# BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER, COLLARDS, KALE, AND KOHLRABI – COLE CROPS

## Varieties[1]

### Recommended Broccoli Varieties

| Variety | Hybrid | Days[1] | Black Rot | Downy Mildew | Hollow Stem | Cold | Heat |
|---|---|---|---|---|---|---|---|
| Arcadia | Yes | 63 | X[2] | X | | X | X |
| Bay Meadows | Yes | 60 | | | | X | X |
| BC1691 | Yes | 83 | | | | | X |
| BC1764 | Yes | 62 | | | | | |
| Belstar | Yes | 66 | | X | | X | |
| DeCicco | No | 48 | | | | X | X |
| Diplomat | Yes | 68 | | X | X | X | X |
| Durapak 16 | Yes | 80 | | | | | |
| Durapak 19 | Yes | 80 | | | | | |
| Emerald Crown | Yes | 63 | | | | X | X |
| Emerald Pride | Yes | 74 | | X | | | X |
| Eureka | Yes | 76 | X | X | | X | |
| Everest | Yes | 61 | | X | | X | X |
| Fiesta | Yes | 60 | | | | X | X |
| Green Magic | Yes | 60 | | | | | X |
| Gypsy | Yes | 60 | | X | | X | X |
| Imperial | Yes | 72 | | | | | X |
| Ironman | Yes | 78 | | | X | | |
| Lieutenant | Yes | 80 | | | X | | |
| Marathon | Yes | 70 | | | | X | |
| Packman | Yes | 50 | | | | | |
| Patron | Yes | 63 | | X | | | |
| Tradition | Yes | 63 | | | | | |
| Windsor | Yes | 68 | | X | | X | X |

[1]Days from transplant to first harvest.
[2]X denotes some degree of resistance or tolerance to disease or environmental conditions.

### Recommended Brussels Sprouts Varieties[1]

| Variety | Days |
|---|---|
| Dimitri (trial) | 105 |
| Jade Cross E | 85 |
| Royal Marvel (trial) | 85 |
| Churchill (trial) | 90 |
| Nelson (trial) | 90 |
| Franklin (trial) | 100 |

[1]All varieties are hybrids.

### Recommended Cabbage Varieties

| | | | | | Pest or Abiotic Stress Reaction[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variety | Hybrid | Days | Lbs. | Use[1] | Yellows | Blackrot | Tipburn | Thrips | Split Head |
| **Green Cabbage** | | | | | | | | | |
| Artost | Yes | 68 | 3-6 | F, P | H | | H | | H |
| Bajonet | Yes | 80 | 3-5 | F | H | | | | |
| Benelli | Yes | 78 | 4-10 | F-P | H | M | M | M | H |
| Blue Dynasty | Yes | 75 | 4 | F | H | H | | | H |
| Blue Lagoon | Yes | 68 | 3-5 | F | H | M | | | |

*(table continued next page)*

## Recommended Cabbage Varieties *(continued)*

| | | | | | Pest or Abiotic Stress Reaction[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Variety** | **Hybrid** | **Days** | **Lbs.** | **Use[1]** | **Yellows** | **Blackrot** | **Tipburn** | **Thrips** | **Split Head** |
| **Green Cabbage *(continued)*** | | | | | | | | | |
| Blue Thunder | Yes | 80 | 4-5 | F | H | M | | | H |
| Blue Vantage | Yes | 72 | 4 | F | H | L | H | H | |
| Bobcat | Yes | 76 | 4-6 | F | H | | H | H | H |
| Bravo | Yes | 85 | 4-10 | F, P | H | H | | | |
| Bronco | Yes | 78 | 3-5 | F | H | | M | M | |
| Caraflex (pointed) | Yes | 68 | 2-3 | F | H | | | H | |
| Cecile | Yes | 80 | 6 | P | H | | H | | |
| Charmant | Yes | 65 | 2.5-3 | F | H | H | | L | H |
| Cheers | Yes | 75 | 5 | F | H | H | | H | |
| Dynamo | Yes | 59 | 2.5-3 | F | H | | | | H |
| Early Thunder | Yes | 72 | 3-4 | F | H | M | M | H | |
| Emblem | Yes | 85 | 3-5 | F | H | H | H | | H |
| Grand Vantage | Yes | 79 | 5-6 | F | H | | | | |
| Megaton | Yes | 85 | 10-20 | P | H | | H | | |
| Padoc | Yes | 70 | 5-8 | P | H | | H | | |
| Platinum Dynasty | Yes | 70 | 4-10 | F, P | H | H | H | | H |
| Quick Start | Yes | 64 | 3-4 | F | H | | H | M | |
| Ramada | Yes | 83 | 3-6 | F | H | H | | | |
| Royal Vantage | Yes | 79 | 3-5 | F | H | H | H | H | |
| Solid Blue 780 | Yes | 79 | 3-4 | F | H | M | H | H | |
| Stonehead | Yes | 67 | 4 | F | H | | | | |
| Superstar | Yes | 85 | 3-4 | F | H | H | H | M | |
| Thunderhead | Yes | 74 | 3-5 | F | H | H | H | H | |
| Vantage Point | Yes | 85 | 5-6 | F | H | H | H | H | |
| **Red Cabbage** | | | | | | | | | |
| Azurro | Yes | 78 | 3-4 | F | | | H | H | |
| Cairo | Yes | 85 | 3-6 | F | M | | H | H | H |
| Primero | Yes | 72 | 2-3 | F | | | H | H | |
| Red Dynasty | Yes | 75 | 5-12 | F, P | | | H | | H |
| Red Jewel | Yes | 75 | 3-5 | F | | | H | | |
| Ruby Perfection | Yes | 80 | 3-4 | F | M | M | M | H | |
| Rio Grande Red | Yes | 83 | 4-5 | F | | | M | | |
| Super Red 80 | Yes | 80 | 2-5 | F | | M | H | | H |
| **Green Savoy Cabbage** | | | | | | | | | |
| Alcosa | Yes | 62 | 2-4 | F | H | | H | | |
| Clarissa | Yes | 78 | 2-3 | F | H | | H | | |
| Famosa | Yes | 75 | 2-4 | F | | | H | | |
| Melissa | Yes | 80 | 2-4 | F | H | | H | | |
| Miletta | Yes | 88 | 3-4 | F | | | H | | |
| Savoy Ace | Yes | 78 | 3-4 | F | M | | | | |
| Savoy Blue | Yes | 85 | 3-5 | F | | | | | |
| Savoy King | Yes | 80 | 4 | F | | | H | | |
| **Red Savoy Cabbage** | | | | | | | | | |
| Deadon | Yes | 105 | 3-5 | F | | | | | |

[1]Use: F=Fresh market, P=Processing (slaw, kraut).

[2]Pest and abiotic stress reactions: H = High level of resistance or tolerance, M = Moderate or intermediate level of resistance or tolerance.

