

Crop Profile for Kale in New Jersey

Prepared: May, 2006

General Production Information

State rank: New Jersey ranks 4th nationally in kale production¹

New Jersey's contribution to total US production: 7.6%¹

Yearly fresh market production:

- 2003= 78,000 lbs.²
- 2002= 80,000 lbs.³
- 2001= 64,000 lbs.⁴
- 2000= 73,000 lbs.⁵
- 1999= 110,000 lbs.⁶

Annual production costs:

Spring Crop: Including growing (\$844.17), and harvesting and marketing (\$1,969.74) = \$2,813.91/acre⁷

Fall Crop: Including growing (\$961.99), and harvesting and marketing (\$1,953.13) = \$2,915.12/acre⁷

Production Regions

Southern New Jersey (area south of Trenton)

Nearly all kale, *Brassica oleracea* var. *acephala* L., is grown in the southern half of southern New Jersey. The soils in this area are coastal plain, generally light soils ranging from sand to sandy loams, but areas of heavier, clay and silt loam soil do exist. Elevations are low with most of the area less than 200 feet in elevation. The warmest, seasonal temperatures occur in the extreme southern part of the state with the Salem County area being the warmest.

Cultural Practices

In New Jersey, kale is a cool season crop that is raised in the spring and fall. Fields are direct seeded into the field in a series of rows. In some situations, kale may be grown in frames and then transplanted to the field. Seeds that are not hot water-treated by the seedsman should be soaked at 122°F (50°C) for 20 minutes. Since hot water treatments reduce germination rates, an alternative is to treat with 1 sodium chlorite, 1 part lactic acid and 18 parts water for 1 to 2 minutes followed by a thorough rinsing in running water for 5 minutes. Either treatment must then be followed by dusting with either Captan 50WP or Thiram 25wp at 1 level teaspoon per pound of seed (3 ounces per 100 pounds). Seeds are sown at a rate of 3 lbs/A in rows spaced 16 to 24 inches apart. Upon emergence, plants are thinned to 4 to 5 inches apart within each row.

Spring seeding typically occurs around April 20th. Seeding for the fall harvest begins in Mid-July through late August. Kale can be harvested three ways: whole plant, bunched leaves, or "stripped" leaves. "Stripped" kale is pre-packaged for fresh market. In all methods, yellow or damaged leaves must be removed before packing.

Insects

In New Jersey, the primary insect pests of kale are: aphids, beet armyworm, black cutworm, cabbage looper, cabbage root maggot, corn earworm, diamondback moth, flea beetles, harlequin bugs, imported cabbage worm and thrips.

Aphids

Aphids, usually green peach aphid, feed on the plant sap and may cause plant stunting if large numbers exist. Feeding damage results in curled leaves and stunted plants. Aphids may further transmit viral diseases such as kale mosaic. In New Jersey, green peach aphids overwinter on hardwood hosts such as peach, cherry and plum. Overwintering eggs hatch in spring into females that reproduce parthenogenetically. After one to two generations winged females migrate to alternative hosts such as kale where they spend the summer. In late summer and early fall temperatures and shortening day length trigger that development of a winged males and females that mate and move back to hardwood hosts. Once there, females lay eggs that remain on shoots until spring.

Threshold: Prior to harvestable leaf maturity, treatment should begin when populations reach 1 aphid per 10 plants⁹. After head formation, kale should be treated when aphid colonization begins

Beet armyworm

This is a migratory pest from the southern states that is found from mid to late summer in several vegetable crops in New Jersey. The armyworm caterpillar is a foliage feeder capable of consuming large

amounts of foliage. The fall planting of kale is the most susceptible to beet armyworm. The moths lay their eggs in the hearts of the plants, with larvae feeding on

Threshold: Prior to harvestable leaf maturity, kale should be treated when populations have reached 1 larva per 50 plants⁹. After head formation, kale can tolerate 1 larva per 100 plants.

Black Cutworm

Seedlings are the most significantly impacted by cutworm attack¹⁰. Newly hatched larvae feed on the leaves temporarily, but then drop to the soil surface and burrow underground. The larvae emerge at night and feed on the kale plants. Cutworms damage kale by cutting the stem at, or just below the soil surface. Sometimes a cutworm will bore into a kale plant from below. Individual cutworms are capable of damaging several plants in one evening and large populations can destroy entire fields. When cutworms have been active, several wilted or collapsed plants in a row can be observed. Recently tinned stands are especially sensitive to cutworm attack. **Threshold:** Fields should be treated as soon as stand loss begins⁹

Cabbage looper

Like other caterpillars these insects feed on the foliage and should be considered one of the major pests of kale. Damage occurs mostly in late summer and early fall. Cabbage loopers may be present at harvest and therefore be a contaminant as well as their feces.

