COOL-SEASON CROPS VEGETABLE PRODUCTION

Fall Gardening Workshop
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Leonard J.M. Githinji, Ph.D.
Assistant Professor and Extension Specialist
Sustainable and Urban Agriculture
Virginia State University

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Introduction

What Do We Mean By Fall Gardening?

- ❑ Planting crops for harvest prior to frost or a hard freeze.
- ❑ Planting crops that can be overwintered.
- ❑ Planting cover crops on unused garden/farm.
- ❑ Extending the season by greenhouse or high/low tunnel.

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Introduction

Why Fall Gardening?

- ❑ Fewer harmful insects.
- ❑ Fewer weeds.
- ❑ Extended use of garden space.
- ❑ Fresh vegetables for the table for a longer time.

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Cool-season vs Warm-season crops

- **Cool-season crops** are those planted so that they mature when the weather is cool, either in spring, early summer or winter.

- The crops come to harvest in cool weather, either in spring, fall or winter.

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Cool-season vs Warm-season crops

- Cool-season crops can be planted when the soil and air temperatures are cool, as low as 40°F.
- Mature crops can survive in temperatures near freezing without protection.
- These crops do not do well in the warmest summer temperature.

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Cool-season vs Warm-season crops

- **Warm-season crops** are those planted so that they mature when the soil and air temperature >50°F.
- They will grow best when the temp is >75°F.
- Warm-season vegetables can be grown in protected structures.

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Cool-season vs Warm-season crops

Cool season	
Beet	Greens
Carrot	Radish
Cabbage	Turnip
Broccoli	Lettuce
Onion	Collard

Warm season	
Corn	Squash
Bean	Cucumber
Okra	Tomato
Pepper	Eggplant

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Cool-season crop groups

- **Cole crops**: broccoli, cabbage, collards, cauliflower, kale, kohlrabi, Brussels sprouts.
- **Greens**: leaf lettuce, spinach, arugula, Asian greens, mustard, Swiss chard, some herbs
- **Root crops**: rutabagas, beets, carrots, turnips, parsnips.

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Climatic and Cultural Requirements

- It's a hardy, cool-season crop that does best under uniform, cool, moist conditions.

- Optimum monthly mean temp. for growth and quality is around 50 to 60° F, with min of 40° F and max. of 75° F.

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Climatic and Cultural Requirements

- Young cabbage plants tolerate cold and hot temp. extremes better than older plants.

- For late winter and spring crops, sandier loams that drain better are preferred.

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Climatic and Cultural Requirements

- ❑ Best pH range is 6.0 to 6.8. Slightly alkaline soil helps to control club root disease.

- ❑ Cabbage requires highly fertile soil and the crop is very responsive to fertilizers.

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Climatic and Cultural Requirements

- Apply the required P and K prior to planting but N as a sidedressing.
- Avoid excess N which may lead to loose heads and rapid secondary growth that may lead to split heads.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Planting and Crop Establishment

- Commercial planting can be started from either transplanting or direct seeding.
- Direct seeding is less expensive and permits higher populations than transplanting, but requires more expertise and attention to ensure a good stand.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Planting and Crop Establishment

- Transplants can be started in the greenhouse or in cold frames.
- Well hardened, stocky plants are best and can be transplanted before the last day of frost.

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Planting and Crop Establishment

- Spacing: 12-18 inches apart between rows for early harvest and 18-24 inches part for late harvest.
- Closer in-row spacing produces smaller heads but larger yield per acre.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Weed control

- Cabbage does not compete well with weeds. Early weed control before planting is very important.
- Effective weed control should include a combination of management practices.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Wakefield

- ✓ Small, pointed head
- ✓ Early-maturing
- ✓ Cold-tolerant
- ✓ Resistant to bolting

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Copenhagen

- ✓ Round
- ✓ Medium-large
- ✓ Early-maturing
- ✓ Prone to bolting

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Flat Dutch

- ✓ Flat
- ✓ Large
- ✓ Very solid head
- ✓ Vary in resistance to bolting

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Danish Ballhead

- ✓ Round-oval, medium-sized head
- ✓ Late maturing
- ✓ Intolerant to cold temperature
- ✓ Excellent for storage

Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Savoy

- ✓ Flat-globe-shaped
- ✓ Medium-large head
- ✓ Crinkly leaves
- ✓ Excellent market quality

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cultivars

Red

- ✓ Round
- ✓ Medium-sized head
- ✓ Reddish-purple color.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cabbage Insects

-**Cabbage worms**: Include cabbage looper, imported cabbage worm, and larvae of diamondback moth.

