**Chapter 7: Maintaining High Tunnel Soil Health**

Management of soils in high tunnels is different from soil management in the open field. The higher planting density, more intense crop rotations, and lack of natural rainfall alter high tunnel soil properties over time. Additionally, as soils spend more time under the cover of the high tunnel and change more and more from the open field, management can get more complex. Soil nutrient imbalances, deficiencies, and soilborne diseases often develop. This chapter is designed to provide resources to help new high tunnel growers understand the unique soil environment in high tunnels and learn management options to maintain soil health and crop productivity. There are also resources to help growers anticipate common soil-related management problems and learn basic tools to adapt to new and developing issues.

Check out the resources below for some important areas of high tunnel soil management.

1. ***What is soil health?***
	1. This site hosted by Sustainable Agriculture Research and Education (SARE) is a good introduction to the topic of soil health and its relationship with your production system. It has an interactive diagram and links to several other resources.

<https://www.sare.org/resources/what-is-soil-health/>

1. **Soil sampling and testing**

Soil tests provide a lot of information about the soil fertility levels needed to manage crops this season and also give you information on trends in factors that can influence your high tunnel soil health in the long term. There are many types of soil tests; ‘Routine’ or ‘Standard’ soil tests are inexpensive tests to give you baseline information needed for crop nutrient management. Additional tests can be requested such as soil organic matter and soluble salts (also known as soil salinity) which are helpful indicators of high tunnel soil health.

**It is recommended to test soil before growing the crop in your rotation that has the greatest nutrient demand (the ‘heaviest feeder’). For many growers, this will be a warm season crop such as tomatoes. Soil testing early enough to have time to act on your soil test results is important. Ideally, this would be in the fall prior to the next spring, but should be at least eight weeks before planting.

*See more resources on soil sampling and testing in Chapter 6 Growing Your First High Tunnel Crop*

1. **Soil Salinity**

Exclusion of rainfall from high tunnels does not allow for excess nutrients to leach from the root zone, especially salts such as nitrates, calcium, potassium, magnesium, and sodium. This leads to high salt levels and nutrient imbalances.

* + 1. *Soil Salinity in High Tunnel Production, CCD-FS-24 (Resource ###)*
		- Crops have varying degrees of salt sensitivity. Effects can include reduced plant growth, low yields, or appearance of burned leaf margins. Choosing fertilizer sources with low salt levels (low salt index) can help prevent salt from building up. The most reliable strategy for reducing salt levels is to allow for natural rainfall to percolate through the soil during the wet, cool months. Leaving high tunnel plastic off for 3-4 months during late fall and winter is a recommended option when possible.
		- This five-page factsheet from the University of Kentucky Center for Crop Diversification (CCD) explains soil salts and their impact on plants grown in high tunnel production.
* <https://ccd.uky.edu/sites/default/files/2024-11/cd-fs-24_soilsalinity.pdf>
1. **Soil organic matter management**

Soil organic matter is an important soil property that is a chemically complex mixture of the byproducts of every organism in the soil, living or dead. Maintaining soil organic matter levels is very important to maintaining long term soil fertility, as it helps hold nutrients and water, prevents compaction, and binds soil particles together to improve soil structure.

*a. Soils and Fertility, AGR 204*

* This chapter of the University of Kentucky Master Gardener Manual covers basic properties of soils, including nutrients and soil organic matter.
* <https://publications.ca.uky.edu/sites/publications.ca.uky.edu/files/agr204.pdf>
1. *High Tunnel Soil Management for Season Extension (Resource ###)*
* Warmer soil temperatures in high tunnels increase the rate of growth and breakdown of organic matter, releasing nutrients and depleting soil organic matter. Tillage, intensive crop rotations, and removing crop material to manage disease also increase the rate of organic matter breakdown and depletion. Cover crops are recommended as an important part of crop rotations to increase soil organic matter and improve soil structure (more below). This three-page article from ATTRA-Sustainable Agriculture discusses the high tunnel soil environment.
* <https://attra.ncat.org/high-tunnel-soil-management-for-season-extension/>
1. *Long Term Soil Health and Fertility (Resource ###)*
* This two-page publication by Cornell Cooperative Extension provides best management practices for high tunnel soil health and fertility in the long term. <https://rvpadmin.cce.cornell.edu/uploads/doc_652.pdf>
1. **Compost**

Many growers turn to compost to maintain or increase organic matter levels, as a primary source of fertilizer, or as a surface mulch for weed control in no-till systems. If the compost is not properly managed to reach appropriate temperatures, composts may carry weed seeds, diseases, and pathogens from animal manures. Make sure your compost source is trusted and test soil salt levels regularly. Composts with animal manures may contain herbicides that are used to kill weeds in pastures. Some herbicides using aminopyralid (Milestone, Grazon, etc.) do not break down in animal digestive tracts or the composting process and may be found in commercial composts. If present, these herbicides may severely damage vegetable crops and may take a long time to leach or break down in high tunnels. *Always make sure your compost comes from a trusted source!*

* + 1. If using compost, it is recommended to test it for salt, nutrient levels, and pH.
* Compost should be tested each year even if the same source is used. Kentucky Residents can submit compost samples through their county Extension office. Samples will be sent to the University of Kentucky Division of Regulatory Services for testing and results will be returned to the grower. Your county Extension agent can assist with interpreting the results and go over management recommendations with you.
* University of Kentucky submission form for manure-based composts: <https://www.rs.uky.edu/soil/forms/AnimalWasteSubmittal.pdf>
	+ 1. *Water, Soil, and Fertility Management in Organic High Tunnels (Resource ###)*
* This is a 10-page resource from Michigan State University. Pages 5-8 discuss soil, fertility and compost.
* <https://www.canr.msu.edu/hrt/uploads/535/78622/HighTunnelWaterSoilFertility2013-10pgs.pdf>
1. **Cover crops in high tunnel crop rotations**

Cover crops can be an important part of a crop rotation that helps maintain soil organic matter and keeps nutrients cycling on high tunnels. They can help build soil organic matter and increase soil health and keep nutrients cycling. They do not bring the risks of adding additional salts or herbicide contamination that compost may. Cover crops do require planning and time in the crop rotation to allow for both growth and decomposition.

