



Harmonious Cultivation

Enhancing Crop Health Through Plant Partnerships and Rotational Wisdom

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Master Gardener since 2014. Vegetable gardener for over a decade or more. Practices planting techniques to amend soil since the last 5-7 years. New insights every season.



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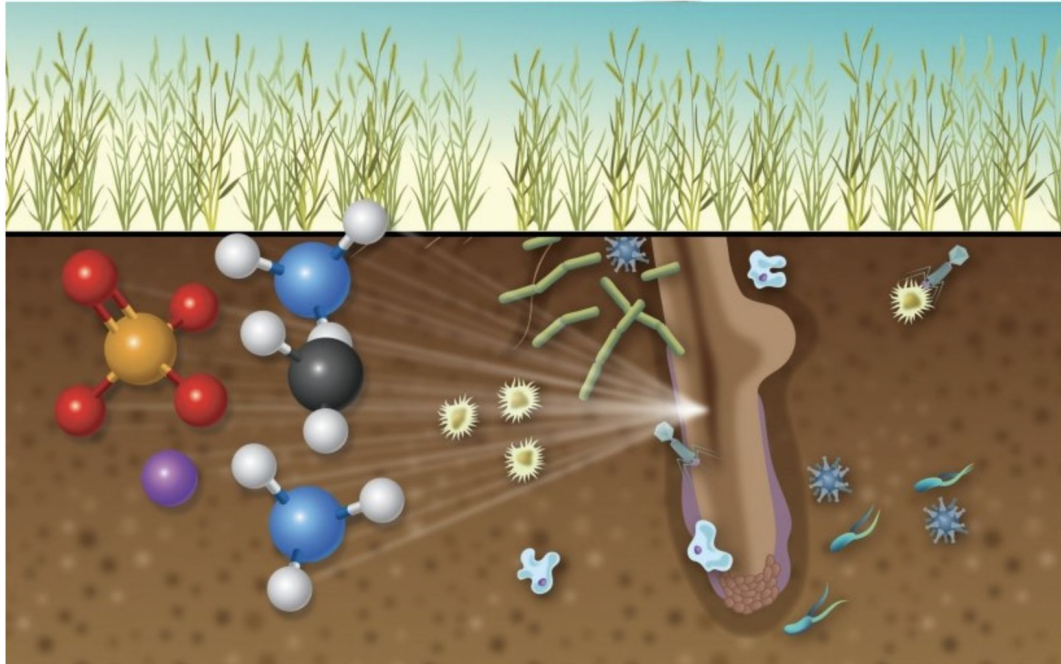


"Functional Soil Microbiome: Belowground Solution to an Aboveground Problem"

Soil Scientists



Soil Microbiome



For the first time, scientists viewed the interactions between bacteria and plants at the molecular level, offering insights for improving agriculture.

Illustration by Nathan Johnson, Pacific Northwest National Laboratory Creative Services.

Plant soil microbiome is the dynamic community of microorganisms associated with plants and soil.

This community includes:

- Bacteria
- Archaea
- Fungi



Improving Plant & Soil Microbiome

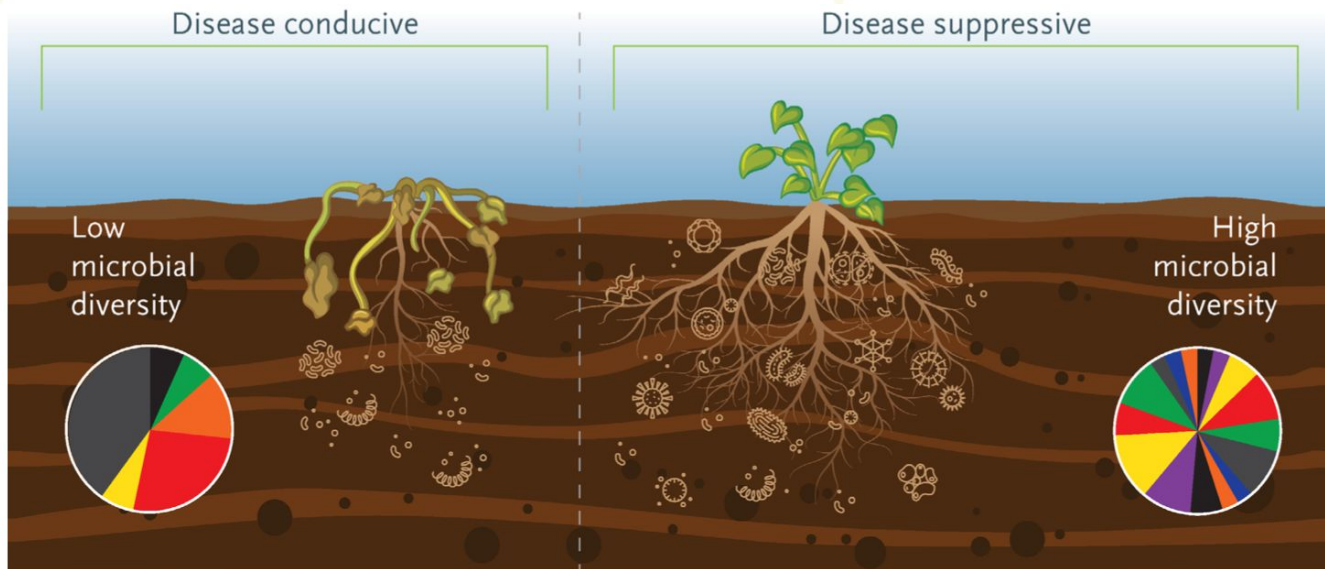


Figure 2 Low microbial diversity and low SOM quality soils associated with plant disease-prone (conductive) soil state (left) while more diverse and higher quality organic matter soils associated with disease suppression (right).

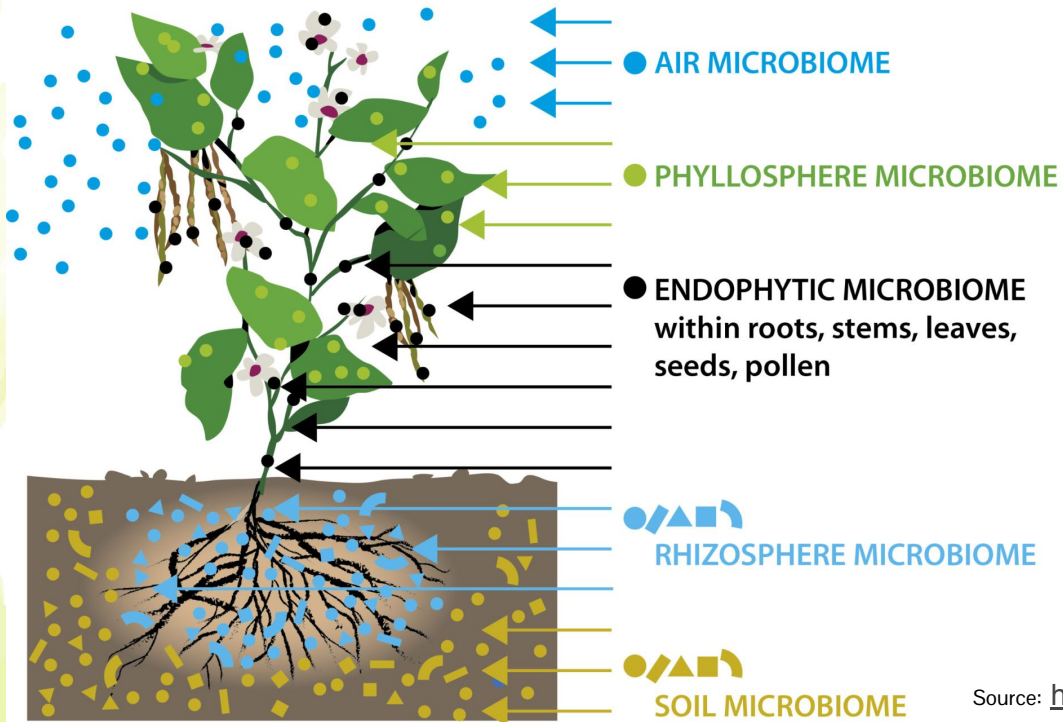
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Microbiome diversity has potential for both beneficial and harmful effects on plant growth and crop yield.



