Insect Management for Celery and Parsley[1]

S. E. Webb[2]

Celery and parsley (and carrots, treated in another chapter) are related crops in the family Apiaceae (Umbelliferae). Both fall in EPA Crop Group 4, Leafy vegetables. To a large degree they share insect pests and are thus treated together here. Most of the information presented refers only to celery, but pest biology and management options can, in most cases, be applied to parsley. Other related leafy vegetables, for which we do not have specific pesticide tables, include Florence fennel (finochio) and chervil. Key insect pests are described below with additional management options. Pesticides registered for use on celery and parsley are listed in two separate tables at the end of this chapter. Many other insects may occasionally attack these crops but seldom cause economic damage.

American Serpentine Leafminer (*Liriomyza trifolii*)

Description

The adult (Figure 1) is a tiny fly, less than 0.1 inches long, with yellow legs and transparent wings. The head is yellow with red eyes. The rest of the body is mostly gray and black. Eggs are tiny, and oval in shape. They are clear at first and then become creamy white. Eggs hatch into small maggots that feed inside the leaf.

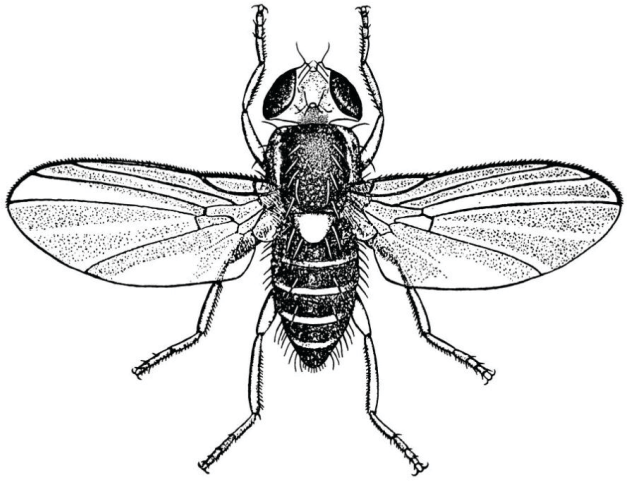

Figure 1. American serpentine leafminer adult (actual size less than 0.1 inches long).

Biology

The serpentine leafminer has historically been one of the most serious pests of celery in Florida. It also attacks parsley. Its host range is very broad, including many vegetable and floral crops and weeds.

Adult leafminers feed at flowers. In addition, adult females puncture leaves with their ovipositors (egg-laying organs) and feed on the plant juices that accumulate at the feeding puncture. Males, which only live a few days, cannot puncture the leaf, so they feed after females have left. The female

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inserts an egg between the upper and lower epidermis (leaf surface), and the larva feeds within the leaf. As the larva feeds, it moves throughout the leaf from within, creating a mine in an irregular line (serpentine mine). The mine increases in diameter as the larva grows and consumes greater amounts of leaf tissue. When fully grown, the larva cuts through the upper leaf surface and leaves the leaf to pupate, falling between the petioles or onto the soil. The larva usually exits the leaf during the morning hours and becomes a pupa by mid-afternoon. After completing the pupal stage, the leafminer emerges from the soil or plant debris as an adult. Adult females can produce 200–400 eggs in their lifetime on celery.

Although leafminers are more abundant during the middle and late part of the season, they can be a problem at any time. The time required for the leafminer to complete its development on celery in the laboratory has been shown to vary from 14 days at 95°F to 64 days at 59°F. Survival of pupae is very low at 95°, however, and reduced egg laying occurs at 59°. Optimum temperature for survival and egg production is 86°F. A complete life cycle is often completed in 21–28 days. Temperatures in southern Florida, where celery is now produced exclusively, allow leafminers to develop throughout most of the year.

Damage

Leafminer damage on celery can result in early senescence of outer petioles, longer time to maturity, and a reduction in yield, although celery plants in southern Florida have been shown to withstand substantial leafminer damage without a reduction in growth or yield. Of greater concern to celery and parsley growers is the effect of leafminer feeding on cosmetic quality. Celery plants with insect damage on more than 2 petioles receive a lower grade, according to USDA standards. Protecting celery plants from leafminer damage during the last month of the growing season has been shown to be the key to preventing cosmetic damage to celery in southern Florida.

Beet Armyworm [*Spodoptera exigua* (Hubner)]

Description and Biology

The highly mobile adult moth has dark front wings with mottled lighter markings and hind wings thinly covered with whitish scales. Adults feed on nectar and other moisture sources. Each female can lay over 600 eggs, generally in masses of 80–100 on the undersides of leaves in the lower plant canopy. Egg masses are covered with fuzzy white scales. Larvae (Figure 2) emerge from egg masses in 3 to 4 days. Very young caterpillars, which are pale with dark heads, feed in groups and then disperse as they grow older (third instar). By the third instar, the dull green caterpillars have wavy, light-colored stripes lengthwise down the back and broader stripes on each side. After feeding from one to three weeks, they construct a cocoon from sand and bits of soil and pupate in the soil, emerging as adults about one week later. Beet armyworm is a tropical insect and survives the winter in southern Florida. It can complete many generations a year there. From southern Florida, adults migrate into northern Florida and other parts of the Southeast.

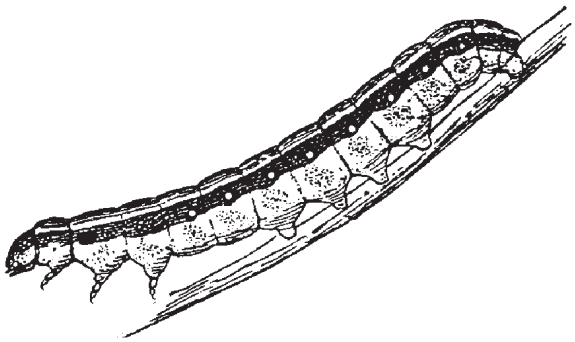

Figure 2. Beet armyworm larva.

Damage

Armyworms are the principal component of a worm complex that is one of the greatest insect problems of celery in the state. The worm complex, which also includes cutworms and occasionally cabbage loopers, among others, appears each year first in south Florida and then moves northward. The most important of the armyworms on celery and parsley is the beet armyworm, which also feeds on many cultivated and wild plants, including corn, pepper, tomato, potato, onion, pea, sunflower, citrus, soybean and tobacco, as well as plantain and lambsquarters.

Beet armyworm damages celery by feeding in and on the petioles and depositing fecal material throughout the plant, rendering it unmarketable. Older larvae feed closer to the base of the plant and are hard to reach with insecticides.

Beet armyworm populations in southern Florida are highest from late March through mid-June, with a smaller population rise from mid-August through October. The increase in the late summer and fall is thought to be related to beet armyworm activity on late summer weeds, while the population increase in the spring coincides with the leafy vegetable production season in southern Florida.

