Processing Carrot
Pest Management Strategic Plan for New Jersey
March 16, 2004

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121 Northville Rd. Bridgeton, NJ

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History of Development of the 'Processing Carrot PMSP for New Jersey'

Carrot was first chosen by the New Jersey State Network Advisory Committee as a candidate for a crop profile and subsequently this PMSP (2005) due to a significant carrot weevil problem that first occurred in 2001. Rutgers Cooperative Research and Extension (RCRE) integrated pest management scouts have continued to work with local carrot growers in monitoring pest activity during the growing season. Extension Vegetable IPM Coordinator Joseph Mahar worked through RCRE's liaison to IR-4, Gerry Ghidiu to assess and formulate a pest management strategy for this continuing severe pest problem in carrot.

Joseph Mahar completed a **'Crop Profile for Carrots for New Jersey'** as a precursor to the PMSP. Gerald Ghidiu, Rutgers University Extension Vegetable Entomologist and Bradley Majek, Rutgers University Extension Weed Scientist, completed technical reviews of the carrot profile. Following address of all comments received in the technical reviews, the crop profile was submitted to USDA for approval and posting to the national IPMC Crop Profile web site. It was posted on February 1, 2003; see www.ipmcenters.org/cropprofiles/docs/njcarrot.html.

Joseph Mahar and Kris Holmstrom of RCRE prepared a working draft of a PMSP for processing carrot for New Jersey for use by a Workgroup gathered to formulate this Plan. New Jersey participants in the Workgroup in this Plan included growers, processors, and Extension staff. Materials for the Workgroup's use were posted at the webpage 'Tools for the PMSP for Carrot for New Jersey'; see www.pestmanagement.rutgers.edu/NJinPAS/PMSPcarrot.htm; it will remain online for future reference even when the PMSP itself is complete.

The Workgroup formally met on March 16, 2004 to review the draft PMSP, as well as to discuss and raise important issues for this commodity in New Jersey. After the Workgroup, Joe Mahar and Kris Holmstrom integrated comments from the meeting, and sent and posted online a Draft PMSP for the Workgroup's review and approval. A few final comments from Workgroup members were addressed and integrated into this final '**Processing Carrot Pest Management Strategic Plan for New Jersey'**.

Table of Contents

I. Executive Summary

Top Priorities of New Jersey Carrot Production in New Jersey
Without question, the top priority in carrot production in New Jersey is effective management of carrot weevil. In other carrot growing regions of the United States and Canada, carrot weevil has a lower pest status but in New Jersey conditions are such that carrot weevil threatens to drive the processing carrot industry out of the State. The two primary issues are 1) lack of effective monitoring techniques and 2) lack of effective registered insecticides. Registration of either existing insecticides such as phosmet, or research and development of new insecticide chemistries to identify effective materials on carrot weevil is needed. Efficacy of applied insecticides might be influenced by the application technique, the toxicity of the insecticides to the weevil, and the biology of the weevil, itself. Biological control possibilities have not been explored. While biological control does not seem likely to become a significant means of managing carrot weevil, it should be investigated. Other cultural and mechanical means of carrot weevil management may be possible but these potential alternatives need to be developed and demonstrated.

Registration of new fungicides with different chemistries for managing fungicide resistance by Alternaria and Cercospora foliar diseases is needed. The concern is that Bravo, which is alternated with strobilurin fungicides may be lost in the reregistrarion process. The priority is to find and test for alternatives to chlorothalonil (Bravo) to alternate with Cabrio and Quadris. Bravo is used in alternating with strobilurin fungicides to help prevent disease resistance from occurring. Both strobilurins Cabrio and Quadris have the same mode of action.

Research and develop new management strategies for effective management of vertebrate pests, deer and woodchucks. Left unmanaged, white-tailed deer especially, will render all other pest management practices useless.

Regulatory Priorities
- Requests to IR-4 for assistance in identifying more effective insecticides for carrot weevil.
- Requests to IR-4 for registration, i.e. Boscalid, alternative/addition to Bravo, for use on foliar diseases such as Alternaria and Cercospora to successfully implement a resistance management program
- Concern about losing both dichloropropene (Telone) and metam sodium (Vapam) as there are no other viable fumigants currently available for use on root knot nematodes. Keeping the registration of these materials is critical.
- Registration of pipeline materials needs to be expedited.

