

Crop Profile for Carrots in New Jersey

Prepared: February, 2003

General Production Information

The information provided in this profile represents 280 acres of processing carrots from three farms in southern New Jersey, which accounts for 93% of all the state's carrot acreage in 2002. This is probably the state's lowest processing carrot acreage in many years. The largest carrot grower (approx. 200 acres) opted not to raise carrots in 2002 due to severe damage caused by carrot weevil.

Production Facts

- **State rank** : New Jersey ranks 9th nationally in carrot production, 1997 data (3)
- **New Jersey's contribution to total US production:** fresh market = <1%; processing = 1%
- **Typical per acre yields:** 20 to 27 tons
- **Annual production costs:** \$800 to \$1200/acre
- **Percent of crop for processing and fresh market:** 93% processing; 7% fresh market

Production Regions

Southern New Jersey (area south of Trenton)

All processing carrots, *Daucus carota sativa*, are grown in the southern half of New Jersey with most of the fresh market acreage grown in central and northern New Jersey. The soils in the south are coastal plain, generally light soils ranging from sand to sandy loams, but areas of heavier, clay and silt loam soil do exist. Elevations are low with most of the area less than 200 feet in elevation. The warmest, seasonal temperatures occur in the extreme southern part of the state with the Salem County area being the warmest.

Cultural Practices

Carrots are raised in both sandy loam and silt loam soils. In an exceptionally dry year as 2002 was the carrots grown on silt loam soils produced higher yields than those grown on sandy loam soils. In a "wet" year the yields probably would have been different with the sandy loam out yielding than the silt loam. Fields are fumigated principally with Vapam prior to planting for nematode, disease pathogen and some weed control. Depending upon soil test results for nematodes Telone II may also be used.

Processing carrots are direct seeded in the field in single rows with 22 inches between rows. All processing carrots are "dicers" and are planted at a rate of 12 to 14 ounces per acre equivalent to approximately 300,000 seeds per acre. The desired seeding rate per foot is from 12 to 15 with a final stand count of 7 to 8 carrots per foot. There is only one planting a year. Planting occurs from mid-April to early May. Harvest begins in October and in most years is completed by mid-November. Weather conditions may interfere with harvesting so that harvesting continues until completion or until the ground freezes. Excessive moisture delayed harvesting in the fall of 2002.

Because Campbell Soup Company is the primary carrot processor for New Jersey farmers, Campbell Soup variety 1374 is the primary variety. Other recommended varieties for processing carrots are Spartan Bonus 80, Danvers 126 and Nantes types. At the first cultivation the soil is mounded up onto the carrots to help prevent greening of the shoulders. After successive cultivations the carrot rows have taken the form of raised beds. Two farmers plant onto 9" tall ridges made prior to seeding; one farmer uses a onerow ridge and the other uses a 3 row bed.

Harvesting is a two step process. First a machine that "tops" the carrot plant is brought through the field which slices off the top end of the carrots – three to six rows at a time depending whether the carrots were on ridges or not. After topping the harvester (a modified potato digger) digs under the carrots lifting them out onto a chain conveyor belt separating the carrots from the dirt. The carrots are loaded directly into a truck and taken to the packing house for further cleaning and sorting. They are then loaded into a second truck which proceeds to the processor.

Insect Pests

In New Jersey, the primary insect pests of carrots are carrot weevils and wireworms.

Carrot weevil – *Listronotus oregonensis*. Carrot weevil is the most important insect pest of carrots in New Jersey and can be found in all or nearly all carrot fields. Within the past few years the carrot weevil population has built up probably in part because of a lack of spatial crop rotation, weather conditions and other factors. Carrot weevil now threatens the viability of processing carrot production in New Jersey.



One practice that may help increase carrot weevil problems is selling culled carrots for deer bait. Farmers sell culled carrots for another source of income. Deer bait is placed in areas where deer frequent to draw them in for hunters. These carrots

may be infested and any remaining carrots in the spring would provide additional food for existing endemic weevil populations. How much this practice influences weevil populations and pest pressure is unknown.