Granulate Cutworm, (*Feltia subterranea*) and Black Cutworm (*Agrotis ipsilon*)

Description

Granulate cutworm moths (Figure 3) have a wingspan of 1.2 to 1.7 inches. The front wings are often yellowish-brown and have distinct bean-shaped and round spots in the center. The hind wings are mostly white. Eggs are hemispherical and ridged. They are initially white and darken with age. Larvae (Figure 4) are grayish to reddish-brown. Each abdominal segment has a dull yellowish oblique mark. A weak gray line occurs along the length of the body with spots of white or yellow.

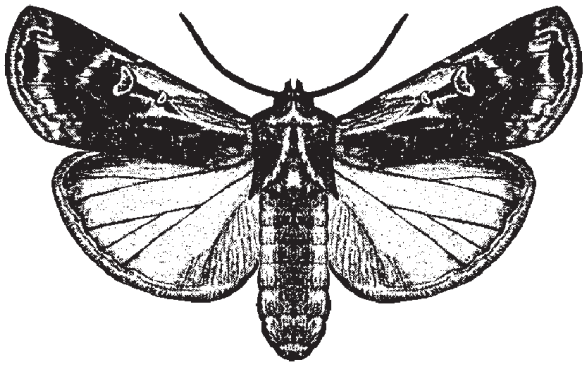

Figure 3. Granulate cutworm moth.

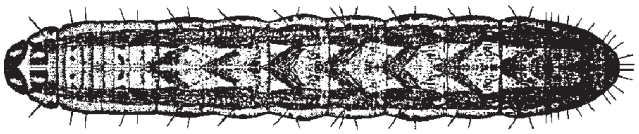

Figure 4. Granulate cutworm larva.

Black cutworm moths (Figure 5) are larger, with a wingspan of 1.5 to slightly over 2 inches. The forewings are dark brown with a lighter band near the end of each wing. The hind wings are whitish to gray. The ribbed eggs are first white, and then turn brown and are usually deposited in clusters. The larvae (Figure 6) are stout, gray caterpillars with a greasy appearance. Black cutworm larvae have numerous dark, coarse granules over most of their bodies.

Figure 5. Black cutworm moths.

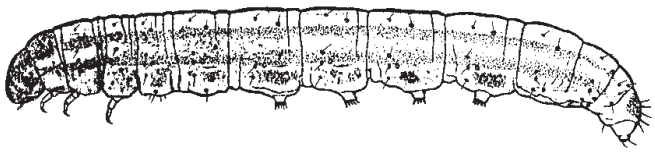

Figure 6. Black cutworm larva.

Biology

Although the black cutworm is one of the most destructive of the cutworms and attacks a wide range of plants, granulate cutworm is a greater problem on celery. Although cutworm larvae can migrate into a field from adjacent areas, most migration occurs by adults flying into the field.

Cutworm moths feed on nectar and other moisture sources. Moths begin depositing eggs on field debris, stubble or leaves near the soil surface 7 to 10 days after emergence. Black cutworm eggs are deposited singly or in groups of up to 30, and granulate cutworms eggs are deposited singly or in small clusters. Larvae emerge from eggs in 3 to 6 days. Larvae tend to curl up into a ring when disturbed or handled. They may also bite and release a greenish-brown fluid. Larvae are active at night, feeding on leaves and stems of mostly young plants. During the day, they take refuge in the soil at the base of the plants. Larvae complete development in 20 to 40 days. Larvae pupate within a chamber in the soil. Adults emerge in 10 to 20 days. Generation time for cutworms is 35 to 70 days, depending on temperature.

Damage

Cutworms are another part of the worm complex that attacks celery every year in Florida. Although the black cutworm may be present, granulate cutworm is a greater problem in Florida. These cutworms attack many field and other vegetable crops, including beans, crucifers, cucurbits, corn, cowpea, lettuce, onion, pea, pepper, potato, spinach, sweet potato, and tomato. Cutworm larvae become active in the spring. They can cut off plant stems near soil level, and they feed on the leaves, chewing into the developing petioles of celery. Older larvae (4th instar and later) can reach 2 inches in length and can cut plants off at their bases and drag them to their burrow in the soil.

Cabbage Looper (*Trichoplusia ni*)

Description

Cabbage loopers feed on a variety of crops. The adults (Figure 7) are night-flying moths with brown, mottled fore wings marked in the center with a small, silver figure eight. Their eggs are small, ridged, round, and greenish-white. The eggs hatch into larvae (Figure 8) that are green with white stripes running the length of their bodies. The caterpillar

has three pairs of slender legs near its head and then three pairs of thick prolegs near the end of its body. It moves in a characteristic looping motion, alternately stretching forward and arching its back as it brings the back prolegs close to its front legs. The caterpillar is about 1.25 inches long when fully grown.

Figure 7. Cabbage looper adult male.

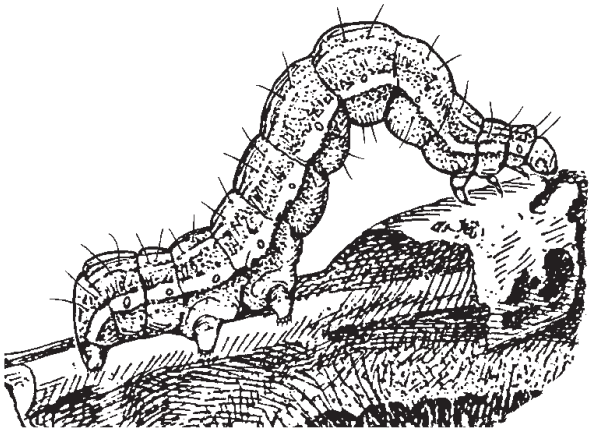

Figure 8. Cabbage looper larva.

Biology

Eggs are deposited singly or in small clusters on either leaf surface, although more are found on the lower leaf surface. Each female moth can produce 300 to 600 eggs during the approximately 10 to 12 days it is alive. Two to four weeks after hatching, the mature larva spins a thin cocoon on the lower leaf surface, or in plant debris or soil. The pupal stage lasts approximately two weeks. Total time required for development from egg to adult can be as little as 18 days at 21°C (69.8°F) and 25 days at 32°C (89.6°F).

Populations tend to be highest during the late spring and summer months, and in some years in the late fall. Cabbage looper does not enter diapause and cannot survive prolonged cold weather. The insect remains active and reproduces throughout the winter months only in the southern part of Florida (south of Orlando). In central Florida, cabbage looper populations peak during early fall and again during late spring.

Damage

The cabbage looper occasionally forms part of the worm complex on celery in Florida. It has a broad host range, including cabbage and related crucifers, lettuce, celery, parsley, tomato, potato, spinach, soybean and cotton. In southern Florida, pheromone trapping data shows adult populations to be highest during the late spring and summer months, and in some years, in the late fall.

