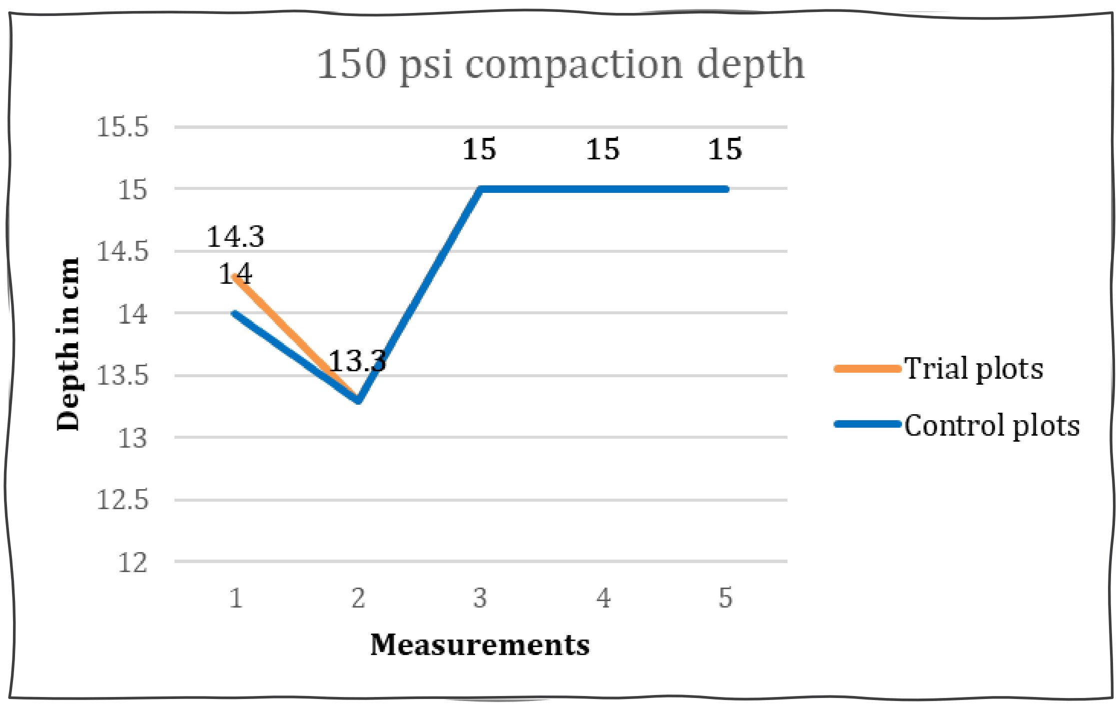
For detailed results, see Appendix 1.