Threshold: Prior to harvestable leaf maturity, kale should be treated when 10% of plants are infested with any combination of caterpillars.

Cabbage root maggot

Cabbage root maggot larvae feed by tunneling into the roots¹¹. Young plants may be stunted or even killed. Larval feeding can deform roots; sometimes the deformed roots are mistaken for a disease called clubroot. A large population of root maggots can potentially destroy a young crop.

Threshold: No thresholds are available.

Diamondback moth

Larvae attack all stages of plant growth, however, damage is most significant during the seedling stage and at harvest¹⁰. Larvae attack the growing points on young plants, stunting growth and decreasing yield. The larvae will chew small holes, mostly on the underside of mature leaves, on mature plants. The larvae of the diamondback moth penetrate kale heads, damaging the head and feeding on the plant's growing point. Kale damaged by diamondback larvae or contaminated by the larvae is unmarketable.

Threshold: Prior to harvestable leaf maturity, kale should be treated when 10% of plants are infested with any combination of caterpillars.

Flea beetle

Flea beetles frequently attack leafy green vegetables. Eggs are laid on the soil surface and larvae feed on

plant rootlets, seldom causing significant damage. The adults cause the shot hole feeding damage in leaves, which sometimes becomes extensive. Usually, only the smaller seedling plants are at risk from flea beetles and the most severe damage occurs on field borders or at the edge of plantings. Depending upon the species of flea beetle there may be multiple generations each year.

Threshold: Prior to harvestable leaf maturity, kale should be treated when 50% of the plants have beetles or a combination of beetles and fresh damage.

Harlequin bug

This pest has the ability to destroy the entire crop where it is not controlled¹². The harlequin bug injures the host plants by sucking the sap of the plants, causing the plants to wilt, turn brown and die. A generation of the harlequin bug requires 50 to 80 days. The life cycle consists of three stages: egg, nymph and adult. Harlequin bugs pass the winter as adults and true hibernation is doubtful.

Threshold: No thresholds are available.

Imported Cabbageworm

Imported cabbageworm larvae chew large, irregular-shaped holes into kale leaves¹⁰. Young plants can be stunted or killed by the feeding action of larvae. Larvae feed for 2 to 3 weeks and then attach themselves to the stem or leaf on the plant or a near by object to pupate. The presence of the larvae, larvae frass or pupae within the kale head or damage to the leaves will render the plant unmarketable.

Threshold: Prior to harvestable leaf maturity, kale should be treated when 10% of plants are infested with any combination of caterpillars.

Thrips

Feeding by thrips causes wrinkling and deformation of leaves, damages heads and stunts growth¹⁰. Feeding also causes brown scars on the leaves of kale. Extreme damage causes leaves to dry and fall off the plant. Thrips feces (Black Dust), on leaves distinguish this damage from windburn or sand burn. Thrips present in harvested kale are considered a contaminant and leaves damaged by thrips feeding are not marketable.

Threshold: No thresholds are available.

Chemical Controls Used in New Jersey Kale

Insecticides used in 2000 -- last year of available data ^{6, 7}

***Bacillus thuringiensis* (BT)**

- BT use was 24.33 lbs ai or about 6.84% of all insecticides used.
- The preharvest interval for BT is 0 days
- The restricted entry interval for BT is 4 hours

Chlorpyrifos (Lorsban)

- Chlorpyrifos use was 48.47 lbs ai or about 13.63% of all insecticides used.
- The preharvest interval for chlorpyrifos is either at planting (15G) or 21 days (4EC, 50WP)
- The restricted entry interval for chlorpyrifos is 12 hours

Diazinon

- Diazinon use was 126.35 lbs ai or about 35.54% of all insecticides used.
- The preharvest interval for diazinon is 10 days
- The restricted entry interval for diazinon is either 12 or 24 hours depending on formulation

Dimethoate

- Dimethoate use was 47.44 lbs ai or about 13.34% of all insecticides used.
- The preharvest interval for dimethoate is 14 days
- The restricted entry interval for dimethoate is 48 hours