Carrot weevils have three overlapping generations a year so that all life stages may be found at any time during the growing season. Adults and pupae, and possibly larvae, overwinter. It has been widely believed that adult weevils survive the winter in fencerows and field borders, but observations during the 2002 growing season indicate that the adults can overwinter in the field. Adults become active in the spring when the soil surface reaches 60 degrees F. Several weeds serve as alternate hosts for weevils including broadleaf plantain, lance-leaf plantain, Queen Anne's lace and various species of dock. In New Jersey parsley is also attacked. Carrots become attractive to the weevil at about the 4 true leaf stage (1). The females lay eggs in slits on the petioles of the leaves. Newly hatched larvae fall to the ground and begin feeding externally on the root. Carrots may still be marketable despite feeding injury as long as it is superficial, however, deep tunneling is unacceptable. After 4 molts pupation occurs either in the carrot or more commonly in a small cell formed in the soil up to an inch away from the carrot. Male and female weevils are extremely difficult to differentiate. Boivin (1) reports that the first ventral abdominal segment is swollen in females and depressed in males but this has not been evaluated in the New Jersey population. Males tend to be smaller but undoubtedly there is an overlap between males and females in size. Adults have wings but apparently fly very little, if at all, and most of their distribution comes from walking.





Currently bait traps are used to help determine the presence of active weevils. A fresh carrot is placed in a slot cut in a 2x4 inch piece of wood and placed on the ground along the borders of the field and is checked once or twice a week for adult weevils. Traps are subject to tampering by deer and groundhogs which limits the effectiveness of the traps. These traps are generally effective until the carrots in the field become attractive to the weevils. In 2002 it was discovered that pitfall traps (plastic cups set in the ground flush with the soil surface containing an antifreeze mixture which both kills insects and preserves them) also trap weevils and these will be deployed in monitoring of carrot weevil in 2003.

Threshold. The presence of adult weevils in the field.

Wireworms – various species. Wireworms are the larval stages of click beetles that are frequent crop pests. The primary species in the carrot growing areas is *Melanotus communis* (?). Wireworm feeding injury tends to be short holes more or less straight into the carrot, though occasionally tunneling occurs in the center of the carrot. *Melanotus* wireworms may exist in the soil for 5 or 6 years although other species have one or three year life cycles.

Threshold. Not established.

Black cutworm – *Agrotis ipsilon*. Cutworms are secondary pests that will feed on the carrot root. The percent of carrots with feeding damage is usually low although damaged carrots are often unacceptable.

Threshold. Not established.

Aster leafhopper – *Macrostelus fascifrons*. This insect is a minor pest that is capable of vectoring the aster yellows plant pathogen. Feeding damage by the leafhopper alone is inconsequential. Of susceptible plant species to aster yellows, carrots are fairly resistant and infected plants are seldom seen.

Threshold. Not established.

TYPICAL USE OF CHEMICAL CONTROLS- INSECTICIDES

General Use Insecticides

None.

Restricted Use Insecticides

Oxamyl – Vydate L (reentry time = 48 hrs; Preharvest internal (phi) = 14 days) (2)

- Used on 280 acres (100%) – 1 to 2 lbs per acre representing 80% of insecticide used
- Up to 4 applications may be made

Cyfluthrin – Baythroid 2(reentry time = 12 hrs; phi = 0) (2)

- Used on 100 acres (35%) – 2.8 oz representing 10% of insecticide used
- One application was made.

Esfenvalerate – Asana XL(reentry time = 12 hrs; phi = 7 days) (2)

- Used on 100 acres (35%) – 6.3 oz representing 10% of insecticide used
- One application was made.

Table 1. Current (2002) Pesticide Recommendations for Insect Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

Carrot weevil		
Esfenvalerate	9.6 fl oz of 0.66 EC/a*	R
Cyfluthrin	2.8 fl oz 2 E/a**	R
Oxamyl	2 to 4 pt 2 L/a (directed spray)***	R
Cutworms		
Esfenvalerate	5.8 to 9.6 fl oz of 0.66 EC/a*	R
Cyfluthrin	1.6 fl oz 2 E/a**	R
Methomyl	1.5 pt to 3 pt LV/a	R
Carbaryl bait	5 to 10 lbs of carbaryl bait/a	G
Aster leafhopper		
Esfenvalerate	5.8 to 9.6 fl oz of 0.66 EC/a*	R
Methomyl	1.5 pt to 3 pt LV/a	R
Malathion	2 pt 57 EC/a	G
Methoxychlor	2 to 4 lbs 50 WP/a	G
Wireworms****		

*Applications of esfenvalerate not to exceed 97 fluid ounces per season.

**Applications of cyfluthrin not to exceed 5 applications per season.

***Applications of oxamyl not to exceed 32 pints per season.

****Currently there is no chemical recommendation for wireworms. Using bait traps and knowledge of field history,

farmers should avoid fields with wireworm infestations.