-Cause considerable damage by chewing holes in the leaves and heads of cole crops.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cabbage Worms

- The adults are gray, brown, and white moths. Control is by chemical and biological (*Bacillus thuringiensis*) measures.


Cabbage looper


Diamondback moth


Imported cabbage worm

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Aphids

- Cabbage aphids are small, green, sucking insects that have waxy covering similar to cabbage leaves.

- Aphids damage causes leaves to curl or cup.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Aphids

- Cultural practices and biological control agents can reduce aphid infestations.
- Plants should be treated before the insects are established and before the leaves start to cup.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Thrips

- These are small, wingless insects that are a serious pests especially in northern growing areas.
- The damage is by their rasping feeding habits on the leaves.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Thrips

- ❑ Chemical control is not very effective.
- ❑ Available options include the use of resistance cultivars.

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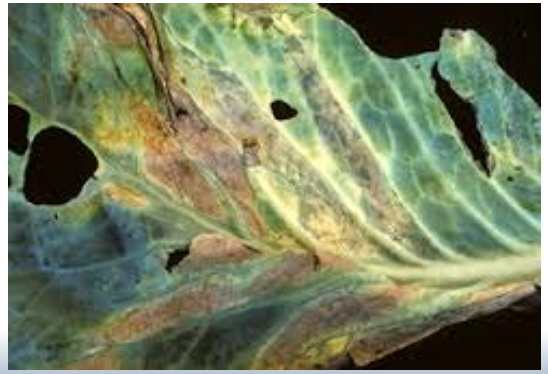
Cole crop – Cabbage *(Brassica oleracea Capitata)*

Cabbage Diseases

Black rot: Caused by a bacterium *Xanthomonas campestris*.

- The diseases can appear at any stage.
- First indicated by yellowing of leaves and blackening of veins.



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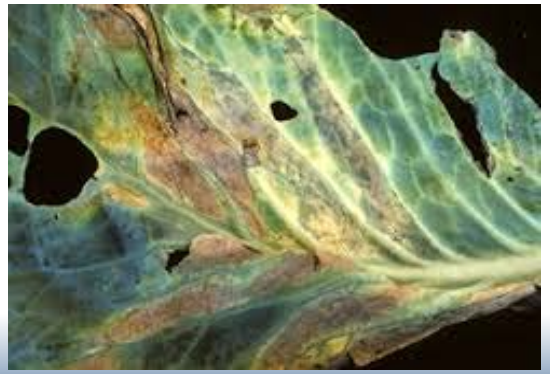
Cole crop – Cabbage *(Brassica oleracea Capitata)*

Black rot:

- If diseases attack early, no head will form.
- Control the disease by cultural methods.
- Potential use of bio-fertilizers.



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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Black leg:

- Caused by fungus *Phoma lingam*.
- It is a dry rot, that attacks the stem of young plants.
- Causes dark, sunken areas and the entire plant wilts.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Black leg:

- It is more active at lower temp. than black rot.
- Control measures similar to those of black rot.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Alternaria:

- Caused by several fungi species.
- Black spot is caused by *Alternaria brassicicola.*
- Characterized by dark black spots.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Alternaria:

- Consist of concentric rings.
- Control is by seed treatment and fungicide application.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Club root:

- Caused by a fungus *Plasmodiophora brassicae.*
- It attacks the roots causing swelling.

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Cole crop – Cabbage *(Brassica oleracea Capitata)*

Club root:

- Most prevalent in high moisture, acidic pH and warm temp.
- Control is by crop rotation and raising pH to around 7.2.

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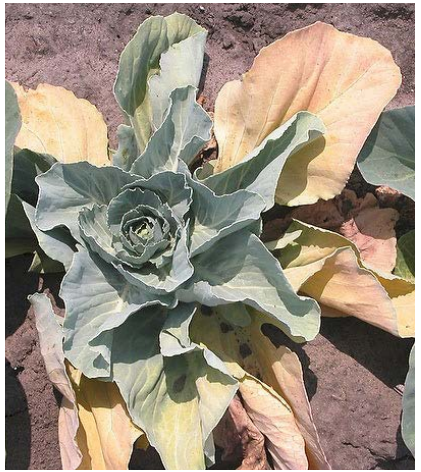
Cole crop – Cabbage *(Brassica oleracea Capitata)*

Yellows:

- Caused by a fungus *Fusarium oxysporum.*
- It attacks the roots causing swelling.
- Severe in high temp.