Imidacloprid

- Imidacloprid use was 1.39 lbs ai or about 0.39% of all insecticides used.
- The preharvest interval for imidacloprid is either 21 (Admire) or 7 (Provado) days
- The restricted entry interval for imidacloprid is 12 hours

Malathion

- Malathion use was 16.26 lbs ai or about 4.57% of all insecticides used.
- The preharvest interval for malathion is 7 days
- The restricted entry interval for malathion is 12 hours
- Malathion is not recommended for use in New Jersey

Methomyl

- Methomyl use was 118.24 lbs ai or about 33.26% of all insecticides.
- The preharvest interval for methomyl is 10 days
- The restricted entry interval for methomyl is 48 hours

Pyrethrin

- Pyrethrin use was 1.0 lbs ai or about 0.28% of all insecticides used.
- The preharvest interval for Pyrellin is 0 days
- The restricted entry interval for Pyrellin is 12 hours
- Pyrellin is not recommended for use in New Jersey

Rotenone

- Rotenone use was 1.68 lbs ai or about 0.47% of all insecticides used.
- The preharvest interval for Pyrellin is 0 days
- The restricted entry interval for Pyrellin is 12 hours
- Pyrellin is not recommended for use in New Jersey.

Spinosad (Spintor)

- Spinosad use was 5.25 lbs ai or about 1.48% of all insecticides used.
- The preharvest interval for spinosad is 1 days
- The restricted entry interval for spinosad is 4 hours
- Spinosad is used primarily for controlling imported cabbageworm, cabbage looper, beet armyworm and thrips.

Tebufenizide (Confirm)

- Tebufenizide use was 6.92 lbs ai or about 1.95% of all insecticides used.
- The preharvest interval for tebufenizide is 7 days
- The restricted entry interval for tebufenizide is 4 hours

Current (2004) Pesticide Recommendations for Insect Pests, Product Rates Per Acre and Use (G=general, R=restricted)⁶

Aphids

Acetamiprid 0.8-1.2 oz 70WP/A G

Diazinon 1 pt 4EC/A R-NJ

Dimethoate 0.5-1 pt 4 EC/A R-NJ

Imidacloprid 10 - 24 fl oz 2FS/A (soil)

Imidacloprid 3.75 fl oz 1.6F/A (foliar)

Oxydemeton-methyl 1 qt 2SC/A R

Pymetrozine 2.75 50W/A G

Beet Armyworm

Bacillus thuringiensis see labeled rate on specific products G

Emamectin benzoate – 2.4 – 2.8 fl oz 5SG/A R

Indoxacarb 3.5 fl oz/A G

Spinosad 1.5 – 6 oz 2SC/A G

Tebufenozide 6 - 8 fl oz 2F/A G

Black Cutworm

Bifenthrin 2.1 – 6.4 fl oz 2EC/A R

Carbaryl 20 – 40 lb 5% bait/A G

Chlorpyrifos 2 lb 50WP/A R

Cyfluthrin 0.8 - 1.6 fl oz 2E/A R

z-Cypermethrin 2.4 – 4.3 fl oz 2EC/A R

Diazinon 2 – 4 qt 4EC/A R-NJ

Cabbage Looper

Bacillus thuringiensis see labeled rate on specific products G

Cyfluthrin 1.6 – 2.4 fl oz 2E/A R
z-Cypermethrin 3.4 – 4.3 fl oz 2EC/A R
Emamectin benzoate – 2.4 – 2.8 fl oz 5SG/A R
Fenpropathrin 10.66 – 16 fl oz 2.4EC/A R
Indoxacarb 2.5 - 3.5 fl oz/A G
Methomyl 1.5 - 3 pt LV/A R
Methoxyfenozide 4 – 8 fl oz 2F/A G
Spinosad 1.5 - 6 oz 2SC/A G
Tebufenozide 6 - 8 fl oz 2F/A G

Cabbage root maggot

Direct Seeded

Diazinon 1.5 fl oz 4EC/1,000 ft of row R-NJ
Chlorpyrifos 4.6 – 9.2 oz 15G/1,000 ft of row R
Diazinon 10.25 – 0.5 lb 50WP/50 gal R-NJ
Diazinon 0.25 – 0.5 pt 4EC/50 gal R-NJ
Chlorpyrifos 1.6 – 3.3 fl oz 4EC/1,000 ft of row R

Diamondback moth

Bacillus thuringiensis see labeled rate on specific products G
Emamectin benzoate – 2.4 – 2.8 fl oz 5SG/A R
Indoxacarb 2.5 - 3.5 fl oz/A G
Spinosad 1.5 - 6 oz 2SC/A G

