Root Crops - Horticulture

Major update by Ben Phillips, Liz Maynard – Dec 2020
Reviewed by Ben Phillips – Mar 2022

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.*

Amaranthaceae, the Pigweed family, contains Beets classified as "root and tuber vegetables" in EPA Crop Group 1. The pests of plants in this family are shared with Spinach and Swiss chard (EPA Crop group 4) in the Leafy Greens and Herbs chapter.

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 of 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 of plants in this family are shared with the Cole Crops and Brassica Leafy Greens, and Leafy Vegetables and Herbs chapters.

Convolvulaceae, the Morning glory 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. Imperator 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 hypocotyl/root structure with a celery flavor.

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 cloned root "sets" cut from harvested roots in nurseries, like garlic, potato, or rhubarb. 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 plants put 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* supsp. *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 P_2O_5 per acre, and 0 to 200 pounds K_2O 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% 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 – Aug 2023

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. There are some varieties of carrot that tolerate aster yellows more than others. 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

mefenoxam/metalaxyl products (mefenoxam) *Carrot* | Several formulations (Apron, MetaStar, Ridomil Gold, Ultra Flourish, and Xyler) are labeled. Several formulations are labeled as pre-plant incorporated or surface broadcast and banded applications at various rates between 0.5 pt. and 8 pt. per acre. For post-emergence control, begin applications 28 days after planting as broadcast sprays, or 40 days after planting for banded sprays. A 33.3% seed treatment formulation can be used at 0.085-0.64 fl. oz. per 100 lb. of seed. REI: 48-hour. PHI: 7-day. FRAC 04.

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

Reason 500SC (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 04, FRAC M05.

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

Presidio (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.

Reason 500SC (fenamidone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.45 fl. oz. per 1000 ft. row. Pythium damping-off only. REI: 12-hour. PHI: 14-day. FRAC 11.

Uniform (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: 0-day. FRAC 04, 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 labelled for use and may slow the spread of bacterial blight. See label for directions. REI: 4 to 48-hour. PHI: 0-day. FRAC M01. *OMRI-listed.*

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* | Several formulations are labeled at various rates (Acadia LFC, AZteroid FC 3.3, Dexter SC, Heritage, Quadris, Satori). Use 34.3% formulations at 3.9-12.8 fl. oz. per acre. Use 22.9% formulations at 6.0-15.5 fl. oz. per acre. Use 18.4% formulations at 7.6-25.6 fl. oz. per acre. REI: 4-hour. PHI: 0-day. FRAC 11.

Cabrio EG (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 are labeled at various rates (Bravo, Echo, Equus, Initiate). Use 38.5% (Zn) formulations at 2.25-2.75 pt. per acre. Use 54% (720) formulations at 1.5-2.0 pt. per acre. Use 82.5% (WDG) formulations at 1.4-1.8 lb. per acre. Use 90% (DF) formulations at 1.25-1.6 lb. per acre. REI: 12-hour. PHI: 0-day for carrot; 10-day for parsnip; 14-day for horseradish. FRAC M05.

Endura (boscalid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 4.5 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 07.

Flint Extra (trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Rutabaga, Turnip* | 2.0-2.9 oz. per acre. Use Gem 500 SC and Flint (50%) formulation at same rate. REI: 12-hour. PHI: 7-day. FRAC 11.

Fontelis (penthiopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 07.

iprodione products (iprodione) *Carrot* | 1-2 pts per acre. Formulations of iprodione include Nevado and Rovral. REI: 24-hour. PHI: 0-day. FRAC 02.

Luna Sensation (fluopyram, trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.6 fl. oz. per acre. High rate only allowed on carrots. REI: 12-hour. PHI: 7-day. FRAC 07, FRAC 11.

Merivon (fluxapyroxad, pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Alternaria at 4-5.5 fl. oz. per acre. Cercospora at 5.5 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 07, FRAC 11.