Influences on Microbiome Composition

THE PLANT MICROBIOME



The composition of any particular microbiome is influenced by factors many, including:

- Environmental
- Soil physical properties
- Nutrient availability
- Plant species

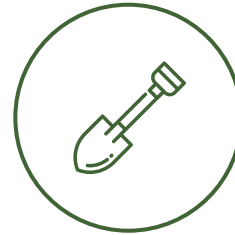


Amending soil throughout the year



During Season

When Planting



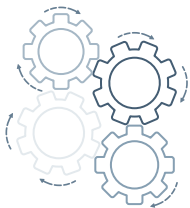
In Between Seasons

When beds are empty



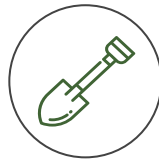


Planting Techniques



During Season

Plant Families



Between Seasons

No till



Crop Rotation



Cover Crops



Companion Planting



Solarizing





Plant Families

Each vegetable can be classified into a particular plant family.

Plants belonging to the same family oftentimes are:

- Susceptible to similar insect pests
- Similar diseases
- Have similar nutrient requirements



Plant Families & Planting in the Same Spot

When vegetables classified in the same plant family and are grown year after year in the same area of a garden, they provide insect pests with

- a reliable food source and disease-causing organisms (i.e., pathogens)
- with a continual source of host plants that they can infect.

Over time, insect pest and pathogen numbers build in the area and increasing potential damage to vegetable and crops.



Plant Families

Common Name	Botanical Family	Edible Members	Common Name	Botanical Family	Edible Members
Onion	Alliaceae	Chives, garlic, leeks, onions, shallots	Cucumber, Gourd, Melon, Pumpkin	Cucurbitaceae	Cucumber, melon, pumpkin, squash, watermelon
Beet	Amaranthaceae	Beet, chard, epazote, quinoa, spinach	Legume	Fabaceae	Beans, lentils, peas, peanuts
Carrot/ Dill	Apiaceae	Anise, caraway, carrot, celery, dill, fennel, parsley, parsnip	Mint	Lamiaceae	Basil, marjoram, mint, oregano, rosemary, sage, thyme
Aster, Daisy, Sunflower	Asteraceae	Artichoke, endive, lettuce, sunflower	Grass	Poaceae	Bamboo, barley, corn, rice, rye, sugarcane, wheat
Brassica, Cabbage, Mustard	Brassicaceae	Arugula, bok choy, broccoli, brussels sprouts, cabbage, cauliflower, kale, mustard, radish, rutabaga, turnip	Nightshade, Potato, Tomato	Solanaceae	Eggplant, pepper, potato, tomato



Onion: *Alliaceae* Family

Onion

Alliaceae

Chives, garlic, leeks,
onions, shallots



Beet: Amaranthaceae Family

Beet	Amaranthaceae	Beet, chard, epazote, quinoa, spinach, amaranth
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Amaranthaceae
(beetroot family)



Carrot/ Dill: Apiaceae Family

The Apiaceae Plant Family

@nonuts4me



Celery



Parsnip



Carrot



Parsley



Fennel



Cilantro



Dill



Anise



Caraway



Coriander



Cumin

Carrot/ Dill	Apiaceae	Anise, caraway, carrot, celery, dill, fennel, parsley, parsnip
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Aster, Daisy: Asteraceae Family

Aster, Daisy, Sunflower	Asteraceae	Artichoke, endive, lettuce, sunflower
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Cabbage, Kale: Brassicaceae Family

Brassica, Cabbage,
Mustard
cruciferous vegetables

Brassicaceae

Arugula, bok choy, broccoli, brussels sprouts, cabbage, cauliflower, kale, mustard, radish, rutabaga, turnip



Image: Pixby

Cucumber, Gourd: Cucurbitaceae Family

Cucumber, Gourd, Melon,
Pumpkin

Cucurbitaceae

Cucumber, melon, pumpkin, squash, watermelon



Image: Pixby



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• Legume: Fabaceae Family

Legume

Fabaceae

Beans, lentils, peas, peanuts



Mint: Lamiaceae Family

Mint

Lamiaceae

Basil, marjoram, mint, oregano, rosemary, sage, thyme



Sage



Marjoram



Geranium



Cinnamon



Anise



Sandalwood



Mint



Ginger



Citrus



Balm



Spruce



Patchouli



Grapefruit



Clove



Basil



Tea Tree



Pine



Jasmine



Cumin



Bay Leaf

Grass: Poaceae Family

Grass

Poaceae

Bamboo, barley, corn, rice, rye, sugarcane, wheat



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Nightshade: Solanaceae Family

Nightshade, Potato,
Tomato

Solanaceae

Eggplant, pepper, potato, tomato



Image: <https://www.pcf.org/blog/nightshade-foods/>



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Crop rotation



In a home vegetable garden, crop rotation involves: changing the planting location of vegetables within the garden each season.

