Crop Profile for Leafy Greens and Collards (Fresh Market) in South Carolina

Prepared: June 2004

General Production Information

Collard Greens: South Carolina producers grew 264,000 cwt. of collard greens in 2001*. This ranked South Carolina 2nd among other states in 2001 and represented 16 % of U. S. production. This amount was harvested from 2,200 acres out of 2,600 acres planted in 2001. South Carolina producers averaged 120 cwt. per acre and the crop was valued at $6,626,000.

Turnip Greens: The farmers in South Carolina sold 162,000 cwt of turnip greens for $3,915,000 in 2001*. This amount came from 900 acres harvested out of 1,000 acres planted. Producers averaged 180 cwt/acre in 2001. South Carolina accounted for 14.5 % of U. S. production in turnip greens ranking them 2nd in the nation.

Mustard Greens: South Carolina farmers produced 133,000 cwt. of mustard greens in 2001*. South Carolina was the 3rd leading state in the production of mustard greens accounting for 11 % of the U.S. production. South Carolina producers planted 700 acres of mustard greens of which 700 acres were harvested with an average production of 190 cwt/acre. The crop was worth $3,141,000.

Kale production in South Carolina in 2001* totaled 115,000 cwt, harvested from 500 acres. Total planted acreage of kale was 500 acres in 2001. South Carolina ranks 2nd nationally in the production of kale, producing 15 % of the U. S. total.

Other leafy brassica greens are commercially produced and shipped in South Carolina. Namely, rape and ‘creasy’ greens (upland cress – Barbarea verna) are produced on fairly significant acreage in at least one county. These greens haven’t been specifically listed on national or state agricultural statistics questionnaires but annually comprise near 10% of the greens acreage.

*2001 was the last year that annual statistics were kept for the individual leafy greens crops.

Production Regions

Collards, turnip and mustard greens, and kale are produced commercially in all three main
physiographic regions of South Carolina: the Piedmont, the Sandhills, and the Coastal Plain. The area of principal production is the Sandhills region in the center of South Carolina near Columbia. Other areas of significant production are the Pee Dee region in northeastern South Carolina, the Savannah Valley area in the southeastern part of the state, and the coastal islands near Charleston and Beaufort. The Piedmont region has the least area in production, although commercial production is reported from several of the counties in Piedmont. As in most of the South, these crops are grown to some extent in all of the 46 counties.

Cultural Practices

Collards, kale, and mustard and turnip greens are usually considered cool season crops and certainly most of the acreage is grown during the cooler seasons. However, South Carolina growers ship approximately ¼ of their annual production during the summer months. Their reputation as reliable producers of an acceptable quality crop allows them to take advantage of the higher prices during this time.

Planting dates vary depending on the area of the state with the eastern part of the state planting from the first of February through mid-May and beginning again around the first of August through the end of October. The western part of the state plants the spring crop from mid-March through the end of June and the fall crop from the first of August through the end of September. Leafy greens grow best in well-drained, loamy soils containing some organic matter, but much of the production in South Carolina takes place on the excessively-drained, sandy soils in the Sandhills region. These soils warm quickly and drain rapidly.

Irrigation and nutrient management are very important production practices for the acreage on these soils. A soil pH of 6.2 - 6.5 is necessary for optimum growth and quality, although many growers on extremely sandy soils adjust the pH to 6.8 to ensure adequate calcium uptake. Rapid, steady growth produces the highest quality crop. Sufficient nitrogen and adequate, timely irrigation are necessary to produce such a crop. Soil testing is recommended, but, for average soils, 1,200 - 1,500 lb/acre of 5-10-10 is added pre-plant. Nitrogen is applied as a side-dressing to give a total of 120 - 150 lb/acre of actual N. On very sandy soils, potash is also added as a side-dressing. Collards and kale are either transplanted or direct seeded, usually into 36 - 38 inch rows with 12 - 16 inches between plants. Some direct-seeded crops are planted in 3 - 5 rows on a 5 - 6 foot bed. Mustard and turnip greens can be direct seeded into single rows spaced 36 - 38 inches apart but more often multiple rows per bed are used. Irrigation is necessary to successfully grow leafy greens of consistent quality. Water volumes of 1 - 1½ inches per acre per week are required for reliable production.

