NC COOPERATIVE EXTENSION

NC STATE Extension Master Gardener

Sustainable Vegetable Gardening




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Horticulture Extension Agent

NCCE Chatham County

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Resources & References

- Slides, many additional Extension resources by late this afternoon.

go.ncsu.edu/chathamveggies

Demonstration Garden Update

- Demo garden install delayed. #governmentbureaucracy
- You will be emailed once install is complete for a series of **free** follow-up demonstration activities
- Also personally invited any time to tour and ask us questions about the garden

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Light Requirements

Hours of Direct Sun per Day

8-10

Fruit Crops

6-8+

Leaf and Root Crops

All vegetables need at least 6-8 hours of direct sunlight per day

Avoid Trees

- Shade
- Water & nutrient competition
- Space at least 2x height of trees

Other Site Considerations

Accessibility

- Foot Traffic
- Tools
- Water Sources

Drainage

- Avoid low areas where water pools after rain

Site Preparation

Remove weeds and grass

- Smother
- Sod cutter
- Herbicides

In-Ground Gardening

- No construction materials
- Keeps space flexible
- Need large area
- Mound beds in heavy clay or poorly drained soils
- Incorporate organic matter

Wide Rows, Mounded Beds

- Make beds 1’-3’ wide
- Paths 2’-4’ wide
- Mound soil so beds are 6”-12” higher than paths
- Plant 2-3 staggered rows within bed
- Mulch between beds!

Raised Beds

Benefits:

- Improve drainage
- Soils warm quicker in spring
- Easier to maintain
- Efficient/productive
- Improve accessibility
- Attractive-better fit for small landscapes

Raised Beds

- **At least 8” deep**
  - Till soil underneath before filling
- **4’ wide** or less
- **Length** – depends on material used and space available
- Fill with **mix** of soil and compost (25-50%)
  - Pinebark fines, purchased topsoil mixes, etc

Raised Beds

Less maintenance if not surrounded by grass! Mulch paths between beds

Treated or untreated boards

Trex – recycled plastic $$

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Corrugated Sheet Metal

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Concrete Blocks

Easy to build

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Add vertical support for vines

Keep in mind:

- Moving around beds
- Reaching into beds

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Why garden in containers?

Grow Food in Small Spaces

Flexibility & Accessibility

Avoid Soil Problems

Other Considerations

- More frequent watering
- More frequent fertilization
- Don’t use native soil

Choosing Containers

Containers can be made of many different materials

Containers must be able to:

1) Hold soil media
2) Drain water

Add drainage holes if needed

Container Materials

Porous

- Clay
- Terracotta
- Unglazed ceramic

Semi-porous

- Wood
- Pressed fiber

Non-porous

- Plastic
- Metal
- Fiberglass
- Glazed ceramic

Container Size

- Need space for roots
- **Shallow rooted veg. crops:**
  Min. 4-8 in. depth
- **Root or fruit crops:**
  Min. 10-12 in. depth

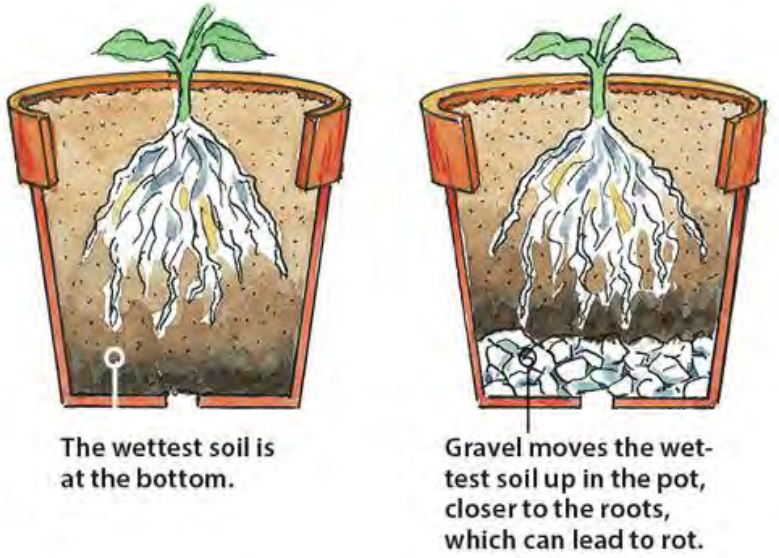
- Larger = better moisture retention
- Penn State Extension Study
  - 14”- 20” diameter

Vegetable	Minimum Size Container	Spacing	Minimum Container Depth
Beans	2 gallon	2–3 inches	8–10 inches
Beets	2 quart	2–3 inches	8 inches
Bok choy	1 gallon	6 inches	20 inches
Carrots	2 quart	2–3 inches	10 inches
Collards	3 gallon	12 inches	12 inches
Cucumbers	1 gallon	1 plant per container or 12–16 inches	8 inches
Eggplant	5 gallon	1 plant per container	12–16 inches
Green garlic	2 quart	4 inches	4–6 inches
Kale	3 gallon	6 inches	8 inches
Lettuce	2 quart	4–5 inches	6–8 inches
Mustard greens	3 gallon	6 inches	4–6 inches
Peas	2 gallon	2–3 inches	12 inches
Peppers	2 gallon	1 plant per container or 14–18 inches	12–16 inches
Potatoes	30 gallon	5–6 inches	
Radishes	2 quart	2–3 inches	4–6 inches
Scallions	2 quart	2–3 inches	6 inches
Spinach	1 gallon	2–3 inches	4–6 inches
Squash	2 gallon	1 plant per container	12–24 inches
Swiss chard	2 quart	4–5 inches	8 inches
Tomatoes	5 gallon	1 plant per container	12–24 inches

Table 18.1 *NC Extension Gardener Handbook*
https://content.ces.ncsu.edu/extension-gardener-handbook

Adding Gravel to the Bottom of Pots?

- Does not improve drainage
- Creates a perched water table
- Fill entire container with uniform media



Commercial Container Media

- Many variants available
- Combination of peat moss, perlite, vermiculite
- Easy to find and purchase
- Look for ‘Mix’ or ‘Media
- Avoid “topsoil”, “potting soil” “garden soil” etc. for containers
- May contain fertilizers – not enough!

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Want more information on container gardening?

go.ncsu.edu/chathamfallveggies

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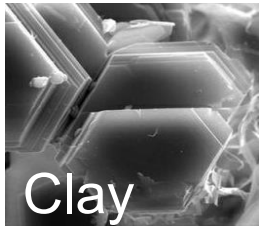
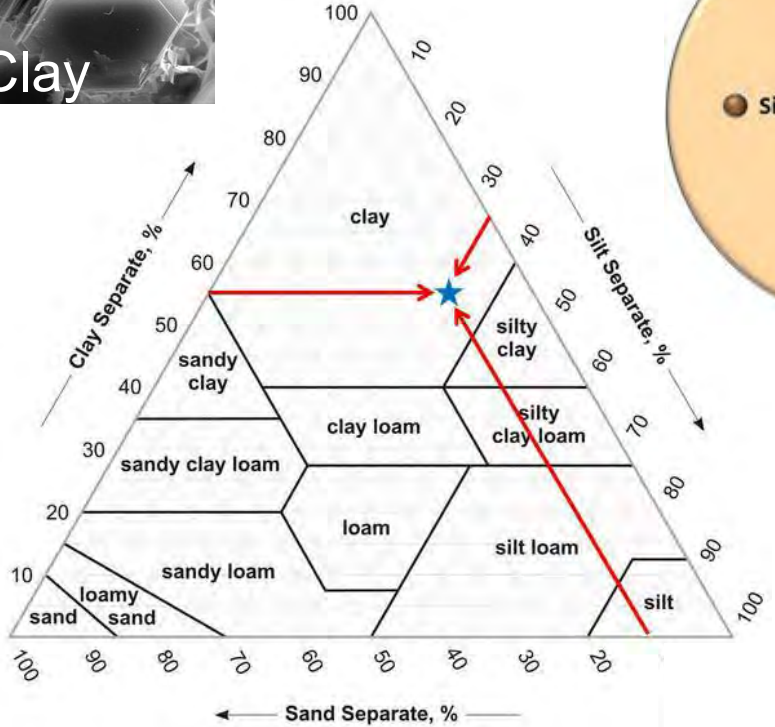
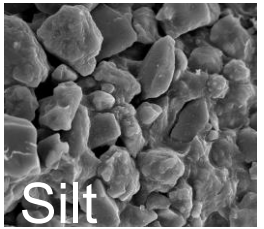
Soil Texture

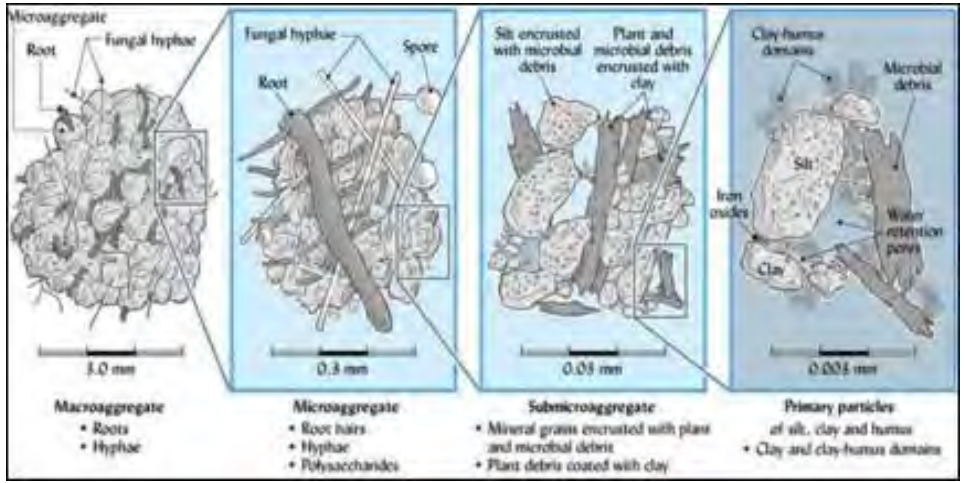






Soil Structure

Organic matter binds soil particles together into aggregates & creates pore spaces for water, air, and roots



Brady and Weil 2010
Elements of the nature and properties of soils

Improve Your Soil with Organic Matter

Add organic matter to soil each season

- 2-3” layer, mix in 6-8” deep at incorporation
  - 1-3” layers annually thereafter
- Improves drainage and moisture retention
- Feeds microbes
- Provides nutrients and increases soil’s ability to hold nutrients

Organic Matter & Compost

Can purchase

- In bulk from mulch dealers
- In bags from garden centers
- Know thy compost!
  - pH
  - NCDA Test $3

Or make your own

- https://composting.ces.ncsu.edu/

Organic Matter:

Amendments vs. Mulch

Soil amendments are composted, suitable for incorporation

- May also be surface applied (topdress)

Mulch is not decomposed; suitable for surface application only

Organic Matter

✓**Ground pine bark** – sold as soil conditioner

✓ **Rotted leaves** (leaf mold) – pile them up and let them rot 2-3 years

✓ **Aged manure** – at least 6 months

✓ **Compost** – the best!

X Peat moss – only holds water, no nutrients, only recommended for extremely sandy soils

X Potting soil – mostly peat

X Sand – Mixed with clay becomes concrete!

Peat moss will not fix your problems!!!

Cover Crops as Green Manures

Cool Season Cover Crops

- Sow Sept-Oct or Feb-March

Legumes (add N): hairy vetch, clover, Austrian winter pea

Grasses (add O.M.)