Research Priorities
- **Critical Need:** Test for new effective insecticide for carrot weevil control– currently used insecticides do not seem effective on established carrot weevil populations.
- **Critical Need:** Research alternatives to chlorothalonil for control of foliar diseases. We need materials for alternating with the strobilurins.
- **Critical Need:** Develop new strategies to deal with vertebrate pests – it doesn't matter how well other pests are managed if in the end vertebrate pests consume the crop.

Education Priorities

- No critical need has been identified.

II. Background

Production Facts

- State rank: New Jersey ranks 9th nationally in carrot production, 1997 data
- 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. 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.

Because Campbell Soup Company is the primary carrot processor for New Jersey farmers, Campbell Soup variety 1374 is the primary variety grown. 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 one-row ridge and the other uses a 3 row bed.

The manner in which carrots are harvested in New Jersey differs significantly from Michigan's harvesting techniques. Michigan farmers rely on healthy top, "fern" growth in order to pull carrots from the soil. This places much greater emphasis on the role of fungicides in Michigan production as foliar diseases significantly reduce the vitality and strength of the fern growth.

Harvesting New Jersey carrots 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 and possibly storage. They are then loaded into a second truck which proceeds to the processor.

Critical Pest Information

The primary pests of the carrot processing industry are carrot weevil, leaf blights, and northern root knot nematode. Several minor pests occur including wireworms, cutworms, aster leafhopper, bacterial blight, fungal rots, and vertebrate pests such as deer and woodchucks. In other carrot production areas such as Ontario, Canada, and Michigan, the same pests may be found but they impact the crops differently. Leaf blights are more important in those areas because of the difference in how the crop is harvested and carrot weevil is less important possibly because of greater flexibility of crop rotation and harsher winters in those areas.

Seven pesticides currently registered for use on carrots may potentially be lost due to regulatory challenges (chlorothalonil, metam sodium, dichloropropene, oxamyl, diazinon, carbaryl and Methomyl). This would be particularly critical for carrot weevil and nematode control as alternate effective materials are lacking and for prevention of disease resistance since chlorothalonil is used alternating with strobilurin use on carrots.

IPM Issues

1) Management of carrot weevil
    - The most effective control appears to be a severe winter
    - Monitoring carrot weevil during the season
    - Weevil survival in the crop is an issue of either insecticide resistance, application method, or lack of insecticide effectiveness
    - Lack of effective registered insecticide
    - Eliminating weedy, fleshy-rooted alternate hosts such as Queen Anne's lace, several species of dock
2) Potential loss of effectiveness of pyraclostrobin and azoxystrobin because of potential disease resistance of strobilurin fungicides if chlorothalonil losses registration
3) There needs to be incorporation of other fungicide class use in Tomcast recommendations
4) Potential loss of currently registered nematicides, Vapam (metam sodium) and Telone (dichloropropene) during reregistration due to FQPA
5) Lack of implementation of biocontrol agents for any of the primary or secondary pests

Resistance Management Issues

Potential disease resistance development to strobilurin fungicides.

Consumer Education Issues – None

Export/Import Issues – None

III. Pest By Pest Profiles

A. Insect Pests

1) 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. It is threatening the viability of the processing carrot industry in New Jersey.

Carrot weevils have historically been a significant pest of carrots in New Jersey as in other carrot production areas. Factors that may enhance carrot weevil problems in New Jersey may include: 1) lack of space for crop rotation, 2) mild winters, 3) lack of effective insecticides, 4) lack of viable alternative management options including management of alternate hosts for the weevil, 5) the use of culled carrots as deer bait.

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 in the fields and other sheltered areas including fencerows and field borders. Several weeds serve as alternate hosts for weevils including broadleaf plantain, lance-leaf plantain, Queen Anne's lace and various species of dock. Carrots become attractive to the weevil at about the 4 true leaf stage. 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. Adults have wings but apparently fly very little, if at all, and most of their distribution comes from walking.

