

Crop Profile for Cauliflower in Michigan

Prepared: August, 1999

General Production Information

- Approximately 700 acres of cauliflower are produced in Michigan annually
- Cauliflower is produced on approximately 160 farms in the state
- Michigan producers typically yield 7 tons of cauliflower per acre planted, with a potential of up to 10 tons/acre

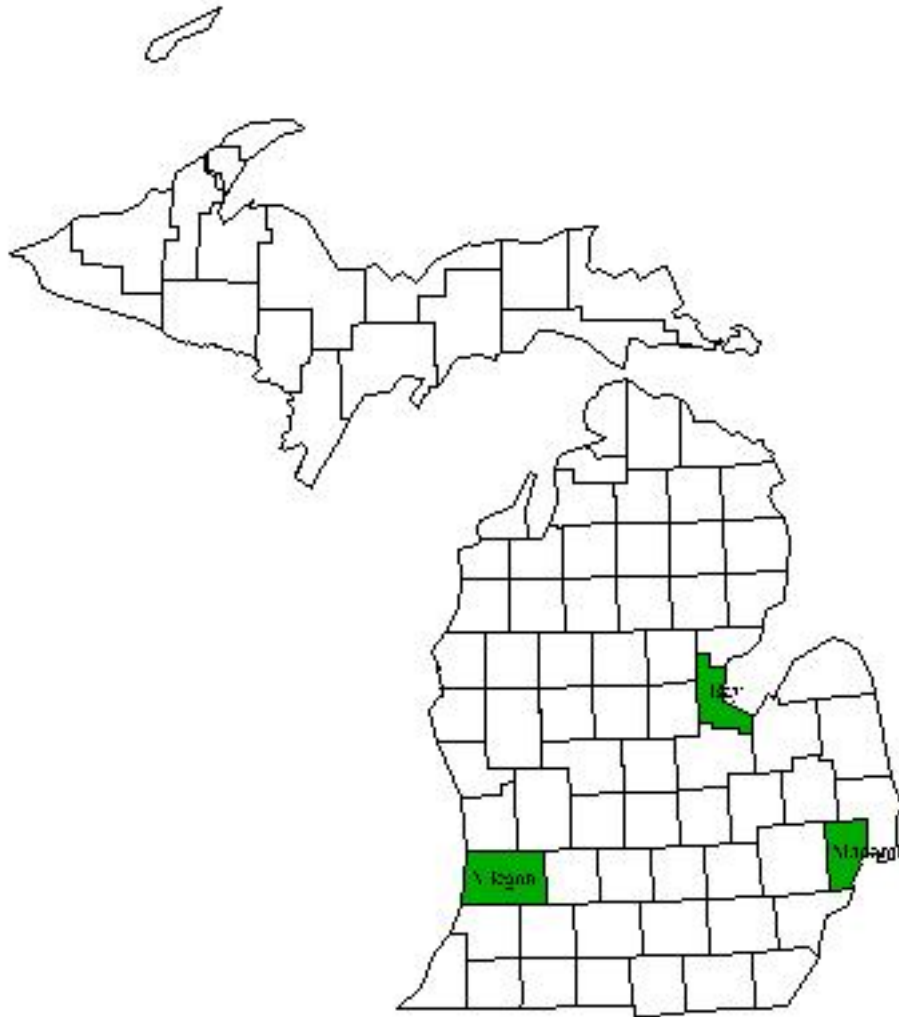
	Cauliflower (fresh & processed)
Michigan Ranking	
Percent of U.S. Production	minor
Area Planted (5 year average)	700 acres
Area Harvested (5 year avg.)	650 acres
Value of Production (thousands) (5 year average)	
Production (thousands)	7,650 rounds

(13)(14)

Production Regions

In Michigan:

- Southwest region, with Allegan County as the top producer (330 out of 360 acres planted for fresh market and processing)
- East Central region, with Bay County as the top producer (135 out of 180 acres planted (fresh market only))
- Southeast region, with Macomb County as the top producer (50 out of 120 acres planted (fresh market only))



The top cauliflower-producing states in 1992 (by acreage) were:

- California
- Arizona
- Oregon
- New York

	Counties	District	Acres Planted	Yield (lb/acre)	Production in District
Fresh Market cauliflower (from 1995-96 MASS, MRS statistics)	Allegan	Southwest	330	22,000	3,150
	Other Counties		30		
	Bay	Central	135	12,000	4,450
	Other Counties		45		
	Macomb	Southeast	50		
Other Counties	70				
Cauliflower for Processing (95-96)					
TOTAL 1996 Acres:					

Cultural Practices

Cauliflower, Broccoli, Brussels sprouts and cabbage are all botanical varieties of the genus and species *Brassica oleracea*. Because they are closely related, cultural practices for the crops are quite similar. However there are important differences both between and within the botanical varieties.

All of the cole crops are cool season crops. They grow best in moderate temperatures and can sometimes withstand mild frosts. Cole crop seeds will germinate at 40° F, but germinate best at temperatures ranging from 70-75° F.

Cauliflower is the most sensitive of the cole crops to adverse weather. The crop can withstand temperatures of up to 85° F, but heads will tend to become soft and over-mature as heat increases. Heads maturing during warmer weather (above 80° F) often suffer from one or more disorders: leafy heads, riciness (over mature florets), purple or green color, soft, loose heads, or poor wrapper leaf development. Cauliflower is usually grown as a fall crop in Michigan, to avoid hot summer temperatures.

Mature cauliflower plants can withstand temperatures as low as 25° F for several hours late in the fall without damage to the curd. However, young plants subjected to freezing temperatures often "button" (form heads prematurely).

Cole crop roots penetrate the soil to a depth of only 18-20 inches. They have a relatively high and constant moisture requirement of at least 1 to 2 inches of rainfall or irrigation per week depending on plant size, growth stage, and soil type. Even moderate drought stress at any time during the growing season may cause significant reductions in growth and yield. Growth during dry periods causes tipburn and buttoning in cauliflower.

Cole crops are irrigated with 1/2 inch of water immediately after transplanting to avoid moisture stress on young plants. If the soil is dry at the time of transplanting, the land is irrigated 2 days before planting with 1/2 to 1 inch of water, and immediately after transplanting with 1/2 inch of water.