* + 1. *Covers Under Cover: Managing Cover Crops in High Tunnels, CCD-SP-16 (Resource ###)*
* This four-page factsheet from the University of Kentucky Center for Crop Diversification (CCD) discusses considerations for cover cropping in high tunnels such as plant selection, timing, as well as potential pros and cons.
* <https://ccd.uky.edu/sites/default/files/2024-11/ccd-sp-16_coversundercover1.pdf>
	+ 1. *Warm Season Cover Crops for High Tunnels in the Southeast, CCD-SP-19 (Resource ###)*
		- Warm season cover crops can be grown with a short amount of time in between spring and fall crops in a high tunnel. Recommended species in this guide grow quickly, but should be killed and tilled in while they are a manageable size. Warm season cover crops can be planted at the end of summer and killed by frost (winter killed) and incorporated in the winter in preparation for early spring planting. This resource from the University of Kentucky Center for Crop Diversification (CCD) describes selection, planting, and management of cover crops in high tunnels. It includes a sample of several cover crop varieties with their potential benefits and management challenges.
		- <https://ccd.uky.edu/sites/default/files/2024-11/ccd-sp-19_warm-season_covercrops.pdf>
		1. *Cool Season Cover Crops for High Tunnels in the Southeast, CCD-CP-18*
	+ Cool season cover crops are good choices if you do not have a market for winter vegetables. Many cover crops that do well in the field as winter cover crops do well in a high tunnel. In this factsheet, there is information about growing cool season cover crops in high tunnels provided by the University of Kentucky Center for Crop Diversification (CCD)
	+ [https://ccd.uky.edu/sites/default/files/2024-11/ccd-sp-18\_cool-season\_covercrops.pdf](https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fccd.uky.edu%2Fsites%2Fdefault%2Ffiles%2F2024-11%2Fccd-sp-18_cool-season_covercrops.pdf&data=05%7C02%7CKathryn.Pettigrew%40uky.edu%7Cc316a29124a0474ceb2008dd4130076e%7C2b30530b69b64457b818481cb53d42ae%7C0%7C0%7C638738396723246081%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=XUhf1DPXb%2FnbhhHDQjNTb6fqAjik%2BlkrooPP4TgpEJA%3D&reserved=0)
1. **Understanding the effect of irrigation water on soil properties**
2. *Basic Aspects of High Tunnel Soil Fertility Management (Resource ###)*
* Irrigation water should be tested for alkalinity (calcium carbonate content), especially well water or if water is known to be particularly ‘hard’. Calcium carbonate levels under 100 parts per million are ideal. Water pH should be between 5.5 – 6.5. This two-page resource from Purdue University describes how irrigation water can influence soil pH and salt levels in soil over time.
* <https://vegcropshotline.org/article/basic-aspects-of-high-tunnel-soil-fertility-management/>
1. *Why Test My Irrigation Water?*
* Water quality can impact plant growth and production. For this reason, it may be valuable to test your water at least once per year, especially if you use a well or open source, such as a pond or river. This two-page resource discusses why testing your irrigation water may be helpful and how to collect a water sample.
* <https://nursery-crop-extension.ca.uky.edu/sites/nursery-crop-extension.ca.uky.edu/files/general/di_knv_why_test_water.pdf>
1. *Submitting a water sample for testing*
* The University of Kentucky offers irrigation water testing. Kentucky residents should submit their samples through their county Extension office.
* <https://www.rs.uky.edu/soil/forms/SoillessMediaSubmittal.pdf>
1. *Understanding and Managing Water Alkalinity*
* Once the results of the irrigation water are returned, your county agent should review them with you. This two-page resource will help with understanding the different factors influencing water quality.
* <https://nursery-crop-extension.ca.uky.edu/sites/nursery-crop-extension.ca.uky.edu/files/general/knv_alkalinity.pdf>
1. *Irrigation Water Quality and Mulches and Water Management (Resource ###)*
* These are chapters 5 and 6 in Water *Management for Vegetable Crops on Small Farm,* a publication by Purdue University*.*Pages 17-21 provide an overview of the chemical, biological, and physical characteristics of irrigation water. Pages 21-22 discuss the benefits of mulching related to soil moisture, various types of mulch materials, and some considerations when practicing each mulching strategy.
* <https://edustore.purdue.edu/ho-341-w.html>
1. **Water management on site**

High tunnels offer the benefit of not only extending the growing season, they keep soil under the cover of the tunnel protected from rainfall when properly sited.

*a. See Chapter 4 Site Selection and Construction*

* + This chapter offers important considerations for soil drainage when siting your tunnel.
1. *See Chapter 6 Growing Your First High Tunnel Crop*
* Chapter 6Includes resources on setting up high tunnel irrigation systems, rainwater catchment, and management water in high tunnels