The clumped distribution of carrot weevil infestations in fields presents a quandary in where the weevils overwinter and how they move about in the spring. Adult weevils may overwinter within the field and may already be present in the field at the time the crop is planted. They may also fly into the interior of a field. G. Boivin notes that the adults have functional wings and may fly under favorable circumstances. Lastly it may be that certain adult individuals move off in random directions from where there is a concentration of adults already existing. Each of these scenarios would help explain how adult weevils are able to colonize fields so rapidly.

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, groundhogs and mice which limits the effectiveness of the traps. These traps are generally useful until the carrots in the field become attractive to the weevils. 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 can be deployed in monitoring of carrot weevil.

A new type of trap consisting of a 9 inch long piece of 2x4 lumber with grooves cut in the wood is being tested for monitoring weevil activity.

Threshold – 1 weevil adult caught in traps in the field after the plants have reached the 4 true leaf stage. Because it is likely that there are 3 generations of carrot weevil in New Jersey a lower threshold is needed in the spring than suggested by G. Boivin, who reviewed the pest management of carrot weevil in Ontario, where apparently there is only one generation. A dynamic threshold may be eventually developed for New Jersey growers taking into account the time of year and number of generations left before harvest but at this time there is no recommended threshold after July 1st.

Insecticides for use on carrot weevil

There is currently no registered insecticide that provides good control of moderate to heavy populations of carrot weevil under New Jersey conditions. In Canada, phosmet (Imidan) is used for excellent management of carrot weevil. New materials need to be tested (IR-4) as well as ones that are registered for use on carrots but are not registered for carrot weevil control such as Diazinon. There is a critical need to find a more effective insecticide for carrot weevil management.

Organophosphates

None recommended

Carbamates

Oxamyl – Vydate L

- Efficacy - poor efficacy and erratic – only good on larvae, need to find eggs, 3 applications 7 days apart, must be ahead of hatching, water soluble so rain washes it away – impacts control, may be the main reason why Vydate doesn't always perform well. Very expensive, need to spray more frequently especially if you more than a .1 of inch of rain, labeled for carrots but not carrot weevil.
- Resistance problems – None.
- IPM Issues
- REI - 48
- PHI – 14 days
- Export/import issues - none
- Why used /not used? As noted above oxamyl provides only poor control and apparently is not effective on adults at current rates. Further, it is an expensive insecticide with little residual in the presence of a small amount of rain.

Pyrethroids

Cyfluthrin – Baythroid 2

- Efficacy – some use, works with light pressure at full rate – adults only.
- Resistance problems - none
- IPM Issues
- REI - 12
- PHI – 0 days
- Export/import issues – none

- Why used /not used? It is used but efficacy is a question. The method of application and spray coverage may factor into its efficacy and it is expensive. Monitoring adult weevil activity would help in timing of applications.

Esfenvalerate – Asana XL

- Efficacy - some use, works with light weevil population pressure at full rate – adults only. Timing is an issue and it is expensive
- Resistance problems
- IPM Issues
- REI - 12
- PHI – 7 days
- Export/import issues – none?
- Why used /not used? Has not been used by growers or only on a limited basis. Other materials are available which may be more cost effective.

Pest Management Concerns

- Biological control of carrot weevils by Anaphes sordidanus (an egg parasitoid). This parasite has not been looked for in New Jersey. At present it does not seem to be a factor in managing carrot weevil populations although the question has not been researched.
- Control of broad leaf weeds in field borders, especially wild carrot and pineapple weed, plantain and others. Management of wild hosts in fence rows and field borders is not currently practiced and may not be practical.
- Trapping to determine pest density and timing of insecticide applications – This tactic is currently under investigation using pitfall traps and other types of traps to indicate weevil activity.
- Use of carrot culls as deer bait – this practice while economically beneficial to the farmers in the short term may help maintain carrot weevils in the surrounding farm area. Although the incidence of infested carrots with either adults or larvae is low there probably has been a low level of re-infestation of weevils into surrounding rural areas. Cull piles for deer bait would also serve as a food source for currently existing weevil populations in the vicinity of the piles.
- Trap cropping with overwintered parsley – This practice seems to be effective in small scale situations but has not been tested in field situations with large acreages of carrots.