Omega 500F (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 07, FRAC 11.

propiconazole products (propiconazole) *Carrot* | 4 fl. oz. per acre. PropiMax EC and Tilt are labeled. See label for tank mix rates. REI: 12-hour. PHI: 14-day. FRAC 03.

Quadris Opti (azoxystrobin, chlorothalonil) *Carrot* | 2.4 pts. per acre. REI: 12-hour. PHI: 0-day. FRAC 11, FRAC M05.

Quadris Top (azoxystrobin, difenoconazole) *Carrot* | 12-14 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11, FRAC 03.

Quilt (azoxystrobin, propiconazole) *Carrot* | 14 oz. per acre. Late blight suppression only. REI: 12-hour. PHI: 14-day. FRAC 11, FRAC 03.

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 09, 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* | Several formulations are labeled at various rates (Acadia LFC, AZteroid FC 3.3, Dexter SC, Heritage, Quadris, Satori). Use 34.3% formulations at 3.9-12.8 fl. oz. per acre. Use 22.9% formulations at 6.0-15.5 fl. oz. per acre. Use 18.4% formulations at 7.6-25.6 fl. oz. per acre. REI: 4-hour. PHI: 0-day. FRAC 11.

Cabrio EG (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 are labeled at various rates (Bravo, Echo, Equus, Initiate). Use 38.5% (Zn) formulations at 2.25-2.75 pt. per acre. Use 54% (720) formulations at 1.5-2.0 pt. per acre. Use 82.5% (WDG) formulations at 1.4-1.8 lb. per acre. Use 90% (DF) formulations at 1.25-1.6 lb. per acre. REI: 12-hour. PHI: 0-day for carrot; 10-day for parsnip; 14-day for horseradish. FRAC M05.

Flint Extra (trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Rutabaga, Turnip* | 2.0-2.9 oz. per acre. Use Gem 500 SC and Flint (50%) formulation at same rate. REI: 12-hour. PHI: 7-day. FRAC 11.

Fontelis (penthiopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 07.

Merivon (fluxapyroxad, pyraclostrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Alternaria at 4-5.5 fl. oz. per acre. Cercospora at 5.5 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 07, FRAC 11.

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 07, FRAC 11.

Quadris Opti (azoxystrobin, chlorothalonil) *Carrot* | 2.4 pts. per acre. REI: 12-hour. PHI: 0-day. FRAC 11, FRAC M05.

Quadris Top (azoxystrobin, difenoconazole) *Carrot* | 12-14 fl. oz. per acre. REI: 12-hour. PHI: 7-day. FRAC 11, FRAC 03.

Quilt (azoxystrobin, propiconazole) *Carrot* | 14 oz. per acre. Late blight suppression only. REI: 12-hour. PHI: 14-day. FRAC 11, FRAC 03.

tebuconazole products (tebuconazole) *Beet* | 3.0-7.2 fl. oz. per acre. There are many 38.7% formulations (Monsoon, Onset, Toledo, Vibe) that use the same rate. REI: 12-hour to 18-day. PHI: 7-day. FRAC 03.

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

K-PAM HL (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 K-PAM HL or Sectagon K54 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 08F, HRAC NC, FRAC NC. *RUP.*

Telone C-17 (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 8A, FRAC NC, IRAC 08B. *RUP.*

Telone II (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 8A, FRAC NC. *RUP.*

VAPAM HL (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, when soil at 6 inches is above 50 F and moist, place VAPAM HL or Sectagon K42 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 08F, HRAC NC, FRAC NC. *RUP.*

Vydate L (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 01A. *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 (boscalid) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.8 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 07.

Fontelis (penthiopyrad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 16-30 fl. oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 07.

Luna Sensation (fluopyram, trifloxystrobin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.6 fl. oz. per acre. High rate only allowed on carrots. REI: 12-hour. PHI: 7-day. FRAC 07, FRAC 11.

