Crop Profile for Cabbage in Michigan

Prepared: June, 1999
Revised: August, 1999

General Production Information

- Cabbage is produced for fresh market and processing
- Over 2000 acres of cabbage are planted annually in Michigan(11)
- Michigan ranks 9th in the country in fresh cabbage production, with minor production of cabbage for processing (1996) (9)

(7)(9)

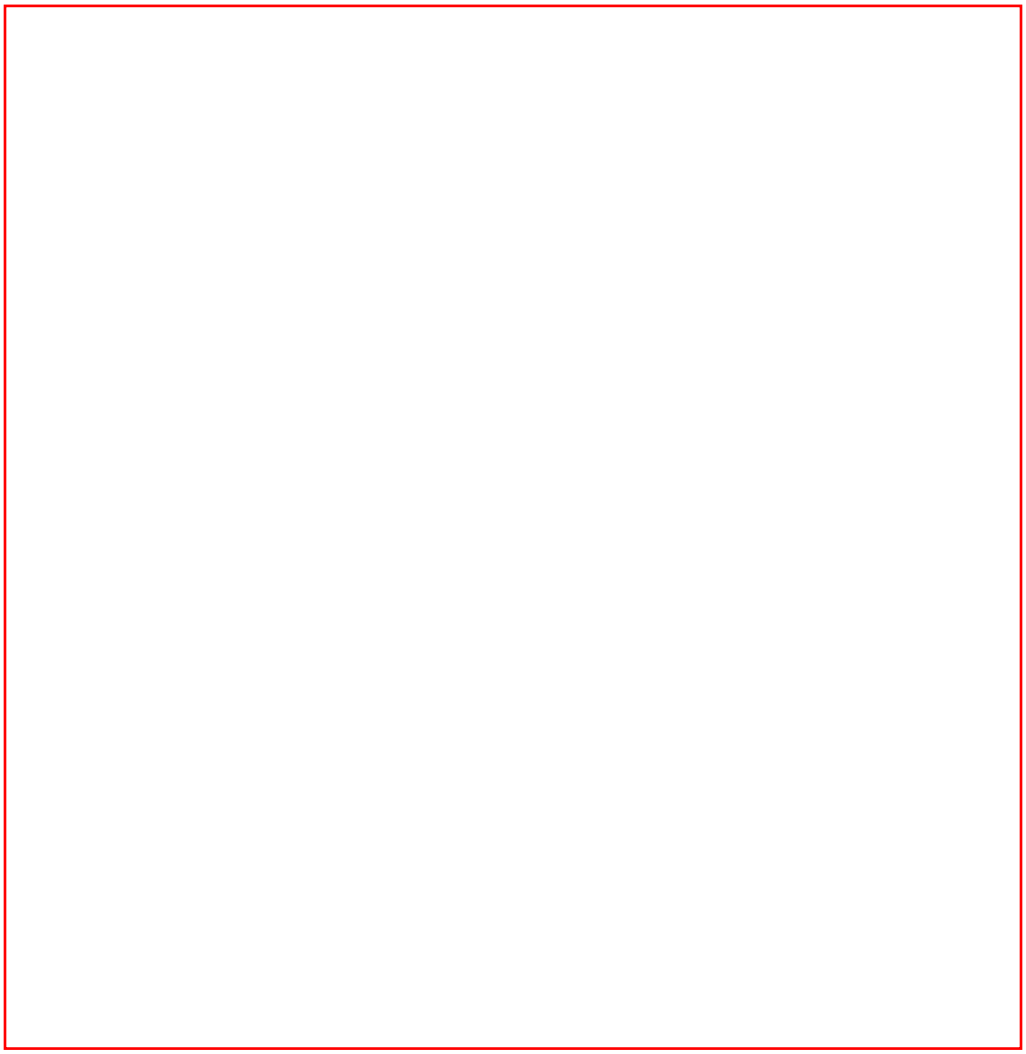
Production Regions

- Southwest District: Kent and Ottawa counties
- East Central District: Bay county
- Southeast District: Macomb and Monroe counties (7)

Over 10,000 acres of cabbage are planted annually in: New York, Texas, Georgia and California

(7)