**Recommended Chinese Cabbage and Pak Choi Varieties**

| Variety | Type | Shape/Color | Hybrid | Days to maturity |
|---|---|---|---|---|
| Apollo | Chinese Cabbage | Napa (barrel) | Yes | 65 |
| Blues | Chinese Cabbage | Napa (barrel) | Yes | 57 |
| China Gold | Chinese Cabbage | Napa (barrel) | Yes | 65 |
| Emiko | Chinese Cabbage | Napa (barrel) | Yes | 55 |
| Optiko | Chinese Cabbage | Napa (barrel) | Yes | 60 |
| Rubicon | Chinese Cabbage | Napa (barrel) | Yes | 52 |
| Yuki | Chinese Cabbage | Napa (barrel) | Yes | 67 |
| Greenwich | Chinese Cabbage | Narrow | Yes | 69 |
| Green Rocket | Chinese Cabbage | Narrow | Yes | 70 |
| Jade Pagoda | Chinese Cabbage | Narrow | Yes | 68 |
| Black Summer | Pak Choi | Green petiole | Yes | 45 |
| Mei Quing Choi | Pak Choi | Green petiole | Yes | 40 |
| Joi Choi | Pak Choi | White petiole | Yes | 50 |
| New Nabai | Pak Choi | White petiole | Yes | 45 |
| Win Choi | Pak Choi | White petiole | Yes | 52 |

**Recommended Cauliflower Varieties**

| Variety | Hybrid | Color | Days | Self Wrapping | Variety | Hybrid | Color | Days | Self Wrapping |
|---|---|---|---|---|---|---|---|---|---|
| Absolute | Yes | White | 70 | Yes | Majestic | Yes | White | 50 | No |
| Accent | Yes | White | 75 | Partial | Minuteman | Yes | White | 53 | No |
| Amazing | Yes | White | 75 | Yes | Panther | Yes | Green | 70 | No |
| Apex | Yes | White | 70 | Yes | Snow Crown | Yes | White | 55 | No |
| Bishop | Yes | White | 65 | Partial | Symphony | Yes | White | 71 | Partial |
| Candid Charm | Yes | White | 68 | Partial | Violet Queen | Yes | Purple | 65 | No |
| Casper | Yes | White | 75 | Yes | Vitaverde | Yes | Green | 71 | No |
| Cheddar | Yes | Orange | 80 | No | Whistler | Yes | White | 78 | No |
| Fremont | Yes | White | 62 | Yes | White Sails | Yes | White | 68 | Yes |
| Freedom | Yes | White | 67 | Yes | 26-701 RZ | Yes | Green | 75 | No |
| Graffiti | Yes | Purple | 75 | No | | | | | |

**Recommended Collard and Kale Varieties**

| Variety | Type | Hybrid | Color | Comments |
|---|---|---|---|---|
| Bulldog | Collard | Yes | Dark Green | Lightly waved leaves |
| Hi-Crop | Collard | Yes | Deep Green | Semi-savoyed leaves |
| Top Bunch | Collard | Yes | Blue Green | Lighly savoyed leaves |
| Flash | Collard | Yes | Deep Green | Flat to lightly waved leaves |
| Vates | Collard | No | Deep Green | Flat to lightly waved leaves |
| Champion | Collard | No | Deep Green | Flat to lightly waved leaves |
| Dwarf Blue Curled (Vates) | Kale | No | Blue Green | Curled leaf |
| Dwarf Siberian | Kale | No | Green | Light to medium curl, overwinters |
| Red Russian | Kale | No | Blue Green-Red | Flat toothed leaf green with red midrib |
| Winterbor | Kale | Yes | Dark Green | Curled leaf |
| Blue Knight | Kale | Yes | Blue Green | Curled leaf |

*(table continued next page)*

**Recommended Collard and Kale Varieties *(continued)***

| Variety | Type | Hybrid | Color | Comments |
|---|---|---|---|---|
| Blue Armor | Kale | Yes | Blue Green | Very curled leaf |
| Blue Ridge | Kale | Yes | Blue Green | Very curled leaf |
| Redbor | Kale | Yes | Deep Red | Curled leaf |
| Lacinato | Kale | No | Blue Green | Puckered strap-like lance leaf |
| Black Magic | Kale | No | Dark Blue Green | Broader leaved lance leaf type |
| Reflex | Kale | Yes | Deep Green | Very tight curled leaf |
| Starbor | Kale | Yes | Blue Green | Curled leaf |

**Recommended Kohlrabi Cultivars**

| Variety | Hybrid | Comments |
|---|---|---|
| Azure Star | Yes | Deep Blue-Purple |
| Grand Duke | Yes | Light Green |
| Kolibri | Yes | Deep Purple |
| Quickstar | Yes | Light Green |
| Winner | Yes | Light Green |

## Recommended Nutrients Based on Soil Tests

**Before using the table below, refer to important notes in the Soil and Nutrient Management chapter in Section B and your soil test report. These notes and soil test reports provide additional suggestions to adjust rate, timing, and placement of nutrients. Your state's soil test report recommendations and/or your farm's nutrient management plan supercede recommendations found below.**

| | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds N per Acre | Low | Med | High (Opt.) | Very High | Low | Med | High (Opt.) | Very High | Nutrient Timing and Method |
| | | Pounds $P_2O_5$ per Acre | | | | Pounds $K_2O$ per Acre | | | | |
| **Broccoli** | 150-200 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended. |
| | 50-100 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in. |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2-3 weeks after planting. |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-6 weeks after planting. |
| **Brussels Sprouts,** | 100-150 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended. |
| **Cabbage, or** | 50-75 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in. |
| **Cauliflower** | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2-3 weeks after planting. |
| **Kale, Collards** | 100-200 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended. |
| | 50-100 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in. |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after each cutting or stripping. |
| **Kohlrabi** | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Total nutrient recommended. |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress if needed according to weather. |

Apply 1.5 to 3.0 pounds of boron (B) per acre for broccoli only. Apply 1.5 to 3.0 pounds of B per acre and 0.2 pounds molybdenum (Mo) applied as 0.5 pound sodium molybdate per acre with broadcast fertilizer for Brussels sprouts, cabbage, and cauliflower. See Table B-9 for more specific boron recommendations. Include 25-40 pounds of sulfur per acre in the fertilizer program for cole crops.

[1]In Virginia, crop replacement values of 25 lbs. $P_2O_5$ and 25 lbs. $K_2O$ per acre are recommended on soils testing Very High.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. The following are critical tissue test values for cabbage.

**Critical Cabbage Tissue Test Values.**

| Timing | Value | N | P | K | Ca | Mg | S | Fe | Mn | Zn | B | Cu | Mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | % | % | % | % | % | ppm | ppm | ppm | ppm | ppm | ppm |
| Most recently matured leaf 5 weeks after transplanting | Deficient | <3.2 | 0.3 | 2.8 | 0.5 | 0.25 | n/a | <30 | 20 | 30 | 20 | 3 | 0.3 |
| | Adequate range | 3.2 | 0.3 | 2.8 | 1.1 | 0.25 | 0.3 | 30 | 20 | 30 | 20 | 3 | 0.3 |
| | | 6 | 0.6 | 5 | 2 | 0.6 | n/a | 60 | 40 | 50 | 40 | 7 | 0.6 |
| | High | >6.0 | 0.6 | 5 | 2 | 0.6 | n/a | >100 | 40 | 50 | 40 | 10 | n/a |
| | Toxic (>) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Most recently matured leaves at 8 weeks after transplanting | Deficient | <3.0 | 0.3 | 2 | 0.5 | 0.2 | n/a | <30 | 20 | 30 | 20 | 3 | 0.3 |
| | Adequate range | 3 | 0.3 | 2 | 1.5 | 0.25 | 0.3 | 30 | 20 | 30 | 20 | 3 | 0.3 |
| | | 6 | 0.6 | 4 | 2 | 0.6 | n/a | 60 | 40 | 50 | 40 | 7 | 0.6 |
| | High | >6.0 | 0.6 | 4 | 2 | 0.6 | n/a | >100 | 40 | 50 | 40 | 10 | 0.6 |
| | Toxic (>) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Wrapper leaf at half head | Deficient | <3.0 | 0.3 | 1.7 | 0.5 | 0.25 | n/a | <20 | 20 | 20 | 30 | 4 | 0.3 |
| | Adequate range | 3 | 0.3 | 2.3 | 1.5 | 0.25 | 0.3 | 20 | 20 | 20 | 30 | 4 | 0.3 |
| | | 4 | 0.5 | 4 | 2 | 0.45 | n/a | 40 | 40 | 30 | 50 | 8 | 0.6 |
| | High | >4.0 | 0.5 | 4 | 2 | 0.45 | n/a | >100 | 40 | 40 | 50 | 10 | n/a |
| | Toxic (>) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |

## Seed Treatment

Check with your seed company to determine if seed is hot water-treated for blackrot. For more information, see the Disease section for treatment to prevent disease.

## Planting and Spacing

All cole crops may be direct seeded or transplanted.

### Direct Seeding

Precision seeders are recommended for direct seeding Seed should be sown 15 to 20 days in advance of the normal transplant date for the same maturity date.

### Transplant Production and Handling for All Cole Crops

Sow in 72 to 128 cell plug trays or sow in transplant production beds at 10 seeds per foot of row in rows 12 to 18 inches apart to be lifted as bare root plants. Early transplant production will require heated greenhouse facilities or frames. Transplants for summer plantings may be produced in field beds. Transplants are ready in 4-6 weeks. Bare root transplants should be planted soon after lifting. If purchasing bare root transplants from nurseries, plant soon upon receipt. Storage of pulled, field-grown cabbage transplants should not exceed 9 days at 32°F (0°C) or 5 days at 66°F (19°C) prior to planting in the field.

### Broccoli. Fall Production.

*Direct field seeding*: Rows 30-36 inches apart; seed: ½ to 1 pound per acre so that plants are 12 to 18 inches apart in row; time: Make successive plantings June 20 to July 20 (June 20 to July 5 in Pennsylvania and northern New Jersey).

*Transplants:* For field transplanting make successive plantings) between July 15 and August 20, depending on location. Set transplants 12 to 18 inches apart in rows 36 inches apart (14,520 plants per acre).

*High population planting for bunched broccoli*: 2 to 4 rows per bed, rows 18 to 20 inches apart, plants 9 to 10 inches in row (27,000 to 32,000 plants per acre); time: Seed June 25 to July 10; transplant July 20 to August 15, depending on location.

For fall plasticulture double cropping, remove previous crop debris and set broccoli transplants 12-21 inches apart in double rows 10-12 inches apart. For larger heads allow greater in-row spacing. Set plants in late July through mid-August, depending on variety maturity and location.

### Spring Production.

Spring production of broccoli is successful in cooler areas of the region but is limited by heat in southern areas. Use heat tolerant varieties. For spring production transplant April 1-April 20.

**Brussels Sprouts.** Brussels sprouts are a long season crop grown for fall production. Transplant rows 3 feet apart; plants 15 inches apart in row. Start planting transplants June 20. Start field seeding June 1.

**Cabbage.** Cabbage is planted from March through early August depending on location, variety, and intended harvest date. Early varieties require 85 to 90 days from seeding to harvest, and main-season crops require 110 to 115 days.

Crops grown from transplants are 14-21 days earlier. Transplants are set in rows 2 to 3 feet apart and 9 to 15 inches apart in the row for early plantings and 9 to 18 inches apart for late plantings, depending on variety, fertility, and market use.

**Cauliflower.** Transplants are set in rows 3 to 4 feet apart, and plants are set 18 to 24 inches apart in the row. Make successive plantings in the field between July 15 and August 20, depending on location.

**Note**. In Pennsylvania and other cool areas, Snow Crown, Snow Grace, and White Cloud cultivars can be grown in the spring. Transplant to the field in early April. Spring production in the southern part of the region is not recommended.

**Collards.** Direct seeded: Seed at the rate of 2 pounds per acre. Transplanting: Transplants are set in rows 16 to 36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Collards for spring and early summer harvest can be transplanted or seeded starting April 1 in Virginia and warmer, southern areas and April 20 in Pennsylvania and normally cooler areas. Collards can be seeded starting in mid-July through late August for fall harvest. Collards for processing are planted in 4 to 6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row.

**Kale**. Direct Seeding: Sow seed at 3-4 pounds per acre in rows spaced 16 to 36 inches apart. Thin to 4 to 5 inches apart in the row. Transplanting: Transplants are set in rows 16 to 36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Kale for spring and early summer harvest can be transplanted or seeded starting April 1 in Virginia and warmer, southern areas and April 20 in Pennsylvania and normally cooler areas. Kale can be seeded or transplanted starting in mid-July through late August for fall harvest. Kale for processing is planted in 4 to 6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row.

**Kohlrabi**. Transplants may be used for a spring crop. Plant in the field at the same time as broccoli or cabbage. Fall crops can be established by direct-seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2 to 3 pounds per acre and thin to 6 to 8 inches between plants in the row. Precision-seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18 to 24 inches apart.

## No-Till / Conservation Tillage

Cabbage and broccoli have been successfully grown by transplanting into rolled or herbicide killed cover crops using a no-till transplanter.

## Irrigation and Water Use

All cole crops benefit from irrigation to achieve the highest yields and quality. Cole crops require a seasonal total of 10-15 inches of water during the season. Amounts will depend on planting date, seasonal variation, variety, and number of times the field is harvested. For spring crops highest demand is near harvest. For fall crops highest demand is mid-season Consistent soil moisture level is especially critical to achieve maximum quality in cauliflower. Any moisture stress, especially when plants reach the 6 to 7-leaf stage may cause cauliflower to button or form heads prematurely.

## Harvest and Post Harvest Considerations

Cabbage is harvested when heads are tight and have reached the desired size for the variety and spacing. The head is harvested by bending it to one side and cutting the base with a knife. Harvesting knives should be sharpened frequently. The stalk should be cut flat and as close to the head as possible, yet long enough to retain two to four wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. It is important that unharvested immature heads are undamaged because fields will be harvested multiple times. Harvested cabbage can be placed in bags, boxes, wagons, or pallet bins, depending on the harvesting method employed. Holding cabbage too long past harvest maturity will result in head splitting. Store harvested cabbage at 32°F and a relative humidity of 98 to 100%.

Broccoli should be harvested when heads have reached maximum diameter and flower buds (beads) are still tight. Bunched broccoli heads are tied together in groups of 3-4 with a rubber band. Store broccoli and 32°F and relative humidity of 95 to 100 %. Broccoli should be hydrocooled or packed in ice immediately after harvest and kept at 32°F to maintain salable condition. Under these conditions broccoli should keep satisfactorily 10 to 14 days.

For processing, both cabbage and broccoli have the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and the best quality.

Cauliflower is harvested while the heads are pure white and before the curds become loose and ricey. Most varieties are self blanching. For those that are not, blanching is achieved by tying outer leaves over the heads when heads are 3 to 4 inches in diameter. Blanching takes about 1 week in hot weather and 2 weeks in cooler weather. Store harvested cauliflower at 32° F and a relative humidity of at least 95%. Avoid bruising heads in harvest, handling and packing.