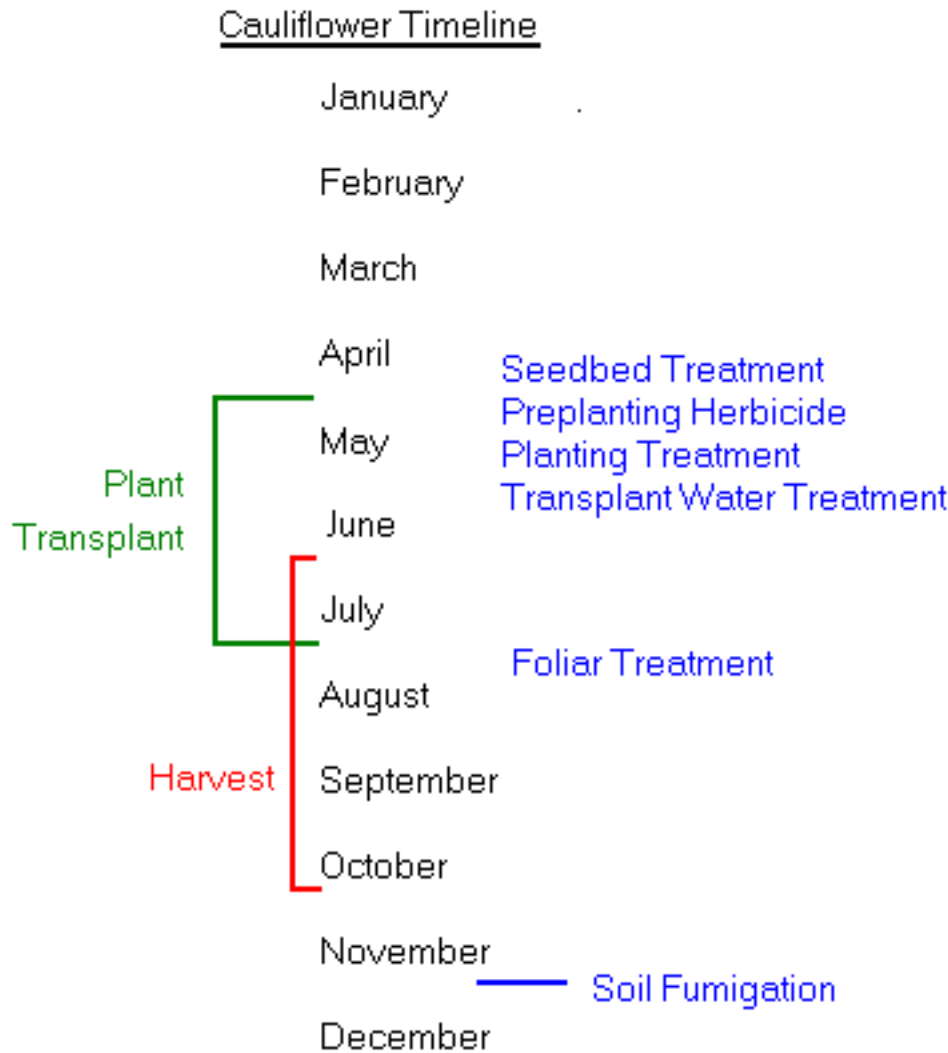
Good drainage is also key to cauliflower maintenance, as cole crops are very sensitive to water-logged soil. If roots are under water for over 24 hours, many plants will die.

The main differences between cauliflower cultivars center around maturity. Early-maturing cultivars tend to be smaller, are not self-blanching, have lighter heads, and are usually more susceptible to environmental stress. Mid-season and late-maturity cultivars grow larger, many are self-blanching, and the heads are larger and more dense.

Some recent mid- and late- season cultivars have a more compact growth habit than traditional cultivars. Heads are borne on a taller stalk and leaves are smaller. These cultivars may be planted at a closer spacing than larger plants, but require more careful management in the field.

The harvested head typically measures 6 inches in diameter and weighs 2 to 3 pounds, although the desired head size may vary somewhat with the market,. Generally, this head size can be achieved by planting in rows 36 to 42 inches apart with 15 to 20 inches between plants.

Soil is often heavily fertilized for best results.



Chemical Controls: Critical Use Issues

No information available

Insect Pests

Cabbage Maggot (*Delia brassicae*)



Cabbage maggots and damage to roots

Biology

The Cabbage Maggot is a serious pest in early direct-seeded or transplanted cole crops. Pupae overwinter in the soil, the adult flies emerging from the soil in early May to lay their eggs on cole crop plants and related weeds near the soil surface or in the soil at the base of the plants. The short (1/4 inch), white maggots emerge a few days later and begin to eat and burrow through the soil into the plant stems and roots. The maggots feed for 3 to 4 weeks and then pupate. Adults emerge in 2 to 3 weeks. (21) Maggots. Young plants that are invaded by maggots usually become stunted, wilt, or die.

There are three generations of cabbage maggot each year. The first generation does the most damage because it emerges when transplants and seedlings are small. Later generations do less damage because many are killed by high soil temperatures and the crops are advanced enough to withstand some injury.

Cabbage maggot problems are most serious in cool, wet weather. (18)

Cultural Controls

Cabbage maggots are difficult to scout for.

Chemical Controls

Preventative treatment in the seedbed at planting or transplanting is suggested. Protect transplanted cole crops with a soil insecticide either in the transplant water or as a drench after transplanting. Treat direct-seeded plantings and seedbeds before seeding or with a drench over the rows after seeding.

Cabbage maggots can be controlled by insecticide applications in the seedbed, in transplant water and as soil treatment

- Diazinon 14G, 21 lb or 500-AG, 3 qt. Lorsban 15G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row.
- Diazinon 50 WP, 1 lb or AG 500, ½ to 1 pt/100 gal
- Guthion Solupak 50 WP, ¼ to 3/8 lb or 2L, ½ pt in 50 gallons of water. .
- Lorsban 4EC 1.6-2.4 fl oz/1000 ft row

Alternative Controls

Several species of parasitic wasps and predators help reduce maggot populations but do not offer complete control (21)

Imported cabbage worm (*Pieris rapae*)

Biology

Imported cabbageworms are the most common foliage pest of cole crops in Michigan. Imported cabbageworm adults, the white butterflies often seen around cruciferous crops, overwinter as pupae and emerge in late April or early May and lay their yellow eggs singly on the leaves of cole crops and other cruciferous crops and weeds. The velvety green worms, which grow to over one inch in length, eat holes in leaves and leave large amount of green debris on the leaves. They tend to leave the plant to pupate in the soil. There are several generations a year, commonly 3, and the adults and larvae may be active until frost.

Damage from imported cabbageworms causes a loss in quality and yield. Some injury can be tolerated in cauliflower prior to heading.

Fields should be monitored for adult activity and plants should be checked for eggs and larvae. Treat cauliflower with an insecticide as soon as the insects appear. Broccoli and cauliflower can tolerate some injury prior to head formation, but should be treated during head formation to avoid insect contamination of the harvested product.

Cultural Controls

Early planting (21)

Chemical Controls avoid the use of broad-spectrum insecticides early in the season

- Ammo 2 EC, 2 ½ to 5 oz or WSB, 1 to 2 bags (1 day)
- Asana XL, 2.9 to 5.8 oz (3 days)
- *Bacillus thuringiensis* Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP II, Match, Vault or Xentari (0 days)
- Carbaryl (Seven) 80 S, 1 1/2 lb or XLR Plus, 1 to 2 qt (3 days)
- Diazinon 500-AG 1 pt or 50 WP, 1 lb (7 days)
- Dibrom 8 EC, 1 pt (1 day)
- Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 ½ lb (7 days)
- Guthion Solupak 50 WP, 1 to 1 ½ lb or 2 L, 2 pt (15 days)
- Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days)
- Lannate SP, ¼ to 1 lb or LV, ¾ to 3 pt (1 day)
- Lorsban 50 W, 2 lb (21 days)
- Malathion 57 EC, 1 to 2 pt (7 days)
- Orthene 75S 1 1/3 lb (14 days)
- Permethrin
 - Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
 - Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
- SpinTor 2SC, 3 to 6 oz (1 day)

Alternative Controls

Several natural enemies attack imported cabbageworms. Eliminating unnecessary sprays and using the biological insecticide, *Bacillus thuringiensis*, helps preserve these natural enemies. (5)

Cabbage looper (*Trichoplusia ni*)



Biology

Cabbage looper can be a serious pest of cole crops in Michigan. They do not overwinter in Michigan.

