NYBG/125
NEW YORK BOTANICAL GARDEN

Grow More Vegetables Citywide

Bronx Green-Up's *Grow More Vegetables Certificate Series* is a free edible gardening course designed to teach the best organic techniques for growing vegetables safely and effectively, particularly in urban settings. This development of this online course material (outlines 1-5 and course handouts available online at http://www.nybg.org/green_up/tips.php) was made possible by The New York Community Trust.

Grow More Vegetables Certificate Series	**4: Organic Growing Techniques I**
Total Time:	2 hours
Learning Objectives	In this class, students will: • discuss various organic gardening methods for growing food crops • understand the importance of cover crops • understand and practice crop planning
Materials	Handouts: *Cover Crops, Vegetable Plant Families, Using Water Wisely,* and *Mulching Vegetables* Cover crop seed and photos Crop planning materials
Quiz 15-20 min	*Review from last class: Soils and Compost*
15 min	**Crop Planning and Rotation** Successful crop planning is an important aspect of organic gardening and the first step in your garden season. A garden plan will save space, time, work, and money. *We will do a planning activity at the end of class.* **Crop Rotation** Rotating your crops can help contribute to the overall fertility of the soil by helping to replenish nutrients and control weeds. This will make tending your garden easier. One aim is to provide an inhospitable environment for weeds and pests that could proliferate if you continually plant the same crop in the same place.

"Plant Family" matching game

Plants are typically grouped into families based on similarities in their structures and characteristics. Handout: *"Vegetable Plant Families."*

Play a matching game to group vegetable and herb crops into plant families. Use photos or catalog cut-outs of vegetables, taping them to the board under headings of different plant families.

Guidelines for Crop Rotation:

- For crops grown during the main season (planted in spring and harvested later in the season), do not grow the same crop or a member of its family in the same growing bed **2 years in a row**.
- In areas where you might grow a second crop in the **same season**, do not grow the same crop or a member of its family in the bed a second time during that season.
- If you plant dense, leafy crops one season, plant something with a more open habit the next season.
- Rotate between crops that require a long growing season and others that mature quickly.
- Another way to think about this is to rotate between heavy feeder, heavy giver, light feeder (agricultural recycling).
- If you choose to plant a **cover crop** (crops grown to protect and nourish the soil), there are also ways to plan rotations for them. By rotating cover crops, the use of different ones over a two- or three-year period can accomplish different tasks: accumulate more nitrogen in the soil, prevent erosion, or increase organic matter. *(We will discuss more.)*

Illustrate an example of a seasonal rotation by choosing crops from the board, and putting them in order for a year-round rotation.
For example:
spring: peas → summer: tomatoes → late fall: winter rye (cover crop) → following spring: lettuce

15 min

Cover Crops
Cover crops are crops that are grown to protect and nourish the soil, a way of creating and replenishing nutrients in your soil. The use of cover crops is popular in organic gardening. The term "green manures" refers to cover crops that you turn into the soil to decompose, thereby increasing organic matter. Cover crops are allowed to grow for

several months to a year or more before they are then tilled into the soil.

One possible drawback to cover crops is that they take up space in your garden that could otherwise be used to grow food crops. This is why they are often planted later in the growing season, or inter-planted with food crops.

There are two categories of cover crops: legume and non-legume.

Legume crops, such as clovers, add nitrogen to the soil via rhizobia bacteria living in nodules on their roots.

Non-legume crops don't add nitrogen but they do redistribute the existing nitrogen along with other nutrients from deep in the soil. They also have other benefits which we will discuss below.

Cover crops (both legume and non-legume) improve the soil by:

- **Greatly increasing the organic matter of the soil**

Review: What is organic matter?

- Organic matter consists of plant and animal material that is in the process of decomposing (breaking down). It is anything that is or once was alive.
- Soil organisms (bacteria, fungi, and worms) break down organic matter which contains nutrients and makes these nutrients available to growing plants.
- Whether turned under in the spring or made into compost, cover crops will act as a slow release fertilizer, feeding the organisms that help feed your vegetables and flowers.
- Both the roots and top growth contribute to the organic matter of the soil after the crop is tilled in. Remember that organic matter is largely responsible for maintaining a soil structure that is good for root growth.
- Inorganic fertilizers, despite nutrients, do not replenish organic matter, so soil life is unable to use them efficiently.
- Generally, **legume cover crops provide more nitrogen (N)** to soil, while non-legume grasses increase organic matter more effectively. Legumes, because of their high N content, decompose more rapidly than others and do not contribute as much organic matter.

