



# Greens Production

## (Spinach, Turnip, Mustard, Collard, and Kale)

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## Production Requirements

Greens are cool season crops and are grown during both the spring and fall seasons. Spinach is also seeded during late fall and the crop overwinters and produces an early spring harvest the following year. Greens make their more vigorous growth at relatively low temperatures. They grow best in moderately deep, friable, highly fertile soil.

Spinach grows most rapidly under sunny conditions, with fairly long days and temperatures of 65° to 75°F during the day and 40° to 45°F at night. During early plant growth with temperatures of 39° to 50°F., 12-hour or longer days, and increasing daytime temperatures, the plant may produce a seedstalk (bolt), making the plant undesirable for market. Spinach and mustard crops planted in the spring are most likely to bolt. Selecting varieties that resist bolting will reduce the problem.

### Good Yield of Greens Grown in Oklahoma.

	<i>Processing</i>	<i>Fresh Market*</i>
Spinach	** 6 to 8 tons/A	500 to 650 bushels/A
Turnip	** 6 to 12 tons/A	500 to 1000 bushels/A
Mustard	** 8 to 10 tons/A	500 to 800 bushels/A
collard	8 to 10 tons/A	500 to 800 bushels/A
Kale	8 to 10 tons/A	500 to 800 bushels/A

\* 22 to 25 pounds per bushel.

\*\* Additional harvests can produce an additional 4 to 5 tons/A each.

## Varieties

- Spinach** — (35 to 45 days) Savoy Supreme, Chesapeake, Hybrid No. 7, America (long standing), Grandstand, Ozarka, Green Valley, Iron Duke, Fall Green, Kent, Coho.
- Turnip** — (45 to 50 days), (for greens only) Improved Crawford, Alltop, Seven Top and Shogoin; (for greens and roots) Purple Top White Globe, Just Right (white).
- Mustard** — (50 to 55 days) Slobolt, Southern Giant Curled, Florida Broad Leaf, Tendergreen.

Oklahoma Cooperative Extension Fact Sheets are also available on our website at: <http://www.osuextra.com>

- Collard** — (75 to 85 days) Vates (good cold tolerance, long standing), Champion, Georgia (bunching).
- Kale** — (45 to 55 days) Vates, Improved Siberian.

Buyers contracting greens for processing will designate the variety to be grown.

## Soil pH and Fertilizer

Neutral to slightly acid soil (pH 5.5 to 6.8) are preferred by turnip, mustard, collard, and kale. Spinach prefers a pH of 6.0 to 6.8. Apply lime if soil pH is too low. Based on OSU soil test results, the following amounts of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are recommended.

### Phosphorus per acre

When test shows	0-19	20-39	40-69	70+
Add lbs/A P <sub>2</sub> O <sub>5</sub>	75	50	25	0

### Potassium per acre

When test shows	0-99	100-149	150-199	200-249	250+
Add lbs/A K <sub>2</sub> O	200	150	100	50	0

**Nitrogen** — Apply 75 lbs per acre of N preplant. Topdress with an additional 50 lbs of N three weeks after emergence. Additional N may be needed for desirable color and rapid growth. When additional cuttings are to be taken from a planting, an additional 50 lbs per acre of N should be applied immediately after cutting to stimulate rapid growth.

For overwintered spinach apply 50 lbs per acre of N preplant and 50 lbs per acre three weeks later. In January and again in February, apply 50 lbs per acre of N for a total of 200 lbs per acre of N for the overwintered spinach crop. For additional information, see OSU Extension Fact Sheet F-6000, "Fertilizing Commercial Vegetables."

## Soil Preparation and Planting

Proper soil preparation is important to ensure uniform stands and high yields. Work the soil before planting to destroy any weeds and to bury all residue from previous crops. Make sure the depth is adequate so future operations will not bring the residue back to the surface. Previous crop

residue, tree leaves, and other plant debris can end up in the harvested crop and be a serious problem. Soil preparation should result in flat or raised beds with a “table top” finish of uniform soil. This permits an even depth of planting and more efficient mechanical harvesting.