Omega 500F (fluazinam) *Carrot* | 16 fl. oz. 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 (pyraclostrobin) *Horseradish, Radish, Rutabaga, Turnip* | 8-16 oz. per acre. REI: 12-hour. PHI: 0-day. FRAC 11.

Ridomil Gold Copper (mefenoxam, copper hydroxide) *Radish* | Use as a foliar spray. REI: 48-hour. PHI: 7-day. FRAC 04, FRAC M01.

Root Crops - Insects

Major update by Marissa Schuh, Ashley Leach – Apr 2025

Aphids

Aphid populations tend to spike during periods of hot weather and when plants have excess nitrogen. Aphids transmit viral diseases. Treatment will not reverse the symptoms of viruses, but will limit further spread. Scout the upper and lower surface of leaves and look for shed skins or honey dew. Selective chemistries (e.g. flonicamid, pymetrozine) that target piercing-sucking insects help to preserve natural enemies.

Non-Pesticide

Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip | Preserve and encourage natural enemies. Aphid mummies indicate the presence of parasitoids. Predatory fly larvae, lady beetles, minute pirate bugs, and lacewings are common predators.

Pesticide

Actara (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. REI: 12-hour. PHI: 7-day. IRAC 04A.

Admire Pro (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 04A.

Beleaf (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. REI: 12-hour. PHI: 3-day IRAC 29.

Brigade 2EC (bifenthrin) *Beet* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre. REI: 12-hour. PHI: 1-day. IRAC 03A. *RUP.*

Brigade 2EC (bifenthrin) *Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre. REI: 12-hour. PHI: 21-day. IRAC 03A. *RUP.*

Lannate LV (methomyl) *Horseradish* | 1.5 pts. per acre. Ground application only. REI: 48-hour. PHI: 65-day. IRAC 01A. *RUP.*

M-Pede (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, Carrot, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 5EC formulations at 1.5-2.0 pts. per acre on beets, carrots, 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. REI: 12-hour on beet, rutabaga, turnip and 24-hour on carrot, horseradish, parsnip. REI: 12-hour. PHI: 7-day. IRAC 01B.

Neemix (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. 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. REI: 12-hour. IRAC 04A.

Sivanto 200 (flupyradifurone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.0-14 fl. oz. per acre. REI: 4-hour. PHI: 7-day. IRAC 04D.

Carrot Weevil Beetle

Prior to transplanting, use carrot-baited monitoring traps to determine level of carrot weevil pressure in the field. Begin insecticide applications in the spring when plants have 3-true leaves (petioles) and direct applications at the base of the plant where adult weevils are active.

Non-Pesticide

Carrot, Parsley | Use crop rotation to reduce buildup of carrot weevil populations. Disk crop residue at the end of the growing season to eliminate food resources and reduce overwintering survival of life stages remaining in the field.

Pesticide

Asana XL (esfenvalerate) *Carrot* | 9.6 fl. oz. per acre. Begin treatment when weevils become active. Thorough spray coverage of crown area is essential. REI: 12-hour. PHI: 7-day. IRAC 03A. *RUP.*

Baythroid XL (beta-cyfluthrin) *Carrot, Parsley* | For carrot, use 2.8 fl. oz. per acre. For parsley, use 2.4-3.2 fl. oz. per acre. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 03A. *RUP.*

Vydate L (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. *IN, MI, OH* do not exceed 8 applications per season. REI: 48-hour. PHI: 14-day. IRAC 01A. *RUP.*

Caterpillars

Cutworms are the most important caterpillar pest of root crop in our region. Other foliage-feeding caterpillars include loopers and armyworms. Always check the label for the specific list of caterpillars that the product can be used on.

Treatment is warranted when 25% of plants are infested.