Brassicas (suppress nematodes): mustard, rapeseed

Crimson Clover

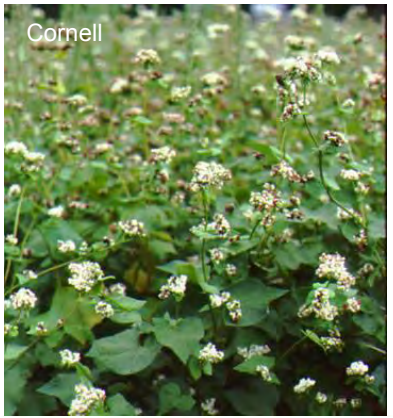
Warm Season Cover Crops

- Sow mid-April - August

Legumes: cowpeas, soybeans, crowder peas

Grasses: millet, sorghum-sudangrass,

Buckwheat: very quick, turn under in 30-45 days



Buckwheat

Seeding Cover Crops

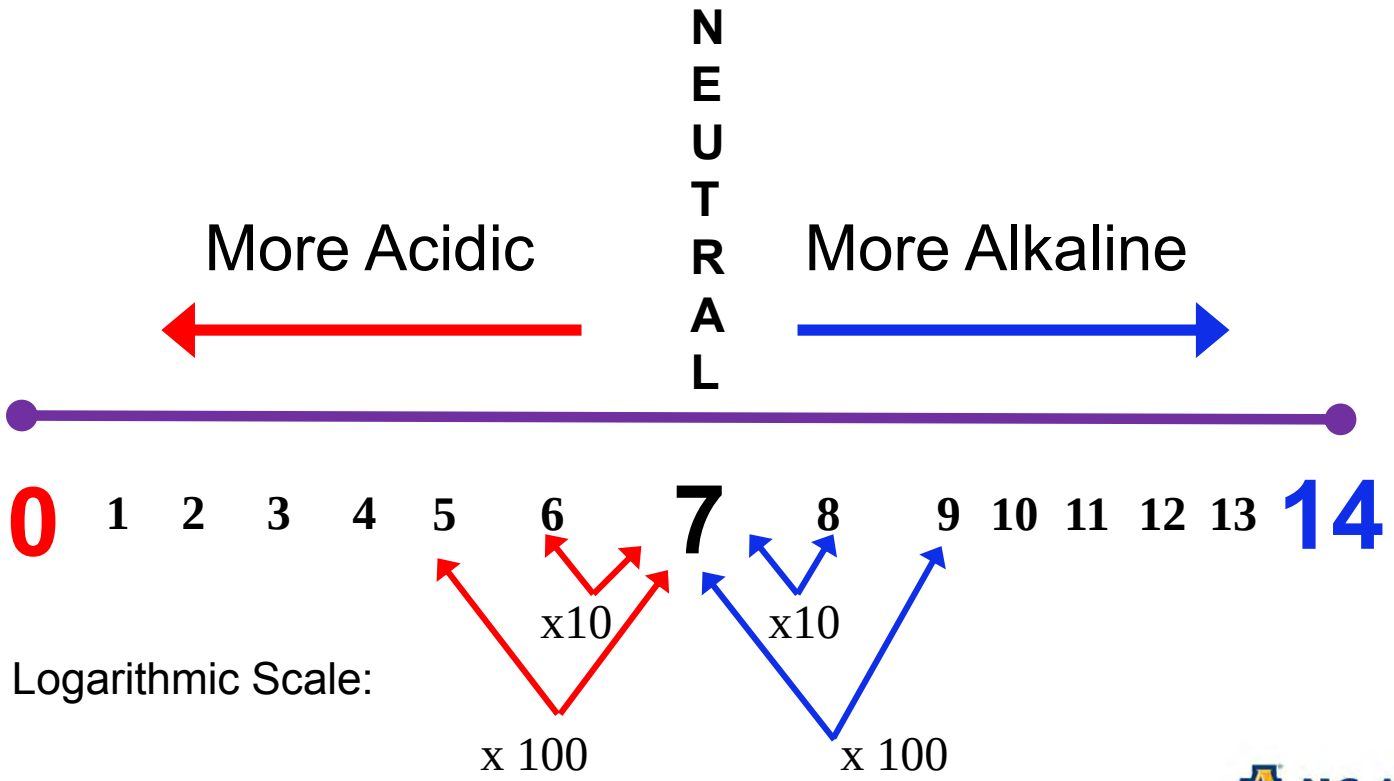
1) Till soil and rake level
2) Scatter seed thickly over soil surface
3) Rake in lightly
4) Water

Cover Crops

Till in before seeding for green manure

Mow before planting for residue mulch

Soil pH


NEUTRAL
More Acidic
More Alkaline
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
x10
x10
Logarithmic Scale:
x 100
x 100

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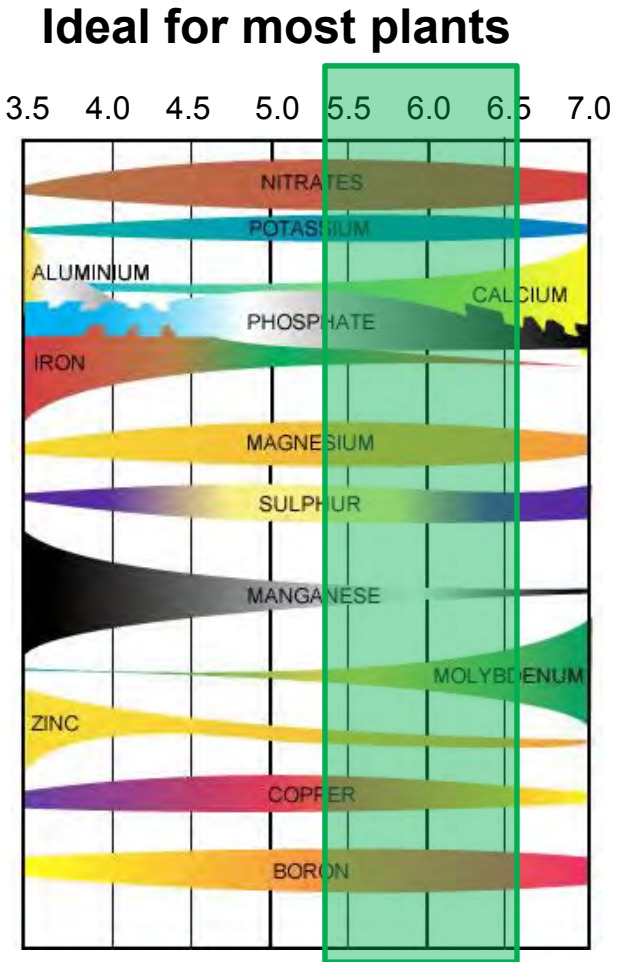
How pH Affects Nutrient Availability

- Width of horizontal bars represent how available nutrient is at different pH levels
- 5.5 to 6.5 ideal for most plants
- **Lime raises pH**
- Sulfur lowers pH



Adding Lime to Raise Soil pH

- Two types of lime for amending gardens and lawns
  - Calcitic lime ($CaCO_3$, $Ca(OH)_2$, CaO)
  - Dolomitic Lime ($MgCO_3$)
- Incorporate into soil
- Takes up to six months to react in the soil to increase pH
  - Finer grain, faster reaction

Adding Sulfur to Reduce pH

Elemental Sulfur

Pounds of Sulfur per10 square feet to Lower the Soil pH to the Recommended Level

Present pH	Desired pH				
	6.5	**6.0**	**5.5**	**5.0**	**4.5**
8.0	0.3	0.4	0.5	0.6	0.7
7.5	0.2	0.3	0.4	0.5	0.6
7.0	0.1	0.2	0.3	0.4	0.5
6.5		0.1	0.2	0.3	0.4
6.0			0.1	0.2	0.3

Aluminum Sulfate

Pounds of Aluminum Sulfate per 10 square feet to Lower the pH to the Recommended Level

Present pH	Desired pH				
	6.5	**6.0**	**5.5**	**5.0**	**4.5**
8.0	1.8	2.4	3.3	4.2	4.8
7.5	1.2	2.1	2.7	3.6	4.2
7.0	0.6	1.2	2.1	3.0	3.6
6.5		0.6	1.5	2.4	2.7
6.0			0.6	1.5	2.1

CLEMSON COOPERATIVE EXTENSION
http://www.clemson.edu/extension/hgic
HGIC 1650 1-888-656-9988
HOME & GARDEN INFORMATION CENTER
Changing the pH of Your Soil

How to determine soil pH?

Soil Testing from the NCDA!

- Only reliable method to asses soil nutrient content and pH
- Boxes and forms available from NC Cooperative Extension
- Analysis is *free* for NC residents (Apr.-Nov.)
  - $4/sample: Dec-Mar

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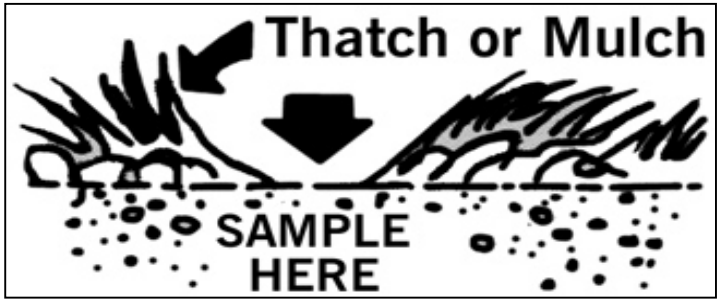
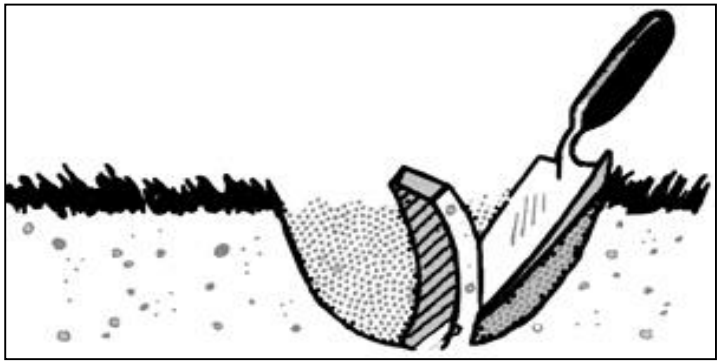
Master Gardener | Chatham County

Chatham MGVs deliver soil samples monthly during the free period!