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

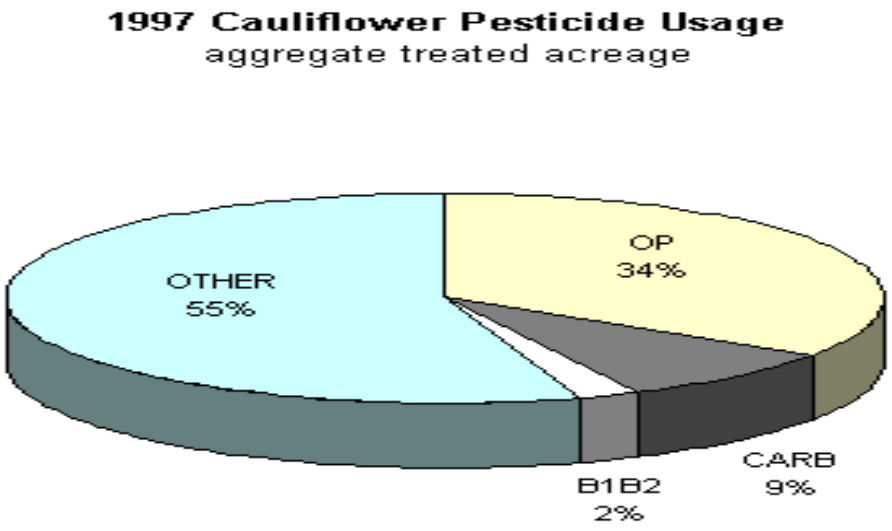


Cultural Practices

Michigan cole crops include broccoli, Brussels sprouts, cabbage and cauliflower. Cole crops are a significant segment of the state's fresh market and processing commodity. Cabbage is a cool-season crop. It grows well under moderate temperatures (up to 85° F) and is able to withstand moderate frosts. Since the roots do not penetrate deep into the soil, constant adequate moisture is essential. Dry periods can result in tipburn in cabbage. Cole crops require 1-2 acre inches of water a week, depending on the size and developmental stage of the plant, as well as the soil type. Cole crops are also sensitive to waterlogging. It is important to grow these crops on well-drained soils with good moisture-holding capacity.

Cole Crops are very sensitive to nutrient deficiencies and low pH. Loams, clay loams, and muck soils are ideal for cole crop production, but lighter soils can also produce good yield if managed carefully.

Because of potential disease problems, crop rotations that do not include members of the *Brassicaceae* family more than 1 year in 3 are more effective. Weeds in the *Brassicaceae* family, such as wild mustard, yellow rocket, shepherdspurse, and wild radish, should be eliminated, since they serve as alternate hosts for several cole crop diseases.(19)(20)



Several varieties of cabbage are grown in Michigan. Early-maturing cabbage cultivars are very compact and grow rapidly. Mid- to late-maturing cultivars are larger, and heads can be harvested early for market or later for processing. Some late-maturing cultivars can even be stored for several months and marketed during the winter. (19)

Herbicide is applied either before planting and incorporated into the soil, or after seeding. Cabbage seeds are sown in early April and periodically thereafter to allow for a constant supply of cabbage. After planting, the soil is drenched with an insecticide to avoid cutworm and maggot damage. The transplanting of seedlings begins in May and continues through mid-July. Harvesting begins in early July and continues into the fall.(19)(20)

Chemical Controls: Critical Use Issues

- There are no alternatives to fonofos in controlling flea beetles and diamondback moths.
- Growers should use caution in tank mixing Bt with certain chemical aphicides because of reports of reduced effectiveness of Bt in such mixtures.

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. All crops are infested with cabbage maggot, they cause approximately 10-20% yield losses. Pupae overwinter in the soil. The adult flies are small, bristly and gray, and emerge from the soil in early May to lay small, white 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. Young plants that are invaded by maggots usually wilt and die. (19)

There are three generations of cabbage maggot each year. The first generation causes the most damage because it emerges when transplants and seedlings are small. Later generations do less damage because high soil temperatures kill many of the insects, and the crops are advanced enough to withstand some injury.(19)

Cabbage maggot problems are most serious in cool, wet weather. They may not kill mature plants; however, they do predispose the plants to secondary infections such as blackleg and soft rot. (19)

Cultural Controls:
The use of tolerant cabbage varieties such as Early Jersey, Wakefield, and Penn State Ballhead is suggested. Cabbage maggots are less of a problem on heavy and muck soils; they are a more significant problem on light, sandy soils. If possible it is best to adjust the planting time to avoid planting during the peak emergence times for cabbage maggots.

Sanitation methods can also reduce infestation. Crop residue should be plowed under immediately after harvesting to reduce the overwintering population of cabbage maggots. Weeds such as yellow rocket and mustard act as hosts for cabbage maggots -- their removal can be help in controlling cabbage maggots.