Kale and collards are harvested by cutting off entire plants near ground level. Whole plants are then bunched, or lower leaves may be stripped from plants and packed individually. For processing, kale and collards are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles have elongated. Multiple harvests are possible. Because of their perishability, kale and collards should be held as close to 32°F as possible. At this temperature, they can be held for 10 to 14 days. Relative humidity of at least 95 % is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but excessive air circulation will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. These leafy greens are commonly shipped with package and top ice to maintain freshness. Kale packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition for 3 weeks at 32°F.

The targeted harvest stage for kohlrabi is when stems are full sized but before they begin to split.

## Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-3 and E-4.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Determine the preharvest interval (PHI) for the crop. See Table E-4 and consult the herbicide label.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-8** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

## Seeded and Transplanted

### Preplant Incorporated

Trifluralin--*Seeded*: 0.50 to 0.75 lb/A. Use 1 to 1.5 pints per acre Treflan 4E. *Transplants*: 0.5 to 1.0 lb/A. Use 1.0 to 2.0 pints per acre Treflan 4E. Incorporate 2 to 3 inches into soil by double-disking within 8 hours after application. **Labeled for broccoli, brussels sprouts, cabbage, cauliflower, collards, and kale only**.

### Preplant Incorporated or Preemergence

Bensulide--5.0 to 6.0 lb/A. Apply 5.0 to 6.0 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence, followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarters, smooth pigweed, and common purslane.

### Transplanted Only

Oxyfluorfen--0.2 to 0.5 lb/A. Apply 0.8 to 2.0 pints per acre Goal 2XL or Galigan 2E, or 0.8 to 1.0 pint per acre GoalTender 4FL before transplanting and transplant through the herbicide on the soil surface to control broadleaf weeds including common lambsquarters, common purslane, common ragweed, pigweed sp., and galinsoga. Use lower rates on coarse-textured soils low in organic matter. Cold, wet conditions in early spring may increase the risk of temporary crop injury which could delay maturity. Annual grasses will not be adequately controlled by Goal. Use Dacthal posttransplant or Poast 1.5EC postemergence to control grasses. Treflan or Dual Magnum may increase the potential for crop injury, especially when conditions are cold and wet, and it is not recommended for use prior to Goal application. Delay cultivation after Goal application, when possible, to reduce deactivation of the Goal by incorporation. **Labeled for broccoli, cabbage, and cauliflower only**.

### Preemergence or Post-Transplant

DCPA--6.0 to 10.5 lb/A. Apply 8.0 to 14.0 pints per acre Dacthal 6F. Apply after seeding or transplanting to a clean, weed-free soil. Use good agitation in tank. Dacthal controls annual grasses, common purslane, and lambsquarters, and suppresses or controls certain other annual broadleaf weeds. Preplant incorporate Treflan to improve control of prostrate pigweed, or use in combination with Dual Magnum to control galinsoga.

S-metolachlor--0.48 to 1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in cabbage in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.50 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat direct-seeded cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat transplanted cabbage with either a pretransplant, surface- applied application or spray post-transplant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!

### Postemergence

Clopyralid--0.047 to 0.188 lb/A. Apply 2.0 to 8.0 fluid ounces of Stinger 3A or OLF per acre in one or two applications to control certain annual and perennial broadleaf weeds. Do not exceed 8 fluid ounces in one year. Stinger or OLF controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger or OLF is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger or OLF is a postemergence herbicide with residual soil activity. Observe follow-crop restrictions, or injury may occur from herbicide carryover.

Clethodim--0.094 to 0.125 lb/A. Apply 6.0 to 8.0 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) or 12.0 to 16.0 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1.0 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when

hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control maybe reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Oxyfluorfen--0.125 to 0.188 lb/A. **A Special Local Needs 24(c) label for broccoli, cabbage, and cauliflower has been approved for the use of GoalTender postemergence in Delaware and New Jersey.** Apply 4.0 to 6.0 fluid ounces per acre of GoalTender 4F to control many seedling annual broadleaf weeds. Treat direct seeded crops when they have more than 4 true leaves, and transplanted crops a minimum of 2 weeks after transplanting and after new growth has replaced foliage present at transplanting. Expect some temporary crop injury after treatment. Crop injury will appear as speckling and/or crinkling of treated foliage. DO NOT tank-mix GoalTender with any other pesticide or use any spray additive, or severe crop injury may result. DO NOT use any oxyfluorfen formulation other than GoalTender 4F, or severe crop injury may result. Two applications of GoalTender may be applied, but DO NOT exceed a total of 8 fluid ounces (0.25 lb/A) per acre. GoalTender will provide residual control in addition to the control of annual broadleaf weeds present at application, but do not cultivate after application, or the herbicide will be deactivated and residual control will be lost. **For use only in broccoli, cabbage and cauliflower. Labeled for use in Delaware and New Jersey ONLY!**

Sethoxydim--0.2 to 0.3 lb/A. Apply 1.0 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1.0 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3.0 pints per acre in one season. **Labeled for broccoli, cabbage, and cauliflower only**.

S-metolachlor--0.48 to 1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in cabbage in Delaware, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability has been completed. The waiver of liability can be completed on the Syngenta website, "farmassist.com". Go to the website "farmassist.com" and register (or sign in if previously registered), then under "products" on the toolbar, click on indemnified labels and follow the instructions.** Apply 0.50 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat **direct-seeded** cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat **transplanted** cabbage with either a pretransplant, surface-applied application or spray posttransplant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!**

Napropamide--1.0 lb/A. Apply 2.0 quarts per acre Devrinol 2-XT preplant incorporated before seeding or transplanting. Primarily controls annual grasses and certain broadleaf weeds. Tank-mix with minimum recommended rate of Treflan 4EC to improve the spectrum of broadleaf weeds controlled. Use only on fine-textured soils such as silt or clay loams with more than 2 percent organic matter. Crop injury has occurred when used on coarse-textured soils low in organic matter. **Labeled for broccoli, Brussels sprouts, cabbage, and cauliflower. Recommended in Pennsylvania ONLY!**

### Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 or OLF for postharvest desiccation of the crop in Delaware, New Jersey and Virginia**. Apply 2.4 pints per acre Gramoxone SL 2.0 or OLF as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

## Insect Control

**THE LABEL IS THE LAW. PLEASE REFER TO THE LABEL FOR UP TO DATE RATES AND RESTRICTIONS.**

**NOTE**: Copies of specific insecticide product labels can be downloaded by visiting websites www.CDMS.net or www.greenbook.net. Also, specific labels can be obtained via web search engines.

**Note:** Not all pesticides are labeled for each crop in this section. Refer to the Days to Harvest Table at the end of this section and/or the pesticide label to determine which pesticides are labeled on specific crops.

## Soil Pests:

### Cabbage Maggot

**Note.** When yellow-rocket (mustard) first blooms, cabbage maggot adults (flies) begin laying eggs on roots or soil near roots.

bifenthrin--3.4 to 6.8 fl oz/A Capture LFR **(soil appl. only)** chlorpyrifos--Lorsban Advanced. See specific rates on label based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. Do NOT apply as a foliar application.

cyantraniliprole--10.0 to 13.5 fl oz/A Verimark (**soil appl. only)**

diazinon--2.0 to 3.0 qts/A Diazinon AG500 (or OLF) as a preplant broadcast or 4.0 to 8.0 fl oz per 50 gallons of transplant solution.

