

# High Tunnel Soil & Nutrient Management

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Extension

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# Purpose of High Tunnels

- **Control** - a system we create and carefully manage
- Crop reliability & profitability
- Greater control of the environment
  - Temperature
  - Water
  - Pests
- Extending the season
  - Spring - Early planting
  - Early summer - cool season crops
  - Fall - Frost & freeze protection
- Crop protection
  - Plastic - wind, rain, snow, hail etc.
  - Shade cloth - sunburn, slow bolting



# High Tunnel Production

- High cost per square foot so make it count.
- This is high intensity production
  - High plant density
  - Successive crops
  - Longer season
  - Greater fertilizer needs



# The Soil Health Challenge

- Nutrient imbalances
  - Too much or too little
- Salt accumulation
  - These are excess nutrients
  - From frequent fertilization
  - Low water applications
- High pH
  - Welcome to Utah - Average = 8
- Soil compaction
  - Small walkways, close to crops
- Disease buildup
- Low biological diversity
  - Short-term cropping, successions



# The Soil Tank

- Our growing practices can either deplete or regenerate the soil
  - Constantly fluctuating in season
- What is in the tank?
  - Organic matter - plant material
  - Added nutrients - fertilizers
  - It is alive with microbes, decomposers, fungi - feed them!
    - Composts and other amendments introduces them
- How big of an area do you need?
  - Maximize space and manage those areas
  - Create permanent beds in the tunnel
    - Soils take time to build



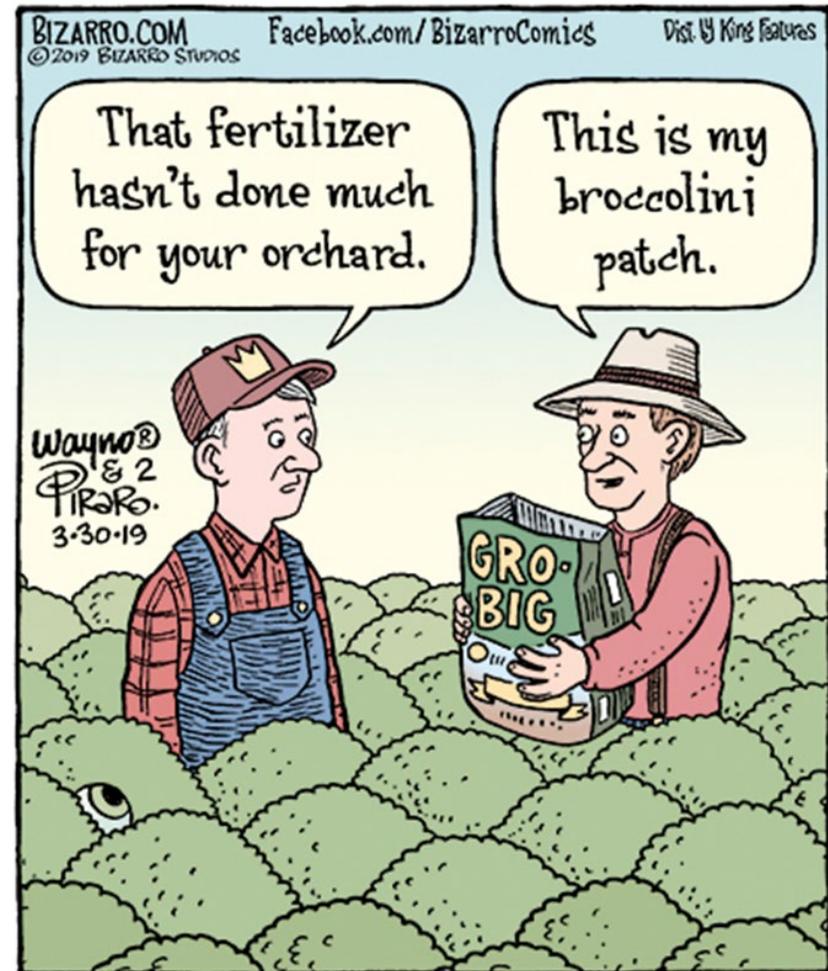
<https://extension.umd.edu/resource/soil-health-drainage-and-improving-soil/>