Crop rotation is used to:

- reduce damage from insect pests,
- limit the development of vegetable diseases, and
- manage soil fertility.



Use of crop rotation can lead to a healthier, more productive garden

Rotate Plant families in same spot seasonally

Plan the crop rotation for your vegetable garden based on the types of vegetables that you grow.

Vegetable crops in the same plant family should NOT be planted in the same area of a garden year after year.

EG: If tomatoes are planted in a bed or area of a garden one year, peppers, eggplant, potatoes and tomatoes should not be planted in the same bed or area the following year because all of these plants belong to the nightshade family (*Solanaceae*)

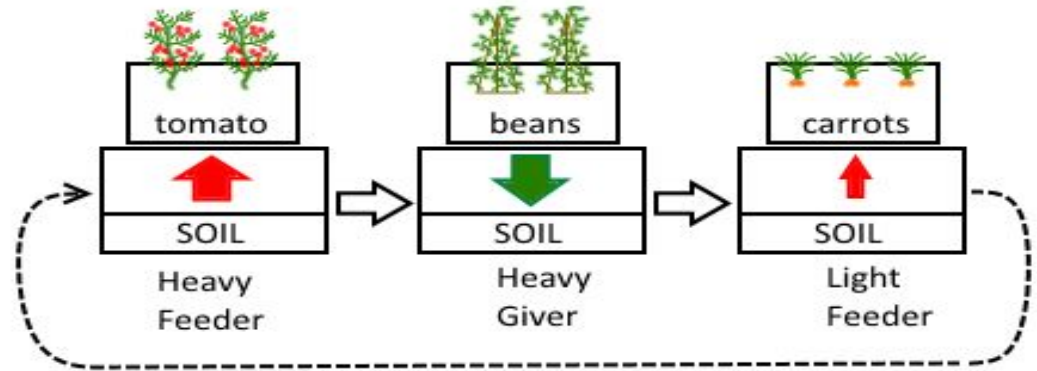


Rotate Giver & Feeder plants

Crop Rotation by Plant Nutrient Demands

Heavy Feeder
Heavy Giver
Light Feeder

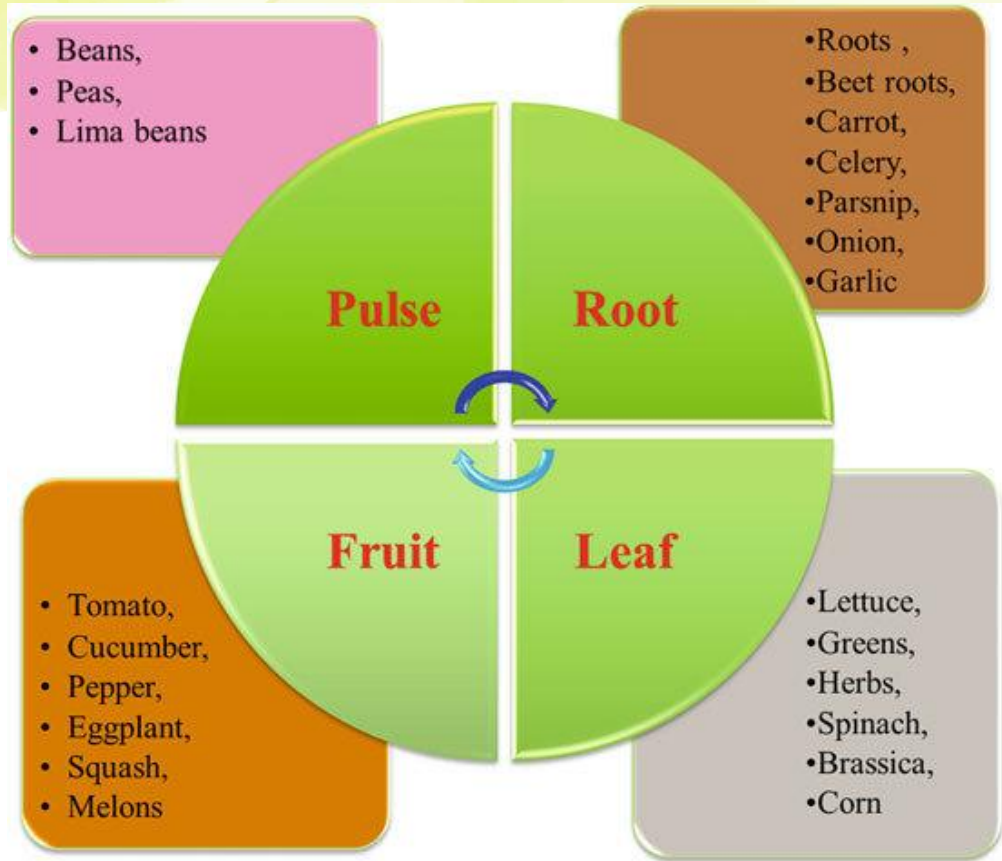
Crop Rotation by Plant Nutrient Demands



Example shows rotation through a single garden bed



Rotate Plant families in same spot seasonally



Suggested Rotations by Plant Groups

Table 1: Crop Grouping for rotation to control soil-borne diseases

Group A	Group B	Group C	Group D	Group E	Group F
Cantaloupe, Cucumber, Honeydew Melon, Pumpkin, Squash, Watermelon.	Brussels Sprouts, Cabbage, Cauliflower, Collards, Lettuce, Mustard, Radish, Rutabaga, Spinach, Swiss Chard, Turnip.	Eggplant, Irish Potato, Okra, Pepper, Tomato.	Beet, Carrot, Garlic, Onion, Shallot, Sweet Potato.	Sweet Corn	Bean, Cowpea, Pea.

Suggested Rotations by Cool & Warm seasons

1. Late-fall-planted fava beans (legumes) > spring-planted beets (chenopodiaceae) > summer-planted corn (other) > fall-planted cabbage (cruciferae)
2. Fall-planted to winter over broccoli (cruciferae) > late spring planted tomatoes (solanaceae) > fall planted carrots (umbelliferae)
3. Spring-planted spinach (chenopodiaceae) > summer-planted summer squash (cucurbitaceae) > fall planted lettuce (other)
