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Carrots (*Daucus carota*)

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VEGETABLE CROP
MANAGEMENT

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Variety Types

Imperator

Most common type grown for the commercial fresh and "cut and peel" market. Long (8 - 10"), tapered, slender roots, small core, deep orange color, smooth skinned.

Nantes

Mainly used for home or farmer market or roadside stands, although can also be grown for commercial fresh market and processing. Roots are medium in length (6 - 7"), 1-2" in diameter, cylindrical, generally with a slight shoulder and an abrupt, blunt taper. Known for excellent color and quality.

Danvers

Used for both commercial fresh market and processing. Sometimes referred to the "half long" carrot. Root length is medium (6 - 7") with a conical shape but thicker in diameter (2- 2¹/₂") than imperator types. Pointed or somewhat blunt root tip. Excellent early quality but can become woody with age.

Chantenay

Primarily used for processing due to its excellent yield recovery. Not generally used for fresh market because of coarse raw product root texture. Roots are short to medium size (4¹/₂ - 5 ¹/₂"), with a large diameter at the crown (2 - 2¹/₂") and a conical shape that tapers quickly . Color is generally lighter in color than other types. Generally, late in maturity.

Amsterdam or Miniature

The true "baby carrot". Mostly used for the cello bag. Also used in processed mixed vegetable packs. Roots are short in size (2¹/₂ - 4" long and ¹/₂ - ³/₄" diameter at crown) with a slender, cylindrical shape. Can be difficult and expensive to grow. Generally, these carrots should be harvested at an early stage of development or they become quite woody.

Comment: Many "baby carrots" are manufactured through extensive cutting and peeling of undersized or damaged carrots intended for other fresh markets or produced by controlling their size by using high plant populations.

Recomended Varieties

Yield of each variety will vary from year to year depending on weather conditions, planting schedules and soil types.

Many cultivars are available and new releases occur each year.

Nantes	Imperator	Danvers	Chantenay
Protogé	Apache	Bolero	Gold King
Presto	Navajo	Eagle	Convert
Nanco	Blaze	Goliath	Condor
Nassau	Six Pak II		
Primo	Choctaw		

Seed Companies

Abbott & Cobb Inc. POB F307, Feasterville, PA 19047
 Asgrow Seed Company, 1905 Lirio Ave., Saticoy, CA 93004
 Bejo Seeds, POB 859, Oceano, CA 93445
 Breeders Seeds Ltd, Summerwood Lane, Halsall, Ormskirk, Lancs. L39 8KQ, U.K.
 Clause Ltd, Charvil Farm, New Bath Road, Charvil, Reading RG10 9RU, U.K.
 Chriseed Company, POB 98, Mount Vernon, WA 98273
 Crookham Company, POB 520, Caldwell, ID 83605
 Daehnfeldt Inc. POB 947, Albany, OR 97321
 Elsoms Seeds Ltd. Spalding, Lincolnshire, England PE11 1QG
 Enza Seeds POB 7, 1600AA, Enkhuisen, The Netherlands
 Ferry-Morse Seed Co. POB 4938, 555 Codoni Ave. Modesto, CA 95352
 Harris Seed Co. 3670 Buffalo Rd. Rochester, NY 14624
 Harris Moran, POB 3091, Modesto, CA 95353
 Novartis Seeds, POB 4188, Boise, ID 83711-4727
 Peter Edwards Seed Company, 302 S.Center Street, Eustis, FL 32726
 Petoseed Co. Inc. P.O.Box 4206, Saticoy, CA 93007-4206
 Royal Sluis Inc. 1293 Harkins Rd. Salinas, CA 93901
 Stokes Seeds Inc. POB 548, Buffalo, NY 14240
 Sunseeds Company, 18640 Sutter Boulevard, Morgan Hill, CA 95037
 Vilmorin Inc. 6104 Yorkshire Ter. Bethesda, Maryland 20814 W.
 Osborne Seed Co. Int'l. 1679 Highway 99 South, Mount Vernon, WA 98273



Soil Conditions

Well drained, sandy loam and muck soils of pH 5.5 to 7.0 are desirable. A chisel plow is recommended to work soils to a depth of 12 to 15 inches to minimize compaction and promote good root penetration. Compacted soils will lead to reduced and distorted root growth. The building of raised beds may help to obtain optimum drainage and maximize root length and quality.