## Compaction rate

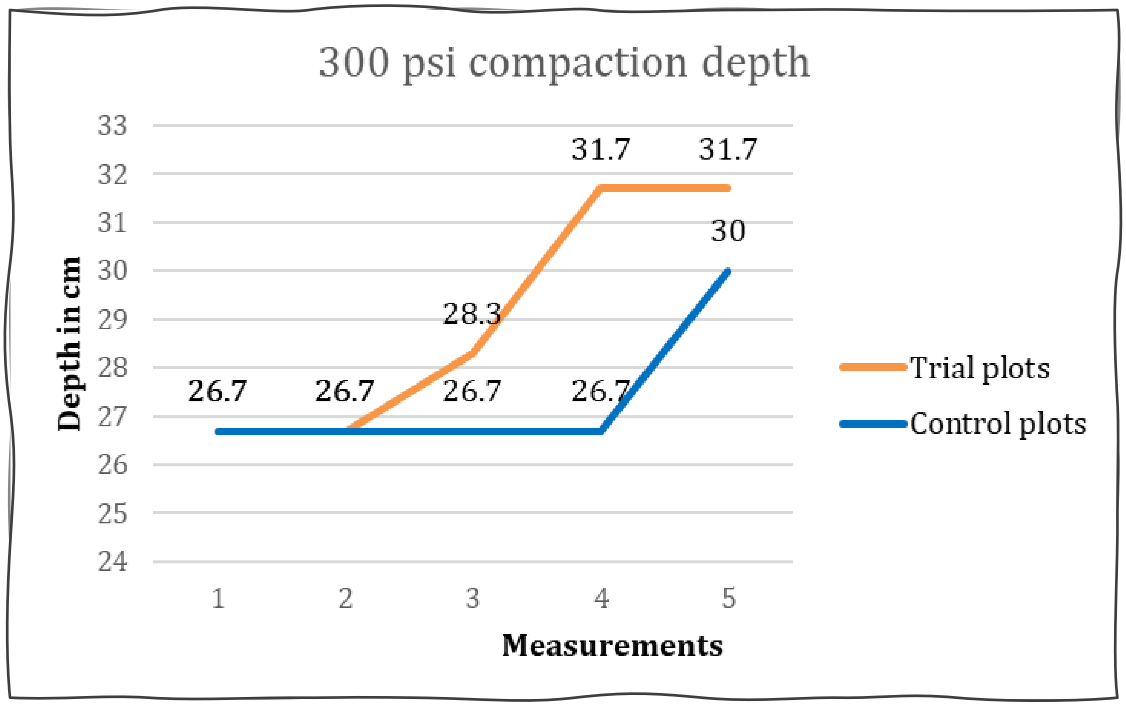
Compaction rates show how well/poorly the soil is structured. Penetrometer measures the compaction in the soils. Agrisoils usually have compaction problems due to tilling and other soil disturbances, making it harder for the plants to penetrate their roots deep enough. It is estimated that most of the plants cannot push their roots where there is a pressure of more than 150 psi. Tap roots, such as carrots, can push through the compacted soil up to 300 psi.

Some changes in compaction rates have been observed (Appendix 2). As we deal with heavy clayey soil, it becomes hard and compacted during the dry periods. Moist soil was observed during the late stages of carrot growth as the green canopy shielded the soil from drying out, making it less compacted.

Even though the compaction problem hasn't disappeared completely from the trial plots, some change is visible compared to the control plot (Graphs 2 and 3).




*Graph 2 Compaction depth comparison at 150 psi.*




*Graph 3 Compaction depth comparison at 300 psi.*

The compaction hasn't been a great problem for carrot growth, even though they prefer sandy soils, as they have grown straight and deep in both trial and control plots (Figure 7 a,b). Few wide and short carrots were occasionally observed, which could indicate that the carrot had some trouble penetrating the compacted soil. The carrots, however, hadn't grown longer than 30 cm in length, so the problem of penetrating the compacted layer of 300 psi hasn't been an issue.