Cabbage looper adults migrate into Michigan during July and August. The adults are about 1 to 1¼ inches across, gray-brown, and fly and lay eggs mostly at night. The larvae are light green, with a white stripe on each side, about 1 inch long, and move by humping their back like an inch-worm, from which they get their name "looper." There may be 2 or 3 generations per year. As the larvae grow, they become more difficult to control. They cause foliar injury and can be a contaminant at harvest for cole crops. Plant damage and product contamination are similar to that of imported cabbage worm.(18)

Hosts of the cabbage looper include cole crops, celery, tomatoes and potatoes. Eggs are laid singly on the underside of the foliage.

Monitor fields regularly for eggs, larvae, and damage. Apply insecticides as needed for control. Cabbage loopers are much more tolerant of insecticides than imported cabbage worms. Be sure of your identification and use higher rates or more toxic materials on loopers.

Cultural Controls

Early planting is slightly effective in controlling the cabbage looper (21)

Chemical Controls

- Ammo 2EC, 3 3/4 to 5 oz or WSB, 1 to 2 bags (1 day)
- Asana XL, 5.8 to 9.6 oz (3 days)
- *Bacillus thuringiensis* Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP II, Match, Vault or Xentari (0 days)
- Dibrom 8 EC, 2 pt (1 day)
- Endosulfan (Phaser, Thiodan) 3 EC, 1 1/3 qt or 50 WP, 2 lb(7 days)
- Larvin (thiodicarb) 3.2 EC, 24 to 40 oz (7 days)
- Lannate SP, 1 lb or LV, ½ to 3 pt (1 day)
- Orthene 75S 1 1/3 lb (14 days)
- Permethrin
 - Ambush 2 EC, 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
 - Pounce 3.2 EC, 4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
- SpinTor 2SC, 3 to 6 oz (1 day)

Alternative Controls

Loopers can be monitored visually, and adults can be monitored with pheromone (sex attractant) lures and traps.(18)

Diamondback moth (*Plutella maculipennis*)

Biology

Diamondback moth does not do major damage but is often seen in Michigan. The gray adults can

overwinter in Michigan on trash in the field, lay eggs in the spring, and the small (1/3 inch) yellow-green larvae emerge soon thereafter. They can also arrive on transplants from the south or migrate into the state. The worms eat numerous small holes in the leaves, they often cause windowpaning. They leave a few small webs in the center of the plant. Diamondback moths can cause foliar injury and contaminate the product. Control of diamondback moth is similar to that for other worms. (18) Rainfall can cause natural mortality in diamondback moth larvae, so they are of less concern in wet years. (21)

Cultural Controls

Cover crop mulch or weeds between rows (21)

Overhead sprinkler irrigation (21)

Chemical Controls

- Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP II, Match, Vault or Xentari (0 days)
- Cryolite (Kryocide) 96W, 18 to 16 lb.
- Diazinon 500-AG 1 pt or 50 WP, 1 lb (7 days)
- Dibrom 8 EC, 1 pt (1 day)
- Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 ½ lb(7 days)
- Guthion Solupak 50 WP, 1 to 1 ½ lb or 2 L, 2 to 3 pt (21 days)
- Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days)
- Lannate, 1 ½ lb or LV ½ to 3 pt(3 day)
- Permethrin
 - Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
 - Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day)
- SpinTor 2SC, 1.5 to 3 oz (1 day)

Alternative Controls

Diamondback larvae and pupae can be monitored visually. Adults can be monitored with pheromone (sex attractant) lures and traps. Adults and larvae can be highly resistant to insecticides. A tiny wasp parasitizes diamondback larvae and may kill 70 to 80% of them. Spraying with the wrong insecticides may kill the natural enemies but not control the resistant diamondback moth larvae. Bacillus thuringiensis insecticides generally control the diamondback moth larvae and do not kill the wasps.(5)

Thrips (*Thrips tabaci*)

Biology

Thrips are very small (1/16 inch), yellow or brown insects that damage cole crops by rasping the leaf surface and sucking the sap. They cause economic injury primarily on cabbage, where they live and eat inside several layers of leaves. Injury looks like rust spots on the inner leaves. Large areas of leaves can

be affected during heavy infestations. Badly infested heads are not usable for fresh market or processing. Thrips damage usually increases during the hot, dry weather of late summer. The presence of thrips inside the head may make them unmarketable. Once thrips are inside cauliflower curds, it is very difficult to control them. High pressure sprays for worm control directed down into the heads will give some thrips control. If thrips are present, begin insecticide application as soon as heads begin to form.

Cultural Controls

Avoid planting near small grain crops which may act as a source of thrips. (21)

Chemical Controls

Thrips are difficult to control with insecticides. (21)

Alternative Controls

Natural enemies are generally not effective in controlling thrips. (21)

Cabbage aphids



Biology

Cabbage aphids are small (1/16 inch), blue-gray insects that suck sap from the plants. They overwinter as eggs on cole crops residue. They are generally most abundant from mid-summer through October. Heavy infestations cause leaves to cup and curl inward. Aphids live in the outer leaves and the presence of live or dead ones makes the cauliflower unmarketable. Aphids can be controlled relatively easily with insecticides.

Cultural Controls

Cover crop mulch or weeds between rows decreases populations. (21)

Weeds may provide habitat for natural enemies. (21)

Destroy crop residue after harvest to minimize aphid spread. (21)

Chemical Controls avoid broad-spectrum insecticides early in the season as they may decrease natural enemies and increase aphid populations (21)

Planting treatment:

- Di-Syston 15 G, 7.4 oz/1,000 or 8 E 1.1 fl oz/1,000 ft (14 days)

Soil Treatment:

- Admire 2 F, 10-24 oz (21 days)

Foliar Treatment: (apply if there are >5 per plant)

- Diazinon 500-AG 1 pt or 50 WP, 1 lb (7 days)
- Dibrom 8 EC, 1 pt (1 day)
- Dimethoate 4 EC, 1 pt (7 days)
- Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 1/2 lb(7 days)
- Metasystax-R2 SC, 1 1/2 to 2 pt (7 days)
- Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days)
- Orthene 75S 2/3 to 1 1/3 lb (14 days)
- Provado 1.6 R, 3.75 fl oz (7 days).

Alternative Controls

Insecticidal soaps reduce aphid populations without affecting natural enemies. (21)

Insecticide Profiles

Azinphos-methyl (Organophosphate)

Formulations: Guthion Solupak 50 WP

Pests Controlled: cabbage maggot, imported cabbageworm, diamondback moth and flea beetles

Percent of Crop Treated: 50% of the farms, 100% of the acreage

Types of Applications: soil treatment, foliar treatment

Application Rates: 4 lb AI per acre

Number of Applications: In the West Central area it is applied twice during the first one-third of the crop cycle. In the East Central area it is applied 7-10 days after transplanting

Timing: is applied preventatively, because cabbage maggots are hard to scout for

Pre-Harvest Interval: 15 days

REI: 48 hours (2)

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: high

Advantages: wide spectrum insecticide

Disadvantages: Odor can be a problem.

