

Crop Profile for Leafy Greens in North Carolina

Prepared: July, 2003

General Production Information

- North Carolina growers produced 243,000 cwt. of collards in 2001. North Carolina ranked third among the states in the production of collards in 2001, representing 14.5 percent of the U. S. production. A total of 2,800 acres of collards were planted and 2,700 acres of collards harvested in North Carolina in 2001. Growers in the state produced 90 cwt. of collards per acre in 2001, valued at \$6,318,000.
- Growers in North Carolina produced 147,000 cwt. of turnip greens in 2001. North Carolina ranked third among the states in the production of turnip greens in 2001, representing 13.1 percent of the U. S. production. A total of 2,200 acres of turnip greens were planted and 2,100 acres of turnip greens harvested in North Carolina in 2001. Growers in the state produced 70 cwt. of turnip greens per acre in 2001, valued at \$3,822,000.
- The production of mustard greens in North Carolina totaled 91,000 cwt. in 2001. North Carolina ranked fifth among the states in the production of mustard greens in 2001, representing 8.8 percent of the U. S. production. A total of 1,400 acres of mustard greens were planted and 1,300 acres of mustard greens harvested in North Carolina in 2001. Growers in the state produced 70 cwt. of turnip greens per acre in 2001, valued at \$2,457,000.

Production Regions

Collards, kale, turnip greens and mustard greens are produced in all three of the regions of North Carolina, the Coastal Plain, Piedmont and Mountains. Leading counties in acreage and production of leafy greens include Sampson, Duplin, Cumberland, Pitt, Wilson, Lenoir, Greene, Wayne, Richmond, Johnston, Halifax, Edgecombe, Onslow, Robeson and Columbus.

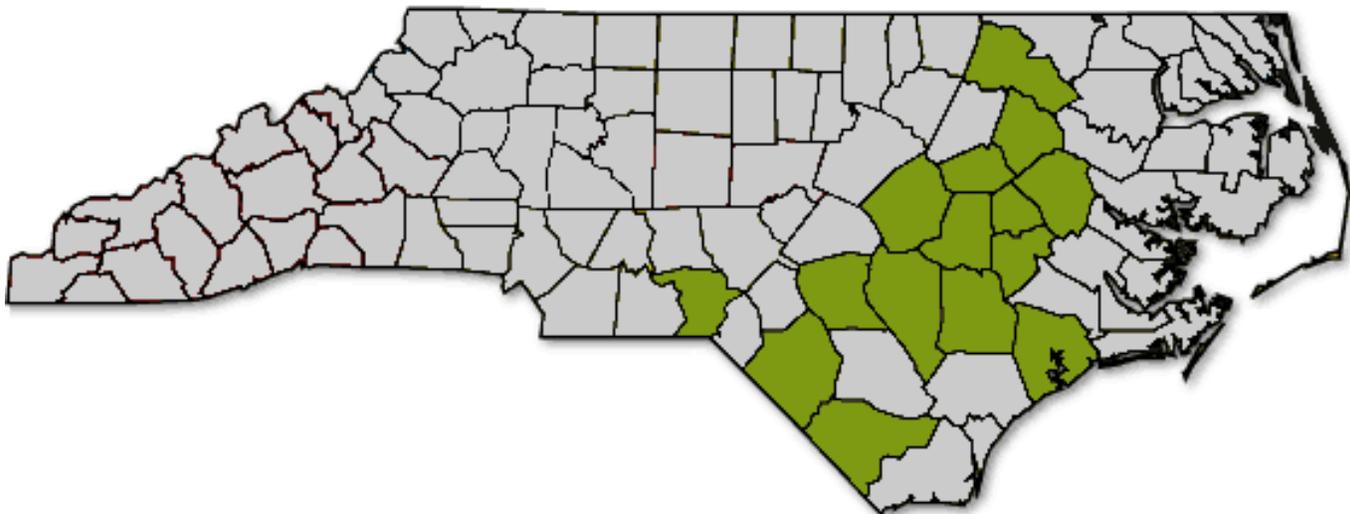


Figure 1. Leading leafy green-producing counties in North Carolina (shaded in green).

Production Practices

Collards, kale and other leafy greens (mustard and turnip) are cool season crops and are grown in the early spring and fall for maximum yields and quality. Kale can withstand temperatures in the upper teens; however, the other greens can withstand medium frosts. Planting dates for leafy greens in the state's Coastal Plain, Piedmont and Mountains are provide in Table 1. Leafy greens grow best in well-drained soils, rich in organic matter. Loams generally produce the greatest yields of leafy greens; however, sandy loams are better for overwintering and spring crops. A soil pH of 6.0 to 6.5 is optimum. Leafy greens require quick, continuous growth to achieve the best quality. Nitrogen is needed for good color and tenderness. Soil testing is recommended; however, for average soils growers use 600 pounds of 10-10-10 fertilizer per acre before planting and sidedress with 15 to 30 pounds of nitrogen per acre after seeding or transplanting. When planting leafy greens, collards can be transplanted or direct seeded, while mustard and turnips are direct seeded. Irrigation of leafy greens is important to provide adequate moisture for continuous growth of the crop. The entire plant or individual leaves can be harvested. At harvest, leafy greens are often packed in ice to maintain freshness for distance shipping.

Table 1. Planting dates for leafy greens in North Carolina.

