

Crop Profile for Broccoli in Michigan

Prepared: August, 1999

General Production Information



- Top states in broccoli production are California, Arizona and Texas (19)
- Broccoli is produced in Michigan for fresh market and processing.
- Counties in Michigan producing broccoli include: Oceana County with 200 acres planted (7)

	Broccoli (fresh & processed)
Michigan Ranking	minor
Percent of U.S. Production	7
Area Planted (5 year average)	250
Area Harvested (5 year avg.)	240
Value of Production (thousands) (5 year average)	2,000.00
Production (thousands)	1,200

(13)(14)



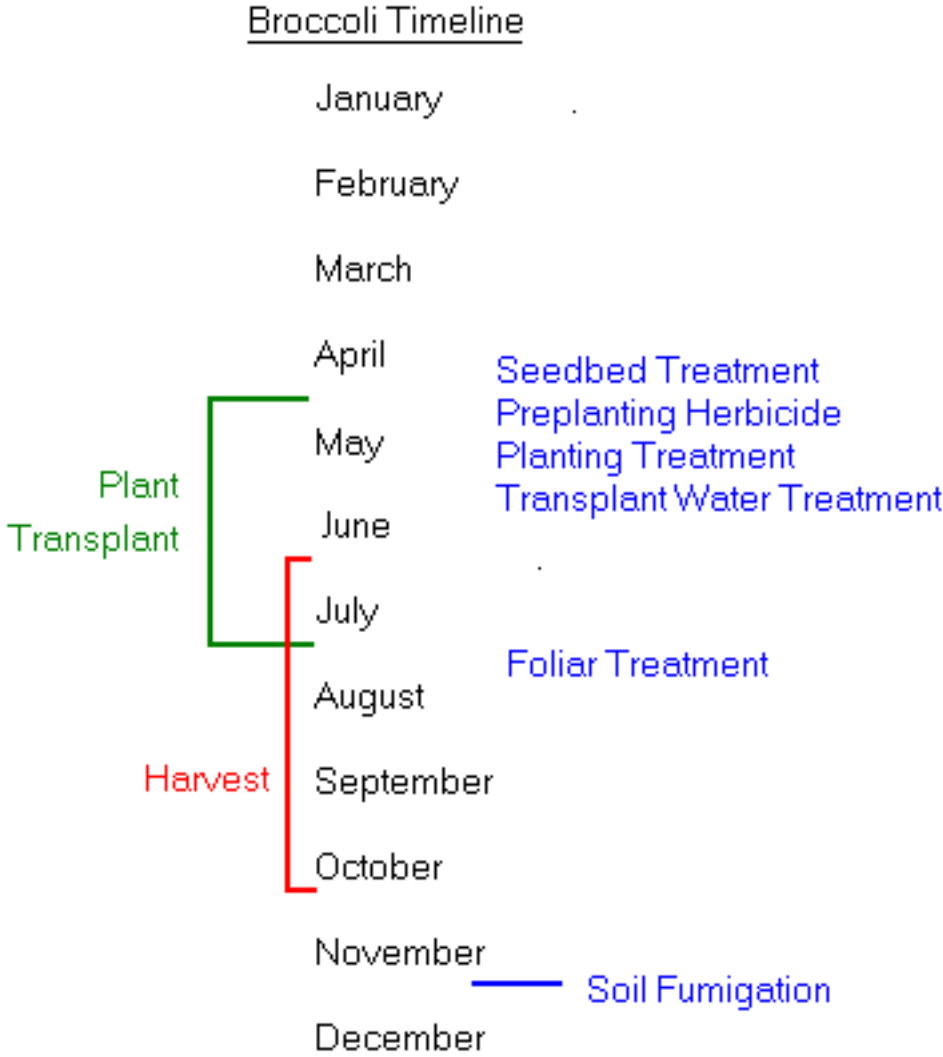
Cultural Practices

Broccoli is a cool-season crop. It grows best between 15° and 17° C. Broccoli can withstand light frosts. It is primarily grown for its edible buds, high nutritional value and attractive appearance. Broccoli production has been decreasing in recent years. It is grown for fresh market and processing. Fresh market broccoli is of high value early in the season. Higher quality production occurs in cooler temperatures. The heads are tighter and larger. Higher temperatures cause rapid growth, loose heads and leafy clusters.

