

CARROTS

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Production: Fresh market carrots: average yield is 350 48-lb bags per acre. Good yield is 600 48-lb bags per acre. Processing carrots: 35 tons per acre is a good yield; 40 tons per acre is excellent yield.

Use: 85% of Michigan carrots are packed for fresh market; 15% are processed.

Recommended Varieties: Fresh market: Spartan Delite (hybrid), Spartan Delux (hybrid), Spartan Fancy (hybrid), Grenadier (hybrid), Trophy (hybrid), Gold Pak
Processing: Spartan Bonus (hybrid), Danvers 126

Climatic Requirements

Carrot is a cool season crop. Seeds germinate at soil temperatures of 40°F or higher. Roots and leaves grow best at temperatures of 60 to 70°F. Carrot seedlings grow rapidly during the cool growing conditions in the spring, producing their mature-length tap roots in the first 3 weeks of growth.

Young carrot seedlings can withstand slight frosts, but hard frosts that penetrate the soil and cause heaving break the carrot taproots, which results in stubby and forked carrots. Young seedlings are burned off easily by high temperatures that occur before the plants are 1 inch high. Hybrid carrots tolerate freeze-heaving, burn-off, and other stresses better than open-pollinated varieties.

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Mature carrot leaves tolerate several nights of frosts in the mid 20's in the fall. Leaves will be frozen when temperatures fall below 20°F for several hours. Since leaves are needed for harvest, recoverable yields of roots will decrease as leaves are killed by frost. Healthy tops resist frost better than blighted tops; therefore, it is essential to control foliar diseases if the harvest season is to be extended into the late fall.

Carrots require about 90 to 120 days to mature in Michigan. Harvest of early fresh market carrots begins in late July or early August. Processing carrots are harvested in September and October.

Carrots should not be exposed to water stress. When irrigating, soak the soil completely so there is no separation between soil and surface moisture. A separation between moisture sources, with a dry middle zone, can cause differential growth and cracking in carrots. Carrots need about 10 to 14 inches of water during the growing season, depending on soil type and water table. The water table should be maintained below 30 inches.

Soil Requirements

Carrots grow best on deep, loose, well-drained mineral and organic soils with good water holding capacity. Most Michigan carrots are grown on deep muck soils. Sandy and marl mucks will produce good carrots but require more careful management. Sandy soils crust easily, which reduces seedling emergence and air penetration, especially after a heavy rain. If crusting occurs, the soil should be opened up with a cultivator as soon as possible.

Carrot roots are very sensitive to soil compaction. Rows next to the wheel track often

have more forked and stubbed carrots than rows in the center of a bed, and yields and packout are reduced. Therefore, limit trips across a field with sprayer, cultivator, fertilizer spreader, or other equipment. During the first 3 weeks of growth, stay off the field completely. On large acreages, apply pesticides by air when possible.

Fertilization

Lime muck soils to maintain a soil pH between 5.5 and 6.0. Mineral soils should be maintained with a pH of 6.0 to 6.5.

It is important to maintain active foliar growth throughout the season to minimize damage from leaf blights. Hybrids are less susceptible than open-pollinated varieties to cracking caused by excess fertilization and water. Therefore, it is often advantageous to increase the nitrogen rate on hybrids if blight is a problem.

A 20-ton carrot crop removes about 100 lbs N, 25 lbs P_2O_5 , and 100 lbs K_2O per acre. Supplemental nutrients can be applied in a combination of broadcast, band, and sidedress applications. About 75 lbs N (up to 120 lbs on sandy or marl muck), 100 lbs P_2O_5 and 200 lbs K_2O should be applied per acre to carrots grown on good muck soil. Base specific fertilizer requirements on soil test results. For example, broadcast and plow down 300 lbs 18-46-0 and 400 lbs 0-0-60 per acre (54 lbs N, 138 lbs P_2O_5 , and 240 lbs K_2O). Sidedress when carrots are 5 to 6 inches high (6 to 9 fern leaves) with 60 lbs 45-0-0 or 80 lbs 34-0-0 per acre (27 lbs N). Increase the sidedress N rate to 50 lbs per acre on sandy and marl mucks. If heavy rains occur, apply a second sidedressing of N. On mineral soils, apply 120 lbs N, 75 lbs P_2O_5 , and 150 lbs K_2O per acre if soil test information is not available.

Manganese (Mn) is commonly lacking in organic soils in Michigan. Since it is very immobile in the soil, it should be applied in a band at planting. If all fertilizer is broadcast before planting, Mn can be foliar-applied. Apply 10 lbs manganese sulfate (2 lbs Mn) in banded fertilizer at planting, or 5 lbs manganese sulfate (1 lb Mn) in water as a foliar spray in late June or early July. Include manganese with the regular

spray schedule for 2 to 3 weeks if manganese deficiency appears.

Boron (B) deficiency can cause necrosis in the growing tip or internal breakdown in carrot roots. To avoid this problem, apply 10 lbs borax (1 lb B) per acre in the broadcast fertilizer each year. Boron deficiency occurs on both sandy and muck soils. Do not apply more than the recommended amount or crops sensitive to boron can be injured the following year.

Copper (Cu) deficiency sometimes occurs on new muck. It results in poor orange-color development in carrot roots. If copper levels are below 20 ppm by soil test, apply 12 lbs copper sulfate or 4 lbs copper oxide (3 lbs Cu) per acre per year, until a total of 20 lbs actual Cu has been applied. Since Cu remains available in the soil system and does not leach, no more should be needed.

Spacing and Planting

Chisel-plow land to be planted to carrots to a depth of 24 to 30 inches in the fall, or in the spring before planting. Plow 12-inches deep and roll to form a firm seed bed immediately before planting.