Individual leaves or whole plants of collard or kale can be harvested, although most collard is harvested as cut whole plants and kale as individual leaves. Mustard and turnip are harvested as cut leaves. All harvesting for these fresh market crops is by hand. Although some may be direct-marketed loose, most
of the leafy greens are packed in approximately one-bushel, waxed, corrugated-paper cartons. A significant portion is now shipped to major retailers in returnable plastic cartons. The majority of South Carolina leafy greens are hydro-cooled and iced in the carton to preserve quality. ‘Top Bunch’ is the major collard variety, although significant amounts of ‘Morris Heading’, ‘Vates’, ‘Blue Max’, and ‘Georgia’ are grown, also. ‘Premier’ and ‘Blue Armor’ are the main kale varieties. Turnip green varieties are ‘Topper’, ‘Alamo’, ‘White Globe’, ‘Purple Top’, and ‘Seven Top’. The principal varieties of mustard green are ‘Southern Curled Giant’ and ‘Florida Broadleaf’.

Worker Activities

In transplanted collard and kale crops, workers obviously handle the plants as they are transplanted from some type of transplanter. Many collard and kale producers grow their own transplants, which necessitates even more handling by farm workers. Mustard and turnip greens are exclusively direct-seeded and require no handling for crop establishment. Collard and kale crops are occasionally hand-weeded or hoed, but this is not an economical practice for mustard or turnip greens. Although these practices are not common, when done they are tedious and require a great deal of time to be spent in close contact with the crop. Several mechanical cultivations are required for optimum growth, nutrient placement, and weed control. This requires one equipment operator and minimal contact with the crops. Likewise, pesticide applications are tractor tasks that also require one equipment operator and little crop contact. Harvesting requires close crop contact over repeated periods. If leaves are picked from collard or kale crops, three to ten harvests can be obtained from one planting. Mustard and turnip greens are harvested at least twice.

Insect Pests

Common insect pests of leafy greens in South Carolina are the cabbageworm complex (the cabbage looper, diamondback moth, and imported cabbageworm), aphids, cabbage webworms, and flea beetles. Whiteflies, thrips, root/seedcorn maggots, cutworms, armyworms, harlequin bugs, vegetable weevils, and wireworms are occasional pests or occur locally. Table 1 lists insecticides used for control of the various pests of leafy greens with estimates of use levels.

Diamondback moth (Plutella xylostella L.)

The larvae of this insect are serious pests of leafy greens worldwide. In South Carolina, they are active throughout the year except in the highest elevations during the winter months. In the summer production area in the Sandhills, they are very serious during the warm months. The adults are slightly larger than and shaped similarly to a grain of rice (about 1/3 inch long). Males have three diamond-
shaped markings on their backs. Eggs are laid singly or in small groups on the undersides of leaves and hatch in about 5 – 6 days with larval development lasting from 2 - 4 weeks. The larvae are small (~ ½ inch) and greenish. Their rear prolegs are visible as a slight ‘Y’ at the rear. Pupae are covered by a loose silken cocoon. Damage is caused by the larvae feeding mainly on the undersides of the leaves.

Insecticides are used for control, although resistance to most classes of insecticides has been reported in the diamondback moth. Preservation of natural enemies by using insecticides with few non-target effects is encouraged. Augmentation of natural enemies (using Cotesia plutellae and Trichogramma pretiosium) is effective in managing the diamondback moth. Most producers use insecticides to manage this insect. Application of insecticides are usually made weekly, although, in Lexington County in the Sandhills region, scouting is used to time applications and has resulted in an overall reduction in the number of applications per crop. Small growers commonly use older broad-spectrum insecticides because of their lower cost, but often with poor results, particularly in cases when multiple applications are used.

**Cabbage looper** (*Trichoplusia ni* Hubner)

Cabbage looper larvae feed on leafy greens primarily during the summer and early fall seasons. The larvae are much larger than the diamondback moth larvae and consequently cause much greater damage. Cabbage looper adults are grayish-brown moths with an indistinct figure-8 design on the front wings. They are approximately one inch long. The eggs are laid singly on both the top and bottom sides of leaves. They hatch in several days into greenish larvae with white stripes running the length of the body. They pupate in loose silken cocoons. There are a number of natural enemies which impact cabbage looper populations, but, due the feeding habits of the larvae, insecticidal control is normally required. Cabbage looper larvae are rather difficult to kill. The molt-accelerating compound, methoxyfenozide (Intrepid®) has begun to be used and is effective in controlling large larvae.