Flea Beetle

Bifenthrin 2.1 – 6.4 fl oz 2EC/A R
Carbaryl 0.67 – 1.25 lb 80S/A G
Cyfluthrin 2.4 – 3.2 fl oz 2E/A R
z-Cypermethrin 2.4 – 4.3 fl oz 2EC/A R
Endosulfan 1 – 1.33 qt 3EC/A R
Fenpropathrin 10.66 – 16 fl oz 2.4EC/A R
Imidacloprid 3.75 oz 1.6F G

Harlequin bugs

Bifenthrin 2.1 – 6.4 fl oz 2EC/A R
Carbaryl 0.67 – 1.25 lb 80S/A G
Cyfluthrin 2.4 – 3.2 fl oz 2E/A R
z-Cypermethrin 2.4 – 4.3 fl oz 2EC/A R
Endosulfan 1 – 1.33 qt 3EC/A R
Fenpropathrin 10.66 – 16 fl oz 2.4EC/A R

Imported cabbageworm

Bacillus thuringiensis see labeled rate on specific products G

Chlorpyrifos 2 lb 50WP/A R

Cyfluthrin 1.6 – 2.4 fl oz 2E/A R

z-Cypermethrin 3.4 – 4.3 fl oz 2EC/A R

Emamectin benzoate – 2.4 – 2.8 fl oz 5SG/A R

Fenpropathrin 10.66 – 16 fl oz 2.4EC/A R

Indoxacarb 2.5 -3.5 fl oz/A G

Methomyl 1.5 - 3 pt LV/A R

Methoxyfenozone 4 – 8 fl oz 2F/A G

Spinosad 1.5 - 6 oz 2SC/A G

Tebufenozide 6 - 8 fl oz 2F/A G

Thrips

Bifenthrin 2.1 – 6.4 fl oz 2EC/A R

Cyfluthrin 0.8 – 1.6 fl oz 2E/A R

z-Cypermethrin 3.4 – 4.3 fl oz 2EC/A R

Spinosad 4 - 10 oz 2SC/A G

Chemical Use in IPM Programs

Kale is harvested for fresh market sales at farm markets and supermarkets. Individual farmers are responsible for maintaining the quality of the crop. The main emphasis is acceptable, marketable produce that contains little leaf or head damage.

Chemical Use in Resistance Management

Producers are encouraged to rotate chemical classes of insecticides when possible.

Alternatives

There is no current alternative to insecticide use.

Cultural Control Practices

A combination of the following cultural strategies can be used to reduce insect problems in kale¹³:

1. plow down cover crops at least 3-4 weeks before planting or transplanting
2. encourage natural enemies whenever possible
3. maintain weed free borders, and
4. remove or plow down field residue promptly after harvest.

Biological Controls

No current intentional uses of biological control are available. Selective use of insecticides can benefit predator and parasitoid activity that may help control aphids and other pest insects.

Post Harvest Control Practices

Growers are encouraged to till under crop residues immediately after harvest. This enhances rapid breakdown of residues and mechanically induces mortality to remaining insect crop pests.

Weeds

All weeds are pests in kale, because they will compete with for nutrients, water, and space. Generally, weeds are considered to be at threshold when they are distributed at the rate of 1 weed per square yard. Weeds cause problems for fresh market kale because workers must separate the weeds by hand before bunching.

Spring crop

Summer Annuals: All annuals and especially zero tolerance weeds including nightshades, morningglory, jimson weed, common cocklebur, and chickweed.

Perennials: Zero tolerance weeds including Horsenettle, yellow nutsedge, Canada thistle, common milkweed, help dogbane, field bindweed, johnsongrass, bermudagrass, and quackgrass. These weeds especially should not be allowed to become established because of either intense competition with the crop or increasing difficulty of harvest.

Fall planted and Over-wintered crop

Winter Annuals: All winter annuals.

Summer Annuals: All summer annuals, and especially zero tolerance weeds including nightshades, morningglory, jimsonweed, and common cocklebur.

Perennials: Zero tolerance weeds including Horsenettle, yellow nutsedge, Canada thistle, common milkweed, help dogbane, field bindweed, johnsongrass, bermudagrass, and quackgrass. These weeds especially should not be allowed to become established, because of either intense competition with the crop or increasing difficulty of harvest.