Region	Spring	Fall
Coastal Plain	February 1 - April 15	August 1 - September 15
Piedmont	February 15 - April 30	July 15 - September 15
Mountains	March 1 - August 15	

Varieties of collards planted by North Carolina growers include Morris Heading, Vates, Georgia Southern, Champion, Carolina and Blue Max, while kale varieties include Siberian, Winterbor, Blue Armor and Vates. Varieties of mustard greens planted by growers in the state include Southern Giant Curled and Tendergreen (Mustard Spinach), and turnip green varieties include Purple Top White Globe and Seven Top.

Worker Activities

For some plantings, workers mechanically transplant young seedlings of collards and kale. Crops of mustard and turnip are always direct seeded and fall crops of collards and kale can be direct seeded or transplanted. Workers on tractors will be in the field for the one to three cultivations necessary for weed control for all the leafy green crops. Sometimes cultivation is not sufficient for weed control. It is necessary to hoe collards and kale plantings and for this activity workers may be in the field for a day. During a spray application, one worker will be in the field driving a tractor with the sprayer. During the one to six harvests, workers are in the field for harvest-related work. Table 2 lists the times that workers may be in the field for each of the leafy green crops.

Table 2. Activities for which workers are in collard, kale, mustard green and turnip green fields.

	Collards	Kale	Mustard	Turnip

Activity:	Plant	Seed	Plant	Seed	Seed	Seed
Crop establishment	M/H ¹	M	M/H	M	M	M
Pesticide application	M	M	M	M	M	M
Cultivation for weeds	M	M	M	M	M	M
Hoeing	H	H	H	H	--	--
Harvesting	3-6H	3-6H	3-6H	3-6H /1M	3H/1M	3H /1M

¹ M = machine; H = hand.

Insect Pests

Insect pests of leafy greens (i.e., collards, kale, mustard greens and turnip greens) in North Carolina include the cabbage worm complex (cabbage loopers, diamondback moths, imported cabbageworms, corn earworms, beet armyworms, cutworms, and cabbage webworms), Harlequin bugs, stink bugs, aphids (cabbage and turnip), flea beetles, vegetable weevils, thrips, whiteflies, and root maggots. These insects must be managed throughout the production season, and especially in the summer and fall. Table 3 contains a list of insects for which North Carolina growers used insecticides to produce leafy greens in 1999. Approximately 78 percent of North Carolina growers used insecticides in 1999.

Table 3. Insects for which insecticides were used by North Carolina growers in producing collards, kale, mustard greens and turnip greens during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Insect	Percent of Leafy Green Growers Reporting Insect ¹			
	Collards	Kale	Mustard Greens	Turnip Greens
Aphids	44.90	16.33	26.53	28.57
Cabbage loopers	77.55	14.29	16.33	16.33
Imported cabbageworms	44.90	14.29	14.29	18.37
Diamondback moths	55.10	18.37	22.45	24.49
Flea beetles	20.41	14.29	18.37	18.37
Harlequin bugs	34.69	12.24	10.20	12.24
Root maggots	8.16	6.12	6.12	6.12
Stink bugs	24.49	10.20	14.29	14.29
Thrips	16.33	6.12	10.20	10.20
Vegetable weevils	14.29	10.20	10.20	12.24
Whiteflies	26.53	10.20	10.20	12.24

¹ Of the 63 leafy green growers responding to the mail survey, 49 respondents used insecticides to control insects in 1999.

Cabbage loopers, *Trichoplusia ni* (Hubner)

Cabbage loopers feed on a variety of vegetable crops, including leafy greens. They are destructive pests that can cause economic damage to these crops. The adult is a brownish-gray moth with a figure-eight design in the forewing and migrates from overwintering sites in Florida and adjacent states into North Carolina in June in most years. Small round greenish-white eggs are deposited singly on the upper and lower sides of leaves and hatch in several days into larvae that are green with white stripes running the length of the body. There are three or more generations of cabbage loopers per year in North Carolina.

Damage to crops occurs as a result of larval feeding on the undersides of the leaves. Management of cabbage loopers primarily involves insecticides. Promotion of natural enemies is also helpful in cabbage looper management. Adults are attracted to both black light and pheromone insect traps which can be used for monitoring purposes.

Diamondback moths, *Plutella xylostella* (Linnaeus)

Diamondback moth larvae are serious pests of collards and other leafy greens in North Carolina. The adults are gray moths that are about 1/3 inch in length. Male moths have three yellow diamond-shaped markings on their backs. Female moths lay small yellow to white eggs singly or in small groups on the leaves or stalk of their host plants, which hatch in 5 to 6 days. Larvae are light green in color, tapered at each end, and covered with tiny, erect black hairs. The larval stage of the diamondback moth consists of 4 instar stages lasting 10 to 30 days. There are 5 to 6 generations of diamondback moths per year in North Carolina.

Damage to crops is caused by the larvae feeding on plant tissue on the undersides of the leaves, leaving holes in the leaves. Diamondback moth larvae can be managed through the use of insecticides; however, they have become increasingly difficult to control due to insecticide resistance. Promotion of natural enemies (i.e., parasites, diseases and predators) is also helpful in diamondback moth larvae management. Adult moths are attracted to sex pheromone traps (water pan traps) which can be used for monitoring purposes. Mating disruption using Check Mate sprays are under evaluation.



Figure 2. County Extension agent checking diamondback moth sex pheromone trap. Photograph by Kenneth A. Sorensen.

Imported cabbageworms, *Pieris rapae* (Linnaeus)

The adults are white moths with 3 or 4 black spots on their wings. Eggs are laid singly on leaves of the host plant. Larvae are velvety green with a slender orange stripe down the middle of the back and along each side and 1-1/4 inches in length when fully grown. There are 3 or 4 generations of imported cabbageworms each year.

