

Sandea (75) (halosulfuron) | 0.5-1.0 oz. per acre. Apply to dormant rhubarb in the spring. If weeds are present, add 0.5 pt. NIS per 25 gal. of solution (0.25% v/v). May cause crop stunting. Use low rate to determine crop safety under field conditions. Controls yellow nutsedge. Does not control grass. REI: 12-hour. PHI: 60-day. WSSA 2.

Grass Weeds Only - Postemergence

Pesticide

clethodim products (clethodim) | Use 2EC formulations at 6-8 fl. oz. per acre with 1 qt. COC per 25 gals. of spray solution (1% v/v). Do not exceed 32 fl. oz. of 2EC formulations per acre per season. Use Select Max at 9-16 fl. oz. per acre with 8 fl. oz. NIS per 25 gals. of spray solution (0.25% v/v). Do not exceed 64 fl. oz. of Select Max per acre per season. Use low rates for annual grasses and high rates for perennial grasses. Spray on actively growing grass. Wait at least 14 days between applications. REI: 24-hour. PHI: 30-day. WSSA 1.

Fusilade DX (2EC) (fluazifop-P) | 10-16 fl. oz. per acre. Add 1 qt. COC (1% v/v) or 0.5 NIS per 25 gal. of spray solution (0.25% v/v). Apply to small actively growing grass. Do not exceed 32 fl. oz. per acre per year. REI: 12-hour. PHI: 14-day. WSSA 1.

Poast (1.5EC) (sethoxydim) | 1-1.5 pts. per acre. Add 1 qt. COC per 25 gal. of spray solution (1% v/v). Spray on actively growing grass. Do not exceed 3 pt. per acre per growing season. REI: 12-hour. PHI: 15-day in Illinois, Indiana, Michigan, and Minnesota; 30-day in other states. WSSA 1.

Root Crops - Horticulture

Reviewed by Ben Phillips, Liz Maynard – Dec 2020

Crop Description

Most root crops are biennial plants that do not normally flower within a typical production season unless they are under stress. They come from a few different plant groups and species. Most are amenable to direct seeding before last frost, and some can be transplanted. Some are short season crops that offer double-cropping opportunities, while others are some of the longest season vegetable crops grown in an annual production system.

It is important to know the botanical relationships of root crops because similar pests will go to related plants. Root crops come from at least five botanical families. Within those family groups you can expect similar pests. In this guide we try to provide some precision to this. *However, when using pesticides, you must abide by the EPA Crop Groupings on pesticide labels.*

Apiaceae, the Carrot family, contains Carrots, Celeriac, and Parsnips classified as “root and tuber vegetables” in EPA Crop Group 1. But this family also includes Celery, Cilantro, Coriander, Dill, Fennel, Florence Fennel, and Parsley (EPA Crop Groups 4 and 19). The pests for plants in this family are shared with the Celery, and Leafy Vegetables and Herbs chapters.

Brassicaceae, the Mustard family, contains Horseradish, Radish, Rutabaga, and Turnip classified as “root and tuber vegetables” in EPA Crop Group 1. But, this family also includes cole crop and mustard-type plants (EPA Crop Groups 4 and 5). The pests for plants in this family are shared with the Cole Crops and Brassica Leafy Greens, and Leafy Vegetables and Herbs chapters.

Chenopodiaceae, the Goosefoot family, contains Beets classified as “root and tuber vegetables” in EPA Crop Group 1. The pests for plants in this family are shared with Spinach and Swiss chard (EPA Crop group 4) in the Leafy Greens and Herbs chapter.

Convolvulaceae, the Morningglory family, contains Sweet Potato classified as a “root and tuber vegetable” in EPA Crop Group 1. Please refer to the Sweet Potato Chapter.

Solanaceae, the Nightshade family, contains Potato classified as a “root and tuber vegetable” in EPA Crop Group 1. Please refer to the Potato Chapter.

Planting, Spacing, and Harvesting

Beet

Sugar beets, table beets, and Swiss chard are all the same species (*Beta vulgaris*) bred for different purposes. Table beets come in red, striped, white, and gold. They are typically round, but there are some longer shaped beets that are utilized for slicing and pickling. Most beet varieties are multigerm types that grow multiple plants from one seedball. There are monogerm beet varieties, such as Solo and Moneta.

Beets can be direct-seeded in rows 18 to 24 inches apart. Plant 6 to 12 seeds per foot of row, depending on sprout count and desired size. Seed 8 to 10 pounds per acre for bunching.

Mechanical harvesters are common for beets, lifting them from their tops, or digging them with an undercutting chain conveyor. Some growers choose monogerm varieties for more reliable sizing in a one-pass harvest with machines. Other growers choose multigerm varieties and hand-harvest large “bully” beets first, allowing small “runts” to size up for later harvests. Time from seeding to harvest ranges from 50 to 60 days.

Carrot and Parsnip

Carrots (*Daucus carota*) and parsnips (*Pastinaca sativa*) have similar production systems. There are five broad types of carrot varieties. Chantenay carrot types have short, girthy, sometimes globe shaped roots that do well in heavy soils. Danvers carrot types are typically diced processing carrots and are thinner, longer, and more cone shaped than Chantenays and require the longest time to maturity. Emperor carrot types are good fresh market carrots that have long and slender roots with a higher sugar content; they require loose and deep soils. Nantes carrot types are good multi-market carrots for processing and fresh market with a more cylindrical root than Danvers, but girthier than Imperators, and an earlier maturation time than Imperators or Danvers. These four types all include orange, yellow, red, purple, and white varieties. The parsnip is a white-rooted plant related to carrots. Parsnip varieties differ in their size and time to harvest, but most are shaped like Danvers carrots.

Carrots and parsnips can be direct-seeded in single rows 16 to 30 inches apart, or in three-row beds with 10 to 12 inches between rows and 36 inches between beds, center to center. Plant 20 to 30 per foot for slicing/fresh market; 10 to 20 plants per foot for dicing. Seed 2 to 4 pounds per acre.

Both mechanical and hand harvest is common and starts when roots are of suitable size for the market between August and November. Undercutting chain-conveyor harvesters are more likely to break roots than top-puller harvesters. Time from seeding to harvest ranges from 60 days for baby carrots to 120 days for parsnips and full-size Danvers type carrots. Parsnips can be harvested up to freeze-up and continued as soon as soils can be worked in the spring.

Celeriac

This type of celery (*Apium graveolens* var. *rapaceum*) has been bred as a root crop with low-growing bushy foliage and a large, bearded, globe-shaped root with a celery flavor.

Root Crops - Horticulture

Start as transplants 8 to 10 weeks before planting, and plant in early spring before last frost date.

Transplant in rows 24 to 30 inches apart with plants 6 to 8 inches apart in row. For an acre of transplanted celeriac, you will need 2 to 4 ounces of seed to start in the greenhouse.

The full flavor is only reached after first frost. Time from transplanting to harvest ranges from 80 to 90 days. From seeding in cell trays, add 20 days.

Horseradish

This perennial Brassica (*Armoracia rusticana*) is grown commercially in Illinois and Wisconsin as an annual crop from root cuttings. The roots are not eaten raw, but grated as a spice for condiments and flavoring. Type I varieties produce large smooth roots and are highly resistant to turnip mosaic virus and white rust. Type III varieties produce large roots but are highly susceptible to those two diseases. Type II varieties produce large roots with bark-like exterior, with intermediate resistance to those two diseases. Numbered commercial varieties are maintained by a small breeding effort supported directly by the largest growers of the commodity.

