

Cabbage

Commercial cabbage production is a significant industry in Ohio, serving local and regional processing (sauerkraut) and fresh (especially slaw) markets. While centered in the northwest part of the state, significant production also occurs in south central Ohio. The cabbage season is also long, often beginning with transplant production as early as February and concluding with November harvests.

Schedule of Cabbage Production Practices

Planning (November to March)

Soil analysis

- Sample and analyze soil for pH and nutrient levels.
- Review results of soil analysis and develop fertilizer application plan.
- Will you irrigate? Irrigation is a primary method to manage yield and quality. If you plan to irrigate, check, repair, and replace equipment as necessary.

Variety selection

- Discuss varieties with your market to learn their preferences.
- Review information on the performance of varieties under local conditions.
- Select varieties using at least the following criteria: 1) resistance to thrips, diseases, and physiological disorders (e.g., tipburn)—resistance is the *primary* means of thrips, disease, and internal quality control! 2) high marketable yield potential, and 3) required maturity to meet targeted delivery dates. Sensory quality is also important in cabbage for fresh and slaw markets. Varieties now commonly used in Ohio are shown in the table below.

Varieties Used in Ohio Cabbage Production					
Season	Kraut			Slaw	
	# days to maturity*		Varieties	# days to maturity	Varieties
	DS	T			
Early	100	80	<i>Almanac</i>	up to 80	<i>Rocket, Morris, Fresco, Grenadier</i>
Mid	115	95	<i>Fortress, Genesee, Megaton</i>	80-95	<i>Bravo, Gideon, Cheers, Red Dynasty</i>
Late	130	110	<i>Hinova</i>	95-120	<i>TransAm, Huron</i>

* DS = direct seeded, T = transplanted.

Note: Many other varieties are used in Ohio; varieties listed are current market preferences. Working with seed companies and the cabbage industry, The Ohio State University regularly completes comprehensive cabbage variety evaluations. Each named or experimental variety is evaluated using numerous criteria, including total and marketable yield, pest and disease tolerance and resistance, internal and external quality, and market/consumer appeal (e.g., flavor). Results of these evaluations are available from Matt Kleinhenz (phone 330-263-3810; E-mail kleinhenz.1@osu.edu; Internet <http://www.oardc.ohio-state.edu/kleinhenz>).

Site selection

- Select site based on crop rotation:
 - To avoid black rot (the key cabbage disease), do not plant cabbage for at least three years after any cole crop, even if no diseases were noticed.
 - To avoid club root, do not plant cabbage for at least 7-10 years after any cole crop.
 - To avoid Sclerotinia (white mold or drop) and Rhizoctonia (wirestem, bottom rot), plant cabbage after corn or small grains.
 - To avoid root knot nematode, plant cabbage after a grass crop or radishes.
- Use fields with alkaline soils (pH 7 or above) to prevent club root; avoid fields with acid soils (pH less than 7).
- Select fields with good drainage to prevent disease problems (such as damping off), encourage good crop growth, and simplify harvest.

- Select sites where weed seed numbers have been reduced through crop rotation, and that are free of very difficult to control perennial weeds such as quackgrass, johnsongrass, or Canada thistle and yellow nutsedge.

Seed sources

- Buy high quality seed to avoid black rot (the key cabbage disease) as well as blackleg and Alternaria leaf spot.
- Select certified disease-free seed. Hot water treated seed are available from some seed sources. If not certified, treat seeds with hot water (page 24) to avoid bacterial diseases (black rot and peppery leaf spot) and fungal diseases (blackleg [*Phoma*]). Dust seed with Thiram.

Pre-plant (March to July)

Field preparation

Apply fertilizer, including micronutrients, based on soil analysis results and crop need. Cabbage grows best in soils with a pH of 6.0-6.8. **Base all applications of lime and fertilizer on current soil tests and reliable recommendations.** Fertilizer amounts should be adjusted for field cropping history, potential for residual nutrients from the previous year, market (kraut, slaw), variety, current climatic conditions. Inappropriate nutrient management may lead to undesirable effects on total or marketable yield, environmental contamination, and profit. For example, excess nitrogen may cause heads to burst and leach to groundwater. Likewise, excess phosphorus may runoff and contaminate surface water. Banded fertilizer applications, approximately 1 inch to the side and 2 inches below the seed or transplant, are more efficient than broadcast applications. Excess fertilizer application also reduces profit.

Boron levels should be monitored as a preplant application may be warranted if soil test values indicate potentially deficient levels (below 1 lb/A).

Pre-plant Fertilizer Application in Ohio Cabbage Production				
Application	Nutrients	Crop		
		Maturity	Kraut	Slaw
Preplant; Fall	P	all	50-100 lb/A	50-100 lb/A
	K	all	100-150 lb/A	100-150 lb/A
	B	all	1.5 lb/A	1.5 lb/A
Preplant; At-planting or Spring	N (ca. 50%)			
		Early	40 lb/A	40 lb/A
		Mid	45-50 lb/A	45-50 lb/A
		Late	50-55 lb/A	50-55 lb/A
	S	all	25-30 lb/A	25-30 lb/A

Prepare seedbeds for direct seeding or transplanting. Pay special attention to proper soil stewardship practices. Do not work soil when it is wet as this results in compaction, higher input costs, and poor crop performance. Recall that excessive tillage also reduces soil quality.

Weed control

Apply preplant incorporated (PPI) herbicides, Command 4 EC, trifluralin, or Prefar:

- Apply Command 3ME, Goal XL or Dual Magnum after final seed or transplant bed preparation. Dual Magnum and Goal XL for transplants only. If Goal XL was used, transplant cabbage without additional soil tillage.
- Command: Be aware of replanting and application restrictions. Good control of lambsquarter, jimsonweed, purslane, ragweed, and velvetleaf.
- Prefar: excellent control of barnyardgrass, crabgrass, fall panicum, and foxtails. Fair to good control of pigweed.
- Annual grasses: Use Dual Magnum, Command, Prefar, trifluralin.
- Broadleaf weeds: Use Goal or Command.

Transplant production

- Buy (or grow) high quality transplants to avoid black rot, insecticide resistant caterpillars, etc.
- Scout seedlings regularly and rogue out and destroy seedlings with black rot symptoms; isolate flats where symptoms were observed in a different greenhouse.
- Refer to the section on pages 20-24 on transplant production for specific information.

Planting (March to July)

Planting Periods for Ohio Cabbage Crops		
Season	Crop	
	Kraut	Slaw
Early (function of soil conditions)	April 20-April 28	April 15-May 1
Mid	April 29-May 5	May 2-June 15
Late	May 6-May 15	June 15-July 25

Note: Dates of first and last planting depend on soil conditions, especially moisture and temperature levels. Statewide, planting may begin in late March in southern Ohio and continue through July 25 in northern Ohio. Most of Ohio's cabbage crop is planted April 20-June 10.

Field management

- Planting when soils are cool and/or wet is a primary cause of poor crop performance and may complicate weed management. Plant when soil temperatures at 2 inches are at least 50 degrees F and moisture is adequate but not excessive.
- Proper seed-soil contact is especially important for direct-seeded crops.
- Refer to seeding and transplant rates described in the table below.

Row Spacing and Plant Populations Used in Ohio Cabbage Production						
Season	Crop					
	Kraut			Slaw		
	in-row	between-row	target population *	in-row	between-bed	target population
Early	16 in.	30 in.	13,00/A	16 in.	60 in.	13,000-13,500/A
				14 in.	66 in.	13,000-13,500/A
Mid	18 in.	30 in.	11,600/A	20 in.	60 in.	10,500/A
				18 in.	66 in.	10,500/A
Late	20 in.	30 in.	10,500/A	20 in.	60 in.	10,500/A
				18 in.	66 in.	10,500/A

* In-row seed spacing should be 4-6 inches for direct seeded crops. Direct seeded crops should be thinned to the target population listed above. Pelletized seed may aid in the control of spacing.