Seed Treatment

Carrot seed numbers approximately 23,000 per ounce. Use high quality size graded and fungicide treated seed for optimum uniformity and performance. Pelleted carrot seed is commonly used with precision spacing, and has been found to be useful in improving size and uniformity. A number of pelleting materials are available which differ in weight, cost, and response to soil moisture. Consult with your seed dealer to explore the options.

Seeding

Fields may be seeded as early as the first half of April and as late as the first of July. Generally 2-4 lbs. of raw seed are needed per acre for fresh market or slicing carrots for processing. For dicing carrots, 1-2 lbs. of seed are needed.

If raised beds are used they should be at least 4 inches high on 20 to 40 inch centers. One or two scatter rows (12-15 inches apart) are seeded per bed. For non-bedded plantings use a row spacing of 16 to 30 inches apart and in-row stands of 10-20 plants per foot for dicing, or 20-30 plants per foot of row for slicing (or fresh market) carrots.

Seeding with a precision seeder (ex. Stanhay or equivalent) is recommended. With a special shoe, 3 lines $1\frac{1}{2}$ in. apart are seeded for each row and the seed belt is punched to drop 7 to 8 seeds per foot of line in the two outside lines and 5 to 6 seeds per foot in the middle line. Use the lower seeding rate when the reported germination is over 90% and for planting dicing carrots for processing.

To obtain a uniform size and shape of "true baby" or cut and peel carrots, seed should be sown at high density and distributed evenly in wide bands or solid beds. The seed should not be pelleted but must be size-graded by the supplier. A precision seeder is not necessary for planting this type of carrot. Adequate results have been obtained by planting with a plate seeder at the rate of 80 to 100 seeds per bed foot. Rows should be 2 to 10 inches apart. As many as 10 rows per bed may be used. Planting scatter rows at 4 in. results in a "solid" stand. At this spacing, approximately 20 to 25 lbs. of seed per acre may be required.

Lime

A lime application is suggested where the soil pH is below 5.8 for mineral soils, and 5.4 for organic soils. The need for lime can be determined from a routine soil test. For further information on lime, lime sources, and reference map refer to Nutrient Management for [Commercial Fruit & Vegetable Crops in Minnesota \(BU-5886-F\)](#), **University of Minnesota Extension Service**. Area I (acid subsoils) refers to Eastern Minnesota and Area II refers to Western Minnesota (alkaline subsoils). Lime should be applied before planting and incorporated to a depth of 6 inches.

Lime should be mixed into the seedbed at least several weeks before seeding and preferably the preceding year. A lime application is effective over several years.

For acid soils low in Mg (less than 100 ppm Mg) one ton/A of dolomite lime can be used as a Mg source. Dolomite and ground lime stone have about the same ability to neutralize soil acidity.



Fertilizer Recommendations

A soil test is the most accurate guide to fertilizer requirements. Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest.

Because of the influence of soil type, climatic conditions, and other cultural practices, crop responses from fertilizer may not always be accurately predicted. Soil test results, field experience, and knowledge of specific crop requirements help determine the nutrients needed and the rate of application.

Fertilizer applications for carrots should insure adequate levels of all nutrients. Optimum fertilization is intended to produce top quality and yield commensurate with maximum returns.

The following are recommendations for **Minnesota Soils**:

For carrots, the suggested method of application for N fertilizer materials are usually 1/2 broadcast and worked into the seed bed ahead of planting, and 1/2 sidedress when plants are established. For other nutrients, fertilizer applications should be made before plants and incorporated. If banding equipment is available, some of the fertilizer can be applied at planting. The suggested fertilizer applications are based on a 24" row spacing and 20-25 plants per linear foot of row.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. The University of Minnesota Soil Testing Laboratory or the Extension Educator (agent) in your county can provide you with soil sampling instructions and soil sample bags and information sheets.