Plant root sets in early spring before last frost date. Sets should be 1/2 to 3/4 inches in diameter and 10 to 16 inches long. Root set ends that were closest to the plant (thicker end) and the ends that were farthest from the plant (thinner end) have to be planted thick end to thin end along the row, with the thick ends elevated about 2 inches higher than the thin end. This is accomplished by first scooping divots in rows 36 inches apart and 12 to 24 inches apart in-row. Then lay roots by hand into the divots with the thin end in the deepest part. That is roughly 10,000 sets per acre. Cover the roots with a disc-hiller to a depth of 5 to 8 inches.

Horseradish puts the most size on their roots in the late summer and fall. Mechanical harvests with an undercutting chain conveyor take place in November until freeze-up and continues as soon as soils can be worked in the spring. Time from

transplanting to harvest ranges from 200 to 250 days.

Radish, Rutabaga, and Turnip

The roots of these Brassica plants are strong to mildly-flavored and come in diverse size, colors, and shapes. For all of these crops, the flavor is sweeter or milder when roots reach marketable size in cool conditions.

Radishes (*Raphanus sativus*) come in globe-shaped bright red varieties that are the most common in United States markets, but market opportunities exist for the torpedo-shaped varieties, as well as for white, black, yellow, green, pink and deep red varieties. Most have white internal flesh, but some have pink internal flesh. Radishes become pungent during hot weather. They can be direct-seeded in single rows 16 to 30 inches apart, or in three-row beds with 10 to 12 inches between rows and 36 inches between beds, center to center. Plant 12 to 15 per foot of row. Seed 10 to 15 pounds per acre.

Rutabagas (*Brassica napus* subsp. *rapifera*) are the largest and mildest-flavored of these root crops. They are commonly white or yellow skinned with white internal flesh. Some develop a pink, purple, or green blush on the shoulders of the root when exposed to the sun. They can be direct-seeded in single rows 24 to 30 inches apart. Plant 3 to 4 seeds per foot of row. Seed 1 to 2 pounds per acre.

Turnip roots (*Brassica rapa* subsp. *rapa*) are larger than a radish, but smaller than a rutabaga, with a flavor that is an intermediate intensity between radish and rutabaga. The variety options are similar in appearance to rutabaga. They can be direct-seeded in single rows 14 to 18 inches apart. Plant 2 to 3 inches apart in row. Seed 1 to 2 pounds per acre.

Both mechanical and hand harvest is common and starts when roots are of suitable size for the market. Time from seeding to harvest ranges from 30 to 60 days for radishes and turnips, or 80 to 100 days for rutabagas.

Fertilizing

pH: Maintain a soil pH of 6.0 to 6.8. For beets, maintain a soil pH of 6.5 to 7.0.

Before planting, apply 60 pounds N per acre, 0 to 160 pounds P₂O₅ per acre, and 0 to 200 pounds K₂O per acre based on soil test results and recommendations from your state.

For beets grown on sandy soils, light-colored silt and clay loams, and alkaline, dark-colored soils apply boron at 2.5 to 5 pounds per acre applied over the row at planting. Do not let boron contact seed. Beans, peas and cucurbits are sensitive to boron so use caution if these crops will follow beets, especially in the same season.

For carrots grown on muck soil with a pH greater than 6.0, apply 6 pounds of manganese sulfate per acre applied over the row at planting, or in a starter band.

For horseradish, add 1 to 2-1/2 pounds per acre boron and 15 to 25 pounds per acre sulfur with the initial N-P-K broadcast application. An optional sidedress application of 50 to 75 lb/acre N can be made 8 to 12 weeks after planting, but overapplication of nitrogen reduces root quality.

For most other root crops, sidedress with 30 to 60 pounds N per acre 4 to 6 weeks after planting. Most radishes mature quickly and do not require sidedressing. Reduce the amount of fertilizer N applied by the value of N credits from green manures, legume crops grown in the previous year, compost and animal manures, and soils with more than 3 percent organic matter. The total amount of N from fertilizer (including starter) and other credits should be 50 (radish), 90 (turnip), 100 (beets, fresh market carrots, horseradish, parsnip, rutabaga), 120 (processing carrots), or 150 (celeriac) pounds N per acre on mineral soils, and 50 pounds less on muck soils.

Root Crops - Diseases

Reviewed by Dan Egel – Nov 2020

Recommended Controls

Aster Yellows (Purple-Top Wilt) of Multiple Crops - *Phytoplasma Mollicutes*

This pathogen is transmitted by leafhoppers. Infection rates can jump when adjacent crops are harvested mid-season, such as alfalfa or wheat.

Non-Pesticide

Beet, Carrot, Celeriac, Parsnip, Radish, Rutabaga, Turnip | Use disease-free seed. Hot water seed treatment may reduce this seedborne disease. Use temperatures and times of 122 F for 20 minutes for carrot, rutabaga and turnip, 122 F for 15 minutes for radish, or 118 F for 30 minutes for celeriac. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up. Destroying perennial weed hosts near high-value crops can reduce inoculum that is transmitted by leafhoppers.

Pesticide

Insecticides *Beet, Carrot, Celeriac, Parsnip* | Use an insecticide to control leafhoppers that transmit the disease. Leafhoppers must be controlled before they feed. See Insect section.

Brittle Root of Horseradish - *Spiroplasma Bacteria*

This pathogen is transmitted by leafhoppers. The symptoms include inward curling and yellowing of leaves, stunting of new growth, and an eventual collapse of the foliar portion of the plant. Root tissue becomes tan to black and they become easy to snap off.

Pesticide

Insecticides *Horseradish* | For **TuMV**: maintain an aphid management program. See Insects section.

For **Brittle Root**: maintain a leafhopper management program. See Insects section.

Cavity Spot of Carrots - *Pythium* Oomycete

Cavity spot can affect root quality and yield.

Pesticide

Presidio (4SC) (fluopicolide) *Carrot* | 4 fl. oz. per acre. Labeled for in-furrow applications. Use 5-10 gallons of water per acre. REI: 12-hour. PHI: 7-day FRAC 43.

Ranman 400SC (34.5) (cyazofamid) *Carrot* | 6 fl. oz. per acre. REI: 12-hour. PHI: 14-day. FRAC 21.

Reason 500SC (4.13) (fenamidone) *Carrot* | 8.2 fl. oz. per acre. REI: 12-hour. PHI: 14-day. FRAC 11.

Ridomil Gold Bravo SC (mefenoxam, chlorothalonil) *Carrot* | 1.5-2.5 pts. per acre. REI: 48-hour. PHI: 7-day. FRAC 4, FRAC M5.

Ridomil Gold SL (4SC) (mefenoxam) *Carrot* | 0.25-1.0 pt. per acre Begin applications 28 days after planting as broadcast sprays, or 40 days after planting for banded sprays. Do not exceed 2.8 pts. per acre per season. REI: 48-hour. PHI: 7-day. FRAC 4.

Damping-Off Seed and Seedling Rots of Multiple Crops - Multiple Pathogens

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Avoid excess moisture to young plants by monitoring irrigation frequency. Plant in warm field soils. The fungi responsible for

damping-off in field soils cause more loss when the seedling is slow to emerge.

Pesticide

azoxystrobin products (azoxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2 lb. a.i. per gallon formulations (Quadris) at 0.4-0.8 fl. oz. per 1,000 row feet. Use 3.3 lb. per gallon formulations (Azteroid) at 0.24-0.48 fl. oz. per 1,000 row feet. Use 0.83 lb. per gallon formulations (Dynasty) for treating seed at 0.10-0.38 fl. oz. per 100 lbs. of seed. REI: 4-hour. PHI: 0-day. FRAC 11.

Presidio (4SC) (fluopicolide) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 3-4 fl. oz. per acre. Pythium damping-off only. REI: 12-hour. PHI: 7-day. FRAC 43.

Reason 500SC (4.13) (fenamidone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 8.2 fl. oz. per acre. Pythium damping-off only. REI: 12-hour. PHI: 14-day. FRAC 11.