- **Preventing erosion and decreasing leaching.**
  Rain, snow melt, and wind can gradually carry away topsoil and critical nutrients. The roots of cover crops are like a safety net, stabilizing the soil (especially on sloped areas) and capturing nutrients that would otherwise wash away in rains. Living plants also protect the soil by providing a cover over the soil surface.

- **Increasing availability of nutrients**
  Thousands of tiny root hairs take up nitrogen and other nutrients from the soil, holding them in the plant until the plant dies; the decomposing plant gradually

releases these nutrients back into the upper part of the soil where they will be available for the next crop. Deep-rooted cover crops may be able to tap sources of nutrients that are deeper in the soil profile than most vegetable crops' roots can normally get to.

- **Improving soil structure and aeration**

Review: What is soil structure?

- Soil structure refers to how soil particles are held together and how pore space is arranged between them. Soil structure is important for biological activity, air and water movement, root growth, and seedling emergence.
- Soil structure is improved by root action. As roots die and decay, tiny channels are left for the exchange of gases, water, and movement of worms and bacteria.
- Also, soil particles held between roots are formed into small clusters (called aggregates) which are held together by substances produced by roots themselves, called exudates.
- Legumes have fewer fibrous roots but are good at stimulating microorganisms to produce glues that help form stable aggregates.

- **Reducing weeds**

  If you plant densely, cover crops can shade out weeds. Some, like hairy vetch, grow so densely that they outcompete weeds. Others, like winter rye, hairy vetch, and oats have an allelopathic effect—the plant produces substances that suppress the germination of other plants. (When tilled in, inhibiting substances quickly decompose.)

- **Help control pests and diseases**

  Organic matter feeds the microorganisms that help in disease suppression. This disrupts disease and pest life cycles in soils (unlike consecutively growing crops). Some cover crops, such as crimson clover and buckwheat, attract beneficial organisms (i.e. predatory mites, wasps, spiders) that prey on pest species.

Give handout "Cover Crops."

10 min

Crop rotation and cover cropping are two key practices in organic vegetable gardening. Here are some other (organic) growing techniques that you may incorporate into your garden plans:

Succession Planting

Planting a succession crop is defined as planting a second crop in the same space during one growing season. The goal is to maximize production. It is important to plan your season in advance, knowing the best conditions to plant each crop and how long each crop will take to mature.

Choosing Plant Varieties

When planning out your season, you can look for varieties that will meet your growing

needs or conditions—for example, crops that produce earlier or can tolerate different temperatures, such as heat-resistant lettuce.

- Cold-hardy, drought tolerant, insect resistant, and disease resistant
- *What varieties have you had success with?*

Square Foot Gardening[1]

This method of gardening builds your growing spaces into a series of squares, each one being 12 inches by 12 inches (you could also lay out the garden in bigger squares, such as 4 feet by 4 feet).

Each square holds a different vegetable, flower, or herb.

- Generally, the seeds are planted the same distance apart as is recommended on seed packets, but are measured as the distance apart from each other and the boundary of the square, rather than down a row. The spacing allows enough space for each plant to mature, while also saving space.
- Create path space. You never want to step on the growing spaces in your garden, as this will compact the soil, eliminating air spaces between soil particles, which are necessary for water and air to penetrate plant roots.
- Your paths can be 1-, 2-, or 3-feet wide, depending on what you are most comfortable with. You can lay out old wood planks, plant grass (needs mowing), or lay a hay mulch.

Vertical Growing

You can save a lot of space in your garden by growing climbing plants vertically. Tomatoes, summer and winter squash, cucumbers, pole beans, melons, and other climbers can be grown successfully in small spaces by building a simple trellis or planting along a fence. Growing vining crops vertically also results in better sunlight and air penetration for the plants, plus reduced damage by pests.

- Be careful not to let your trellis shade out other plants in your garden. Taller plants should be kept to the northern side of the garden.
- One of the most simple trellis designs can be made with three bamboo stakes and twine.

Growing Without Full Sun: 10 Vegetables You Can Grow in Part Shade

Many urban gardens are part shade because of trees, buildings, or other structures. A general rule is that if you grow a plant for the fruit or the root, it needs full sun. If you grow it for the leaves, stems, or buds, shade is just fine, but vegetables will require three to six hours of sun per day.

- Salad greens, such as leaf lettuce, arugula, endive, cress, mustard greens, and radicchio
- Broccoli (also its relatives kale, kohlrabi, collards, and cabbage)
- Cauliflower
- Peas
- Beets
- Brussels Sprouts

- Radishes
- Swiss Chard
- Spinach
- Beans

Using Water Wisely

Handout :"Using Water Wisely"

5 min

Not watering enough or watering too often will cause your plants to be water-stressed. This can negatively affect your plant's yield, and in the latter case, wastes a precious resource and can saturate the soil enough to interfere with plant growth. Overwatering can also leach minerals into the subsoil and out of reach of most plant roots.