Critical Use Issue: There are no alternative chemicals for flea beetle control

Chlorpyrifos (Organophosphate)

Formulations: Lorsban 50 W

Pests Controlled: imported cabbageworm and cabbage looper, although it also controls cabbage maggots and suppresses flea beetles

Percent of Crop Treated: on 50% of the farms in Michigan, 100% of the acreage

Types of Applications: applied preventatively, planting treatment

Application Rates: 8.4 lb AI per acre

Number of Applications: no information available

Timing: no information available

Pre-Harvest Interval: 50 days (11)

REI: 24 hours (2)

IPM Concerns: Cabbage maggots are difficult to monitor, problem is irreversible.

Hazardous to beneficial insects due to broad spectrum.(11)

Use in Resistance Management Programs Fonofos and fumigation are effective alternatives, though fumigation is very expensive.

Efficacy Issues: no information available

Advantages: This is a broad spectrum insecticide. Odor problem not as bad as with Guthion. This also represses flea beetles.(11)

Disadvantages: it is harmful to beneficial insects. Recommendation is to treat with transplant water but this is not the safest method because workers are exposed.(11)

Methomyl (Carbamate)

Formulations: Lannate SP or LV

Pests Controlled: control aphids, imported cabbageworm, cabbage looper, thrips, flea beetles and diamondback moth

Percent of Crop Treated: 100% of the farms, 100% of the acreage

Types of Applications: foliar treatment

Application Rates: 0.5 lb AI per acre

Number of Applications: twice in a growing season

Timing: In the East Central region growers apply the last 4 weeks of the season

Pre-Harvest Interval: 1 day (11)

REI 48 hours (11)

Use in IPM Programs: It needs to be rotated with other chemicals to avoid the development of resistance.

Use in Resistance Management Programs: It needs to be rotated with other chemicals to avoid the development of resistance.

Efficacy Issues: good efficacy

Advantages: It is a broad-spectrum insecticide

Disadvantages: highly volatile and presents human health concerns, it is harmful to beneficial insects

Alternatives: Bt and Permethrin (pyrethroid) with poor efficacy.

Naled (Organophosphate)

Formulations: Dibrom 8 EC

Pests Controlled: imported cabbageworm, cabbage looper, diamondback moth, thrips and aphids

Percent of Crop Treated: 100% of the farms, 100% of the acreage

Types of Applications: foliar treatment

Application Rates: 4 lb AI per acre

Number of Applications: once in a growing season

Timing: It is used late in the season because it can be used up to 4 hours before harvest

Pre-Harvest Interval: 1 day

REI: 48-72 hours

Use in IPM Programs: no information available

Use in Resistance Management Programs: It is used as part of a resistance management program

Efficacy Issues: no information available

Advantages: short pre-harvest interval

Disadvantages: no information available

Alternatives: Bt, which is reported to have medium efficacy, and pydrin (fenvalerate) and methomyl (carbamate), with high efficacy

Thiodicarb (Carbamate)

Formulations: Larvin 3.2 EC

Pests Controlled: diamondback moth, cabbage looper, and imported cabbageworm

Percent of Crop Treated: 100% of the farms, 100% of the acreage

Types of Applications: foliar treatment

Application Rates: 4 lb AI per acre

Number of Applications: six times in a growing season

Timing: Generally used in the last 4 weeks in rotations

Pre-Harvest Interval: 5 days

REI: 12 hours

PM Concerns: Hard on bees.(11)

Resistance Management Concerns: Need to rotate with Asana, especially if using four or more applications.(11)

Efficacy Issues: moderate knockdown and good residual control (11)

Advantages: Good insecticide to rotate with.

Disadvantages: Not effective if pH of water is not right.(11).

Alternatives: Thiodan (organochlorine), esfenvalerate (pyrethroid) and permethrin (pyrethroid) with good efficacy. The pyrethroids are not good when the weather is hot and humid

Permethrin (Pyethroids)

Formulations: Ambush 2 EC or 25 WP, Pounce 3.2 EC or 25 WP

Pests Controlled: Aphids, Imported cabbage worm, Loopers, Thrips, Diamond black moths

Percent of Crop Treated: no information available

Types of Applications: foliar treatment

Application Rates: Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz., Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz

Number of Applications: no information available

Timing: before, at or after first flowering

Pre-Harvest Interval: 1 day

REI: 12 hours (11)

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: poor

Advantages: no information available

Disadvantages: Reflects an increase in chemical costs.(2) Very hard on bees.(3)

Alternatives: no information available

Cypermethrin (Pyrethroids)

Formulations: Ammo 2EC or Ammo WSB

Pests Controlled: Aphids, Imported Cabbage Worm, Loopers, Thrips

Percent of Crop Treated: no information available

Types of Applications: foliar treatment

Application Rates: Ammo 2EC 3.75 to 5 oz, or Ammo WSB 1-2 bags

Number of Applications: no information available

Timing: flowering

Pre-Harvest Interval: 1 day

REI: 12 hours

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: no information available

Advantages: Safer handling for harvest and applications

Disadvantages: no information available

Alternatives: no information available

Endosulfan (Organochlorine)

Formulations: Thiodan 3 EC, Phaser3 EC
Pests Controlled: Cabbage Loopers, Diamond Black Moth
Percent of Crop Treated: no information available
Types of Applications: foliar spray
Application Rates: 1 1/3 qt or 50 WP, 2 lb
Number of Applications: no information available
Timing: at flowering or after
Pre-Harvest Interval: 7 days
REI: 24 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: Moderate efficacy
Advantages: compatible with most pesticides, relatively non-toxic to bees
Disadvantages: highly toxic to fish, corrosive to iron
Alternatives: no information available

Esfenvalerate (Pyrethroids)

Formulations: Asana XL
Pests Controlled: Cabbage Loopers, Diamond Black Moth
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Application Rates: 5.8 to 9.6 oz
Number of Applications: no information available
Timing: at or before first flowering
Pre-Harvest Interval: 3 days
REI: 12 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: Good
Advantages: no information available
Disadvantages: Disadvantages: Kills predators of mites, which could lead to a mite
Alternatives: no information available

Diazinon

Formulations: Diazinon 50 WP, Diazinon 500-AG
Pests Controlled: cabbage maggot
Percent of Crop Treated: no information available
Types of Applications: seedbed treatment, transplant water treatment
Application Rates: Diazinon 500-AG 1 pt, Diazinon 50 WP 1 lb/100 gal
Number of Applications: no information available
Timing: no information available

Pre-Harvest Interval: not applicable

REI: 12-24 hours

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: good (2) (25)

Advantages: compatible with other pesticides (25)

Disadvantages: bird and bee toxicity (25)

Comments: Long residual time (25)

Malathion (Organophosphate)

Formulations: Malathion 57 EC

Pests Controlled: imported cabbage worm

Percent of Crop Treated: no information available

Types of Applications: foliar spray

Application Rates: 2 pt

Number of Applications: no information available

Timing: no information available

Pre-Harvest Interval: 2 days

REI: 12 hours

Use in IPM Programs: no information available

IPM concerns: This is a broad-spectrum insecticide that kills beneficial insects.