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 wet soil. It is important to grow these crops in well-drained soil. Broccoli grows best on light soils with good moisture-holding capacity and pH values between 6.0 and 6.8. Broccoli does well on soils with high organic matter. Large acreage in Oceana county is grown in sandy soils. (21)

Broccoli can be grown from seeds (4/15 – 7/15) or transplanted (4/15 – 7/15) into fields. Transplants are ready in 4 to 5 weeks. Transplants generally mature earlier. Broccoli can mature in 45 to 60 days after transplanting, 60 to 75 days after direct seeding. Harvesting continues through the season. The rate of harvesting depends on the weather and growth conditions. It is harvested at the bud stage. Broccoli is harvested from June through October in Michigan.

Because of potential disease problems, use a crop rotation that does not include members of the *Brassicaeaceae* family more than 1 year in 3. Eliminate weeds in the *Brassicaeaceae* family, such as wild mustard, yellow rocket, shepherdspurse, and wild radish since they serve as hosts for several cole crops diseases.(18) (19)



Chemical Controls: Critical Use Issues

There are no alternatives to fonofos in controlling flea beetles and diamondback moths.

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 broccoli. Pupae overwinter in the soil. The adult flies emerge from the soil in early May and 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. (22) Young plants that are invaded by maggots usually wilt and die. Maggots can kill or stunt plants. (18)

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. (18)

Cabbage maggot problems are most serious in cool, wet weather. (18) Broccoli planted in light, sandy

soils are more susceptible to cabbage maggot. (22)

Cultural Controls

Cabbage maggots are difficult to scout for. (18)

"Crop residues should be disked under immediately after harvest to reduce overwintering sites." (22)

Avoid peak fly emergence time for planting. (22)

Chemical Controls

- Seedbed Treatment: Diazinon 14G, 21 lb or 500-AG, 3 qt
- 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.
- Soil Treatment: Diazinon 50 WP, 1 lb or AG 500, ½ to 1 pt/100 gal
- Soil Treatment: Guthion Solupak 50 WP, ¼ to 3/8 lb or 2L, ½ pt in 50 gallons of water. (2)

Alternative Controls

Several species of parasitic wasps and predators help reduce maggot populations but do not offer complete control (22)

Imported cabbageworm (*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. (18)

Damage from imported cabbageworms causes a loss in quality and yield. Fields should be monitored for adult activity and plants should be checked for eggs and larvae. Treat broccoli with an insecticide as soon as the insects appear. Broccoli can tolerate some injury prior to head formation, but should be treated during head formation to avoid insect contamination of the harvested product. (18)

Cultural Controls

Early planting (22)

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 1/2 lb (7 days)
- Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L, 2 pt (15 days)
- Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days)
- Lannate SP, 1/4 to 1/2 lb or LV, 3/4 to 3 pt (1 day)
- Lorsban 50 W, 2 lb (21 days)
- Malathion 57 EC, 2 pt (7 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)
- Scout X-tra 2.3 to 2.8 fl oz (5 days)
- SpinTor 2SC, 3 to 6 oz (1 day)
- Warrior 1 E, 1.9 to 3.2 fl oz (1day) (2)

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 1 1/4 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 inchworm, 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 cabbageworm. (18)

Hosts of the cabbage looper include cole crops, celery, tomatoes and potatoes. Eggs are laid singly on the underside of the foliage. (18)

Monitor fields regularly for eggs, larvae, and damage. Apply insecticides as needed for control. Cabbage loopers are much more tolerant of insecticides than imported cabbageworms. Be sure of your identification and use higher rates or more toxic materials on loopers. (18)

Cultural Controls

Early planting is slightly effective in controlling the cabbage looper (22)

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

- 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, 1/2 to 3 pt (1 day)
- 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)
- Scout X-tra 2.3 to 2.8 fl oz (5 days)
- SpinTor 2SC, 3 to 6 oz (1 day)
- Warrior 1 E, 1.9 to 3.2 fl oz (1day) (2)

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 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. (22)

Cultural Controls

Cover crop mulch or weeds between rows (22)

Overhead sprinkler irrigation (22)

Chemical Controls

- *Bacillus thuringiensis* Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP II, Match, Vault or Xentari (0 days)
- Carbaryl (Sevin) 80 S, 1 ½ lb or XLR Plus, 1 to 2 qt (3 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)
- Mustang 1.5 W, 2.2 to 4.3 fl oz (1 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)
- Scout X-tra 2.3 to 2.8 fl oz (5 days)
- SpinTor 2SC, 1.5 to 3 oz (1 day)
- Warrior 1 E, 2.6 to 3.8 fl oz (1 day) (2)