### Cutworms

(Also see the "Cutworms" section in Soil Pests-Their Detection and Control.) Apply one of the following formulations:

beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL (or other labeled mixtures containing beta-cyfluthrin, like Leverage 360)

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (or Sniper) **(soil appl. only)**

chlorpyrifos--Lorsban Advanced. See specific rates on label based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. Do NOT apply as a foliar application

cyfluthrin--0.8 to 1.6 fl oz/A Tombstone

esfenvalerate--5.8 to 9.6 fl oz/A Asana XL

gamma-cyhalothrin--1.92 to 3.20 fl oz/A Proaxis

lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (LambdaT, or OLF) (or other labeled mixtures containing lambda-cyhalothrin, like Endigo ZC)

lambda-cyhalothrin + chlorantraniliprole--5.0 to 8.0 fl oz/A Voliam Xpress

methomyl--Lannate LV (see label for rates and current registration status)

zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx (or OLF)

zeta-cypermethrin + bifenthrin--4.0 to 10.3 fl oz/A Hero EC

## Above-ground Pests:

### Aphids

Apply one of the following formulations:

acephate **(Brussels sprouts and cauliflower only)**--0.5 to 1.0 lb/A Orthene 97S (or OLF)

acetamiprid--2.0 to 4.0 oz/A Assail 30SG (or OLF)

*Chenopodium* extract--2.0 to 4.0 qts/A Requiem

clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC

cyantranilaprole--**soil** 6.75 to 13.5 fl oz/A Verimark, **foliar** 13.5-20.5 fl oz/A Exirel

flonicamid--2.0 to 2.8 oz/A Beleaf 50SG (or OLF)

flupyradifurone--7.0 to 12.0 fl oz/A Sivanto 200 SL

imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro, **foliar** 1.3 fl oz/A Admire PRO (or other labeled mixtures containing imadacloprid, like Leverage 360 or Brigadier)

lambda-cyhalothrin+thiamethoxam--4.0 to 4.5 fl oz/A Endigo ZC

pymetrozine--2.75 oz/A Fulfill 50W

spirotetramat--4.0 to 5.0 fl oz/A Movento

thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG (or other labeled mixtures containing thiamethoxam, like Endigo, Durivo (soil) or Voliam Flexi (foliar)

### Caterpillar "worm" Pests including: Cabbage Looper (CL), Diamondback moth (DBM), Imported Cabbageworm (ICW), Cross-striped Cabbageworm, Cabbage Webworm, and Armyworms

Cole crops may require multiple treatments per season. Not all materials are labeled for all crops, insects or application methods; be sure to read the label for use directions. Due to resistance development, pyrethroid insecticides are not recommended for control of DBM or beet armyworm (BAW). Other insecticides may no longer be effective in certain areas due to DBM resistance; consult your local county Extension office for most effective insecticides in your area. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

**Threshold:** For fresh-market cabbage, Brussels sprouts, broccoli and cauliflower, treat when 20 percent or more of the plants are infested with any species during seedling stage, then 30 percent infestation from early vegetative to cupping stage. From early head to harvest in cabbage and Brussels sprouts use a 5 percent threshold. For broccoli and cauliflower, use 15 percent at curd initiation/cupping, then 5 percent from curd development to harvest. Underleaf spray coverage is essential for effective control particularly with Bacillus thuringiensis and contact materials. With boom-type rigs, apply spray with at least 3 nozzles per row--one directed downward and one directed toward each side. Evaluate effectiveness to consider need for further treatment.

**Apply one of the following formulations:**

acephate **(Brussels sprouts and cauliflower only)**--1.0 lb/A Orthene 97S (or OLF)

*Bacillus thuringiensis*--1.0 lb/A Dipel (or OLF) **OMRI-listed**

beta-cyfluthrin--1.6 to 2.4 fl oz/A Baythroid XL (or other labelled mixtures containing beta-cyfluthrin, like Leverage 360) **(Not recommended for DBM or BAW)**

bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC (Sniper or OLF) [or other labelled mixtures containing bifenthrin, like Brigadier (**ICW only**)

chlorantraniliprole--3.5 to 5.0 fl oz/A Coragen 1.67SC (or other labelled mixtures containing chlorantraniliprole like Durivo (soil) or Voliam Flexi or Voliam Express (foliar)

cyantraniliprole--**soil** 5.0 to 10.0 fl oz/A Verimark, **foliar 7**.0-13.5 fl oz/A Exirel

cyfluthrin--1.6 to 2.4 fl oz/A Tombstone (or OLF) **(Not recommended for DBM or BAW)**

emamectin benzoate--3.2 to 4.8 oz/A Proclaim 5SG

esfenvalerate--5.8 to 9.6 fl oz/A Asana XL **(Not recommended for DBM or BAW)**

fenpropathrin--10.67 to 16.00 fl oz/A Danitol 2.4EC **(Not recommended for DBM or BAW)**

flubendiamide--2.0 to 2.4 fl oz/A Belt SC (or other labeled mixtures containing flubendiamide, like Vetica)

gamma-cyhalothrin--1.92 to 3.20 fl oz/A Proaxis **(Not recommended for DBM or BAW)**

indoxacarb--2.5 to 3.5 oz/A Avaunt 30WDG (or OLF)

lambda-cyhalothrin--0.96 to 1.60 fl oz/A Warrior II or 1.92 to 3.20 fl oz/A Lambda-Cy (or other labelled mixtures containing lambda-cyhalothrin, like Endigo ZC or Voliam Express) **(Not recommended for DBM or BAW)**
methomyl--1.5 to 3 pts/A Lannate LV
methoxyfenozide--4.0 to 8.0 fl oz/A Intrepid 2F
novaluron--6.0 to 12.0 fl oz/A Rimon 0.83EC
spinetoram--5.0 to 10.0 fl oz/A Radiant SC
spinosad--3.0 to 6.0 fl oz/A Entrust SC **OMRI-listed**
tebufenozide--6.0 to 8.0 oz/A Confirm 2F
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx **(Not recommended for DBM or BAW)**
zeta-cypermethrin +bifenthrin--4.0 to 10.3 fl oz/A Hero EC **(Not recommended for DBM or BAW)**

## Flea Beetles

Treat for flea beetles if population reaches 1 beetle per transplant or 5 beetle per 10 plants during cotyledon stage. Apply one of the following formulations:
beta-cyfluthrin--2.4 to 3.2 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A A Bifenture 2EC
carbaryl--0.5 to 1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC, **foliar** 3.0 to 4.0 fl oz/A Belay 2.13SC
cyantranilaprole--**soil** 6.75 to 13.5 fl oz/A Verimark
cyfluthrin--2.4 to 3.2 fl oz/A Tombstone
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
esfenvalerate--5.8 to 9.6 fl oz/A Asana XL
gamma-cyhalothrin--2.56 to 3.84 fl oz/A Proaxis
imidacloprid-- **foliar** 1.3 fl oz/A Admire PRO
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--1.28 to 1.92 fl oz/A Warrior II or 2.56 to 3.84 fl oz/A Lambda-Cy (or other labeled mixtures containing lambda-cyhalothrin, like Voliam Xpress or Endigo ZC
thiamethoxam--1.5 to 3.0 oz/A Actara 25WDG (or other labeled mixtures containing thiamethoxam, like Durivo(soil) or Voliam Flexi(foliar))
zeta-cypermethrin--2.24 to 4.00 fl oz/A Mustang Maxx
zeta-cypermethrin +bifenthrin--4.0 to 10.3 fl oz/A HeroEC