4. Wintered-over green onions (amaryllidaceae) > spring-planted snow peas (leguminosae) > mid-summer corn (other) > fall-planted Asian greens (cruciferae)
5. Summer-planted carrots (umbelliferae) > November-planted garlic (amaryllidaceae) > late-spring-planted winter squash (cucurbitaceae) > fall-planted lettuce (other)
6. Late summer planted cabbage (stands into late fall) (cruciferae) > spring-planted peas (leguminosae) > late-summer-planted corn (other)
7. Winter-planted bulb onions (amaryllidaceae) > summer-planted beans (leguminosae) > fall-planted broccoli (cruciferae)
8. Winter-to-spring repeat planting of chard (chenopodiaceae) > late-spring-planted tomatoes (solanaceae) > fall-planted fava beans (leguminosae)

Garden Log

To help in planning crop rotations, keep a garden log or map as a reminder of where vegetables are planted each year.

Planting Log														
Crop & Variety	Date Planted	Soil Block Size/ Spacing	N u m b e r	Germination Date	Date Transplanted	Soil Block Size/ Spacing	N u m b e r	Date Transplanted	Soil Block Size/ Spacing	N u m b e r	Days to Maturity (from packet)	Initial Harvest Date Estimate	Actual Initial Harvest Date	Notes
Chives	3/20	3/4"	10											
Thyme	3/20	3/4"	10											
Parsley	3/20	3/4"	10											
Oregano	3/20	3/4"	10											
Dill	3/20	3/4"	10											
Basil	3/20	3/4"	20											
Chard, Five Color	3/20	3/4"	30								55			
Spinach, Space	3/20	3/4"	30								39			
Spinach, Bloomsdale	3/20	3/4"	30								50			
Arugula	3/20	3/4"	30											
Arugula, Astro	3/20	3/4"	30											
Lettuce, Red Oakleaf	3/20	3/4"	30								51			
Lettuce, Florensenschuss	3/20	3/4"	15								60			
Lettuce, Amish Deer	3/20	3/4"	15								50			
Endive, Bianca Riccia	3/20	3/4"	30								35			
Beet, Bulls Blood	3/20	3/4"	30								35			
Tomato, Egg Yolk	3/20	3/4"	10								80			
Tomato, Brandywine	3/20	3/4"	15								80			
Tomato, Green Zebra	3/20	3/4"	15								75			
Pepper, Quadrato	3/20	3/4"	10								80			
Pepper, Red Knight	3/20	3/4"	10								77			
Eggplant, Long Purple	3/20	3/4"	10								89			