# Managing HT Nutrients

Causes of nutrient level changes

- How can I manage these better?
- Adding nutrients
  - Conventional & organic
- Subtracting nutrients
  - Plant growth
  - Leaching
- Cycling of nutrients
  - Cover crops
  - Plant material



# Adding Fertilizer

- Before you add more...why?
  - Get regular(yearly) soil tests
    - Gives actual amounts, plus recommendations
    - County agents can help assess
- Fertilizer types
  - Complete fertilizers - contain N-P-K
  - Single element
  - Conventional - generally faster release
  - Organic - apply 70% before planting
- Correctly calculate planting beds, exclude walkways

## Vegetables



### General Vegetable Production

- [Recommended Vegetable Varieties for Northern Utah](#)
- [Using Shade for Fruit and Vegetable](#)
- [Production/Vegetable Production and Pest Management Guide](#)
- [Use of Plastic Mulch for Vegetable Production](#)



### Cabbages and Cousins

- [Broccoli in the Garden](#)
- [Brussel Sprouts in the Garden](#)
- [Cabbage in the Garden](#)
- [Cauliflower in the Garden](#)
- [Kohlrabi in the Garden](#)



### Melons and More

- [Cantaloupe /Muskmelon in the Garden](#)
- [Cucumbers in the Garden](#)
- [Honeydew and Other Winter Melons in the Garden](#)
- [Pumpkins in the Garden](#)
- [Summer and Winter Squash in the Garden](#)
- [Watermelon in the Garden](#)



[extension.usu.edu/productionhort/small-acreage/vegetables/](http://extension.usu.edu/productionhort/small-acreage/vegetables/)

Horticulture



extension.usu.edu

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## Calculating Fertilizer for Small Areas

*Tiffany Maughan, Grant Cardon, and Dan Drost*



# Managing HT Nutrients - Salinity

- Imbalances and buildup of salts or excess nutrients
  - Flush with water
  - Uncover tunnel for natural moisture
  - Move high tunnel if possible
  - Grow more tolerant crops
  - Cover crops can be grown and removed

[https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1042&context=extension\\_histall](https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1042&context=extension_histall)

**Table 4. Salinity tolerance of common vegetables grown in Utah.**

Crop	Threshold value	Yield loss		
		10%	25%	50%
----- EC <sub>e</sub> (dS/m) -----				
Asparagus	5.0	8.0	11.0	13.0
Beans	1.0	1.5	2.3	3.6
Beets	5.3	8.0	10.0	12.0
Broccoli	2.7	3.5	5.5	8.2
Cabbage	1.8	2.8	4.4	7.0
Cantaloupe	2.2	3.6	5.7	9.1
Carrot	1.0	1.7	2.8	4.6
Cauliflower	2.7	3.5	4.7	5.9
Celery	1.8	3.5	5.8	10.1
Corn, Sweet	1.7	2.5	4.0	6.0
Cucumber	2.5	3.3	4.4	6.3
Lettuce	1.3	2.1	3.2	5.2
Onion	1.2	1.8	2.8	4.3
Peas	0.9	2.0	3.7	6.5



Reviewed December 2010

## SOLUTIONS TO SOIL PROBLEMS I. High Salinity (soluble salts)

Vernon Parent, Washington County Extension Agent  
Rich Koenig, Extension Soil Specialist

# Soil Organic Matter

- "Healthy soil" needs 3-5% content
- Important for:
  - Nutrient cycling
  - Microbial life
  - Soil structure
  - Water holding capacity
  - Water infiltration
- Yearly replenishment
  - At least - 1" organic material
  - More depending on soil use and initial conditions
- But: Compost alone ≠ full soil health strategy



# Organic Matter - Sources

- Leaves
  - Carbon, Organic Matter
- Compost
  - Phosphorous\*, Micronutrients, Organic Matter
- Composted manure
  - Phosphorous, Nitrogen, Salts\*
- Cover Crops (green manure)
  - Organic Matter (green tissue & roots)
  - Nitrogen (legumes & green tissue)
- Fresh Manure
  - Nitrogen, Organic Matter, Salts
- Low nutrient content
  - Coconut coir, peat moss
  - Use when soil is unbalanced