Pesticide

Asana XL (esfenvalerate) *Carrot* | 5.8-9.6 fl. oz. per acre. For cutworms. REI: 12-hour. PHI: 7-day. IRAC 03A. *RUP.*

Baythroid XL (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. For cutworms. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day. IRAC 03A. *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. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre. REI: 12-hour. PHI: 1-day for beet. 21-day for carrot, celeriac, parsnip, radish, rutabaga and turnip. IRAC 03A. *RUP.*

Coragen (chlorantraniliprole) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 3.5-7.5 fl. oz. per acre. For armyworms. REI: 4-hour. PHI: 1-day. IRAC 28.

Diazinon AG500 (diazinon) *Beet, Carrot, Radish* | For cutwoms. Use 50W formulations at 4-8 lbs. per acre as a pre-plant incorporation. Use AG500 formulations at 2-4 lbs. per acre for radish and beet, 4 lbs. per acre for carrot as a pre-plant incorporation. Use AG600 formulations at 51-102 fl. oz. per acre as a pre-plant incorporation. REI: 2 to 4-day. PHI: 14-day. IRAC 01B. *RUP.*

Entrust SC (spinosad) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | For armyworms, borers, and loopers. Use 2SC formulations at 3.0-6.0 fl. oz. per acre on carrot, horseradish, parsnip, radish, rutabaga, turnip and 3.0-10 fl. oz per acre on beets. Use 80WP formulations at 1.0-3.0 oz. per acre. REI: 4-hour. PHI: 3-day. IRAC 05. *OMRI-listed.*

Lannate LV (methomyl) *Beet, Carrot* | For cutworms. Use 1.5 pts. per acre for beets. Use 0.75-1.5 pts. per acre for carrots. REI: 48-hour. PHI: 0-day for beet roots, 10-day for beet tops, 1-day for carrot. IRAC 01A. *RUP.*

Mustang Maxx (zeta-cypermethrin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.28-4.0 fl. oz. per acre. For cutworms. Leaves cannot be used for food or feed. REI: 12-hour. PHI: 1-day. IRAC 03A. *RUP.*

Radiant 1SC (spinetoram) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 6-8 fl. oz. per acre. For armyworms. REI: 4-hour. PHI: 3-day for carrot, parsnip. radish, rutabaga, and turnip; 7-day for beet. IRAC 05.

Sevin XLR Plus (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1-2 qts. per acre. For armyworms, and cutworms. REI: 12-hour. PHI: 7-day. IRAC 01A.

Flea Beetles

Pesticide

Actara (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. REI: 12-hour. PHI: 7-day. IRAC 04A.

Asana XL (esfenvalerate) *Radish, Turnip* | 5.8-9.6 fl. oz. per acre. REI: 12-hour. PHI: 7-day. IRAC 03A. *RUP.*

Baythroid XL (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day IRAC 03A. *RUP.*

Brigade 2EC (bifenthrin) *Beet* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre. Use 10DF, 10 WP, or 10WSB formulations at 12.8-16.0 oz. per acre. REI: 12-hour. PHI: 1-day. IRAC 03A. *RUP.*

Brigade 2EC (bifenthrin) *Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2EC formulation at 5.1-6.4 fl. oz. per acre. Use 10DF, 10 WP, or 10WSB

formulations at 12.8-16.0 oz. per acre. REI: 12-hour. PHI: 21-day. IRAC 03A. *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. 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. REI: 12-hour. IRAC 04A.

Sevin XLR Plus (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.5-1 qts. per acre. REI: 12-hour. PHI: 7-day. IRAC 01A.

Leafhoppers

Aster leafhopper is a migratory species that affects carrots and beets, and are a concern because they vector aster yellows. The amount of aster yellows present in any leafhopper population varies by year and location. Some states in the region have programs that test for and track the percentage of aster leafhoppers that are carrying aster yellows. Aster leafhoppers can move into vegetable fields when neighboring wheat or alfalfa is harvested.

Management efforts can be stopped 2-3 weeks before harvest, as plants that are infected during that time will be harvested before symptoms manifest.

For susceptible varieties of carrots, a threshold of 20 leafhoppers per 100 sweeps can be used.