Uniform (L) (mefenoxam, azoxystrobin) *Beet, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.34 fl. oz. per acre per 1,000 ft. of row. Make one application per crop season. For damping-off caused by *Pythium* or *Rhizoctonia* spp. REI: 0-hour. PHI: NA FRAC 4, FRAC 11.

Internal Root Discoloration of Horseradish - *Fusarium* and *Verticillium* Fungi

This long-lived complex of soil pathogens reduce marketability by discoloring roots to a black color.

Non-Pesticide

Horseradish | Use disease-free root stocks generated from tissue-culture. Hot water seed treatment may reduce this disease in root clones. Use temperatures and times of 115 F for 10

minutes. Control volunteer horseradish in rotation years.

Leaf Blight of Carrots - *Xanthomonas* Bacteria

Copper products that are labeled for *Cercospora* may be helpful; however, bacteria may become resistant to copper products. Early bacterial leaf blight symptoms may mimic *Alternaria* leaf spot.

Bacteria may occur on seed and can survive on carrot debris in soil. Bacteria spread within a field by rain or overhead irrigation. Under dry conditions, low levels of bacterial leaf blight may not result in significant crop loss. Under hot and wet conditions, high levels of bacterial blight may develop and lead to premature defoliation and an inability to harvest the roots via a mechanical harvester.

Non-Pesticide

Carrot | Use disease-free seed. Hot water seed treatment may reduce this seedborne disease. Use temperatures and times of 122 F for 20 minutes for carrot. Rotate to non-host crops for 2 years. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up.

Pesticide

copper products (copper hydroxide, copper octanoate, copper oxychloride, copper sulfate, copper diammonium diacetate complex, cuprous oxide) *Carrot* | Several formulations of copper (Badge, Champ, Kocide) products are labeled for use and may slow the spread of bacterial blight. See label for directions. REI: 4 to 48-hour. PHI: 0-day. FRAC M1.

Leaf Blight of Root Crops - *Alternaria* Fungus

Scout fields to initiate a spray program when foliar blights are first detected (trace of disease). TOM-

CAST with 15 disease severity values (DSVs) can help carrot farmers time their fungicide applications for control of foliar blights. See Disease Forecasting Systems for details. *Cercospora* leaf spot is sometimes known as early blight. *Alternaria* leaf blight is sometimes known as late blight.

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Use disease-free seed. Hot water seed treatment may reduce this seedborne disease. Use temperatures and times of 122 F for 20 minutes for carrot, rutabaga and turnip, 122 F for 15 minutes for radish, or 118 F for 30 minutes for celeriac. Rotate to non-host crops for 2 years. Varieties with partial resistance are available. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up.

Pesticide

azoxystrobin products (azoxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2 lb. a.i. per gallon formulations (Quadris) at 6.0-20.0 fl. oz. per acre. Use 3.3 lb. per gallon formulations (Azteroid) at 3.9-12.8 fl. oz. per acre. REI: 4-hour. PHI: 0-day. FRAC 11.

Cabrio EG (20) (pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 8-12 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 11.

chlorothalonil products (chlorothalonil) *Carrot, Horseradish, Parsnip* | Several formulations of chlorothalonil (Bravo, Echo, Equus) are labeled at various rates and crops. See label for directions. REI: 12-hour. PHI: 0-day for carrot; 10-day for parsnip; 14-day for horseradish. FRAC M5.

Endura (WG) (boscalid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 4.5 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7.

Root Crops - Diseases

Flint Extra (4.05) (trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Rutabaga, Turnip* | 2.0-2.9 oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11.

Fontelis (1.67SC) (penthioopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7.

iprodione products (iprodione) *Carrot* | 1-2 pts per acre. Formulations of iprodione include Nevado and Rovral. REI: 24-hour. PHI: 0-day. FRAC 2.

Luna Sensation (fluopyram, trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 4.0-7.6 fl. oz per acre. High rate only allowed on carrots. REI: 12-hour. PHI: 7-day. FRAC 7, FRAC 11.

Luna Tranquility (SC) (fluopyram, pyrimethanil) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 8-11.2 fl. oz. per acre. REI: 12-hour. PHI: 7-day FRAC 7, FRAC 9.

Merivon (fluxapyroxad, pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 4.0-5.5 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 7, FRAC 11.

Omega 500F (4.17) (fluazinam) *Carrot* | 16 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 29.

Pristine 38WG (boscalid, pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 8.0-10.5 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7, FRAC 11.

propiconazole products (propiconazole) *Carrot* | 4 fl. oz. per acre. PropiMax EC and Tilt are labeled. REI: 12-hour. PHI: 14-day. FRAC 3.

Quadris Opti (SC) (azoxystrobin, chlorothalonil) *Carrot* | 2.4 pts. per acre. REI: 12-hour. PHI: 0-day. FRAC 11, FRAC M5.

Quadris Top (SC) (azoxystrobin, difenoconazole) *Carrot* | 12-14 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11, FRAC 3.

Quilt (SE) (azoxystrobin, propiconazole) *Carrot* | 14 oz. per acre. Late blight suppression only. REI: 12-hour. PHI: 14-day. FRAC 11, FRAC 3.

Switch 62.5WG (cyprodinil, fludioxonil) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 11-14 oz. per acre. Do not exceed 2 applications to radish. REI: 12-hour. PHI: 7-day. FRAC 9, FRAC 12.

Leaf Spot of Root Crops - Cercospora Fungus

Scout fields to initiate a spray program when foliar blights are first detected (trace of disease). TOM-CAST with 15 disease severity values (DSVs) can help carrot farmers time their fungicide applications for control of foliar blights. See Disease Forecasting Systems for details. Cercospora leaf spot is sometimes known as early blight. Alternaria leaf blight is sometimes known as late blight.

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Use disease-free seed. Hot water seed treatment may reduce this seedborne disease. Use temperatures and times of 122 F for 20 minutes for carrot, rutabaga and turnip, 122 F for 15 minutes for radish, or 118 F for 30 minutes for celeriac. Rotate to non-host crops for 2 years. Varieties with partial resistance are available. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up.

Pesticide

azoxystrobin products (azoxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2 lb. a.i. per gallon formulations (Quadris) at 6.0-20.0 fl. oz. per acre.

Use 3.3 lb. per gallon formulations (Azteroid) at 3.9-12.8 fl. oz. per acre. REI: 4-hour. PHI: 0-day. FRAC 11.

Cabrio EG (20) (pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 8-12 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 11.

chlorothalonil products (chlorothalonil) *Carrot, Horseradish, Parsnip* | Several formulations of chlorothalonil (Bravo, Echo, Equus) are labeled at various rates and crops. See label for directions. REI: 12-hour. PHI: 0-day for carrot; 10-day for parsnip; 14-day for horseradish. FRAC M5.

copper products (copper hydroxide, copper octanoate, copper oxychloride, copper sulfate, copper diammonium diacetate complex, cuprous oxide) *Beet, Carrot, Celeriac* | Several formulations of copper (Badge, Champ, Kocide) products are labelled for use and may slow the spread of *Cercospora*. See label for directions. REI: 4 to 48-hour. PHI: 0-day. FRAC M1.

Flint Extra (4.05) (trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Rutabaga, Turnip* | 2.0-2.9 oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11.

Fontelis (1.67SC) (penthioopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7.

Merivon (fluxapyroxad, pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 5.5 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 7, FRAC 11.

Quadris Opti (SC) (azoxystrobin, chlorothalonil) *Carrot* | 2.4 pts. per acre. REI: 12-hour. PHI: 0-day. FRAC 11, FRAC M5.

Quadris Top (SC) (azoxystrobin, difenoconazole) *Carrot* | 12-14 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11, FRAC 3.