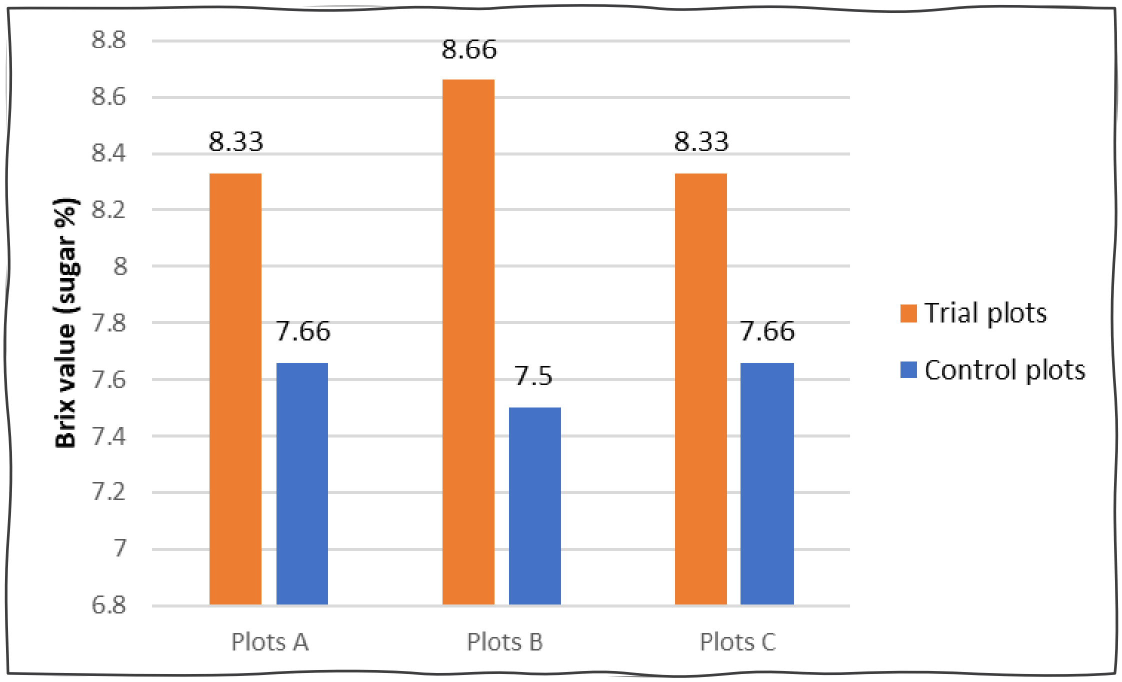

*Figure 7 a, b Carrots' appearance.*

A detailed Compaction rate table can be found in Appendix 2.

## Brix values

Brix values (Appendix 3) have been taken from the three carrots from every plot upon harvest. The results show a difference in sugar content between carrots picked from the trial plot and those picked from the control plot (Graph 2). Even though some of the results are the same (there are brix values of 8 and 8.5 measured in carrots from both plots), the average value shows higher BRIX values on the trial plots, which means that, on average, the carrots on the trial plots have been photosynthesizing more efficiently than the ones in the control plot. The overall difference in brix readings between trail and control plots is 0.84 percentile.

According to the book "USING A REFRACTOMETER TO TEST THE QUALITY OF FRUITS & VEGETABLES," the refractive index of crop juice of carrots calibrated in % sucrose or degree brix: poor = 4; average = 6; good = 12; and excellent is 18. These data show that carrots from both plots would be above average.




*Graph 4 Average values of the three trials and three control plots.*

## Yield/average carrot weight

### Germination and growth phase:

As the progress was monitored regularly, a significant difference (as seen in Figures 8 a, b) in the number of seeds that sprouted and their size was noticeable. The seeds in the trial plots germinated one day sooner, and the seedlings looked more vigorous than the seedlings in the trial plots from the start. The difference in the size of above-ground plants stayed observable well into the growing season (Figure 9, 10).

Figure 8 a, b Germination rates: control plot left, trial plot right (31.5.2023).

Figure 9 trial plot left, control plot right (14. 6. 2023).

*Figure 10 a,b Growth difference control plot left, trial plot right (22.6.2023).*