Nitrogen(N)

Because of the mobility of nitrate in soils and the complex transformations from organic matter, soil tests for nitrogen are not reliable for predicting nitrogen fertilizer needs in the eastern half of Minnesota (Area 1), particularly on sandy irrigated soils. Therefore, Nitrogen recommendations are based on yield goal, previous crop, and soil organic matter content.

In western Minnesota (Area 2), the amount of residual N in the soil varies considerably because of lower amounts of rainfall. A soil test for nitrate-N (NO₃-N) helps in evaluating the N carry-over from the previous crop in the case of mineral soils, and it should be used to adjust N applications. Soil samples for NO₃-N should be taken from the 0-24 inch soil depth in the spring prior to the application of N fertilizer. Use the following formula to determine your N application for carrots in western Minnesota:

$$\text{Fert}_N = \text{N}_{\text{Rec low O.M.}} - \text{Soil}_{\text{N 0-2ft}}, \text{ where:}$$

$$\text{Fert}_N = \text{Fertilizer N to Apply}$$

$$\text{N}_{\text{Rec low O.M.}} = \text{N Recommendation at Low Organic Matter}$$

$$\text{Soil}_{\text{N 0-2 ft}} = \text{Soil Nitrate (0-2 ft.)}$$

Refer to Nutrient Management for [Commercial Fruit & Vegetable Crops in Minnesota \(BU-5886-F\)](#), University of

Minnesota Extension Service, for more information and reference map.

Nitrogen recommendations for carrots:

Approximate Yield Goal ² cwt/A	Soil Organic Matter Level (O.M.) ¹			Organic Soil
	Low	Medium	High	
	-----N to Apply (lb/A)-----			
350	120	100	80	50

Suggested Method Of Application^{2,3,4}

1/2 broadcast, 1/2 sidedress when plants are established

¹ Low O. M. = less than 3.1%, Medium O. M. = 3.1 - 4.5%, High O. M. = 4.6 - 19%, Organic soil = greater than 19% O. M.

² Recommendations are based on attaining approximate yield goals listed.

³ Suggested methods of application are a general guide and can be modified when appropriate.

⁴ On sandy soils, sidedress applications may be split 1 - 2 more times (not to exceed total recommended unless a need is indicated).

Nitrogen credits for previous crops:

Alfalfa (good stand)	50 lb N/A
Alfalfa (poor stand)	40 lb N/A
Alsike clover	
Birdsfoot trefoil	
Grass-legume hay	
Grass-legume pasture	
Red clover	
Snap beans	20 lb N/A
Peas	20 lb N/A
Soybeans	40 lb N/A
All other crops	0 lb N/A

Phosphorus(P)

Carrots require adequate available P for satisfactory growth. Broadcast P and work into the seed bed before planting.

Phosphorus recommendations for carrots:

Bray-P1	Soil Test P Level (ppm)					
	0-10	11-20	21-30	31-40	41-50	51+
Olsen-P	0-7	7-15	16-25	26-33	34-41	42+
Yield Goal ¹ cwt/A	---P ₂ O ₅ to Apply (lb/A) ² ---					
350	150	100	75	50	25	0

¹ Recommendations are based on attaining approximate yield goals listed.

² Recommended rates are for total amount to apply: broadcast + starter. Up to 70 lb P₂O₅ can be banded at planting.

Potassium(K)

For optimum growth carrots require a good supply of available K. Broadcast K and work into the seed bed before planting.

Potassium recommendations for carrots:

	Soil Test K Level (ppm)					
	0-40	41-80	81-120	121-160	161-200	201+
Yield Goal ¹ cwt/A	---K ₂ O to Apply (lb/A) ² ---					
350	200	150	100	75	50	0

1 Recommendations are based on attaining approximate yield goals listed. 2 Recommended rates are for total amount to apply: broadcast + starter. Up to 30 lb K

Secondary Nutrients

The secondary macronutrients, calcium, magnesium, and sulfur, are generally not limiting to crop production in most Minnesota soils except under certain conditions.