How to Take Soil Samples

- Avoid thatch or mulch
- Take a ‘slice’ of soil
- **Turf:** 4” deep
- **Landscape beds, Vegetables**: 6” deep
- Mix subsamples together to make one composite sample for each unique area





How to Sample Soil

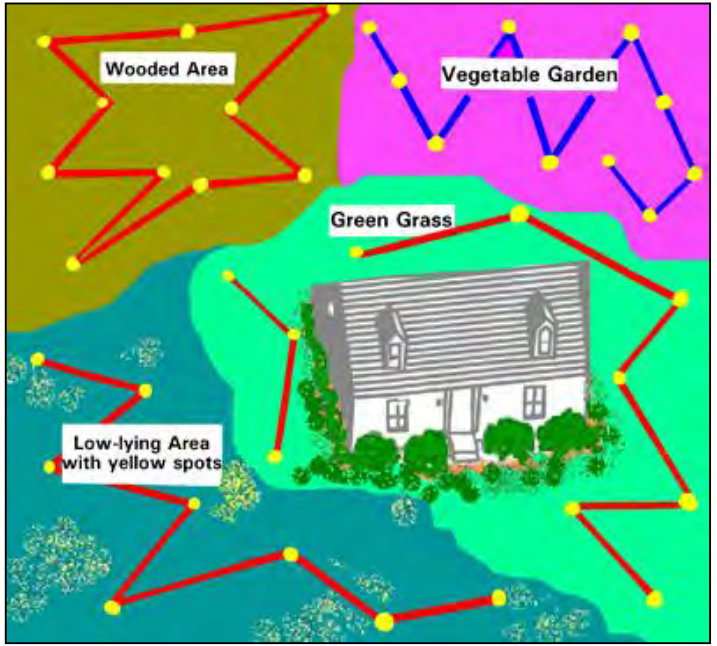
Sample different areas separately

- Plants/Crops
- Topography
- Soil texture
- Plant health

Avoid areas that will obviously skew results

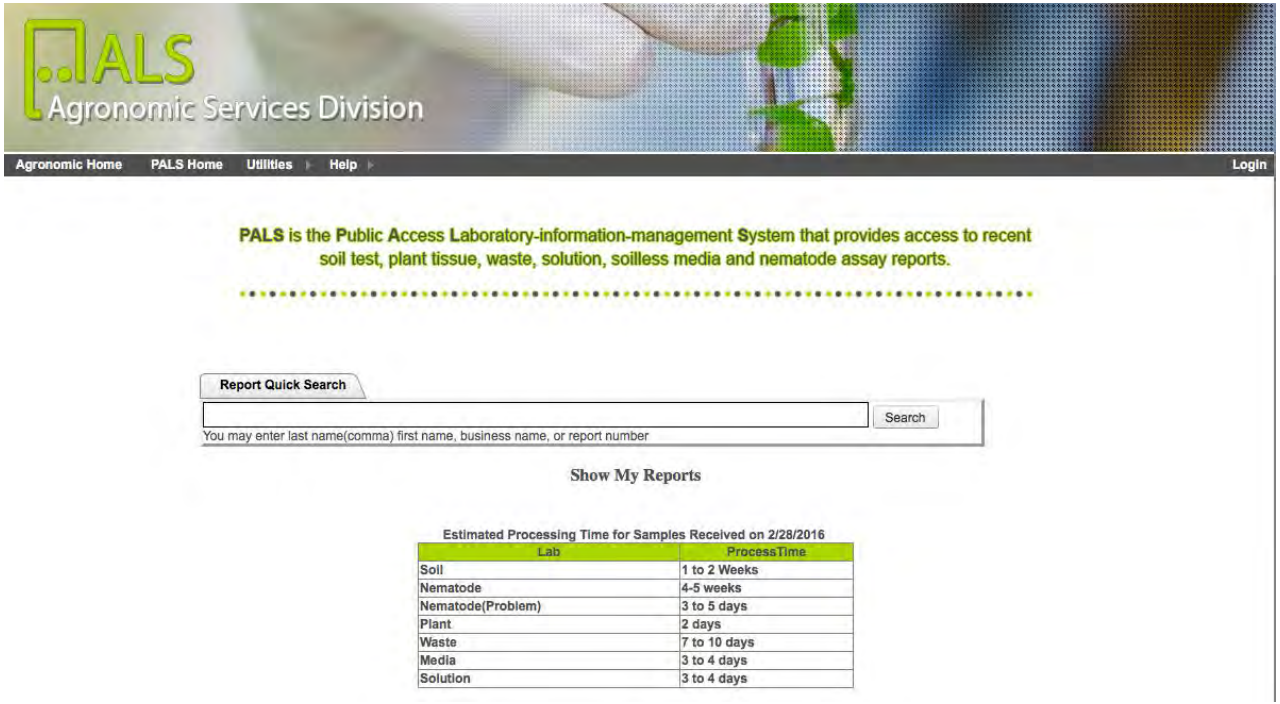
- Compost piles
- Burn piles
- Animal ‘minefields’

Take 5-10 subsamples per area



Where to Find Sample Results

http://www.ncagr.gov/agronomi/pals/



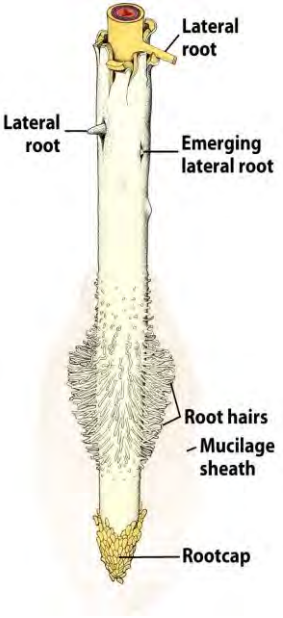
We will help your interpret the soil test report!

Plant Nutrients

- What is the difference between a food and a nutrient?
- What is “plant food” ?
- Nutrients are chemicals necessary for an organism's biochemistry
- Nutrients help a plant *make* food

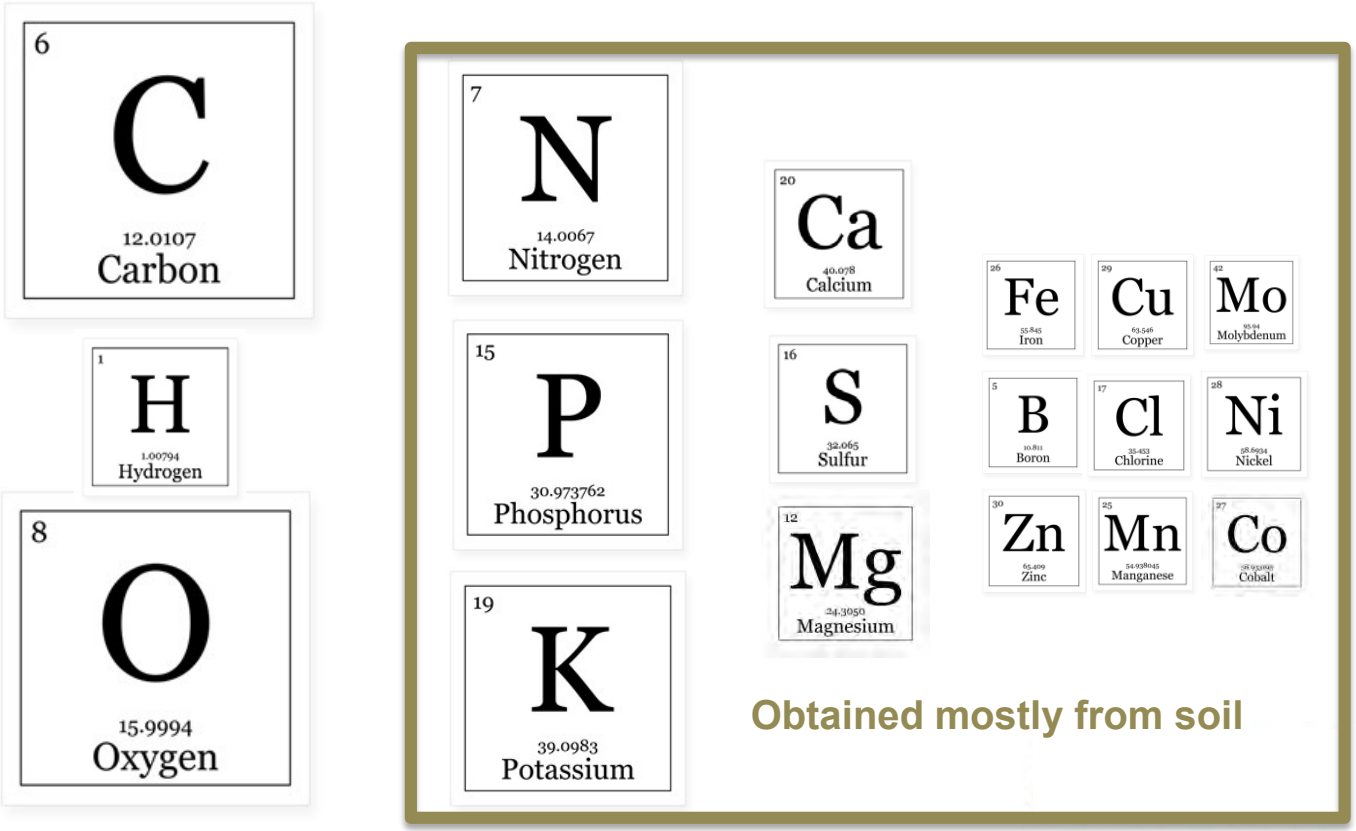
How do Plants Absorb Nutrients?

- Roots absorb water and nutrients *dissolved in water*
- Cannot absorb solid pellets!
- What happens when the soil is dry?
- Roots must be healthy to absorb nutrients



Raven *et al. Biology of Plants 7th ed.* 2005

The Macro- and Micronutrients



Nutrient Deficiencies

Univ. of Arizona

Marginal Chlorosis

Interveinal Chlorosis

Some nutrient deficiencies (and toxicities) are symptomatic in leaves

Generally distributed evenly throughout the plant

- Not on one stem
- Not in circular spots

Consider

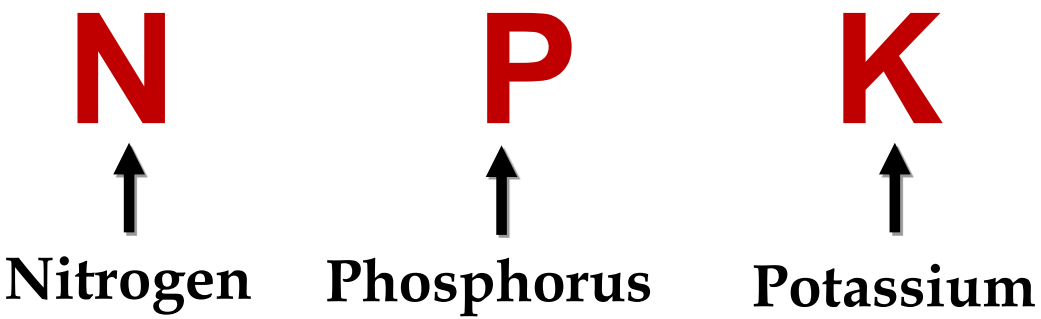
- Chlorosis or necrosis
- Entire leaf, margin, or interveinal
- Older or younger leaves

Mobile nutrient:
Deficiency on older leaves

Immobile nutrient:
Deficiency on younger leaves

Fertilizer Nutrient Analysis

Number on the bag represent % of:



For a 100 pound bag of fertilizer:

10 – 5 – 15

= 10 lbs. N, + 5 lbs. P, + 15 lbs. K, + 70 lbs. filler

Fertilizer Nutrient Analysis

Fertilizers with the same ratio are substitutable, but must change application rate.

For example:

- 5 lbs of 10-20-10 is equal to 10 lbs of 5-10-5
- 10 lbs of 5-10-10 is equal to 5 lbs of 10-20-20

Analysis	Ratio
10 - 10 - 10	1 : 1 : 1
5 - 10 - 5	1 : 2 : 1

Natural Fertilizers

Derived from natural sources

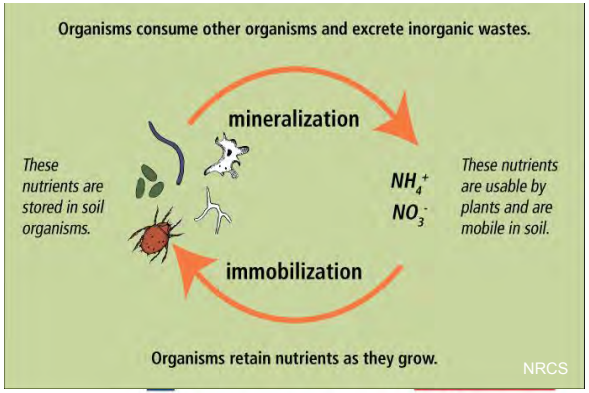
- Composts and manures
- Mined minerals
- Animal byproducts

Nutrient content

- Required on label if sold as fertilizer
- Not required if sold as bulk organic materials

Depend on soil microbial activity

- Mineralization of compounds into forms roots can absorb: **slow release**
- Nutrient content varies with age



Common Natural Fertilizers

- Dried Blood Meal ~10-0-0
  - Could burn
- Fish Emulsion 10-6-2
  - Strong odor
  - Trace micronutrients
- Poultry Manure 4-4-2
  - MUST BE COMPOSTED
- Rock Phosphate 0-3-0
- Wood Ash 0-2-6, 25% Ca
  - Raises pH

See Table 17-2 of the Organic Gardening Chapter of the NC Extension Gardener Handbook

Table 17–2. Organic fertilizers[abc]

Items below are generally acceptable under the NOP for commercial organic farmers, unless otherwise noted.