Note: The majority of slaw cabbage production in Ohio occurs on raised beds on 60 inch or 66 inch centers, always containing twin crop rows. When raised beds are not used for slaw cabbage production, between-row spacing is 30 inches and in-row spacing is 16 inches (early; 13,000 plants/A) or 20 inches (mid-late; 10,500 plants/A).

Direct Seeding and Transplanting

The Ohio cabbage industry in general is set up to establish the crop using transplants. There has been a movement away from direct seeding. Currently, in Ohio, direct seeding is used in kraut cabbage production only. Although direct seeding is less common than in the past, it still has a role and the industry is likely to rely on both direct seeding and transplanting. Whether growers choose to use seed or transplants will depend on their crop rotation and other factors. Direct seeding machinery can be used for row crops, allowing both cabbage and row crops to be planted in the same day more easily than if using transplants. This is a primary concern early in the season. A direct seeded crop may require less labor to establish as six to eight people may be required for transplanting. Given unpredictable weather (especially in the spring), other work would presumably be required to occupy transplanting crews should planting not be possible.

Compared to transplanting, direct seeding may increase the risk associated with stand establishment. Re-seeding fields with poor stands is a challenge and complicates crop and harvest management. Re-seeding may essentially create two crops in the field, often not blocked as they are normally, due to differences in planting date. Variable stands in direct-seeded crops may be slightly less detrimental in kraut cabbage production as heads with few neighbors may grow larger, a trait preferred by processors. However, these risks associated with direct seeding must be weighed against transplant production concerns, including the need to time transplant readiness to targeted field planting dates. Once transplants are in hand (usually 4-6 weeks after seeding), optimal stand establishment is more easily achieved with them than in direct seeding.

Cabbage maggot management

When possible, schedule planting time to avoid cabbage maggot egg laying.

Cabbage is most susceptible to damage by cabbage maggot larvae if it is in seedling stages at the time that newly emerged cabbage maggot adults (small flies) are laying eggs. Transplanted crops are most susceptible during the first 2 to 3 weeks after planting. Emergence of the adult flies is on different calendar dates each year but always occurs at the same time that certain well known plants are flowering, according to a study in upstate New York. The indicator plants for each generation are given below.

- If planting in March-May, schedule planting to avoid the first generation of cabbage maggot. First generation maggots develop from eggs laid when yellow rocket is blooming (usually early May in Ohio). Do not transplant during the time that yellow rocket is blooming, or do not seed approximately 2 weeks before yellow rocket is blooming. The ideal time to seed is toward the tail end of the yellow rocket bloom period.
- If planting in June, schedule planting to avoid the second generation of cabbage maggot. Second generation maggots develop from eggs laid when day lilies are blooming (usually late June). Do not transplant during the time that day lilies are blooming, or do not seed approximately 2 weeks before day lilies are blooming. The ideal time to seed is toward the tail end of the day lily bloom period.
- If planting in July or August, schedule planting to avoid the third generation of cabbage maggot. Third generation maggots develop from eggs laid when Canada thistle or early goldenrod are blooming (usually early August). Do not transplant during the time that Canada thistle or early goldenrod are blooming, or do not seed approximately 2 weeks before Canada thistle or early goldenrod are blooming. The ideal time to seed is toward the tail end of the Canada thistle or early goldenrod bloom period.

If cabbage maggot cannot be avoided by choice of planting time, then apply soil insecticide (Guthion, Lorsban, or Diazinon) at seeding or at transplanting for cabbage maggot control; see insecticide details on page 115.

Disease management

- For **damping-off** control, apply Ridomil Gold 4E (for Pythium) plus Thiram (for other fungi).
- If clubroot has been a problem at this site, add Terraclor 75WP in the transplant solution.

Weed management

- Apply POST PLANT herbicides for weed control:
 - Dacthal: mainly annual grasses
 - Dual Magnum: mainly annual grasses but also controls galinsoga, eastern black nightshade and purslane when applied before they emerge. Apply within 48 hours of transplanting. Use on transplanted cabbage only.
 - Lantagran: controls very small broadleaf weeds.
- Cultivate when *weeds* are very small, preferably during the 'white thread' stage (between germination and emergence).

Seedling, Early Vegetative Stages (March to July)

Weed management

Cultivate when weeds are very small, preferably during the 'white thread' stage (between germination and emergence).

Flea beetle management

- Scout direct-seeded crops twice per week during the seedling stages for flea beetles, especially on sunny, windless days. If beetles are causing stand loss, then spray insecticide, but choose a product that is not disruptive to natural enemies if diamondback moth larvae or aphids are present.
- If seedling stage occurs in March-May: Scouting for flea beetles is especially important during cool weather when plants are growing slowly.
- If seedling stage occurs in June-July: Flea beetle activity normally declines in June.

Caterpillar management

- Scout crop once per week for caterpillars (see page 113); determine which species are present and the average number per plant.
- If seedling stage occurs in March-May: Imported cabbageworm and diamondback moth may show up this early (use B.t. for control); cutworms are also possible.
- If seedling stage occurs in June-July: Diamondback moth activity often begins in June and imported cabbageworms often require treatment in early July. If threshold is exceeded (pages 114-115), use B.t. for control so that natural enemies survive.
- If seedling stage occurs in August-September: Cabbage looper activity often begins in August. If threshold is exceeded (pages 114-115) but looper numbers are low, use B.t. for control so that natural enemies survive, otherwise use a material that is more effective for loopers but still has low impact on natural enemies (e.g., Confirm, Spintor, Proclaim).

Disease management

- If seedling stage occurs in March-May, scout for black rot.
- If seedling stage occurs in June-July, scout for black rot and *Alternaria* leaf spot.
- If seedling stage occurs in August-September, scout for downy mildew, black rot, and *Alternaria* leaf spot.
- If **black rot** appears, apply fixed copper sprays, and restrict insect scouting to afternoon on dry days. Black rot is the key cabbage disease. It is favored by warm moist conditions especially if crop is mechanically injured.
- If symptoms of ***Alternaria* leaf spot** appear, apply Bravo or Maneb on a weekly schedule. *Alternaria* is favored by warm moist conditions.

Pre-heading Stage (April to September)

Caterpillar management

- Scout crop once per week for caterpillars (see page 113); determine which species are present and the average number per plant.
- If pre-heading stage occurs in March-May: Imported cabbageworm and diamondback moth may show up this early (use B.t. for control); cutworms are also a possibility.
- If pre-heading stage occurs in June-July: Diamondback moth activity often begins in June and imported cabbageworms often require treatment in early July. If threshold is exceeded (pages 114-115), use B.t. for control so that natural enemies survive.
- If pre-heading stage occurs in August-September: Cabbage looper activity often begins in August. If threshold is exceeded (pages 114-115) but looper numbers are low, use B.t. for control so that natural enemies survive, otherwise use a material that is more effective for loopers but still has low impact on natural enemies (e.g., Confirm, SpinTor, Proclaim). Natural enemies may be declining in September, and if so then more disruptive insecticides can be used. Pyrethroids are more effective in cool temperatures and tend to be effective for cabbage looper. Loopers tend to move into the head in cooler weather.

Thrips management

- If growing a variety susceptible to onion thrips (see note on thrips control on page 118), and thrips are numerous, and/or crop is near a field of maturing grain, then apply an insecticide with systemic and long residual activity. Make a note not to grow a thrips-susceptible variety next year!

- If pre-heading stage occurs in June-July: Thrips often invade cabbage in June and July as they leave maturing or harvested wheat fields.

Disease management

- If pre-heading stage occurs in March-May, scout for black rot.
- If pre-heading stage occurs in June-July, scout for black rot and Alternaria leaf spot.
- If pre-heading stage occurs in August-September, scout for downy mildew, black rot, and Alternaria leaf spot.
- If **black rot** appears, apply fixed copper sprays, and restrict insect scouting to afternoon on dry days. Black rot is the key cabbage disease. It is favored by warm moist conditions especially if crop is mechanically injured.
- If symptoms of **Alternaria leaf spot** appear, apply Bravo or Maneb on a weekly schedule. Alternaria is favored by warm moist conditions.
- If symptoms of **downy mildew** appear, apply Ridomil Gold/Bravo on a weekly schedule. Downy mildew is most common in the fall when conditions are cool and wet.