- Knowing your soil type is helpful when watering. Clay soils hold water more easily, so need less frequent watering—and you'll never want to overwater. Sandy soils hold water less easily, so you may need to water for less time but more often. If the soil is loamy, water so the soil is deeply soaked.
- If you don't water deeply enough, then little water reaches the root zone. This results in slow growth or dying plants. Frequent light watering moistens the surface, encouraging the roots to grow only in the uppermost layer of soil. The plant will then dry out more quickly and will suffer greatly under drought conditions. The roots also do not grow deep enough to take up minerals from deeper down.
- The best way to know if your garden needs water is to probe down about **3 inches** into the soil. If the soil at this depth is dry and will not stick together, it is time to water.
- Pay attention to your plants for signs that they need water. Some wilting in the afternoon is normal on a hot day, but if your plant does not recover as the temperature cools later in the evening, this is usually a sign that it needs water.
- The best time of day to water is early morning or early evening. Watering then will help your plants achieve the maximum water absorption, with less water lost to evaporation.
- **Drip irrigation** is an excellent method for watering. It delivers water right to the roots, and little water is wasted on evaporation. There are two types of drip irrigation: 1) long tubes with holes at each plant and, 2) long tubes with tiny holes all along the length of the tube.

BREAK

Companion Planting[2]

Ask people about their experiences.

20 min

Scientific definition: growing plants in close proximity of one another that have complementary physical demands

An alternative description: growing as many elements together as possible that encourage life and growth; in other words, creating a mini-ecosystem that might include vegetables, fruits, trees, flowers, insects, and spiders

There are many reasons to try companion planting: plant health and nutrition, crop rotation, space demands in the garden, and weed, insect, and animal interactions. Companion planting is still an experimental field, with more research needed. Much of our knowledge of companion plants comes from the direct experience of farmers and gardeners in the field. You may want to try it yourself.

What are some examples of companion planting that you have tried?
Examples of companion planting:

- Carrots and radishes: While carrots take a while to mature, radishes take as little as 25 days. Harvest your radishes, and you will free up space for the carrots to continue to grow.
- Tomatoes and cabbage: Tomatoes repel diamondback moth larvae, caterpillars that chew holes in cabbage leaves.[3]

Using Space Efficiently in Companion Planting
Spacing: A general rule with plant spacing is to grow plants so that each plant's leaves are barely touching at maturity.

- **Sun/Shade**

While most vegetables require full sun to grow, some, like lettuce, prefer some shade during the hottest months. You can grow tall plants next to shorter plants to provide the shade they need. Remember to plant the tallest plants in the garden at the north side, that way they won't shade other plants as the sun moves in the sky.

- **Shallow/Deep Roots**

You might plant shallow-rooting beans with deeper-rooting corn. Over time, the root systems can obtain nutrients at different depths of the soil, improving soil structure. As you rotate the areas you plant, you will improve the soil in different spots.
Another example: carrots (deep) and lettuce (shallow).

- **Fast/Slow Maturing**

If you time your garden right, you may be able to grow multiple crops throughout the season in the same area. French Intensive gardeners were able to grow radishes, carrots, lettuce, and cauliflower, all in one area. Since those plants mature at different times, you can stagger the planting times so that all can mature in a single growing season. An example we mentioned earlier was planting radishes with carrots; another example is lettuce with cauliflower.

All-around beneficial plants
Certain herbs have a beneficial influence on ALL of the plants around them, making them generally good choices for any garden. Most of these plants also attract pollinators and are consumed by humans for their medicinal and/or culinary properties. Perennials should be planted in an area where the soil will not be disturbed, like a row at the edge of your garden.

- **Chamomile** *(Chamaemelum nobile):* Used as a tea (spray or soil drench), it combats diseases such as damping off, a fungal disease, in young plants.
- **Dandelion** *(Taraxacum officinale)* and **Sow thistle** *(Sonchus oleraceus):* Their deep taproots break up compacted soils and bring up nutrients from deeper down in the soil profile than most vegetable plants are able.
- **Dill** (*Anethum graveolens)* and **Fennel** *(Foeniculum vulgare)* are host plants for the larvae of native pollinators and attract many beneficial insects like syrphid flies and parasitic wasps.
- **Lemon balm** (*Melissa officinalis)* is part of the mint family and attracts bees and ladybugs. Be careful: like most mints, it spreads quickly.
- **Marjoram** *(Origanum majorana)* and **Oregano** *(Origanum vulgare)* are thought to have a beneficial effect on surrounding plants. They are also easy to grow and require little water.
- **Stinging nettle** *(Urtica dioica)*: Many insects feed on it and the larvae of several species of Lepidoptera are dependent on it for food.[4]
- **Valerian** *(Valeriana officinalis):* Stimulates phosphorus activity in its surrounding areas. Encourages health and disease resistance in plants.