Gardening Topics ▾ Monthly Tips Research Basics of Gardening Events Gardening Courses More Gardening ▾

Table 1: Organic matter sources and approximate nutrient analyses as % Nitrogen, % Phosphate, and % Potash

Plant Materials			
Source	% Nitrogen	% Phosphate	% Potash
Grass clippings	1-2	0-0.5	1-2
Leaves	1	0-0.5	0-0.5
Legumes	2-4	0-0.5	2-3
Pine needles	0.5	0	1
Sawdust	0-1	0-0.5	0-1

Composts			
Source	% Nitrogen	% Phosphate	% Potash
Chicken manure-based	1.4	5.8	2.8

<https://extension.usu.edu/yardandgarden/research/preparing-and-improving-garden>



# Cover Crops

- How do cover crops improve soil health?
  - Improve soil structure
  - Recycle nutrients
  - Increase organic matter
  - Water infiltration
  - Reduce soil compaction
- Challenges
  - Time constraints
  - Space limitations
  - Water management



# Cover Crop Resources

Appendix A. - Table 4. Cover Crop Interseeding Systems

Note: Only systems that cause negligible yield reduction have been included. All of these systems provide a cover which lives through the winter or is winter-killed. All cover crops resist major damage during harvest of the cash crop unless otherwise noted.

Cover Crop	Cash Crop	Method	Benefits	Problems
Red clover, annual or perennial ryegrass <sup>1</sup>	Corn, late sweet corn	Broadcast after last cultivation <sup>1</sup>	Good organic matter production; N-fixation by red clover	Establishment may be poor in a dry summer; annual rye-grass may winter-kill
Rye <sup>2</sup>	Corn, late sweet corn	Broadcast in early fall at 3 bu/acre	Reasonable establishment most	Stand may be patchy; stand may be poor if the fall is dry
Red clover, alsike clover, alfalfa, yellow sweet clover	Winter wheat, spelt	Sow on frozen ground in early spring	Good organic matter production and N-fixation before next spring crop	Ground may not freeze sufficiently to support tractor
Bell bean <sup>3</sup>	Fall brassicas	Plant two rows of bell bean between crop rows after last cultivation	N-fixation for next crop; grows fast and then winter-kills; upright growth does not interfere with crop	Expensive seed; cover crop will be damaged at harvest
Annual rye-grass	Tomato, pepper	Broadcast after last cultivation <sup>1</sup>	Good dry matter production by next spring	May winter-kill
Hairy vetch	Late harvested vegetables	Plant 1 or 2 rows between rows of vegetables after last cultivation	N-fixation for next crop; no interference with crop; spreads out to give fair winter cover and good spring production	May become a recurring weed
Rye	Late harvested vegetables	Plant 1 or 2 rows between rows of vegetables after last cultivation	Falls over to give fair winter cover; no interference with crop	None apparent
Rye	Late harvested vegetables	Broadcast at 2 to 3 bu/acre 3 to 5 weeks before harvest	Provides more uniform cover than drilling between rows	Stand may be patchy; stand may be poor if the fall is dry; interferes with harvest of short, leafy crops