Water management

- Irrigation scheduling for cabbage is likely to be based on the “feel” method. The feel method assumes that farmers know their soil best and can gauge by its condition whether soil moisture is low enough to warrant irrigation. In general, for fine textured soils, soil moisture will be adequate for cabbage growth if a small amount of soil removed from the root zone clumps if gently squeezed in the palm of the hand. If the soil does not cling together, irrigation may be needed. The goal in irrigation scheduling is to maintain soil at a relatively constant level of moisture as wide fluctuations disrupt growth and reduce quality. Therefore, more applications of less water may be better than fewer applications of large amounts.
- If irrigation is needed, schedule it during the twilight period to disrupt mating and egg laying of diamondback moth. Bacterial diseases, white mold, Alternaria and downy mildew may be favored by this practice, so don't irrigate at twilight when these diseases are present.

Nutrient Management

Sidedress applications or applications via irrigation water (fertigation) may be needed to meet crop nutrient needs, especially for nitrogen, during the period of rapid growth (typically after stand establishment to the beginning of head formation). Split applications of fertilizer (pre-plant, at-planting, after stand establishment) tend to be more effective and efficient than single applications pre- or at planting. Applications made after planting require highly soluble materials to be effective. To meet a crop's nitrogen requirement, a rule of thumb is to apply 50% by planting and the remaining 50% in two equal applications through vegetative growth. There is little research-based evidence to suggest that foliar applications of nutrients are effective in cabbage, possibly due to its thick, waxy cuticle. See the table below for guidelines regarding after-planting fertilizer applications.

Application	Nutrients	Maturity	Crop	
			Kraut	Slaw
Sidedress; 4-6 true leaf stage	N (ca. 50%)			
		Early	40 lb/A	40 lb/A
		Mid	45-50 lb/A	45-50 lb/A
		Late	50-55 lb/A	50-55 lb/A
Total N requirement (approximate, actual amount depends on market, cropping history, maturity, variety, soil test)		Early	80 lb/A	80 lb/A
		Mid	90-100 lb/A	90-100 lb/A
		Late	100-110 lb/A	100-110 lb/A

Heading Stage (June to November)

Caterpillar management

- Scout crop once per week for caterpillars (see page 113); determine which species are present and the average number per plant.
- If heading occurs in June-July: Diamondback moth activity often begins in June and imported cabbageworms often require treatment in early July. If threshold is exceeded (pages 114-115), use B.t. for control so that natural enemies survive.
- If heading occurs in August-September: Cabbage looper activity often begins in August. If threshold is exceeded (pages 114-115) but looper numbers are low, use B.t. for control so that natural enemies survive, otherwise use a material that is more effective for loopers but still has low impact on natural enemies (e.g., Confirm, SpinTor, Proclaim). Natural enemies may be declining in September, and if so then more disruptive insecticides can be used. Pyrethroids are more effective in cool temperatures and tend to be effective for cabbage looper. Loopers tend to move into the head in cooler weather.
- If heading occurs in October-November: If threshold is exceeded (pages 114-115) but looper numbers are low, use a material that is effective for loopers but still has low impact on natural enemies (e.g., Confirm, SpinTor, Proclaim). Natural enemies may be declining, and if so then more disruptive insecticides can be used. Pyrethroids are more effective in cool temperatures and tend to be effective for cabbage looper. Loopers tend to move into the head in cooler weather.

Disease management

- If heading occurs in June-July, scout for black rot and Alternaria leaf spot.
- If heading occurs in August-September, scout for downy mildew, black rot, and Alternaria leaf spot.
- If heading occurs in October-November, scout for downy mildew.
- If **black rot** appears, apply fixed copper sprays, and restrict insect scouting to afternoon on dry days. Black rot is the key cabbage disease. It is favored by warm moist conditions especially if crop is mechanically injured.
- If symptoms of **Alternaria leaf spot** appear, apply Bravo or Maneb on a weekly schedule. Alternaria is favored by warm moist conditions. Alternaria is more common when cabbage is in late maturity stages.
- If symptoms of **downy mildew** appear, apply Ridomil Gold/Bravo on a weekly schedule. Downy mildew is most common in the fall when conditions are cool and wet.

Water management

If irrigation is needed, schedule it during the twilight period to disrupt mating and egg laying of diamondback moth. Bacterial diseases, white mold, Alternaria, and downy mildew may be favored by this practice, so don't irrigate at twilight when these diseases are present.

Harvest (June to November)

The table below lists typical cabbage harvest periods in Ohio.

Harvesting Periods for Ohio Cabbage Crops		
Season	Crop	
	Kraut	Slaw
Early	July 20-September 1	June 20-July 20
Mid	September 1-October 15	June 21-September 15
Late	October 15-November 15	Sept 16-November 15

Note: Dates of first and last harvest depend on dates of planting, varieties used, and seasonal conditions, especially moisture and temperature levels. As planting is nearly continuous from late March through late July, harvest is nearly continuous from late June through mid-November. Most of Ohio's cabbage crop is harvested mid-July to late September.

Management beginning in the planning stages through crop development clearly influences the season's outcome for the grower. It is also true that proper harvest management is necessary to benefit from the effort that went into produc-

ing a large, high-quality crop. Testing heads for harvest readiness and protecting the crop during and after harvest are key components of quality-oriented management. Markets impose increasingly strict quality criteria on growers. Pay attention to the following when scheduling and completing harvest:

- scheduling harvest requires regular assessments of head condition throughout the field, just as proper disease, insect, and weed management require regular scouting.
- all crops must meet **market** criteria for head size, density, color, freedom from debris and damage due to diseases and insects, and amount usable. Sensory properties, including flavor, color, and texture are also important in fresh and slaw markets. Trading quality for tonnage may be required.
- crop quality (in the market's opinion) can decline during harvest by allowing debris, soil, torn or partial heads, etc., into the load or bin. Quality also declines if the load sits for an extended period of time before being delivered, especially if warm.
- accurate and complete crop records, perhaps computer generated, may be needed prior to shipping or delivery.

Post-harvest (June to November)

Disease management

Sanitize equipment to reduce risk of pathogen spread to neighboring fields.

Weed management

Control weeds after harvest to prevent further seed production. Use tillage, herbicides, and/or mowing to accomplish this. In fall, leave any dead weed residue on the surface as long as possible. Predation and weathering may reduce the number of over-wintering weed seed. Apply Roundup or other glyphosate product to emerged perennial weeds.

Soil management

- For winter soil erosion control, plant a cover crop in early September to mid-October. To discourage thrips from overwintering, plant oats or rye rather than wheat.
- Sample and test soil. Low quality soil samples cannot be used to develop a high quality nutrient management plan. When sampling soil, make sure that enough samples are taken to make reliable judgements about the soil's condition and that the samples are taken in a pattern consistent with cabbage production practices.
 - In fields receiving banded fertilizers and the location of the bands is known: paired sampling approach—take twenty samples from outside the cropping for every one sample taken from within the cropping row.
 - In fields receiving banded fertilizers and the location of the bands is unknown: paired sampling approach—collect separate samples perpendicular to the band direction.
 - In fields receiving broadcast fertilizers: stratified systematic sampling approach—grid the field and collect samples from each unit, aligning samples in the same east-west or north-south position in adjacent units.
 - In fields receiving broadcast fertilizers: stratified systematic unaligned sampling approach—grid the field and collect samples from randomly chosen locations within each unit.
- Apply lime in the fall if necessary. Minimum desired soil pH is 6.0. Recall that lime differs in several properties which will impact pH and nutrient management in the near and long term.
 - dolomitic and calcitic lime differ in their content of calcium and magnesium and buffering capacity.
 - lime particle size strongly influences its rate of action. The smaller the particle size, the faster (but often the shorter-lived) the effect.