Use in Resistance Management Programs: no information available

Efficacy Issues: no information available

Advantages: no information available

Disadvantages: expensive

Carbaryl (carbamate)

Formulations: Sevin 80 S, Seven XLR Plus

Pests Controlled: imported cabbageworm, diamondback moth

Percent of Crop Treated: no information available

Types of Applications: foliar spray

Application Rates: Sevin 80 S 1 1/2 lb., Seven XLR Plus 1 to 2 qt

Number of Applications: no information available

Timing: no information available

Pre-Harvest Interval: 3 days

REI: 12 hours

Use in IPM Programs: no information available

IPM concerns: Kills beneficial insects. Excessive use leads to aphid outbreak

Use in Resistance Management Programs: Used as part of a resistance management program

Efficacy Issues: inexpensive yet effective

Advantages: s. It is an inexpensive yet effective product.

Disadvantages: no information available

Alternatives include: Bt, Orthene, SpinTor, Di-Syston, Metasystox

Diseases

Damping off or Wirestem (*Rhizoctonia solani*)

Biology

Rhizoctonia solani causes a number of closely-related diseases of cole crops, including damping off, wire stem, bottom rot, and head rot. If the fungus attacks very young seedlings, the disease is called damping off. The fungus penetrates seedlings near the soil line causing water-soaked constrictions of the stem, which girdle the plant. The plants then wilt and topple over. If plants survive the initial attack, the center of the stem decays while the outer stalk provide sufficient support to keep the plants erect. At this stage the disease is called wire stem. Stems are brown or black and wiry above the soil line. The plants grow very slowly and usually do not develop to maturity. Bottom rot occurs as a carry-over from wire stem. *Rhizoctonia* can attack low lying leaves at the petioles and midribs. This produces reddish brown lesions, and the leaf will eventually become slimy and brown while the disease progresses to inner leaves. Head rot may develop, causing a darkening and decaying of the stem at the base of the heads and spotting and wilting of the leaves in the center of the head. (18)

Rhizoctonia overwinter as mycelium or sclerotia in the soil or on infected plant material. Once the pathogen is present in soil it remains there indefinitely. The pathogen can be spread through moving water, transport of contaminated soil and equipment and contaminated seeds and transplant seedlings. The disease develops more rapidly in moderately wet soils as opposed to saturated or dry soils. Plants that grow rapidly and vigorously tend to resist infection better than slow growing plants. (1)

Cultural Controls

Control damping off and wirestem in the greenhouse and field seedbeds by using sanitized media and containers and avoiding overwatering. Whenever possible use disease free seeds, although infected seeds can be treated by hot water. Planting seeds on raised beds with good aeration between plants can decrease occurrence. A three year crop rotation will reduce infect rates. Do not grow cole crops in low-lying fields with heavy soils, do not use diseased transplants. (18)

Chemical Controls

Treat seeds or soil with a fungicide.

- Kodiak 0.1 - 0.5 oz/100 lb seed
- Fludioxonil (Maxim) 0.08 to 0.16 oz/100 lb seed
- Oxadixyl (Anchor) at 1 ½ oz/100 lb seed.
- Captan (30-DD or 300) at 1 ¼ oz/100 lb seed, or Captan (400 or 400-D) at 1 to 2 oz/100 lb seed. (REI)
- Thiram (42-S or 50 WP Dyed) is used as a seed treatment at a rate of 8 oz/100 lb seed. (REI 24 hours) (2)

Alternative Controls

Mulching and composting soils can reduce the disease. Biocontrol agents have also been used to control *Rhizoctonia*. The pathogen is parasitized by a variety of fungi including *Trichoderma*, *Gliocladium* and *Laetisaria* as well as predatory nematodes.

Black rot (*Xanthomonas campestris* pv. *Campestris*)

Biology

Black rot is a bacterial disease that affects all the cole crops. Cotyledons on infected plants become water soaked and shrivel and drop off. On true leaves, the infection generally appears as a yellow v-shaped area along the leaf margin that progresses to the midrib. As the lesions enlarge, the leaf veins within them turn black. Numerous brown specks appear in yellow areas on the leaf surface. The pathogen moves through the leaf into the water-conducting (vascular) system, causing a blackening and a plugging of the veins. Once in the veins the bacteria multiply and spread. Early infections usually cause plant wilting and death. Later infections cause stunting, smaller heads, or possibly only leaf spotting. (18)

Under conditions favorable for black rot development (80 to 86° F and high humidity), the disease moves rapidly through infected plants and spreads to adjoining plants in wind and rain. The black rot organism overwinters on crop debris in the field, but infection occurs more often from infected seed. To avoid black rot, use seed that has been hotwater-treated or assayed and found to be completely free of black rot. Rotate fields out of cole crops for at least 2 years to avoid reinfestation in the field. (18)

Cultural Controls

It is important to use seeds that are free of the disease. Hot water treatment for seeds reduces the incidence of the disease. Rotations out of fields with black rot for 2 years with non-cole crops is beneficial. (18)

Chemical Controls

Seed treatments and foliar sprays are used to control black rot. Spray foliar treatment with copper sprays applied with a boom sprayer may reduce spread of the organism in the field. Do not use an airblast sprayer, because it will increase the spread of the pathogen. Apply foliar treatment in transplant bed at

lowest rate and start weekly treatments in the field as soon as transplants are established. (2)

- **Copper Ammonium Carbonate** (REI 12 hours, PHI 0 days)
Copper Count N 8L applied at a rate of 2 quarts
- **Copper Hydroxide** (REI 24 - 48 hours, PHI 0 days)
Champ F or Kocide LF at a rate of 2 2/3 pt
Champ Formula 2F at a rate of 1 1/3 pt
Champion WP or Kocide (101 or DF) or Nu-Cop 50 DF at a rate of 2 lbs
Kocide 2000 at a rate of 1 1/2 lb
Kocide 4.5 LF at a rate of 2/3 to 1 1/3 pt
Nu-Cop 3L at a rate of 1 1/3 to 2 2/3 pt (2)

Alternative Controls

Antibiotic seed treatments including tetracycline or streptomycin have been used to reduce seed-borne inoculum.