Non-Pesticide

Carrot | Avoid planting near early harvested grain or alfalfa fields. There are some varieties of carrots that tolerate aster yellows more than others.

Pesticide

Actara (thiamethoxam) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.5-3.0 oz. per acre. REI: 12-hour. PHI: 7-day. IRAC 04A.

Admire Pro (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 04A.

Asana XL (esfenvalerate) *Carrot* | 5.8-9.6 fl. oz. per acre. REI: 12-hour. PHI: 7-day. IRAC 03A. *RUP.*

Baythroid XL (beta-cyfluthrin) *Carrot, Radish* | 1.6-2.8 fl. oz. per acre. Do not harvest tops for human consumption. REI: 12-hour. PHI: 0-day IRAC 03A. *RUP.*

Lannate LV (methomyl) *Carrot* | 1.5-3.0 pts. per acre. REI: 48-hour. PHI: 1-day. IRAC 01A. *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. 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. REI: 12-hour. IRAC 04A.

Sevin XLR Plus (carbaryl) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.5-1 qts. per acre. REI: 12-hour. PHI: 7-day. IRAC 01A.

Sivanto 200 (flupyradifurone) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 7.0-14 fl. oz. per acre. REI: 4-hour. PHI: 7-day. IRAC 04D.

Seed and Root Maggots

Cabbage maggot is the main root maggot of radish, rutabaga, and turnip. Cabbage maggot causes the biggest problems during cool, wet springs when plants are growing slowly. Egg-laying adults are attracted to the smell of decaying organic matter, and are attracted to fields where green manures, cover crops, and weeds have been recently killed. Foliar applications of pyrethroids are only partially effective, and require careful timing. Degree day models exist for states across the region, and can be used to time management actions.

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. 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. Row covers can be effective in small plantings.

Pesticide

Diazinon AG500 (diazinon) *Rutabaga* | Use 50W formulations at 4-6 lbs. per acre as a pre-plant incorporation. Use AG500 formulations at 2-4 lbs. per acre as a pre-plant incorporation. Use AG600 formulations at 51-102 fl. oz. per acre as a pre-plant incorporation. REI: 2 to 4-day. PHI: 14-day. IRAC 01B. *RUP.*

Mustang Maxx (zeta-cypermethrin) *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 3.2-4.0 fl. oz. per acre. Apply weekly, broadcast applications starting at fly emergence and continuing through the activity period, typically 6 applications. Leaves cannot be used for food or feed. REI: 12-hour. PHI: 1-day. IRAC 03A. *RUP.*

Root Crops - Weeds

Reviewed by Stephen Meyers, Ram Yadav, Chris Galbraith – Feb 2025

All Weeds

Herbicides are not widely labeled across the many root crops. Instead, herbicides are labeled based on the root crop plant families. 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, flame weeder, or very shallow cultivation. In fields with lower weed pressure, it may be possible to plant into some emerged weeds, and then use an approved burndown herbicide prior to crop emergence to control emerged weeds. For crops like carrots and parsnips that take a long time to emerge, a burndown application made just prior to crop emergence 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 the Relative Effectiveness of Herbicides for Vegetable Crops table.

Rates provided in the recommendations below are given for overall coverage. For a banded 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 root crops includes basket weeders, narrow-bladed hoes, finger weeders, and others. Prepare a stale seedbed with flaming or very shallow cultivation, instead of herbicides.

Pesticide

Aim EC (carfentrazone) POST *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 (1% v/v) or NIS (0.25% v/v). 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. HRAC 14.

Caparol 4L (prometryn) POST | PRE   *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. HRAC 05.

clethodim products (clethodim) POST  *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | Use 2EC formulations at 6-8 fl. oz. per acre with COC (1% v/v). Use Select Max at 9-16 fl. oz. per acre with COC (1% v/v) or NIS (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. HRAC 01.

clopyralid products (clopyralid) POST  *Beet, Turnip* | 4-8 fl. oz. per acre. Apply Spur or Stinger (40.9% formulations only). Beets must have 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. HRAC 04.