Damage by cabbage looper larvae is similar to that caused by beet armyworm, but is not as severe. Older larvae are harder to control.

Wireworms or Click Beetles (Elateridae)

Description

The adult stage (Figure 9) of this insect is a slender, somewhat flattened, medium to dark brown or gray beetle between ½ and ⅞ in. long. Their exoskeletons are smooth or with very short hairs and they have a large tooth-like projection between the rear legs that fits into a groove on the undersurface of the abdomen. These beetles feign death when disturbed and can then right themselves from their backs by quick flexion at the juncture of the thorax and abdomen. The larvae or wireworm (Figure 10) has a narrow, hardened, creamy yellow to orange-brown, tubular body. Characteristic hardened projections on the next to last abdominal segment can be used to identify them to species. They have three pairs of short true legs and no prolegs and can reach 1 ¼ in. long. Pupae are naked with legs, antennae and wing buds completely visible.

Biology

Depending on species and soil temperature, wireworm larvae can take from 1 to 5 years to develop. Corn wireworm (*Melanotus communis*), common in Florida, may complete its development in 2 to 3 years in south Florida. Most flight activity occurs in May and June. Females lay eggs in cracks or crevices or burrow into the soil. Larvae tend to move deeper as soil temperatures become hotter and move closer to the soil surface when it is cooler. If temperatures drop further, larvae will again move deeper into the soil. Other wireworms found in Florida (*Conoderus* spp.) can complete their development in a year or less, resulting in up to three generations per year in south Florida. These species tend to stay close to the soil surface.

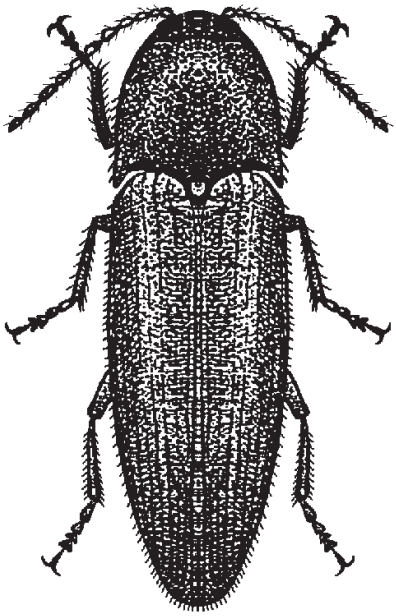

Figure 9. Click beetle (adult).

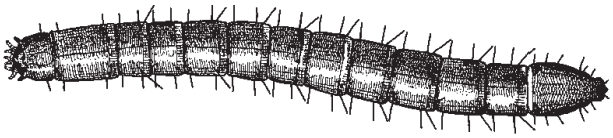

Figure 10. Corn wireworm larva.

Damage

Larvae attack seeds, roots and crowns of plants below the soil surface. They chew into the base of plants and then hollow out the stem, eliminating the growing points. Young plants first exhibit severe wilting and desiccation of the youngest leaves. Plant death and stand loss quickly follow after plants begin to wilt.

Aphids

Aphids are usually minor pests on celery in Florida, but they may be of concern because of their role as virus vectors. The most important aphids on celery are the green peach aphid (*Myzus persicae*) and the melon aphid (*Aphis gossypii*). Green peach aphid is the primary aphid attacking parsley. The green citrus aphid (*Aphis spiraecola*) may also colonize celery in Florida. An aphid pest newly introduced to Florida, *Hyadaphis coriandri*, may colonize celery and parsley. Primarily a pest of coriander and other umbelliferous herbs, it has the potential to become a serious pest if it becomes established in crop areas.

Description

Adults are soft-bodied, pear- or spindle-shaped insects with a posterior pair of tubes (cornicles or siphunculi), which project upward and backward from the upper surface of the abdomen and which are used for excreting a defensive fluid. Aphids have needle-like piercing-sucking mouthparts. Immature aphids or nymphs are smaller but otherwise similar in appearance to wingless adults. Green peach aphid adults (Figure 11) vary from 0.04 to 0.08 inches in length and are light green to yellow to pink and pear-shaped. The tubercles (bumps between antennae) point inward and are a distinguishing characteristic. Winged forms have a black patch on the back of the abdomen.

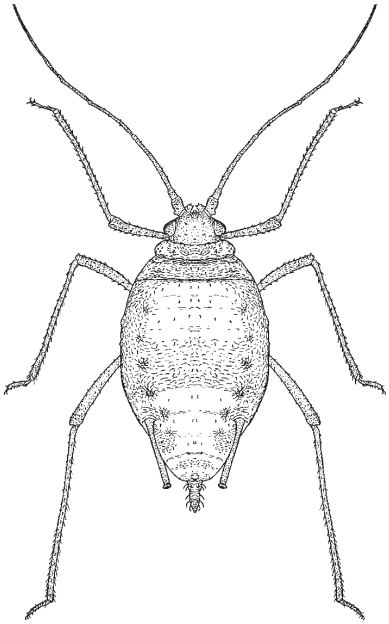

Figure 11. Green peach aphid.

Melon aphids (Figure 12) are almost egg-shaped when viewed from above. The largest ones are not much longer than one-sixteenth of an inch in length. Their color can vary from pale yellow to orange to dark green to almost black. The cornicles are dark and the cauda (a small tail-like structure) is pale or dusky.

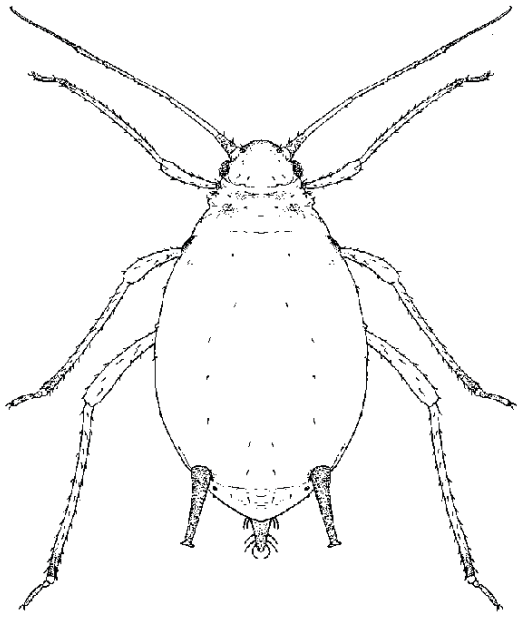

Figure 12. Melon aphid.

Biology

Aphids feed by inserting their needle-like mouthparts into plant tissue and sucking up plant juices. In addition to depleting the plant of nutrients, they can inject toxins that produce abnormal plant growth. While feeding, they also excrete large amounts of a sweet, sticky liquid called honeydew that ants are attracted to and feed on. Ants will defend aphids against predators. Sooty mold will grow on heavy deposits of honeydew.