Damage to crops is caused by larvae feeding on the leaves, resulting in large holes in the leaves. Management of these pests involves the application of insecticides, cultural controls (crop rotation, destruction of crop residues and use of resistant varieties), and promoting natural enemies (parasites, predators and diseases).

Harlequin bugs, *Murgantia histrionica* (Hahn)

Harlequin bugs are a major pest of collards, turnips and other crucifers. The adults are black, shield-shaped bugs (Order Hemiptera) with reddish-orange and yellow markings. The nymphs resemble the adults, but are smaller, oval-shaped and wingless. The adults survive the winter months in overwintering sites and emerge in the spring. Females lay eggs on the undersides of the leaves of the host plant. Black and white barrel-shaped eggs are laid in double-row clusters of 10 to 13 eggs, with each female depositing approximately 155 eggs. The eggs hatch in 4 to 5 days and the nymphs feed for 6 to 8 weeks (developing through 5 instar stages into adults). There are 2 to 4 generations of

Harlequin bugs per year.

Both the nymphs and adults pierce stalks and leaves with needle-like mouthparts to feed on plant juices. Injury to the stalks and leaves of younger plants can cause wilting, brown coloration and eventual death of the plant. Older plants can be stunted. Overwintering populations of adult Harlequin bugs can be reduced by plowing under field debris at the onset of winter and the destruction of weeds in fields and along field borders to eliminate overwintering sites. Cultural practices such as planting resistant varieties also help to manage these insect pests. Insecticides are used to manage harlequin bugs when they are small and first appear. Repeated application of insecticides are often required.



Figure 3. Harlequin bugs on collards. Photograph by Kenneth A. Sorensen.

Aphids

Several species of aphids are pests of leafy greens, including the cabbage aphid, *Brevicoryne brassicae* (Linnaeus), and the turnip aphid, *Lipaphis erysimi* (Kaltenbach). Aphids are pale green with cornicles (or points) on their abdomens. Cabbage aphids have a gray, waxy coat and can be winged or wingless. Cabbage and turnip aphids feed and breed through the winter in North Carolina, often on the host plants. Their activity increases as the weather warms. Wingless females produce 50 to 100 live progeny (all develop into females) without mating. Winged females periodically develop and fly to new host plants. Reproduction continues throughout the summer, producing

many generations of aphids each year in North Carolina.

Aphids cluster on the undersides of the leaves of the host plant and suck the sap from the leaves. This feeding causes the plant foliage to curl, wilt or become distorted, resulting in plants that are killed or unmarketable. Management of aphids include cultural controls, natural enemies (parasites and predators), and insecticide application.

Striped flea beetles, *Phyllotreta striolata* (Fabricius)

Striped flea beetles are common pests of collards, turnips and other leafy greens. The adult beetles are black with a yellow stripe on each wing cover. Larvae are wormlike, slender and cylindrical.

The adult striped flea beetles chew small, rounded holes in the leaves ("shot holes"), while the larvae feed on roots. Management includes effective weed control and destruction of crop residues to reduce overwintering populations, planting resistant varieties, and insecticide application.

Vegetable weevils, *Listroderes difficilis* Germar

Vegetable weevils feed on collards, mustard and turnips in the fall and spring. Adult females are 1/4 in length, have a short snout, and are a dull grayish brown with a light-colored V-shaped mark on their wing covers. Larvae are pale green and legless. The adult weevil is active in the fall, winter and spring and becomes dormant in the summer in trash, leaves or grass along edges of fields. Females lay eggs that develop into females (parthenogenetic reproduction). Emerging adults feed for a month and then lay eggs on collards and turnips. Oviposition begins in the fall and may last into the next spring. Larvae become full grown in 23 to 45 days. The vegetable weevil has one generation per year.

Both larvae and adults feed on the roots and foliage of host plants. Weevil populations can be reduced by cultivation in the fall and winter. Insecticides also used to manage these insects pests.

Cabbage maggots, *Delia radicum* (Linnaeus)

Cabbage maggots are major soil pests of crucifers in the higher elevations in western North Carolina. The larvae are white, legless maggots with a pointed head. They grow to be about 1/4 inch in length. The adult resemble a small house fly. Cabbage maggots overwinter as pupae under 1 inch of soil. The adult flies emerge in the spring as the soil begins to warm. They feed on flower nectar and mate. Female flies lay eggs in the soil at or near the base of the host plant. The eggs hatch in 3 to 7 days and the larvae move into the soil to feed on the roots of the host plant. The maggots feed for 3 to 4 weeks before pupating. This pupation lasts 2 to 3 weeks in the soil or root burrows. At least three generations occur in North Carolina each year.

Cultural practices can prevent severe infestation of cabbage maggots. These include planting in late May or early June (few flies present to lay eggs), careful selection of seedbed location (distance from growing area and protected with row cover), and elimination of crop residue and weed hosts. Obtaining transplants grown at elevations below 3,000 feet in North Carolina will eliminate the danger of introducing maggots on the transplants. Improving host plant tolerance through proper fertilization, irrigation and soil practices lessen the damage of cabbage maggots. Insecticide can be broadcast and incorporated into the soil just before planting seed or setting transplants, or a drench can be applied after transplanting.

Chemical Control of Insect Pests

According to a mail survey of North Carolina leafy green growers conducted in 2000, 78 percent of survey respondents used insecticides to manage insects in their 1999 collard, kale, mustard green and/or turnip green crops. Tables 4-7 contain lists of insecticides applied by North Carolina growers to collards, kale, mustard greens and turnip greens in 1999.