Sulfur(S)

Base sulfur needs on a soil test (table below). S is sometimes contained in fertilizers used to supply other nutrients such as N, P, and K, but may not be present in sufficient quantity. Plants absorb S in the form of sulfate. Fertilizer materials supply S in the form of sulfate and elemental S.

Elemental S must convert to sulfate in the soil before the S becomes available to plants. The conversion of elemental S to sulfate is usually rapid for fine ground (less than 40 mesh) material in warm moist soil.

Sulfur in the sulfate form can be applied at planting time. Some S fertilizer materials such as elemental and ammonium sulfate have an acidifying effect on soil.

Sulfate is susceptible to leaching on sandy soils and deficiency is most common on sandy low organic matter soils. Soil tests for sulfur are only accurate for low or medium organic matter soils. If deficiency is known or suspected, refer to the following table for sulfur soil test recommendations.

Sulfur recommendations for carrots:

Sulfur Soil Test	Relative level	Sulfur to apply	
		Broadcast	Row
---- ppm ----		----- lb/A -----	
0 - 6	low	20 - 30	10 - 15
7 - 12	medium	trial only	
12.1 +	high	0	0

Magnesium(Mg)

Magnesium deficiency may occur in acid sandy soils. Soil tests less than 50 ppm Mg are considered low. If Mg deficiency is known or suspected, the use of dolomitic limestone is the best long range approach. Apply low rates (approximately) 1,000 lb/A if maintenance of soil acidity is desired. Other more immediate available sources of Mg include potassium-magnesium sulfate (11% magnesium) or epsom salts (10% magnesium).

Magnesium recommendations for carrots:

Magnesium Soil Test	Relative level	Magnesium to apply	
		Broadcast	Row
---- ppm ----		----- lb/A -----	
0 - 49	low	100	20
50 - 99	medium	50	10
100+	high	0	0

Micronutrients

Copper(Cu)

Muck soils tend to be deficient in Cu and "fix" Cu. If Cu levels are less than 2.5 ppm, apply 10 lb Cu/A to the soil before planting, OR two foliar applications of 0.15 lb Cu in 100 gal water /A may be applied to carrot leaves. Soil Cu applications need not be repeated every year. The best indicator for copper is leaf analysis.

Consider copper applications when leaf copper levels are below 5 ppm. When Cu levels are between 2.6 to 5 ppm, broadcast 6 lb Cu/A or apply 0.1 lb as a foliar spray.

Boron(B)

Deficiency of boron is most likely on sandy soils low in organic matter. Excessive rainfall or irrigation may leach boron from sandy soils. A suspected boron deficiency should be confirmed by soil and plant analysis before a boron fertilizer is applied.

Do not exceed the recommended rate of application. Excess B can be toxic to carrots. Recommended rates of boron application based on soil and plant tests are given in the following table.

Boron recommendations for carrots:

Boron Soil Test	Relative Level	Boron to Apply
--- ppm ---		--- lb/A ---
0.0 - 0.4	low	2
0.5 - 0.9	medium	1
1.0+	high	0

Boron should be broadcast uniformly on the soil. Never place boron in a side-band close to the seed at planting.

Manganese(Mn)

Manganese deficiency problems are most likely to occur on organic soils with a pH greater than 5.8. Soil tests for Mn are not that reliable for predicting Mn needs. Manganese fertilizer applications are suggested if carrots are grown on organic soils with a pH greater than 5.8. Broadcast 10-15 lbs. Mn/A or apply 0.2-0.4 lbs. Mn/A as a foliar chelated Mn spray with 50-100 gallons of water. Foliar applications should be repeated two or three times during the growing season.

Other Nutrients

Responses of carrots to nutrients other than those discussed in this guide have not been observed in Minnesota.