Mention in notes - which planter - what plant - date season

Companion Planting

Companion planting is the planting of more than one crop in proximity to get benefits such as:

- Pest control
- Pollination
- Attract beneficial insects
- Maximizing use of space
- Increase crop yield



Otago Daily times - Gillian Vine



Inter Planting

Scientists prefer terms like

- Inter-cropping
- inter-planting

to describe creating a polyculture to achieve desired benefits in the garden.



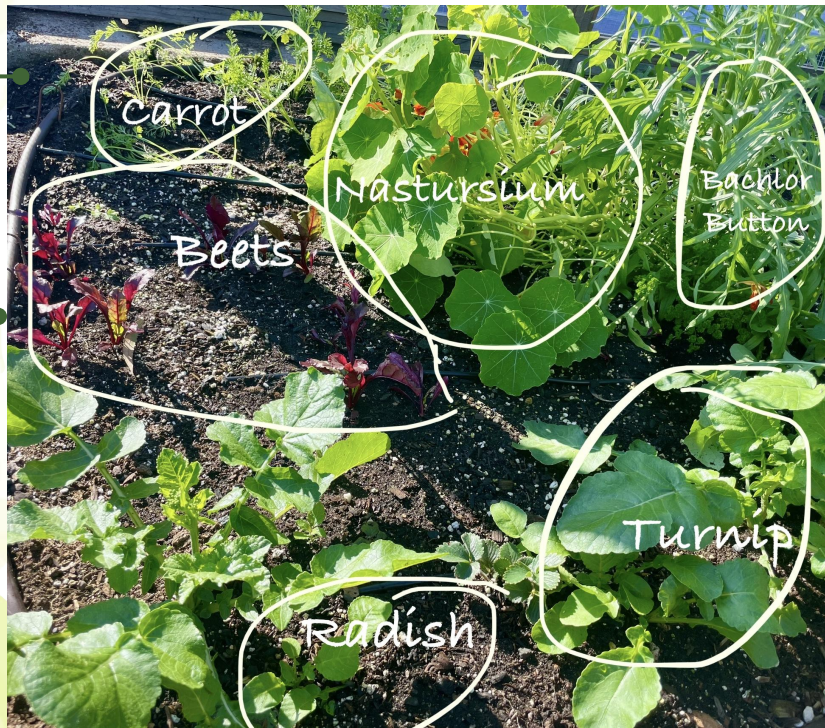
• Inter Planting Many Concepts

Direct Sow

All of these work as direct sow from seed.

Pest Abatement

Nasturtiums
- Trap crop attracts aphids
- Edible Flowers



Pollinator

Bachelor's Button
- Pollinator
- Cut & Dry Flower

Succession

Planting a few every 2 weeks for continuous harvest

Variety, Size

White Long Radish
ed Small Radish

Companions

Carrots, Onion and Lettuce can be planted together to maximize space. Their roots grow at different depths and uses water efficiently.



Planting onions in and around your carrot crop significantly reduces the damage from carrot maggot flies. Univ of Tennessee ext. ser.



Strawberries do well with sage, carrots in my garden. Spinach produces saponin in the roots, whose antifungal and antibacterial properties can add a layer of protection strawberry plants

Peas, legumes, Lupin, white clover is another nitrogen fixer that will boost the health and productivity of your strawberry plants. Planted between strawberry rows it also effectively suppresses weeds and can be used to make a delicious delicate tea. Lettuce provides good mulch and hides fruits from birds when planted together. Deter Pests: Marigold, Sweet alyssum, Thyme, Caraway, Chrysanthemum, alliums. <https://strawberrypants.org/strawberry-companion-plants/#strawberry-companions-who-serve-nutrients-and-protect>

<https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=17642>

Tomatoes, Carrots, Basil, Marigold, Borage
- Basil helps deterring thrips and tomato hornworms.