Aphids reproduce rapidly, giving birth to nymphs rather than laying eggs. The newborn nymphs begin feeding immediately. The nymphs pass through several instars before molting into adults in 7 to 10 days. As a result of this rapid reproduction, aphid populations can increase dramatically. When aphids become crowded or if their host plant deteriorates, winged aphids develop and fly to new plants.

Damage

The green peach aphid (*Myzus persicae*), in addition to feeding on celery, also colonizes a wide range of plants, including cabbage and related crucifers, parsley, turnip, lettuce, chard, endive, tomato, potato, pepper, beets, spinach, and mustard greens. It is one of the most important aphid virus vectors and can transmit over 100 plant viruses, including those that affect celery in Florida (*Cucumber mosaic virus* and *Celery mosaic virus*). The green peach aphid has developed resistance to a great number of insecticides.

The melon aphid (*Aphis gossypii*) is also a vector of both celery viruses in Florida. It has a broad host range as well and can colonize beans, cowpea, citrus, cucurbits, eggplant, peppers, potato, tomato, spinach, okra, beets, cotton, and many ornamental plants, as well as having many weed hosts. Many overlapping generations occur each year.

In addition to depleting plant nutrients by their feeding, and transmitting plant viruses, aphids also contaminate plants. Contamination of fresh market celery with honeydew, cast skins, and aphids, both dead and alive, can lower the value of the crop.

Twospotted Spider Mite (*Tetranychus urticae*)

Description and Biology

Spider mites are nearly microscopic, but stippling on the upper surface of leaves and mites and webbing on the lower surface are good indicators of their presence. Eggs are whitish and spherical. The first instar is called a larva and has only 3 pairs of legs. Later stages are called nymphs and have 4 pairs of legs like the adults. Adults (Figure 13) have numerous long hairs on their legs, but only a few on their bodies. Often, the feeding female is greenish with two dark spots on her back, but color is not very reliable for identification.

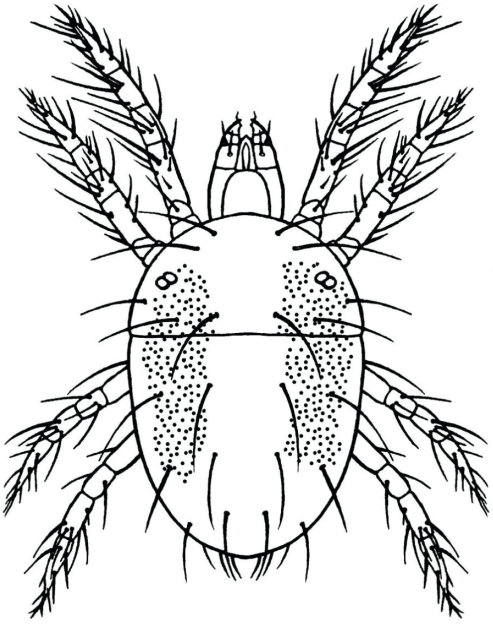

Figure 13. Twospotted spider mite (female).

Hot, dry weather speeds spider mite development, and populations may increase rapidly under optimum conditions. Each female may produce up to 19 eggs per day and a total of up to 100 eggs. The larvae hatch after 6 to 19 days and begin to feed, piercing the leaf surface (epidermis) with their long, slender mouthparts and withdrawing plant sap. Mites experience a resting period after the larval stage, then pass through two nymphal stages, with another resting period after each one. Maturity into adults may take as few as five days or as many as 20 days, depending on the temperature.

Damage

Twospotted spider mites are a minor and occasional pest of celery in Florida. They are more of a problem later in the season, when their presence on the harvested product is undesirable. Symptoms of spider mite damage begin with a bronzed appearance on leaves and include yellow and reddish-brown blotches on both leaf surfaces. Under severe infestations, paling and dropping of leaves may occur.

Table 1. Insecticides approved for managing insect pests of celery.

Labels change frequently. Be sure to read a current product label before applying any chemical. Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.						
Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code[1]**	**Notes**
Actara (thiamethoxam)	1.5–5.5 oz	12	7	aphids, flea beetles, leafhoppers, whiteflies	4A	Do not use if other 4A insecticides have been or will be used.
Admire Pro (imidacloprid)	4.4–10.5 fl oz	12	45	aphids, leafhoppers, whiteflies, foliage feeding thrips	4A	Do not apply more than 0.38 lb ai per acre per year.
Agree WG (*Bacillus thuringiensis* subspecies *aizawai*)	0.5–2.0 lb	4	0	lepidopteran larvae (caterpillar pests)	11A	Apply when larvae are small for best control. OMRI-listed[2].
***Agri-Mek SC** (abamectin)	1.75–3.5 fl oz	12	7	*Liriomyza* leafminers, spider mites	6	No more than 2 sequential applications. Must be used with an adjuvant (but not binder sticker types). Not for use on leafy vegetables grown for transplant.
***Ambush 25W** (permethrin)	6.4–12.8 oz	12	1	beet armyworm, cabbage looper, corn earworm, cutworms, fall armyworm, leafminers	3A	Do not apply more than 128 oz/acre per season.
Assail 30SG (acetamiprid)	2.0–4.0 oz	12	7	aphids, whiteflies	4A	Begin applications for whiteflies when first adults are noticed. Do not apply more than 5 times per season or apply more often than every 7 days.
Avaunt (indoxacarb)	3.5 oz	12	3	beet armyworm, cabbage looper,	22	Do not apply more than 14 ounces of product per acre per crop.
Aza-Direct (azadirachtin)	1–2 pts, up to 3.5 pts	4	0	aphids, beetles, caterpillars, leafhoppers, leafminers, thrips, weevils, whiteflies	un	Antifeedant, repellant, insect growth regulator. OMRI-listed[2].
Azatin XL (azadirachtin)	5–21 fl oz	4	0	aphids, beetles, caterpillars, leafhoppers, leafminers, thrips, weevils, whiteflies	un	Antifeedant, repellant, insect growth regulator.
***Baythroid XL** (beta-cyfluthrin)	0.8–3.2 fl oz	12	0	beet and southern armyworm (1st and 2nd instars), cabbage looper, corn earworm, cutworms, flea beetles, grasshoppers, potato leafhopper, saltmarsh caterpillar, thrips, vegetable weevil, yellowstriped armyworm, suppression of adult whitefly	3A	Maximum of 12.8 fl oz per acre per season.