Chemical Use in IPM Programs

An IPM program has not been developed to address preferred selection of materials. Esfenvalerate may be a more environmentally benign material but its overall effectiveness in reducing carrot weevil populations is questionable.

Chemical Use in Resistance Management

Although growers are always urged to rotate chemical classes in their spray programs the paucity of registered materials makes resistance management difficult.

Alternatives

The vegetable entomologist is in the process of requesting an emergency use exemption for Imidan.

Cultural Control Practices

Crop rotation is practiced but the carrot growing region seems to have a high natural population of carrot weevils and wireworms.

Biological Controls

None.

Post Harvest Control Practices

None.

Weeds

Although all weeds are pests in carrot fields there are few that are especially noxious. Because of the time of planting and harvesting, winter annuals are not a problem for the carrot grower.

Summer Annuals

Dodder – *Cuscuta sp.* Dodder is a parasitic plant deriving its water and nutrient needs from other plants. Shortly after germination and emergence the dodder plant begins its parasitic existence complete with the withering of the stem and roots. Dodder prefers moist field conditions and will form mats of orange tendrils which often cover host plants. Dodder can reduce yields but seldom causes serious problems. One farmer will pull dodder off of the carrots and another farmer spot sprays paraquat on dodder infestations.

Typical Use of Chemical Controls - Herbicides

General Use Herbicides

Trifluralin – Treflan HFP (reentry time = 12 to 24 hrs; preplant incorporated) (2)

- 1 lb of active ingredient per acre applied to 280 acres
- 1 application made as a preplant incorporated material

- represents 50% of herbicide active ingredients

Linuron - Linex 4L (reentry time = 24 hrs; phi = 14 days) (2)

- 1 lb of linuron applied to 280 acres 1 to 3 times
- 2 farmers use 2 applications made one week apart after carrots have reached two or more inches in size
- represents 50% of herbicide active ingredients

Clethodim – Select (reentry time = 12 to 24 hrs; phi = 30 days) (2)

- Used for grass control 1 to 2 applications
- Applied on 100 acres of carrots

Restricted Use Herbicides

None.

Table 2. Current (2002) Pesticide Recommendations for Weed Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

<i>Preplant Incorporated</i>		
Trifluralin	0.5 to 0.75 lb/a	G
<i>Preemergent</i>		
Linuron	0.5 to 1.5 lb/a	G
<i>Postemergent</i>		
Clethodim	0.094 to 0.125 lb/a	G
Sethoxydim	0.2 to 0.5 lb/a	G
Fluazifop	0.125 to 0.188 lb/a	G
Linuron	0.75 to 1.5 lb/a	G
Metribuzin	0.25 lb/a	R

Chemical Use in IPM Programs

Given the general nature of weed problems the current herbicide selections fit well with an IPM approach.

Chemical Use in Resistance Management

While farmers are urged to rotate classes of herbicides for resistance management, most likely the farmers have continued using the same materials.

Alternatives

None aside from cultivation.

Cultural Control Practices

In 2002 one farmer did have field crews go through all the carrot fields removing jimson weed by hand. Another farmer typically hand weeds in addition to herbicides especially for dodder.

Biological Controls

None.

Post Harvest Control Practices

None.

Diseases

Two of the three carrot growers rely upon Tomcast, a computer program used to forecast optimal periods of disease pathogen activity, for applying fungicides to manage alternaria and cercospora leaf blights. The disease severity values are produced by equipment operated by Steve Johnston, Specialist in Vegetable Pathology, Rutgers Cooperative Extension. The information is provided to Violet Packing Company which makes the information available to carrot and tomato growers via a dial-up codaphone.

Bacterial leaf blight – *Xanthomonas campestris* pv *carotae*. (5) This disease is occasionally seen in New Jersey carrots. The primary source of infection is seed contamination. Depending upon the amount of contamination, wet conditions cause the disease to flare up. Excessive rainfall or irrigation after planting may be sufficient to initiate the disease. Brown lesions occur initially in the forked areas of the leaves and may cause the whole leaves to wilt, significantly reducing yields. Once detected on the foliage, copper fungicides can be applied to slow the disease spread.

Threshold – Presence of disease in the field.