Disease Control

Seed Treatment

Black rot caused by bacteria in the seed has been a serious problem in Ohio. It is suggested that the supplier be requested to certify by testing that the seed is free of black rot or heat (hot water) treat the seed. Also, it can be requested that the transplant producer use seed that has been certified black rot free or heat treated (see "Seed Treatments," page 24).

Damping off

Buy seed commercially treated with Thiram. If Pythium has been a problem, apply **Ridomil Gold EC** at 0.25-0.5 pt/treated A preplant (broccoli, cabbage and cauliflower only). See label directions.

Clubroot

Adjust soil pH to 7.2 with hydrated lime; use long (>5 years) rotations away from cruciferous crops.

Terraclor 75 WP 2 lb/100 gal in transplant water, or in band or broadcast applications (see label instructions).

Alternaria Leaf Spot and Downy Mildew

Use hot water treated seed or disease-free certified transplants. If possible, use disease resistant cultivars. Several hybrid cultivars of broccoli are available that are tolerant to downy mildew, including Arcadia, Cindy, Citation, Esquire, Eureka, Green Belt, Hi-Caliber, Marathon, Mariner, Pinnacle, Samurai, Sprinter and Zeuss.

Spray at 7-10 day intervals at the first signs of disease, or when necessary to maintain control, with one of the following fungicides:

Bravo Ultrex 1.25-1.8 lb/A (7 days-PHI).

Bravo Weather Stik 1.5 pt/A (7 days-PHI).

Equus 720 1.5 pt/A (7 days-PHI).

***Quadris** 6-15.5 fl oz/A (0 days-PHI). Do not apply more than one foliar application of Quadris before alternating with a fungicide with a different mode of action. Limit these applications per crop per year.

Maneb 75 DF or **80 WP**, 1.5-2.0 lb/A (7 days-PHI).

Manex 1.2-1.6 qt/A (7 days-PHI).

***Kocide 3000** 0.5-0.75 lb/A (7 days-PHI) (or other copper formulation).

***Switch** (alternaria leaf spot only) 11-14 oz/A (7 days-PHI).

If downy mildew is the primary disease, use one of the following:

***Ridomil Gold/Bravo 81 W** 1.5-2 lb/A (7 days-PHI).

***Aliette WDG** 2.0-5.0 lb/A (3 days-PHI). See label directions.

***Aliette/Maneb 2+2** 4.0 lb/A (7 days-PHI). See label directions.

For kohlrabi only

Apply **Aliette/Maneb 2+2** 4.0 lb/A (7 days-PHI); also controls alternaria leaf spot.

Black leg and black rot

Use certified disease-free transplants. Application of fixed copper (Nu-Cop 3C, 50 DF; **Kocide** 3000 or other formulation [see label for instructions]) is advised if black rot threatens (0 days-PHI). Slight foliar injury may result with copper. For broccoli only, if black leg threatens, apply **Rovral** 2 pts/A (0 days-PHI) according to label directions.

White mold

Apply **Contans WG** biofungicide (2-4 lb/A in 50-100 gal water) immediately after harvest to reduce numbers of sclerotia in soil. Alternately, apply 3 months before planting.

*Follow guidelines for fungicide resistance management on the product label (see pages 59-60).

Insect Control

• Scouting for Insect Pests of Cabbage

1. Determine the crop growth stage (so that best threshold can be selected):

- Examine several plants that represent the average plant size.
- For young pre-heading cabbage:
 - Count the number of true leaves.
 - Do not count the cotyledons.
 - Do not count leaf scars that indicate a leaf has broken off.
 - In the heart, count leaves that are at least 1 inch long.
- For larger cabbage, just measure the head diameter.

2. Determine the number of plants to inspect:

- Examine cabbage in **10 segments** across the field.
- The number of plants per segment depends on which strategy you use.
 - You can use a fixed sample size:
 - examine **4 plants per segment** if plants have 8 or less leaves (= total 40 plants per field),
 - or examine **2 plants per segment** if plants have more than 8 leaves (= 20 plants per field).
 - If a portable computer is used with the “Cole Crops Pest Management Analysis” program, the computer will tell you how many plants to sample in each of the 10 segments; the number will vary from **1 to 4 plants** per segment. (Contact Casey Hoy or Celeste Welty for a copy of this program or for a handout on variable intensity sampling plans for cabbage.)

3. Choose plants to inspect:

- Choose a path that allows you to look at as much of the field as possible. A V-shaped path works well; start at one corner and walk to the middle of the opposite side, and back to the opposite corner.
- Plants inspected should be at fairly even spacing along the entire length of that path.
- Be sure to move well beyond the headlands before examining the first plant.
- Within each segment, **randomly** choose plants to examine for insects. Do not bias your sample by looking for damaged or undamaged plants to inspect.

4. Inspect the plants for target pests:

- Look for insects on the upper and lower surfaces of each leaf on the plant.
- On seedlings, be sure to check for diamondback larvae inside *unfolded heart leaves*.
- On heading cabbage, examine the outer 2 head leaves as well as all wrapper and frame leaves.
- On each plant examined, record **presence or absence** of onion thrips and cabbage aphid.
- On each plant examined, **count** the number of insects in these 7 categories:
 - larvae of the diamondback moth
 - imported cabbageworm, eggs (yellow, pointy)
 - imported cabbageworm, small larvae (< 1/2 inch)
 - imported cabbageworm, large larvae (> 1/2 inch)
 - cabbage looper, eggs (white, round)
 - cabbage looper, small larvae (< 1/2 inch)
 - cabbage looper, large larvae (> 1/2 inch)
- As you walk, survey constantly for disease symptoms, weeds, and any unusual problems.

• Decision-Making for Cabbage Pest Management

1. For each of the five categories of larvae, determine the average number per plant. Do this by adding up total numbers found and dividing by the number of plants inspected.
2. Convert the average numbers of larvae to a single number of **larval units**. Do this by multiplying the average in each category by the conversion factors listed below, then adding the five sub-totals.

Average number per plant of:

diamondback larvae	=	_____	x	0.1	=	_____
cabbageworm small larvae	=	_____	x	0.1	=	_____
cabbageworm large larvae	=	_____	x	0.67	=	_____
looper small larvae	=	_____	x	0.67	=	_____
looper large larvae	=	_____	x	1.0	=	_____
Total (average larval units per plant)	=	_____				

3. Find the appropriate **action threshold**:

Processing cabbage: First, determine today’s average temperature by adding today’s high and tonight’s low and dividing the sum by 2. Find this average temperature in the list along the left side of the threshold table below. Then find the crop growth stage along the top of the table and follow down this column to find the action threshold for the appropriate temperature.

The table below shows several representative thresholds; complete tables are available for other growth stages and temperatures.

Fresh-market cabbage: For cabbage up to the cupping stage, follow the directions above for processing cabbage thresholds. After cupping, the action threshold is **0.5 larval units per plant** regardless of crop growth stage or temperature.

An alternative threshold to use for fresh market cabbage after cupping is **50% of the plants infested with any species of worm pest**. Note that this simplifies sampling. Rather than counting the larvae in each category, simply determine whether each plant has any worms, regardless of the category, or has no worms.

Thresholds (expressed in larval units) for Processing Cabbage at Representative Growth Stages and Temperatures					
Average Temperature	Cabbage Growth Stage				
	4-leaf	10-leaf	18-leaf	4-inch head	10-inch head
55	0.14	0.95	3.10	7.00	20.33
60	0.08	0.57	1.85	4.18	12.16
65	0.05	0.37	1.21	2.72	7.91
70	0.04	0.27	0.87	1.96	5.71
75	0.03	0.21	0.70	1.57	4.56
80	0.03	0.19	0.61	1.37	3.97
85	0.03	0.17	0.56	1.26	3.66

4. **Compare** the pest infestation in your field (number of larval units from Step No. 2) with the action threshold (number of larval units from Step No. 3).