Planting of fresh market carrots begins about April 15 and continues until June 15. Schedule plantings to provide carrots to the packinghouse throughout the season. Carrots planted in mid-April will mature in about 110 days. Carrots planted during warmer weather will mature in 80 to 100 days. Hybrid carrots mature and oversize in about one week, so scheduling of planting and harvest is important. Open-pollinated varieties size more slowly and thus have more flexibility for harvest. Processing carrots are planted from late April to early July. Processing varieties mature in 110 to 130 days, depending on the variety and season.

Carrots are planted with a standard vegetable planter (such as Planet, Jr.) equipped with a multiple row or scatter shoe. The multiple or scatter row should not be more than 4 inches wide because of difficulties with harvesting. Uniform spacing of carrots in the row is desirable to obtain uniform carrots at harvest.

Plant enough seed to obtain 24 live seeds per foot of multiple row for fresh market carrots. Plant 16 to 18 seeds per foot for processing carrots such as Spartan Bonus and Danvers 126, and 12 to 14 per foot of row for Chantenay strains when large size for dicing is desired.

Rows should be 15 to 20 inches apart. Closer spacing makes harvesting difficult and prevents air movement through the leaf canopy, which may result in more blight infestation. Plant carrot seeds $\frac{1}{8}$ to $\frac{1}{4}$ inch deep. Irrigate the fields immediately after planting. If irrigation is not available, plant seeds $\frac{3}{8}$ to $\frac{1}{2}$ inch deep.

Approximately 2 to 3 lbs of carrot seed are needed per acre for fresh market varieties and 1 to 2 lbs for processing varieties. Always plant according to desired plant stand count, considering the germination rate and number of seeds per pound.

Rye or barley strips are often planted between every 3 to 6 rows of carrots to protect early carrots from wind damage. Remove windbreak strips when carrots are 3 to 4 inches high, either with herbicides or mechanically.

Harvest and Postharvest

Harvest begins when carrots are of suitable size. For fresh market, this is around the first week of August. Maximum marketable yield of fresh market carrots is usually obtained when 20% of the carrots in a field are jumbos (over $1\frac{1}{2}$ inch in diameter). Carrots are mechanically harvested by undercutting the roots and elevating them out of the soil and into the machine by grasping the tops. For this reason, it is important to maintain healthy tops until the carrots are harvested. The carrot harvest usually extends into November.

Fresh market carrots are usually packed in 1, 2, 3 or 5-lb plastic bags and then packed in masters. Jumbo carrots are packed in 25 to 50 lb bulk sacks. Care should be taken in harvesting carrots to avoid injuring the roots. Injuries reduce shelf life and increase chances of decay. Fresh market carrots are especially susceptible to injury since they are harvested immature to obtain small sizes. Fresh market

carrots can be stored for 4 to 6 weeks if held at 32°F and 95 to 99% relative humidity.

Harvest of processing carrots usually begins about October 1 and proceeds into late November. Since processing carrots are harvested mature, they can be stored for 4 to 5 months under proper conditions (32°F and 95 to 99% relative humidity). Remove excess soil and rotten carrots but do not wash carrots before being placed in storage.

Do not store carrots in the same room as apples, pears, or other fruit, since these fruits give off ethylene gas which causes a bitter flavor in carrots.

Pests

Annual grasses and broadleaf weeds are the major weed problems in carrots. Since there are few herbicides available for use on carrots, it is essential to use those which are available most effectively. Treat carrots with a preemergence herbicide soon after planting. Any weeds that emerge should be treated with a postemergence herbicide before they are 1 inch tall. Crop rotation and cultivation are also important methods of maintaining fields as weed-free as possible.

If nematodes are a problem, fumigate the soil every 2 or 3 years as needed. Fumigate in the fall with a low-volatile material when soil temperatures are above 50°F at 6-inch depth. After injection of fumigant, roll or float the soil to seal the fumigant in the soil. Crop rotation will help reduce the incidence of nematodes. Depending on the time and location of nematode infection, they can cause forking, stubbing, galling, or fasciculation (many hair roots) of carrot roots.

The most common insect pests of carrot in Michigan are aster leafhoppers (which carry aster yellows), and green peach aphids. Carrot weevils are becoming increasingly common in Michigan. (See Extension Bulletins E-890, Detection and Control of Carrot Weevil, and E-970, Celery and Carrot Insect Pests).

Common foliar diseases of carrots are *Alternaria* leaf spot (blight) (*Alternaria dauci*), *Cercospora* leaf spot (blight) (*Cercospora carotae*), bacterial blight (*Xanthomonas carotae*), and aster yellows. If unchecked,

foliar diseases cause loss of leaves, and root production is diminished. Harvesting becomes difficult, and many carrots may be left in the field.

The symptoms of *Alternaria* and *Cercospora* blights are very similar. Spots on the leaves have a dark center surrounded by a yellow band. Curling of leaves results when lesions appear on the edge of leaf segments. Bacterial blight causes dark brown, water-soaked spots on leaves, and as the lesions age, the centers of the lesions become brittle and have an irregular yellow zone surrounding them. Small brown or maroon spots, or water-soaked flecks may appear on roots. *Alternaria* and *Cercospora* blights can be controlled quite ef-

fectively with fungicides. Bacterial blight may be partially controlled with fixed copper compounds.

Aster yellows causes yellowing, twisting, and eventual reddening of leaves, and excessive formation of fibrous roots. The roots become woody, brittle, and bitter in taste. The leafhopper vector must be controlled to prevent spread of this disease.

A regular spray program is necessary to control weed, insect, and disease pests. Check the latest editions of MSU Extension Bulletins E-312, Control of Insects, Diseases, and Nematodes on Commercial Vegetables, and E-433, Weed Control Guide for Vegetable Crops for current pest control recommendations.

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