Alternaria leaf blight – *Alternaria dauci* (= *A. porri* f sp. *dauci*). (5) This is a common fungal disease that sometimes can be confused with bacterial blight because of similar foliar lesions. The brownishblack lesions often have a yellow halo about the lesion. Once lesions occupy about 40% of the leaf the leaf wilts and dies. Seedlings may become infected and often die becoming a source for spore release. Moderate temperatures and prolonged leaf wetness favors disease development. Most infections come from contaminated seed but spores may be wind blown and new infections may occur in fields downwind from other infected fields. Soilborne infections may occur but annual crop rotation appears to prevent this type of infection.

Threshold - Presence of disease in the field, or presence of optimal weather conditions.

Cercospora leaf blight – *Cercospora carotae*. (5) This is another common fungal disease that attacks foliage. In contrast to Alternaria leaf blight cercospora blight tends to infect younger foliage and often precedes Alternaria infections. Lesions begin as brown flecks on the foliage which increase in size turning tan with yellow halos. Lesions occurring along the leaf margins are elongate and lesions occurring inside away from the margins are more circular. Foliar lesions may coalesce causing the leaves to curl and wither. Stem lesions which are elliptical also occur. Contaminated seed and spores arising from wild species of *Daucus* are the primary sources of infection but spores can be easily transported by contact by man or machine or splashing water either as irrigation or rain.

Threshold – Presence of disease in the field, or presence of optimal weather conditions.

The leaf blights have less yield reduction potential for New Jersey growers because of the manner in which the carrots are harvested. Where carrots are harvested by pulling the carrots out by the leaves, blight weakened leaves will break

more readily than healthy ones so that carrot roots are often left in the ground. Since New Jersey growers typically cut off the tops and then dig up the carrots do not have this kind of potential yield loss.

Crown rot – *Rhizoctonia solani*. (5) Crown rot is occasionally seen in mature carrots near harvest. Root infections are favored by wet soil and moderate temperatures. Lesions are dark brown and sunken occurring near the crown or further down the carrot. Sometimes these lesions may be confused with insect injury. If the lesions are severe enough the stricken carrots may not be marketable. Crop rotation is one of the best ways to avoid severe problems with crown rot. Carrots probably should not be planted following alfalfa or other crops typically susceptible to *Rhizoctonia* infections.

Threshold – None established.

Root dieback – *Pythium spp.* (5) Root dieback occurs when any damage occurs to the main taproot of the plant including biotic and abiotic conditions. When the root tip is damaged it loses its apical dominance and other root tips develop ultimately causing forked or stubby roots. The soilborne *Pythium* fungi also contribute to the incidence of root dieback. Disease caused root dieback most often occurs in moist soil.

Threshold – None established.

Aster yellows – *mycoplasma-like organism*. This disease is common among herbaceous plants and vegetables in the mid-West but is relatively uncommon in New Jersey. In carrots it is a relatively minor disease because carrots generally seem to be resistant to some degree. The incubation period in the plant is fairly long also so that plants that become infected within two weeks of harvest will show no symptoms by harvest. The pathogen is vectored primarily by the aster leafhopper. Other leafhoppers vector it but not as well. Infected plants become yellowish with a proliferation of twisted leaves and petioles which will easily break off. Masses of new roots develop but eventually the plant dies. Plants exhibiting symptoms are unmarketable.

Threshold – None established.

Typical Use of Chemical Controls - Fungicides

The onset of fungicide use is either from referring to Tomcast data or the size and density of the carrot canopy.

General Use Fungicides

Chlorothalinalol – Bravo 500 (Reentry time 12 hrs – phi = 0) (2)

- Used on 100 % of carrot acreage
- One farmer typically applies 1 ½ pt with each insecticide application
- One farmer applies chlorothalinalol alternating with quadris every two weeks

Azoxystrobin – Quadris (Reentry time 4 hours – phi = 0) (2)

- One farmer applies 12 oz. as needed, alternating with chlorothalinalol from early July to within 2 weeks of harvest
- Used on 64% of the carrot acreage

Restricted Use Fungicides

None.

Table 3. Current (2002) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

<i>Damping Off</i>		
Mefenoxam	1 to 2 pt 4 E/a (Ridomil Gold)	G
<i>Aster yellows</i>	Manage the vectoring leafhoppers.	
<i>Leaf blights</i>		
Chlorothalonil	1.5 to 2 pt 6 F/a	G
Azoxystrobin	9.2 to 20.3 fl oz of 2.1 F/a	G
Iprodione	1 to 2 lb of 50 WP/a	G

Chemical Use in IPM Programs

The two fungicides are both recommended as broad spectrum fungicides of different classes which makes a good fit in an IPM approach to disease management.