If your average number of larval units is **less** than the action threshold, then the field probably does not need to be treated. Treatment may be needed even if the action threshold was not exceeded under certain conditions, such as if larvae are concentrated in the unfolded heart leaves of seedlings; if infestation is much higher in some parts of the field; or if plants are under stress from heat or drought.

If your average number of larval units is **greater** than the action threshold, then the field probably needs to be treated, unless a rainstorm or harvest is imminent.

If your average number of larval units is **close to** the action threshold, treatment may be required soon. Consider the size of the larvae, predicted temperature, and current and forecasted spraying conditions before making a decision. Treat sooner if larvae are large and the predicted temperature is high; treatment can be delayed if larvae are small and the predicted temperature is low. If you are unsure of whether treatment will be needed, you can always sample again in a few days.

• Preplant broadcast soil treatment

Note on cabbage maggot control: Treatment is preventive and most effective when applied before the eggs hatch. Cabbage maggot flies deposit eggs close to the stem in cracks and crevices in the soil. When the eggs hatch, the young maggots move downward along the stem, feeding on the root and stem tissues. Placement of insecticide in this area is very important if good control is to be obtained.

Diazinon

For cabbage maggot, wireworms, cutworms.

Diazinon AG500 (4EC): 2-4 qt/A.

Diazinon AG600: 51-102 fl oz/A.

Diazinon 50WP: 4-8 lb/A.

Diazinon 14G: 14-21 lb/A.

Ethoprop

For garden symphytan and nematodes.

Mocap 15G: 34 lb/A.

Insecticides for Use on Cole Crops in Ohio

(E = excellent; G = good; F = fair; P = poor; ✓ = pest listed on label but efficacy uncertain; - = pest not on label; rating in parentheses = pest not on label but product known to provide some control)

Pest >>	Pre-harvest interval (days)	Cut-worms	Cabbage maggot	Flea beetles	Imported Cabbageworm	Cabbage looper	Diamond-back (larva)	Onion thrips	Aphids	Impact on beneficial insects
<i>How often an insecticide has been needed on Ohio farms for this pest in the past >></i>		rare	occasional	often in spring ¹	every year, often	most years, especially late season	most years	every year ²	rare	
ORGANOPHOSPHATES										
Dibrom (naled)		-	-	-	✓	✓	✓	-	✓	moderate/disruptive
Diazinon	7, 10, 21	✓	G	-	G	-	F	-	F	moderate
dimethoate (Cygon)	7	-	-	-	-	-	-	(F)	G	disruptive
Di-Syston (disulfoton)	14-42	-	-	✓	-	-	-	(F)	G	moderate
Lorsban (chlorpyrifos)	21	✓	G	-	G	(G)	G	-	F	moderate
malathion (Cythion)	3, 7	-	-	(G)	✓	✓	(F)	-	(F)	low/moderate
MSR (oxydemetonmethyl)	7, 10	-	-	-	-	-	-	F	G	moderate
Mocap (ethoprop)	-	-	-	-	-	-	-	-	-	-
Orthene (acephate)	14	-	-	-	G	G	G	-	G	moderate/disruptive
CARBAMATES										
Lannate (methomyl)	1, 3, 10	G	-	(F)	G	F	F	-	-	disruptive
Larvin (thiodicarb)	7	-	-	G	G	G	G	-	-	disruptive
Sevin (carbaryl)	3, 14	-	-	G	P	-	P	-	-	disruptive
PYRETHROIDS										
Ammo (cypermethrin)	1	G	-	G	G	G	(G)	F	-	disruptive
Asana (esfenvalerate)	3	G	-	G	G	G	(G)	(F)	-	disruptive
Baythroid (cyfluthrin)	0	✓	-	✓	✓	✓	✓	✓	-	disruptive
Capture, Brigade (bifenthrin)	7	G	✓	G	G	G	G	F	F	disruptive
Danitol (fenpropathrin)	7	-	-	-	G	G	-	-	-	disruptive
Hero (bifenthrin + z.c.)	7	✓	-	G	G	G	G	F	F	disruptive
Mustang (zeta-cypermethrin)	1	G	-	G	G	G	G	F	-	disruptive
Pounce (permethrin)	1	(G)	-	(G)	G	G	G	P	-	disruptive
Proaxis (gamma-cyhalothrin)	1	G	-	G	G	G	G	✓	F	disruptive
Warrior (lambda-cyhalothrin)	1	G	-	G	G	G	G	(F)	-	disruptive
NEONICOTINOIDS (CHLORONICOTINYLS)										
Actara (thiamethoxam)	0	-	-	✓	-	-	-	✓	✓	low/moderate
Admire (imidacloprid)	21	-	-	-	-	-	-	-	G	low/moderate
Assail (acetamiprid)	7	-	-	G	-	-	-	G	G	low/moderate
Platinum (thiamethoxam)	30	-	-	✓	-	-	-	✓	✓	low/moderate
Provado (imidacloprid)	7	-	-	✓	-	-	-	(G)	G	low/moderate
Venom (dinotefuran)	1, 21	-	-	-	-	-	-	-	✓	low/moderate
OTHER INSECT NERVE POISONS										
Avaunt (indoxacarb)	3	-	-	-	G/E	E	E	-	-	low/moderate
Beleaf (flonicamid)	0	-	-	-	-	-	-	-	✓	
Fulfill (pymetrozine)	7	-	-	-	-	-	-	-	G	low
Proclaim (emamectin benzoate)	7	-	-	-	G/E	F/G	E	-	-	low/moderate
Pyronyl, PyGanic (pyrethrins)	0	✓	-	✓	✓	✓	✓	✓	✓	moderate
Radiant (spinetoram)	1	-	-	-	✓	✓	✓	✓	-	
SpinTor (spinosad)	1	-	-	-	G	G	E	G	-	low
Thionex (endosulfan)	7-14	F	-	G	G	F	G	(G)	G	moderate
INSECT GROWTH REGULATORS										
Confirm (tebufenozide)	7	-	-	-	G/E	G/E	F	-	-	low
Intrepid (methoxyfenozide)	1	-	-	-	G/E	G/E	F	-	-	low
Neemix, Aza-Direct (azadirachtin)	0	✓	-	-	✓	✓	✓	✓	✓	low/moderate
Rimon (novaluron)	7	-	-	-	✓	✓	✓	-	-	low
MISCELLANEOUS										
<i>Bacillus thuringiensis</i> (B.t.; Javelin)	0	(F)	-	-	G	F	G	-	-	very low
cryolite (Kryocide)	7, 14	✓	-	G	✓	✓	✓	-	-	low
Oberon (spiromesifen)	7	-	-	-	-	-	-	-	-	-
soap (M-Pede)	0	-	-	-	-	-	-	-	F	low

¹Mostly for seedlings of direct-seeded crops.

²Thrips are difficult to control with insecticides; use thrips-resistant varieties for best management.

• At-planting treatment

See note on cabbage maggot control in the preplant section (page 115).

Bifenthrin (3 days-PHI)

For maggot, wireworm, grubs.

Brigade 10WSB: 8-16 oz/A. Apply in-furrow with seed or transplant.

Chlorpyrifos

For cabbage maggot.

Lorsban 75WG: 1.1-1.8 oz per 1,000 ft of row.

Lorsban 15G: 4.6-9.2 oz/1,000 ft of row in a 4-inch band, for direct seeded or transplant crops.

Lorsban 4E, Warhawk 4EC, Yuma 4E: Apply as a band over the row at seeding; shallow incorporation needed. For transplants use 1.6-2.4 fl oz/1,000 ft for cauliflower, or 1.6-2.75 fl oz/1,000 ft for broccoli, Brussels sprouts, cabbage, and kohlrabi; apply as a water-based soil drench immediately after setting; use a minimum of 40 gal of water/A.