Pipeline pest management tools

- Status of imidan – It does not appear that this material will ever be registered for use on carrots.
- 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.

To Do

Regulatory

- Registration of effective insecticides for management of carrot weevil

Research

- Testing for effective insecticides against both larvae and adults of carrot weevil
- Need research on cold hardiness of adults and finding over-wintering sites
- Cooperation between IR-4 and extension in testing new insecticidal materials
- Need research on cold hardiness of adults and finding over-wintering sites
- Design pitfall traps for easier monitoring of carrot weevil in the field
- Design woodchuck resistant bait traps

Education

- No critical need has been identified.

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Minor Insect Pests

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The following insect groups are minor pests of carrots and rarely are control measures taken against them. Subeconomic carrot damage caused by two insects, wireworms and cutworms, has been observed in recent years. Damage from aster leafhopper, two-spotted spider mites and aphids has seldom been observed.

Recommended insecticides are listed in the 'Commercial Vegetable Production Recommendations 2004' or on-line at www.rce.rutgers.edu/pubs/pdfs/e001t.pdf in the event that these pests flare up to cause economic damage.

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2) Wireworms

Wireworms are a secondary pest. Currently there is no chemical recommendation for wireworms in carrots. Using bait traps and knowledge of field history, farmers should avoid fields with significant wireworm infestations. Two of the carrot farms are in areas where wireworm infested fields are common. 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. Damage also occurs when the carrot root splits from the uptake of excessive moisture. The splitting of the outer root layer (from which the carrot can recover) exposes the inner root to disease and insect attack. As many as 5 wireworms have been found feeding on the root interior of a single carrot in this situation. The most common crop damaging species is *Melanotus communis*, which is probably responsible for 90% of all wireworm crop injury in New Jersey. *Melanotus* wireworms may exist in the soil for 5 or 6 years although other species have one or three year life cycles. Bait traps can be used to estimate the severity of wireworm infestation before the crop is planted, either in the fall or spring prior to planting. Field avoidance is the best alternative if a field is known to have a wireworm infestation.

Threshold – None established.

Insecticides for wireworm control

Diazinon – Diazinon has not been used primarily because wireworms have generally not caused economic damage to the carrot crop.

Pest Management Concerns

- Trapping to determine pest density – Bait trapping or other detection means can be used to estimate populations on a relative scale, that is, none or very low, moderate or severe. However there is no threshold to provide a plant/no plant recommendation for infested fields.
- Mapping fields of known infestations for avoidance – Because of the abundance of wireworms especially in the Salem County area of New Jersey, a map indicating which existing fields have known wireworm populations may be feasible. This would be of potential use for many other crops besides carrots. Once a field becomes infested it seems to remain that way for several years. This would not mean that susceptible crops that are planted into these fields would suffer significant injury. Wireworm damage remains sporadic even in heavily infested fields and more research is required to better understand crop risks.

Pipeline pest management tools - None

To Do

Regulatory

- As long as wireworms remain a minor pest there is no specific need to register soil insecticides for managing wireworms in carrots.

Research

- Bait trapping to determine pest density and crop thresholds and map infested fields.

Education

- Present information to farmers at commodity meetings on wireworm biology and the means to detect their presence in the field before planting

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3) Cutworms

Among the cutworms, the black cutworm is probably the most troublesome. There are multiple generations in New Jersey making it difficult to synchronize larval activity with pesticide applications. Resulting damage sporadically occurs late in summer or early fall resulting in large excavated cavities in the root. This is in contrast to Michigan information which suggests more early-season problems. Despite its dramatic appearance in the carrot roots, cutworm damage is usually light and growers have not been concerned with spraying for cutworms. Applications of insecticides for the management of carrot weevil may help suppress cutworm populations reducing crop injury on carrots.

Threshold – None established

Insecticides for cutworm control – The following insecticides are registered for use in carrots for cutworm control. The effectiveness of these materials should be good; however, they are not generally used specifically for cutworm control because there has been little economic need to control cutworms in New Jersey carrots. Timing of insecticide applications for cutworm management would also hinder the use of these insecticides.