Fertilizer	Primary Benefit	Average Analysis	Notes
Alfalfa meal	Organic matter	5–1–2	Contains triacontanol, a natural fatty acid growth stimulant, and trace minerals.
Algae	Organic matter	N/A	Includes photosynthetic organisms of the Kingdom Protista typically found in aquatic or shoreline environments. Algae do not have true roots, stems, or leaves. Organic Materials Review Institute (OMRI) approved.
Amino acid (nonsynthetic)	Chelating agent	N/A	A chelating agent improves plant uptake of a nutrient. Also used as a plant growth regulator.
Ash	Liming effect, source of calcium, micronutrients	25% calcium carbonate; 9% potash	Ash from plant or animal sources only. Ashes from burning minerals, manure, or other substances are prohibited.
Basalt dust	Micronutrients	N/A	Improves cation exchange capacity.
Blood meal (dried)	Nitrogen	10–0–0	Dried blood collected from slaughtered animals. One of the highest non-synthetic forms of nitrogen. Over-application can burn plants with too much ammonia.
Bone meal (steamed)	Phosphate	3–15–0; 20% total phosphate; 24% calcium	Ground animal bones that have been steamed under pressure, heated, or rendered sterile. Bone meal phosphorus is only plant-available in soils lower than pH 7. Widely available at feed stores.
Borax	Trace minerals	10% boron	Also known as sodium tetraborate.
Calcitic limestone	Calcium	65–80% calcium carbonate	Mined calcium carbonate.
Coffee grounds	Nitrogen	2–0.3–0.2	Acid-forming soil amendment. Needs limestone supplement.
Colloidal phosphate	Phosphate	0–2–2	
Compost (commercial or homemade)	Organic matter	Varies with components added	The product of a managed process through which microorganisms break down plant and animal materials into plant-available soil nutrients. Composted materials produced in vessels or static aerated piles must be maintained at a temperature between 131° F to 170° F for 3 days. Windrow systems must maintain at the above temperature for 15 days and turned at least 5 times. NCDA&CS waste analysis recommended if fertilizer content unknown.

https://content.ces.ncsu.edu/extension-gardener-handbook/17-organic-gardening

Synthetic Fertilizers

Derived from industrial sources

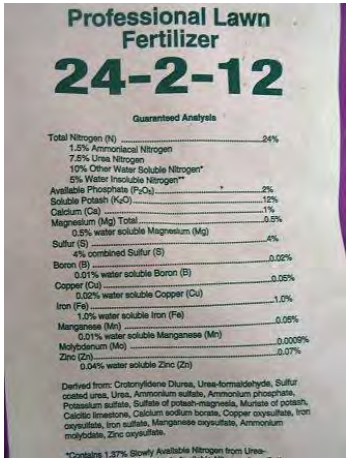
- Less monetarily expensive, much more energy intensive

Nutrient content

- Precisely known, measured and labeled
- Many formulations

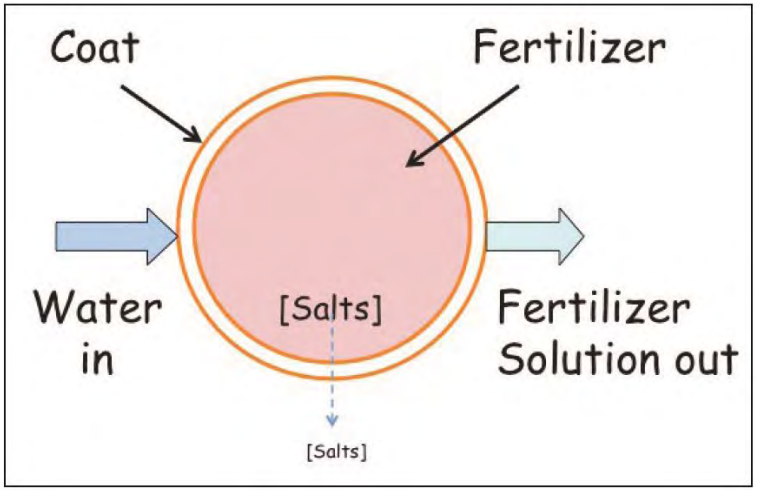
Purified, mixed and blended

- Skips the microbial mineralization process
- Can be absorbed by plants immediately unless in slow release coating



Slow & Controlled Release

- Released into soil over a longer period of time
- Used more efficiently by plants
- Natural fertilizer release rate depends on microbial activity
- More expensive



Quick Release

- Available for immediate root uptake
  - Granulated
  - Liquid
- More like to leach from soil
  - Waste
  - Pollution
- More likely over apply and cause ‘burning’
- Less expensive

Fertilizing Vegetable Gardens

Fertilize based on soil test recommendations

- Row gardens: 2/3 broadcast, remainder banded
- Raised beds: broadcast, scratch or rake in
- Make sure fertilizer is watered-in before planting

Banding Fertilizer

Fertilizing Vegetable Gardens

Some crops require “side-dressing” later in the season

- Cabbage, peppers, potatoes, squash, sweet corn, tomatoes, and okra
- Apply approx. 1 Tbsp. high N fertilizer per plant about halfway through growing season
  - Corn gluten meal, bloodo meal, etc

- See Extension Gardener Handbook online for complete lists

Cool Season Crops

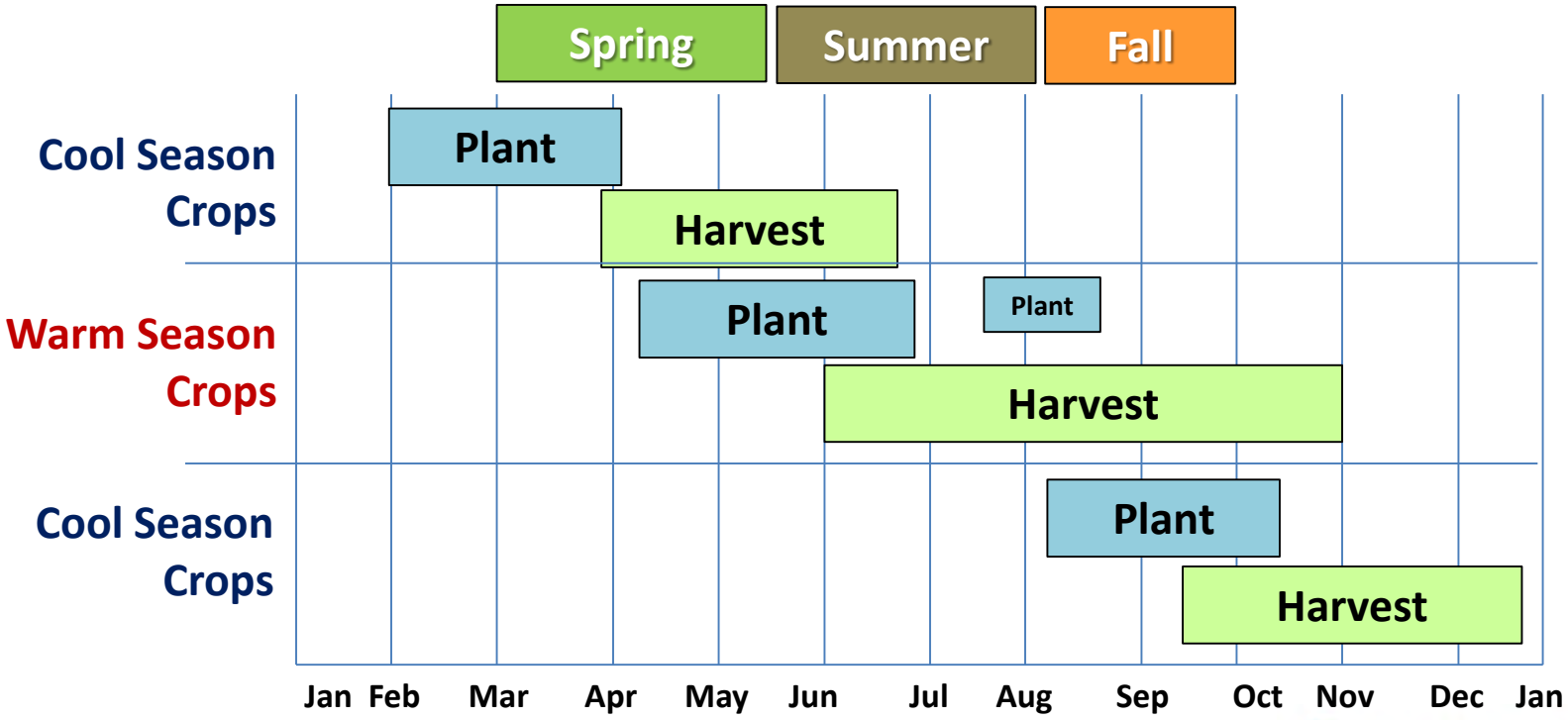
Cold-hardy and planted in early spring or early fall, when temperatures are below 70º F

Warm Season Crops

Frost-sensitive crops planted after last freeze.

Thrive in temperatures are above 70º F

Planting Seasons



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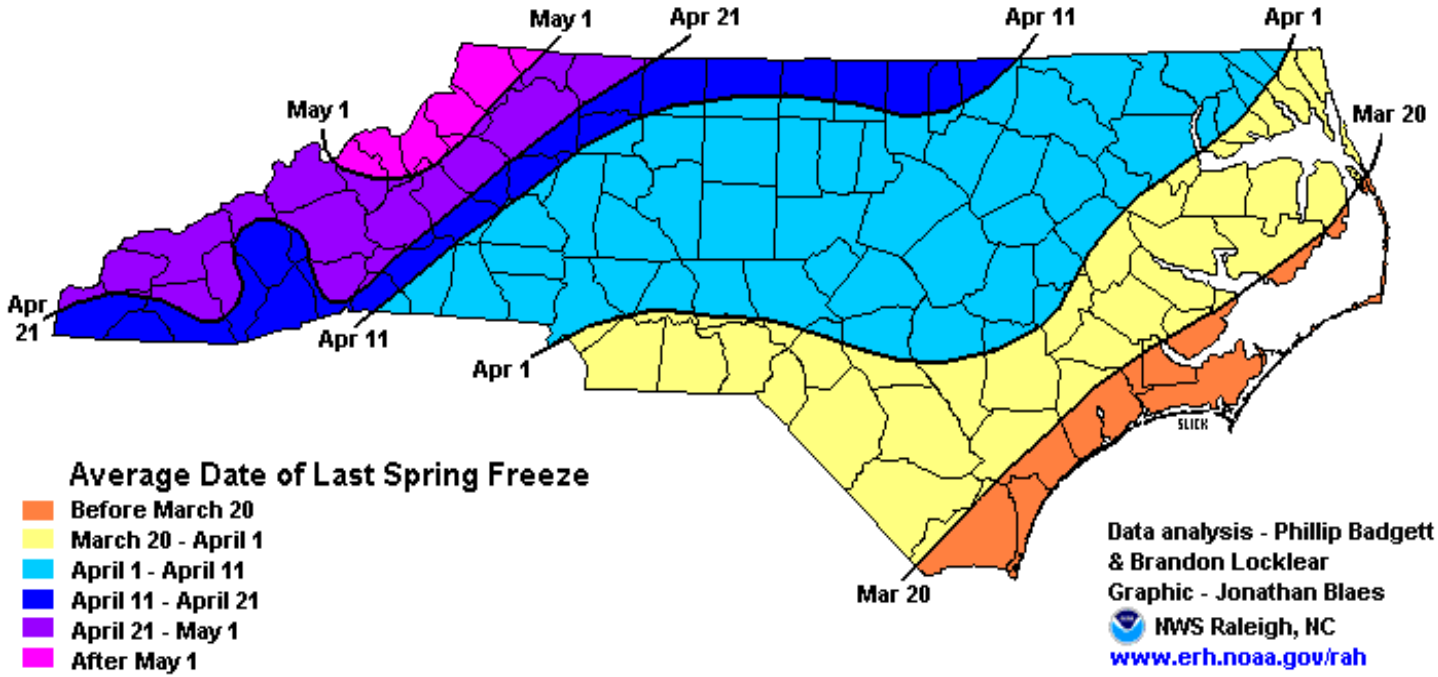
Average Last Frost Date