(5)

Chemical Controls:
Preventative treatment at planting or transplanting is suggested. Transplanted cole crops can be protected with a soil insecticide, either in the transplant water or as a drench after transplanting. Direct-seeded plantings and seedbeds should be treated 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.(2)

- Planting treatment: Lorsban 15G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row. (2)
- Soil treatment: Guthion Solupak 50 WP, ¼ to 3/8 lb or 2L, ½ pt in 50 gallons of water. (2)
- Transplant water treatment: Diazinon 50 WP 1 lb/100 gal. (2)

Alternative Controls:
Natural enemies of cabbage maggot help in regulating the population, but do not generally maintain the level low enough to avoid economic damage. The mass release of predators combined with the use of chemicals with low residuals can help regulate the population. Release of predaceous nematodes has potential in controlling cabbage maggots. There are no effective chemicals to protect from cabbage maggots. (5)

Imported cabbageworm (*Pieris rapae*)

Biology:
Imported cabbageworms are the most common foliage pest of cole crops in Michigan. The feeding of the cabbageworm can kill small plants and delay maturity of older plants. Damage from imported cabbageworms causes a 100% loss in quality and 25-60% loss in the quantity of cabbage yields. Some injury can be tolerated in cabbage prior to heading. (11)

Imported cabbageworm adults, the white butterflies often seen around cruciferous crops, overwinter as pupae and emerge in late April or early May to lay their yellow eggs singly on the leaves of cole crops and other cruciferous crops and weeds. The velvety green worms, which grow to just over one inch in length, eat holes in leaves and leave large amounts of green debris on the leaves. They tend to migrate from the plant to pupate in the soil. There are commonly 3 generations a year, the adults and larvae may be active until frost. (19)

Cultural Controls:

- Soil cultivation in the fall and early spring exposes overwintering pupae to predators and reduced the population of imported cabbageworms.
- Planting early season varieties helps to avoid peak damage periods.

- Early harvesting also helps in avoiding damage.(19)

Chemical Controls:
Chemical treatment is applied only if 20% or more of the acreage is infested with cabbageworms before heading, or if more than 10% is infested at or after heading.
Foliar Treatments:

- Ammo 2.5 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, Mattch, Vault or Xentari (0 days)
- Carbaryl (Sevin) 80 S, 1 1/2 lb. or SLR 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 (21 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, 2 pt (7 days)
- Mustang 1.5 W, 2.2 to 4.3 fl. oz. (1 day)
- Permethrin
- Ambush 2 EC, 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)
- Warrior 1 E, 1.9 to 3.2 fl. oz. (1day) (2)

Alternative Controls:

- *Bacillus thuringiensis* (Bt)
- Parasitoids (2)(5)

Several natural enemies attack imported cabbageworms. *Trichogramma* wasps are available commercially and have been successful in controlling imported cabbageworms, when released under favorable conditions. Eliminating unnecessary sprays and using the biological insecticide, *Bacillus thuringiensis*, helps to preserve these natural enemies. (5)

Cabbage Looper (***Trichoplusia ni***)

Biology:
Cabbage looper can be a serious late season pest of cole crops in Michigan. They cause foliar injury and can be a contaminant at harvest for cole crops; plant damage and product contaminations are similar to that of imported cabbageworm. They do not overwinter in Michigan, but migrate into the state during July and August. The adults are about 1 to 1 ¼ inches across, gray-brown – they 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 their get their name "looper'). There may be 2 or 3 generations per year. As the larvae grow, they become more difficult to control.(19)(5)

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

Fields are monitored regularly for eggs, larvae, and damage. Insecticides are applied as needed for control. Cabbage loopers are much more tolerant of insecticides than imported cabbageworms. Proper identification is important, as higher rates or more toxic materials are used on loopers than on cabbageworms.

Cultural Controls:

- Choosing more resistant varieties: Green varieties of cabbage are less susceptible to cabbage loopers than red varieties.

Chemical Controls:
Applications of chemical insecticides should be considered during critical crop stages when sizable numbers of larvae are present or when control of ovipositing adults is desirable.(21)
Foliar Treatments:

- Ammo 2.5 EC, 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, Mattch, 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, 3 pt (1 day)
- Lorsban 50 W, 2 lb (21 days)
- Malathion 57 EC, 2 pt (7 days)
- Mustang 1.5 W, 3.4 to 4.3 fl oz (1 day)
- Permethrin
- Ambush 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (1 day)
- Pounce 3.2 EC, 2 to 8 oz or 25 WP, 3.2 to 12.8 oz (1 day)
- SpinTor 2SC, 3 to 6 oz (1 day)
- Warrior 1 E, 1.9 to 3.2 fl oz (1day) (2)

Alternative Controls:

- *Bacillus thuringiensis* (Bt)
- Release of Predators(5)

Loopers can be monitored visually, and adults can be monitored with pheromone (sex attractant) lures and traps. Carefully timed use of Bt is suggested. This can be used along with mass releases of parasites such as *Trichogramma* wasps.(5)

Bt (bacterial), Premethrin (pyrethroid) Ammo (pyrethroid), thiodicarb (carbamate), Lannate (carbamate) have good efficacy as alternatives to control cabbage looper. Alternatives to thiodicarb include Thiodan (organochlorine), esfenvalerate (pyrethroid) and with good efficacy. The pyrethroids are not good when it is hot and humid.(5)