## Yield results

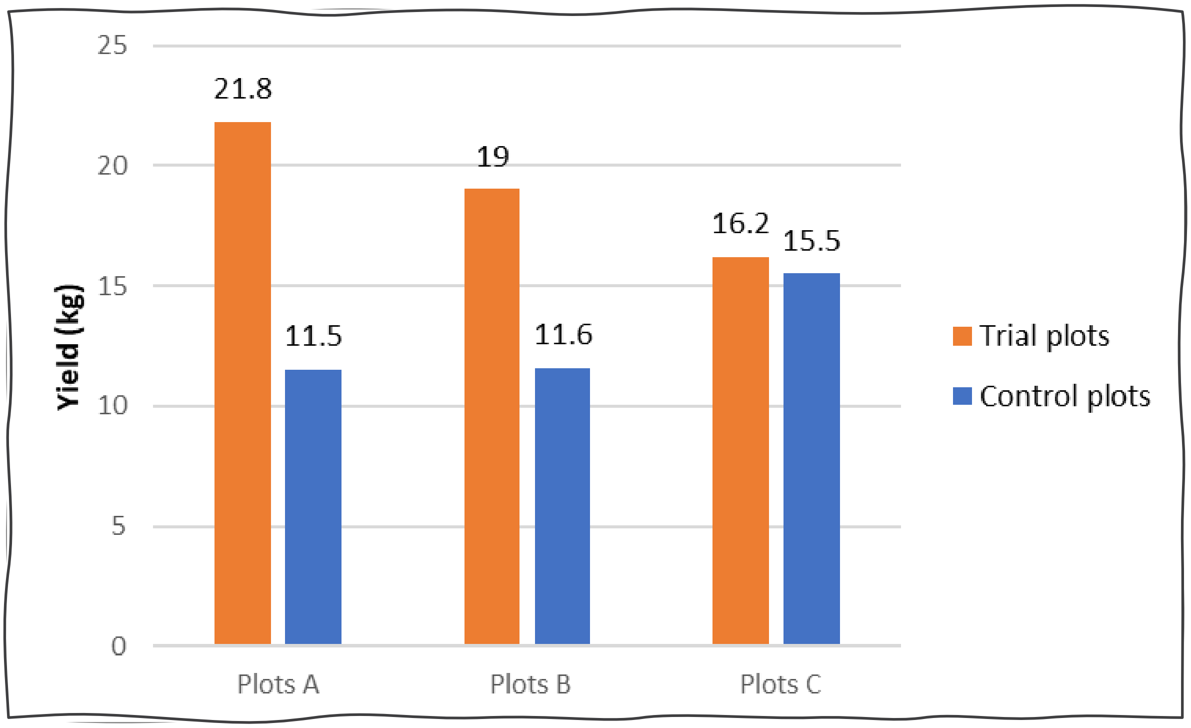
As mentioned before, the harvest took place in two phases. The harvest results are shown in the graphs in this section to show the yield for each pair of trial and control plots separately, A, B, and C.

Harvest showed a significant difference in yield in weight for plots A and B (Graph 5), numbers of carrots (Graph 6), and average carrot weight (Graph 7) on trial and control plots.

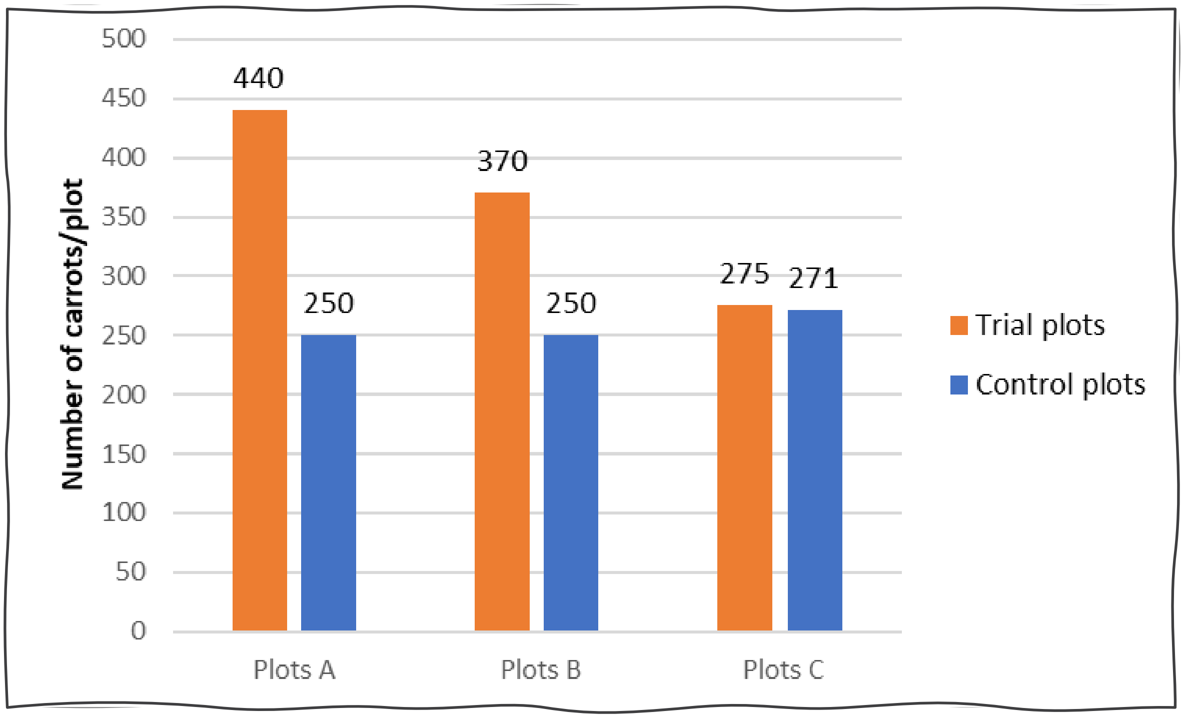
Harvest of the C plots showed these results (plotted in the same graphs above): Trial plot yield was 16.2kg with 275 carrots, with an average carrot weight of 58.9 g, and control plot had a yield of 15.5kg with an average carrot weight of 57.1g per carrot.