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Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code[1]**	**Notes**
Belay Insecticide (clothianidin)	3–4 fl oz	12	7	aphids, flea beetles, leafhoppers, whiteflies (suppression)	4A	Regardless of application method, do not apply more than 0.2 lb ai/acre per year (12 fl oz). Do not apply at intervals of less than 10 days. Highly toxic to bees--do not allow drift to flowering weeds or nearby crops in bloom.
Belay Insecticide (clothianidin)	9–12 fl oz (soil application)	12	21	aphids, flea beetles, leafhoppers, leafminers (suppression), earwigs, crickets, grasshoppers, whiteflies (suppression)	4A	See label for application methods. Regardless of application method, do not apply more than 0.2 lb ai/acre per year (12 fl oz).
Belay 50 WDG (clothianidin)	1.6–2.1 oz	12	7	aphids, flea beetles, suppression of leafminers and whiteflies	4A	Do not apply more than 6.4 oz per acre per season. Do not use an adjuvant. Toxic to bees. Do not allow drift to flowering weeds or nearby crops in bloom.
Belay 50 WDG (clothianidin)	4.8–6.4 oz (soil application)	12	Apply at planting	aphids, flea beetles, leafhoppers, leafminers (suppression), whiteflies (suppression)	4A	Do not apply more than 6.4 oz per acre per season. See label for application instructions.
Beleaf 50 SG (flonicamid)	2.0–2.8 oz	12	0	aphids, plant bugs	9C	Do not apply more than 8.4 oz/acre per season. Begin applications before pests reach damaging levels.
Belt SC (flubendiamide)	1.5 fl oz	12	1	armyworms, corn earworm, green cloverworm, loopers, saltmarsh caterpillar, tobacco budworm	28	Do not apply more than 4.5 fl oz/acre per season.
Biobit HP (*Bacillus thuringiensis* subspecies *kurstaki*)	0.5–2.0 lb	4	0	caterpillars (will not control large armyworms)	11A	Treat when larvae are young. Good coverage is essential. Can be used in the greenhouse. OMRI-listed[2].
BotaniGard 22 WP, ES (*Beauveria bassiana*)	0.5–2 qt/100 gal	4	0	aphids, thrips, whiteflies	--	May be used in greenhouses. Contact dealer for recommendations if an adjuvant must be used. Not compatible in tank mix with most fungicides.
Closer SC (sulfoxaflor)	1.5–5.75 fl oz	12	3	aphids, silverleaf or sweetpotato whitefly	4C	Do not make more than 2 consecutive or 4 total applications per crop.
Coragen (rynaxypyr)	3.5–7.5 fl oz	4	1	beet armyworm, cabbage looper, corn earworm, leafminers, suppression of whitefly nymphs	28	May be applied via drip chemigation in addition to foliar and various soil application methods.
Courier 40SC (buprofezin)	9.0–13.6 fl oz	12	7	leafhoppers, planthoppers, whiteflies	16	Do not make more than 2 applications per crop cycle. IGR targets immatures.

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Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code[1]**	**Notes**
Crymax WDG (*Bacillus thuringiensis* subspecies *kurstaki*)	0.5–2.0 lb	4	0	caterpillars	11A	Use high rate for armyworms. Treat when larvae are young.
Deliver (*Bacillus thuringiensis* subspecies *kurstaki*)	0.25–1.5 lb	4	0	caterpillars	11A	Use higher rates for armyworms. OMRI-listed[2].
Dimethoate 4EC (dimethoate)	1 pt	48	7	leafminers	1B	Do not apply more than 3 pt per acre per year.
DiPel DF (*Bacillus thuringiensis* subspecies *kurstaki*)	0.5–2.0 lb	4	0	caterpillars	11A	Treat when larvae are young. Good coverage is essential. See label for rates for specific pests. For organic production.
Durivo (thiamethoxam, chlorantraniliprole)	10.0–13.0 fl oz	12	30	aphids, beet armyworm, cabbage looper, corn earworm, fall armyworm, flea beetles, leafhoppers, whiteflies	4A, 28	Do not exceed more than 13 fl oz per acre per season.
Entrust SC (spinosad)	1.5–10.0 fl oz	4	1	armyworms, cabbage looper, leafminers, thrips	5	See label for resistance management recommendations. Apply no more than 29 oz per acre per year. OMRI-listed[2].
Exirel (cyazypyr)	7.0–20.5 fl oz	12	1	beet armyworm, cabbage looper, corn earworm, cutworms, diamondback moth, fall armyworm, green peach aphid, leafminers, whitefly	28	Do not apply more than 0.4 lb ai of cya- zypyr or cyantraniliprole-containing prod- ucts (such as Verimark) per crop whether applications are made to soil or foliage.
Extinguish ((S)-methoprene)	1–1.5 lb	4	0	fire ants	7A	Slow-acting IGR (insect growth regulator). Best applied early spring and fall where crop will be grown. Colonies will be reduced after three weeks and eliminated after 8 to 10 weeks. May be applied by ground equipment or aerially.
Grandevo *Chromobacterium subtsugae* strain PRAA4-1	1–3 lb	4	0	aphids, armyworm, cabbage looper, cutworms, diamondback moth, green cloverworm, mites, tobacco budworm, thrips, whiteflies	_	Can be used in organic production. OMRI-listed[2].
Fulfill (pymetrozine)	2.75 oz	12	7	aphids, suppression of whiteflies	9B	Apply when aphids first appear, before populations build to damaging levels. Two applications (maximum allowed) may be needed to control persistent aphid populations.

Labels change frequently. Be sure to read a current product label before applying any chemical. Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.						
Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code**[1]	**Notes**
Intrepid 2F (methoxyfenozide)	4–10 fl oz	4	1	armyworms, cabbage looper, webworms	18	Do not apply more than 64 fl oz per acre per season.
Javelin WG (*Bacillus thuringiensis* subspecies *kurstaki*)	0.12–1.5 lb	4	0	most caterpillars, but not Spodoptera species (armyworms)	11A	Treat when larvae are young. Thorough coverage is essential. OMRI-listed[2].
***Lannate LV, *SP** (methomyl)	**LV:** 0.75–3 pt **SP:** 0.25–1.0 lb	48	7	armyworms, aster leafhopper, beet armyworm, loopers, variegated cutworm	1A	Do not apply more than 24 pt of LV or 8 lb SP per acre per season.
***Larvin 3.2** (thiodicarb)	16–30 fl oz	48	14	armyworms, beet armyworm, cabbage looper, corn earworm, fall armyworm, southern armyworm	1A	Do not exceed 60 fluid ounces of Larvin per acre per season.
Malthion 5EC (malathion)	2.4 pt	24	7	aphids, spider mites	1B	Maximum number of applications per year is two and minimum retreatment interval is 7 days.
Malathion 8F (malathion)	1–1.5 pt	24	7	aphids, spider mites	1B	Do not apply more than twice per year.
Movento (spirotetramat)	4.0–5.0 fl oz	24	3	aphids, whiteflies	23	Do not apply more than 10 fl oz/acre/crop.
M-Pede 49% EC (Soap, insecticidal)	1–2% V/V	12	0	whiteflies	--	OMRI-listed[2].
***Mustang** (zeta-cypermethrin)	2.4–4.3 oz	12	1	corn earworm, cucumber beetles, cutworms, flea beetles, leafhoppers, saltmarsh caterpillar, tobacco budworm, aphids, whiteflies, armyworms, ground beetles, crickets, loopers, *Lygus* bugs, stink bugs, wireworm adults	3A	A maximum of 0.3 lb ai/acre per season may be applied. Do not make applications less than 7 days apart.
Neemix 4.5 EC (azadirachtin)	4–16 fl oz	12	0	aphids, armyworms, cabbage looper, cutworms, leafminers, webworms, whiteflies	un	IGR and feeding repellant. OMRI-listed[2].
Orthene 97 (acephate)	0.5–1.0 lb	24	21	cabbage looper, fall armyworm, green peach aphid	1B	Do not use more than 2 lb active ingredient per acre per season. All tops must be removed before shipment.