Club root (*Plasmodiophora brassicae*)

Biology

Club root is a protozoan that acts as a parasite on cruciferous plants. They are restricted to soil environments where they cause the formation of galls on susceptible plant roots. Club root can be a problem if the pH is below 7.2. Cells in the roots become enlarged and reproduce excessively forming large gall-like structures. (18)

Club root is a fungal disease that attacks the roots of all cole crops and other cruciferous crops and weeds. Infected plants wilt in the middle of hot, sunny days, and leaves turn pale green to yellow. Eventually, infected plants wilt permanently and die, or survive in a stunted condition. (18)

Swimming spores of the pathogen enter roots through root hairs or wounds. The organism stimulates plant cell multiplication, causing roots to enlarge and form spindle-shaped galls or "clubs." The growth of the clubs inhibits development of a normal root system and blocks the vascular system. The clubbed roots eventually decay and are invaded by soft rot bacteria that release a toxin. Lack of sufficient water and the presence of the toxin causes foliar wilting. (18)

Cultural Controls

Clubroot incidence can be reduced by using uninfected transplants, avoiding movement of machinery from infested acres into clean fields, and maintaining a soil pH of 7.3 or higher. Crop rotation is not very effective because the resting spores can survive in the soil for many years. (18)

Chemical Controls

- Seedbed treatment

Terraclor F (PCNB) at a rate of 5.6 gal in 25 gal water or 7.5 gal in 30 gal water. (REI 12 hours)

Terraclor 10 G 200 lb (row) or 300 lb broadcast (REI 12 hours)

Terraclor (PCNB) 75 W at a rate of 30 lb in 25 gal of water or 40 lb in 30 gal of water (REI 12 hours)

Alternative Controls

No information available

Downy mildew (*Peronospora parasitica*)

Biology

The initial symptom of this fungal disease is the appearance of small, irregularly shaped grayish-purple spots on stems and the undersides of leaves. Under cool, moist conditions the spots enlarge and become covered with fluffy, grayish-white mycelia. The upper surface turns yellow and dries out. Heavily infected leaves eventually drop off. The organism may move systemically in the plant causing internal darkening of cabbage heads. Downy mildew overwinters in plant debris or on cruciferous weed hosts. It spreads in the field with splashing water during cool weather, and is primarily a problem during the fall. Fungicide applications help prevent spread of the organism in the field. (18)

Cultural Controls

No information available

Chemical Controls

Use foliar applications when conditions favor the disease and repeat every 7 to 10 days. Fungicides that protect against *Alternaria* also protect against downy mildew.

- Fosetyl-Aluminum

Aliette WDG at a rate of 2 to 5 lb at 7 to 21 day intervals (PHI 3 days) (REI 12 hrs)

- Fosetyl-Aluminum (Maneb)

Aliette/Maneb 2+2 at a rate of 4 lb (PHI 7 days) (REI 24 hrs)

Mefenoxam/Chlorothalonil (Ridomil Gold/Bravo) at a rate of 1½lb (PHI 7 days)(REI 12 to 48 hrs) (2)

Alternative Controls

No information available

Blackleg (*Phoma ligam*)

Biology

Blackleg is most common on cabbage, but it also affects other cole crops. Symptoms may appear early in the growing season on seedlings not yet transplanted in the field. Inconspicuous, small, circular, dark lesions appear on the leaves of the infected plants. The spots gradually enlarge, becoming well defined with a gray center filled with numerous black, pimple-like, spore-bearing structures called pycnidia. The lesions on stems are oval shaped and often surrounded by a purplish margin. Spots spread over the whole plant including the root system. The dark cankers which form on affected roots may eventually destroy the fibrous root system. The disease causes wilting, stunting, and death of infected plants. (18)

Cultural Controls

To avoid blackleg, use disease-free seed and rotate fields out of cole crops for at least three years. (18)

Chemical Controls

No chemicals are registered for this disease.

Alternative Controls

No information available

Alternaria spp. Fungi

Biology

Alternaria is a fungus that causes leaf spotting and head rotting of crucifers. The initial disease symptom is the appearance of small dark spots on older leaves. The spots are generally circular, ranging from ½ to 1½ inches in diameter. A brown or black velvety mold, composed of masses of fungal spores, rapidly covers the lesion. These spores rub off the lesion surface easily. Lesions may coalesce to form large, irregular, diseased areas on the leaf surface. cabbage leaf margins are often colonized by *Alternaria spp.* Plants are highly susceptible after tipburn or other injuries. Bacterial soft rot and Brown rot often follow *Alternaria* infection. On cauliflower, tiny brown sunken lesions appear on the curds. On cabbage heads the lesions are yellow. The spots enlarge rapidly and are eventually covered with black spores. (18)

Cultural Controls

To avoid *Alternaria* diseases, use high quality, disease-free seed; irrigate early in the day so that leaves dry rapidly; and tie cauliflower leaves as high as possible to allow air movement to reduce free moisture on the head. (18)

Chemical Controls

- **Chlorothalonil**

Bravo 500 at a rate of 2 ¼pt (PHI 0 days) (REI 48 hrs)

Bravo Ultrex 82.5 WDG 1.4 lb (PHI 7 days) (REI 48 hrs)

Bravo Weather Stik or Bravo 720 or Supanil 720 or Terranil 6L at 1 ½pt (PHI 0 days, 7 days-Chinese cabbage) (REI 48 hrs)

- **Copper Ammonium Carbonate**

Copper Count N 8L at 2 qt (PHI 0 days) (REI 12 hrs)

- **Maneb**

Manex at 1 1/5 to 1 3/5 qt (PHI 7 days) (REI 24 hrs)

Maneb 75 DF or 80 WP at 1 ½to 2 lb (PHI 7 days) (REI 24 hrs)

Maneb 75 DF at 1 to 1 ½lb (PHI 10 days) (REI 24 hrs)

- **Copper Sulfate**

Basicop 53 WP at 1 to 3 lb (PHI 0 days) (REI 24 hrs)

- **Copper hydroxide**

Kocide LF at 2 2/3 pt (PHI 0 days) (REI 24-48 hrs)

Kocide 101 or Kocide DF at 1 to 2 lb (PHI 0 days) (REI 24-48 hrs)

Kocide 2000 at ¾to 1 ½lb (PHI 0 days) (REI 24-48 hrs)

Kocide 4.5 LF at 2/3 to 1 1/3 pt (PHI 0 days) (REI 24-48 hrs)

- **Fosetyl-Aluminum(Maneb)**

Aliette/Maneb 2+2 at a rate of 4 lb (PHI 7 days) (REI 24 hrs)

- **Mefenoxam/Chlorothalonil**

Ridomil Gold/Bravo at a rate of 1½lb (PHI 7 days) (REI 12 to 48 hrs) (2)

Alternative Controls

No information available

Soft rot (*Erwinia carotovora*)

Biology

Soft rot bacteria cause a watery, soft, foul-smelling rot of the cole crops. Bacterial infection often occurs

after chemical, mechanical, pest or other injury. It often follows external or internal tipburn. The bacteria soften the cell walls of plant tissue, which results in a rapid collapse into a slimy mess. Soft rot may be a primary pathogen on cabbage heads, especially during warm, humid weather. (18)

Cultural Controls

The bacteria become established in small droplets of water that remains on the heads. Cultivars with domed heads that shed surface water are less susceptible. To avoid soft rot, grow cole crops on well-drained soils and maintain adequate soil moisture to avoid tipburn. Select cultivars recommended for Michigan, and avoid injury to plants. (18)

Chemical Controls

No information available

Alternative Controls

No information available

Turnip mosaic virus and cauliflower mosaic virus

Biology

Transmitted by aphids, Turnip mosaic virus and cauliflower mosaic virus cause serious economic losses in stored cabbage. Early infection in the field cause leaf spotting and leaf drop. The spots become black and sunken on inner cabbage leaves during long-term storage. Turnip mosaic spots are larger than cauliflower mosaic spots. The viruses are transmitted by aphids. Aphid control is the primary means of virus control. (18)

Cultural Controls

Select cabbage cultivars that are resistant to virus infection. Where the viruses have been a problem, make an extra effort to control cruciferous weeds near seed beds. (18)

Chemical Controls

Control aphids

Alternative Controls

No information available

Sclerotinia Head Rot (*Sclerotinia sclerotiorum*)

Biology

Sclerotinia Head Rot, a soil-borne fungus, attacks hosts late in the growing season, invading the main stem of the plant near the soil line, causing a soft decay of the outer layer of the stem. An infected plant may succumb rapidly or become stunted and decline slowly in health. Lower leaf drop accompanies the decline in plant vigor. A cottony, white mycelium is visible on infected plant parts. Black fruiting structures $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, called sclerotia, are often found embedded in the mycelium growing on the outer leaves of cauliflower heads.