Organophosphates
Diazinon

Carbamates
Carbaryl bait
Methomyl

Pyrethroids
Cyfluthrin
Esfenvalerate – Asana XL

Pest Management Concerns - None

Pipeline pest management tools - None

To do
Regulatory
- No critical need has been identified.

Research
- Develop timetable for application of insecticides, if necessary. Since multiple generations occur through the growing season timing is critical for effective control.

Education
- Stress importance of weed-free fields

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4) Aster leafhopper

Not usually considered to be a problem in New Jersey for vectoring aster yellows, in sharp contrast to the aster yellows situation in Michigan. While a list of materials has been provided that are registered for use on leafhoppers, New Jersey growers seldom if ever use insecticides to manage aster leafhopper. Insecticide applications for carrot weevil may help suppress aster leafhoppers to the point that there is little concern regarding aster yellows. It is not clear why aster leafhoppers/aster yellows is not a significant problem here. The Campbell Soup carrot varieties are not resistant to aster yellows.

Insecticides for leafhopper control – The following insecticides are registered for use in carrots for aster leafhopper control. The effectiveness of these materials should be good; however, they are not generally used specifically for leafhopper control because there has been little economic need to control leafhoppers in New Jersey carrots. There are scouting protocols already established for aster leafhopper in carrots should the need to monitor their activity arise.

Organophosphates
Malathion

Carbamates
Methomyl
Carbaryl

Pyrethroids
Esfenvalerate

Chlorinated Hydrocarbons
Methoxychlor
Endosulfan

Pest Management Concerns - None

Pipeline pest management tools - Nothing specific to aster leafhopper.

To Do
Regulatory
- No critical need has been identified.

Research
- Investigate why aster leafhopper is not a problem here.

Education
- No critical need has been identified.

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5) Two-Spotted Spider Mites
Spider mites are minor pests in carrots. Hot, dry weather could cause a flare-up of mites as well as over spraying pyrethroid insecticides which could happen in controlling carrot weevils. New Jersey growers have not recently sprayed for two-spotted spider mites.

Threshold – None established.

Insecticides/Miticides registered for two-spotted spider mites - The following insecticides are registered for use in carrots for spider mite control. The effectiveness of these materials should be good; however, they are not generally used specifically for mite control because there has been little economic need to control mites in New Jersey carrots.

Organic-based materials
Agroneem
Valero

Pest Management Concerns - None

Pipeline pest management tools - None

6) Aphids

Aphids as a group would be considered minor pests of carrots. Most likely species to be present would be the green peach aphid. Cool, wet springs would favor the build-up of aphids in conjunction with the application of carbaryl insecticide. Under most circumstances naturally occurring predators would keep aphids in check. In New Jersey growers have not recently used insecticides for managing aphids.

Threshold – None established.

Insecticides registered for aphids in carrots - The following insecticides are registered for use in carrots for aphid control. The effectiveness of these materials should be good; however, they are not generally used specifically for aphid control because there has been little economic need to control aphids in New Jersey carrots.

Organophosphates
Malathion
Diazinon

Chlorinated hydrocarbons
Endosulfan

Carbamates
Oxamyl

Insecticidal soap
M-Pede Insecticide

Pest Management Concerns - None

Pipeline pest management tools - Nothing specific to aphids.

IR-4 Insecticides either Potential or Pending for Insect Control

Fipronil – phenylpyrazole neurotoxin
Flonicamid – nicotinamide
Thiacloprid – neonicotinoid
Zeta-cypermethrin – pyrethroid
Methoxyfenozide – molting accelerator
Bistrifluron – benzoylphenyl urea
Chromafenozide – insect growth regulator
Metarhizium anisopliae – fungus
Bifenthrin – pyrethroid
Thiamethoxam – neonicotinoid
Spinosad – macrocyclic lactone

B. Disease Pests

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 were produced by equipment operated by Steve Johnston and others. The information is provided to Violet Packing Company which makes the information available to carrot and tomato growers via a dial-up codaphone.

1) Alternaria and Cercospora leaf blights

Alternaria dauci (= A. porri f sp. dauci). This is a common fungal disease that sometimes can be confused with bacterial blight because of similar foliar lesions. The brownish-black 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. Soil borne infections may occur but annual crop rotation appears to prevent this type of infection.