Dual Magnum (s-metolachlor) PRE   *Beet, Carrot, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | For **carrot** *with special 24c label*: 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, radish, rutabaga, and turnip** *with special 24c label*: 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. For **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. HRAC 15.

Fusilade DX (fluazifop-P) POST *Carrot* | 10-12 fl. oz. per acre. Use COC (1% v/v) or NIS (0.25% v/v). Spray on actively growing grass. REI: 12-hour. PHI: 45-day. HRAC 01.

glyphosate products (glyphosate) POST   *Beet, Carrot, Celeriac, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 0.375-3.75 lbs. acid equivalent (ae) per acre. Divide lb. acid equivalent (ae) per acre target rate by lb. ae per gal and then multiply by 4. For example, for RoundUp ULTRA at the high rate, (3.75 lb. ae per acre / 3 lb. ae per gal) * 4 = 5 qt. per acre of actual product. 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-hour to 12-hour. PHI: 14-day for foliar applications directed between rows, 7-day for wiper applications on carrot only. HRAC 9.

GoalTender (oxyfluorfen) POST | PRE  *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. HRAC 14.

Lorox DF (linuron) POST | PRE   *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. HRAC 05.

metribuzin products (metribuzin) POST PRE

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. HRAC 05.

Nortron SC (ethofumesate) POST PRE *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. HRAC 15.

Optogen (bicyclopyrone) POST PRE

Horseradish | For **horseradish**: 2.6-3.5 fl. oz. per acre after transplanting but at least 3 days prior to crop emergence or 3.5 fl. oz. per acre after transplanting as a row middle or post-directed application, avoiding contact with crop foliage. If weeds are present, add COC (1% v/v) or NIS (0.25% v/v). Spray grade ammonium sulfate (AMS) may also be added to improve weed control consistency. Apply to weeds less than 2 inches. Do not apply prior to transplanting. Do not exceed 1 application per year. Do not exceed 3.5 fl. oz. per acre per year. REI: 24-hour. PHI: 30-day. HRAC 27.

Outlook (dimethenamid-p) PRE *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. HRAC 15.

paraquat products (paraquat) POST *Carrot, Turnip* | Use 2-4 pt. per acre of 2SL formulation or 1.3-2.7 pt. per acre of 3SL formulation. Use COC (1% v/v) or NIS (0.25% v/v). Apply before or after seeding but before crop emerges. Certified applicators must successfully complete an EPA-approved training program before mixing, loading, and/or applying paraquat. REI: 12 to 24-hour. HRAC 22. *RUP.*

pendimethalin products (pendimethalin) PRE

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. HRAC 03.

Poast (sethoxydim) POST *Beet, Carrot, Horseradish, Parsnip, Radish, Rutabaga, Turnip* | 1.0-1.5 pts. per acre. Use COC (1% v/v). Spray on actively growing grass. Do not exceed 2.5 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. HRAC 01.

Ro-Neet (cycloate) PRE *Beet* | 0.5-0.67 gals. per acre. Apply before planting and incorporate immediately. Use on mineral soils only. REI: 48-hour. HRAC 15.

Spartan 4F (sulfentrazone) PRE *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. HRAC 14.

Spartan Charge (carfentrazone, sulfentrazone) POST PRE *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. HRAC 14.

Spin-Aid (phenmedipham) POST *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. HRAC 05. *RUP.*

Sulfen 4SC (sulfentrazone) PRE *Turnip* | 8 fl. oz. per acre. Make one application after emergence 40-60 days before harvest. Do not make more than one application per year. Do not apply more than 8 fl. oz. per acre or per 12-month period. Do not use on sand or soils with less than 1% organic matter. REI: 12-hour. HRAC 14.

trifluralin products (trifluralin) PRE *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. HRAC 03.

UpBeet (triflusulfuron) POST *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. HRAC 02.