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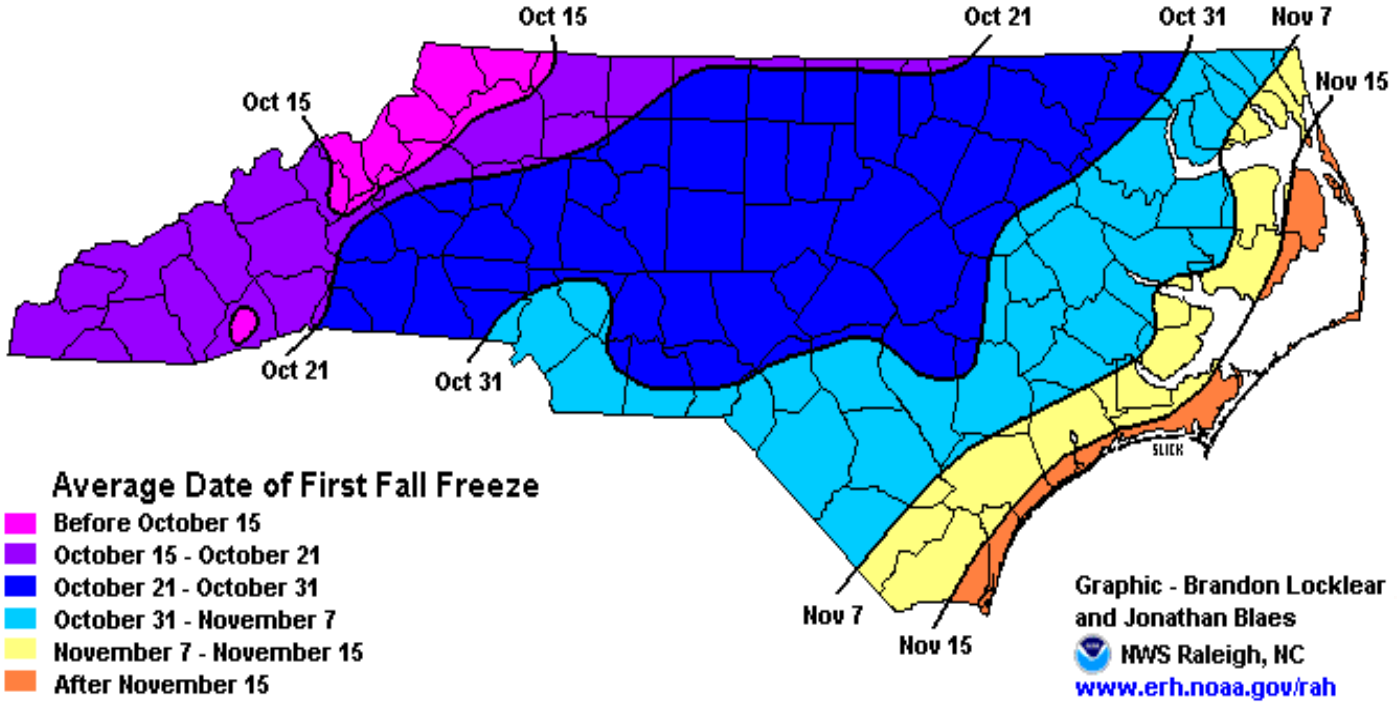
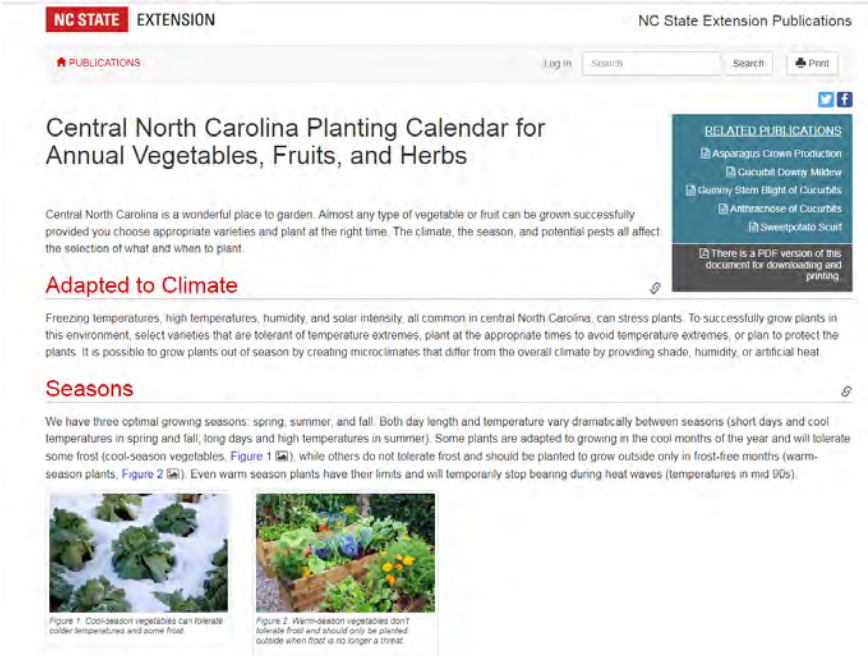
Average First Frost Date



Planting Calendars

- Use Extension planting calendars
- Do not rely on seed packets for regionally-accurate information!
- Refer to direct planting, not seed starting



NC STATE EXTENSION

NC State Extension Publications

PUBLICATIONS

Log in Search Search Print

Central North Carolina Planting Calendar for Annual Vegetables, Fruits, and Herbs

RELATED PUBLICATIONS

- Asparagus Crown Production
- Cucurbit Downy Mildew
- Gummy Stem Blight of Cucurbits
- Anthracnose of Cucurbits
- Sweetpotato Scurf

There is a PDF version of this document for downloading and printing.

Central North Carolina is a wonderful place to garden. Almost any type of vegetable or fruit can be grown successfully provided you choose appropriate varieties and plant at the right time. The climate, the season, and potential pests all affect the selection of what and when to plant.

Adapted to Climate

Freezing temperatures, high temperatures, humidity, and solar intensity, all common in central North Carolina, can stress plants. To successfully grow plants in this environment, select varieties that are tolerant of temperature extremes, plant at the appropriate times to avoid temperature extremes, or plan to protect the plants. It is possible to grow plants out of season by creating microclimates that differ from the overall climate by providing shade, humidity, or artificial heat.

Seasons

We have three optimal growing seasons: spring, summer, and fall. Both day length and temperature vary dramatically between seasons (short days and cool temperatures in spring and fall; long days and high temperatures in summer). Some plants are adapted to growing in the cool months of the year and will tolerate some frost (cool-season vegetables, Figure 1), while others do not tolerate frost and should be planted to grow outside only in frost-free months (warm-season plants, Figure 2). Even warm season plants have their limits and will temporarily stop bearing during heat waves (temperatures in mid 90s).

Figure 1. Cool-season vegetables can tolerate colder temperatures and some frost.

Figure 2. Warm-season vegetables don't tolerate frost and should only be planted outside when frost is no longer a threat.

https://content.ces.ncsu.edu/central-north-carolina-planting-calendar-for-annual-vegetables-fruits-and-herbs

Table 1. Garden Planting Calendar for Annual Vegetables, Fruits, and Herbs in Central North Carolina (continued)

Fruit, Herb, or Vegetable	Days to Harvest (from seed unless otherwise noted)	Distance Between Plants (inches)	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15
Collard greens	T = 32–72 S = 60–100	18				T	T	T	T	T	T	T	T	T		S, T	S, T	S, T	S, T							
Corn, sweet	85–90	12						S	S	S	S	S														
Cucumbers	T = 28–37 S = 56–65	12								S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T									
Dill	40–55	2–4						S									S	S	S							
Eggplant	T = 90–95 S = 150–155**	24								T	T	T	T				T	T								
Fennel, Florence	60–90	6–12					S	S	S	S					S	S	S	S								
Garlic	B = 180–210	4–6																		B	B	B	B	B		
Kale	T = 14–22 S = 40–50	6				S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T			S, T	S, T	S, T	S, T						
Kohlrabi	T = 22–32 S = 50–60	4				S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T			S, T	S, T	S, T							
Leek	T = 50–80 S = 120–150	4				S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T	S, T												
Lettuce, head	T = 45–60 S = 70–85	10			S	S	S	T	T	T								S	S	T	T					
Lettuce, leaf	T = 15–25 S = 40–50	6			S, T	S, T	S, T	S, T	S, T	S, T							S, T	S, T	S, T	S, T						
Melons, cantaloupe	T = 57–62 S = 85–90	24								S, T	S, T	S, T	S, T	S, T	S, T											
Melons, watermelon	T = 62–72 S = 90–100	60								S, T	S, T	S, T	S, T	S, T												
Mustard	30–40	2				S	S	S	S	S	S	S	S	S			S	S	S	S						
Okra	T = 18–28 S = 60–70	12									S, T	S, T					S	S								
Onions, bulb	B = 75–105 S = 90–120	4	S	S	S	S	S, B	S, B									S	S	S	S	S	S	S	S	S	S
Onions, green	T = 42–56 S = 60–70	1–2			S	S	S, T	S, T										T	S, T							

Planting Seeds

- Less expensive
- Much greater variety
- Sow directly into garden or in containers

Planting Seeds

- Plant in well prepared, moist soil.
  - Water 4-6 in., allow surface to drain
  - Water required for germination
  - Damping-off diseases
- Plant according to recommendations
  - Depth = 1-2x diameter, deeper in fall
  - Space closer, then thin seedlings
- Seed directly in the garden, or in containers for later transplanting
- Cover and firm (not pack) soil

Thinning Seedlings

When in doubt…

DECAPITATE!