The overall yield on the C plots left to grow longer is bigger, as it would be, considering the carrots had more time to grow. However, even though the result in the weight of the third trial plot is somewhat lower due to the rodent damage (that I would estimate to be around 25% loss of the crop in the number of carrots and about 30% in weight), the comparison between the third pair of trial and control plots (Graphs 3,4 and 5, C plots) are still in favour of trial plot. Overall results are in favour of trial plots. The damaged carrots were included in the overall harvest count, while the carrots where only the stems were left weren't.

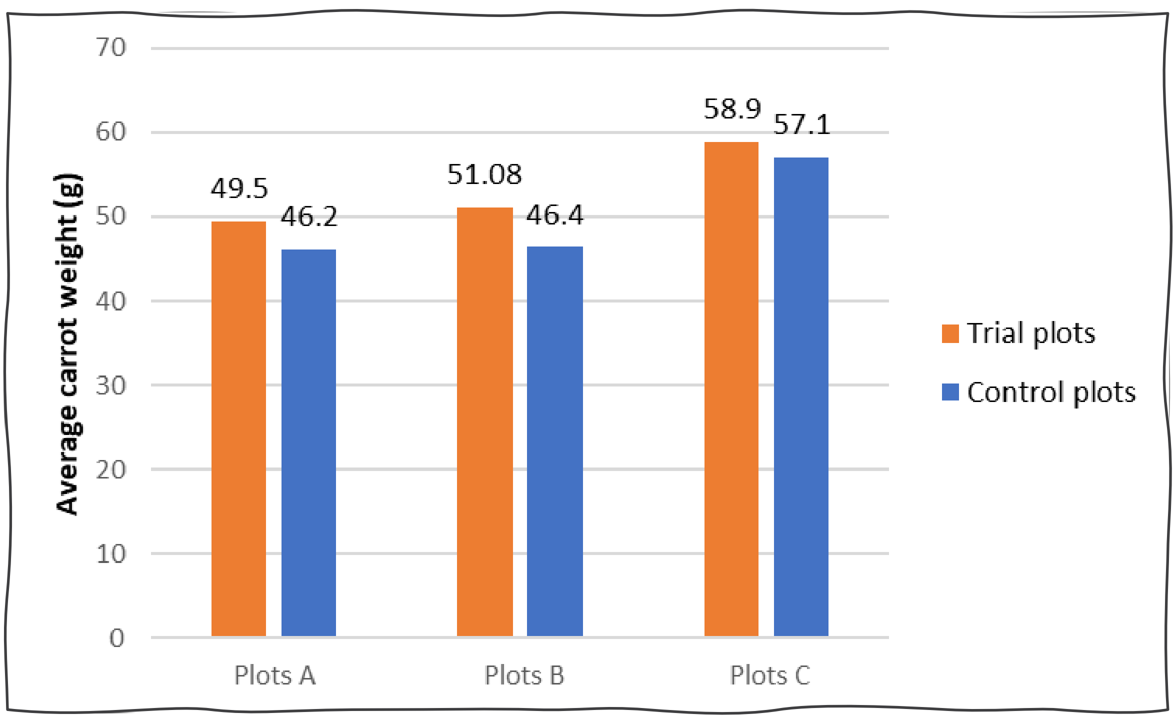
Detailed yield results are expressed in the table in Appendix 4.