Diazinon

For cabbage maggot.

Apply one of the following at transplanting at rate of 200-300 gal/A or 4-8 fl oz (1/2-1 cupful) per plant.

Diazinon AG500 (4EC): 4-8 fl oz/50 gal.

Diazinon AG600: 3.25-6.5 fl oz/50 gal.

Diazinon 50WP: 4-8 oz/50 gal.

Dinotefuran (21 days-PHI)

For aphids (suppression), whiteflies, leafminer, harlequin bug, stink bugs.

Venom 70SG: 5-6 oz/A, applied as in-furrow spray, post-seeding drench, transplant drench, or sidedress. Limit 12 oz/A per year.

Disulfoton (42 days-PHI, cabbage; 40 days-PHI, cauliflower; 30 days-PHI, Brussels sprouts; 14 days-PHI, broccoli)

For flea beetles, aphids; for thrips on Brussels sprouts.

Apply in seed furrow, or in transplant row, or sidedress. Limit 1 application per season on cabbage and broccoli. Limit 2 applications per season on Brussels sprouts and cauliflower.

Di-Syston 8EC: 1.1 fl oz/1,000 ft of row.

Di-Syston 15G: 7.4 oz/1,000 ft of row.

Ethoprop

For garden symphylan and nematodes.

Mocap 15G: band at 0.9 lb/1,000 ft of row (13 lb/A for 36-inch rows), or broadcast at 34 lb/A.

Mocap 6EC: band at 2.4 fl oz/1,000 ft of row, or broadcast at 3.3 qt/A.

Imidacloprid (21 days-PHI)

For aphids.

Admire 2F, Alias 2F: 10-24 fl oz/A. Apply in furrow, or as post-seeding drench, or transplant drench.

Admire Pro (4.6F): 4.4-10.5 fl oz/A.

Thiamethoxam (0 days-PHI)

For aphids, flea beetles, thrips, whiteflies.

Platinum 2SC: 5-11 fl oz/A as in-furrow spray, post-seeding drench or transplant drench.

• Bait treatment

Carbaryl (3 days-PHI)

For cutworms, armyworms.

Sevin 5B: 20-40 lb/A or 7.3-14.7 oz/1,000 sq ft.

Prozap Sevin 10% Bait Granules: 10-20 lb/A.

Metaldehyde (0 days-PHI)

For slugs. Broadcast before heads form, or band between rows once heads form.

Deadline MP (4B): 20-40 lb/A.

Prozap Snail and Slug AG (3.5B): 24-40 lb/A.

Metaldehyde 7.5G: 20 lb/A.

Permethrin (1 day-PHI)

For crickets, cutworms.

Ambush 0.5% Bait: 10-40 lb/A for cabbage; 10-20 lb/A for other cole crops.

• **Sidedress treatment**

Imidacloprid (21 days-PHI)

For aphids.

Admire 2F, Alias 2F: 10-24 fl oz/A.

Thiamethoxam (0 days-PHI)

For aphids, flea beetles, thrips, whiteflies.

Platinum 2SC: 5-11 fl oz/A in drip irrigation.

• **Foliar treatment**

Note on worm control: Best results are obtained when the spray is applied after the eggs hatch, but while larvae are small (less than 1/4-inch). Direct spray to the undersurface of leaves, especially in controlling loopers. Thorough coverage is essential. The use of spray adjuvants (spreader-stickers) may improve the performance of the pesticides.

Note on thrips control: Control of thrips on cabbage is difficult once heads form; treat in the cupping stage or early post-cupping stage if plants are infested with thrips. With the exception of B.t., insecticides used to control other pests will also kill thrips. In susceptible varieties, thrips damage is likely regardless of insecticide use because thrips are able to take refuge inside the cabbage head. Varieties that are not highly susceptible to thrips injury are Bravo, Titanic, Roundup, and King Cole. Relatively susceptible varieties are Krautpacker, Superdane, Bartolo, Rodolpho, Kraut King, and Hinova.

Note on aphid control: *Green peach aphid* is common on cabbage but usually not harmful. Green peach aphid is green, pink, or yellow, not waxy, and does not cause distorted plant growth. *Cabbage aphid* causes distorted plant growth and is covered by a grayish-white wax that looks like ashes. If cabbage aphid is detected, control is suggested before the population can build up to damaging levels; this can occur quickly in hot, dry weather. Cabbage aphid is most common late in the season.

Acephate (14 days-PHI, Brussels sprouts, cauliflower)

For aphids, cabbage looper, imported cabbageworm, and diamondback moth.

Orthene 75SP: 0.7-1.3 lb/A for aphids; 1.3 lb/A for worms. Do not apply more than 2.7 lb/A per season on Brussels sprouts.

Orthene 97S: 8-16 oz/A. Limit 2.12 lb/A per season.

Bracket 90S: 0.5-1.1 lb/A.

Acetamiprid (7 days-PHI)

For aphids, whiteflies, thrips, Swede midge and flea beetles.

Assail 30SG: 1.8-4.0 oz/A. Use the high rate for thrips control.

Bacillus thuringiensis (B.t.) (0 days-PHI)

For cabbage looper, imported cabbageworm, and diamondback moth.

Use lower rate for imported cabbageworm, intermediate rate for diamondback, and higher rate for loopers. B.t. preparations are toxic only when eaten by the larvae. B.t. may take up to a week to cause death. Good coverage is essential; the use of a spreader-sticker is recommended.

Agree WG (3.8% a.i.): 0.5-2 lb/A.

Biobit HP WP (6.4% a.i.): 0.5-2 lb/A.

CryMax WDG (15% a.i.): 0.5-1.5 lb/A.

Deliver (18% a.i.): 0.25-1.5 lb/A.

DiPel DF (10.3% a.i.): 0.25-1 lb/A.

Javelin WG (6.4% a.i.): 0.25-1 lb/A.

Lepinox WDG (15% a.i.): 1-2 lb/A.

XenTari WDG: 0.25-1 lb/A.

Bifenthrin (7 days-PHI)

For imported cabbageworm, loopers, diamondbacks, flea beetles, thrips, aphids.

Brigade 2EC, Capture 2EC, Discipline 2EC, Fanfare 2EC, Sniper 2EC, Tundra 2EC: 2.1-6.4 fl oz/A.

Brigade 10WSP: 5.3-16 oz/A.

Bifenthrin + zeta-cypermethrin (7 days-PHI)

For caterpillars, thrips, flea beetles, aphids.

Hero 1.24EC: 4-10.3 fl oz/A.

Carbaryl (3 days-PHI, cabbage, cauliflower, broccoli, Brussels sprouts; 14 days-PHI, Chinese cabbage)

For flea beetles, imported cabbageworm, diamondback moth.

Carbaryl 90DF: 0.6-1.1 lb/A for beetles; 1.1-2.2 lb/A for worms.

Carbaryl 4L, Sevin 4F, Sevin XLR Plus (4EC): 0.5-1 qt/A for flea beetles; 1-2 qt/A for diamondbacks and cabbageworm.

Sevin 80S: 0.7-1.25 lb/A for flea beetles; 1.25-2.5 lb/A for cabbageworm.

Sevin 50W: 1-2 lb/A for flea beetles; 2-4 lb/A for cabbageworm.

Chlorpyrifos (21 days-PHI)

For flea beetles and aphids.

Lorsban 75WG: 0.67-1.33 lb/A.

Lorsban 50W: 2 lb/A. Limit 6 applications per season.

Cryolite (7 or 14 days-PHI)

For flea beetles, cabbage looper, imported cabbageworm, diamondback moth, cutworms.

Kryocide (96% a.i.): 8-16 lb/A (14 days-PHI)

Prokil Cryolite 96 (96% a.i.): 10-16 lb/A (14 days-PHI, cabbage; 7 days-PHI, broccoli, Brussels sprouts, cauliflower).

Cyfluthrin (0 days-PHI)

For cutworms, thrips, flea beetles, caterpillars.