Diamondback moth (*Plutella maculipennis*)

Biology:
Diamondback moths do not do major damage, but are often reported in Michigan. The gray adults overwinter in Michigan on trash in the field, lay eggs in the spring, and emerge soon thereafter as small (1/3 inch) yellow-green larvae. They can also arrive on transplants from the south or migrate into the state. The worms eat numerous small holes in the leaves, often causing windowpaning. They leave a few small webs in the center of the plant. Diamondback moths can cause foliar injury and contaminate the product.(19)(3)

Cultural Controls:

- Sanitation
- No-till, the presence of cover crop mulch or weeds between rows may reduce diamondback moth populations compared to those in tilled plots.(21)
- Cabbage leaves that display their leaves vertically have improved insect control over varieties

that display their leaves horizontally.(21)

Crop residue should be removed and destroyed after harvesting to limit overwintering sites. No-till, weedy areas encourage natural enemy populations and are less attractive to diamondback moths.(5)

Chemical Controls:
Chemicals should be applied only if 20% or more of the acreage is infested with any cabbage "worm" before heading, or if more than 10% is infested at or after heading.
Depending on the source of pest population, resistance to insecticides may vary from field to field.(21)
Foliar Treatments:

- *Bacillus thuringiensis* Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP II, Mattch, Vault or Xentari (0 days)
- Asana XL, 5.8 to 9.6 oz (3 days)
- Carbaryl (Sevin) 80 S, 1 ½ 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 to 3 pt (21 days)
- Larvin (thiodicarb) 3.2 EC, 24 to 40 oz (7 days)
- Lannate, 1 ½ lb (1 day)
- Mustang 1.5 W, 2.2 to 4.3 fl oz (1 day)
- Permethrin
- Ambush 2 EC, 3.2 to 12.8 oz or 25 WP, 3.2 to 12.8 oz (1 day)
- Pounce 3.2 EC, 2 to 8 oz or 25 WP, 3.2 to 12.8 oz (1 day)
- SpinTor 2SC, 1.5 to 3 oz (1 day)
- Warrior 1 E, 2.6 to 3.8 fl oz (1day)
- Fonofos (There are no alternatives to Fonofos in controlling flea beetles and diamondback moths) (2)

Alternative Controls:

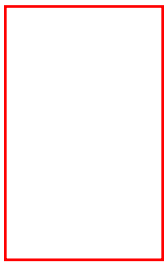
- *Bacillus thuringiensis*
- Release of parasitic wasps(5)

There are no alternatives to fonofos in controlling flea beetles and diamondback moths. Pyrethroids esfenvalerate and permethrin are good alternatives to Larvin, however they are not good in hot and humid conditions.

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. The release of parasitic wasps may adequately control diamondback larvae. 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. However, there are reports of Bt resistance developing in diamondback moths.

Thrips (***Thrips tabaci***)



Biology:
Thrips are very small (1/16 inch), yellow or brown insects which damage cole crops by rasping the leaf surface and sucking the sap. They cause economic injury primarily on cabbage, where they live and eat into and within several layers of leaves. Damage appears as 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. Once thrips are inside cabbage heads, 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 discovered, insecticide application is begun as soon as heads begin to form.(19)

Thrips overwinter in plant debris as adults and nymphs. The eggs are inserted into cabbage leaves. There are 5 to 8 generations a year.

Cultural Controls:

- Remove crop residue
- Field location
- Harvest time
- Plant resistance (5)

Crop residue should be removed and destroyed after harvesting to limit overwintering sites. Thrips are commonly a problem when cabbages are planted near winter wheat, oat or alfalfa -- they migrate to cabbage when grains senesce or alfalfa is harvested. Planting cabbage near these crops should be avoided. Thrips prefer tighter headed varieties, so cabbage varieties with looser heads should be used. Red varieties are also less susceptible.(5)

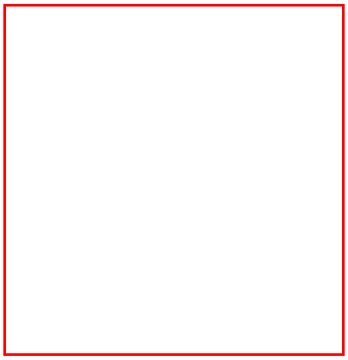
Early harvesting can help to reduce thrips damage when feasible.(5)

Chemical Controls:
Insecticide should be applied if thrips are present at cupping.