Chemical Controls

Herbicides used in 2000 – last year of available data^{7, 8}

Bensulide (Prefar)

- Bensulide use was 15.28 lbs ai or about 12.68% of all herbicides used in 2000.
- The restricted entry interval for bensulide is 12 hours
- Bensulide is applied as either a pre-plant or pre-emergent herbicide and has activity on several grass and broadleaved species.

DCPA (Dacthal)

- DCPA use was 84.44 lbs ai or about 70.06% of all herbicides used.
- The restricted entry interval for DCPA is 12 hours
- DCPA is applied as a pre-emergent herbicide and has activity on several grass and broadleaved species.

Trifluralin (Treflan)

- Treflan use was 20.8 lbs ai or about 17.26% of all herbicides used.
- The restricted entry interval for trifluralin is 12 hours
- Trifluralin is applied as a pre-emergent herbicide that has activity on several grass and broadleaved species.
- Incorporate 2 to 3 inches into soil by double disking within 8 hours after application.

Current (2004) Pesticide Recommendations for Weed Pests, Product Rates Per Acre (G=general, R=restricted)⁶

Seeded

Trifluralin 1 – 1.5 pt 4E/A G

Transplanted

Trifluralin 1 – 2 pt 4E/A G

Preplant Incorporated

Bensulide 5 – 6 qt 4E/A G

Post Planting

DCPA 8 – 14 lb 75WP/A G

Chemical Use in IPM Programs

None.

Chemical Use in Resistance Management

Growers are urged to rotate chemical classes when spraying for weeds.

Alternatives

Depending upon circumstances and the weeds involved, hand weeding may be done to make sure that the weeds are removed.

Cultural Control Practices

Crop rotation is recommended to assist in weed management.

Biological Controls

None.

Post Harvest Control Practices

Tillage immediately after harvest is encouraged to reduce pest populations. After the spring crop, any weeds left in fields when the kale is harvested would remain as a cut stem. Tilling of fields will destroy weeds before they have a chance to regrow and go to seed.

Diseases

Alternaria

Alternaria leaf spot (*Alternaria brassicae* and *A. Brassicola*) forms round leaf spots that are typically tan to dark brown. Lesions are often surrounded by yellow halos. Leaves with 2% affected surface area are unmarketable and should be trimmed or left in fields during cutting.

Threshold: Presence of the disease.

Black Rot

Black rot, caused by *Xanthomonas campestris* sp. *campestris*, is a common bacterial disease of kale that occurs in cool to moderate temperatures. The bacterium is often seed-borne and can also overwinter in plant debris. If soil-borne, the bacterium can enter the leaves through hydathodes present at leaf margins. Black rot causes leaf veins to turn black and leaves to turn yellow. Whole plant infections will cause the plant to wilt. Infected leaves are unmarketable and symptoms may develop after harvest.

Threshold: Presence of the disease.

Blackleg

The fungal disease Blackleg, *Phoma lingam*, prefers moist conditions and cooler temperatures. Black

leg symptoms begin as small necrotic spots on the leaves and stems of plants that enlarge in cool, moist conditions. Spots often develop black fungal fruiting bodies (pycnidia) in the center of lesions. Severe stem infection often results in a dry, dark rot above the soil line, thus the black leg name. The lesion can girdle the entire stem, causing the plants to wilt and eventually die.

The fungus survives in plant residue (crop and weeds) and on infested seed coats. Under the right environmental conditions, overwintering fungi produce spores that are spread to other plants by water, wind and machinery. Seed-borne inoculum has been shown to be important in disease development, seed infections greater than 1% severe crop losses.

Threshold: Presence of the disease.

Clubroot

Clubroot is caused by the fungus *Plasmodiophora brassicae*. The pathogen can survive in the soil for seven to ten years without the presence of a susceptible host. Susceptible crops or weeds (i.e. mustard family) grown or present during this period may allow the disease to become more prevalent. The movement of soil and dead crop debris into uninfected areas may help move the fungus to new locations. Resting spores are produced in infected roots and released into the soil., thereby allowing the fungus to survive for many years without the presence of a susceptible host.

Initial symptoms include plant decline (yellowing of leaves) and a tendency to wilt during hot days. Examination of the roots reveals swollen, club-shaped roots instead of the normal fine network of roots. In severe cases, most roots will become infected. The swollen roots decay and eventually disintegrate. Slightly infected plants may show few symptoms above ground other than slow growth and will have very small knots on roots; young infected plants may not show severe enough symptoms to be detected until later in the production season.