*Graph 5 Yield in weight (kg).*




*Graph 6 Number of carrots harvested per plot.*




*Graph 7 Average carrot weight per plot.*

# Conclusions

The trial demonstrated the positive effects of bioactive compost and extract on soil biology and structure and, consequently, on carrot germination, vigour, and yield. Soaking the seeds in the extract proved to be an effective way of giving the plants a biological boost right from the start. This will be a routine part of the garden from now on. All seeds will be soaked in extract before sowing, either directly in the garden or for seedling propagation.

Four extract applications have been shown to further support the positive change in soil biology and, consequently, plant performance, resulting in higher yields in the trial plots.

The desired range for the successional stage of carrots wasn't fully achieved, as shown by the F:B ratio, since the soil was still highly bacterially dominated and lacked predatory nematodes. However, a positive trend and a shift towards the desired F:B ratio was observed. If it hadn't been for the early harvest, another extract would have been applied, which, according to the trends observed up to that point, could have resulted in an even more favorable F:B biomass ratio. This experiment was, in part, documentation of what can be achieved with bioactive compost and extract alone. Still, there could have been other biologically sound treatments that could have helped to move the succession into the desired range, such as the application of humic acid to boost the fungal population or the application of nematode extraction to reduce bacterial numbers further.

Weeds were observed in both plots, but no significant weed problems occurred in either plot group, and no weed control methods were applied. The reasoning behind this was that the self-propagating plants (in such small quantities) could only contribute to soil and plant biodiversity and overall soil performance. Mushrooms were growing in the trial plots, which may indicate a higher fungal biomass and an abundance of fungal food, enabling the fungi to develop fruiting bodies.

Regarding rodent damage, the garden has always had problems with mice due to the plastic covers used for weed control in other parts of the garden. They find these covers a convenient hiding place. The garden also has plenty of food, so they are naturally attracted to it. The dense canopy of carrots and parsnips was a good nesting site, and while the nest in the carrot bed was found and removed early in the season, the nest in the parsnip bed wasn't found until it was too late to respond (during the harvest of the last two pairs of plots). In addition, the damage observed (carrots eaten from underneath) suggests that there may also have been damage from the voles. In any case, rodents damaged the trial plot much more than the control plot. One could speculate that this was because the carrots on the trial plot tasted much better, as the brix reading indicated; carrots from the trial plot had an overall higher sugar concentration. The speculation might be supported by Nicole Masters' citation, saying that herbivores can detect a 0.5 difference in sugar content and prefer to eat more nutritious plants.

*Figure 10 Author having fun during harvest.*

Despite the rodent damage, the overall yield in the trial plots was higher and satisfactory, and this type of biological soil management proved to be an effective method with great potential to be used and further promoted in Finnish vegetable production.

This final project and the whole experience of the CTP training have given me the tools, practical and theoretical knowledge, and professional confidence to continue developing the SFW approach in the local context, not only in vegetable production but also in other soil systems.