- Ammo 2.5 EC, 3 ¾ to 5 oz or WSB, 1 to 2 bags (1 day)
- Metasystax-R2 SC, 1 ½ to 3 pt (7 days) (2)

Alternative Controls:
No effective control agents are currently available. Some species of predacious mites and minute pirate bugs can be helpful in controlling thrips, but normally don't occur in sufficient numbers to provide effective control. (5)(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 of cabbage, and the presence of live or dead ones makes the cabbage unmarketable. Aphids can be controlled relatively easily with insecticides. Aphids can transmit diseases, therefore control is important. Aphids can cause a 100% loss in the quality of the crop. (19)

Cultural Controls:

- Sanitation
- No-till, aphids are less attracted to cabbage when cover crop mulch or weeds are present in rows than when crop plants are are highlighted against bare soil.(21)
- Intercropping of earlier planted beans and grasses within fields of Brussels sprouts and cabbage in England significantly reduced numbers of cabbage aphids. (21)

Crop debris on which the eggs overwinter should be removed and destroyed, as well as weeds and other alternative hosts near the field. No-till, weedy areas encourage natural enemy populations and are less

attractive to aphids.(5)

Chemical Controls:
Chemical controls should be applied if there are more than five aphids 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)
- Malathion 57 EC, 2 pt (7 days)
- Metasystax-R2 SC, 1 ½ to 3 pt (7 days)
- Provado 1.6 R, 3.75 fl oz (7 days). (2)

Alternative Controls:

- Insecticidal soaps
- Predators, parasites and pathogens.(5) These are often numerous enough to keep low aphid populations from building to damaging levels.(21)

Alternatives for using Naled to control aphids include Bt, which is reported to have medium to poor efficacy. Permethrin and pydrin (fenvalerate) are pyrethroids with poor efficacy. Methomyl and Larvin are carbamates with good efficacy.

Low toxicity insecticides and well-timed sprays may be combined when spraying is found to be necessary, allowing parasites to survive. Fungal pathogens have been effective in controlling aphids, particularly in humid conditions.

Insecticide Profiles

Azinphos-methyl (Organophosphate)

Formulations: Guthion 2L, Guthion Solupak 50WP
Pests Controlled: cabbage maggot, imported cabbageworm, diamondback moth and flea beetles
Percent of Crop Treated: 50% of the farms, 100% of the acreage (11)
Types of Applications: soil treatment for foliar spray
Application Rates: 4 lb AI per acre (11)
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 (11)
Timing: is applied preventatively, because cabbage maggots are hard to scout for
Pre-Harvest Interval: 50 days (11)

REI: 48 hours (2)
IPM Concerns: Hazardous to beneficial insects. Non-specific.(11)
Resistance Management Concerns: None reported in grower interviews.(11)
Efficacy Issues: excellent
Advantages: Preventative treatment. Treats other early pests such as flea beetle and cabbage worm. (11)
Disadvantages: Odor can be a problem. Exposure to workers can be a problem. Cannot put in transplant water because of Worker Protection Standard.(11)
Critical Use Issue: There are no alternative chemicals for flea beetle control (11)

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 (11)
Types of Applications: applied preventatively during first 21 days of the season.(11)
Application Rates: 8.4 lb AI per acre (11)
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.
Resistance Management Concerns: None reported in grower interviews.(11)
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)

Fonofos (Organophosphate)

Formulations: Dyfonate
Pests Controlled: cabbage maggot, soil insects, cabbage looper
Percent of Crop Treated: 50% of the farms, 100% of the acreage (11)
Types of Applications: It is used preventatively as a soil insecticide
Application Rates: 4 lb AI per acre (11)
Number of Applications: 2 applications (11)
Timing: near planting time
Pre-Harvest Interval: 50 days (11)

REI: no information available
IPM Concerns: Broad spectrum, therefore eliminates many beneficial insects.(11)
Use in Resistance Management Programs Very few growers use Fonofos; therefore, resistance is not a likely problem.
Efficacy Issues: no information available
Advantages: broad-spectrum insecticide. Preventative treatment because Cabbage maggot overwinters.(11)
Disadvantages: It is harmful to beneficial insects. More toxic to humans than Lorsban but less toxic than Guthion.(11)
Alternatives: Bt, Premethrin (pyrethroid), and thiodicarb (carbamate) have good efficacy as alternatives to control cabbage looper
Critical Use Issue: There are no alternatives to fonofos in controlling flea beetles and diamondback moths.