Chemical Use in Resistance Management

The use of different classes of fungicides helps reduce disease resistance to either material.

Alternatives

There are other fungicides but they don't have the utility of chlorothalinol and azoxystrobin.

Cultural Control Practices

Crop rotation is useful for disease management of carrots. Avoidance of fields that were recently planted to carrots helps reduce new infections. Use of disease resistant varieties will help reduce disease severity.

Biological Controls

None.

Post Harvest Control Practices

None.

Nematodes

Root knot nematode – *Meloidogyne* spp. probably *hapla*. Root knot nematode has been a significant pest of carrots in southern New Jersey. The nematode causes distortion of the root system including swollen gall or knots by the feeding activities of mature nematodes. Both males and females develop on the roots, however the females stay inside the roots while the males remain active outside. The female retains the eggs which ultimately hatch. The young nematodes live freely for awhile in the soil and then return to a suitable host to feed upon. There may be as many as three generations per growing season.

Severely infested plants are stunted or killed during germination and may produce small or unmarketable carrot roots.

Sandy soil is more conducive to root knot nematode presumably because of the larger pore spaces facilitates their movement when the soil is moist. Yield reductions can be severe. Crop rotation may be of benefit especially if small grains are grown in root knot infested fields. However, root knot nematode has many host plants and elimination of this nematode from a field using crop rotation alone would be difficult.

Threshold – Presence of nematodes in a soil sample prior to planting.

Cyst nematode – *Heterodera carotae*. The carrot cyst nematode has a very narrow host range that is restricted to within the genus Daucus. This nematode is not currently found in New Jersey although *H. carotae* has apparently been found in Michigan (5).

Threshold – Presence of nematodes in a soil sample prior to planting.

Chemical Controls Used in 2002

General Use Nematicides/fumigants

None.

Restricted Use Nematicides/fumigants

Metam sodium – Vapam HL (21 days after use before planting) (2)

- 40 gallons per acre used on 80 % of acreage.

Dichloropropene + chloropicrin – Telone II (5 day reentry period) (2)

- Used on 7% of 2002 acreage

Table 3. Current (2002) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

For both nematode and plant pathogen management:		
Chloropicrin	50 gal/a	R
Metam-sodium	37.5 to 75 gal/a	R
Methyl bromide	225 to 350 gal/a	R
For nematodes only:		
Dichloropropene	9 to 12 gal/a	R
Dichloropropene + Chloropicrin	11 to 17 gal/a (Telone 17)	R
Dichloropropene + Chloropicrin	13 to 20.5 gal/a (Telone 35)	R

Chemical Use in IPM Programs

Most of the fumigant choices are highly toxic. Knowledge of the field and cropping history would help in the selection of fumigant, whether plant pathogens occur as well as nematodes.

Chemical Use in Resistance Management

Choices are limited so resistance management is not a priority.

Alternatives

None.

Cultural Control Practices

Crop rotation can be used to reduce root knot populations but is limited in its effectiveness.

Biological Controls

None.

Post Harvest Control Practices

None.

Pesticide Risk Assessment

For most of the carrot growers their greatest point of risk is with the mixing of pesticides. Most growers have cabs on the tractors that prevent contamination by drift to the applicator. It is unknown how many have cabs with their own ventilating systems.

Generally fumigants are quite toxic. The fumigant is applied by injection shanks which place the material approximately 8 inches deep into the soil. A chain behind the applicator smoothes out the soil sealing in the fumigant.

There may be some hand weeding depending upon the amount and species of weeds that survive the herbicide treatments. Generally hand weeding is limited and exposure to residues would be minimal.

Contacts

1. Steve Johnston – Specialist in Plant Pathology, Rutgers Cooperative Extension, phone 856-455-3100; e-mail: johnston@aesop.rutgers.edu
2. Gerry Ghidiu – Specialist in Vegetable Entomology, Rutgers Cooperative Extension, phone: 856-455- 3100; e-mail: ghidiu@aesop.rutgers.edu
3. Brad Majek – Specialist in Weed Science, Rutgers Cooperative Extension, phone: 856-455-3100; email: majek@aesop.rutger.edu
4. Peter Probasco, Rutgers Cooperative Extension of Salem County, phone: 856-769-0090; email: probasco@aesop.rutgers.edu
5. Joe Ingerson-Mahar, Vegetable IPM Coordinator, phone: 732-932-9802; email: mahar@aesop.rutgers.edu

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