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 have a wide host range and can cause economic injury. 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. Thrips overwinter in crop debris and border plants as adults and nymphs. There can be 5 to 8 generations a year. (2)

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. (18)

Cultural Controls

Avoid planting near small grain crops which may act as a source of thrips. (22)

Chemical Controls

Thrips are difficult to control with insecticides. (22)

Alternative Controls

Natural enemies are generally not effective in controlling thrips. (22)

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 broccoli unmarketable. Aphids can be controlled relatively easily with insecticides. (18)

Cultural Controls

Cover crop mulch or weeds between rows decreases populations. (22)

Weeds may provide habitat for natural enemies. (22)

Destroy crop residue after harvest to minimize aphid spread. (22)

Chemical Controls avoid broad-spectrum insecticides early in the season as they may decrease natural

enemies and increase aphid populations (22)

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:

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)

Lorsban 50 W, 2 lb (21 days)

Malathion 57 EC, 2 pt (3days)

Metasystox-R2 SC, 1 ½ to 2 pt (7 days)

Methyl parathion 7.5 EC, 1 to 1 ½ pt (21 days)

Provado 1.6 R, 3.75 fl oz (7 days). (2)

Alternative Controls

Insecticidal soaps reduce aphid populations without affecting natural enemies. (22)

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: 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 WP

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

Application Rates: 8.4 lb AI per acre

Number of Applications: no information available

Timing: no information available

Pre-Harvest Interval: 21 days (2)

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

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

Types of Applications: It is used preventatively as a soil insecticide to control cabbage maggot

Application Rates: 4 lb AI per acre

Number of Applications: 2 applications

Timing: near planting time

Pre-Harvest Interval: no information available

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

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 (2)

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 2.5 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: 2 pt or 50 WP, 1 1/2 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 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: 3 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: SpinTor, Di-Syston, Metasystox, Warrior

Diseases

Blackleg (*Phoma ligam*)

Biology

Blackleg is an occasional concern in broccoli. 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. (21)

In Michigan less than 1% of the acreage is infested with blackleg, causing approximately 25% yield losses.

Cultural Controls

To avoid blackleg, use disease-free seed, ensure clean seed beds or sanitary green house conditions and rotate fields out of cole crops for at least three years. (21)

Chemical Controls

Iprodione

Alternatives

No information available

Downy mildew (*Peronospora parasitica*)

Biology

Downy mildew is a common problem with broccoli in Michigan. 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 and soft rot bacteria then move in. 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.

Downy mildew attacks less than 15% of the broccoli acreage in Michigan annually. If left untreated losses would be 50-100% of the infected acreage. When downy mildew is controlled in infected acreage losses are less than 1%. (21)

Cultural Controls

Rotation

Chemical Controls

Foliar Applications:

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 (REI 12 to 48 hrs)

Alternative Controls

No information available

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 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 head.

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.

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. Cole crops should not be grown in low-lying fields with heavy soils, and diseased transplants should not be used.

Chemical Controls

Treat seeds or soil with a fungicide.

Bacillus subtilis GB03 Kodiak 0.1-0.5 oz/100lb seed

Fludioxonil (Maxim) 0.08 to 0.16 oz/100 lb seed

Captan (30-DD or 300) at 1 ¼oz/100 lb seed, or Captan (400 or 400-D) at 1 to 2 oz/100 lb seed.

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)

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. These methods have not been field tested in Michigan and may not provide adequate control under severe disease conditions. (21)

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

Biology

Black rot is a bacterial disease that affects all cole crops and can be a problem in broccoli in Michigan. 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.

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. This disease can cause 20% crop losses in affected acreage. Less than 1% of Michigan broccoli acreage is affected by black rot. (21)

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.

Chemical Controls

Seed treatments and foliar sprays are used to control black rot.

- **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)

Kocide LF at a rate of 2 2/3 pt

Kocide 101 or DF at a rate of 1 - 2 lbs

Kocide 2000 at a rate of 3/4 to 1 1/2 lb

Kocide 4.5 LF at a rate of 2/3 to 1 1/3 pt

Alternative Controls

None are available

Club root (*Plasmodiophora brassicae*)

Biology

Plasmodiophora brassicae 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.