Quilt (SE) (azoxystrobin, propiconazole) *Carrot* | 14 oz. per acre. Late blight suppression only. REI: 12-hour. PHI: 14-day. FRAC 11, FRAC 3.

tebuconazole products (tebuconazole) *Beet* | 3.0-7.2 fl. oz. per acre. There are many brand names (Monsoon, Onset, Vibe) with 3.6 lbs. a.i. per gallon that use the same rate. REI: 12-hour to 18-day. PHI: 7-day. FRAC 3.

Nematodes

Northern root knot nematode (NRKN) has a wide host range, including most broadleaf crops and weeds, but seem to have a disproportionate effect on carrots resulting in large yield losses if uncontrolled. Carrot cyst nematodes (CCN) are also found throughout the region and only feed on carrots. Sugar Beet Cyst Nematode (SBCN) will infect beets, radishes, rutabagas, and turnips.

Non-Pesticide

Beet, Carrot, Horseradish, Radish, Rutabaga, Turnip | Collect soil samples for nematodes in the fall and avoid fields with high numbers. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue and displace nematodes is an important method to prevent nematode build-up. Anaerobic soil disinfestation (ASD) is an effective sterilization method for greenhouse and high tunnel soils that contain nematodes. For **NRKN**: rotate to a non-broadleaf crop, such as grass grains or sweet corn for >3 years. For **SBCN**: a late-summer, or early-fall cover crop of 'Defender', 'Concorde', or 'Control' radishes are effective trap crops for SBCN.

Pesticide

Sectagon K42 (4.2L) (metam sodium) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 37.5-75 gals. per acre. Use high rates on muck, and lower rates on sands. In the fall,

Root Crops - Diseases

when soil at 6 inches is above 50 F and moist, place Sectagon K42 or VAPAM HL about 8 inches beneath the surface through shank-injectors, or broadcast sprayers directly in front of tillage tools to bury it. Seal with soil packing or irrigation. Or, in the spring, it can be applied through drip irrigation under unperforated plastic beds. Before planting, allow product to dissipate for 1 week for every 10 gals. per acre plus 1 more week. REI: 5-day. IRAC 8F, FRAC M3, WSSA 17. *RUP.*

Sectagon K54 (5.63L) (metam potassium) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 30-62 gals. per acre. Use high rates on muck, and lower rates on sands. In the fall, when soil at 6 inches is above 50 F and moist, place Sectagon K54 or K-PAM HL about 8 inches beneath the surface through shank-injectors, or broadcast sprayers directly in front of tillage tools to bury it. Seal with soil packing or irrigation. Or, in the spring, it can be applied through drip irrigation under unperforated plastic beds. Before planting, allow product to dissipate for 1 week for every 10 gals. per acre plus 1 more week. REI: 5-day. IRAC 8F, FRAC M3, WSSA 17. *RUP.*

Telone C-17 (L) (1,3-dichloropropene, chloropicrin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | *Muck soils:* Use C-17 formulation at 27.4-30 gals. per acre, and C-35 formulation at 33-36 gals. per acre. *Mineral soils:* Use C-17 formulation at 10.8-17.1 gals. per acre, and C-35 formulation at 13-20.5 gals per acre. In the fall, when soil at 6 inches is above 50 F and moist, place Telone C-17 or C-35 about 8 inches beneath the surface through shank-injectors, or broadcast sprayers directly in front of tillage tools to bury it. Seal with soil packing, irrigation, or plastic. Or, in the spring, InLine may be applied through drip irrigation under unperforated plastic beds at 13-20.5 gals. per acre on mineral soils only. Before planting, allow product to dissipate for 1 week for every 10 gals. per acre plus 1 more week. REI: 3-5-day. IRAC UN, FRAC NC, IRAC 8B. *RUP.*

Telone II (9.85L) (1,3-dichloropropene) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | *Muck soils:* Use at 25 gals. per acre. *Mineral soils:* Use at 9-12 gals. per acre. In the spring or fall, when soil at 6 inches is above 50 F and moist, place Telone II about 8 inches beneath the surface through shank-injectors, or broadcast sprayers directly in front of tillage tools to bury it. Seal with soil packing or irrigation. Or, in the spring, Telone EC may be applied through drip irrigation under unperforated plastic beds at 9-18 gals. per acre on mineral soils only. Before planting, allow product to dissipate for 1 week for every 10 gals. per acre plus 1 more week. REI: 5-day. IRAC UN, FRAC NC. *RUP.*

Vydate L (2WSL) (oxamyl) *Carrot* | 1-2 gal. per acre. Apply as a banded or shank-injected pre-plant, at-plant in-furrow or directed post-plant soil treatment with at least 20 gals. water per acre incorporated 2-4 inches deep by water or mechanical means, or overhead chemigate before crop emergence to deliver in 0.5 inch of irrigation water. Allow 14 days between applications. *IA, IL, KS, MN, and MO* use low rate only and do not exceed 4 applications or 2.5 gals. per acre per season. *IN, MI, OH* use high rate and do not exceed 8 applications or 8 gals. per acre per season. REI: 48-hour. PHI: 14-day. IRAC 1A. *RUP.*

Viruses of Multiple Crops - Multiple Pathogens

Turnip Mosaic Virus is transmitted by multiple species of aphids. In horseradish the pathogen can increase with each growing season as root clones are propagated.

Non-Pesticide

Horseradish | For **TuMV**: start new plantings with virus-free root stocks generated from tissue-culture.

Pesticide

Insecticides *Horseradish* | For **TuMV**: maintain an aphid management program. See Insects section. For **Brittle Root**: maintain a leafhopper management program. See Insects section.

White Mold (Timber Rot, Drop, Stem Rot) of Multiple Crops - *Sclerotinia* Fungus

This soil pathogen is long-lived in the soil, and has a wide host range on broadleaved crops and weeds, including beans, vine crops, lettuce, tomatoes, peppers, and cole crops. It goes by other names in other crops, such as Drop, White Mold, Stem Rot, and Timber Rot.

It is more commonly found where humidity and temperatures are high. The fungus often infects flowers, which then drop off and infect the stems that they land on. The stems take on a woody appearance and can split open. On root crops, the pathogen infects the root crown and stem, which makes the leaves drop and rot. Inspection of the stems will reveal small black pellets that are the overwintering body of the pathogen.

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Avoid fields with a history of the problem. Rotate to a non-broadleaf crop, such as grass grains or sweet corn for >6 years. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up. Anaerobic soil disinfestation (ASD) is an effective sterilization method for greenhouse and high tunnel soils that contain this pathogen.

Pesticide

Endura (WG) (boscalid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.8 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7.

Fontelis (1.67SC) (penthioopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 7.

Luna Sensation (fluopyram, trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 5.8-7.6 fl. oz. per acre. High rate only allowed on carrots. REI: 12-hour. PHI: 7-day. FRAC 7, FRAC 11.

Luna Tranquility (SC) (fluopyram, pyrimethanil) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 11.2 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 7, FRAC 9.

Omega 500F (4.17) (fluazinam) *Carrot* | 1 pt. per acre. REI: 12-hour. PHI: 7-day. FRAC 29.

White Rust of Multiple Crops - *Albugo* Oomycete

Non-Pesticide

Horseradish, Radish, Rutabaga, Turnip | Use disease-free seed and transplants. Hot water seed treatment may reduce this seedborne disease. Use temperatures and times of 122 F for 20 minutes for rutabaga and turnip, 122 F for 15 minutes for radish. Rotate to non-host crops for 2 years. Varieties with partial resistance are available. Brassica weeds like shepherd's purse, yellow rocket, and wild mustard can host the pathogen and should be managed. Prompt destruction of the finished crop with tillage to rapidly breakdown tissue is an important method to prevent disease build-up.