Cercospora carotae. 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 whither. 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.

Fungicides registered for use on carrots

Strobilurins

Pyraclostrobin (Cabrio)

- Efficacy - Works well but is expensive.
- Resistance problems - It should be used alternating with Bravo to prevent the development of resistance.
- IPM Issues
- REI - 12
- PHI – 0 day
- Export/import issues – none?
- Why used /not used? This is a relatively new product and growers may be satisfied with the standard disease treatments that they have been using.

Azoxystrobin (Quadris)

- Efficacy - similar in efficacy to pyraclostrobin.
- Resistance problems - It is recommended to alternate its use with Bravo to manage resistance.
- IPM Issues
- REI - 12
- PHI – 0 day
- Export/import issues – none?
- Why used /not used?

Other

Chlorothalonil (Bravo) – B2 carcinogen

- Efficacy – Good material, effective.
- Resistance problems – It is needed to aid in resistance management of strobilurin fungicides.
- IPM Issues
- REI - 12
- PHI – 0 days
- Export/import issues - none
- Why used /not used? It is less expensive than the strobilurin fungicides. It is one of the fungicidal standards.

Iprodione

- Efficacy – Good.
- Resistance problems
- IPM Issues
- REI - 12
- PHI – 0 days
- Export/import issues – none?
- Why used /not used? It is more expensive than other fungicides and is useful only on Rhizoctonia.

Pest Management Concerns - Expand and improve the use of Tom-cast. Make Tom cast more available through easier to use equipment or provide updated information to growers. "Recalibrate" Tom cast for newer products like the strobilurins. Incorporate irrigation into Tom cast DSV accumulations.

Field scouting – Proper identification of alternaria and cercospora lesions.
Crop residue management
Maintaining non-strobilurin fungicides

Pipeline pest management tools

- Boscalid + pyraclostrobin – IR4 needs efficacy data – could be used in resistance management program (boscalid alone).
- Endura – (Boscalid) – equivalent to Bravo in efficacy, suitable addition for resistance management

To Do

Regulatory

- Requests to IR4 for reduced risk alternative/addition to Bravo, i.e. Boscalid, to be used in resistance management program.

Research

- Determine efficacy and use patterns of reduced risk fungicides and biocontrol agents
- Optimize fertilization program for enhanced foliar vigor, blight resistance and late season foliage growth
- Determine the efficacy of coppers used alone and alternated with strobilurins and other new chemistries
- Develop resistance programs for fungicides
- Identify effective product suitable for use as a seed treatment
- Test other fungicidal materials incorporating sulfur
- Evaluate and incorporate other fungicide classes into the Tomcast program

Education

- Demonstrate the use of Watchdog environmental sensors for measuring Tom cast parameters

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Minor Disease Pests

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2) Bacterial leaf blight

Xanthomonas campestris pv *carotae*. 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.

Bactericides for use on carrots

Fixed coppers

- Efficacy – Fair, but must be used in advance of symptoms.
- Resistance problems - none
- IPM Issues -
- REI – 12,24,48 hr
- PHI – 0 day
- Export/import issues – none
- Why used /not used?

Pest Management Concerns

- Field scouting – proper identification of bacterial lesions
- Postharvest tillage to reduce crop residue
- Spread diseases between fields on equipment – proper cleaning of equipment between fields

Pipeline pest management tools

To Do

Regulatory

- No critical need has been identified.

Research

- Establish disease severity, i.e. determine to what extent foliar infection is yield-limiting.
- Develop seed testing and treatment
- Develop contaminated seed threshold

Education

- Educate growers on disease symptoms and identification

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3) Crown Rot and Root Dieback

Rhizoctonia solani; *Pythium spp.* These rots can be primary or secondary pests causing the root tissue to rot. Both are favored by wet soil conditions and symptoms may be aggravated by high temperatures and humidity. There is no effective control to prevent these diseases other than cultural practices including planting on light soils that allow good drainage. These diseases are more prevalent in poorly drained heavy soils. Mefenoxam is registered for use on crown rot but generally control of Rhizoctonia fungi with mefenoxam is ineffective.