Tomatoes with French marigolds protects tomato plants from glasshouse whiteflies through the emission of airborne limonene
Carrots and Lettuce grow well in the shade of tomatoes.

Borage attracts pollinators



Companion Vegetables



Source: SD MG Heather Holland



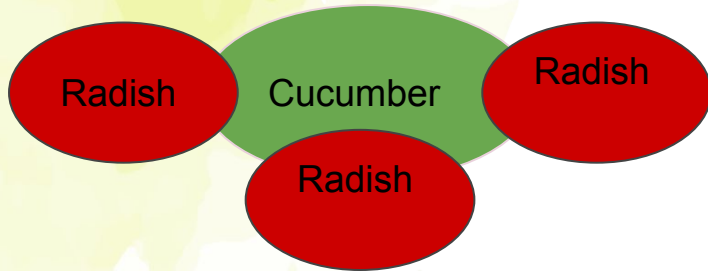
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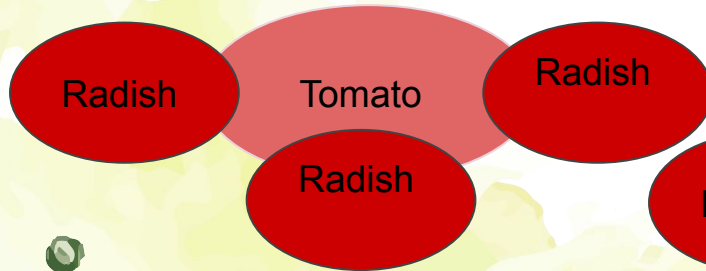
Trap Crop

A plant that steers pests away from a more desirable crop.

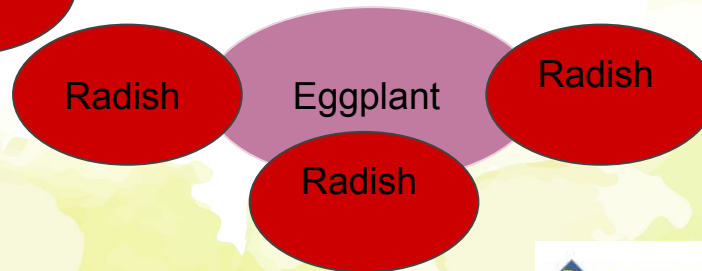


A few radishes can attract cucumber beetles and keep them away from your cucumbers. Radishes can lure pests away from eggplants and tomatoes, too.

Plant them a few weeks before your main crop. So, the leaves sprout as a trap crop. Since the pests only consume the radish leaves, you can still eat the radish root.



Understanding proximity of trap crop to main crop is important..



Source: <https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=17642>

Squash

Nasturtium
Dill

Cucumber



Spinach

Strawberry

Lettuce

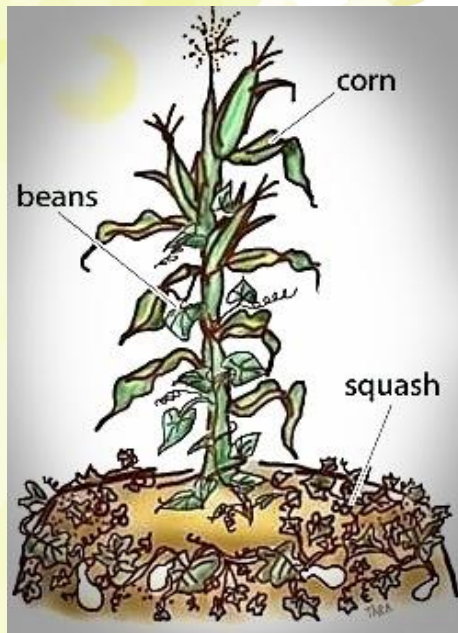
Cucumber

Carrot

- Nasturtiums and Dill both make good companions for squash and cucumber because they repel squash bugs and attract beneficial insects.
- Sweet corn does well with peas, pumpkins and squash (corn, legumes and the squash family are the traditional “Three Sisters”)
- Lettuce grows well with strawberries, cucumbers and carrots.
- Pumpkins grow well with corn, but pumpkins and potatoes have an inhibiting effect on each other.
- Tomatoes dislike cabbage, potatoes and fennel, but will protect asparagus.