Pesticide

Cabrio EG (20) (pyraclostrobin) *Horseradish, Radish, Rutabaga, Turnip* | 8-16 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 11.

Ridomil Gold Copper (WSB) (mefenoxam, copper hydroxide) *Radish* | Use as a foliar spray. REI: 48-hour. PHI: 7-day. FRAC 4, FRAC M1.

Root Crops - Insects

Reviewed by Laura Ingwell, Kacie Athey – Nov 2020

Recommended Controls

Aphids

Pesticide

Actara (25WDG) (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. Apply as a foliar spray. Do not exceed 4.0 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 7-day. IRAC 4A.

Admire Pro (4.6SC) (imidacloprid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.31-0.74 fl. oz. per 1,000 ft. of row. Apply as chemigation through drip, as an in-furrow spray, shanked in to seed trench, or as a narrow banded spray over eventual row within 14 days of planting. Do not apply more than once per season. REI: 12-hour. PHI: 21-day. IRAC 4A.

Beleaf (50SG) (flonicamid) *Beet, Carrot, Celeriac, Parsnip, Radish, Rutabaga, Turnip* | 2.0-2.8 oz. per acre. Use lower rate for building populations and use higher rate for greater populations or dense foliage. Do not exceed 8.4 oz. per acre per year. Allow 7 days between applications REI: 12-hour. PHI: 3-day IRAC 29.

Brigade 2EC (bifenthrin) *Beet* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre and do not exceed 32 fl. oz. per acre per season. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre and do not exceed 80 oz. per acre per season.

Allow 7 days between applications. REI: 12-hour. PHI: 1-day. IRAC 3A. *RUP.*

Brigade 2EC (bifenthrin) *Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre and do not exceed 32 fl. oz. per acre per season. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre and do not exceed 80 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 21-day. IRAC 3A. *RUP.*

Lannate LV (2.4L) (methomyl) *Horseradish* | 1.5 pts. per acre. REI: 48-hour. PHI: 65-day. IRAC 1A. *RUP.*

M-Pede (3.8) (potassium salts of fatty acids) *Beet, Carrot, Horseradish, Parsnip, Radish, Rutabaga* | 1-2% by volume. Must contact aphids to be effective. REI: 12-hour. PHI: 0-day. IRAC UN, FRAC NC. *OMRI-listed.*

Malathion 5EC (malathion) *Beet, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 5EC formulations at 1.5-2.0 pts. per acre on beets, parsnips and horseradish; 1.5 pts. per acre on radishes and rutabagas; or 1.0-2.0 pts. per acre on turnips. Use 57EC formulations at 1.5-2.0 pts. per acre on beets, carrots, and parsnips; 1.0-1.6 pts. per acre on radish and rutabagas; or 1.0-2.0 pts. per acre on horseradish and turnips. Do not exceed 3 applications per season. Allow 7 days between applications. REI: 12 to 24-hour. PHI: 7-day. IRAC 1B.

Neemix (0.39) (azadirachtin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 5-7 fl. oz. per acre. Suppression of nymphs and adult feeding deterrence. REI: 4-hour. PHI: 0-day. IRAC UN. *OMRI-listed.*

Platinum 2SC (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2SC formulations as a soil treatment at 5.0-12.0 fl. oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 5.0-6.5 fl. oz. per acre on

radish, and do not exceed 12 fl. oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 6.5 fl. oz. per acre on radish. Use 75SG formulations as a soil treatment at 1.7-4.0 oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 1.7-2.2 fl. oz. per acre on radish, and do not exceed 4.0 oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 2.2 oz. per acre on radish. REI: 12-hour. IRAC 4A.

Sivanto 200 (1.67SL) (flupyradifurone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.0-10.5 fl. oz. per acre. Do not exceed 28.0 fl. oz. per acre per season. Allow 10 days between applications. REI: 4-hour. PHI: 7-day. IRAC 4D.

Carrot Weevil Beetle

Pesticide

Asana XL (0.66EC) (esfenvalerate) *Carrot* | 9.6 fl. oz. per acre. Begin treatment when weevils become active. Thorough spray coverage of crown area is essential. Do not exceed 96 fl. oz. per acre per season. REI: 12-hour. PHI: 7-day. IRAC 3A. *RUP*.

Baythroid XL (1EC) (beta-cyfluthrin) *Carrot, Radish* | 2.8 fl. oz. per acre. Do not exceed 14.0 fl. oz. per acre per season. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 3A. *RUP*.

Vydate L (2WSL) (oxamyl) *Carrot* | 2-4 pts. per acre. Apply as a soil-directed spray with at least 20 gals. water per acre, incorporated 2-4 inches deep by water or mechanical means. Start when eggs or larvae are first seen and repeat in 2 to 3 weeks. Allow 14 days between applications. *IA, IL, KS, MN, and MO* do not exceed 3 applications per season. *IN, MI, OH* do not exceed 3 applications per season. REI: 48-hour. PHI: 14-day. IRAC 1A. *RUP*.

Caterpillars

For cutworm caterpillars, treatment is warranted when 25% of plants are infested.

Pesticide

Asana XL (0.66EC) (esfenvalerate) *Carrot* | 5.8-9.6 fl. oz. per acre. For cutworms. Do not exceed 96 fl. oz. per acre per season. REI: 12-hour. PHI: 7-day. IRAC 3A. *RUP*.

Baythroid XL (1EC) (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. For cutworms. Do not exceed 14.0 fl. oz. per acre per season. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 3A. *RUP*.

Brigade 2EC (bifenthrin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | For armyworms, cabbageworms, and cutworms. Use 2EC formulation at 5.1-6.4 fl. oz. per acre and do not exceed 32 fl. oz. per acre per season. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre and do not exceed 80 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 1-day for beet. 21-day for carrot, celeriac, parsnip, radish, rutabaga and turnip. IRAC 3A. *RUP*.

Coragen (1.67SC) (chlorantraniliprole) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 3.5-7.5 fl. oz. per acre. For armyworms. Do not exceed 15.4 fl. oz. per acre per crop, or 16.4 fl. oz. per acre per year. Allow 3 days between applications. REI: 4-hour. PHI: 1-day. IRAC 28.

Diazinon AG500 (4ES) (diazinon) *Beet, Carrot, Radish* | For cutworms. Use 50W formulations at 4-8 lbs. per acre as a pre-plant incorporation and do not exceed 8 lbs. per acre per season. Use AG500 formulations at 2-4 lbs. per acre for radish and beet, 4 lbs. per acre for carrot as a pre-plant incorporation. Do not exceed 4 lbs. per acre per season. Use AG600 formulations at 51-102 fl. oz.

Root Crops - Insects

per acre as a pre-plant incorporation and do not exceed 102 fl. oz. per acre per season. REI: 3-day. PHI: 2 to 4-day. IRAC 1B. *RUP*.

Entrust SC (2) (spinosad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | For armyworms, and loopers. Use 2SC formulations at 3.0-10.0 fl. oz. per acre and do not exceed 21 fl. oz. per acre per season. Use 80WP formulations at 1.0-3.0 oz. per acre and do not exceed 9 oz. per acre per season. Allow 5 days between applications on carrots, celeriac, horseradish, parsnip, radish, rutabaga, and turnip. Allow 7 days between applications on beets. REI: 4-hour. PHI: 3-day. IRAC 5. *OMRI-listed*.

Lannate LV (2.4L) (methomyl) *Beet, Carrot* | For cutworms. Use 1.5 pts. per acre for beets. Use 0.75-1.5 pts. per acre for carrots. Do not exceed 12 pts. per acre per season for beets. Do not exceed 21 pts. per acre per season for carrots. REI: 48-hour. PHI: 0-day for beet roots, 10-day for beet tops, 1-day for carrot. IRAC 1A. *RUP*.