## Harlequin Bugs

Apply one of the following formulations:
beta-cyfluthrin--3.2 fl oz/A Baythroid XL
bifenthrin--6.4 fl oz/A A Bifenture 2EC
carbaryl--1.0 qt/A Sevin XLR Plus (or OLF)
clothianidin--**soil** 12.0 fl oz/A Belay 2.13SC, **foliar** 4.0 fl oz/A Belay 2.13SC
cyfluthrin--3.2 fl oz/A Tombstone
dinotefuran--**soil** 10.5 fl oz/A Scorpion 35SL; or 6.0 oz/A Venom 70SG; **foliar** 7.0 fl oz/A Scorpion 35SL or 4.0 oz/A Venom 70SG
gamma-cyhalothrin--3.84 fl oz/A Proaxis
imidacloprid--**foliar** 1.3 fl oz/A Admire PRO
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
lambda-cyhalothrin--1.92 fl oz/A Warrior II or 3.84 fl oz/A Lambda-Cy (or other labelled mixtures containing lambda-cyhalothrin, like Voliam Xpress or Endigo ZC
zeta-cypermethrin--4.00 fl oz/A Mustang Maxx
zeta-cypermethrin +bifenthrin--10.3 fl oz/A Hero EC

## Thrips

Apply one of the following formulations:
acetamiprid--4.0 oz/A Assail 30SG (or OLF)
beta-cyfluthrin--0.8 to 1.6 fl oz/A Baythroid XL
bifenthrin--2.1 to 6.4 fl oz/A Bifenture 2EC
bifenthrin + imidacloprid--3.8 to 6.1 fl oz/A Brigadier
clothianidin--**soil** 9.0 to 12.0 fl oz/A Belay 2.13SC
cyfluthrin--0.8 to 1.6 fl oz/A Tombstone
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro **foliar** 1.3 fl oz/A Admire PRO
imidacloprid+beta-cyfluthrin--3.0 fl oz/A Leverage 360
spinetoram--6.0 to 10.0 fl oz/A Radiant SC
spinosad--4.0 to 10.0 fl oz/A Entrust SC **(OMRI listed)**
spirotetramat--4.0 to 5.0 fl oz/A Movento
thiamethoxam--5.5 oz/A Actara 25WDG (or other labeled mixtures containing thiamethoxam, like Endigo ZC, Durivo (soil) or Voliam Flexi (foliar))
zeta-cypermethrin--3.2 to 4.0 fl oz/A Mustang Maxx
zeta-cypermethrin + bifenthrin--10.3 fl oz/A Hero EC

## Whiteflies

acetamiprid--2.5 to 4.0 fl oz/A Assail 30SG (or OLF)
buprofezin--9.0 to 13.6 fl oz/A Courier (or other labeled mixtures containing buprofezin, like Vetica)
cyantranilaprole--**soil** 10.0 to 13.0 fl oz/A Verimark, **foliar** 4.0 to7.0 fl oz/A Exirel
dinotefuran--**soil** 9.0 to 10.5 fl oz/A Scorpion 35SL; or 5.0 to 6.0 oz/A Venom 70SG; **foliar** 2.0 to 7.0 fl oz/A Scorpion 35SL or 1.0 to 4.0 oz/A Venom 70SG
imidacloprid--**soil** 4.4 to 10.5 fl oz/A Admire Pro , **foliar** 1.3 fl oz/A Admire PRO (or other labeled mixtures containing imidacloprid, like Brigadier)
flupyradifurone--10.5 to 14.0 fl oz/A Sivanto 200 SL
novaluron--12.0 fl oz/A Rimon 0.83 EC
pymetrozine--2.75 oz/A Fulfill 50W
pyriproxyfen--8.0-10.0 fl oz/A Knack
spirotetramat--4.0 to 5.0 fl oz/A Movento
thiamethoxam--3.0 to 5.5 oz/A Actara 25WDG (or other labeled mixtures containing thiamethoxam, like Durivo(soil) or Voliam Flexi (foliar)

## Nematode Control

See Chapter E "Nematodes" section of Soil Pests-Their Detection and Control.

## Disease Control

### Seed Treatment

Check with your seed company to determine if seed is hot water-treated for blackrot. Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kills pathogens on the surface of the seed coat. Plant treated and/or certified seed. If you are unsure whether your seeds have been treated, consult a qualified seed testing service such as STA Laboratories (www.eurofinsus.com/stalabs/). Hot water treatment is worth considering for non-treated seed that could be contaminated. Proper heat-treatment kills pathogens inside seed as well as on the surface. This treatment may reduce germination and vigor when done incorrectly, and may not eradicate the pathogen from heavily infested lots. It is especially important to follow treatment protocols precisely when treating brassica seed as they can split; therefore also treat immediately prior to planting or have done by seed company. Two baths are required; one for pre-heating the seeds, and a second for heat-killing pathogens on and in the seeds. The initial pre-heat cycle is for 10 minutes at 100°F (36.8°C) followed by the effective temperature at 122°F (50°C). Use a 20 minute soak for broccoli, cauliflower, collards, kale, and Chinese cabbage. Soak brussels sprouts and cabbage for 25 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Pelleted seeds are not recommended for heat treatment. Heat treat only seed that will be used immediately.

An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes and rinse for 5 minutes in running water at room temperature.

Following either treatment above, dry the seed, then dust with captan 50WP or thiram 480DP at 1 level teaspoon per pound of seed (3 oz/100 lb).

### Damping-Off

Use the following as a banded application after seeding. See label for banded rates based on row spacing. Apply one of the following in a band up to 7 inches wide:

azoxystrobin--0.4 to 0.8 fl oz 2.08F/1000 row ft or OLF
mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A)
metalaxyl (MetaStar--See label 2E AG/A)
mefenoxam (Ridomil Gold--1.0 to 2.0 pt 4SL/A) *plus* azoxystrobin--0.4 to 0.8 fl oz 2.08F/1000 row ft or OLF
Uniform--0.34 fl oz 3.66SE/1000 row ft (Collards and Kale only)

### Black Rot and Blackleg

Use resistant varieties and hot water seed treatment. Select field not previously planted to crucifers for seedbeds. (See the "Disease Control in Plantbeds" section.) Rotate to allow 2 years between cole crop plantings for black rot control and 4 years between cole crop plantings for blackleg control.

For blackleg control in broccoli only, use iprodione at 2.0 lb/A or OLF immediately after thinning as a directed spray to the base of the plant and adjacent soil surface. A second application may be made up to the day of harvest.

For black rot control, fixed copper sprays (1.0 lb a.i./A) will aid in reducing spread of black rot if treatments are started when disease first becomes evident.

### Bacterial Head Rot

Bacterial head rot is a problem on broccoli. The only effective control strategy is to use tolerant varieties. Tolerant varieties to bacterial head rot have dome-shaped, tight heads with very small beads.

