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Final Project
Soil Food Web School
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Biological Conversion of Sonoran Desert “Dirt” to Soil. From compacted horse turn out to productive vegetable garden.

Introduction.

This purpose of this experiment was to test biological farming techniques developed by Dr. Elaine Ingham ph.d., founder of Soil Food Web inc. Improving certain biological markers in the soil should in turn yield improved plant production, increased soil fertility, and less pest and disease pressure. The objective of the project was to take a dry, barren, extremely rocky section (12’x6’) of a previously used horse turnout (arena) that was infested with exotic invasive weeds (Globe Chamomile) and turn it into a productive fertile garden site. The project site also had extreme soil compaction (videos provided). Surface compaction was also extreme.





Project Objectives

1. To Increase and/or balance the biological biomass of the soil and return to a healthy balanced soil food web
2. To increase organic matter and water holding capabilities to the soil.
3. To re-establish proper nutrient cycling restoring fertility to the soil to grow better crops.
4. To grow healthy plants, while reducing pest, weed and disease pressures in the garden.
5. To show quantifiable data that proves the soil food web has improved and things are heading in a positive direction.

Methods

This garden site was chipped by hand using a 16lb digging bar. The main purpose was to break up the extreme surface compaction. Before the chipping, compaction readings and water infiltration tests were taken. The area was loosened with the digging bar to approximately 3” depth. Larger rocks were removed but the site was left extremely rocky and no tilling or subsoiling was done. Soil samples for biological and chemical assessment were taken at this time and data was logged. One half of a bale of peat moss was incorporated into the top 3” of soil to add additional organic matter. After the peat was added, bio complete compost extract

was watered in to evenly moisten the plot and the garden area was mulched with local straw. Drip irrigation was installed and the garden was planted. Into each planting hole, a small spade full or two of peat and a small handful of compost was added and mixed. The winter crops were then planted and watered in with Fish and Kelp fertilizer. See *Biological Timeline* for data on assessments, exact dates, amounts and dilutions. Every time anything was added to the garden, data was logged on the timeline. Compost Extracts were made by hand in a 5 gallon bucket with fulvic/humic acid treated water, using a brisk massaging technique for 3-5 minutes. Compost tea bags were 400 micron mesh size. When compost teas were used, a Tea Lab 5 gallon bubble snake brewer *https://www.composttealab.com/store/p2/compostteaaerator-bubblesnake-by-tealab.html* was used with a 1030 gph air pump. Brew length varied on the teas depending on temperature, but on average they were brewed for roughly 24hrs. More mulch was added to the garden when it looked thin. Being in an extreme desert climate the main goal was to keep the soil cool and moist as much as possible to promote favorable biological conditions. Many anti evaporative strategies were deployed such as deep mulching, drip irrigation under mulch, and 50% shade cloth over the top of the garden. Understory summer crops were planted amongst the existing winter crops. If the plants appeared to be growing slow, applications of fish and/or kelp were used. Sometimes they were used as a soil drench, other times foliar fed. See *Biological Timeline*.

Results

Two weeks after initial building and inoculation of the garden site, biological biomass, especially fungal biomass, increased greatly but dropped back down over time. Bacterial biomass was extraordinarily high (15,065ug) and Fungal Biomass was (0ug) prior to any work being done in the garden. The bacterial biomass decreased over time which was welcomed. Plants were a bit slow to get established but progressed at an acceptable rate. Weed pressure from Globe Chamomile, an exotic invasive in the area, was negligible in the garden throughout the entire growing season. Yields of vegetables were good (pics in photo log provided), but there was no control to compare data. All data containing biological markers of the garden soil and of the biological inputs used can also be found in the *Biological Timeline.*

Overall, as the growing season progressed the biology of the soil improved and plant growth increased. Disease pressures were low. One infection of powdery mildew was treated twice with compost tea successfully. The powdery mildew was only affecting the Swiss chard extremely late in the season when it should not of been growing anymore due to high temperatures. Shortly after that the kale was affected by aphids. These were treated with two applications of compost tea and it did help control the aphids which were mainly on the lower leaves. They are no longer an issue and Kale continues to grow in the garden in late July, 2020 although it has been partially consumed by Desert Quail in search of water. Temperatures in July have hit 111F, multiple days with averages over 102 F.