Mustang Maxx (0.8) (zeta-cypermethrin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.28-4.0 fl. oz. per acre. For cutworms. Do not exceed 24 fl. oz. per acre per season. Allow 4 days between applications. Leaves cannot be used for food or feed. REI: 12-hour. PHI: 1-day. IRAC 3A. *RUP*.

Radiant 1SC (spinetoram) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 6-8 fl. oz. per acre. For armyworms. Do not exceed 24 fl. oz. per acre per season for radish, rutabaga, and turnip. Do not exceed 28 fl. oz. per acre per season for carrot and parsnip. Do not exceed 32 fl. oz. per acre per season for beet. Allow 7 days between applications. REI: 4-hour. PHI: 3-day for carrot, parsnip, radish, rutabaga, and turnip; 7-day for beet. IRAC 5.

Sevin XLR Plus (4SC) (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1-2 qts. per acre. For armyworms, and

cutworms. Do not exceed 6 qts. per acre. REI: 12-hour. PHI: 7-day. IRAC 1A.

Flea Beetles

Pesticide

Actara (25WDG) (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. Apply as a foliar spray. Do not exceed 4.0 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 7-day. IRAC 4A.

Asana XL (0.66EC) (esfenvalerate) *Radish, Turnip* | 5.8-9.6 fl. oz. per acre. Do not exceed 77 fl. oz. per acre per season for turnip. Do not exceed 19.4 fl. oz. per acre per season for radish. REI: 12-hour. PHI: 7-day. IRAC 3A. *RUP*.

Baythroid XL (1EC) (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. Do not exceed 14.0 fl. oz. per acre per season. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 3A. *RUP*.

Brigade 2EC (bifenthrin) *Beet* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre and do not exceed 32 fl. oz. per acre per season. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre and do not exceed 80 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 1-day. IRAC 3A. *RUP*.

Brigade 2EC (bifenthrin) *Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre and do not exceed 32 fl. oz. per acre per season. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre and do not exceed 80 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 21-day. IRAC 3A. *RUP*.

Platinum 2SC (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2SC formulations as a soil treatment at

5.0-12.0 fl. oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 5.0-6.5 fl. oz. per acre on radish, and do not exceed 12 fl. oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 6.5 fl. oz. per acre on radish. Use 75SG formulations as a soil treatment at 1.7-4.0 oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 1.7-2.2 fl. oz. per acre on radish, and do not exceed 4.0 oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 2.2 oz. per acre on radish. REI: 12-hour. IRAC 4A.

Sevin XLR Plus (4SC) (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.5-1 qts. per acre. Do not exceed 6 qts. per acre. REI: 12-hour. PHI: 7-day. IRAC 1A.

Leafhoppers

For susceptible varieties: 20 leafhoppers per 100 sweeps.

Pesticide

Actara (25WDG) (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. Apply as a foliar spray. Do not exceed 4.0 oz. per acre per season. Allow 7 days between applications. REI: 12-hour. PHI: 7-day. IRAC 4A.

Admire Pro (4.6SC) (imidacloprid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.31-0.74 fl. oz. per 1,000 ft. of row. Apply as chemigation through drip, as an in-furrow spray, shanked in to seed trench, or as a narrow banded spray over eventual row within 14 days of planting. Do not apply more than once per season. REI: 12-hour. PHI: 21-day. IRAC 4A.

Asana XL (0.66EC) (esfenvalerate) *Carrot* | 5.8-9.6 fl. oz. per acre. Do not exceed 96 fl. oz. per acre per season. REI: 12-hour. PHI: 7-day. IRAC 3A. *RUP.*

Baythroid XL (1EC) (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. Do not exceed 14.0 fl. oz. per acre per season. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 3A. *RUP.*

Lannate LV (2.4L) (methomyl) *Carrot* | 1.5-3.0 pts. per acre. Do not exceed 21 pts. per acre per crop. REI: 48-hour. PHI: 1-day. IRAC 1A. *RUP.*

Platinum 2SC (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2SC formulations as a soil treatment at 5.0-12.0 fl. oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 5.0-6.5 fl. oz. per acre on radish, and do not exceed 12 fl. oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 6.5 fl. oz. per acre on radish. Use 75SG formulations as a soil treatment at 1.7-4.0 oz. per acre on beet, carrot, parsnip, rutabaga, and turnip or 1.7-2.2 fl. oz. per acre on radish, and do not exceed 4.0 oz. per acre per season on beet, carrot, parsnip, rutabaga, and turnip or 2.2 oz. per acre on radish. REI: 12-hour. IRAC 4A.

Sevin XLR Plus (4SC) (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.5-1 qts. per acre. Do not exceed 6 qts. per acre. REI: 12-hour. PHI: 7-day. IRAC 1A.

Sivanto 200 (1.67SL) (flupyradifurone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.0-10.5 fl. oz. per acre. Do not exceed 28.0 fl. oz. per acre per season. Allow 10 days between applications. REI: 4-hour. PHI: 7-day. IRAC 4D.

Seed and Root Maggots

Non-Pesticide

Radish, Rutabaga, Turnip | Plant after the peak flight and egg-laying window of the first generation of flies looking to lay eggs around 700 GDD base 40. Handle seeds carefully to prevent cracking.

Root Crops - Weeds

Plow winter vegetation under early in the spring and thoroughly cover to limit attractiveness of rotting vegetation to the first generation of flies to lay eggs on.

Pesticide

Diazinon AG500 (4ES) (diazinon) *Rutabaga* | Use 50W formulations at 4-6 lbs. per acre as a pre-plant incorporation and do not exceed 6 lbs. per acre per season. Use AG500 formulations at 2-4 lbs. per acre as a pre-plant incorporation and do not exceed 4 lbs. per acre per season. Use AG600 formulations at 51-102 fl. oz. per acre as a pre-plant incorporation and do not exceed 102 fl. oz. per acre per season. REI: 2 to 4-day. IRAC 1B. *RUP*.

Lorsban 4E (chlorpyrifos) *Radish, Rutabaga, Turnip* | 4.6-9.2 oz. per 1,000 ft. of row. Use 4E formulations at 4.0-5.5 pts. per acre as a pre-plant incorporation, or 1.0-3.2 fl. oz. per 1,000 foot of row as an at-plant soil drench. Use 15G formulations at 3.3-9.2 oz. per 1,000 foot of row as an at-plant application. Use 75WG formulations at 3.0-3.67 lb. per acre as a pre-plant incorporation or 0.67-2.15 oz. per 1000 linear ft. of row as an at-plant soil drench. Do not apply to foliage. Do not exceed one application per acre per season. REI: 24-hour to 3-day. PHI: 30-day. IRAC 1B. *RUP*.

Root Crops - Weeds

Reviewed by Stephen Meyers, Ben Phillips – Nov 2020

Recommended Controls

All Weeds

Herbicide are not widely labeled across the many root crops. Instead, herbicides are labeled based on the plant families the crops come from. For example, beets have several herbicides that can be applied over the top of the crop that would damage any other root crop.

Prepare a stale seedbed several weeks in advance of planting, allow weeds to emerge, and kill weeds without bringing new weed seeds to the surface with a burndown herbicide. It may be possible to plant without killing the weeds, and then kill them just before the crop emerges. For crops like carrots and parsnips that take a long time to emerge, controlling these weeds is especially useful, but it can also pay off for faster-emerging species like radishes or beets.

For specific weeds controlled by each herbicide, check Relative Effectiveness of Herbicides for Vegetable Crops table.

Rates provided in the recommendations below are given for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Weed control in root crops often relies heavily on cultivation and hand weeding for full season weed control. These operations are most efficient when planting arrangement is designed with weed control in mind and is designed to work with available weed control equipment. Specialized weeding equipment for leafy vegetables includes basket weeders, narrow-bladed hoes, finger weeders, and others. Prepare a stale seedbed with flaming or very shallow cultivation, instead of herbicides.