Table 4. Insecticides applied to collards in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Insecticide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Agree (<i>B.t.</i>)	10.45	0.71	7.77
Ambush	444.40	30.05	4.98
Asana XL	547.00	36.99	3.29
Diazinon	453.25	30.65	1.00
Dibrom ²	1.00	0.07	
Dimethoate	300.00	20.29	2.00
Dipel (<i>B.t.</i>)	1,249.20	84.48	1.25
Lannate	282.00	19.07	2.02
Liquid Rotenone / Pyrethrin ²	0.50	0.03	
Lorsban	100.00	6.76	1.00
Malathion	432.75	29.26	1.76
Matth (<i>B.t.</i>) ²	200.00	13.52	
M-Pede	12.00	0.81	1.00
MVP (<i>B.t.</i>)	5.50	0.37	5.00
Phaser	740.50	50.08	1.81
Provado	450.00	30.43	1.67
Pyrellin	41.00	2.77	1.12
Sevin	293.85	19.87	1.28
Spectracide ²	1.25	0.08	
Spintor	1,307.40	88.41	1.95
Thiodan	850.00	57.48	1.36
Xentari (<i>B.t.</i>)	1,054.25	71.29	3.81

¹ Number of acres of collards planted by respondents = 1,478.775 acres.

² Number of applications not reported by some growers; therefore, data are not available.

Table 5. Insecticides applied to kale in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Insecticide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Ambush	250.00	55.66	4.00
Asana XL	155.00	34.51	3.37
Diazinon ²	250.75	55.82	
Dimethoate	150.00	33.39	2.00
Dipel (<i>B.t.</i>) ²	350.50	78.03	
Liquid Rotenone / Pyrethrin	0.10	0.02	2.00
Lannate	75.00	16.70	2.00
Malathion	75.75	16.86	1.99
Matth (<i>B.t.</i>) ²	180.00	40.07	
Phaser	155.00	34.51	1.97
Provado	110.00	24.49	1.68
Pyrellin	0.25	0.06	4.00
Sevin	0.75	0.17	0.95
Spectracide ²	0.25	0.06	
Spintor	170.00	37.85	3.70
Thiodan	75.00	16.70	2.00
Xentari (<i>B.t.</i>)	350.00	77.92	5.00

¹ Number of acres of kale planted by respondents = 449.175 acres.

² Number of applications not reported by some growers; therefore, data are not available.

Table 6. Insecticides applied to mustard greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Insecticide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
-------------	-------------------------	---------------------------------------	---

Diazinon ²	0.25	0.03	
Dimethoate	200.00	25.07	2.00
Dipel (<i>B.t.</i>) ²	703.55	88.19	
Liquid Rotenone / Pyrethrin ²	0.20	0.03	
Malathion	102.50	12.85	1.02
Matth (<i>B.t.</i>) ²	30.00	3.76	
Phaser	200.325	25.11	1.00
Provado	73.00	9.15	1.71
Sevin	50.825	6.37	1.63
Spintor	700.00	87.75	2.14
Thiodan	0.525	0.07	1.62
Xentari (<i>B.t.</i>)	700.00	87.75	5.00

¹ Number of acres of mustard greens planted by respondents = 797.75 acres.

² Number of applications not reported by some growers; therefore, data are not available.

Table 7. Insecticides applied to turnip greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Insecticide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Agree (<i>B.t.</i>)	0.25	0.03	4.00
Ambush	151.25	19.78	5.00
Diazinon ²	150.25	19.65	
Dimethoate ²	300.00	39.23	1.33
Dipel (<i>B.t.</i>)	654.075	85.54	2.02
Liquid Rotenone / Pyrethrin ²	0.10	0.01	
Malathion	102.225	13.37	1.04
Matth (<i>B.t.</i>) ²	100.00	13.08	
Sevin	29.825	3.90	1.26
Spectracide ²	0.25	0.03	
Xentari (<i>B.t.</i>) ²	5.25	0.69	

¹ Number of acres of turnip greens planted by respondents = 764.65 acres.

² Number of applications not reported by some growers; therefore, data are not available.

Forty-one percent of North Carolina leafy green growers surveyed in 2000 reported that they chose pesticides less damaging to beneficial insects, 38 percent alternating used different types of pesticides as a means to avoid resistance by pests, and 67 percent applied pesticides as they needed rather than routine spraying during the 1999 growing season. A high-pressure sprayer (200 to 400 psi) was used by 17 of the growers in 1999.

Current Insecticide Recommendations: Current North Carolina Cooperative Extension Service recommendations for insecticide use on collards, mustard greens and turnip greens are provided in the *Insect Control for Commercial Vegetables* section of the North Carolina Agricultural Chemicals Manual (<http://ipm.ncsu.edu/agchem/chptr5/510.pdf>). These recommendations include target insects, insecticides and formulations, rates of application, and pre-harvest intervals.

Nonchemical Control of Insect Pests

Nonchemical control of insect pests of leafy greens include producing insect-free transplants, growing varieties with some resistance or tolerance to insects, rotating fields on which leafy greens are planted to avoid insect infestations, promoting proper soil fertility and plant growth conditions, conserving natural enemies of pest insects (i.e., parasites, predators and diseases), and destroying crop refuse immediately after harvesting leafy greens to reduce overwintering insect and pathogen populations.