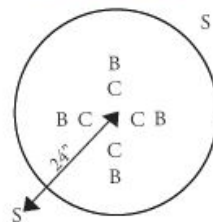


Three Sisters



THREE SISTER MOUNDS

This is the classic three sisters layout similar to Iroquois gardens. Mound the soil approximately 4 inches high with a small well in the center. It should resemble a moon crater.



Plant 4 corn seeds in the center in the well, 6 inches apart and 1-3 inches deep. After corn is about 4 inches tall, plant 4 beans seeds halfway down the sides of the mound at least 3 inches from the corn plant, 1 inch deep. After the beans have emerged, plant 2 squash seeds 24 inches from the center of the mound on opposite sides. Train squash to vine outward from the mound and not crowd the corn and beans. Place additional mounds 3-4 feet apart from the center.

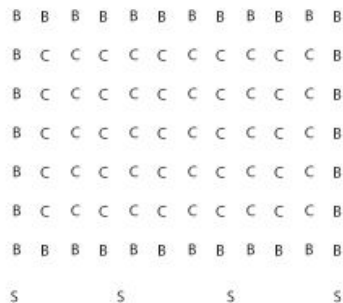
Within this layout it can be hard to harvest beans and corn at the center of the mounds, particularly if there are multiple rows of mounds. Therefore it is recommended to have a single or double row of mounds that can be approached from each side or create walking paths between mounds.

THREE SISTER FIELD

This layout is ideal for corn pollination because the corn is planted in a large block. This layout is similar to traditional Tarahumara fields.

Plant corn 1-3 inch deep, 6-12 inches apart. The size of the interior block of corn can vary but ideal is at least 5 plants on each side. The pole beans can be planted 1 inch deep and close enough to climb the corn, 3-12 inches away. Allow the corn to emerge and grow 4 inches high before planting the beans.

Plant squash in a row set back 3 feet from a bean row. Plant 2-3 seeds per location 3 feet apart. Isolating the squash to one side of the field makes access to the beans and corn easier.



THREE SISTER LANDSCAPE

In this layout, plant separate areas or fields of corn, beans, and squash. Each year shift the crops to the area to the right. Corn is a heavy feeder, meaning it requires fertile soil. Follow the beans with corn as the beans will have added nutrients to the soil. Plant corn and bean seeds 6-12 inches apart in row that are 18 inches apart. Squash can be planted in rows 3 feet apart.



<https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=25836>



Planting Beneficial Flowers



Calendulas with my cauliflower and kale to keep off aphids. The flowers work as a trap plant.

Companion planting is growing two or more crops near each other with the theory that:

- they help each other in nutrient uptake,
- improved pest management



Companion Flowers Attracting Beneficials



Umbelliferae flowers - Dill



Aster flowers - Blanket Flower



Lantana



Sweet alyssum



Mustard flowers



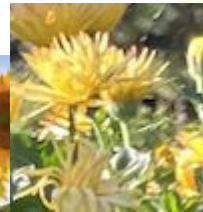
Marigolds



Nasturtium



Sunflowers



Calendula



Bachelors Buttons

Solarizing



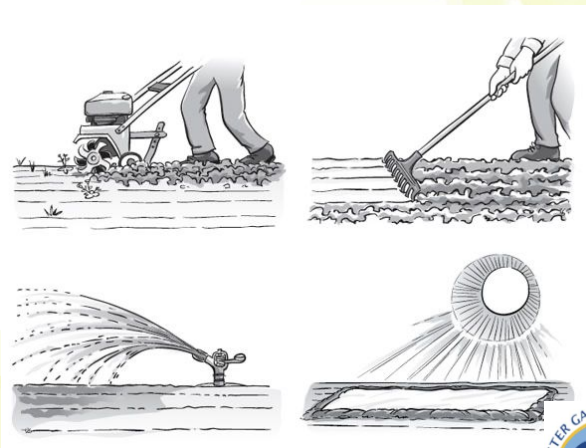
Benefits of Solarizing

- Broad-spectrum pest control technique
- May improve soil health by increasing the availability of nitrogen and other nutrients and
- Beneficially alters soil microbiome
- Can be effective in killing nematodes and other soilborne pathogens



Method

- Clean
- Rake
- Irrigate
- Put transparent plastic touching the soil for 4-6 weeks





Thanks!

Do you have any questions?

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