Using Manure

The amount of plant nutrients in a fertilizer program can be reduced if manure is used. The nutrient content of manure varies with type of livestock and methods used in storage, handling, and application. Many laboratories will measure the nutrient concentrations in manure. Manure analysis is strongly recommended if routine applications are made for crop production. The results of such an analysis will give a more precise measurement of the nutrient value of manure. Over application of manure can cause excessive top growth at the expense of shoot growth.

Tissue Analysis

Plant tissue analysis can be used during the growing season to monitor the nutrient status of the plant and help diagnose nutritional problems. Although not a substitute for soil testing, it can help to provide additional information related to crop nutrition and the effectiveness of a particular fertilizer program. Sufficiency levels can be determined from young mature leaf taken at time of mid-growth. Depending on the field size, at least 25 leaves should be taken for an adequate analysis. Plant analysis can be done at the University of Minnesota Soil Testing Lab or other commercial laboratories in MN on a fee basis.

Nutrient Concentration Sufficiency Ranges for Carrots

N	P	K	Ca	Mg	S	Fe	B	Cu	Zn	Mn	Mo
----- % -----						----- ppm -----					
2.5-3.5	.20-.30	2.8-4.3	1.4-3.0	.30-.50	---	50-300	30-100	5-15	25-250	60-200	.5-1.5

Refer to [Nutrient Management for Commercial Fruit & Vegetable Crops in Minnesota \(BU-5886-F\)](#), University of Minnesota Extension Service, for more information on plant analysis and tissue testing.



Irrigation Management

Critical Growth Periods

Carrots are most sensitive to moisture stress during root enlargement and seed germination. Irrigation can improve emergence, reduce wind erosion, and lower temperature at the soil line during germination. Carrot yield, like beets, radishes and onions depends on production and translocation of carbohydrates from the leaf to the root. Moisture stress is reported to cause small, woody, and poorly flavored roots. Irregular watering can also cause rough, lumpy, carrots with obvious growth rings. Water stress may also cause growth cracks and cracking often occurs when watering after the plant has suffered from water deficiency. Carrots grown on Minnesota peat land generally are not irrigated as these soils hold adequate water but in some years have been put under water stress.

Water Use

In Washington carrots require about the same irrigation amount of water as sweet corn and about 3 inches less than crucifers. Michigan reports that carrots need about 10 to 14 inches of water during the growing season. In California carrots are irrigated generally about 1 inch per week and 14 and 15 inches over the growing season (50-95 days). Michigan reports that carrots like a uniform supply of water throughout the growing season (Zandstra). Peirce suggests that carrots need about 1.5 inches per week. Kruse in Colorado found Spartan Sweet carrots to yield 1100 to 1400 pounds per inch of ET. Melstad in South Dakota found Scarlet Nantes carrots to use 28 inches of water to yield 2600 to 3500 pounds per inch of water.

Daily crop water use is very dependent on stage of growth and usually will peak when plants are nearing midway in their growth season. Haldeman reports that peak water use of carrots in Arizona occurs when the plant leaves are 7 to 10 inches tall. Listed in the table below are estimated daily crop water use values for various maximum temperature ranges at different plant weekly growth stages using historical weather data from St. Cloud, Minnesota.

Average crop water use for carrots in inches per day:

(°F)	WEEKS AFTER EMERGENCE													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50-59	.01	.03	.04	.06	.07	.09	.09	.09	.09	.09	.08	.07	.07	.06
60-69	.02	.04	.06	.09	.11	.13	.13	.13	.13	.13	.12	.11	.10	.08
70-79	.03	.05	.08	.11	.12	.16	.17	.18	.17	.17	.16	.15	.13	.11
80-89	.03	.06	.10	.14	.17	.20	.21	.22	.22	.21	.20	.18	.16	.14
90-99	.04	.07	.12	.17	.21	.24	.25	.26	.26	.26	.24	.21	.19	.16

Irrigation Systems

When irrigation is determined necessary, several factors need to be considered in planning an effective irrigation system. The first step in designing an irrigation system is doing an evaluation of the existing resources and proposed cropping needs such as soil types, water supply availability, plant water needs in peak use periods, field layout, land topography, and available labor, electric power and capital. When reviewing the land site, include any areas that possibly may be used for future expansion.