Threshold: Presence of the disease.

Downy Mildew

Downy mildew, caused by *Peronospora parasitica*, poses the largest threat to kale production in New Jersey. Downy mildew thrives in cool, humid weather that promotes spore (sporangia) formation and dispersal and subsequent plant infection. Under favorable conditions, *P. parasitica* can spread rapidly via wind and rain. Downy mildew can survive on infected seed and be transported via infected transplants.

The development of gray-white fungi on the lower leaf surface is a sign of plant infection. Damage begins with chlorotic lesions that later turn purple and eventually brown and can damage to upper and lower leaf surfaces. Young leaves may dry and drop off; older leaves generally remain on the plant and often develop a papery texture. Severe infections can result in decreased photosynthesis, stunted plants and reduced yield. Downy mildew is a systemic disease that results in darkened areas and/or black streaks in the stem that makes the plant susceptible to secondary infections.

Threshold: Presence of the disease.

Damping off

Damping-off is caused by soil borne fungi (*Pythium* spp. or *Rhizoctonia solani*) that attack germinated seedlings prior to or just after emergence. Cool, wet weather promotes *Pythium* infections; whereas more warmer, moderate weather promotes *Rhizoctonia* infections. Poorly drained fields that have

compacted soil and/or high green organic matter are ideal for allowing Damping-off infections to occur. Damage usually occurs at soil level, causing lesions in the stem tissue that becomes dark and withered eventually causing the seedling to collapse and die. *Pythium* can also attack the seedling's roots, causing them to turn brown and rotten. After plants that have reached the three to four leaf susceptibility to fungal damping-off declines stage.

Threshold: No thresholds exist for this disease.

White Mold

White mold, caused by *Sclerotinia sclerotiorum*, causes damage ranging from little to complete destruction of the plant. While some varieties are resistant, susceptible plants may develop wilts and/or rots. The pathogen can cause damage to both above-and below-ground parts. Infected plants are typically randomly distributed throughout the field. Infected plants develop a dark green, greasy or water-soaked appearance. Stem lesions may become brown to bleached white in color. Under conditions of high humidity, white fluffy mycelia develop into hard, black sclerotia. White mold sclerotia can persist in soils for several years. Sclerotia at or just below the soil surface can germinate to form very small, orange-colored, mushroom-like structures called apothecia that forcibly discharge ascospores into the air. These spores can be carried for a mile or more and if they come into contact with a susceptible plant, and moisture levels and temperatures are correct, an infection can occur.

Threshold: Presence of the disease.

Yellows

Yellows is caused by *Fusarium oxysporum* f. sp. *conglutinans* and is common as temperatures increase in the summer. Infected plants are not marketable due to the wilting and yellowing of leaves. Kale is very susceptible to this disease and may die prior to obtaining marketable size.

Threshold: Presence of the disease.

Chemical Controls

Fungicides used in 2000 – last year of available data^{6, 7}

Copper (Champ)

- Copper use was 3.21 lbs ai of copper or about 0.54% of all fungicides used.
- The preharvest interval for copper is 0 days
- The restricted entry interval for copper is 24 hours.

Fosetyl

- Fosetyl-aluminum use was about 78.99 lbs ai or about 13.39% of all fungicides used.
- The preharvest interval for fosetyl-aluminum is 3 days
- The restricted entry interval for tebufenizide is either 12 or 24 hours

Quintozine (Terrachlor)

- Quintozine use was 507.82 lbs or about 86.07% of all fungicides applied on kale, was used.

- The preharvest interval for quitozine can be applied at planting.
- The restricted entry interval for quitozine is 12 hours

Current (2004) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (G=general, R=restricted)⁶

Damping-Off

- *Plantbed*: Use 0.5 pound Terraclor 75WP per 100 gallons of solution for control of Rhizoctonia. Apply to the soil at the rate of 100 gallons per 2,000 square feet of bed surface.
- *Field*: Use the following as a banded application after seeding. See label for banded rates based on row spacing. Apply the following in a band up to 7 inches wide:
 - Ridomil Gold--1-2 pt 4E/A *plus* azoxystrobin (Quadris at 0.4-0.8 fl oz 2.08F/1000 row ft Amistar at 0.125-0.25 oz 80WDG/1000 row ft labeled only for seedling root or stem rot caused by Rhizoctonia on leafy greens).