**Imported cabbageworm** (*Pieris rapae* L.)

This butterfly lays single, cigar-shaped eggs on the tops of leaves. The larvae are heavy feeders and will quickly move into the bud area of collard and kale plants causing severe damage. Adults are the large (~ 2-inch wing span), white butterflies seen commonly visiting flowering plants adjacent to leafy greens plantings. The larvae are green, covered with short, velvety hairs, and have a yellowish stripe down their backs. Being butterflies, they pupate in a chrysalis which has two sharp projections near the head end and is suspended from the leaf by silk threads. Natural enemies (particularly parasitic wasps) exert a strong effect in reducing imported cabbageworm populations. However, insecticides are still required in most areas of the state. In the major production area, the Sandhills, this pest is minor due to natural enemies and the insecticide programs for diamondback moth and cabbage looper. *Bacillus thuringiensis* toxin insecticides are very effective for management of this insect, and, if this is the principal pest in a locality, these may be the only insecticides necessary to produce a clean crop.

**Aphids** (various species)
Several species of aphids attack leafy greens. Aphids will reproduce during the season without mating (parthenogenetically), bearing all females. There are a large number of generations per year - 15 to 45 for some species. The green peach aphid (*Myzus persicae* Sulz.) is often found infesting mustard and turnip and can be a vector of Turnip Mosaic Virus. It is a particularly problematic when discovered just before harvest. The green peach aphid is also reported from collard where it can be a vector for Cucumber Mosaic Virus and other non-persistent, stylet-borne viruses. Although natural enemies will normally reduce populations to less than damaging levels, insecticides are used for infestations near harvest or in an effort to prevent virus diseases (See Disease Control Section). The turnip aphid (*Hyadaphis erysimi* (Kaltenbach) and cabbage aphid (*Brevicoryne brassicae* (L.)) are similar insects which secrete a waxy material and can cause severe yellowing and cupping of the leaves. These aphids should be controlled with insecticides before cupping of the leaves occurs.

**Webworms** (Cabbage webworm, (*Hellula rogatalis*(Hulst))

The larvae of this moth is found in leafy greens and can be a serious pest of collard and kale. The cabbage webworm is gray with reddish stripes running down the body. It has a dark head, will bore into stems and midveins, and produce silken tunnels on or between leaves. The cabbage webworm will feed in the bud destroying apical dominance, resulting in a bushy, unmarketable plant. Even light infestations of this pest can cause serious losses in collard and kale. Although *Bt* based insecticides will kill this insect, due their webbing, sprays of *Bt* materials often do not reach it in high enough concentration for control. Chemical insecticides must be used.

**Flea beetles and leaf beetles** (Striped flea beetle (*Phyllotreta striolata* (F.)) and the yellowmargin leaf beetle (*Microtheca ochrolema* Stål))

The striped flea beetle is a small dark insect with a light stripe on each wing cover. It is common statewide and attacks all leafy greens; it readily hops using its rear legs, hence the name. The larvae develop in the soil feeding on roots. It is more common in heavy soils or those with higher organic matter content. Weedy field borders provide good habitat for reproduction and overwintering. The yellowmargin leaf beetle isn’t a true flea beetle but is closely related to them. It is larger that the striped flea beetle and has yellow stripes along the margins of each wing cover. It has been more frequently reported in the past few years. The larvae and adults feed mainly on the leaves of turnip and mustard but are occasionally found feeding on collard. It can be locally severe causing almost complete losses in some plantings where growers are relying on a *Bt* program for insect control. These beetles are normally early season pests with usually no more than two generations per season.

**Harlequin bugs** (*Murgantia histrionica* (Hahn))

These brightly colored red and black bugs are related to stink bugs but are scentless. Although in other areas of the Southeast they are described as serious pests of leafy greens, they haven’t been as serious in South Carolina. However, with more growers beginning to produce greens, particularly collard in the summer, this insect is becoming more of a pest. The adults and nymphs feed on the leaves causing
whitish areas on them. Only moderate feeding damage is enough to render the plant unmarketable. There are 2 - 4 generations of harlequin bugs per year, and they overwinter in field debris and weedy borders. The adults are difficult to control with insecticides.