Water supply is the foundation of an irrigation system. For sandy textured soils in Minnesota, it is desirable to design an irrigation system to meet a plant's water needs during peak water use periods. The table below lists the minimum pumping capacity in gallons per minute (GPM) per acre for various daily pumping times that is needed with a sprinkler irrigation system to meet a crop's water needs of .25 inches per day.

Minimum Irrigation Pumping Capacities:

Pumping Hours/Day	8	12	16	20	24
GPM/Acre	19	13	9	8	6

In Minnesota, if more than 10,000 gallons/day (equal to 7 GPM) or 1 million gallons /year (equal to 36 acre-inches) is needed for irrigation, a State Water Appropriation Permit is required from the Minnesota Department of Natural Resources (612-296-4800).

Irrigation systems consist of some type of a water distribution system, pipelines, and a pumping plant. There are several types of irrigation distribution systems. Irrigation of most vegetables on sandy soils in Minnesota is best accomplished by a sprinkler irrigation system like a solid set, center pivot, linear move, or a traveling gun. Trickle/drip is another irrigation option for some crops but cannot provide a good system for germination assistance. Each type of system has several arrangements with capabilities and limitations that should be considered in the selection process. If irrigation for germination is a projected need, a sprinkler system should be selected that offers a spray pattern with medium to fine droplet size to reduce soil crusting. Center pivots and linear systems have several sprinkler package options that provide the right droplet size and drift control. Initial investment for any system is very dependent on field size and can range from less than \$300 to over \$1000/acre plus the cost for water supply construction, pumping plant, automatic controls, etc.

For a specific design, an experienced irrigation dealer or engineer should be involved in the actual system design. Also, other local experts should be consulted as to special needs for the crop and soil.

Water Strategy

Carrots grow best in deep sandy or sand loam soils or organic soils. They will root between 6 and 36 inches depending on variety. Optimum root growth occurs at 60 to 70 degrees and higher temperatures may reduce root length (Peirce). Uneven irrigation can lead to misshapen or split roots in carrots. Irrigation in Arkansas was found not to affect carotene content but did reduce solids and the shortest (7) day frequency of supplement water produced best yield (Stewart). Preplant irrigation should be encouraged if soil moisture is inadequate. Good sub soil moisture in the beginning of the season promotes a deeper root system. Sanders suggests that when watering, the soil should be soaked so that there is no separation between the surface and sub-moisture. North Carolina reports that carrots like soil moisture between field capacity and 50 percent depletion and a soil tension not greater than 45 centibars.

Soil Water Monitoring

Careful attention to monitoring of the soil moisture, climate and crop growth is essential if growers are to apply the correct amount of irrigation water at the correct time. Several soil moisture monitoring methods are available to assist the grower in proper timing of irrigation water to maintaining healthy plant growth such as tensiometers, soil water block sensors, soil probe, and checkbook water balancing worksheet. A discussion of the typical monitoring methods can be found in University of Minnesota Extension Service bulletin ([FO-3875](#)) [Irrigation Water Management Considerations for Sandy Soil in Minnesota](#) and ([FO-1322](#)) [Irrigation Scheduling - Checkbook Method](#).

Irrigation Management References:

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Harvest, Handling, and Storage

Carrots for processing are harvested between August 15 into late fall. The prime processing harvest period is between September 15 and October 25. Early fresh market carrots are harvested from late July to September and late carrots are harvested into October. For the wholesale fresh market, carrots must be over 5 inches long and between 3/4 and 1 1/2 inches in diameter. Carrots harvested and handled in hot weather are more likely to decay, and care should be exercised in handling to prevent wilting.