Black Rot and Blackleg

Use hot water seed treatment and resistant varieties. Select site not previously planted to crucifers for seedbeds. Rotate to allow 2 years between cole crop plantings for black rot control and 4 years between cole crop plantings for blackleg control. For black rot control, fixed copper sprays (1 pound active ingredient per acre) will aid in reducing spread of black rot if treatments are started when disease first becomes evident

Clubroot

Use of irrigation water containing spores of the fungus is one of the principal ways the disease is spread to new fields. If clubroot occurs, take care to clean and disinfest any equipment to be used in other fields to prevent spread. Adjust soil pH with hydrated lime to as close to 7 as possible. Improve the drainage in the field by making ditches, etc., and grow the crop on raised beds. Use Terraclor 75WP in one of the following ways. Do NOT use the Terraclor 2EC formulation.

1. Use 30 lb/A or 37 oz/1000 ft of row. Apply in a 12 to 15-inch band and incorporate 4 to 6 inches deep before planting, or
2. Use 40/lb/A acre broadcast and incorporate 4 to 6 inches deep before planting, or
3. Use 2 pounds per 100 gallons of solution and 0.5 pint per plant as a transplant solution.

Downy Mildew and Alternaria

Use one of the following at the first sign of disease and continue every 7 to 10 days:

- maneb--1.5-2 lb 75DF/A or OLF, or
- Switch--11-14 oz 62.5WG/A (Alternaria only)

For downy mildew only, use:

- Actigard--1 oz 50WG/A. Begin applications 7-10 days after thinning and re-apply every 7 days for a total of 4 applications per season, or
- Aliette--2-5 lb 80WDG/A (14-day schedule)

White Mold

The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Yellows (*Fusarium*)

Use resistant varieties. Where resistant varieties are not available, practice long crop rotation intervals.

Chemical Use in IPM Programs

None.

Chemical Use in Resistance Management

Growers are urged to alternate fungicides with different modes-of-action (MOA) to reduce the chances for fungicide resistance development. Fungicides with the same MOA, and/or in the same FRAC grouping should not be applied consecutively and/or tank-mixed together.

Alternatives

There are some varieties with resistant to Black rot, Blackleg, and Downy mildew.

Cultural Control Practices

Crop rotation is important to prevent infection by yellows (3-4 years), downy mildew (2 years), Alternaria (2 years) and black rot (2 years). Cleaning and disinfecting equipment can assist in preventing clubroot infection in addition to avoiding contaminated irrigation water and adjusting soil pH to 7.0. Treatment of seed with hot water can prevent black rot and blackleg. Increased row spacing and not entering wet fields helps prevent the spread of black rot. Avoiding overhead irrigation helps limit spread of Alternaria, black rot and downy mildew. Removal of weeds in the mustard family in and around fields will remove potential reservoirs for many of the diseases that affect kale.

Biological Controls

contans – for White mold

Post Harvest Control Practices

Farmers are encouraged to till under crop residues as soon as harvest is completed to help break disease cycles.

Nematodes

Nematodes are not significant pests of kale in New Jersey as most kale is grown on sandy soils or light soils.

Chemical Controls

Nematicides used in 2000 – last year of available data^{6, 7}

Metam-Sodium (Vapam)

- Metam-sodium use was 2.37 lbs.
- The preharvest interval for metam-sodium is applied prior to planting.
- The restricted entry interval for metam-sodium is 48 hours
- Metam-sodium is applied as a general fumigant to control both diseases and nematodes.

Current (2004) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (G=general, R=restricted)⁶

Fumigants

Chloropicrin 50 G/A R

Dichloropropene 9-12 G/A R

Dichloropropene + Chloropicrin 11-17 G/A, 13-20.5 G/A R

Dichloropropene

Metam-Sodium 37.5-75 A/A R

Metam-Potassium 30-60 G/A R

Methyl Bromide 225-350 G/A R

Non-fumigants

Nemacur 30 lb 15G/A R

Chemical Use in IPM Programs

None.

Chemical Use in Resistance Management

Growers are urged to use different chemical classes when treating for nematodes.

Alternatives

None.

Cultural Control Practices

Preventing the spread of nematodes into uninfested fields can be prevented by good sanitation and removal of soil from tools and equipment prior to entering a new field. The use of nematode-free transplants can also help prevent spread. Green manures and soil amendments can be used to reduce population of some plant parasitic nematodes.

Biological Controls

None.