**Minor Pests**

Cabbage maggots are pests of collard and kale only in the higher elevations of the Upstate region. Root maggots can be pests in the early spring throughout the state when decaying crop residues are present in the field. Proper crop management, including good sanitation, and good site selection will limit problems with these insects.

Whiteflies are problematic along the southern coast and will persist into the winter months. Their feeding causes yellowing of the leaves and results in a sticky residue.

Cutworms, wireworms, thrips, and vegetable weevils will occasionally be reported on leafy greens or are localized problems but aren’t generally considered to be significant pests on the majority of the acreage of leafy greens in South Carolina. Control of the soil pests (wireworms and maggots) often is not attempted, because damage isn’t noticed until after the proper time to apply insecticides. Cutworms are managed by directed-sprays of pyrethroids or high volume sprays of diazinon. Good pre-plant management of weeds and proper field preparation has reduced cutworm problems in recent years. Vegetable weevils occur locally around the state with the Pee Dee region reporting the greatest problem. As growers of leafy greens have reduced their reliance on broad-spectrum insecticides or these materials have become unavailable, the incidence of thrips problems on leafy greens has declined in South Carolina.

**Table 1. Common Pests of Leafy Greens in South Carolina and Insecticides Used for Control.**

<table>
<thead>
<tr>
<th>Pest</th>
<th>Insecticide</th>
<th>Use Level*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamondback moth</td>
<td><em>Bt</em> (Xentari®, Javelin®, Dipel®, MVP®, and others, [0.5 to 2 lb/A]), Spintor® (6 oz/A), Proclaim® (4.8 oz/A)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Pyrethroids (0.025 to 0.1 lb ai/A)</td>
<td>O</td>
</tr>
<tr>
<td>Pest</td>
<td>Recommended Control Measures</td>
<td>Mode of Action</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Cabbage looper</td>
<td>Carbaryl (1 to 1.5 lb ai/A), malathion (0.75 to 1.0 lb ai/A), endosulfan (0.75 lb ai/A)</td>
<td>R – O</td>
</tr>
<tr>
<td></td>
<td>Dipel® (0.5 to 1.0 lb/A)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Intrepid® (4 to 10 oz/A), Proclaim® (3.2 – 4.8 oz/A), and pyrethroids (0.025 to 0.1 lb ai/A)</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Lannate SP® (0.5 lb/A)</td>
<td>R</td>
</tr>
<tr>
<td>Imported cabbageworm</td>
<td>Bt materials (0.5 to 2.0 lb/A)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Pyrethroids (0.025 to 0.1 lb ai/A), carbaryl (1 to 1.5 lb ai/A), malathion (0.75 to 1.0 lb ai/A), endosulfan (0.75 lb ai/A)</td>
<td>O</td>
</tr>
<tr>
<td>Aphids</td>
<td>Dibrom (1 pt/A), pyrethroids (0.025 to 0.1 lb ai/A), Provado® (3.75 oz/A)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Malathion (0.75 to 1.0 lb ai/A), endosulfan (0.75 lb ai/A)</td>
<td>O</td>
</tr>
<tr>
<td>Cabbage webworm</td>
<td>Pyrethroids (0.025 to 0.1 lb ai/A), Lannate SP® (0.5 lb/A)</td>
<td>O</td>
</tr>
<tr>
<td>Insects</td>
<td>Proclaimed® (3.2 – 4.8 oz/A), Spintor® (6 oz/A)</td>
<td>R</td>
</tr>
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<td>---------</td>
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</tr>
<tr>
<td>Flea beetles</td>
<td>Provado® (3.75 oz/A), pyrethroids (0.025 to 0.1 lb ai/A), endosulfan (0.75 lb ai/A), carbaryl (1 to 1.5 lb ai/A)</td>
<td>O</td>
</tr>
<tr>
<td>Harlequin bugs</td>
<td>Pyrethroids (0.025 to 0.1 lb ai/A), endosulfan (0.75 lb ai/A)</td>
<td>O</td>
</tr>
</tbody>
</table>

*Number of growers claiming use and amount of acreage to which materials are applied.

R = rarely, few acres; O = occasionally, moderate acreage; F = frequently, large acreage. Information from grower visits and grower and Extension agent interviews.