Methomyl (Carbamate)

Formulations: Lannate SP, Lannate 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 (11)
Types of Applications: Ground/Boom spray, aerial.(11)
Application Rates: 0.5 lb AI per acre (11)
Number of Applications: twice in a growing season (11)
Timing: In the East Central region growers apply the last 4 weeks of the season
Pre-Harvest Interval: 1 day (11)
REI: 48 hours. 3 days.(11)
IPM Concerns: non-specific material, broadspectrum, eliminates many beneficials.(11)
Use in Resistance Management Programs: It needs to be rotated with other chemicals to avoid the development of resistance.
Resistance Management Concerns: Diamondback moth is showing resistance to this product. (11)
Efficacy Issues: good efficacy
Advantages: It is a broad-spectrum insecticide. Keeps down thrips and flea beetles when used with Bt and synthetic pyrethoids.(11)
Disadvantages: highly volatile and presents human health concerns, it is harmful to beneficial insects. Affected by pH in water, wrong pH could reduce effectiveness from 5 days to 2 hours. Broad toxicity.(11)
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 (11)

Types of Applications: Ground/Boom Spray.(11)
Application Rates: 4 lb AI per acre (11)
Number of Applications: once in a growing season (11)
Timing: It is used late in the season.(11)
Pre-Harvest Interval: 1 day because it is a gas (11)
REI: 48-72 hours (2)
IPMConcerns: None reported in grower interviews.(11)
Use in Resistance Management Programs: It is used as part of a resistance management program
Efficacy Issues: no information available
Advantages: Can be use four hours before harvest.(11)
Disadvantages: None reported in grower interviews.(11)
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 (11)
Types of Applications: foliar treatment
Application Rates: 4 lb AI per acre (11)
Number of Applications: six times in a growing season (11)
Timing: Generally used in the last 4 weeks in rotations.
Pre-Harvest Interval: 5 days (11)
REI: 12 hours (2)
IPM 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 (11)

Bt was applied to 42% of the acreage in Michigan, with an average application 1.8 times per year. (13)
References: (11) (13) (2)

Diseases

White Mold (*Sclerotinia*)

Biology:
White mold is a moderate problem in cabbage in Michigan. White mold is caused by the fungus *Sclerotinia sclerotiorum.* It is a fungus that is widely distributed throughout the U.S. and attacks many vegetable and field crops. The initial symptom of the disease is a mass of fluffy, white mycelium. Later, small black, hard bodies called sclerotia are produced on and in the stems and pods of infected plants. At harvest the sclerotia are scattered over the soil surface, but below the surface they can lie dormant for up to five years. Sclerotia serve as sources of inoculum in the year following the one in which they were produced. They germinate to form stems that can be up to 3 cm long. After the stems reach the soil surface they are stimulated by light to form another structure, the apothecium, at their tips. These produce ascospores that are discharged into the air and can travel as far as one-half mile before landing on plant parts such as leaves or flowers. They normally only infect dead or dying plant material. Wounds by hail or cultivation are sites of infection. Secondary spread of inoculum occurs when infected plant tissues come into contact with health tissues. (1)

Cultural Controls:
No information available

Chemical Controls:

- Benomyl - Benlate 50W or SP, 2 lb (2)

Alternative Controls:
No information available

Damping off and 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. The disease severity is moderate, it is not a common disease, however does occur occasionally. 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 provides 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 leave 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. (19) (1)

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.
- Planting seeds on raised beds with good aeration between plants can decrease occurrence.
- A three year crop rotation will reduce infection rates.
- Do not grow cole crops in low-lying fields with heavy soils.
- Do not use diseased transplants.(12) (19) (1)

Chemical Controls:
Seeds or soil can be treated with a fungicide.

- 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. This is a B2 carcinogen.
- 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:
No information available

Black rot (*Xanthomonas campestris pv. Campestris*)

Biology:
Black rot is a bacterial disease that affects all the cole crops, and can cause severe crop losses. As long as seeds are treated and tested, black rot is not a common problem. 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. (19)

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. (19)

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. Two-year **rotations** with non-cole crops is beneficial when planting in fields with previous problems. (19)

Chemical Controls:
Seed treatments and foliar sprays are used to control black rot. Foliar treatment should be applied with copper sprays; application with a boom sprayer may also reduce spread of the organism in the field. Do not use an airblast sprayer, because it will increase the spread of the pathogen. Foliar treatment should be applied in transplant beds at the lowest rate, starting weekly treatments in the field as soon as transplants are established. (19)

- **Copper Ammonium Carbonate** (REI 12 hours, PHI 0 days)

  Copper Count N 8Lapplied 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 ½lb
  Kocide 4.5 LF at a rate of 2/3 to 1 1/3 pt
  Nu-Cop3L at a rate of 1 1/3 to 2 2/3 pt (2)

Alternative Controls:
No information available

Blackleg (*Phoma ligam*)

Biology:
Blackleg is most common on cabbage, but it also affects other cole crops. It occurs more commonly than some other diseases, affecting less than 5% of the acreage and causing 5-50% yield loss. The primary losses occur when infected seedlings are used to establish fields. 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. (19)

Cultural Controls:

- **Use disease-free seed**
- **Rotate fields** out of cole crops for at least three years (the fungus can persist in residue up to 3 years) (19)

Chemical Controls:
No chemicals are registered for this disease.