Post Harvest Control Practices

Crop rotation, allowing fields to remain fallow and the use of nematode suppressive cover crops can be effective in reducing nematode populations.

Worker Activities

Post-emergent pesticides are applied by ground sprayers from tractors or terragators (large 3 wheeled tractors often equipped with boom sprayer arms) with enclosed cabs. Thus, exposure to pesticides to applicators is minimal. IPM scouts and others visit fields about twice a week starting at plant emergence and make recommendations for pest control until harvest. Currently the longest REIs exist for bifenthrin at 5 days; chlorothalonil, dimethoate, disulfoton, emamectin benzoate and mfenoxam, methomyl at 48 hours; and acephate, Aliette, chlorpyrifos, l-cyhalothrin, diazinon, fenproparthrin, maneb and permethrin at 24 hours; these REI's do not negatively impact the activities of IPM scouts. It is estimated that REIs greater than 7 days would negatively impact inspection by scouts. When destructive harvesting of kale is not employed, hand removal of leaves of harvestable size could result in exposure to materials. No issues

related to REI's should occur when the period of time necessary for re-growth of leaves is considered.

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References

1. Kelley, W.T., G. MacDonald and D.B. Adams. 2000. Commercial production of leafy greens. University of Georgia Cooperative Extension Service Bulletin 1181. Accessed on December 23, 2004 at <http://pubs.caes.uga.edu/caespubs/pubcd/B1181.htm>
2. New Jersey Agricultural Statistics: New Jersey Principal Vegetables Annual Summary 2002 and 2003. Accessed on December 23, 2004 at <http://www.nass.usda.gov/annsum20022003fran.pdf>.
3. New Jersey Agricultural Statistics: New Jersey Principal Vegetables Annual Summary 2001 and

2002. Accessed on December 23, 2004 at <http://www.nass.usda.gov/annsum20012002fran.pdf>.
4. New Jersey Agricultural Statistics: New Jersey Principal Vegetables Annual Summary 2000 and Preliminary 2001. Accessed on December 23, 2004 at <http://www.nass.usda.gov/annsum02.pdf>.
 5. New Jersey Agricultural Statistics: New Jersey Principal Vegetables Annual Summary 1999 and Preliminary 2000. Accessed on December 23, 2004 at <http://www.nass.usda.gov/annsum01.pdf>.
 6. Dhillon P.S. and R.G. Latimer. 1986. Collards, Kale, Turnip Tops and Mustard Greens. In Costs of Producing Fresh Market Vegetables in Southern New Jersey. New Jersey Agricultural Experiment Station Bulletin P-02131-1-86. Pgs. 26-30.
 7. Commercial Vegetable Production Recommendations for New Jersey, 2005. S. Garrison, Ed. New Jersey Agricultural Experiment Station Bulletin E001T.
 8. Private Applicator Pesticide Survey, 2000 Database. New Jersey Department of Environmental Protection – Pesticide Control Program. Trenton
 9. University of Arizona (1999) Insect Pests of Leafy Vegetables, Cole Crops and Melons in
Accessed on December 23, 2004 at <http://Ag.Arizona.Edu/aes/yac/veginfo/bracken.htm>
 10. Crop Profile for Kale in Arizona. <http://www.ipmcenters.org/cropprofiles/docs/AZkale.html>
 11. Simms, J., W.L. Kline and C. McClurg. 2000. Enterprise Guide for Southern Maryland: Growing Cauliflower, FS-451. University of Maryland. Accessed on December 27, 2005 at <http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=234&cat=C>
 12. Spring, A. and E. Day. <http://everest.ento.vt.edu/~idlab/vegpests/vegfs/harlequin.html>
 13. Clemson University. 2004. Crop Profile for Leafy Greens and Collards (Fresh Market) in South Carolina. Accessed on December 27, 2005 at <http://www.ipmcenters.org/cropprofiles/docs/scleafygreens.html>.
 14. Biller, C.R. and M.A. Draper. 2001. White mold of vegetables and ornamentals in the home garden. NDSU Extension circular, SSE Fact Sheet 910. Accessed on December 27, 2005 at <http://www.ext.nodak.edu/extpubs/plantsci/hortcrop/pp899.pdf>
 15. STA Laboratories. Black leg of crucifers. http://www.stalabs.com/black_leg_of_crucifers.htm
 16. Cornell University, 2005. Clubroot of cabbage. Accessed on <http://plantclinic.cornell.edu/>

FactSheets/clubroot/clubroot.htm