### Weeds

Weeds can seriously limit yields in leafy brassica crops. Herbicides are applied to almost all of the acreage, although many small producers do not use herbicides and manage weeds by using cultivation and hoeing only. Even in fields where herbicides are used, cultivation is practiced for horticultural purposes and provides some weed control especially in row middles. Because cultivation is a common production practice, banding of herbicides is practiced particularly for direct-seeded, leafy brassica crops.

Pigweeds (*Amaranthus* spp.), lambsquarter (*Chenopodium album*), smartweeds (*Polygonum* spp.), chickweeds (*Stellaria media* and *Cerastium* spp.), carpetweed (*Mollugo oleracea* and *pilosa*), and annual grasses such as crab grass (*Digitaria* spp.) and goose grass (*Eleusine indica*) are found in brassica fields across the state. Trifluralin (various manufacturers) is widely used at 0.5 to 0.75 lbs of active ingredient/A as a pre-plant incorporated (PPI) treatment to control many of the weeds listed above. In areas where the crops are planted on beds, redistribution of PPI materials during the bedding process results in erratic weed control. DCPA (Dacthal®) at 6 – 7.5 lb active ingredient/A is used on significant acreage in the Sandhills region particularly on direct-seeded collards and kale and on turnip and mustard greens. Bensulide (Prefar®) at 5 – 6 lb active ingredient/A is used in place of trifluralin on some acreage. Incorporation by irrigation is necessary if PPI application is not used; a number of growers do not use irrigation, so Prefar® is not used as widely as trifluralin. The graminicides, Sethoxydim (Poast®) @ 0.2 to 0.3 lb active ingredient/A and Clethoxydim (Select®) @ 0.09 to 0.125 lb active ingredient/A) are used on approximately 10% of the leafy brassica acreage.
Peppery leaf spot (caused by *Pseudomonas syringae* pathovar *maculicola*)

Peppery leaf spot has been most damaging on turnip, but also is found on mustard, rape salad greens, and collard in South Carolina. This bacterial disease starts as tiny water-soaked to yellow spots on leaves. The spots turn dark ("peppery") and are surrounded by a yellow halo, caused by the coronatin toxin produced by the bacterium. Peppery leaf spot is a sporadic disease; occurrence also is affected by weather. Hard rains with driving wind or sandblasting injure leaves and allow the bacteria, if present, to rapidly enter the plants. The leaf spots damage the leaves and make them unmarketable. If more than 1-2% of the leaves are infected, the plant is not marketable, even if diseased leaves are trimmed. In certain years, 10% of the acreage in the major greens-growing area of South Carolina has been affected with peppery leaf spot. Control measures must be implemented before infection. The yield loss has been 5% per year on average but may be as high as 100% in severely affected fields.

**Chemical Controls:** *Note:* Copper hydroxide *significantly increased* disease in three field experiments compared to no copper sprays. As few as two applications of copper hydroxide (Kocide DF) at 1.2 lb/A induced disease development when bacteria were present on leaf surfaces. Copper salts of fatty and rosin acids (Tenn-Cop 5E) at 1 pt/A also increased disease in certain experiments. Therefore, copper is not recommended for this disease.

**Alternatives:** Serenade (a strain of *Bacillus subtilis*) at 4-6 lb/A, Messenger (harpin protein) at 0.3 lb/A, and phosphorous acid derivatives (Prophyt) at 6 oz/A have been tested, but the trials were inconclusive. *Note:* Applications of Sonata (a strain of *Bacillus pumilus*) *increased* disease.

**Cultural Control Practices:** Avoid overhead irrigation. Increase plant spacing. Using a grassy cover between rows may reduce sandblasting injury, but this has not been tested. Crop rotation away from leafy brassica crops for 1 to 2 years allows infested debris to decay.

**Other Issues:** Avoid contaminated seed. Because this disease has appeared in CA, OK, and OH at various times previously, contaminated seed is suspected in initial outbreaks. Currently, there are no effective control measures for this disease.