Single rows may be spaced 30 to 36 inches apart for hand harvesting. For mechanical harvesting, plan the row and bed spacing to fit the harvester. As a general rule, plant four rows of turnip, mustard, collard, or kale about 16 inches apart on 72-inch beds. Plant three and a half to five lbs of seed per acre for turnips. About five lbs of seed per acre is needed for mustard, collard, and kale. For processing spinach, plant 15 lbs of seed per acre with six or seven rows on a 72-inch bed. Hand harvested fresh market spinach can be planted with eight to ten lbs of seed per acre. Plant seeds about one-half inch deep on sandy loam soils and more shallow on heavier textured soils.

The table below provides planting dates for central Oklahoma. Dates for southern Oklahoma would be about one week earlier and northern areas one week later than the central Oklahoma dates.

**Approximate planting Dates for Greens Grown in Central Oklahoma.**

	<i>Spring Crop</i>	<i>Fall Crop</i>	<i>Overwintered Crop</i>
Spinach	Mid January to late March	September to late October	November and December
Turnip	Earl March to May 1	September to early October	none
Mustard	Mid March to May 1	September to early October	none
Collard	Mid March to mid April	September	none
Kale	Mid March to May 1	September to early October	none

**Cultivation and Chemical Weed Control**

Shallow cultivation is desirable and is usually necessary to aid in controlling weeds. For chemical weed control recommendations, consult OSU Extension Fact Sheet F-6008 or the latest edition of OSU publication E-832, “Extension Agents’ Handbook of Insect, Plant Disease, and Weed Control.”

**Irrigation**

Greens are shallow-rooted and fast growing. Most processors will not contract with growers who cannot provide irrigation. Irrigation must be applied before plants begin to suffer to keep them in an active growing condition. Yields and quality are usually enhanced by irrigation.

**Diseases**

Because leaves are the edible portion, foliar diseases of greens are of particular economic importance. The occurrence of foliar diseases results in down-grading or rejection of the commodity at the market place. Foliar diseases of collard, mustard, and turnip caused by fungi include: *Alternaria* leaf

spot and black spot (*Alternaria* spp.). *Cercospora* leaf spot (*Cercospora brassicae*), downy mildew (*Peronospora parasitica*), and white spot (*Pseudocercospora capsellae*). The most common and detrimental bacterial disease of this group is black rot (*Xanthomonas campestris* pv. *campestris*). Foliar fungal diseases of spinach are represented by downy mildew or blue mold (*Peronospora spinaceae*) and white rust (*Albugo occidentalis*). Collard, mustard, and turnip are commonly infected by viruses, whereas spinach is not. All greens are subject to damping off caused by *Fusarium* spp., *Pythium* spp., and *Rhizoctonia solani*. Roots of these crops are sometimes affected by *Phytophthora* root and crown rot (*Phytophthora* spp.) and root-knot nematodes (*Meloidogyne* spp.). For a detailed description and recommended control procedures for diseases of collards, mustard, turnips, and spinach, consult the current edition of OSU publication E-832, “Extension Agents’ Handbook of Insect, Plant Disease, and Weed Control.”

**Insects**

Several insect pests are common problems in growing greens, which include spinach, turnip, mustard, collard, and kale. The insects described herein are common to each of these crops. The approach to managing pests of greens varies somewhat according to the crop’s intended use. For example, fresh market greens can tolerate little damage to the foliage, while the primary concern for processed greens is contamination of the product with insects. For specific insecticide information, refer to the current edition of OSU publication E-832, “Extension Agents’ Handbook of Insect, Plant Disease, and Weed Control.”

**Aphids.** Aphids are small soft-bodied insects which remove plant sap through their sucking-type mouthparts. Aphids are recognized by their cornicles (“exhaust pipelike” appendages) on their abdomen, visible under light magnification. Several aphid species, including the cabbage aphid, turnip aphid, and the green peach aphid, may be serious pests of greens. Aphids live in small compact colonies formed after the immigration of winged adults. Females reproduce asexually and give live birth to several nymphs per day. Because generation time is short, less than two weeks, many generations per year are produced, allowing for tremendous reproductive potential. Fields are colonized by winged adults migrating from other crops or weeds, and non-winged individuals reproduce and spread throughout the field. Damage to greens by aphids is manifested as stunting of growth, distortion of leaves, and potentially a reduction in tonnage. They are found on the underside of leaves and often stick to leaves after they have been killed by insecticides. Contamination of the harvested greens with aphids requires considerable effort during the washing process to remove them. The presence of aphids in greens creates a secondary problem by attracting lady beetles and parasitic wasps, which attach themselves to leaves as they reach the pupal stage. In spinach, aphids usually increase to greater populations on an overwintered crop than spring-planted spinach.