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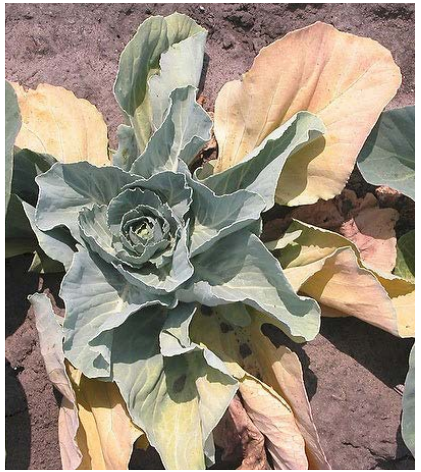
Cole crop – Cabbage *(Brassica oleracea Capitata)*

Yellows:

- Similar to black rot.
- Control by using resistant cultivars.



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Greens – Spinach *(Spinacia oleracea)*

- Greens refers to those vegetables grown for their leafy portions.
- They are cool-season crops with very similar cultural requirements.
- They are recognized for their high mineral content.

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Greens – Spinach *(Spinacia oleracea)*

- Spinach (belongs to the goosefoot family, Chenopodiacea.
- This family also includes beets and chard.
- Spinach is the most important vegetable green grown in the US, with significant commercial production for both fresh market and processing.

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Greens – Spinach *(Spinacia oleracea)*

- Spinach requires less labor than any other crop except green peas and sweet corn for processing.
- Spinach matures in about 30 to 50 days.
- Long days and high temperature causes bolting, marking the end of productive life.

Greens – Spinach *(Spinacia oleracea)*

- Since bolting is in response to photoperiod and warm temperature, fall production is important when days are short and cool.

- Cultivar selection is important as varieties differ in their resistance to bolting.

Greens – Spinach *(Spinacia oleracea)*

Climatic and Cultural Requirements

- Spinach is a hardy, cool-season crop that does best at temperatures of 60 to 65°F.

- It withstands hard frosts and temperatures as low as 20°F.

Greens – Spinach *(Spinacia oleracea)*

Climatic and Cultural Requirements

- It is very intolerant of warm temperatures above 77°F, which is combination with long days cause plant to bolt.
- Spinach grows best on a fertile sandy loam well supplied with organic matter.

Greens – Spinach *(Spinacia oleracea)*

Climatic and Cultural Requirements

- It requires a high level of fertility especially nitrogen. Also very responsive to boron.
- It is very sensitive to acidic conditions. Optimum pH range is 6.0 to 7.0. High pH can cause manganese deficiency.

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Greens – Spinach *(Spinacia oleracea)*

Planting and Crop Establishment

- Spinach is planted so as to allow the plants to grow and mature in cool weather.
- It is direct seeded in the field. Commercial crop is not thinned and the in-row spacing is adjusted by seeding rate.

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Greens – Spinach *(Spinacia oleracea)*

Planting and Crop Establishment

- The optimum range of soil temperature for seed germination is 45 to 75°F.

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Greens – Spinach *(Spinacia oleracea)*

Weed Control

- Machine-harvested processing spinach requires that weeds be effectively controlled.
- Weeds can complicate harvest operations as well as increasing the risk of crop rejection.

Greens – Spinach *(Spinacia oleracea)*

Weed Control

- Preplant incorporation of herbicides can help the control of weeds, especially broadleaved.

- Plastic mulches can be used for weed control.

Greens – Spinach *(Spinacia oleracea)*

Cultivars

- Spinach cultivars are classified as:
  - Prickly-seeded or smooth-seeded types; and
  - Savoy-leaved or smooth-leaved

Greens – Spinach *(Spinacia oleracea)*

Cultivars

- Commercial cultivars are of the smooth-seeded type, which are much easier to handle and plant accurately.
- The savoy types tend to be larger and are preferred for fresh market.

Greens – Spinach *(Spinacia oleracea)*

Cultivars

- The smooth-leaved cultivars are used for processing, because the leaves are easier to wash.
- Cultivars vary in their resistance to bolting and longstanding characteristics.

Greens – Spinach *(Spinacia oleracea)*

Cultivars

- Other desirable qualities for spinach include:

  - Dark green, thick, tender leaves.
  - Mosaic and mildew resistances.

Greens – Spinach *(Spinacia oleracea)*

Cultivars

- Other desirable qualities for spinach include:
  - Cold resistance
  - Days to harvest and high-yielding (F1).