Table 2. Examples of Cover Crops for Organic Prod

	Cover Crop	Seeding Rates	Advantages	
Warm Season (spring sown)	Buckwheat	50 to 60 lbs/acre at 0.5 to 1.5 inches deep; 6 to 8 inch rows. For weed suppression, use up to 96 lbs/acre (2 bu./acre)	Fast-growing cover crop can be incorporated 40 days after planting and breaks down quickly. Does well on poor soils. Good alley crop for vineyards.	> Pref > Not > Avo
	Sorghum- Sudan grass	Broadcast 40 to 50 lbs/acre, or drill 35 to 40 lbs/acre as deep as 2 inches to reach moist soil.	Drought tolerant and wide pH tolerance (5-9). Good crop for rehabilitating poorly managed, low-organic matter soils (high biomass, good root structure, weed and nematode suppression.)	> Req > N/as > Bion > mov > chq > dec > Toxi > esp > anin > is at
Cold Season (fall sown)	Sunn Hemp <i>Crotalaria juncea</i>	40-50 lbs/acre minimum rate for organic (75-100 lbs/acre for weed suppression, or for 4-5 week cover crop)	Tolerates poor, sandy soils, but needs good drainage. Can make a green manure crop in 60 days. Fast growing, good at smothering weeds.	> Not > kill i > Req > Som > cont > lives > Sup > See
	Hyacinth Bean <i>Lablab purpureus</i>	Broadcast 70-120 lb seed per acre, or drill 30-90 lb seed per acre. Broadcast and cover, or drill to a depth of 2 inches	Fast early growth effective to smother weeds and cover ground. In northern California, a 75-day Lablab crop was estimated to contribute 65-140 lb/acre of nitrogen. Very palatable to livestock, and can be mowed near to ground level and regrow. Performs very well with minimal irrigation.	> Req > Inoc > rhiz > Doe > rhiz > Sust > bact
	Brassicas	Canola: drill 5 to 10 lbs/acre no deeper than 1/4 in. or broadcast 8 to 14 lbs/acre. Mustard: drill 5 to 12 lbs/acre, 1/4-3/4 in. deep or broadcast 10 to 15 lbs/acre. Radish: drill 8 to 12 lbs/acre, 1/4-1/2 in. deep, or broadcast 12 to 20 lbs/	Good N scavenger. Natural fumigant potential against bacteria, fungi, insects, and weeds.	> Mini > 45°F > Pref > Avo > mus > effe > Attr > alte > dise > Can > Fall

Table 2. Examples of Cover Crops for Organic Production (continued)

	Cover Crop	Seeding Rates	Advantages	Considerations
Cold Season (fall sown)	Rye and Vetch	20:80 or 30:70 rye: vetch at 120 lbs/acre is standard, but for weed suppression that rate can be doubled or more.	Fast growing with potential to suppress weeds.	> Depending on variety, about 20% of vetch seed will not germinate in the first season and can become a weed in subsequent crops. For better weed suppression, use higher seeding rates. Check with local extension to determine the appropriate variety as many are available.
	Crimson Clover	15-20 lbs/acre drilled or 22-30 lbs/acre broadcast. This can be increased for more effective weed suppression. Plant at .25-.5 inch depth.	Grows well in mixes of small grains, grasses and other clovers. Flowers support bees and minute pirate bugs (a mite & thrip predator). Excellent for grazing and haying.	> Wait 2-3 weeks after incorporation of crimson to plant seeds or transplants to allow decomposition. > Secondary host for corn earworm (also known as the tomato fruit worm and cotton bollworm).
	Phacelia <i>Phacelia z</i>	7-12 lbs/acre drilled, 11-18 lbs/acre broadcast (use cultipacker or rake). This can be increased for more effective weed suppression. Plant at .25 inch depth.	Attractive to flower flies (Syrphid larvae eat aphids), bumble bees and honey bees. Grows well in dry soil and can limit nitrate leaching if planted in early fall.	> Phacelia can host verticillium; flower attractive to lygus (especially avoid planting near strawberries). > Will winterkill if temperatures fall to mid-teens.
	Fava beans <i>Vicia faba</i> (bell bean is a small-seeded selection of fava bean) (See Figure 2.)	80-200 lbs/acre (more for weed suppression), plant 1-4" (deeper range for large-seeded cultivars, shallow range for smaller seeded cultivars).	Fava beans do well in wide range of soils, including heavy clays. Fava bean residue persists longer than that of other leguminous cover crops, which can help improve heavy soils.	> Technically a vetch, but is more susceptible to frost damage, and fixes a bit less N than most vetches (100-150 lbs N/acre). > Has extra-floral nectaries which attract beneficials. > Host to root-knot nematode.

<https://www.sare.org/>

<https://www.sare.org/wp-content/uploads/Cover-Crop-in-Organic-Systems-Idaho-Implementation-Guide.pdf>

<https://www.midwestcovercrops.org/selector-tools/>

<https://www.sare.org/publications/building-soils-for-better-crops/cover-crops/>



# Key Takeaways

- Routine soil testing
- Monitor EC(salinity) and pH
- Diversify organic matter inputs
- Integrate cover crops when possible
- Avoid over-applying compost & fertilizers
- Manage irrigation intentionally



# Thank You for Attending!

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