**Management:** Natural control from parasites, predators (such as lady beetles and lacewings), and environmental factors (such as heavy rainfall) can sometimes be effective in maintaining aphid populations, especially during fall production. However, the presence of these parasites and predators

also poses a contamination problem, especially for processed greens. Wild mustards serve as hosts for cabbage aphids and may speed the colonization of aphids into greens; therefore the destruction of these weeds before planting and maintenance of field margins may reduce aphid problems. Chemical control can be achieved with insecticides, provided care is taken to insure good coverage. This problem of poor coverage is especially true for spinach with leaves that curl under or are of the savoy type. Economic thresholds for aphids are not well defined for Oklahoma production. Control procedures are usually warranted shortly after aphids initially colonize and should be maintained below one to five percent of leaves infested, if possible. Monitoring of fields twice per week should be done to gain representative samples of each area of a field in order to quickly detect aphid immigrations.

Several species of foliage-feeding caterpillar pests are common in greens grown in Oklahoma, including (in order of importance) the cabbage looper, the diamondback moth, the imported cabbageworm, and occasionally the armyworm.

**Cabbage Looper.** Cabbage loopers are generally the most prevalent pest of the caterpillar complex. Looper adults are robust moths with brownish-gray forewings which have a silver '8' shaped marking. Hind-wings are light colored with dark margins. Eggs are dome-shaped and laid singly, usually on the undersurface of leaves. The light green larvae have three pair of jointed prolegs at the rear. Their name comes from their characteristic method of moving about plants by a "looping" action. Young larvae feed on the lower surface of leaves, creating a windowpane effect. Under warm temperatures, development of all the stages of the cabbage looper, from egg to adult, takes about 18 to 25 days. Four to five generations of cabbage loopers per year occur, with peak activity usually occurring in May or June, and in late September for fall-planted crops.

**Diamondback Moths.** Adults of the diamondback moth (DBM) are small, grayish-brown moths whose wings have a light-colored diamond pattern when folded at rest. Larvae are much smaller than looper larvae (usually less than one third inch long) and have a distinctive appearance. At the rear of the larvae, prolegs on the last segment are spread apart, forming a "V" shape. DBM larvae wriggle abruptly when disturbed, often dropping from the plant. Pupae are light green and are covered with a loosely spun, gauzelike cocoon. The life cycle takes about four to six weeks from egg to adult. In recent years, the DBM has achieved major pest status in greens and has become increasingly difficult to control with insecticides.

**Imported Cabbageworm.** Adults of the imported cabbageworm (ICW) are white butterflies with brown or black-tipped forewings and one or two dark spots on each forewing. Eggs are cigar-shaped, pale yellow, and are laid singly on the undersides of leaves. The velvet-like larvae of the ICW are pale green with a faint stripe down the back. The chrysalis or pupae is angle-shaped and may be green, gray, or brown. Cabbageworm eggs hatch in three to seven days and larvae develop through five instars in ten to fourteen days. The entire life cycle takes four to six weeks. The ICW is more cool weather adapted than the other caterpillar pests, occurring usually in mid-April in most years.

**Armyworms.** This group includes several species, with the beet armyworm and yellow striped armyworm usually being most common. Adult armyworms are robust dark colored moths that somewhat resemble cabbage looper adults.

Eggs are laid in tight clusters, and in the case of the beet armyworm, are covered with hairlike scales from the female's body giving them a cottony appearance. Beet armyworm larvae are usually light green with a dark spot on the side of the body above the second true leg, while the yellow striped armyworm has a pair of yellow stripes running the length of its body on top. The life cycles of armyworms take about three to five weeks to complete, depending on the temperature. Many hosts can be utilized by armyworms, including other crops such as beets, peppers, tomatoes, beans, and cotton. Some weeds are also good hosts, particularly pigweed (*Amaranthus* spp.)