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Greens – Spinach *(Spinacia oleracea)*

Insect Pests

Aphids (*Myzus persicae)*

- Cause damage by sucking the juice from foliage and by transmitting mosaic disease.

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Greens – Spinach *(Spinacia oleracea)*

Spinach Leaf miners (*Pegomyia hyoscyami*)

- Damage the crop by feeding inside the leaves between the leaf surfaces.

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Greens – Spinach *(Spinacia oleracea)*

Diseases

Damping-off (*Pythium*).

- Fungal disease
- Affects germinating seeds causing poor stand.

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Greens – Spinach *(Spinacia oleracea)*

Diseases

Damping-off (*Pythium*).

- Can be controlled by treating seeds with appropriate fungicides.

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Greens – Spinach *(Spinacia oleracea)*

Mosaic

- Commonly known as blight.
- It is a virus complex caused by cucumber mosaic virus (CMV).
- Plant leaves develop mosaics and die.

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Greens – Spinach *(Spinacia oleracea)*

Mosaic

- Disease is transmitted by insects, especially aphids.

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Greens – Spinach *(Spinacia oleracea)*

Downy Mildew or blue mold (*Peronospora effusa*)

- Can cause serious losses in cool, wet weather.
- Disease start as irregular patches on underside of leaves.

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Greens – Spinach *(Spinacia oleracea)*

Downy Mildew or blue mold (*Peronospora effusa*)

- Can ruin whole spinach field.
- Use resistant cultivars and fungicides to suppress the disease.

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Greens – Spinach *(Spinacia oleracea)*

Fusarium Wilt (*Fusarium salani*)

- Causes young plants to appear yellow and stunted and older leaves may wilt and fail to recover.
- Air temp. >72°F or soil temp. >70°F conducive to disease development.

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Greens – Spinach *(Spinacia oleracea)*

Fusarium Wilt (*Fusarium salani*)

- Use crop rotation and grow spinach during cold weather to control the disease.

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Greens – Spinach *(Spinacia oleracea)*

Harvesting

- Spinach is ready for harvest when it has reached edible size.
- The processing crop is harvested when foliage growth is at a maximum.

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Greens – Spinach *(Spinacia oleracea)*

Harvesting

- For fresh market use, the time of harvest depends on the market, and size and condition of the plant.
- Most commercial crop is machine-harvested.

Greens – Spinach *(Spinacia oleracea)*

Postharvest Handling

- Spinach is very perishable and can be stored no more than 10 to 14 days.

- The crop should be cooled as rapidly as possible to 32°F and place under RH of 95-100 percent.

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Root Vegetables

- They include carrots, beets, parsnips, radishes, rutabagas, turnips, horseradish and Jerusalem artichokes.


Carrots


Beets


Parsnips


Radishes

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Root Vegetables

- The include carrots, beets, parsnips, radishes, rutabagas, turnips, horseradish and Jerusalem artichokes.


Rutabagas


Turnips


Horseradis
h


Jerusalem
artichokes

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Root Vegetables

- Of the root vegetables, carrots and beets are the most widely grown.
- Others are of minor commercial significance.
- These crops are grown for their enlarged fleshy roots that may include some stem tissue.

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Root Vegetables

- They all grow in cool weather and have similar cultural requirements.

- They are all biennials except radishes, horseradish, and Jerusalem artichokes.

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Root Vegetables

- Radishes are either annuals or biennials.
- Horseradish and Jerusalem artichokes are perennials.

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Carrots (*Daucus carota* var. *sativus*)

- The Carrot belongs to the parsley family, *Umbelliferae*.
- This family also includes celery, parsnips, and parsley.

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Carrots (*Daucus carota* var. *sativus*)

- There are about 60 species of *Daucus*, many which are wild types.
- The cultivated forms belong to the subspecies *sativus*.

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Carrots (*Daucus carota* var. *sativus*)

Plant Growth and Development

- The carrot is a biennial that is grown as an annual for its root, which accumulates starches and sugars.

- The edible part is an enlarged taproot that includes stem, hypocotyl, and root tissue.