# Appendix 1: Soil Biology

| Treatment/ Assessment Date | Treatment Description | F:B Ratio | Bacteria (µg/g) | | Actinobacteria (µg/g) | | Beneficial Fungi (µg/g) | | Average Fungal Diameter (µm) | Total Beneficial Protozoa (µg/g) | | Total Beneficial Nematodes/g) | Oomycetes (µg/g) | | Ciliates/g | | Root Feeding Nematodes/g |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dd/mm/yy | | | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | | Mean | Std Dev | | Mean | Std Dev | Mean | Std Dev | |
| 09/05/2023 | Initial assessments | | | | | | | | | | | | | | | | |
| | average of all 3 trial plots | 0.02 | 5,436 | 521 | 0 | | 132 | 112 | 4 | 29,535 | 29,224 | 0 | 0 | | 0 | | 0 |
| | average of all 3 control plots | 0.01 | 5,876 | 452 | 0 | | 85 | 22 | 4 | 31,133 | 25,509 | 0 | 0 | | 0 | | 0 |
| 10/05/2023 | Compost applied | 0.25 | 890 | 70 | 2.25 | 1.60 | 222 | 152 | 3.8 | 254,359 | 89,633 | 126 | 0.0 | | 0 | | 0 |
| 10/05/2023 | Extract for soaking seeds | 0.37 | 578 | 43 | 0.39 | 0.40 | 211 | 106 | 3.9 | 220,968 | 37,557 | 162 | 0.0 | | 5,892 | 8,069 | 0 |
| 08/06/2023 | 1st extract application | 0.25 | 851 | 96 | 2.00 | 1.80 | 215 | 47 | 3.8 | 227,242 | 88,904 | 765 | 0.0 | | 0 | | 0 |
| 22/06/2023 | 1st assessment | | | | | | | | | | | | | | | | |
| | average of all 3 trial plots | 0.07 | 3,049 | 187 | 0 | | 203 | 100 | 4 | 24,292 | 25,383 | 0 | 0 | | 0 | | 0 |
| | average of all 3 control plots | 0.01 | 4,913 | 500 | 0 | | 52 | 28 | 4 | 4,881 | 16,373 | 0 | 0 | | 0 | | 57 |
| 23/06/2023 | 2nd extract application | 0.29 | 648 | 34 | 1.52 | 0.55 | 190 | 59 | 3.6 | 158,298 | 61,415 | 1,020 | 0.0 | | 10104 | 15062 | 0 |
| 06/07/2023 | 2nd assessment | | | | | | | | | | | | | | | | |
| | average of all 3 trial plots | 0.05 | 4,001 | 248 | 0 | 1 | 181 | 87 | 4 | 81,710 | 59,568 | 113 | 0 | | 0 | | 0 |
| | average of all 3 control plots | 0.01 | 5,492 | 607 | 0 | 0 | 63 | 28 | 3 | 26,501 | 26,328 | 0 | 0 | | 0 | | 0 |
| 07/07/2023 | 3rd extract application | 0.30 | 986 | 60 | 1.08 | 0.59 | 297 | 83 | 4.2 | 322,777 | 66,287 | 102 | 0.0 | | 0 | | 0 |
| 24/07/2023 | 3rd assessment | | | | | | | | | | | | | | | | |
| | average of all 3 trial plots | 0.13 | 2,337 | 392 | 0 | 1 | 297 | 185 | 5 | 46,376 | 25,163 | 57 | 0 | | 0 | | 0 |
| | average of all 3 control plots | 0.02 | 4,017 | 410 | 0 | 0 | 71 | 41 | 3 | 17,667 | 18,794 | 0 | 0 | | 0 | | 0 |
| 25/07/2023 | 4th extract application | 0.31 | 871 | 135 | 1.08 | 0.98 | 270 | 127 | 3.9 | 267,126 | 120,649 | 306 | 0.0 | | 55650 | 12444 | 0 |
| 09/08/2023 | 4th assessment | | | | | | | | | | | | | | | | |
| | average of all 3 trial plots | 0.15 | 1,997 | 234 | 0 | 0 | 305 | 145 | 4 | 57,418 | 29,629 | 113 | 0 | | 0 | | 0 |
| | average of all 3 control plots | 0.01 | 5,376 | 965 | 0 | 1 | 68 | 42 | 3 | 11,042 | 17,034 | 0 | 0 | | 0 | | 57 |