Attracting bees, butterflies, and other animals

You can encourage nature to pollinate your crops and control pests for you by growing flowering plants and herbs which provide food and shelter for **beneficial insects** and other wildlife. Some that you can attract are:

- **Ladybugs** are a type of beetle that eats aphids. They also do not eat beneficial insects.
- **Tachinid Flies** are parasites that help control caterpillars, Japanese beetles, earwigs, gypsy moths, brown-tail moths, tomato worms, and grasshoppers.
- **Syrphid Flies** are parasites that prey upon aphids; they are also effective pollinators.
- **Bees** are attracted by hyssop, thyme, catnip, lemon balm, pot marjoram, sweet basil, summer savory, borage, mint, and some blue flowers.

Additionally, other animals are also important:

- Birds are effective insect predators. Moving water and shrubs provide habitat and protection to **birds** in your garden. Fruiting bushes, especially natives, and plants that produce seed, will provide food for birds.
- **Hummingbirds** are pollinators and are attracted to red flowers.
- **Chickens** are also good for the garden. Their manure (after being composted) can be used as fertilizer. Chickens are reliable for controlling earwigs, sow bugs, pill bugs, snails, grasshoppers, and maggots. Protect your young seedlings from chickens.

Here is a link to a companion planting list:
from Wikipedia: http://en.wikipedia.org/wiki/List_of_companion_plants

Crop Planning Activity

Activity: 15 min to plan; 10 min to share with partners

A garden plan will save you time, space, work, and money. Creating a plan should be your first activity of the garden season.

Take Notes and Make a Sketch

1. Find your crop plan from last year, or if you don't have one, try and remember what you grew in the different areas of your plot (make a list). Your plan should include a rotation of your crops so that you don't grow the same plant or a member of its family in the same space.

2. Decide how the sun moves over your vegetable plot.
Plan to plant the tallest plants, like corn or trellised plants, on the north side, so that they don't shade out smaller plants when the sun is strongest.

3. Decide which crops you wish to grow this year and make a list. (Seed catalogs are your friend here.) Are there existing perennials (plants that grow back every spring) in your garden? Will you plant any new perennials? Where would be the best place to put them?

4. Figure out which method(s) of planting you will use. Those new to gardening may want to start with one or two methods to keep it simple.

☐ Square foot garden
☐ Plant in rows
☐ Succession planting (grow more than one crop in the same space in one growing season)
☐ Vertical growing with trellis or fence
☐ Companion planting
☐ Cover crops
☐ Other methods:_____

5. Now, create a sketch of your garden plot. Draw the plot big enough so that you can add the crops you plan to grow. If you know the dimensions of the growing area, include that in your sketch. Make sure to include the following:

- Direction in which the sun moves (you can use arrows for this)
- Any trees, buildings, or other structures that might shade your plot at different times of day (you might make note of this as the season progresses)

Create a Table or List

After you have completed your sketch, you might add more detail to your crop plan by listing each crop you will grow in a table. Remember the first and last frost dates for the NYC area, May 1st and November 15th, respectively.

Treehugger.com provides a useful reference for the tech-savvy gardener:
7 High-Tech Online Gardening Tools to Plan the Perfect Garden
Available at: http://www.treehugger.com/economics/7-high-tech-online-gardening-

	tools-to-plan-the-perfect-garden.html

[1] Bartholomew, Mel (2013). *All New Square Foot Gardening, Second Edition: The Revolutionary Way to Grow More In Less Space (*2nd edition*).* Cool Spring Press.

[2] Jeavons, John (2012). *How to Grow More Vegetables, Eighth Edition: (and Fruits, Nuts, Berries, Grains, and Other Crops) Than You Ever Thought Possible on Less Land Than You Ever Thought Possible* (8th Edition). Ten Speed Press.

[3] Organic Gardening. (February 2014). *Beginner's Guide to Companion Planting.* Retrieved from: http://www.organicgardening.com/learn-and-grow/companion-planting.

[4] Plants for a Future. (February 2014). *Urtica dioica*. Retrieved from: http://www.pfaf.org/user/plant.aspx?LatinName=Urtica+dioica.