Labels change frequently. Be sure to read a current product label before applying any chemical. Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.						
Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code**[1]	**Notes**
Platinum 75SG (thiamethoxam)	5.0–11.0 fl oz 1.66–3.67 oz	12	30	aphids, flea beetles, leafhoppers, leafminers (suppression), whiteflies	4A	Maximum = 11 oz/acre or 3.67 oz/acre (75SG) per season. Do not use in conjunction with other 4A insecticides.
***Proclaim** (emamectin benzoate)	2.4–4.8 oz	12	7	beet armyworm, corn earworm, fall armyworm, *Liriomyza* leafminers, loopers, tobacco budworm	6	Provides suppression of leafminers. Rotate with other products with different modes of action.
PyGanic Crop Protection EC 5.0 (pyrethrins)	4.5–18 fl oz	12	0	Aphids, beetles, caterpillars, leafhoppers, leafminers, thrips, whiteflies, others	3A	Can be used in greenhouses. Thorough coverage is essential. Breaks down rapidly in sunlight. OMRI-listed[2].
Radiant SC (spinetoram)	5–10 fl oz	4	1	armyworms (not yellowstriped), cabbage looper, corn earworm, *Liriomyza* leafminer, thrips	5	Maximum of 6 applications, no more than 2 consecutive applications before rotating to another MOA.
Requiem 25EC (extract of *Chenopodium ambrosioides*)	2.0–4.0 qt	4	0	green peach aphid, suppression of *Liriomyza* leafminers, potato aphid, turnip aphid, whiteflies	un	
Scorpion 35 SL insecticide (dinotefuranl)	**Foliar:** 2–5.25 fl oz **Soil:** 9–10.5 fl oz	12	foliar - 7, soil - 21	brown stink bug, cucumber beetle, flea beetles, grasshoppers, green stink bug, harlequin bug, leafhoppers, leafminers, southern green stink bug, thrips, whiteflies, suppression of green peach aphid	4A	No more than 2 applications at highest rate per acre per season.
Sevin XLR; 4F; 80S (carbaryl)	**XLR; 4F:** 0.5–2 qt **80S:** 0.63–2.5 lb	12	14	armyworms, aster leafhopper, corn earworm, fall armyworm, flea beetles, leafhoppers, Lygus bug, spittlebugs, stink bugs, tarnished plant bug	1A	Repeat, as needed, up to 5 times, with at least 7 days between applications.

Labels change frequently. Be sure to read a current product label before applying any chemical. Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.						
Trade Name (Common Name)	**Rate (Product/acre)**	**REI (hours)**	**Days to Harvest**	**Insects**	**MOA Code**[1]	**Notes**
SunSpray 98.8%, JMS Stylet-Oil, Saf-T-side, others (Oils, insecticidal)	3–6 qt/100 gal (JMS) 1–2 gal/100 gal	4	0	aphids, beetle larvae, leafhoppers, leafminers, mites, thrips, whiteflies (pests controlled vary by product)	--	See label for cautions on tank mixes. Organic Stylet-Oil and Saf-T-Side are OMRI-listed[2].
Torac Insecticide (tolfenpyrad)	14–21 fl oz	12	1	aphids (except lettuce aphid), flea beetles, leafhoppers, thrips, supression of lepidopteran pests and whiteflies	21A	Do not apply until at least 14 days after emergence or after transplanting. Do not apply more than 42 fl oz per acre per crop cycle and apply no more than twice per crop or 4 times per year. To protect pollinators, do not allow to drift to flowering weeds or nearby crops in bloom.
Trigard (cyromazine)	2.66 oz	12	7	leafminers	17	Do not make more than six applications per crop.
Trilogy (extract of neem oil)	0.5–2.0% V/V	4	0	aphids, mites, suppression of thrips and whiteflies	un	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment. OMRI-listed[2].
Venom Insecticide (dinotefuran)	**foliar:** 1–3 oz **soil:** 5–6.0 oz	12	7	**Foliar**: brown stink bug, cucumber beetle, flea beetle, grasshopper, green stink bug, suppression of green peach aphid and potato aphid, southern green stink bug, whiteflies **Soil**: suppression of green peach aphid and potato aphid, leafhoppers, leafminers, whiteflies	4A	Do not apply more than 6 oz per acre per season (foliar) or 12 oz per acre per season (soil). Do not use both methods of application. Do not apply when bees are foraging or to blooming plants. Toxic to bees for more than 38 hours following treatment.
Verimark (cyazypyr)	5.0–13.5 fl oz	4	N/A: applied at planting	beet armyworm, corn earworm, cabbage looper, diamondback moth, green peach aphids, *Liriomyza* leafminers, whitefly	28	Do not apply more than 13.5 fl oz at planting or more than 0.4 lb ai/acre of cyantraniliprole-containing products per crop, whether applied to soil or foliage.

Labels change frequently. Be sure to read a current product label before applying any chemical.
Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.

Trade Name (Common Name)	Rate (Product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Vetica (flubendiamide and buprofezin)	12.0–17.0 fl oz	12	7	armyworms, cabbage looper, corn earworm, cutworms, green cloverworm, imported cabbageworm, leafhoppers, saltmarsh caterpillar, tobacco budworm, whitefly	28, 16	Do not apply more than three times per season or apply more than 38 fl oz per acre per season. Use high rate for leafhoppers and whitefly.
Voliam Flexi (thiamethoxam, chlorantraniliprole)	4.0–7.0 oz	12	7	aphids, beet armyworm, cabbage looper, corn earworm, fall armyworm, flea beetles, leafhoppers, southern armyworm, tobacco budworm, whiteflies	4A, 28	Do not apply more than 14 oz per acre per growing season. An adjuvant may be used when applying to celery.
***Vydate L** (oxamyl)	2–4 pt	48	21	leafminers (except *Liriomyza trifolii*)	1A	
Xentari DF (*Bacillus thuringiensis* subspecies *aizawai*)	0.5–2.0 lb	4	0	caterpillars	11A	Treat when larvae are young. Thorough coverage is essential. May be used in the greenhouse. Can be used in organic production.