Thin to recommended spacing by snipping with scissors

Seedlings/Starts/Transplants

- Small/young plants
- Easy – higher rate of success
- Good when only need a few plants
- Grow your own transplants – sow seed 4-6 weeks early

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Want more information on seed starting?

go.ncsu.edu/veggieseedresources

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Purchasing Transplants

Look for stocky plants with well-developed roots and no flowers

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Planting Transplants

1) Moisten container

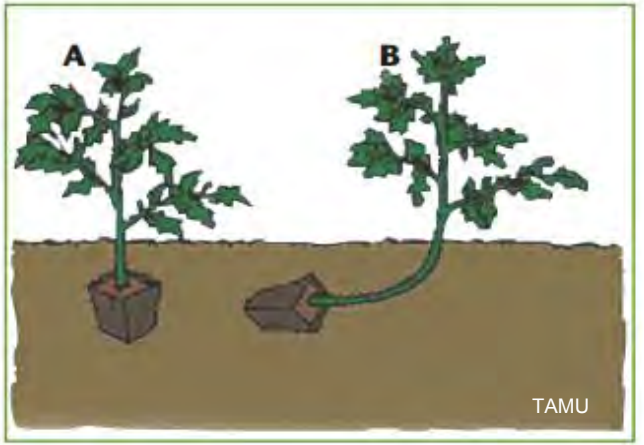
2) Remove from pot carefully, preserving roots

3) Dig a hole same depth as container

4) Row covers or other protection from wind, sun (summer)

Planting Tomatoes

- Tomatoes produce adventitious roots on stems
- Burying stems promotes root formation
- If the plant is 6-10 in. tall, remove all but upper 3 sets of leaves
- Bury stem below leaves



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Planting Tomatoes

Plant ‘leggy’ tomato transplants horizontally

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How Vegetables are Typically Planted

	Seed Sown Direct	As Transplants
Warm Season	• Beans and Field Peas • Peanuts • Sweet Corn	• Tomatoes • Peppers • Eggplants • Sweet Potatoes • Okra • Basil
Cool Season	• Radish • Rutabaga • Turnips, Mustard • Carrots • Beets • Garden Peas • Potatoes (seed potatoes)	• Broccoli, Cauliflower • Cabbage, Collards • Kale • Garlic – cloves

Both ways: lettuce , spinach, parsley, dill, cilantro, onions cucumber, squash , zucchini, melons

Charlotte Glen
NCSU Chatham

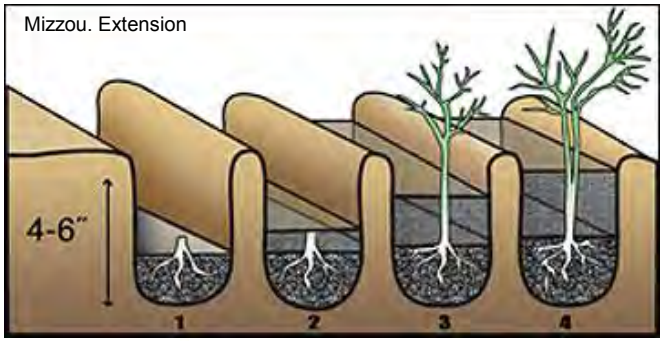
Other Vegetable Propagules

- Certified ‘seed’ **potatoes**
  - Tubers
  - Store bought not recommended
- Cut to size of an egg, 1-2 ‘eyes’ per piece
- Allow to heal for a few days before planting 4-6 in. deep

Other Vegetable Propagules

Asparagus usually planted as ‘crowns’

- 1-year old plants grown from seed by nurseries
- Plant 4-6 inches deep, cover with 2 inches with soil
- Add soil as ‘ferns’ emerge
- Cut down after fall frost
- Do not start harvesting spears until the following year



Other Vegetable Propagules

Garlic is planted as individual cloves

- Purchase certified, disease free garlic from catalogs, online, or garden centers
- 1 inch deep, 4 inch spacing

Weed Management

Weeds

- Weeds steal **sunlight, water and nutrients** from plants
- Can harbor **insect pests** and **reduce air circulation**
- Start weed control **before weeds get out of control!**

Too late for weed control!

Weedy Lifestyles

Perennial Weeds

- **Live for multiple years**return from same roots
- **More difficult to control** – eliminate with herbicides before planting
- Most are able to sprout from **root segments**

Annual Weeds

- Germinate, grow, flower, set seed, die **all in one season**
- **Easier to control** – to break cycle, control before they flower and set seed
- **Seeds** this year become next year's weeds

Weed Management

No magic bullet!

Use a combination of methods:

- **Eliminate perennial weeds before planting!**
- **Mulch** minimizes annual weeds
  - 1”-2” layer of ground leaves, straw, ground pine bark in beds
  - Wood chips, hardwood mulch, leaves, pine straw for rows

Mulch beds and rows

Hand Weeding

- Weeds compete for water, light, and nutrients
- Scout frequently and remove young weeds
- Remove roots, if possible

Weeding Knife = Matt's friend

Cultivation

Hoeing and Tilling

- Target young annual weeds
- Hoe as shallow as possible
- Perennial weeds can be spread by cultivation

Scuffle Hoe

Herbicide Injury

Glyphosate Injury
Bleaching of young leaves

2-4, D injury
Twisting, strapping,
cupping of young leaves

Deer and Other Critters

- Fencing only effective method of keeping critters out
- Complete enclosure
- Deer will search for openings!
- At least 8’ tall if not electric
- Extend 6” into soil

Wire Mesh Fencing

Electric Fencing

- Single wire at 30” or double wires, 18” and 36”
  - Bait with peanut butter
- Offset and slanted designs
  - Take advantage of poor depth perception
- Design diagrams:
  - NCWRC
  - Controlling Deer Damage
  - Wildlife Damage Mgmt


Offset electric fence


Slanted fence

Deer Repellents

- **Most cannot be applied directly to edible plants**
- Can apply a band around garden perimeter **if low deer pressure**
- **Scare devices** – effectiveness reduced over time as deer get use to them

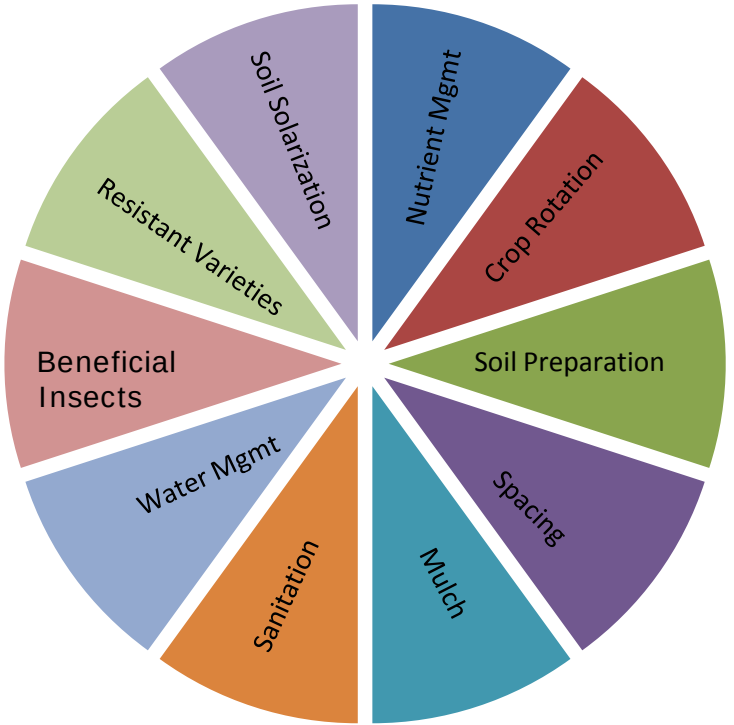
ScareCrow Deer Sprinkler

Managing Insects and Diseases

- **If you plant it, they will come!!**
- **Scout** regularly to find problems before they become widespread
- Most insects and diseases **are host specific**

Integrated Pest Management:

- **Maximize Plant Health**
  - Build healthy soils!
  - Sanitation
  - Plant selection
  - Reduce stress
- **Encourage Beneficial Insects**
- **Treatment when necessary**
  - » Natural/less toxic products

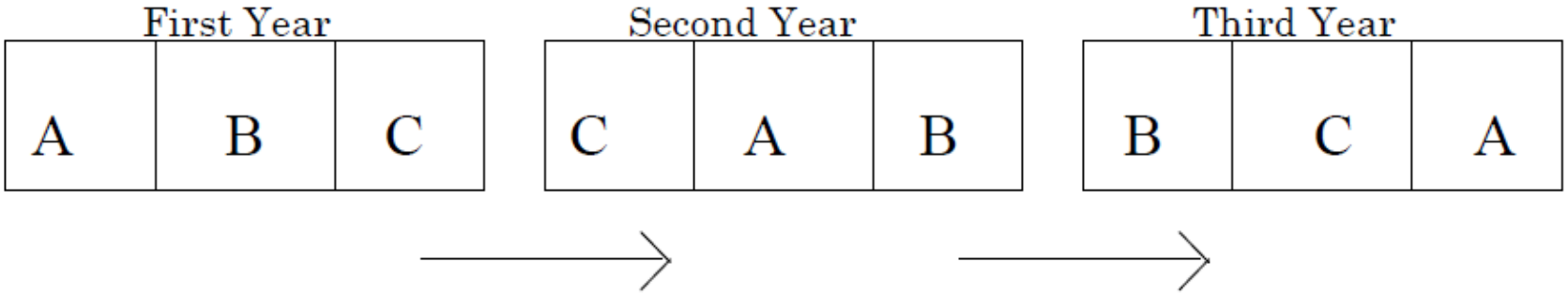


Best Practice to Avoid Pests

- **Start with a good site**
  - Sunny and well drained soil
- **Support healthy growth!**
  Prepare soil – add organic matter/compost
  - Adds some nutrients
  - Increases soil's ability to hold nutrients and moisture
  - Improves drainage
  - Supports beneficial microbes

Crop Rotation

- Avoid planting crops in the same family in the same location year after year
- **Minimum 3 year** rotation ideal
- Include **cover crops** in rotation
- Requires **planning and record keeping**!



Plant Families

Brassicaceae (Mustard Family):

- Broccoli, Brussel Sprouts, Cauliflower, Cabbage, Collards, Kale, Mustard, Radish, Turnips, Rutabaga, Kohlrabi

Cucurbitaceae (Squash Family):

- Cucumbers, Squash, Zucchini, Winter Squash, Pumpkins, Cantaloupe, Watermelons

Solanaceae (Nightshade Family)

- Tomatoes, Peppers, Eggplant, Potatoes

Fabaceae (Bean Family)

- Garden peas, peanuts, green beans, lima beans, southern peas

Plant Families

Amarylidaceae (Onion Family)

- Onions, garlic, leeks, scallions

Apiaceae (Carrot Family)

- Carrots, parsnips, dill, fennel, parsley, cilantro

Amaranthaceae (Amaranth Family)

- Spinach, Swiss Chard and Beets

Vegetables with no close relatives:

- Lettuce, endive (Asteraceae)
- Sweet Corn (Poaceae)
- Sweet Potato (Convululaceae)
- Okra (Malvaceae)

Diversity

- Avoid placing all plants of one kind together
- If space, plant in different areas of the yard
- Alternate groups of different plants within rows or patches
- **Flowers help attract beneficials and confuse pests**

Variety Selection

- Choose **resistant cultivars** when possible – research possible diseases and resistant varieties
- Purchase **disease- & insect free** - plants
- Select crops that have less known pest problems/pests that can be effectively controlled organically

White firm roots = Healthy

Brown soft roots = Unhealthy

Planting Dates

Optimum for crop

- cool season
- warm season

Avoid known pest problems by planting early or late.

Corn earworm is more severe in late crops , plant as early as possible

Proper Spacing

Plan for mature size

- Allows air flow between plants to **promote drying** & prevent disease
- **Allow adequate space to minimize:**
- Competition for water, nutrients, & light
- Habitat for pests

Proper spacing depends on mature size of plant – most plants do best when leaves just touch at full size

Watering

- **Application method: avoid wetting leaves**
  - Most leaf diseases require 4 hrs + of continual leaf wetness to infect
- Keep top 6-8” of soil moist to **prevent stress**

Drip irrigation delivers water through pipes directly to the soil – helping with disease and weed management

Exclusion

- Floating row covers can keep **flying adult insects** from laying eggs on vegetables**Will also keep out pollinators** – not an issue for leafy crops
- **Cover when insects are active** – stake down edges
- Lay directly onto crop or install PVC supports

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Handpicking

- **Inspect** plants for egg clusters and insect pests
- Squish or drop them in soap water
- Remove diseased leaves early

Sanitation

- **Pull out infested plants early!**
- Remove infected leaves
- **Clean up crop debris at end of season**
- Do not compost unless reaching 140 degrees

Soil Solarization

- **Kills weed seed, diseases and insects** in soil surface (3”-4”)
- Till beds, water, and cover with clear plastic **for 6-8 weeks in July-August**
- **Disturb soil as little possible afterward** to avoid bring untreated soil up to the surface.