**Damage by Caterpillar Pests.** Cabbage loopers, diamondback moths, imported cabbageworms and beet armyworms, all damage crucifers by chewing on foliage, causing ragged holes in leaves, and contaminating the harvested product with fecal material. In addition, as these caterpillars pupate, they usually attach themselves to leaf tissue and can subsequently contaminate the harvested leaves. These attached pupae are difficult to remove. Defoliation of leaves by larvae can be tolerated to a certain extent on processed greens, but very little on greens for the fresh market.

**Management.** Insecticide application decisions should be based primarily on the presence of larvae. If the greens crop is sold for fresh market, little damage can be tolerated. Slightly more damage can be tolerated in processed greens. However, if good control is not maintained, the risk of contaminations of the harvested crop increases. Recently, the diamondback moth has become more difficult to control with insecticides and high levels of resistance have been observed in several production areas. It is strongly advised to use a *Bacillus thuringiensis* (B.t.) product in each of the insecticide sprays as a basis for a control program. Destruction of crop residue and weeds that serve as alternate hosts for caterpillar pests is an important form of cultural control through the reduction of source populations. Because diamondback pupae survive in the soil and crop residue left behind after a cole crop is harvested, it is important to destroy crop residue after harvest by shredding and plowing it under. Armyworm populations often build up on pigweed at field margins and in fields where weed control is poor. It is important to destroy any pigweed near fields where greens are grown a couple of weeks before planting.

**Flea Beetles.** Flea beetles are tiny beetles that vary in color from metallic green to dark brown. Flea beetles chew on foliage of greens and when present in large numbers, they can cause severe defoliation of plants. Although larvae can feed on the roots of plants, it is the adult beetle that causes the greatest damage. Through feeding, they make small pits in leaves which create a "shothole" appearance in the leaf. Flea beetles will feed on newly emerged plants and can destroy the cotyledons by feeding on the growing plant. Their host range is broad and they sometimes move in large numbers into crops from adjacent weeds.

**Management.** It is important to provide good weed control in and around the field to reduce the source plants for the beetles. The use of an insecticide becomes necessary when beetles are present in fairly large numbers and a significant amount of defoliation is imminent.

**Seedcorn Maggots.** Seedcorn maggots can be a serious problem, especially during cold, wet seasons and on soils high in organic matter. Adults are small gray colored flies,

resembling a small house fly. Larvae (called maggots) are white, cone-shaped, and legless. They feed in the terminal, damaging the emerging leaves and larger plants (overwintered spinach), and their numbers peak in October and April of years with excessive rainfall. Freshly disturbed soil, fields with decaying crop residue, or soils high in organic matter are preferred egg-laying sites for females. Several generations per year occur and the pest's host range is broad, including most vegetable crops. Survival of maggots is low during the summer months or during periods when soil moisture is limiting.

*Management.* In soils where crop residue has not had time to degrade sufficiently or where organic matter content is relatively high, it is advisable to broadcast and lightly incorporate a soil insecticide in order to prevent seedcorn maggot eggs from hatching. Plowing crop residue earlier, to allow degradation, may be appropriate under some circumstances.

## Harvesting

Greens for processing are machine harvested and bulk loaded for delivery to the processing plant. With good cultural practices, up to three or four harvests of spinach may be obtained from a single planting. Turnips and mustard may also be harvested more than once per planting.

Greens for fresh market are usually hand harvested except for spinach, which is often machine harvested. Turnip,

mustard, collard, and kale are harvested when stalks are fairly young and tender. They should be clean and free of discolored and dying leaves.

## Handling and Marketing

Turnip, mustard, collard, and kale greens are hand bunched with three to five stalks per bunch. Lower leaves that are discolored or dying are removed when they are bunched. Bunched greens are usually washed and packed in bushel buckets, crates, or cartons containing 24 bunches weighing 23 to 24 lbs. Cartons or crates of 24 bunches of spinach usually weigh 20 to 22 lbs. Spinach is also packed in bush crates (20 to 25 lbs) without bunching. Spinach is often prepackaged before retail marketing in ten-ounce cello bags to maintain freshness. Greens are usually top-iced before shipment. This is a slow cooling method. Greens have high respiration rates, making them very perishable.

Some wholesale buyers are demanding more effective cooling prior to loading for long distance shipping.

## Storage

Greens are not usually stored. If they are kept iced at 32°F, they will remain in fairly good condition for 10 to 14 days in fresh market channels.