Baythroid 2EC: 0.8-3.2 fl oz/A. Limit 4 applications per year.

Cypermethrin (1 day-PHI)

For onion thrips, caterpillars, beetles.

Ammo 2.5EC, Battery 2.5EC: 3.75-5 fl oz/A for thrips and loopers; 2.5-5 fl oz/A for imported cabbageworm and flea beetles.

Cyromazine (7 days-PHI)

For leafminers.

Trigard 75WP: 2.66 oz/A. Limit 6 applications per crop.

Diazinon (21 days-PHI, cabbage; 10 days-PHI, Chinese cabbage; 7 days-PHI, broccoli, Brussels sprouts, cauliflower)

For aphids, diamondback moth, imported cabbageworm.

Diazinon AG500 (4EC): 0.5-1 pt/A.

Diazinon 50WP: 0.5-1 lb/A.

Dimethoate (7 days-PHI, broccoli, cauliflower)

NOTE: Dimethoate use on cabbage was canceled in 2006.

For aphids.

Dimethoate (4EC), Dimate 4EC: 0.5-1 pt/A.

Dimethoate 2.67EC: 0.75-1.5 pt/A.

Dinotefuran (1 day-PHI)

For aphids (suppression), whiteflies, leafminer, harlequin bug, stink bugs.

Venom 70SG: 1-4 oz/A. Limit 6 oz/A per season.

Emamectin benzoate (7 days-PHI)

For caterpillars.

Proclaim (5WDG): 2.4-4.8 oz/A for diamondbacks, imported cabbageworm; 3.2-4.8 oz/A for cabbage looper. Limit 28.8 oz/A per season.

Endosulfan (14 days-PHI, Brussels sprouts, cauliflower; 7 days-PHI, cabbage, broccoli)

For flea beetles, cabbage looper, imported cabbageworm, diamondback moth, aphids.

Limit 4 applications per year or 4 qt/A per year.

Thionex 3EC, Endosulfan 3EC: 1-1.3 qt/A.

Thionex 50WP: 1.5-2 lb/A.

Esfenvalerate (3 days-PHI, broccoli, cabbage, cauliflower)

For flea beetles, cabbage looper, imported cabbageworm, and diamondback moth.

Asana XL 0.66EC, Adjourn 0.66EC: 2.9-5.8 fl oz/A for cabbageworm; 5.8-9.6 fl oz/A for flea beetles, looper. Limit 78 fl oz/A per season.

Fenpropathrin (7 days-PHI)

For cabbage looper, imported cabbageworm.

Danitol 2.4EC: 10.7-16 fl oz/A.

Flonicamid (0 days-PHI)

For aphids.

Beleaf 50SG: 1.2-2.8 oz/A. Limit 3 applications per year.

Gamma-cyhalothrin (1 day-PHI)

For caterpillars, flea beetles.

Proaxis (0.5EC): 1.92-3.84 fl oz/A.

Imidacloprid (7 days-PHI)

For aphids, flea beetles, whiteflies.

Provado 1.6F, Pasada 1.6F: 3.75 fl oz/A. Limit 18.75 fl oz/A per year.

Indoxacarb (3 days-PHI)

For caterpillars.

Avant 30WG: 2.5-3.5 oz/A. Limit 14 oz/A per year.

Lambda-cyhalothrin (1 day-PHI)

For caterpillars, flea beetles.

Warrior 1EC, Silencer 1EC, Taiga Z 1CS: 1.92-3.84 fl oz/A. Limit 1.92 pints/A per year.

Malathion (7 days-PHI, cabbage, cauliflower, Brussels sprouts, kohlrabi; 3 days-PHI, broccoli)

For cabbage looper, imported cabbageworm, diamondback moth, aphids.

Malathion 5EC; Malathion 57EC: 1-2 pt/A for looper, cabbageworm, aphids; 2-4 pt/A for diamondbacks.

Malathion 8EC: 1-2.5 pt/A.

Malathion 25WP: 2 lb/A for aphids.

Methomyl (3 days-PHI, broccoli, cauliflower, Brussels sprouts; 1 day-PHI, cabbage; 10 days-PHI, Chinese cabbage).

For cabbage looper, imported cabbageworm, diamondback moth.

Limit 10 applications/crop for broccoli, Brussels sprouts, cauliflower; 15 applications/crop for cabbage.

Lannate 90SP: 0.25-1 lb on cabbage, broccoli, cauliflower; 0.5-1 lb on Brussels sprouts.

Lannate LV (2.4WSL): 0.75-3 pt on cabbage, broccoli, cauliflower; 1.5-3 pt on Brussels sprouts.

Methoxyfenozide (1 day-PHI)

For caterpillars.

Intrepid 2F: 4-10 fl oz/A for loopers and imported cabbageworm; 12-16 fl oz/A for diamondback suppression. Limit 64 fl oz/A per year.

Naled (1 day-PHI)

For cabbage looper, imported cabbageworm, diamondback moth, aphids.

Dibrom 8EC: 1 pt/A for cabbageworm, diamondback, aphids; 2 pt/A for looper.

Novaluron (7 days-PHI)

For diamondback moth, imported cabbageworm, cabbage looper.

Rimon 0.83EC: 6-12 fl oz/A. Limit 3 applications per year.

Oxydemetonmethyl (10 days-PHI, Brussels sprouts; 7 days-PHI, cabbage, broccoli, cauliflower, tight-headed Chinese cabbage)

For aphids, thrips.

MSR (Metasystox-R 2SC): 1.5-2 pt/A on broccoli, Brussels sprouts, and cauliflower; 1.5-3 pt/A on cabbage. Do not apply more than 3 times per season.

Permethrin (1 day-PHI)

For cabbage looper, imported cabbageworm, diamondback moth, flea beetles, thrips.

Pounce 3.2EC, Arctic 3.2EC, Permethrin 3.2EC: 2-8 fl oz/A on cabbage and Chinese cabbage (limit 40 fl oz/A per season); 2-4 fl oz/A on broccoli, Chinese broccoli, Brussels sprouts, cauliflower, kohlrabi (limit 32 fl oz/A per season).

Ambush 25WP: 3.2-12.8 oz/A on cabbage (limit 64 oz/A per season); 3.2-6.4 oz on broccoli, Brussels sprouts, and cauliflower (limit 51 oz/A per season).

Pounce 25WP: 3.2-6.4 oz/A. Limit per season of 64 oz/A on cabbage, or 51 oz/A on broccoli, Brussels sprouts and cauliflower.

Pymetrozine (7 days-PHI)

For aphids, whiteflies.

Fulfill 50WDG: 2.75 oz/A.

Pyriproxyfen (7 days-PHI)

For whiteflies.

Esteem 35WP: 2.5-3 oz/A. Limit 2 applications or 6 oz/A per season.

Soap (0 days-PHI)

For aphids.

M-Pede (49% a.i.): 1-3 gal/A.

Spinetoram (1 day-PHI)

For caterpillars, thrips.

Radiant 1SC: 5-10 fl oz/A. Limit 6 applications per year.

Spinosad (1 day-PHI)

For diamondback moth, imported cabbageworm, cabbage looper, armyworms.

SpinTor 2SC: 1.5-8 oz/A. Limit 29 oz/A/year.

Entrust (80WP): 0.5-3 oz/A.

Spiromesifen (7 days-PHI)

For whiteflies.

Oberon 2SC: 7.0-8.5 fl oz/A. Limit 3 applications per crop season.

Tebufenozide (7 days-PHI)

For imported cabbageworm, cabbage looper.

Confirm 2F: 6-8 oz/A for small plants; 8 oz/A for larger plants and heavy infestation. Limit 56 fl oz/A per year.

Thiamethoxam (0 days-PHI)

For aphids, flea beetles, thrips, whiteflies.

Actara 25WDG: 1.5-3 oz/A for aphids, flea beetles; 3-5.5 oz/A for thrips, whiteflies. Limit 11 oz/A per growing season.