According to a mail survey of North Carolina leafy green growers conducted in April 2000, 56 percent of survey respondents claimed that they practiced integrated pest management (IPM) in growing leafy greens in 1999, while 85 percent considered IPM to be a good pest control practice. A total of 88 percent of the growers rotate the fields that they plant leafy green on each year. Half of the growers surveyed apply fertilizer to their leafy green crops based on the results of soil and/or leaf tissue analysis. Eighty-six percent of respondents reported that they walked their fields to scout for insects and their damage; however, only 10 percent kept records of their scouting information. Approximately 7 percent of respondents used parasites and/or predators to management insect pests of leafy greens. Three percent of respondents used seed baits in soil or light traps to monitor insect pests, while only 1 percent used sex pheromone traps. Asked who scouted their leafy greens for weeds, insects and diseases, 98 percent of respondents reported that they or a family member scouted their crop in 1999. Nearly 7 percent claimed that an employee scouted their crop, while professional scouts or consultants provided this service for less than 2 percent of the respondents.

Diseases

Leafy greens crops produced in North Carolina are subject to several leafspot and soil-borne diseases which can cause significant economic loss by reducing the quantity and quality of marketable leaves. Table 8 contains a list of diseases for which North Carolina growers used fungicides to produce leafy greens in 1999. Approximately 8 percent of North Carolina growers used fungicides in 1999.

Table 8. Diseases for which fungicides were used by North Carolina growers in producing collards, kale,

mustard greens and turnip greens during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Disease	Percent of Respondents Reporting Disease ¹			
	Collards	Kale	Mustard Greens	Turnip Greens
Alternaria leaf spot	40.00	20.00	40.00	60.00
Damping-off	20.00	20.00	20.00	20.00
Downy mildew	20.00	20.00	40.00	40.00
Powdery mildew	20.00	20.00	20.00	20.00
Wire stem	20.00	20.00	20.00	20.00

¹ Of the 63 leafy green growers responding to the mail survey, five respondents used fungicides to control diseases in 1999.

Damping-off (*Pythium* spp., *Rhizoctonia* spp.)

Damping-off is a disease of seedlings caused by soil-borne fungi such as *Pythium* spp., *Rhizoctonia solani*, and others. The seedlings rot at the soil line, resulting in plants that can collapse and die rapidly or survive and become stunted and less vigorous. The disease is sporadic and most common under cool, wet weather conditions. Management of damping-off includes fungicide-treated seed, proper seeding depth, proper drainage, and treatment.

Black rot (*Xanthomonas campestris*)

Black rot is a soil-borne disease caused by the seed-borne bacterium *Xanthomonas campestris*. Symptoms are V-shaped, yellow to orange-colored areas on the margins of the leaves. As the disease progresses, the leaf veins turn black. Management of black rot involves using various practices: pathogen free seed or transplants, tolerant varieties, burying/destroying crop residues, rotating fields planted with leafy greens, and avoiding the introduction of diseases into fields.

Alternaria leafspot (*Alternaria brassicae*)

Alternaria leafspot or brown spot is a fungal disease caused by *Alternaria brassicae*. Symptoms are small, dark-colored round spots on the leaves that often form concentric rings. The disease is the most severe during the coolest part of the season. Alternaria leafspot can be managed with fungicides and the use of pathogen free seed.

Anthracnose leafspot (*Colletotrichum higginsianum*)

Anthracnose leafspot is caused by the fungus *Colletotrichum higginsianum*. Symptoms include small, rounded spots with dry straw-colored centers on the leaves, petioles and stems. The disease favors warm weather. It is managed with fungicides.

White spot (*Cercospora brassicae*)

White spot is a fungal disease caused by *Cercospora brassicae*. Large, irregular spots (that are almost white in color) occur on the leaves. The disease favors cool temperatures. It is managed with fungicides.

Downy mildew (*Peronospora parasitica*)

Downy mildew is caused by the air-borne fungus *Peronospora parasitica*. Symptoms are the presence of a white-gray mold on the undersides of leaves. Spots grow on the upper sides of the leaves to form yellow areas. The disease favors cool, wet weather. Fungicides can be used to manage downy mildew. Management also includes using tolerant varieties, bury/destroy crop residues, and rotate fields planted with leafy greens.

Powdery mildew (*Erysiphe polygoni*)

Powdery mildew is a fungal disease caused by the air-borne fungus *Erysiphe polygoni*. The symptoms of this disease are white powdery fungal growth on the upper surface of the leaves. It usually occurs during dry weather. It is managed with fungicides.

Wire stem (*Rhizoctonia solani*)

Wire stem is caused by the soil-borne fungus *Rhizoctonia solani* and involves the drying up of the stem near the soil. Management of wire stem is similar to the management of damping-off.

Club-root (*Plasmodiophora brassicae*)

Club-root is caused by a soil-borne fungus *Plasmodiophora brassicae*. In North Carolina, it is most prevalent in the mountains in the northwest part of the state. Symptoms of the disease include plants that often wilting during the day and the presence of large galls (*clubs*) on the roots. The disease is favored by wet soils following planting. Management of the disease includes disease free transplants, and incorporating quick lime and fungicide in the soil prior to setting plants.

Chemical Control of Diseases

According to a mail survey of North Carolina leafy green growers conducted in 2000, eight percent of survey respondents used fungicides to manage diseases in their 1999 collard, kale, mustard green and/or turnip green crops. Tables 9-12 contain lists of fungicides applied by North Carolina growers to collards, kale, mustard greens and turnip greens in 1999.

Table 9. Fungicides applied to collards in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Fungicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Bravo	200	13.52	1.00

Copper (Kocide, Tenn-Cop)	552	37.33	1.00
Maneb	800	54.10	1.00
Ridomil	1.5	0.10	1.00

¹ Number of acres of collards planted by respondents = 1,478.775 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each fungicide used.