### Clubroot

Use of irrigation water containing spores of this fungus is the principal way the disease is spread into new fields. If clubroot occurs, clean and disinfest any equipment to be used in other fields to prevent spread. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve the drainage in the field and grow the crop on raised beds. Use Terraclor 75WP in one of the following ways. Do NOT use the Terraclor 2EC formulation.

1. Use 30.0 lb/A or 37.0 oz/1000 ft of row. Apply in a 12 to 15-inch band and incorporate 4 to 6 inches deep before planting, or
2. Use 40.0 lb/A acre broadcast and incorporate 4 to 6 inches deep before planting, or
3. Use 2.0 lb per 100 gallons of solution and 0.5 pint per plant as a transplant solution.

In addition, Ranman 3.33SC can be used as a transplant soil drench (12.9 to 25.75 fl oz/A) or incorporated into the soil (20.0 fl oz/A), please see label for additional instructions.

### Leafspots (Alternaria and Cercospora)

Use one of the following at the first sign of disease and continue every 7 to 10 days **(Refer to the pesticide table for this section to determine which fungicide is labeled for each specific cole crop. Apply one of the following formulations):**

azoxystrobin--6.0 to 15.5 fl oz 2.08F/A or OLF
Fontelis--14.0 to 30.0 fl oz 1.67SC/A
Cabrio--12.0 to 16.0 oz 20EG/A
chlorothalonil--1.5 pt 6F/A or OLF
Endura--6.0 to 9.0 oz 70WG/A
Inspire Super--16.0 to 20.0 fl oz 2.82SC/A
Priaxor--6.0 to 8.2 fl oz 4.17SC/A
Quadris Top--12.0 to 14.0 fl oz 2.72SC/A
Ridomil Gold Bravo--1.5 lb 76.5WP/A (14-day schedule)
Switch--11.0 to 14.0 oz 62.5WG/A

Materials with different modes of action (FRAC code) should be rotated.

### Downy Mildew

Presidio--3.0 to 4.0 fl oz 4SC/A
Ranman--2.75 fl oz 3.33SC/A
Revus--8.0 fl oz 2.08SC/A
Zampro--14.0 fl oz 4.38SC/A
Actigard--1.0 oz 50WG/A. (Begin applications 7-10 days after thinning and reapply every 7 days for a total of 4 applications per season),
Aliette--3.0 to 5.0 lb 80WDG/A (14-day schedule)
Cabrio--12.0 to 16.0 oz 20EG/A
chlorothalonil--1.5 pt 6F/A or OLF (See Pesticide Table at end of this section for crop use)
azoxystrobin--6.0 to 15.5 fl oz 2.08F/A or OLF

## White Mold

Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.
Contans—2.0 to 4.0 lb 5.3WG/A

Alternatively, during seasons when soils remain wet for extended periods of time apply the following preventatively:

Endura--6.0 to 9.0 oz 70WG/A (Do not make more than two applications per season.)
Fontelis--16.0 to 30.0 fl oz 1.67SC/A

## Yellows (*Fusarium*)

Use resistant varieties when possible and practice long crop rotations.

# Cole Crop Physiological Disorders

**The following are some common physiological disorders that affect these crops and their causes.**

### Bolting

Bolting in cabbage, collards and kale, and "buttoning" in cauliflower can occur if the early-planted crop is subjected to 10 or more continuous days of temperatures between 35° to 50°F (1.67° to 10°C). The degree of the temperature-induced bolting response depends upon variety.

### Tipburn of Cauliflower, Cabbage, and Brussels Sprouts

This problem can cause severe economic losses. Tipburn is a breakdown of plant tissue inside the head of cabbage, individual sprouts in Brussels sprouts, and on the inner wrapper leaves of cauliflower. It is associated with an inadequate supply of calcium in the affected leaves, causing a collapse of the tissue and death of the cells. Calcium deficiency may occur where the soil calcium is low or where there is an imbalance of nutrients in the soil along with certain weather conditions (high humidity, low soil moisture, high potash and high nitrogen aggravate calcium availability). Secondary rots caused by bacteria can follow the onset of tipburn and heads of cauliflower can be severely affected. Some cabbage and cauliflower cultivars are relatively free of tipburn problems.

### Boron Deficiencies

Cole crops have a high boron requirement. Symptoms of boron deficiency vary with crop type. Most boron deficient cole crops develop cracked and corky stems, petioles and midribs. The stems of broccoli, cabbage and cauliflower can be hollow and are sometimes discolored. Cauliflower curds become brown and leaves may roll and curl, while cabbage heads may be small and yellow.

### Hollow Stem in Broccoli and Cauliflower Not Caused by Boron Deficiency

This condition starts with gaps that develop in stem tissues. These gaps gradually enlarge to create a hollow stem. Ordinarily, there is no discoloration of the surface of these openings at harvest but both discoloration and tissue breakdown may develop soon after harvest. Some cultivars of hybrid cauliflower and broccoli may have openings from the stem into the head. Hollow stem increases with wider plant spacings and as the rate of nitrogen increases. The incidence of hollow stem can be greatly reduced by increasing the density of the plant population.

### Cabbage Splitting

Cabbage splitting is mainly a problem with early cabbage. A problem can develop when moisture stress is followed by heavy rain. The rapid growth rate associated with rain, high temperatures and high fertility cause the splitting. Proper irrigation and deep cultivation may help prevent splitting. There are significant differences between cultivars in their susceptibility to this problem.

### Cauliflower and Broccoli Premature Heading in (Buttoning)

Losses are usually most severe when transplants have gone past the juvenile stage before setting in the field. Stress factors such as low soil nitrogen, low soil moisture, disease, insects, or micronutrient deficiencies can also cause this problem. Some cultivars, particularly early ones, are more susceptible to buttoning than others.

### Lack of Heads in Broccoli and Cauliflower

During periods of extremely warm weather (days over 86°F and nights over 77°F) broccoli and cauliflower can remain vegetative due to inadequate cold exposure. This can cause a problem in scheduling the maturation and marketing dates for these crops.

### Cauliflower Blanching and Off Colors

Heads exposed to sunlight may develop a yellow and/or red to purple pigment. Certain varieties such as Snow Crown are more predisposed to purple off-colors, especially in hot weather. Self-blanching varieties have been developed to reduce problems with curd yellowing. For open headed varieties, the usual method to exclude light is to tie the outer leaves when the curd is 8 cm in diameter. Leaves may also be broken over the curd to prevent yellowing. In hot weather, blanching may take 3 to 4 days, but in cool weather, 8 to 12 days or more may be required. Cauliflower fields scheduled to mature in cool weather (September and October) that are well supplied with water and planted with "self-blanching" cultivars do not require tying. Newer orange cauliflower and green broccoflower varieties are being planted. They are less susceptible to off-colors but can still turn purple under warm conditions.

### Cauliflower Ricing

"Riciness" and "fuzziness" in heads is caused by high temperatures, exposure to direct sun, rapid growth after the head is formed, high humidity, or high nitrogen. "Ricing" is where the flower buds develop, elongate and separate, making the curd unmarketable. Proper cultivar and nutrient management can help minimize this condition.

### Development of Curd Bracts in Cauliflower

Curd bracts or small green leaves between the segments of the curd in cauliflower is caused by high temperature or drought. Heat-resistant cultivars and proper water management can help minimize this condition.

### Edema on Cole Crop Leaves

Edema is water blistering on cole crop leaves. The most common cause of edema is the presence of abundant, warm

soil water and a cool, moist atmosphere. Proper water management can help to minimize this condition.