# Appendix 2: Soil Compaction Table

| Date | Plot Tested | 150 psi Depth #1 | 150 psi Depth #2 | 150 psi Depth #3 | Mean Depth at 150 psi | Standard Deviation 150 psi | 300 psi Depth #1 | 300 psi Depth #2 | 300 psi Depth #3 | Mean Depth at 300 psi | Standard Deviation 300 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/05/2023 | Test | 13 | 15 | 15 | 14.3 | 1.7 | 25 | 30 | 25 | 26.7 | 2.9 |
| | Control | 15 | 12 | 15 | 14 | 1.2 | 25 | 25 | 30 | 26.7 | 2.9 |
| 22/06/2023 | Test | 15 | 10 | 15 | 13.3 | 2.9 | 25 | 25 | 30 | 26.7 | 2.9 |
| | Control | 13 | 15 | 12 | 13.3 | 1.5 | 25 | 25 | 30 | 26.7 | 2.9 |
| 06/07/2023 | Test | 15 | 15 | 15 | 15 | 0 | 30 | 25 | 30 | 28.3 | 2.9 |
| | Control | 15 | 15 | 15 | 15 | 0 | 25 | 30 | 25 | 26.7 | 2.9 |
| 24/07/2023 | Test | 15 | 15 | 15 | 15 | 0 | 30 | 35 | 30 | 31.7 | 2.9 |
| | Control | 15 | 15 | 15 | 15 | 0 | 25 | 25 | 30 | 26.7 | 2.9 |
| 09/08/2023 | Test | 15 | 15 | 15 | 15 | 0 | 30 | 30 | 35 | 31.7 | 2.9 |
| | Control | 15 | 15 | 15 | 15 | 0 | 30 | 30 | 30 | 30 | 0 |
| **Values are expressed in centimeters** | | | | | | | | | | | |

# Appendix 3: Brix Values Table

| carrots tested from: | 1 | 2 | 3 | AVG | Total A+B | Total AVG |
|---|---|---|---|---|---|---|
| Trial plot 1A | 8 | 8 | 9 | **8.33** | **8.49** | **8.44** |
| Trial plot 1B | 9 | 8.5 | 8.5 | **8.66** | | |
| Trial plot 1C | 8.5 | 8.5 | 8 | **8.33** | **8.33** | |
| Control plot 2A | 8 | 8 | 7 | **7.66** | **7.6** | **7.6** |
| Control plot 2B | 8.5 | 7 | 7 | **7.5** | | |
| Control plot 2C | 7.5 | 8 | 7.5 | **7.66** | **7.66** | |

# Appendix 4: Yield Table

| PLOT | Harvest weight (in kg) | Nr. of carrots/plot | average weight of carrot per plot (in grams) | Harvest in kg/m2 |
|---|---|---|---|---|
| Trial plot 1A | 21.8 | 440 | 49.5 | |
| Trial plot 1B | 19 | 370 | 51.08 | |
| A+B | **40.8** | **810** | **50.29** | |
| Trial plot 1C | 16.2 | 275 | 58.9 | |
| **Total A+B+C** | **57** | **1085** | **53.16** | **10.8** |
| Control plot 2A | 11.5 | 250 | 46.2 | |
| Control plot 2B | 11.6 | 250 | 46.4 | |
| A+B | **23.1** | **500** | **46.3** | |
| Control plot 2C | 15.5 | 271 | 57.19 | |
| **Total A+B+C** | **38.6** | **771** | **49.93** | **7.3** |