Broadleaf and Grass Weeds - Postemergence

Pesticide

Caparol 4L (prometryn) *Carrot, Celeriac* | Use lower rates on sandy soils. For **carrot**: Apply 2-4 pts. per acre preemergence and/or postemergence through the 6-leaf stage of carrot development. Do not exceed 8 pts. per acre per year. For transplanted **celeriac**: Make a single application of 1.6-4 pts. per acre after crop the crop has 6-8 leaves. REI: 12-

hour. PHI: 30-day for carrot, 60-day for celeriac. WSSA 5.

glyphosate products (glyphosate) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae per gal. (4 lbs. isopropylamine salt per gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae per gal. (5 lbs. potassium salt per gal.) at 0.66-3.3 qt. per acre. Broadcast before seeding, or apply between crop rows with wipers or hooded or shielded sprayers. Use lower rate for annuals and higher rates for perennials. For carrot and rutabaga only wipers may be used over top of crop, see label. See label for suggested application volume and adjuvants. REI: 4 to 12-hour. PHI: 14-day for foliar applications directed between rows, 7-day for wiper applications on carrot only. WSSA 9.

Lorox DF (50) (linuron) *Carrot, Celeriac, Horseradish, Parsnip* | Use low rate on coarse soils and higher rate on heavy soils and muck. Do not use on sand, loamy sand, or soils with less than 1% organic matter. For **carrot**: *In Minnesota only*, apply 1-2 lbs. per acre after planting but before carrots emerge. *In Michigan and Ohio only*, apply 1-3 lbs. per acre per acre after planting but before carrots emerge. Do not exceed 4 lbs. per acre per season. *In all states*, an additional application of 1.5-3 lbs. per acre can be made after carrots seedlings they are 3 inches tall. For **celeriac**: Make a single application of up to 3 lbs. per acre as a broadcast spray after celeriac has been transplanted and established, but before celeriac is 8 inches tall. Do not add surfactants, nitrogen (or other fertilizers), or other pesticides to the spray mix. For **horseradish**: Make a single application of up to 3 lbs. per acre as a broadcast spray after planting or during dormancy, but before leaves emerge in spring. After planting, allow rainfall or irrigation of at least 0.5 inch prior to application. For **parsnip**: Make a single application of 1.5-3 lbs. per acre as a broadcast spray after planting but prior to crop emergence. Plant at least 0.5 inch deep. REI: 24-hour to 8-day.

PHI: 14-day for carrot, 60-day for celeriac. WSSA 7.

Nortron SC (4) (ethofumesate) *Beet* | Apply 60 fl. oz. per acre at (or soon after) seeding and before weed seeds germinate, 5.25 fl. oz. per acre. when beets have 2-4 true leaves, or 10.5 fl. oz. per acre when beets have 6-8 true leaves. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 96 fl. oz. per acre per season. REI: 12-hour. WSSA 8.

paraquat products (paraquat) *Carrot, Turnip* | 2-4 pts. per acre of 2 lb. per gal. formulation. Use 1 qt. of COC (1% v/v) or 0.5 pt. of NIS (0.25% v/v) per 25 gals. of spray solution. Apply before or after seeding but before crop emerges. REI: 12 to 24-hour. WSSA 22. *RUP*.

Broadleaf and Grass Weeds - Preemergence

Pesticide

Caparol 4L (prometryn) *Carrot, Celeriac* | Use lower rates on sandy soils. For **carrot**: Apply 2-4 pts. per acre preemergence and/or postemergence through the 6-leaf stage of carrot development. Do not exceed 8 pts. per acre per year. For transplanted **celeriac**: Make a single application of 1.6-4 pts. per acre after crop the crop has 6-8 leaves. REI: 12-hour. PHI: 30-day for carrot, 60-day for celeriac. WSSA 5.

Dual Magnum (7.62EC) (s-metolachlor) *Beet, Carrot, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | *Illinois, Indiana, Michigan, Minnesota, and Ohio only. IL 24c exp. 12/31/20. MI 24c exp. 12/31/21. MN 24c exp. 12/31/20. OH 24c exp. 12/31/22.* For **carrot** in states listed above: apply 0.5-1.33 pts. per acre after planting but before carrots emerge, or 0.67-1.33 pts. per acre after carrots have 3-5 true leaves. Increase rates to 1.33-2.0 pts. per acre on muck soils. Do not apply both pre- and postemergence. Only the postemergence application is allowed in Ohio. For **beet, parsnip,**

Root Crops - Weeds

radish, rutabaga, and turnip in states listed above: 0.67-1.0 pt. per acre before planting with or without incorporation, or apply after seeding before crop emerges. Risk of crop injury is generally greater with preplant incorporated applications and on coarse-textured soils with less than 1.5% organic matter. Increase rate to 1.33 pts. per acre on muck soils. Do not exceed 1.3 pts. per acre per crop or 1 application per crop. **Horseradish** in all states: Apply after planting but before weeds emerge. Do not exceed 1 application per crop. REI: 24-hour. PHI: 64-day for carrot. WSSA 15.

Nortron SC (4) (ethofumesate) *Beet* | Apply 60 fl. oz. per acre at (or soon after) seeding and before weed seeds germinate, 5.25 fl. oz. per acre. when beets have 2-4 true leaves, or 10.5 fl. oz. per acre when beets have 6-8 true leaves. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 96 fl. oz. per acre per season. REI: 12-hour. WSSA 8.

Outlook (6) (dimethenamid-p) *Horseradish* | 12-21 fl. oz. per acre. Apply from 2-leaf stage to 8-leaf stage of horseradish. Cold, wet conditions at application may stunt horseradish. Will not control emerged weeds. REI: 12-hour. PHI: 40-day. WSSA 15.

pendimethalin products (pendimethalin) *Carrot* | Apply 3.8 lb. per gallon formulations at 2 pts. per acre within 2 days after seeding and before crop and weeds emerge. Or apply at layby as a directed spray between rows. Do not allow spray to contact carrot plants. Will not control emerged weeds. Do not exceed 2 pts. per acre per season. REI: 24-hour. PHI: 60-day. WSSA 3.

Ro-Neet (6) (cycloate) *Beet* | 0.5-0.67 gals. per acre. Apply before planting and incorporate immediately. Use on mineral soils only. REI: 48-hour. WSSA 8.

trifluralin products (trifluralin) *Carrot, Radish* | 0.5-0.75 lb. a.i. per acre. Use 4EC formulations at 1-1.5 pts. per acre. Use 10G formulations at 5-7.5

lbs. per acre. Apply and incorporate 1-2 inches before planting. Use low rate on coarse soils with less than 2% organic matter. Not effective on muck or high organic matter soils. Not effective on muck or high organic matter soils. REI: 12-hour. WSSA 3.

Broadleaf Weeds Only - Postemergence

Pesticide

Aim EC (2) (carfentrazone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.5-2.0 fl. oz. per acre. Apply with hooded sprayers as a directed application between crop rows. Use COC or NIS. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season. REI: 12-hour. WSSA 14.

metribuzin products (metribuzin) *Carrot* | Apply 0.5 pts. per acre for 4F, 0.33 lbs. per acre for 75DF. Broadcast after carrots have 5-6 true leaves and when weeds are less than 1 inch tall or across. Do not apply within 3 days of cool, cloudy weather or other pesticide application, or when temperature is above 85 F. Do not exceed 1 application per season if carrots are rotated with onions; otherwise do not exceed 1 pt. of 4F products per acre per season, or 0.66 lb. of 75DF products per acre per season. REI: 12-hour. PHI: 60-day. WSSA 5.