Table 10. Fungicides applied to kale in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Fungicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Copper (Kocide, Tenn-Cop)	200	44.53	1.00
Maneb	200	44.53	2.00

¹ Number of acres of kale planted by respondents = 449.175 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each fungicide used.

Table 11. Fungicides applied to mustard greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Fungicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Alliette	20	2.51	1.00
Bravo	150	18.80	1.00
Copper (Kocide, Tenn-Cop)	200	25.07	1.00
Maneb	200	25.07	1.00

¹ Number of acres of mustard greens planted by respondents = 797.75 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each fungicide used.

Table 12. Fungicides applied to turnip greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Fungicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Alliette	20	2.62	1.00
Bravo	150	19.62	1.00
Copper (Kocide, Tenn-Cop)	200	26.16	1.00
Maneb	200	26.16	1.00

¹ Number of acres of turnip greens planted by respondents = 764.65 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each fungicide used.

Current Fungicide Recommendations: Current North Carolina Cooperative Extension Service recommendations for fungicide use on collards, mustard greens and turnip greens are provided in the *Vegetable Crop Disease Control* section of the North Carolina Agricultural Chemicals Manual (<http://ipm.ncsu.edu/agchem/chptr6/612.pdf>). These recommendations include target diseases, fungicides and formulations, rates of application, and pre-harvest intervals.

Nonchemical Control of Diseases

Nonchemical control of diseases of leafy greens include rotating leafy greens with crops that are not in the "mustard family" (i.e., broccoli, brussels sprouts, cabbage, cauliflower, collards, kale, kohlrabi, leaf mustard, radish, turnips and water cress), growing resistant varieties when available, using pathogen-free seed and transplants, using proper fertilization, avoiding fields with a history of club-root, and destroying weeds and volunteer crop plants in the fields or field borders to prevent aphid transmitted viral diseases.

According to a mail survey of North Carolina leafy green growers conducted in April 2000, 56 percent of survey respondents claimed that they practiced integrated pest management (IPM) in growing leafy greens in 1999, while 85 percent considered IPM to be a good pest control practice. A total of 88 percent of the growers rotate the fields that they plant leafy greens on each year. Half of the growers surveyed apply fertilizer to their leafy green crops based on the results of soil and/or leaf tissue analysis.

Fourteen percent of growers planted resistant varieties of leafy greens in 1999. The source of collard and kale plants was plants raised at their own farm for 66 percent of leafy green growers, plants purchased within their county for 9 percent of growers, plants purchased with North Carolina for 14 percent of growers, and plants purchased from outside of North Carolina for 7 percent of growers in 1999. Only 15 percent of leafy green growers indicated that they used certified collard and kale plants, 75 percent indicated that they did not use certified collard and kale plants, and 10 percent indicated that they did not grow collards or kale.

Asked who scouted their leafy greens for weeds, insects and diseases, 98 percent of respondents reported that they or a family member scouted their crop in 1999. Nearly 7 percent claimed that an employee scouted their crop, while professional scouts or consultants provided this service for less than 2 percent of the respondents.

Nematodes

Nematodes are microscopic round worms which reside in the soil. Root-knot nematodes (*Meloidogyne* spp.) can be a pest of leafy greens, but are not generally a problem because leafy greens are normally grown in cool temperatures. Root-knot nematodes feed on the roots of the plant, causing galls or *knots* to form on the roots and predisposes roots to root-rot fungi. This prevents the uptake of water and nutrients by the roots, which results in stunted growth and rapid decline. Nematode management on leafy greens includes the use of nematicides and crop rotation.

Chemical Control of Nematicides

According to a mail survey of North Carolina leafy green growers conducted in 2000, nineteen percent of survey respondents took a soil sample for nematode analysis and thirteen percent used nematicides to manage nematodes in their 1999 collard, kale, mustard green and/or turnip green crops. Tables 13-16 contain lists of nematicides applied by North Carolina growers to collards, kale, mustard greens and turnip greens in 1999.

Table 13. Nematicides applied to collards in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Nematicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Telone C-17	9.25	0.63	1.08
Telone II	4	0.27	1.00

¹ Number of acres of collards planted by respondents = 1,478.775 acres.

Table 14. Nematicides applied to kale in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Nematicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Diazinon	0.25	0.06	4.00
Telone C-17	0.25	0.06	4.00

¹ Number of acres of kale planted by respondents = 449.175 acres.

Table 15. Nematicides applied to mustard greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Nematicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Diazinon	0.25	0.03	4.00
Telone C-17	0.25	0.03	4.00

¹ Number of acres of mustard greens planted by respondents = 797.75 acres.

Table 16. Nematicides applied to turnip greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Nematicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Telone C-17	0.25	0.03	4.00

¹ Number of acres of turnip greens planted by respondents = 764.65 acres.

Current Nematicide Recommendations: Current North Carolina Cooperative Extension Service recommendations for nematicide use on vegetable crops are provided in the *Nematode Control in Vegetable Crops* section of the North Carolina Agricultural Chemicals Manual (<http://ipm.ncsu.edu/Agchem/chptr6/617.pdf>). These recommendations include nematicides, formulations and rates of application.

Weed Control

A number of broadleaf weeds and grasses are problems for leafy green growers in North Carolina. According to a mail survey of North Carolina leafy green growers conducted in April 2000, approximately 29 percent of North Carolina growers used herbicides in 1999. Table 17 contains a list of broadleaf weeds and grasses for which North Carolina growers used herbicides in the production of leafy greens in 1999. Leafy green growers in North Carolina are most concerned with the winter annual weeds chickweed species, henbit, pepperweed, and wild mustard, and the annual summer weeds common purslane, crabgrass species, common lambsquarters, pigweed species, and common ragweed. It also appeared from the survey results that weed problems that growers were concerned with were most similar with collards, mustard greens and turnip greens. Based on percentage growers who applied herbicides for weed control, it appeared that they were less concerned with weeds in kale.