Black rot (caused by *Xanthomonas campestris* pv. *campestris*)

Black rot affects all leafy greens, but collard and kale are more commonly infected than mustard and turnip. The bacteria enter leaves through hydathodes at the leaf margins, causing the veins to turn black and leaf laminae to yellow. If the bacterium reaches the main stem, the entire plant may be affected and wilt. Leaves on infected plants are unmarketable, as the disease may develop post-harvest on infected but asymptomatic leaves. The disease is sporadic and is more common in cool or moderate temperatures than during the summer. Control measures must be implemented before infection. Yield losses average
less than 5% over the years, but may be as high as 100% in severely affected fields.

**Chemical Controls:** Various formulations of copper-containing fungicides (copper hydroxide, copper salts of fatty and rosin acids, copper oxychloride) are recommended in general for bacterial diseases. Research in other states has shown that applications of copper in seedbeds or to transplants reduced disease incidence.

**Alternatives:** No alternative products have been tested.

**Cultural Control Practices:** Avoid overhead irrigation. Increase plant spacing. Do not enter fields when leaves are wet. Crop rotation away from leafy brassica crops for 1 to 2 years to allow infested debris to decay.

**Other Issues:** Do not use suspected contaminated seed.

**Downy mildew** (caused by *Peronospora parasitica*)

Downy mildew is a weather-related disease in South Carolina that occurs during fall, winter, and spring production periods, particularly when mornings are foggy. Downy mildew causes irregular, pale yellow spots on leaves with gray fungus growth on the leaf undersides. Collard and kale are more susceptible to downy mildew than other leafy brassicas. Leaves with more than 1% surface area affected are unmarketable and these leaves must be trimmed (on collard and kale), culled, or left in the field when cutting. Control measures should begin before infection or as soon as disease is detected, if newer systemic fungicides are used. Yield losses average 5-10% and, in a year with heavy disease pressure, up to 25% of the acreage may be affected.

**Chemical Controls:** Fosetyl-Al (Aliette WSP or WDG) at 3-5 lb/A or azoxystrobin (Quadris SC at 6.2-15.4 fl. oz./acre) are the most effective fungicides. When downy mildew is present or threatening, crops are sprayed about three times per growing period. The pre-harvest interval (PHI) on Aliette is 3 days, but it is 0 days on Quadris. Maneb (WSP or DF at 1.5-2 lb/A) may still be used on kale only; however, the long PHI of 10 days mandates early-season use only. Approximately 75% of the crop is treated during fall and spring, but some small-acreage producers do not spray for downy mildew.

**Alternatives:** Copper hydroxide (Kocide DF at 1-2 lb/acre or 4.5 LF at 2/3 - 1 1/3 pt/acre) or basic copper sulfate (Top Cop - Tri Basic at 2 qt/A or Cuprofix Disperss DF at 1.5-2.5 lb/A) were used to a greater extent before Aliette and Quadris were labeled on leafy brassica crops. These alternatives are less effective because they are protectants only and multiple applications cause phytotoxicity.

**Cultural Control Practices:** Avoid overhead irrigation. Rotate away from all brassica crops for 2 years to allow woody stem tissue, which may harbor survival spores (oospores) of the pathogen, to decay.
**Alternaria leaf spot** (caused by *Alternaria brassicae* and *A. brassicicola*)

Alternaria leaf spot occurs yearly on leafy brassica crops grown in South Carolina, particularly collard. Leaf spots are generally round and tan to dark brown. On some cultivars, yellow haloes are present around leaf spots. Leaves with more than 2% surface area affected are unmarketable and must be trimmed or left in the field when cutting. Control measures should begin before infection or as soon as disease is detected, if azoxystrobin is used. Approximately 40% of the crop is affected at some level each year, and yield losses average 5% yearly.

**Chemical Controls:** Azoxystrobin (Quadris SC at 6.2-15.4 fl. oz./acre) is the most effective fungicide. Crops are sprayed two or three times per growing period. The PHI on Quadris is 0 days. Maneb (WSP or DF at 1.5-2 lb/A) may still be used on kale only; however, the long PHI of 10 days mandates early-season use only. Approximately 30% of the crop is treated, although some small-acreage producers do not spray for diseases at all.

**Alternatives:** Copper fungicides are not effective against Alternaria leaf spot.

**Cultural Control Practices:** Increasing row spacing by 25% reduces length of leaf wetness periods and reduces the number of infections. Avoid overhead irrigation. Rotate away from all brassica crops for 1-2 years to allow infested debris to decay.