Threshold – None established.

Fungicides for use on carrots

Mefenoxam

- Efficacy
- Resistance problems
- IPM Issues
- REI - 0
- PHI
- Export/import issues – none?
- Why used /not used?

Pest Management Concerns

Crop rotation

Field scouting

Pipeline pest management tools - None

To Do

Regulatory

- No critical need has been identified.

Research

- Development of resistant varieties or varieties tolerant to wet soil conditions.

Education

- No critical need has been identified.

==========

4) Aster yellows

A *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 plus the vectoring leafhoppers appear to have a very low level of infectivity. 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 easily break off. Masses of new roots develop but eventually the plant dies. Plants exhibiting symptoms are unmarketable.

Threshold – None established.

Pest Management Concerns - Disease best managed by controlling the aster leafhopper

Pipeline pest management tools - None

To Do

Regulatory

- No critical need has been identified.

Research

- No critical need has been identified.

Education

- No critical need has been identified.

==========

IR-4 Fungicides and Bactericides either Potential or Pending for Disease Control

Fenamidone – respiration inhibitor
Boscalid BAS 510 - nicotinamide
Fluazinam – pyridinamine
Nocobifen BAS 510 – nicotinamide
Famoxadone – Oxazolidinedione
Ipconazole – triazole

Streptomyces lydicus WYEC 108 – bacterium
Gliocladium *catenulatum* strain 11446 – fungus
Glutamic acid – acidic amino acid
Ampelomyces quisqualis isolate M 10 – fungus
Muscodor albus – biofungicide
Bacillus subtilis – microbial
Bacillus pumilus strain 2808 – microbial
Bacillus subtilis strain QST 713 – microbial
Coniothyrium minitans – fungus
Cyprodinil/Fludioxonil – a pyrimidine and pyrrole
Propamocarb hydrochloride – carbamate systemic
Propiconazole – triazole
Trifloxystrobin – strobilurin

C. Nematode Pests

1. 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 hatch releasing the young nematodes to live freely for awhile in the soil before returning 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.

Nematicides registered for use on carrots

Carbamates

Metam sodium (Vapam HL) – B2 carcinogen (EPA)

- Efficacy – quite effective
- Resistance problems - none
- IPM Issues - none
- REI - 48
- PHI
- Export/import issues – none
- Why used /not used? It is the primary fumigant used for carrot production.

Chlorinated Hydrocarbons

Dichloropropene (Telone) – B2 carcinogen (EPA)

- Efficacy – In comparison with Vapam it is not as effective
- Resistance problems - none
- IPM Issues - none
- REI – 72 hrs.
- PHI
- Export/import issues – none
- Why used /not used? Telone is more expensive, less effective and more toxic to handlers than Vapam

Pest Management Concerns

- Crop rotation
- Field scouting
- Use and results of nematicidal cover crops may be inconsistent
- Concern with resistance of nematodes to nematicides
- Losing Telone and Vapam due to regulatory issues

Pipeline pest management tools

IR 4 materials - potential

- Iodomethane – methyl iodide
- AKD-3088
- Terrapy – fatty acid in polyglycoside

To Do

Regulatory

- Post-plant use of Vydate?

Research

- Determine effects of soil amendments such as crab meal and other chitinous materials, municipal leaves
- Develop precision agriculture technology to identify and treat problem areas
- Determine soil quality that minimizes nematode problems

Education

- Stress soil sampling of unfamiliar fields for presence of nematodes

D. Weed Pests

1) Winter annuals – generally not a problem

2) Summer annuals – certain species are problematic depending upon the stage of growth when herbicides are applied, for example, jimson weed and morning glory.

Herbicides

Trifluralin (Treflan HFP) - EPA C carcinogen

- Efficacy
- Resistance problems
- IPM Issues
- REI – 12,24
- PHI
- Export/import issues – none?
- Why used /not used?

Linuron (Linex 4L) – EPA C carcinogen

- Efficacy
- Resistance problems
- IPM Issues
- REI – 24
- PHI
- Export/import issues – none?
- Why used /not used?