Alternatives Controls:
No alternative controls are currents used.

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: 22% of the acreage (13)
Types of Applications: spray
Application Rates: 0.9 pounds per acre (13)
Number of Applications: 2.9 applications (13)
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: 9% of the acreage (13)
Types of Applications: foliar treatment
Application Rates: 0.5 pounds per acre (13)
Number of Applications: 1.2 applications (13)
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

Benomyl (Carbamate)

Formulations: Benlate SP or 50W
Diseases Controlled: White mold
Percent of Crop Treated: information not available
Types of Applications: foliar treatment
Application Rates: 2 lb ai/ac (2)
Number of Applications: no information available
Timing: 14 day intervals (2)
Pre-Harvest Interval: no information available
REI: 24 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: preventative and eradicating fungicide, excellent residual activity(26)
Disadvantages: no information available

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
REL: 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: no information available
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 0.08 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
Comments: used as an experimental treatment (26)

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
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, Aliette WDG
Diseases Controlled: Damping off and Downy mildew
Percent of Crop Treated: information not available
Types of Applications: no information available
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: no information available
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 persistant 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: information not 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 days
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

References: (13) (2)

Nematodes

General

Biology:
Nematodes are not a major economic concern in cole crop production in Michigan.(22) Sugar beet cyst, northern root-knot, and root-lesion nematodes all reduce cabbage 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 cabbage production. It is best not to plant cabbage 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. (22) Sugar beet cyst nematodes have sufficient host specificity that rotation with non-hosts is generally an effective management practice. (22)

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 (Broadcast)
- 1,3-D (Telone II) at a rate of 36 gal (muck soil), 15 gal (mineral soil)
- Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. In some limited situations soil fumigants can be applied in the spring in Michigan (REI 5 days)
- Preplant soil treatment
- Mocap 6 ED at 3.3 qt or 10G, 50 lb, applied prior to one week before planting and incorporated to a depth of 3 inches (incorporate 6 EC immediately).
- Soil treatment at planting
- Fenamiphos (Nemacur) 15 G, 7.3 to 18.4 oz per 1000 row feet in 6 – 15 inch band width. Application may be made prior to planting, at planting or immediately following transplanting. The chemical is incorporated mechanically or with overhead irrigation.
- Mocap 6 EC 1.3 to 2 qt (36 inch row spacing) or 10 G, 20 lb (36 inch row spacing) applied in a 12- to 15-inch band over the row. (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
Application Rates: of 36 gal (muck soil), 15 gal (mineral soil) is suggested (2)
Number of Applications: 1
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

Fenamiphos (Organic Phosphate)

Formulations: Nemacur 15 G
Pests Controlled: nematodes, soil insects
Percent of Crop Treated: no information available
Types of Applications: The chemical is incorporated mechanically or with overhead irrigation (2)
Application Rates: (recommended rates) 7.3 to 18.4 oz per 1000 row feet in 6 – 15 inch band width (2)
Number of Applications: no information available
Timing: Application may be made prior to planting, at planting or immediately following transplanting.(2)
Pre-Harvest Interval: not applicable
REI: 48 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: contact soil nematicide-insecticide (24)
Disadvantages: no information available
Critical Use Issue: no information available

Ethoprophos (Fumigant)

Formulations: Mocap 6 EC
Pests Controlled: nematodes and soil insects
Percent of Crop Treated: no information available
Types of Applications: Fumigant
Application Rates: (recommended rates) Preplant soil treatment: Mocap 6 EC at 3.3 qt. or 10G,

50 lb. At planting: Mocap 6 EC 1.3 to 2 qt (36 inch row spacing) or 10 G, 20 lb (36 inch row spacing) applied in a 12- to 15-inch band over the row (2)
Number of Applications: 1
Timing: applied prior to one week before planting or as a soil treatment at planting (2)
Pre-Harvest Interval: not applicable
REI: 48 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: contact nematicide and insecticide
Disadvantages: no information available
Critical Use Issue: no information available

Diazinon

Formulations: Diazinon 14G, 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 14G 21 lb, Diazinon 500-AG 3 qt, 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 hoursfont>
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)

Endosulfan (Organochlorine)

Formulations: Phaser, Thiodan 3EC or 50 WP
Pests Controlled: flea beetles
Percent of Crop Treated: no information available
Types of Applications: foliar spray
Application Rates: (suggested) 3 EC, 2 pt or 50 WP 1 1/2 lb (2)
Number of Applications: no information available
Timing: apply when insects first appear (19)
Pre-Harvest Interval: 7 days (2)