Cultural Controls

- Avoiding low-lying fields with heavy, moist soils
- Adequate interval spacing
- Field sterilization
- Crop rotation

Since the disease is favored by high soil moisture and high air humidity and affects both cultivated and wild plants, susceptible crops should be planted only in well-drained soils, the plants should not be spaced too close together for air circulation, and the soil should be kept free of weeds between crops.

If the disease has become severe on susceptible crops, infected plants should be pulled and burned to either prevent the fungus from forming sclerotia or to remove from the field as many sclerotia as possible.

Since sclerotia remain viable in the soil for at least three years, and since they do not all germinate or die out at the same time, infected fields should be rotated to nonsusceptible plants such as corn and small grains for at least 3 years before susceptible crops are planted again.

Chemical Controls

In several crops, good control of the disease has been obtained by spraying the soil with metham sodium, benomyl, dichloran, or thiophanate-methyl before and during their stage of susceptibility to the pathogen. Two newer contact fungicides, iprodione and vinclozolin, give excellent control of Sclerotinia and are being used on a wide variety of crops.

Alternative Controls

- *Coniothyrium minitans*
- *Gliocladium roseum*
- *G. Virens*
- *Sporodesmium sclerotivorum*
- *Trichoderma viride*

In the last several years, more than 30 species of fungi, bacteria, insects, and other organisms have been reported to parasitize or to interfere with the growth of Sclerotinia sp. Encouraging results of biological

control of Sclerotinia disease in some crops have been obtained by incorporating into the soil the mycoparasitic fungi *Coniothyrium minitans*, *Gliocladium roseum*, *G. Virens*, *Sporodesmium sclerotivorum*, and *Trichodermaviride*. The mycoparasites destroy existing sclerotia or inhibit the formation of new sclerotia by the fungus, thereby, markedly reducing the fungus population in the soil. So far, however, no practical control recommendations have been developed.

Fungicide Profiles

Chlorothalonil (Nitrile Compound)

Formulations: Echo, Daconil, Bravo (Bravo 500, Bravo Ultrex 82.5 WDG, Bravo Weather Stik, Bravo 720, Supanil 720, Terranil 6L)

Diseases Controlled: Alternaria Leaf Spot

Percent of Crop Treated: no information available

Types of Applications: spray

Application Rates: Bravo 500 at a rate of 2 ¼ pt, Bravo Ultrex 82.5 WDG 1.4 lb, Bravo Weather Stik or Bravo 720 or Supanil 720 or Terranil 6L at 1 ½ pt

Number of applications: no information available

Timing: when conditions favor disease development, every 7-10 days (2)

Pre-Harvest Interval: 0 days (2)

REI: 48 hours (2)

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: very effective

Advantages: broad-spectrum foliage protectant fungicide

Disadvantages: B2 carcinogen

Copper hydroxide (Inorganic Compound)

Formulations: Kocide, Champ, Nu-Cop

Diseases Controlled: Black rot

Percent of Crop Treated: no information available

Types of Applications: foliar treatment

Application Rates: Kocide 101 at 1 to 2 lb, Kocide 2000 at ¾ to 1 ½ lb, Kocide 4.5 LF at 2/3 to 1 1/3 pt, Kocide LF at 2 2/3 pt

Number of Applications: 1.2 applications

Timing: no information available

Pre-Harvest Interval: 0 days

REI: 24-48 hours

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: a protectant for vegetables
Disadvantages: toxic to fish

Thiram (Carbamate)

Formulations: Thiram 42-S or 50 WP dyed
Diseases Controlled: Damping off
Percent of Crop Treated: information not available
Types of Applications: seed treatment (2)
Application Rates: 8 oz/100lb seed (2)
Number of Applications: 1
Timing: for seed treatment
Pre-Harvest Interval: not applicable
REI: 24 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: It is a broad-spectrum pesticide and less expensive than alternatives
Disadvantages: no information available

Captan (Carboximide, Sulfenimide)

Formulations: Captan 30-DD or 300 or 400, 400-D
Diseases Controlled: Damping off
Percent of Crop Treated: no information available
Types of Applications: seed treatment
Application Rates: recommended (2) Captan 20-DD or 300 at 1 1/4 oz/100 lb seed, or Captan (400 or 400-D) at 1 to 2 oz/100 lb seed
Number of Applications: 1
Timing: seed treatment
Pre-Harvest Interval: not applicable
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: no information available
Disadvantages: Captan is a B2 carcinogen

Fludioxonil (Organic Compound)

Formulations: Maxim 4 FS

Diseases Controlled: Damping off
Percent of Crop Treated: no information available
Types of Applications: seed treatment
Application Rates: recommended 0.8 to 0.16 oz/100 lb seed (2)
Number of Applications: no information available
Timing: seed treatment
Pre-Harvest Interval: no information available
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: no information available
Disadvantages: no information available

Oxadixyl (Oxaolidinone)

Formulations: Anchor
Diseases Controlled: Damping off
Percent of Crop Treated: information not available
Types of Applications: seed treatment
Application Rates: recommended (2) 1 1/2 oz/100 lb seed
Number of Applications: no information available
Timing: seed treatment
Pre-Harvest Interval: no information available
REI: not applicable
Use in IPM Programs: no information available
Use in Resistance Management Programs: used in combination with other fungicides to reduce risk of resistance (26)
Efficacy Issues: no information available
Advantages: curative and eradicant (26)
Disadvantages: no information available
Comments: available in combination with fungicides to broaden spectrum of effect (26)

Terraclor (Chlorinate Hydrocarbon)

Formulations: Terraclor (PCNB) 10 G, Terraclor F, Terraclor 75 W
Diseases Controlled: Clubroot, wirestem
Percent of Crop Treated: no information available
Types of Applications: seedbed treatment
Application Rates: Terraclor F 5.6 gal/25 gal water, Terraclor 10 G 200 lb in row or 300 lb broadcast, Terraclor 75 W 30 lb in 25 gal water or 40 lb in 35 gal water.
Number of Applications: no information available
Timing: seedbed application
Pre-Harvest Interval: not applicable

REI: 12 hours (2)

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: not effective for control of Pythium and Fusarium (26)

Advantages: no information available

Disadvantages: no information available

Fosetyl-Aluminum (Inorganic Compound)

Formulations: Aliette/Maneb 2 + 2, Aliette WDG

Diseases Controlled: Damping off, Downy mildew and alternaria leaf spot

Percent of Crop Treated: <1%

Types of Applications: foliar

Application Rates: Aliette WDG at a rate of 2 to 5 lb, Aliette/Maneb 2 + 2, 4 lb.