[1] Mode of Action (MOA) codes for plant pest insecticides from the Insecticide Resistance Action Committee (IRAC) Mode of Action Classification v. 7.3, February 2014. Number codes (1 through 28) are used to distinguish the main insecticide mode of action groups, with additional letters for certain sub-groups within each main group. All insecticides within the same group (with same number) indicate same active ingredient or similar mode of action. This information must be considered for the insecticide resistance management decisions. un = unknown, or a mode of action that has not been classified yet.
[2] Information provided in this table applies only to Florida. Be sure to read a current product label before applying any product. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by the University of Florida Cooperative Extension Service nor discrimination against similar products or services not mentioned. OMRI listed: Listed by the Organic Materials Review Institute for use in organic production.
* Restricted use insecticide.

Table 2. Celery fungicides ordered by disease and then FRAC group according to their mode of action.

Labels change frequently. Be sure to read a current product label before applying any chemical.
Refer to Table 18.1 for biopesticide and other alternative products labeled for disease management.

Pertinent Diseases or Pathogens	Fungicide Group [1]	Chemical (active ingredients)	Max. Rate/Acre		Min. Days to		Remarks [2]
			Applic.	Season	Harvest	Reentry	
Alternaria **Botrytis**	7	Endura (boscalid)	9 oz	18 oz	0	0.5	Alternate with non-FRAC code 7 fungicide.
Sclerotinia	7	Fontelis (penthiopyrad)	24 fl oz	72 fl oz	3	0.5	Alternate with non-FRAC code 7 fungicide.
Bacterial blight	M1	(copper compounds) **Many labels available:** Badge SC, Badge X2, Basic Copper 53, COCS WDG, Champ DP, Champ WG, Champ Formula 2, Champ WP, Champion++, COC DF, COC WP, Copper Count N, Cuprofix Ultra, Cuproxat, Cuerva, Kentan DF, Kocide DF, Kocide 2000, Kocide 3000, Kocide 4.5 LF, Kop-hydroxide, Mastercop, Nordox 75 WG, NuCop 50WP, NuCop 3L, NuCop HB, NuCop DF, Stretch, Tenn-Cop 5E, Top Cop w/ Sulfur	-	-	1	Varies by product from 4 hr to 2 day	
	25	Agri-mycin 17 Bac-Master Firewall 17 WP (streptomycin)	200 ppm			0.5	See label for details. For transplant production.
Early blight (Cercospora)	M2	(sulfur) **Many labels available:** Cosavet, Crusade DF, Dusting Sulfur – IAP, Kumulus DF, Micro Sulf, Microfine Sulfur, Microthiol Disperss, Sulfur 90W, Super-Six, Top Cop w/ Sulfur	**SEE INDIVIDUAL LABLES**		1	1	Do not apply during periods of warm weather. Do not apply within 2 weeks of an oil spray.

Table 2. Celery fungicides ordered by disease and then FRAC group according to their mode of action. (continued)

Labels change frequently. Be sure to read a current product label before applying any chemical.
Refer to Table 18.1 for biopesticide and other alternative products labeled for disease management.

Pertinent Diseases or Pathogens	Fungicide Group [1]	Chemical (active ingredients)	Max. Rate/Acre		Min. Days to		Remarks [2]
			Applic.	Season	Harvest	Reentry	
	M5	(chlorothalonil) **Many labels available:** Bravo Ultrex, Bravo Weather Stik, Bravo ZN, Chloronil 720, Chlorothalonil 720 SC, Echo 720, Echo 90DF, Echo ZN, Equus 500 ZN, Equus 720SST, Equus DF, Initiate 720, Initiate ZN	**SEE INDIVIDUAL LABLES**		7	0.5	
	M5 & 33	Catamaran (chlorothalonil + phosphite)	4 pt	60 pt	7	0.5	
	7 & 11	Merivon SC (pyraclostrobin & fluxapyroxad)	11.0 fl oz	33 fl oz	1	0.5	Alternate with fungicides of dissimilar modes of action
	11	Aftershock (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Evito 480SC (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Flint (trifloxystrobin)	3 oz	12 oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Gem 500SC (trifloxystrobin)	2.9 fl oz	11.6 fl oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11 & M5	Quadris Opti (azoxystrobin + chlorothalonil)	3.7 pt	22.2 pt	7	0.5	Do not exceed 2 sequential and 6 total appl. of Quadris Opti. or rotate with non QoI fungicides.
	11 & 3	Quilt (azoxystrobin + propiconazole)	14 fl oz	56 fl oz	14	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11 & 3	Quilt XCEL (azoxystrobin + propiconazole)	14 fl oz	56 fl oz	14	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	27 & 11	Tanos (cymoxanil + famoxadone)	8 oz	72 oz	3	0.5	Do not alternate or tank mix with another FRAC group 11 fungicide.
Late blight (Septoria)	M2	(sulfur) **Many labels available:** Cosavet, Dusting Sulfur – IAP, Kumulus DF, Micro Sulf, Microfine Sulfur, Microthiol Disperss, Sulfur 90W, Super-Six, Top Cop w/ Sulfur	**SEE INDIVIDUAL LABLES**		1	1	Do not apply during periods of warm weather. Do not apply within 2 weeks of an oil spray.
	M5	(chlorothalonil) **Many labels available:** Bravo Ultrex, Bravo Weather Stik, Bravo ZN, Chloronil 720, Chlorothalonil 720 SC, Echo 720, Echo 90DF, Echo ZN, Equus 500 ZN, Equus 720SST, Equus DF, Initiate 720, Initiate ZN	**SEE INDIVIDUAL LABLES**		7	0.5	
	M5/33	Catamaran (chlorothalonil + phosphite)	4 pt	60 pt	7	0.5	
	27 & 11	Tanos (cymoxanil + famoxadone)	8 oz	72 oz	3	0.5	Do not alternate or tank mix with another FRAC group 11 fungicide.
	3	(propiconazole) **Many labels available:** Amtide Propiconazole, Bumper 41.8EC, Fitness, Propicure, Propi-Star EC, Propimax EC, Shar-Shield PPZ, Tilt 3.6E, Topaz	4 fl oz	16 fl oz	14	0.5	Do not exceed 4 total appls.

Table 2. Celery fungicides ordered by disease and then FRAC group according to their mode of action. (continued)

Labels change frequently. Be sure to read a current product label before applying any chemical.
Refer to Table 18.1 for biopesticide and other alternative products labeled for disease management.