REI: 24 hours(2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: Moderate efficacy (25)
Advantages: compatible with most pesticides, relatively non-toxic to bees (25)
Disadvantages: highly toxic to fish, corrosive to iron (25)

Malathion (Organophosphate)

Formulations: Malathion 57 EC
Pests Controlled: imported cabbabe 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
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

Permethrin (Pyrethroids)

Formulations: Ambush 2 EC, Ambush 25 WP, Pounce 3.2 EC, Pounce 25 WP
Pests Controlled: diamondback moth, cabbage loopers, imported cabbageworm
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Application Rates: (suggested) Ambush 2 EC, 3.2 to 6.4 oz, Ambush 25 WP 3.2 to 6.4 oz; Pounce 3.2 EC 2 to 8 oz; Pounce 25 WP 3.2 to 12.8 oz (2)
Number of Applications: no information available
Timing: no information available
Pre-Harvest Interval: 1 day (2)
REI: 12 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: High
Advantages: Short pre-harvest interval.
Disadvantages: Ineffective against larvae, only useful for control of adults. Can cause increased aphid problems (2)

Cypermethrin (Pyrethroids)

Formulations: Ammo 2.5 EC 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 2.5 EC 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

Additional chemicals include: Mustang, SpinTor, Warrior, Metasystox

Weeds

Biology:
Weed control is important for the control of diseases and pests. Weeds in the *Brassicaceae* 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 crop diseases. Crop rotation, cultivation and herbicide applications help to control weeds. Herbicide can be applied either before planting and incorporate into the soil or after seeding. Other herbicides can be applied after crop emergence. (19)

Cultural Controls:

- Crop Rotation
- Cultivation

Chemical Controls:

- Trifluralin
- Paraquat
- Napropamide
- Oxyfluorfen
- Sethoxydim
- Glyphosate
- Metolachlor
- Clomazone
- Pyridate (17)

Alternative Controls:
No information available

Herbicide Profiles

Trifluralin (Dinitroanaline 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
Advantages: Cheap, selective
Disadvantages: not very effective on muck soils, short residual period; may cause root stunting.

Paraquat (Bipyridylium)

Formulations: Gramoxone Extra
Weeds Controlled: emerged weeds before crop emergence
Percent of Crop Treated: 10%(13)
Types of Applications: preplant
Application Rates: recommended rate (17): 0.7-1 lb AI, 2.5 lb/gal
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: 5%(13)
Types of Applications: Preplan incorporation
Application Rates: recommended rate (17): 1-2 lbs AI
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: 2%(13)
Types of Applications: Pre-transplant
Application Rates: recommended rate (17): 0.25-0.5 lbs
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 grasses
Percent of Crop Treated: 50%(13)
Types of Applications: no information available
Application Rates: recommended rate: 0.19 to 0.28 lb AI/ac,(17)
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: 10(13)
Types of Applications: Pre plant
Application Rates: recommended rate: 2-3 lbs (17)
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

Clomazone (isoxazolidinone)(22)

Formulations: Command 4E
Weeds Controlled: germinating annuals
Percent of Crop Treated: 21% of the acres planted in processing cucumber production in Michigan in 1996
Types of Applications: incorporate before seeding
Application Rates: 0.25 - 0.5 ai/ac
Number of Applications: 1.0 applications
Timing: before seeding
Pre-Harvest Interval: 45 days
REI: 12 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: good control of velvet weed(28)
Advantages: relatively non-toxic to fish, may be tank mixed with ither herbicides, absorbed by the roots and shoots of weed plants, half life in the soil is 15-45 days(28)
Disadvantages:incorporate within 3 hours of application, may cause early stunting and discoloration of cabbage

Metolachlor (acetamide)

Formulations: Dual 8E
Weed controlled: germinating grasses, yellow nutsedge
Percent of Crop Treated: No information available
Types of Applications: No information available
Application Rates: 0.75-2.0 lb AI/ac (15)
Number of Applications: No information available
Timing: Apply before or immediately after transplanting
Pre-Harvest Interval: No information available
REI: 12 hours (15)
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: need to use high rate on muck soils

Comments: for use by members of Michigan Veg. Council only

Pyridate (pyridazine)

Formulations: lentagran 45 WP
Weed controlled: emerged broadleaves
Percent of Crop Treated: No information available
Types of Applications: No information available
Application Rates: 0.90 lb AI/ac (15)
Number of Applications: No information available
Timing: apply after cabbage is well established, after transplanting or has 3 fully developed leaves after seeding, post emergence
Pre-Harvest Interval: 45 days
REI: 12 hours (15)
Use in IPM Programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: No information available
Advantages: selective, contact herbicide
Disadvantages: causes some yellowing of cabbage leaves

Alternative Controls:
No information available

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