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.

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.

Club root can be a problem in Michigan broccoli production. Commonly less than 1% of the broccoli acreage in Michigan is affected with club root. 100% yield losses can occur in infected acreage. Chemical controls are not very effective in controlling this disease.(21)

Cultural Controls

Clubroot incidence can be reduced by 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.

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

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. Leaf margins are often colonized by *Alternaria spp.* Plants are highly susceptible after tipburn or other injuries. Bacterial soft rot often follows *Alternaria* infection. The spots enlarge rapidly and are eventually covered with black spores.

Alternaria is a concern in Michigan broccoli production. Commonly less than 20% of the acreage is affected. Yield losses of 50-100% can occur if infected acreage is left untreated. (21)

Cultural Controls

To avoid *Alternaria* diseases, use high quality, disease-free seed; irrigate early in the day so that leaves dry rapidly.

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) (REI 48 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 treatments are not typically recommended

Alternative Controls

No alternative controls are 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. Typically it is a secondary infection following alternaria. 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. (21)

Cultural Controls

The bacteria become established in small droplets of water that remains on the heads. Select cultivars recommended for Michigan, and avoid injury to plants.

Chemical Controls

Chemical control of the disease is not suggested, however chemical control of pests may reduce the spread of the soft rot.

Alternative Controls

No information available

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 2 ¼pt, Bravo Ultrex 82.5 WDG 1.4 lb, Bravo Weather Stik or Bravo 720 or Supanil 720 or Terranil 6L at 1 ½pt (2)

Number of Applications: no information available

Timing: when conditions favor disease development, 7-10 day intervals (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 2000, Kocide 101 or DF, Kocide LF, Kocide 4.5 LF

Diseases Controlled: Black rot and alternaria leaf spot

Percent of Crop Treated: no information available

Types of Applications: foliar treatment

Application Rates: Kocide LF at 2 2/3 pt, Kocide 101 or DF at 1 to 2 lbs, Kocide 2000 at 3/4 to 1 1/2 lb, Kocide 4.5 LF at 2/3 to 1 1/3 pt (2)

Number of Applications: no information available

Timing: when conditions favor disease development, at 7 to 10 day intervals (2)

Pre-Harvest Interval: 0 days(2)

REI: 24-48 hours(2)

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: 100%

Types of Applications: seed treatment

Application Rates: 8 oz/100 lb seed. (2)

Number of Applications: 1

Timing: for seed treatment

Pre-Harvest Interval: not applicable

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: 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: <1%

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: 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: no information available

Comments: used as an experimental treatment (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: transplant water treatment, 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: no information available
Pre-Harvest Interval: not applicable
REI: 12 hours
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, alternaria leaf spot and Downy mildew
Percent of Crop Treated: <15%
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

Iprodione (Dicarboximide)

Formulations: Rovral 50 W or WG, Roveral 4 F

Diseases Controlled: blackleg

Percent of Crop Treated: <1%

Types of Applications: banded over the row (21)

Application Rates: Rovral 50 W or WG 2 lbs, Roveral 4 F 2 pt

Number of Applications: maximum 2 applications

Timing: immediately after thinning

Pre-Harvest Interval: 0 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: B2 carcinogen

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: 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 Program: no information available

Use in Resistance Management Programs: no information available

Efficacy Issues: particularly effective against cyst forming nematodes and meadow nematodes. (23)

Advantages: also helps control weeds and diseases(23)

Disadvantages: cannot use on heavy soils(23)

Critical Use Issue: no information available

Fenamiphos (Organic Phosphate)

Formulations: NemaCur 15 G

Pests Controlled: nematodes and 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 (23)

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

Weeds

Weed control is important for the control of diseases and pests. Weeds in the *Brassicaceae* family, such as wild mustard, yellow rocket, shepherdspurge, 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. Herbicide can be applied either before planting and incorporate into the soil or after seeding. 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

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

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 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

Weeds Controlled: germinating grasses and broadleaves

Percent of Crop Treated: 5

Types of Applications: PPI

Application Rates: 1- lbs a/i

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

Types of Applications: Pre-transplant

Application Rates: 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

Types of Applications: no information available

Application Rates: 0.19 to 0.28 lb AI/ac,

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

Types of Applications: Pre plant

Application Rates: 2-3 lbs

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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