Number of Applications: no information available

Timing: 7 to 21 day intervals

Pre-Harvest Interval: 7 days

REI: 12 hours (2)

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: no information available

Advantages: gives long persistent control (26)

Disadvantages: no preventative action (26)

Mefenoxam/Chlorothalonil (Nitrile Compound)

Formulations: Ridomil Gold/Bravo

Diseases Controlled: Damping off and Downy mildew

Percent of Crop Treated: no information available

Types of Applications: foliar treatment

Application Rates: 1 1/2 lb

Number of Applications: maximum 4 applications / crop

Timing: 14 day intervals

Pre-Harvest Interval: 7 day

REI 12 to 48 hrs

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: no information available

Advantages: no information available

Disadvantages: no information available

Nematodes

General

Biology

Nematodes are not a major economic concern in cole crop production in Michigan.(20) Sugar beet cyst, northern root knot and lesion nematodes can reduce broccoli yields. Fields with soil or root problems of undetermined cause should be tested for nematodes. If the above plant parasitic nematodes are present in population densities above the economic threshold for cabbage, crop rotation or application of nematicides are suitable for control of sugar beet cyst, root-knot and lesion nematodes in broccoli production. It is best not to plant broccoli on land infested with sugar beet cyst nematodes. (2)

Cultural Controls

Crop rotation with non-host crops. Corn and small grain crops are not hosts for root knot nematodes. (20) Sugar beet cyst nematodes have sufficient host specificity that rotation with non-hosts is generally an effective management practice. (20)

Chemical Controls

Nematodes can be controlled chemically through nematicide fumigations in the fall, preplanting soil treatment and soil treatment at planting.

- Fall soil fumigation (Broadcast)
- 1,3-D (Telone II) at a rate of 36 gal (muck soil), 15 gal (mineral soil) (2)

Chemical Controls

Nematodes can be controlled chemically through nematicide fumigations in the fall, pre-planting soil treatment and soil treatment at planting.

- Fall soil fumigation
- Preplant soil treatment
- Soil treatment at planting (2)

Nematicide Profiles

1,3-Dichloropropene (Fumigant)

Formulations: Telone II

Pests Controlled: nematodes and soil insects

Percent of Crop Treated: no information available

Types of Applications: Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application, broadcast

Application Rates: of 36 gal (muck soil), 15 gal (mineral soil) is suggested (2)

Number of Applications: no information available

Timing: Fumigate in the fall, in some limited situations soil fumigants can be applied in the spring in Michigan (2)

Pre-Harvest Interval: not applicable

REI: 5 hours

Use in IPM Programs: no information available

Use in Resistance Management Programs no information available

Efficacy Issues: particularly effective against cyst forming nematodes and meadow nematodes. (20)

Advantages: also helps control weeds and diseases(20)

Disadvantages: cannot use on heavy soils(20)

Critical Use Issue: no information available

Weeds

Biology

Weed control is important for the control of diseases and pests. All annual broadleaf and grasses are a problem in cauliflowers in Michigan. Weeds in the *Cruciferae* family, such as wild mustard, yellow rocket, shepherd's purse, and wild radish need to be eliminated because they serve as hosts for several cole crops diseases. Weeds such as yellow rocket and mustard are hosts for cabbage maggots.

Crop rotation, cultivation and herbicide applications help to control weeds. Herbicides can be applied either before or after seeding or as top dressing. Other herbicides can be applied after crop emergence.

Cultural Controls

- Crop Rotation
- Cultivation

Chemical Controls

- Paraquat (Gramoxone extra)
- Trifluralin (Treflan)

- Napropamide (Devrinol 50DF)
- Oxyfluorfen (Goal 2XL)
- Sethoxydim (Poast 1.5E)
- Glyphosate (Roundup)

Alternative Controls

No information available

Herbicide Profiles

Trifluralin (Dinitroaniline Compound)

Formulations: Treflan 4EC, Trilin 4E

Weeds Controlled: to control broadleaves and annual grasses

Percent of Crop Treated: 60% of the acres; 43% (13)

Types of Applications: incorporated into soils for pre-plant weed control on mineral soils

Application Rates: 0.5-1 pounds per acre, rates increase with increasing clay and organic content in the soil (17); 0.81 lb/ac(13)

Number of Applications: 1.0 applications (13)

Timing: Preplant incorporation

Pre-Harvest Interval: not applicable

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: Good herbicide Primarily a grass herbicide; 3-4 weeks residual activity

Advantages: Cheap, selective and effective

Disadvantages: not very effective on muck soils, short residual period; may cause root stunting.

Paraquat (bipyridylum)

Formulations: Gramoxone Extra

Weeds Controlled: emerged weeds

Percent of Crop Treated: 10%

Types of Applications: pre plant

Application Rates: 0.5-1 lb a/i

Number of Applications: 1

Timing before crop emergence or before transplanting

Pre-Harvest Interval: not applicable

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: kills most emerged vegetation

Advantages: Cheap, effective

Disadvantages: no residual activity

Napropamide (Amide)

Formulations: Devrinol 50DF

Weeds Controlled: germinating grasses and broadleaves

Percent of Crop Treated:

Types of Applications:

Application Rates:

Number of Applications: 1

Timing: before seeding or transplanting and incorporated to a depth of 2-3 inches, also applied after planting

Pre-Harvest Interval: not applicable

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: Weak herbicide

Advantages: No root stunting

Disadvantages: Expensive, weak, irrigation should occur within 24 hours of application

Oxyfluorfen (Diphenyl Ether)

Formulations: Goal 2XL

Weeds Controlled: germinating broadleaf weeds in the field

Percent of Crop Treated: no information available

Types of Applications: Pre-transplant

Application Rates: no information available

Number of Applications: 1

Timing: is applied to the soil after the final tillage but before transplanting

Pre-Harvest Interval: not applicable

Use in IPM Programs: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: very effective

Advantages: cheap

Disadvantages: can cause phytotoxicity

Sethoxydim (Cyclohexenone)

Formulations: Poast 1.5E

Weeds Controlled: Emerged

Percent of Crop Treated: no information available
Types of Applications: no information available
Application Rates: 0.19 to 0.28 lb AI/ac, 5 pt
Number of Applications: no information available
Timing: applied to actively growing grasses
Pre-Harvest Interval: 30 days
Use in IPM Programs: no information available
Use in Resistance Management Programs: kills emerged weeds
Efficacy Issues: good herbicide
Advantages: Kills emerged grasses, effective, inexpensive
Disadvantages: no residual control, poor control of quackgrass

Glyphosate (Phosphono amino acid)

Formulations: Roundup 4L
Weeds Controlled: wide spectrum weed control, perennial weeds after they have emerged
Percent of Crop Treated: no information available
Types of Applications: no information available
Application Rates: no information available
Number of Applications: 1
Timing: Apply either before planting in the spring or after harvest in the fall.
Pre-Harvest Interval: not applicable
Use in IPM Programs: no information available
Use in Resistance Management Programs: Kills emerged weeds
Efficacy Issues: kills most emerged weeds
Advantages: Kills perennial weeds
Disadvantages: Can't be used in crops, no residual

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