Of the survey respondents that used herbicides in 1999, 39 percent identified reduced yield as a problem caused by broadleaf weeds and grasses in their leafy greens. Thirty-nine percent of these growers reported that broadleaf weeds and grasses interfered with the harvest of leafy greens, while 28 percent claimed that broadleaf weeds and grasses reduced the quality of their leafy greens. Approximately 17 percent reported that broadleaf weeds and grasses contaminated their harvested crops.

Table 17. Broadleaf weeds and grasses for which herbicides were used by North Carolina growers in producing collards, kale, mustard greens and turnip greens during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Broadleaf Weed or Grass	Percent of Respondents Reporting Broadleaf Weed or Grass ¹			
	Collards	Kale	Mustard Greens	Turnip Greens
Chickweed	44.44	16.67	27.78	44.44

Common purslane	22.22	11.11	22.22	22.22
Crabgrass	11.11			5.56
Henbit	38.89	11.11	27.78	38.89
Lambsquarters	27.78	11.11	22.22	33.33
Pepperweed	5.56	5.56	5.56	5.56
Pigweed	11.11	11.11	11.11	11.11
Ragweed			5.56	5.56
Wild mustard	5.56	5.56	5.56	5.56

¹ Of the 63 leafy green growers responding to the mail survey, 18 respondents used herbicides to control broadleaf weeds and grasses in 1999.

Chemical Control of Weeds

According to a mail survey of North Carolina leafy green growers conducted in 2000, 29 percent of survey respondents used herbicides to manage broadleaf weeds and grasses in their 1999 collard, kale, mustard green and/or turnip green crops. Tables 18-21 contain lists of herbicides applied by North Carolina growers to collards, kale, mustard greens and turnip greens in 1999. Treflan preplant incorporated and Poast postemergence were the most common herbicides used to control weeds in leaf green crops. Treflan controls many of North Carolina's weed problems associated with these crops. Poast is effective in controlling many grass weeds and is used on a large percentage of the acreage. Growers have expressed interest in Dual and Devrinol registrations for these crops.

Table 18. Herbicides applied to collards in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Herbicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Gramoxone Extra	1	0.07	2.50
Poast	306	20.69	1.00
Roundup Ultra	105.5	7.13	1.00
Treflan	304.5	20.59	1.03
Methyl bromide	1	0.07	1.00

¹ Number of acres of collards planted by respondents = 1,478.775 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each herbicide used.

Table 19. Herbicides applied to kale in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Herbicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Gramoxone Extra	0.25	0.06	4.00
Poast	50	11.13	1.00
Roundup Ultra	50	11.13	1.00
Treflan	132	29.39	1.02

¹ Number of acres of kale planted by respondents = 449.175 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each herbicide used.

Table 20. Herbicides applied to mustard greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Herbicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Gramoxone Extra	0.25	0.03	4.00
Poast	22	2.76	1.00
Roundup Ultra	20	2.51	1.00
Treflan	123.50	15.48	1.02

¹ Number of acres of mustard greens planted by respondents = 797.75 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each herbicide used.

Table 21. Herbicides applied to turnip greens in North Carolina during 1999, according to a mail survey of North Carolina leafy green growers conducted in April 2000.

Herbicide	Number of Acres Treated	Percent of Acres Treated ¹	Average Number of Applications Per Acre Treated
Gramoxone Extra	0.5	0.07	2.50
Roundup Ultra	40.25	5.26	1.00
Treflan	124.5	16.28	1.01

¹ Number of acres of turnip greens planted by respondents = 764.65 acres; the sum of percentages in this column may exceed 100% as respondents reported the number of acres treated with each herbicide used.

Current Herbicide Recommendations: Current North Carolina Cooperative Extension Service recommendations for herbicide use on collards, mustard greens and turnip greens are provided in the *Chemical Weed Control in Vegetable Crops* section of the North Carolina Agricultural Chemicals Manual (<http://ipm.ncsu.edu/Agchem/chptr8/817.pdf>). These recommendations include target weeds, herbicides, formulations, and rates of applications.

Nonchemical Control of Weeds

Nonchemical control of broadleaf weeds and grasses in leafy greens include crop rotation, cultivation, and mechanical control (i.e., hand weeding and hoeing). According to a mail survey of North Carolina leafy green growers conducted in April 2000, 56 percent of survey respondents claimed that they practiced integrated pest management (IPM) in growing leafy greens in 1999, while 85 percent considered IPM to be a good pest control practice. A total of 88 percent of the growers rotate the fields that they plant leafy green on each year. Eighty percent of the growers reported that they cultivated their leafy greens an average of 4.05 times to manage broadleaf weeds and grasses, while 73 percent hand weeded their leafy greens an average of 1.96 times.

Asked who scouted their leafy greens for weeds, insects and diseases, 98 percent of respondents reported that they or a family member scouted their crop in 1999. Nearly 7 percent claimed that an employee scouted their crop, while professional scouts or consultants provided this service for less than 2 percent of the respondents.