Protect and Encourage Beneficials

- **Plant flowers** to attract pollinators and beneficial insects

Best flowers for beneficials:

- **Herbs:** fennel, dill, cilantro, basil, lemon balm
- **Flowers:** purple coneflower, black eyed susans, salvias, *Asclepias*, Zinnia, Yarrow
- **Cover Crops**: buckwheat, hairy vetch

Protect and Encourage Beneficials

- **Minimize use of pesticides**
- Most synthetic insecticides are very harmful to beneficial insects and pollinators
- Organic insecticides are less harmful because they have **less residual activity**

Hover Fly adults look like bees or wasps

Beneficials

- Learn to recognize all **life stages** of beneficials
- **Must have pests** as food source – strive for balance
- Pest levels may build up to damaging levels before beneficials provide effective control

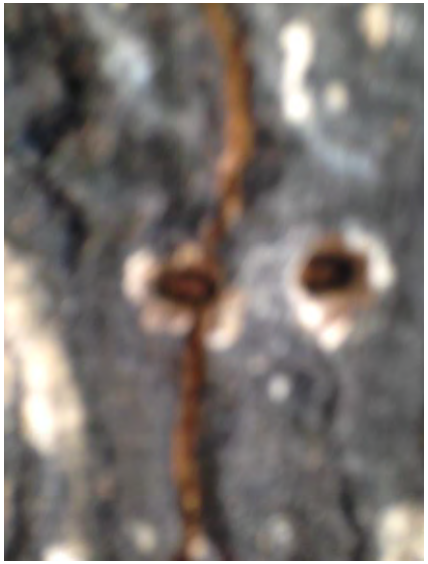
Hover fly larvae look like small slugs or caterpillars – voracious aphid eaters

Don’t know what it is?

Send us a photo or bring in a sample!

- chathamemgv@gmail.com
- matt_jones@ncsu.edu

- Samples: in bag with plant, or in ethanol



Diagnosis: cataracts?

Once Problem Correctly ID'd

Choose appropriate product – active ingredients can be:

- **Synthetic** = man-made
- **Natural** = derived from naturally occurring materials
  - Minerals
  - Plants
  - Microbes
  - Soaps and Oils

Read and follow label directions for ALL products!

Always Read the Label

The label is the law! It includes:

- **Directions** for mixing/application
- Where the product can be legally used/what type of plants can be treated
- **Pre-Harvest Interval** – how long you have to wait after treating to harvest
- **Environmental hazards** – including bee warnings
- **First aid**

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How Do You Know if a Product is Organic?

- **Active ingredients** listed on the label
- **OMRI listed** – approved for use by certified organic farmers
- **Some products have natural active ingredients but are not OMRI approved**

OMRI™ Listed
Organic Materials Review Institute

Active ingredients are listed on the label

Pesticides and Beneficials

- **Insecticides most toxic** pesticides to beneficials and pollinators
- Check for beneficials and bees before spraying
- **Apply pesticides late in evening once bees have returned to hive**
- Use natural products when possible – less residual activity

Characteristics of Organic Pesticides

Not persistent

- Break down quickly, sometimes in a day
- Most are much safer to beneficials!

No residual activity or systemic uptake

- Must reapply often

Insecticides kill by contact or ingestion

- Thorough coverage essential
- Pest must be present

Treat after insect pests are present – re-treatment usually necessary

Insecticidal Soaps & Horticultu

Insecticidal Soap

- Soft body pests: aphids, whitefly, mites
- Kills only what it contacts – not eggs
- Repeated applications often necessary

Horticultural Oil

- Kills by smothering,
- Kills all life stages (eggs must be exposed)
- Scale, spider mites, aphids, whitefly
- Can damage plants at high temperatures

No residual activity for either

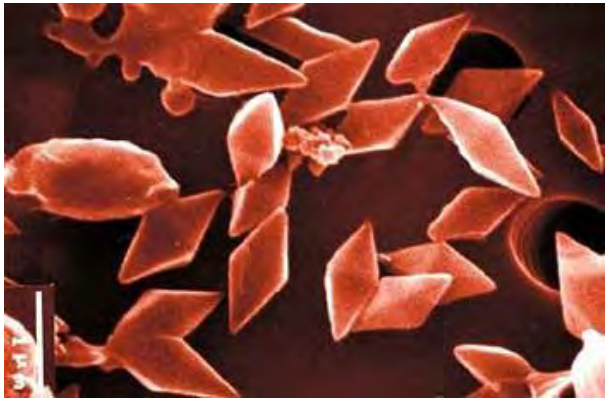
Pyrethrin

- **Broad spectrum** – helps control many pests
- **More harmful to beneficials** than most organics
- Many synthetic insecticides are based on Pyrethrin

B.t.– *Bacillus thuringiensis*

- Derivied from soil bacteria
- Sporulate and produce toxin

- Must be ingested
- Stop feeding within a few hours, slow death



Neem Oil

- Derived from Neem tree seed oil
- Over 70 cmpds, **Azadirachtin** believed most active
- **Controls** aphids, mites, thrips, whitefly
- May help control powdery mildew
- Primarily acts as **growth regulator** – works best on young insects
- Breaks down in sunlight

Spinosad

Developed from soil dwelling bacterium

- Causes death within a few days
- A little more persistent than B.t. and neem (3-5 days)

Effective against

- **Caterpillars,**
- **Colorado potato beetle,**
- **Fire ants (baits)**

Natural Disease Control Products

- **Protect plants** from disease as part of integrated system
- **New growth protected**
- **Neem and oils** may have some effect on diseases, particularly powdery mildew

Minerals

Sulfur

Fungal disease control

Copper

Fungal and bacterial diseases

- Contact protectant
- Apply carefully - Leaf damage can occur

Natural Fungicides

- ***Bacillus subtilis***
  - For leaf diseases
- **Potassium bicarbonate**
  - Especially effective for powdery mildew
  - Sold as ‘Remedy’ and other brands
- **Must apply at first symptoms!**

Serenade is one brand name of B. subtilis

Cucumbers

***Cucumis sativus* (Cucurbitaceae)**

- Native to India
  - Cultivated in Mediterranean for 4000 years
- Fruit is called a *pepo*
- Vining growth habit with shallow roots
- Monoecious flowers

pfaf.org

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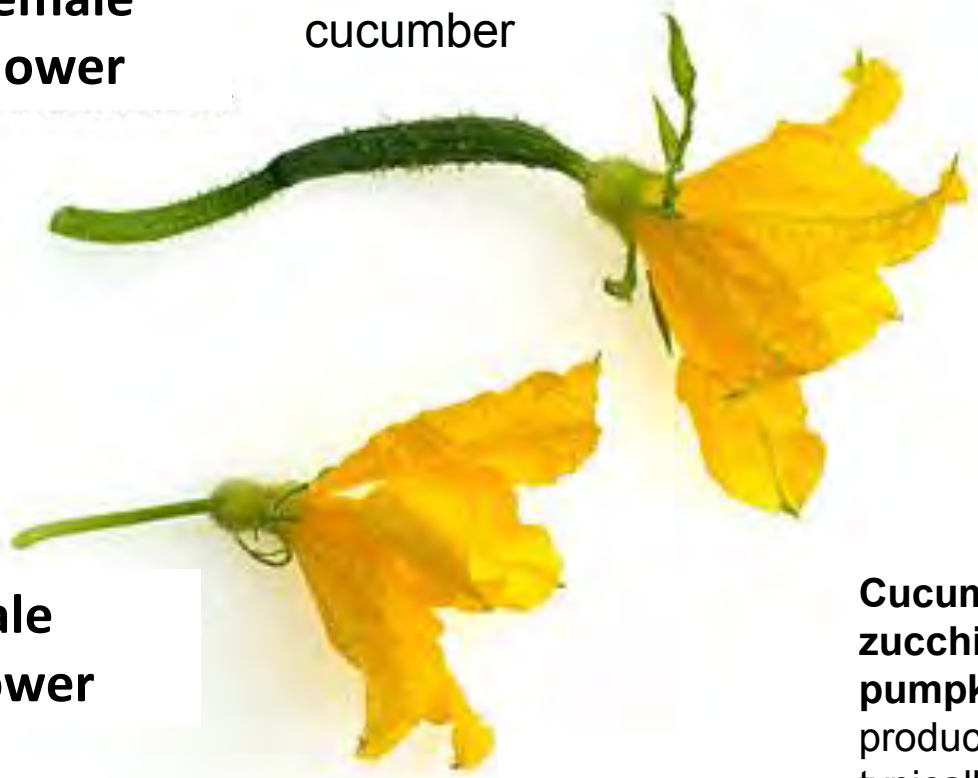
Female Flower

Young fruit of cucumber



Male Flower

Photography: Neil Bromhall

Charlotte Glen
NCCE Chatham Co.

Cucumbers, squash, zucchini, melons, pumpkins – male flowers produced first few weeks, typically more male than female flowers

Types of Cucumbers

Slicers

Pickling

Armenian

Cucumbers naturally produce *cucurbitacins* that deter insect (and human) herbivores

“Burpless” cucumbers lack cucurbitacins.

Planting Cucumbers

Seed

- ½ in deep
- Spreading
  - 2 in. spacing, thin to 8-12 in. spacing, rows 5 ft. apart
  - Or hill 3-4 seeds
- Trellising
  - 4-5 seeds/foot, 3 ft. between rows
  - This to 9-12 in spacing when vines are 4-5 in. high
  - Remove lowest 4-6 runner stems

Transplants

Harvesting Cucumber

- Ready in 50-70 days after planting
- Pick frequently
  - Avoid oversized fruit
  - Promote production of more fruit
- Typically at least 2 in. long
- Pick before turning yellow

Squash Vine Borer

- Attack squash and zucchini in May/June and August
- **Plant as early as possible** – early April
- Crop rotation helps, but adults fly
- **Spray** Pyrethrin, Neem (organic), or Permethrin (synthetic) beginning mid-May, every 7-14 days, lower part of stem

Sweet Corn

- Plant early April
- **Wind pollinated**
- Plant in blocks of at least 3-4 rows
- Require lots of Nitrogen (slow release)
- **Drought sensitive!**
- Plant in soils with plenty of organic matter

Plant Early!

- Seedlings tolerate light frost – can sow late March
- **Corn earworm** is more severe in late crops – plant early
- One harvest per stalk - Stagger plantings every 2 weeks

Sweet Corn

Sugary Varieties (SU1)
- Traditional – sugars break down quickly
- Silver Queen, Seneca Chief

Sugary Enhanced (Se)
- Higher levels of sugar
- Bodacious, Legend

Super-sweet Varieties (sh2)
- More sugar than SU1 and does not break down rapidly
- Serendipity

These are not GMO!