Spartan Charge (SE) (carfentrazone, sulfentrazone) *Horseradish* | 2.9-10.2 fl. oz. per acre Broadcast in the spring before planting or after planting but at least 5 days before crop emergence; or band into row middles after crop emergence. Applications made in the spring shortly before planting may be incorporated, but do not incorporate at other times. Rainfall or irrigation is required to move herbicide into the soil when not incorporated. Do not broadcast if sprouts are close to soil surface, or over top of emerged crop. Do not use on sandy soils with less than 1% organic matter. Do not exceed 10.2 fl. oz. of Spartan Charge per 12-month period. REI: 12-hour. WSSA 14.

Spin-Aid (1.3) (phenmedipham) Beet | 1.5-3 pts. per acre in 10-20 gals. of water. Apply to beets with at least 4 true leaves to avoid injury. Do not apply if beets are stressed. Do not exceed 3 applications. Does not control pigweed. REI: 12-hour. PHI: 60-day. WSSA 5. *RUP*.

Stinger (3) (clopyralid) Beet, Turnip | 4-8 fl. oz. per acre. Apply to beets when crop has 2-8 true leaves. Controls primarily composites and nightshade. Do not exceed 8 fl. oz. per acre per crop for beet. Do not exceed 1 application per crop for turnip. REI: 12-hour. PHI: 30-day. WSSA 4.

UpBeet (50DF) (triflurosulfuron) Beet | 0.5 oz. per acre. Apply postemergence when beets have 2-4 and 4-6 leaves to control velvetleaf and mustards. Suppresses lambsquarters, pigweed, nightshade, ragweed, smartweed, and wild buckwheat. Add 8 fl. oz. NIS per 25 gals. spray solution. Do not exceed 1.5 oz. per acre per season. REI: 4-hour. PHI: 30-day. WSSA 2.

Broadleaf Weeds Only - Preemergence

Pesticide

GoalTender (4) (oxyfluorfen) Horseradish | 1 pt. per acre for GoalTender 4SC, or 2 pts. per acre for Goal 2XL. Apply after planting but prior to crop emergence. REI: 24 to 48-hour. WSSA 14.

Spartan 4F (sulfentrazone) Horseradish | 2.25-8.0 fl. oz. per acre Broadcast in the spring before planting or after planting but at least 5 days before crop emergence; or band into row middles after crop emergence. Applications made in the spring shortly before planting may be incorporated, but do not incorporate at other times. Rainfall or irrigation is required to move herbicide into the soil when not incorporated. Do not broadcast if sprouts are close to soil surface, or over top of emerged crop. Do not use on sandy soils with less than 1% organic matter. Do not exceed 8 fl. oz. of Spartan 4F per 12-month period. REI: 12-hour. WSSA 14.

Spartan Charge (SE) (carfentrazone, sulfentrazone) Horseradish | 2.9-10.2 fl. oz. per acre Broadcast in the spring before planting or after planting but at least 5 days before crop emergence; or band into row middles after crop emergence. Applications made in the spring shortly before planting may be incorporated, but do not incorporate at other times. Rainfall or irrigation is required to move herbicide into the soil when not incorporated. Do not broadcast if sprouts are close to soil surface, or over top of emerged crop. Do not use on sandy soils with less than 1% organic matter. Do not exceed 10.2 fl. oz. of Spartan Charge per 12-month period. REI: 12-hour. WSSA 14.

Grass Weeds Only - Postemergence

Pesticide

clethodim products (clethodim) Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Use 2EC formulations at 6-8 fl. oz. per acre with 1 qt. of COC per 25 gals. of spray solution (1% v/v). Use Select Max at 9-16 fl. oz. per acre with 8 fl. oz. of NIS per 25 gals. of spray solution (0.25% v/v). Spray on actively growing grass. Use lower rates for annual grasses, the higher rates for perennial grasses. Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 32 fl. oz. of 2EC formulations or 64 fl. oz. of Select Max per acre per season. REI: 24-hour. PHI: 15-day for radish, 30-day for beet, carrot, celeriac, horseradish, parsnip, rutabaga, and turnip. WSSA 1.

Fusilade DX (2EC) (fluazifop-P) Carrot | 10-12 fl. oz. per acre. Use 1-2 pts. of COC or 0.5-1 pt. of NIS per 25 gals. of spray solution. Spray on actively growing grass. REI: 12-hour. PHI: 45-day. WSSA 1.

Poast (1.5EC) (sethoxydim) Beet, Carrot, Horseradish, Parsnip, Radish, Rutabaga, Turnip | 1.0-1.5 pts. per acre. Use 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 2.5

Sweet Corn - Horticulture

pts. per acre per season for parsnip, radish, rutabaga, and turnip or 5 pts. per acre per season for beet, carrot, and horseradish. REI: 12-hour. PHI: 14-day for parsnip, radish, rutabaga, and turnip, 30-day for carrot, and 60-day for beet and horseradish. WSSA 1.

Sweet Corn - Horticulture

Reviewed by Ben Phillips, Liz Maynard, Bill Tracy
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Crop Description

Sweet corn (*Zea mays* subsp. *mays*) originates from a wild relative in Central America. Sweet corn is usually described by color (yellow, bicolor, or white) and by the major gene names that make it sweet. Despite the many marketing terms and trademarked names, sweet corn can be categorized into five major types.

The original sweet corn (called standard, sugary, or *su*) contains the *su1* genetic variant that makes it sweet instead of starchy like field corn. Sugary sweet corn is grown today primarily for processing and specialized markets.

A second type of sweet corn (called sugar-enhanced, sugary enhancer, EH, or *se*) contains the *se1* genetic variant that increases sugar content and makes the kernels more tender. Heterozygous *se* corn has one copy of the *se1* mutation and homozygous *se* corn has two copies of the *se1* mutation, increasing its effect. Sugar-enhanced sweet corn is grown primarily for direct retail sales and local wholesale markets.

A third type of sweet corn (called supersweet, ultrasweet, extra sweet, or shrunken-2) contains the *sh2* genetic variation. This type typically has a higher sugar content than *su* corn, and the sugar content does not decline rapidly after picking, so it

remains sweet for several days after harvest. Kernels typically are not as tender as *se* corn. Shrunken-2 (*sh2*) types are grown for retail sales, local fresh markets, and wholesale shipping markets.

Many of the newest sweet corn varieties combine the *sh2* (or similar genes) with *se* and/or *su* genetics. Sugar-enhanced sweet corn that also includes *sh2* (or similar) genes is called synergistic, and may be abbreviated as *sessh2*, *syn*, or *sy* corn. Current synergistic varieties are typically very sweet and very tender. Shrunken-2 sweet corn varieties with genetics increasing tenderness and flavor are categorized as augmented or improved supersweet or *sh2*, sometimes abbreviated *shA*. These varieties are typically extremely sweet and tender. Many of these varieties have performed well in midwestern trials and receive top ratings for eating quality. The new types are often identified by trademarked brand names.

Sweet corn varieties with resistance to certain insects, and/or glyphosate or glufosinate herbicides are also available.

Planting and Spacing

Common spacing 30 to 40 inches apart between rows. Plant early varieties 8 to 10 inches apart in the row, late varieties 9 to 12 inches apart in the row. Seed 10 to 15 pounds per acre.

Sweet corn flavor is affected by pollen source. Isolate all sweet corns from all other non-sweet corns, including dent (field), flint (Indian), flour, and popcorn by 250 feet or by a 14-day difference in tasseling dates. Likewise, supersweet (*sh2*) and augmented (*shA*) sweet corn varieties must be isolated from sugary (*su*), sugar-enhanced (*se*) and synergistic (*sy*) types. If not isolated, kernels of both varieties will be starchy instead of sweet. Refer to the table below for isolation requirements or check with your seed supplier.