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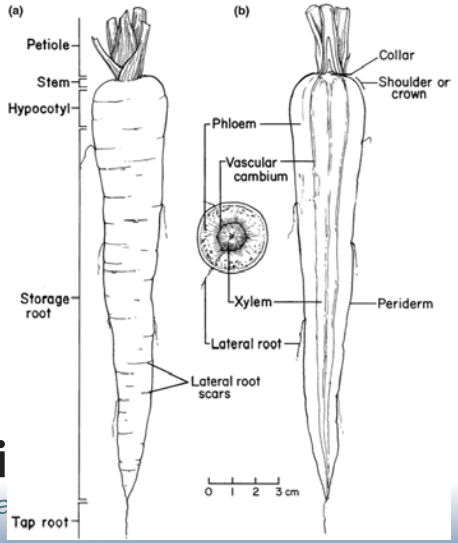
Carrots (*Daucus carota* var. *sativus*)

Plant Growth and Development



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Carrots (*Daucus carota* var. *sativus*)

Climatic and Cultural Requirements

- The carrot is a cool-season vegetable, that is affected by extreme temperatures.
- For optimum yield and quality including color development, carrots grow best at temp. of 59-65 °F.

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Carrots (*Daucus carota* var. *sativus*)

Climatic and Cultural Requirements

- High temp. causes roots to become shorter while cooler temp. makes them long and pointed.
- Temp. below 50°F decrease carotene production, resulting in poor color development.

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Carrots (*Daucus carota* var. *sativus*)

Climatic and Cultural Requirements

- Soil for carrot production should be deep, loose, well-drained sandy loams with slightly acidic pH.

- Heavy soil may cause carrots to produce abundant leaf growth and forked roots.

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Carrots (*Daucus carota* var. *sativus*)

Climatic and Cultural Requirements

- If manure is added, it should be well composted, otherwise it may stimulate branching of the roots.
- Soil fertility for carrots is relatively modest.
- Seedling are salt-sensitive.

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Carrots (*Daucus carota* var. *sativus*)

Planting and Crop Establishment

- Crop planting entirely from seed, and establishment is a major concern in commercial production.
- The seed is small and generally slow to germinate.
- Optimum soil temp. for germination is 50-85 °F.

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Carrots (*Daucus carota* var. *sativus*)

Planting and Crop Establishment

- Seedling growth is quite weak, and soil crusting can severely interfere with germination.
- The seedbed should be well pulverized.

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Carrots (*Daucus carota* var. *sativus*)

Weed Control

- Carrot seedlings grow slowly, so weed control is necessary.
- Weeds are difficult to control by machine cultivation.
- Hand weeding is too expensive in commercial plantings.

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Carrots (*Daucus carota* var. *sativus*)

Weed Control

- Options include both pre- and post-emergent herbicides.
- There are several herbicides available that will control weeds until carrot foliage is large enough to shade weed.
- Options include both pre- and post-emergent herbicides.

Carrots (*Daucus carota* var. *sativus*)

Cultivars

-Carrot cultivars may be grouped according to shape and length of the root and by intended market use.

-Grouping by shape and length, there are 4 types:

- Danvers
- Nantes
- Chantenay
- Imperator.

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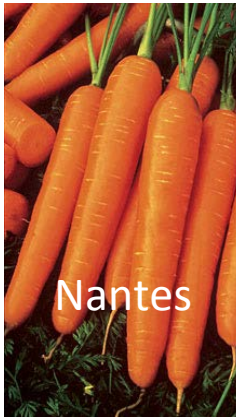
Carrots (*Daucus carota* var. *sativus*)



❑Use of beneficial organisms

➢ Natural enemies of garden pests

♦ **Parasites**: organisms that live and feeds in or on a host.

♦ **Pathogens**: microorganisms such as bacteria, fungi, nematodes, protozoa, and viruses that can infect and kill the host.

♦ **Predators**: kill and feed on several to many individual prey during their lifetimes.

- **Use of beneficial organisms**

  - **Natural enemies of garden pests**

❑ Use of beneficial organisms

➢ Natural enemies of garden pests

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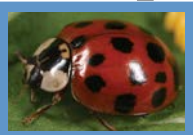
Natural enemies of garden pests

PESTS	 Lacewings	 Lady beetles	 Parasitic flies	 Parasitic wasps	 Predatory mites
Aphids	X	X		X	
Caterpillars	X		X	X	
Mealybugs	X	X		X	
Scales	X	X		X	X
Spider mites	X	X			X
Thrips	X			X	X
Whiteflies	X	X		X	

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Thank you for listening

Leonard J.M. Githinji, Ph.D.
Assistant Professor and Extension Specialist
Sustainable and Urban Agriculture
Virginia State University
(804) 524-5962
lgithinji@vsu.edu
www.agriculture.vsu.edu

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