Contacts

Leafy Green Production

Douglas C. Sanders

Department of Horticultural Science
North Carolina State University
Campus Box 7609
Raleigh, NC 27695-7609
Telephone: 919-515-1222
Fax: 919-515-2505
E-mail: Doug_Sanders@ncsu.edu

Insect Pest Management

Kenneth A. Sorensen

Department of Entomology
North Carolina State University
Campus Box 7626
Raleigh, NC 27695-7626
Telephone: 919-515-1662
Fax: 919-515-7273
E-mail: Kenneth_Sorensen@ncsu.edu

James F. Walgenbach

Department of Entomology
North Carolina State University
Mountain Horticulture Research and Extension Station
455 Research Drive
Fletcher, NC 28732

Telephone: 828-684-3562
Fax: 828-684-8715
E-mail: James_Walgenbach@ncsu.edu

Disease Management

Marc A. Cubeta

Department of Plant Pathology
North Carolina State University
Partners Building II, 840 Main Campus Drive
Raleigh, NC 27607
Telephone: 919-513-1227
Fax: 919-513-0024
E-mail: Marc_Cubeta@ncsu.edu

Weed Management

David W. Monks

Department of Horticultural Science
North Carolina State University
Campus Box 7609
Raleigh, NC 27695-7609
Telephone: 919-515-5370
Fax: 919-515-7747
E-mail: David_Monks@ncsu.edu

References

1. Averre, C. W. 2000. Diseases of Greens and Their Control. Vegetable Disease Information Note 14 (VDIN-0014). Department of Plant Pathology, North Carolina State University, Raleigh. 4 pp.[<http://www.ces.ncsu.edu/depts/pp/notes/oldnotes/vg14.htm>]
2. North Carolina Agricultural Chemicals Manual. College of Agriculture and Life Sciences, North Carolina State University, Raleigh.[<http://ipm.ncsu.edu/agchem/agchem.html>]
3. Sanders, D. C. 2001. Collard production. Horticultural Information Leaflet 12. Department of Horticultural Science, North Carolina State University, Raleigh. 2 pp.[<http://www.ces.ncsu.edu/depts/hort/hil/pdf/hil-12.pdf>]
4. Sanders, D. C. 2001. Greens for Market. Horticultural Information Leaflet 16. Department of Horticultural Science, North Carolina State University, Raleigh. 2 pp.[<http://www.ces.ncsu.edu/depts/hort/hil/pdf/hil-16.pdf>]
5. Sanders, D. C., ed. 2003. Vegetable Crop Guidelines for the Southeastern U.S. (2003-2004). Bulletin published by the North Carolina Vegetable Growers Association. 205 pp.

6. Sanders, D. C., Davis, J. M., Baird, J. V., Sneed, R. E., Walgenbach, J. F., Sorensen, K. A., Duncan, H. E., Shoemaker, P. B., Monks, D. W., Wilson, L. G., Boyette, M. D., and Estes, E. A. 1996. Cabbage, Broccoli, Cauliflower, and Greens Production in North Carolina. Publication AG-487. North Carolina Cooperative Extension Service, Raleigh. 26 pp.
7. Sanders, D. C., Davis, J. M., Schultheis, J. R., and Monks, D. W. 1997. Suggested Commercial Vegetable Varieties. Horticultural Information Leaflet 00. Department of Horticultural Science, North Carolina State University, Raleigh. 20 pp.[<http://www.ces.ncsu.edu/depts/hort/hil/pdf/hil-00.pdf>]
8. Sherrell, E. M., ed. 2002. North Carolina Agricultural Statistics 2002. Publication Number 200. North Carolina Agricultural Statistics, Raleigh. 130 pp.[<http://www.agr.state.nc.us/stats/vegetabl/vegallyr.htm>]
9. Sorensen, K. A., Cubeta, M., and Sanders, D. Knowing and Managing Crucifer Pests. Poster. North Carolina Cooperative Extension Service, Raleigh.[<http://ipm.ncsu.edu/vegetables/pamphlets/crucifer/index.html>]
10. Sorensen, K. A. 1993. Cabbage Looper. Vegetable Insect Note 40. Department of Entomology, North Carolina State University, Raleigh.[<http://www.ces.ncsu.edu/depts/ent/notes/Vegetables/veg040e/veg040e.htm>]
11. Sorensen, K. A. 1993. Cabbage Worm Complex. Vegetable Insect Note 12. Department of Entomology, North Carolina State University, Raleigh.[<http://www.ces.ncsu.edu/depts/ent/notes/Vegetables/veg012e/veg012e.htm>]
12. Sorensen, K. A. 1993. Diamondback Moth. Vegetable Insect Note 11. Department of Entomology, North Carolina State University, Raleigh.[<http://www.ces.ncsu.edu/depts/ent/notes/Vegetables/veg011e/veg011e.htm>]
13. Sorensen, K. A. 1994. Flea Beetles on Vegetables. Vegetable Insect Note 27. Department of Entomology, North Carolina State University, Raleigh.[<http://www.ces.ncsu.edu/depts/ent/notes/Vegetables/veg27.html>]
14. Toth, S. J., Jr. 2003. Survey of Pest Management Practices Used by North Carolina Leafy Green Growers in 1999. Data Report Submitted on May 16, 2003 to the Southern Region Pest Management Center, University of Florida, Gainesville. 79 pp.

Prepared by: Stephen J. Toth, Jr., Extension Entomologist and Pest Management Information Specialist, Department of Entomology, North Carolina State University, Raleigh, NC 27695-7613; Telephone: 919-515-8879; Fax: 919-515-7746; E-mail address: Steve_Toth@ncsu.edu

Reviewed by: Douglas C. Sanders, Kenneth A. Sorensen, David W. Monks, Marc A. Cubeta, and Charles W. Averre (Professor Emeritus, Department of Plant Pathology, North Carolina State University)