As the summer crops filled in (ie, basil, tomatoes, peppers, eggplant, okra) they look extremely healthy. Unfortunately, the early, unseasonal, extremely hot temps dramatically decreased fruit set on the tomatoes. Flowers refused to open, many fell off which happens in hot weather. The west side of the garden, not under shade cloth during the late afternoon hours, are showing signs of leaf burn. Peppers are performing well in the heat and some varieties started fruiting in mid July 2020. Eggplant is flowering as well.

Discussion

Some observations noted from the first growing season: The soil visibly changed color becoming more brown as opposed to grayish tan. The second row of crops (summer and winter) on the left side of the garden grew much slower in the beginning than the other rows. It's visually obvious in the photo journal attached to the report. The compaction in this area is visually more pronounced as water would pool slightly after excessive irrigation or winter rain. Produce quality was good, very firm flesh, sweet and the shelf life was great. Pest pressures were very low. Very little inputs/amendments were used in the initial building of the garden. The plants never displayed a "deficiency." Applications of fish/kelp fertilizer along with humic/fulvic acids were used to accelerate growth of plants when applied foliar, or used to feed microbes in the soil when used as a root drench. No immediate plant response from any application of additional foods was witnessed.

Fungal biomass, protozoa and nematodes all increased over the course of one growing season while bacterial biomass continually fell. Nutrient cycling improved while nutrient levels increased and became more balanced as represented in the soil chemistry reports. I cannot conjecture that the organic matter improvement was specifically because of the added biology and food resources due to the fact that one half of a bale of peat moss (organic matter) was incorporated into the top 3" of soil in the beginning of the project. When taking cores for soil chemistry sampling care was taken to sample from the bottom of the core where the soil was mostly clay to avoid adding peat moss to the sample.

Weed growth was halted. It was a very obvious distinction where the where the weeds stopped right at the edge of the garden site. I cannot be 100% certain that this is solely because of the improvement in biological markers due to the fact that the test area was mulched. The light exclusion from the straw mulch alone could of hastened the Globe Chamomile (exotic invasive) from germinating and becoming an issue. Research on light exclusion and efficacy of germination of this particular plant is non-existent.

The tomatoes are likely to continue to grow into fall when cooler temperatures return and respectable yields can be expected. Peppers are doing well in the extreme heat and some varieties started fruiting in mid July 2020. Eggplant is flowering as well.

PH of the soil actually increased thru the summer. I attribute this to the fact that the soil is still bacterially dominated and the growth of beneficial fungi in this climate has been slow. I also hypothesize that the bicarbonate in the water chemistry is driving this raise in PH as irrigation was heavily increased since triple digit temperatures arrived in late May 2020. The water source is municipal tap water ran through a cheap inline granulated activated carbon filter. The water chemistry report is also included.

Accurate compaction readings were very hard to obtain due to extreme rockiness of the site. The readings were very consistent before any work too the area was done. They were always above 300psi and just a small portion of the tip of the penetrometer would move into the soil due to extreme surface compaction. This was consistent everywhere tested. In June 2020 additional compaction readings were taken and the penetrometer needed to be moved around continuously until rocks weren't being hit when pushed into the soil. In these gaps between rocks readings were better and averaged 3.7". But again, this is not accurate data because the penetrometer would stop at 3.7" due to hitting a rock, not because it hit actual soil compaction.

The shady, cooler, more moist environment in the garden has been a haven for birds in the area as well. The straw mulch is constantly being disturbed and scratched up by Desert Quail and Cactus Wren. As far as I can tell this is not affecting production of the vegetables besides the desert quail sometimes eating kale leaves.

Soil structure and color before any work (left) Oct. 2019. Soil structure and color July 2020 (right) after biological conversion.