**White spot** (caused by *Pseudocercosporella capsellae*)

White spot is a sporadic disease in South Carolina, where it occurs most frequently during the spring when temperatures are moderate. White spot is the most common foliar disease on mustard and turnip, but it is not common on collard or kale. Off-white, beige or tan spots form on leaves; yellowing may or may not be present. Leaves with more than 2% surface area affected are unmarketable and must be trimmed or left in the field when cutting. Control measures should begin before infection or as soon as disease is detected, if azoxystrobin is used. Approximately 20% of the acreage of mustard and turnip is affected with average yield losses of 5%.

**Chemical Controls:** Azoxystrobin (Quadris SC at 6.2-15.4 fl. oz./acre) is the most effective fungicide. Crops are sprayed two or three times per growing period. The PHI on Quadris is 0 days. Some small-acreage growers do not spray their crops.

**Alternatives:** Copper hydroxide (Kocide DF at 1-2 lb/acre or 4.5 LF at 2/3 - 1 1/3 pt/acre) or basic copper sulfate (Top Cop - Tri Basic at 2 qt/A or Cuprofix Disperss DF at 1.5-2.5 lb/A) were used before Quadris was labeled on leafy brassica crops. Coppers are less effective because they are protectants only and cause phytotoxicity to the tender leaves of mustard and turnip.

Serenade (*Bacillus subtilis*) at 4 lb/A may give some control compared to no sprays, but it is much less effective than conventional fungicides.
**Cultural Control Practices:** Eliminate cruciferous weeds, such as wild radish, near fields of leafy brassica vegetables. Avoid overhead irrigation. Rotate away from all brassica crops for 1-2 years to allow infested debris to decay.

**Other Issues:** Other strobilurins also are known to be effective, but are not yet registered on leafy brassica greens.

**Yellows (caused by *Fusarium oxysporum* f. sp. *conglutinans)*

Yellows is the name given to Fusarium wilt of cole crops. Yellows affects collard and kale when these crops are grown during the summer months in South Carolina. This disease occurs yearly if infested fields are planted during June to September. Approximately 30% of the acreage is infested, but only 10% of the acreage is severely infested. Diseased plants are not marketable, due to yellowing or wilting of leaves. Kale is very susceptible and infected plants often die before reaching marketable size. Yield losses of 20-40% occur in severely infested fields.

**Chemical Controls:** No chemicals are effective.

**Cucumber mosaic (caused by *Cucumber mosaic cucumovirus* [CMV])**

Cucumber mosaic virus occurs sporadically on leafy brassica crops, particularly collard. Aphids transmit this virus in a non-persistent manner by as they probe leaves in search of feeding sites. The virus causes yellowing, mottling (mosaic), and rugosity (crinkling) of leaves and, when severe, stunting of plants. Yield losses can be 5%.

**Chemical Controls:** Imidacloprid (Provado 1.6F at 3.75 fl. oz./A) is applied as a foliar spray sometimes after virus symptoms are noticed in an attempt to control aphid vectors of viruses. Insecticides do not prevent transmission of viruses carried in a non-persistent manner by aphids.

**Alternatives:** None.

**Cultural Control Practices:** Eliminate weeds that are hosts of CMV, such as shepherd’s purse, lamb’s quarter, clovers, and vetches. Using reflective mulch for aphid control is not economically feasible with leafy brassica crops.

**Turnip mosaic (caused by *Turnip mosaic potyvirus* [TuMV])**
Turnip mosaic virus occurs sporadically on leafy brassica crops. Aphids, particularly *Myzus persicae*, transmit this virus in a non-persistent manner by as they probe leaves in search of feeding sites. The virus causes yellowing, mottling (mosaic), and rugosity (crinkling) of leaves and, when severe, stunting of plants. Yield losses are less than 5%.

**Chemical Controls:** Imidaclopid (Provado 1.6F at 3.75 fl. oz./A) is applied as a foliar spray sometimes after virus symptoms are noticed in an attempt to control aphid vectors of viruses. Insecticides do not prevent transmission of viruses carried in a non-persistent manner by aphids.

**Alternatives:** None.

**Cultural Control Practices:** Eliminate weeds that are hosts of TuMV, such as shepherd’s purse and chickweed. Using reflective mulch for aphid control is not economically feasible with leafy brassica crops.

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**References**

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