Pertinent Diseases or Pathogens	Fungicide Group [1]	Chemical (active ingredients)	Max. Rate/Acre		Min. Days to		Remarks [2]
			Applic.	Season	Harvest	Reentry	
	7	Fontelis (penthiopyrad)	24 fl oz	72 fl oz	3	0.5	Alternate with non-FRAC code 7 fungicide. See label for directions.
	7 & 11	Merivon SC (pyraclostrobin & fluxapyroxad)	11.0 fl oz	33 fl oz	1	0.5	Alternate with fungicides of dissimilar modes of action
	11	Aftershock (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Evito 480SC (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Reason (fenamidone)	8.2 fl oz	24.6 fl oz	2	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Flint (trifloxystrobin)	3 oz	12 oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Gem 500SC (trifloxystrobin)	2.9 fl oz	11.6 fl oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11 & M5	Quadris Opti (azoxystrobin + chlorothalonil)	3.7 pt	22.2 pt	7	0.5	Do not exceed 2 sequential and 6 total appl. of Quadris Opti. or rotate with non QoI fungicides.
	11 & 3	Quilt (azoxystrobin + propiconazole)	14 fl oz	56 fl oz	14	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11 & 3	Quilt XCEL (azoxystrobin + propiconazole)	14 fl oz	56 fl oz	14	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
Pink rot (Sclerotinia)	14	Botran 75W (dichloran)	2 lb	5.33 lb	7	0.5	Direct spray to base of plant.
Powdery mildew	M2	(sulfur) **Many labels available:** Cosavet, Crusade DF, Dusting Sulfur – IAP, Kumulus DF, Micro Sulf, Microfine Sulfur, Microthiol Disperss, Sulfur 90W, Super-Six, Top Cop w/ Sulfur	**SEE INDIVIDUAL LABLES**		1	1	Do not apply during periods of warm weather. Do not apply within 2 weeks of an oil spray.
Pythium	33	Aliette WDG	5 lb	20 lb		0.5	
		Legion 80WDG	5 lb	20 lb		0.5	
		Linebacker WDG (fosetyl-Al)	5 lb	20 lb		0.5	
Pythium seedling blight	4	Apron XL LS (mefenoxam)	0.64 fl. oz./ 100 lb seed			2	Seed treatment only.
	4	Metastar 2E AG (metalaxyl)	8 pt			2	Apply as a broadcast soil application and incorporate into top 2 inches. See label for directions.
Pythium seedling diseases	4	Ridomil Gold EC (mefenoxam)	2 pt			2	Apply at seeding in a 7-12" band on soil over seed furrow.
	4	Ridomil Gold GR (mefenoxam)	40 lb			2	See label for specifics regarding preplant incorporated applications and surface applications at the time of planting.

Table 2. Celery fungicides ordered by disease and then FRAC group according to their mode of action. (continued)

Labels change frequently. Be sure to read a current product label before applying any chemical.
Refer to Table 18.1 for biopesticide and other alternative products labeled for disease management.

Pertinent Diseases or Pathogens	Fungicide Group [1]	Chemical (active ingredients)	Max. Rate/Acre		Min. Days to		Remarks [2]
			Applic.	Season	Harvest	Reentry	
	4	Ultra Flourish (mefenoxam)	4 pt			2	See label for specifics regarding preplant incorporated applications and surface applications at the time of planting.
Stalk rot (Rhizoctonia)	M5	(chlorothalonil) **Many labels available:** Bravo Ultrex, Bravo Weather Stik, Bravo ZN, Chloronil 720, Chlorothalonil 720 SC, Echo 720, Echo 90DF, Echo ZN, Equus 500 ZN, Equus 720SST, Equus DF, Initiate 720, Initiate ZN	**SEE INDIVIDUAL LABLES**		7	0.5	
	3	(propiconazole) **Many labels available:** Amtide Propiconazole, Bumper 41.8EC, Propi-Star EC, Propimax EC, Shar-Shield PPZ, Tilt 3.6E	4 fl oz	16 fl oz	14	0.5	Do not exceed 4 total appls.
	7 & 11	Merivon SC (pyraclostrobin & fluxapyroxad)	11.0 fl oz	33 fl oz	1	0.5	Alternate with fungicides of dissimilar modes of action
	11	Aftershock (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Evito 480SC (fluoxastrobin)	5.7 fl oz	22.8 fl oz	3	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Flint (trifloxystrobin)	3 oz	12 oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11	Gem 500SC (trifloxystrobin)	2.9 fl oz	11.6 fl oz	7	0.5	Alternate every other application with a fungicide of dissimilar mode of action.
	11 & M5	Quadris Opti (azoxystrobin + chlorothalonil)	3.7 pt	22.2 pt	7	0.5	Do not exceed 2 sequential and 6 total appl. of Quadris Opti. or rotate with non QoI fungicides.
Various	7 & 11	Merivon SC (pyraclostrobin & fluxapyroxad)	11.0 fl oz	33 fl oz	1	0.5	Alternate with fungicides of dissimilar modes of action
	11	Cabrio EG (pyraclostrobin)	16oz	64 oz	0	0.5	Do not exceed 1 sequential appl. of QoI fungicides. See label for soil appl.
	11	Quadris, Satori, Willowood Azoxy (azoxystrobin)	15.4 fl oz or 0.8 fl oz/ 1000 row ft	2.88 qt	0	4 hr	Do not exceed 1 sequential appl. of QoI fungicides. See label for soil appl.
	19	OSO 5%SC (polyoxin D zinc salt)	13 fl oz	84 fl oz	0	4 hr	See label for details.
	33	(mono- and di-potassium salts of phosphorous acid) **Many brands available:** Alude, Confine Extra, Fosiphite, Fungi-phite, K-Phite, Oxiphos, Phiticide, Phostrol, Prophyt, Rampart, Reveille	3 qt		0	4 hr	See label for details.

Table 2. Celery fungicides ordered by disease and then FRAC group according to their mode of action. (continued)

Labels change frequently. Be sure to read a current product label before applying any chemical.
Refer to Table 18.1 for biopesticide and other alternative products labeled for disease management.

Pertinent Diseases or Pathogens	Fungicide Group [1]	Chemical (active ingredients)	Max. Rate/Acre		Min. Days to		Remarks [2]
			Applic.	Season	Harvest	Reentry	
Various seedling diseases	12	Maxim 4FS (fludioxonil)	0.16 fl oz/ 100 lb of seed			0.5	Seed treatment only.
	4 & 11	Uniform SC (mefenoxam + azoxystrobin)	0.34 fl oz/ 1000' of row	1 appl.		0	Soil incorporated.

[1] FRAC code (fungicide group): Number (1 through 46) and letters (U and P) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with same number or letter) indicate same active ingredient or similar mode of action. This information must be considered for the fungicide resistance management decisions. U = unknown, or a mode of action that has not been classified yet and is typically associated with another number; P = host plant defense inducers. Source: FRAC Code List 2013; http://www.frac.info/ (FRAC = Fungicide Resistance Action Committee).

[2] Information provided in this table applies only to Florida. Be sure to read a current product label before applying any chemical. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by the University of Florida Cooperative Extension Service nor discrimination against similar products or services not mentioned.