### Black Petiole

Black petiole or black midrib is an internal disorder of cabbage that has been observed in recent years. As heads approach maturity, the under side of the internal leaf petioles or midribs turn dark gray or black at or near the point where the midrib attaches to the main stem. It is believed that this disorder is associated with a potassium (K)-phosphorus (P) imbalance. Proper nutrient management and choice of culivar will help minimize this condition.

### Floret (Bead) Yellowing in Broccoli

Yellowing florets may be due to overmaturity at harvest, high storage temperatures after harvest, and/or exposure to ethylene. Any development of yellow beads ends commercial marketability. Bead yellowing due to senescence should not be confused with the yellow to light-green color of areas of florets not exposed to light during growth, sometimes called "marginal yellowing". Proper postharvest handling and packaging will help to minimize this problem.

### Brown Floret (Bead) in Broccoli

This is a disorder in which areas of florets do not develop properly, die and lead to brown discolored areas on the broccoli head. This is thought to be caused by plant nutritional imbalances but also may be due to feeding damage on florets from insects such as harlequin bugs.

| | | | Days to Harvest[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pesticide** | **Use Category[2]** | **Hours to Reentry[3]** | **Broc-coli** | **Brus. Sprt.** | **Cab-Bage** | **Cab. (Chin.)[4]** | **Cauli-flower** | **Col-lards** | **Kale** | **Kohl-rabi** |
| **INSECTICIDE** | | | | | | | | | | |
| acephate | G | 24 | -- | 14 | -- | -- | 14 | -- | -- | -- |
| acetamiprid | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| *Bacillus thuringiensis* | G | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| beta-cyfluthrin | R | 12 | 0 | 0 | 0 | 0 | 0 | -- | -- | 0 |
| bifenthrin (soil/foliar) | R | 12 | AP/7 | AP/7 | AP/7 | AP/7 | AP/7 | AP/7 | AP/7 | AP/7 |
| bifenthrin + imidacloprid | R | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| buprofezin | G | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| carbaryl | G | 12 | 3 | 3 | 3 | -- | 3 | 14 | 14 | 3 |
| chlorantraniliprole | G | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| chlorpyrifos (Lorsban 15G) | R(NJ),G | 24 | AP | AP | AP | AP | AP | AP | AP | AP |
| (Lorsban Advanced) | R | 24/72 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| clothianidin (soil/foliar) | G | 12 | AP/ 21 | AP/ 21 | AP/ 21 | AP/21 | AP/ 21 | AP / 21 | AP/ 21 | AP/ 21 |
| cyfluthrin | R | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| cyantraniliprole (soil/foliar) | G | 4/12 | AP/1 | AP/1 | AP/1 | AP/1 | AP/1 | AP/1 | AP/1 | AP/1 |
| diazinon | R | 96 | AP | AP | AP | AP | AP | AP | AP | AP |
| dimethoate | R,G | 48 | 7 | -- | -- | -- | 7 | -- | 14 | -- |
| dinotefuran (soil/foliar) | G | 12 | 21/1 | 21/1 | 21/1 | 21/1 | 21/1 | -- | -- | 21/1 |
| emamectin benzoate | R | 12 | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 7 |
| esfenvalerate | R | 12 | 3 | -- | 3 | 3 | 3 | 7 | -- | 3 |
| fenpropathrin | R | 24 | 7 | 7 | 7 | 7 | 7 | -- | -- | 7 |
| flonicamid | G | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| flubendiamide | G | 12 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| flubendiamide + buprofezin | G | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| flupyradifurone | G | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| gamma-cyhalothrin | R | 24 | 1 | 1 | 1 | 1 | 1 | -- | -- | 1 |
| imidacloprid (soil/foiliar) | G | 12 | 21/7 | 21/7 | 21/7 | 21/7 | 21/7 | 21/7 | 21/7 | 21/7 |
| imidacloprid +beta-cyfluthrin | R | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| indoxacarb | G | 12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| lambda-cyhalothrin | R | 24 | 1 | 1 | 1 | 1 | 1 | -- | -- | 1 |
| lambda-cyhalothrin + chlorantraniliprole | R | 24 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| lambda-cyhalothrin + thiamethoxam | R | 24 | 1 | 1 | 1 | 1 | 1 | -- | -- | 1 |
| methomyl | R | 48 | 3 | 3 | 1 | 10 | 3 | 10 | 10 | -- |
| methoxyfenozide | G | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| novaluron | R | 12 | 7 | 7 | 7 | 7 | 7 | -- | -- | 7 |
| pymetrozine | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| pyriproxyfen | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| spinetoram | G | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*(table continued next page)*

| Pesticide | Use Category[2] | Hours to Reentry[3] | Days to Harvest[1] Broc-coli | Brus. Sprt. | Cab-Bage | Cab.[4] (Chin.) | Cauli-flower | Col-lards | Kale | Kohl-rabi |
|---|---|---|---|---|---|---|---|---|---|---|
| **INSECTICIDE** *(continued)* | | | | | | | | | | |
| spinosad | G | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| spirotetramat | G | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| tebufenozide | G | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| thiamethoxam | G | 12 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 7 |
| thiamethoxam+ chlorantraniliprole (foliar) | G | 12 | 3 | 3 | 3 | 3 | 3 | 7 | 7 | 3 |
| thiamethoxam+ chlorantraniliprole (soil) | G | 12 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| zeta-cypermethrin | R | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| zeta-cypermethrin+bifenthrin | R | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| **FUNGICIDE (FRAC code)** | | | | | | | | | | |
| Actigard (Group P1) | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Aliette (Group 33) | G | 12,24 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| azoxystrobin (Group 11) | G | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cabrio (Group 11) | G | 12 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 |
| chlorothalonil (Group M5) | G | 12 | 7 | 7 | 7 | 7 | 7 | -- | -- | -- |
| Contans WG (biological) | G | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| copper, fixed (Group M1) | G | see label | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Endura (Group 7) | G | 12 | 0,14[5] | 0 | 0 | 0,14[5] | 0 | 14 | 14 | 0 |
| Fontelis (Group 7) | G | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Inspire Super (Groups 3 + 9) | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| MetaStar (Group 4) | G | 48 | AP | AP | AP | AP | AP | AP | AP | AP |
| Presidio (Group 43) | G | 12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Priaxor (Groups 7+11) | G | 12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Quadris Top (Groups 3 + 11) | G | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ranman (Group 21) | G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revus (Group 40) | G | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ridomil Gold (Group 4) | G | 48 | AP | AP | AP | AP | AP | AP | AP | AP |
| Ridomil Gold Bravo (Groups 4 + M5) | G | 48 | 7 | 7 | 7 | 7 | 7 | -- | -- | -- |
| Switch (Groups 9 + 12) | G | 12 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Terraclor (Group 14) | G | 12 | AP | AP | AP | AP | AP | AP | AP | AP |
| Uniform (Groups 4 + 11) | G | 0 | AP | AP | AP | AP | AP | AP | AP | AP |
| Zampro (Groups 40 + 45) | G | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[1] AP = At-planting time only
[2] G = general, R = restricted
[3] Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.
[4] Tight-heading varieties of Chinese cabbage
[5] See label for specific recommendations
Dash (-) in table indicates pesticide is **not** labeled for that crop