Thiodicarb (7 days-PHI, broccoli, cabbage, cauliflower)

For looper, cabbageworm, diamondback, flea beetles.

Larvin 3.2F: 16-32 fl oz/A for flea beetle and imported cabbageworm; 24-40 fl oz/A for diamondback moth and looper.

Limit 160 fl oz/A per season.

Zeta-cypermethrin (1 day-PHI)

For caterpillars, flea beetles, thrips.

Mustang 1.5EW: 2.4-4.3 fl oz/A for flea beetles, imported cabbageworm, diamondback; 3.4-4.3 fl oz/A for loopers, thrips.

Mustang Max (0.8EC): 2.24-4.0 fl oz/A.

Weed Control

Preemergence

For Transplanted Cabbage, Cauliflower and Broccoli

Goal 2XL: Controls annual broadleaf weeds in transplanted cole crops. Do not use on Brussels sprouts. Apply 1-2 pt/A.

Can be used in conjunction with trifluralin or Devrinol. Use the lower rate on coarse textured soils. Applications must be made after completion of soil preparation but before transplanting broccoli, cauliflower, or cabbage plants.

Transplanting should be completed with minimal soil disturbance. Treated soil surfaces should be left undisturbed after transplanting to obtain greatest benefit from Goal herbicide. Do not apply more than 2.0 pt/A/season. Do not apply post-transplant.

Prefar 4E: Controls annual grasses and a few annual broadleaf weeds. Apply 5-6 qt/A preplant incorporated, or pre-emergence (only if followed by irrigation within 36 hours to provide activation). For broccoli, Brussels sprouts, cabbage, cauliflower, Chinese broccoli, broccoli, raab, collards, Chinese cabbage (bok choy, napa), Chinese mustard, all Chinese brassica crops.

Trifluralin: Controls annual grasses and some annual broadleaf weeds. Preplant incorporate 2-3 inches deep soon after application. Use lower rates on coarse and medium textured soils and higher rate on fine textured soils.

Albaugh Trifluralin 4EC, Gowan Trifluralin 4EC, Riverside Trifluralin 4EC, Treflan HFP, Trilin 4EC: 1-1.5 pt/A.

Gowan Trifluralin 5EC, Trilin 5EC: 0.8-1.2 pt/A.

Gowan Trifluralin 10G, Treflan 10G, Trilin 10G, Wilbur-Ellis Trifluralin 10G: 5-7.5 lb/A of 10G.

Trific 60DF: 0.8-1.33 lb/A.

Dacthal 75W: Controls annual grasses and some annual broadleaf weeds. Apply 6-14 lb/A Dacthal 75 WP after transplanting to clean, weed-free soil. Use on mineral soils only. Irrigation or rain soon after applying Dacthal improves weed control.

Dual Magnum: Controls annual grasses and some annual broadleaf weeds. Apply 0.5-1.33 pt/A. Make surface application prior to transplanting, or a broadcast application within 48 hours after transplanting cabbage. Use lower rates on coarse soils (sandy) and higher rates on heavy soils (silty, clay). See product label for specific information. Do not incorporate. Do not apply to direct seeded cabbage. Do not tank mix with Goal. Crop maturity may be delayed by Dual application. Note: Ohio 24(c) Special Local Needs label. The use of this product is legal only if a Waiver of Liability and Indemnification provided by Ohio Vegetable and Potato Growers Association has been signed by the grower, all fees have been paid, and a label is in your possession provided by the grower's association.

Direct-seeded or Transplanted

Clomozone (For Cabbage Only): Incorporate to a depth of 1 inch or may cause early stunting or whitening of leaves.

Good control of velvetleaf. Ohio 24C. You must have a copy of the label. See the label for other restrictions. May cause temporary bleaching of tissue. Certain varieties may be very sensitive.

Command 4EC: 0.5 pt/A on direct seed cabbage, 0.5-1 pt/A on transplanted cabbage. Incorporate prior to planting to a depth of 1 inch or less before seeding or transplanting.

Command 3ME: 0.67 pt/A on direct seeded cabbage, 0.67 to 1.3 pt/A on transplanted cabbage. Incorporation is not required.

Trifluralin: Preplant incorporate 2-3 inches deep within 8 hours after application.

Albaugh Trifluralin 4EC, Gowan Trifluralin 4EC, Riverside Trifluralin 4EC, Treflan HFP, Trilin 4EC: 1-1.5 pt/A.

Gowan Trifluralin 5EC, Trilin 5EC: 0.8-1.2 pt/A.

Gowan Trifluralin 10G, Treflan 10G, Trilin 10G, Wilbur-Ellis Trifluralin 10G: 5-7.5 lb/A.

Trific 60DF: 0.8-1.33 lb/A.

Dacthal 75W: Apply 6-14 lb/A Dacthal 75 WP after seeding to clean, weed-free soil. For annual weed control. Use on mineral soils only. Irrigation or rain soon after applying Dacthal improves weed control.

Postemergence

For Brussels sprouts, cabbage, cauliflower, broccoli:

Select 2EC: For emerged grasses apply 0.5 pt/A. Include COC at 1% V/V (30 days-PHI).

Poast 1.5E: For emerged grasses apply 1.5 pt/A. May be applied repeatedly to a maximum of 3 pt/A/season. Include COC at 3% V/V (30 days-PHI).

Stinger: For control of sensitive broadleaf weeds including common ragweed, cocklebur, and smartweed apply 0.25-0.5 pint/A when weeds are actively growing. Two applications are permissible with no more than 1 pint/A applied for the growing season (30 days-PHI).

For cabbage only:

Lentagran 45WP (pyridate): For cabbage only. Apply 2lb/A. In seeded cabbage, apply only after crop has 3 fully developed leaves. In transplanted crops, apply only after plants are well established (about 14 days) but before head formation. Apply to broadleaf weeds in the 2-4 leaf stage and annual grasses in the 1-2 leaf stage (45 days-PHI). Lentagran is no longer being manufactured but is still a legal use. Expect supplies to be extremely limited.

Poast: Controls emerged annual grasses. Apply 1-1.5 pt/A (30 days-PHI). Do not exceed 3 pt/A/season. Add 1 qt/A nonphytotoxic oil concentrate. Rate is dependent on grass species and stage of development.

Directed/shielded application

Gramoxone Extra: Controls emerged annual weeds and top growth of emerged perennial weeds. Apply 1.5 pt/A. For control or suppression of emerged weeds between rows after crop establishment. Prevent contact with crop otherwise crop injury will result. See the label for specific precautions.

Preplant Incorporated Preemergence For Broccoli

Devrinol 50 DF: Controls annual grasses and suppresses some broadleaf weeds from seed. Does not control emerged weeds. Apply 2 lbs/A to transplant or direct seeded cabbage, broccoli, brussels sprouts and cauliflower. Preemergence applications will need rainfall/ irrigation to a depth of 2-4 inches within 24 hours of application in order to activate the herbicide.

For Cabbage

Devrinol 50 DF: Controls annual grasses and suppresses some broadleaf weeds from seed. Does not control emerged weeds. Apply 2 lbs/A to transplant or direct seeded cabbage, broccoli, brussels sprouts and cauliflower. Preemergence applications will need rainfall/ irrigation to a depth of 2-4 inches within 24 hours of application in order to activate the herbicide.

Preplant Post-Transplant For Cabbage

Spartan 4F: Transplanted Processing Cabbage. Controls annual broadleaf weeds. Apply Spartan at 2.25-12 fl.oz/A, depending on soil organic matter and texture. Refer to the Spartan 4F label for specific information on rate selection. Broadcast Spartan prior to transplanting or band between the rows within the first 72 hours after transplanting. Do not apply Spartan to seeded cabbage. The concentration of Spartan in the soil water increases greatly at soil pH of 6.5 or above and crop tolerance may be inadequate under these circumstances. Vegetable growers who use Spartan must indemnify FMC Corp. of any liability for crop loss that occurs as a result of using this product.