(Quoted from USDA Ag. Handbook #66):

Mature topped carrots can be stored 7 to 9 months at 32 to 34°F. with a very high relative humidity, 98 to 100 %. However, even under these optimum conditions 10 to 20 % of the carrots may show some decay after 7 months. Under commonly found commercial conditions (32 to 40°F.) with 90 to 95 % relative humidity, 5 to 6 months storage is a more realistic expectation. Prompt cooling to 40°F or below after harvest is essential for extended storage. Poorly pre-cooled roots decay more rapidly.

Store carrots at 32°F and relative humidity of 98 to 100 %. Mature carrots are well adapted for storage and are stored in large quantities during the fall and winter for both the fresh market and processing. Careful handling during and after harvest to avoid bruising, cutting and breakage will help ensure successful storage. Carrots held at or below 30°F will freeze. Ice crystals will form, giving the roots a bristly appearance and cracks. Severe injury in carrots immediately after freezing is identified by lengthwise cracking and by blistering caused by the formation of ice crystals immediately beneath the surface. After thawing, a darkened and water-soaked skin is observed, and the carrots are soft and flabby.

The most important decays of carrots in storage are gray mold rot (*Botrytis*), watery soft rot (*Sclerotinia*), crater rot (*Rhizoctonia*), *Fusarium* rot, *Rhizopus* soft rot, bacterial soft rot, black rot (*Stemphylium*), and sour rot (*Geotrichum*). Spoilage losses will be minimized if the following precautions are observed: Use new or disinfected storage containers, handle carefully to prevent injuries, pre-cool carrots, maintain them at a temperature near 32°F and avoid temperature fluctuations.

Carrots lose moisture readily and wilting results. Humidity should be kept high. Carrots stored at 98 to 100 % relative

humidity develop less decay, lose less moisture, and remain crisper than those stored at 90 to 95 % relative humidity. A temperature of 31 to 34°F. is essential if decay and sprouting are to be minimized. With storage at 40 to 50°F, considerable decay and sprouting may develop within 1 to 3 months.

Prestorage washing of carrots in clean water containing 100 ppm chlorine is desirable. Many potential decay-causing organisms are removed by washing. Also, clean, washed carrots allow freer air circulation. Air circulation within bulk piles of stored carrots is desirable to remove respiratory heat, maintain uniform temperatures, and help prevent condensation. An air velocity of about 14 to 20 ft/min is adequate at low storage temperatures.

Immature bunched carrot storage life is limited by the high perishability of the tops. They should keep 2 weeks at 32°F with 95 to 100 % relative humidity. Contact ice is recommended to maintain freshness.

Immature or partially mature carrots should be topped and packed in polyethylene consumer bags or 50 lb. mesh bags for marketing. Most carrots for the fresh market are of this type. If pre-cooled promptly before packaging and trimmed of all traces of leaf growth, they can be held 4 to 6 weeks at 32°F with 98 to 100 % relative humidity recommended. Film bags for carrots should be perforated to allow ventilation and prevent development of off-odors or off-flavors. Six 1/8th inch holes of 1 lb. bags are suggested for ventilation.

Immature, topped carrots may be hydrocooled or packed in crushed ice for cooling. Loose carrots can be hydrocooled from 75 to 40°F in about 9 minutes if the water is 33°F. If the carrots are in 50 lb. mesh bags, the same degree of cooling requires about 11 minutes. Sometimes top ice is used with bagged, pre-cooled carrots. The top ice provides some of the necessary refrigeration and prevents dehydration.

Bitterness in carrots, which may develop in storage, is due to abnormal metabolism caused by ethylene. This gas is given off by apples, pears, and certain other fruits and vegetables and from decaying tissues. Bitterness can be prevented by storing carrots away from such produce. Also, development of bitterness can largely be avoided by low-temperature storage, as it minimizes ethylene production. Some surface browning or oxidative discoloration often develops in stored carrots. The most immature carrots are the most susceptible to surface browning.

Packaging

Fresh market carrots are washed, sorted, and packed in one or two pound plastic bags packaged 48 - 1 lb. bags, or 24 - 2 lb. bags per carton; or loose in 50 pound mesh or plastic sacks at a packing house.

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