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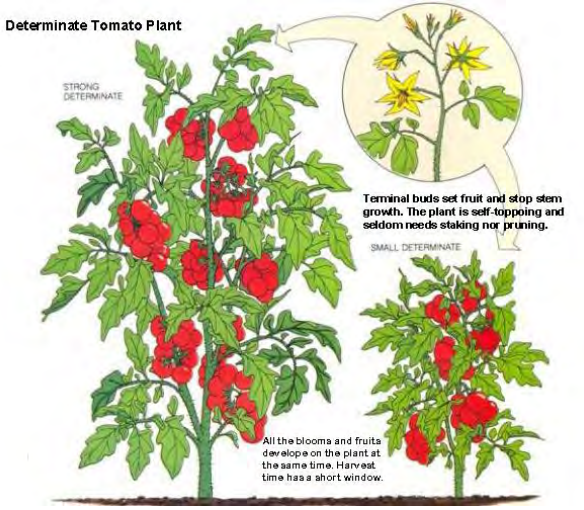
Tomatoes

- **Plant mid April/May –** earlier with frost protection
- **Space plants 3' apart**
- **Cage** or stake tomatoes at planting time
- Avoid planting tomatoes in **same location** year after year
- Plant **multiple varieties**
- Plant in a couple of **different locations**

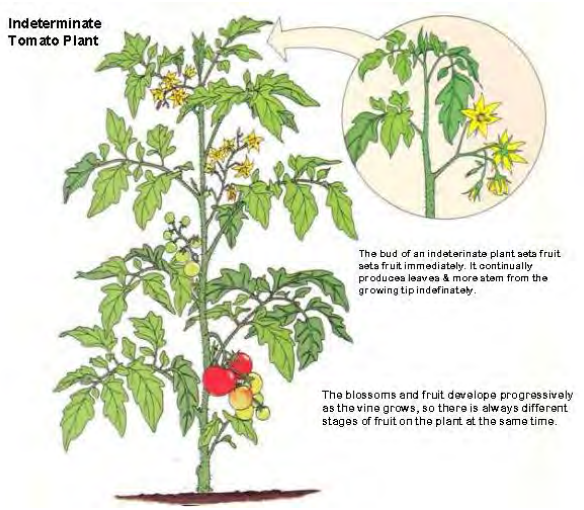
Tomato Growth Habits

Determinate



- Grow 1-5’ tall, then stop
- Flowers between each leaf and end of each stem
- Ripen simultaneously
- Hybrid and heirloom

Indeterminate



- Grow continuously until frost, 5-8’
- Flower on every third leaf
- Hybrid, heirloom, and cherry

Heirloom Tomatoes

- Local selections that have been preserved over the years
- **Flavor but little disease resistance**
- Some better adapted to south than others:
  - **‘German Johnson’**, **‘Homestead’, ‘Cherokee Purple’, ‘Marglobe’**
- Most are **indeterminate**
- **Can save seed** – come “true to type”

Disease Resistance

- **Hybrids** developed for disease resistance
- Most important disease resistance to look for:
  - **V -** Verticillium
  - **F** - Fusarium
  - **N** - Nematodes
- **No tomato is resistant to all** (or even most) tomato diseases!
- **No resistance to most soil borne wilt diseases**

Reliable Hybrid Varieties

- **Cherry Tomatoes –** easiest!
  - **Sweet 100**, **Sweet Million**, and **Juliet** are favorites
- **Celebrity**
  - Determinate, F & N resistant
  - **Bush Celebrity** is good for containers
- **Better Boy, Early Girl**
  - Indeterminate, Better Boy - F & N resistant, Early Girl – F resistant
- **Big Beef**
  - Indeterminate, extra large fruit, F & N resistant
  - **Big Boy** is similar, NOT F,N resistant

'Juliet' Tomato

Tomato Relatives: Eggplant & Peppers

- Generally easy
- **Susceptible to wilt diseases**
- **Hot peppers and Eggplant** have good drought resistance
- **Sweet peppers** very productive when watered and fertilized
- Wait to plant when really warm (May)

Carrots

***Daucus carota* (Apiaceae)**

- Native to Eurasia
- Wild and culinary relatives
- Biennial
- Consume fleshy taproot

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Carrot Varieties

Imperator

Chantenay

Danvers

Nantes

Oxheart

Deep Purple

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Carrots

Planting and Establishment

- Feb-Mar., Mid June – Mid Sept
- Loamy-Sandy soils
  - Not in clay
  - Not in crusty soil
- pH 6.0-6.8
- Direct seeded
- 12-18in. x ¼ in. x 1/8-1/4in.
- Tiny seeds
- Thin to 2-3 in. by cutting when seedlings 2 in. tall

Carrots

Care and Cultivation

- 1-3 weeks to germinate
- No germination if soil temp. > 95 ° F
- Weed carefully!
- 70-80 days to maturation
- Reduce watering near harvest to prevent cracking

Carrots

Harvest and Storage

- Desired size for variety
- ¾ in. -1 ¼ in. diameter at shoulder
- Store at 33 ° F high humidity
  - 4-6 months
  - 10-14 days with tops
- Store in-ground with 1-2 in. extra soil over root tops

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Carrots

Common Problems

Aster Yellows
Virus spread by leafhoppers

Macrosteles quadrilineatus

Root-Knot Nematodes

Parsley Worm

= Swallowtail
Leave it alone!

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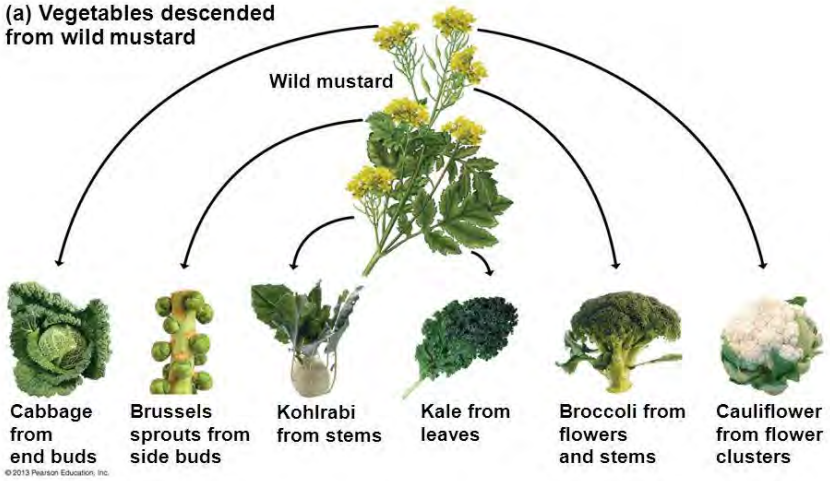
Broccoli

Brassica oleracea (Brassicaceae)

- Native to SW Europe as wild cabbage or mustard
- Diverse agricultural relatives
- Consume immature flower stalk



Broccoli Varieties

Heading Broccoli

Sprouting/Calabrese Broccoli

Broccoli Romanesco

Green Comet
Southern Comet
Many others…

Broccolini

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Broccoli

Planting and Establishment

- Mid Feb - Mid April (Spring)
- Aug – Mid. Sept. (Fall)
- Sandy-loam to loamy-sand
- pH 6.0-6.5
- Transplants best for home gardeners
- Space transplants 24-36 in. x 12-18 in.
  - Lower success with seeds
  - ½ - 1 in. deep

Broccoli

Care and Cultivation

- 70-80 days to maturation
  - May be slower in fall
  - Add 4 weeks for seeds
- Nitrogen hungry
  - Side dress 3-4 weeks after transplant
  - 1 lb./100 ft. 33-0-0
  - ¼ lb./10 ft. 10-10-10
  - Blood meal, feather meal, corn gluten meal
- Provide ample soil moisture
  - 1.5 in. / week

Broccoli

- Cut heads when 4-8” across
- Cut to include 6-8” of stem
- Leave plants in the ground
  - Produces side shoots
- Tolerates to 26 ° F
  - Heads more sensitive
  - High N more sensitive
  - May turn purple

NC COOPERATIVE EXTENSION

Broccoli

Common Abiotic Problems

Hollow Stem
Excess N (no color)
B deficiency (browning)

Bolting (blooming)

Buttoning
Small Heads

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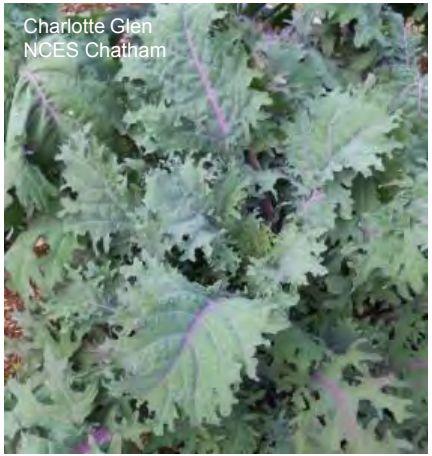
Kale

Brassica oleracea (Brassicaceae)

- Native to Eurasia
- Doesn't form heads like cabbage, no edible buds like broccoli
- Consume leaves
  - Cooked
  - Fresh
- Rich in vitamins, higher protein content than other crucifers

Types of Kale

‘Winterbor’



‘Red Russian’

‘Toscano’

‘Dwarf Blue Curled Vates’

Kale

Planting and Care

- Aug - mid Oct. (Autumn)
- Mid Feb. to June (Spring)
- Grow as baby green or to mature leaf size
- Well drained, fertile soil high in organic matter
  - pH 6.0-7.5
- Seeds: 3-4” x 1-2” x ½” (baby greens)
  - Re-sow every 2-4 weeks
  - Thin to allow more growth: 40-50 days
- Transplants: 2-3’ x 6”
- Check soil daily for top 3-4’ soil moist

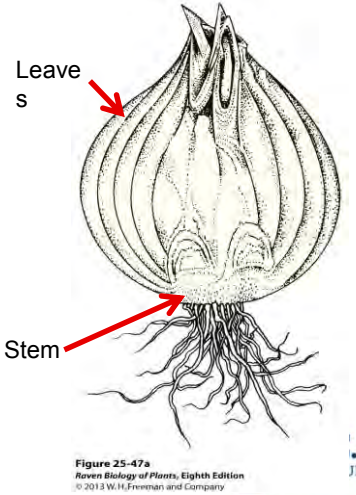
Onions

***Allium cepa* (Amaryllidaceae: Alloideae)**

- 500+ species of *Allium*, hundreds of cultivars
- Unknown, ancient cultivated origin
- Consume leaves
  - Green leaves above ground
  - Storage leaves below ground

Allium

Garlic, leek, chives, scallion, shallot



Types of Onions

Bulb Onions

- Bulb formation induced by changes in day length
- Long Day
  - Northern climates
  - Store well
- Short Day
  - Sweeter
  - Do not store well
- Intermediate Day

Green Onions

- Harvest leaves before bulb formation
- Any variety can be grown for green tops
- Some bred for green tops

Varieties of Onions

Bulb

‘Texas Super Sweet’

‘Red Grano’

‘Granex’ aka Vidalia

‘Candy Hybrid’

Green

‘Evergreen Bunching’

Onions

Planting and Establishment

- Bulbs
  - Aug – Feb.
- Green/Scallions (exclusively)
  - Late Aug. –Mid Sept.
- Rich, loamy soil with high organic matter
  - pH 6.0-6.5
  - Heavier soils produce hotter onions

- Seeds 1-2’ x 1(2)” x ½”
  - Thin to 3”- 4” within rows
  - Green onions!

Onions

Care and Cultivation

- 60-80 days to maturity
- May require sidedress in sandy soils
  - 12 lbs. 5-10-5 /1000 sq.ft. 1-2 weeks after bulb enlargement
  - ½ lb. sulfur
- Ensure good moisture
- Compete poorly with weeds
  - Cultivate shallowly

Onions

Harvest and Storage

- Gradually work soil away from top of bulbs 1 month before harvest
- By 1 week pre-harvest, about 1/3 of bulb exposed
  - Hastens bulb and neck drying
- Stop watering 1 week before harvest

- Harvest when about ¾ of tops fall over.
- Cut tops to 1-1.5 in.
- Harvest green onions when 6-8 in. tall

Onions

Common Problems

Onion Thrips

Onion Maggots

Types of Lettuce

Looseleaf

Crisphead a.k.a. Iceberg

Butterhead a.k.a. Bibb

Romaine a.k.a. Cos

Planting Lettuce

- Aug- Oct, Feb-Apr.
- Seed: ¼ in. deep
- Transplant
- 6-10 in. spacing
  - Or plant tightly in patches
- Make successive sowings every 2 weeks
- May be heavy nitrogen feeders
  - May require side dressing

Harvesting Lettuce

- Leaf lettuce: 5-6 in. tall
  - If planted in patches, use scissors for 2-3 harvests
- Bibb: leaves cup and form a loose head
- Romaine: leaves elongated, fairly tight head, 6-8 in. tall