Clethodim (Select)

- Efficacy
- Resistance problems
- IPM Issues
- REI – 12,24
- PHI
- Export/import issues – none?
- Why used /not used?

Metribuzin (Sencor) – EPA D carcinogen

- Efficacy
- Resistance problems
- IPM Issues
- REI - 12
- PHI
- Export/import issues – none?
- Why used /not used?

Fluazifop (Fulsilade)

- Efficacy
- Resistance problems
- IPM Issues
- REI - 12
- PHI
- Export/import issues – none?
- Why used /not used?

Sethoxydim (Poast)

- Efficacy
- Resistance problems
- IPM Issues
- REI – 12,24
- PHI
- Export/import issues – none?
- Why used /not used?

Pest Management Concerns

- Given the general nature of weed problems the current herbicide selections fit well with an IPM approach
- Field scouting
- Hand weeding
- Potential loss of linuron as no suitable replacement for weed control

Pipeline pest management tools

- S-metolachlor (Dual Magnum)
- Pendimethalin (Prowl)

To Do

Regulatory

- No critical need has been identified.

Research

- Determine the value of mulching and composting as weed management aids
- Develop innovative mechanical weed control methods
- Determine the efficacy of strip tillage with banded application of herbicides in managing weeds

Education

- No critical need has been identified.

3) Summer Annual- 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.

Herbicides

Glyphosate (Round-up)

- Efficacy
- Resistance problems
- IPM Issues
- REI - 24
- PHI
- Export/import issues – none?
- Why used /not used?

Paraquat

- Efficacy
- Resistance problems
- IPM Issues
- REI – 12,48
- PHI
- Export/import issues – none?
- Why used /not used?

Pest Management Concerns

Spot spraying

Pipeline pest management tools

To Do

Regulatory

- No critical need has been identified.

Research

- No critical need has been identified.

Education

- No critical need has been identified.

4) Summer Annual- Spurred anoda

This summer annual is resistant to all herbicides registered for carrots. A relative of velvet leaf, spurred anoda is considered to be a southern weed that is reaching its northern range limit in New Jersey. The mature plant may reach 4 feet tall but lower limbs of the weed may extend as far as 12 feet. The stem becomes woody with age interfering with harvests in soybeans. Although it generally maintains low populations in most fields it occasionally occurs in abundance, crowding out crop plants and hindering harvest of the crop. In carrots the weed has to be hand-pulled adding to the expense of crop production. Spurred anoda should be considered a zero tolerance weed in carrot production.

5) Perennial Weeds

Perennial weeds, both broadleaves, grasses and sedges, present special problems for carrot growers. While some of the labeled herbicides may affect the growth of the perennials, none will eradicate the weeds in a single season. Glysophate products or paraquat can be used for spot treatment but such applications will harm the carrots in those specific localities. Wicking, using either hand held devices or tractor mounted wicks can be used to limit the contact of glysophate with the crop plants by brushing only the weeds that rise above the carrot fern growth. However even then, multiple applications may be needed to kill the perennials. Yellow nutsedge may be even more problematic since its leaves may not exceed the height of the carrot leaves. The best way to deal with perennial weeds in carrots may be to eliminate the perennials prior to planting carrots.

IR-4 Herbicides either Potential, Pending

Flucarbazone-sodium – ALS inhibitor
Carfentrazone-ethyl – PPO inhibitor
Pelargonic acid – fatty acid
Colletotrichum gloeosporiodes – fungus
Flumioxazin – PPO inhibitor

E. Vertebrate Pests

1) Deer

Damage carrots by grazing the fern growth, pulling carrots up (?), and trampling by hooves.

To Do

Regulatory

- No critical need has been identified.

Research

- No critical need has been identified.

Education

- Review the latest in deer repellants to see if something is applicable to carrots

2) Woodchucks/groundhogs

Woodchucks graze the tops of the carrots near their burrows, greatly reducing yields in affected areas.

Pest Management Concerns

- Clearance of fencerows
- Interference with pest monitoring tools, especially bait traps for carrot weevils

To Do

Regulatory

- No critical need has been identified.

Research

- No critical need has been identified.

Education

- No critical need has been identified.

Table 1: General Timeline for Worker Activity in the Field for NJ Carrot Production

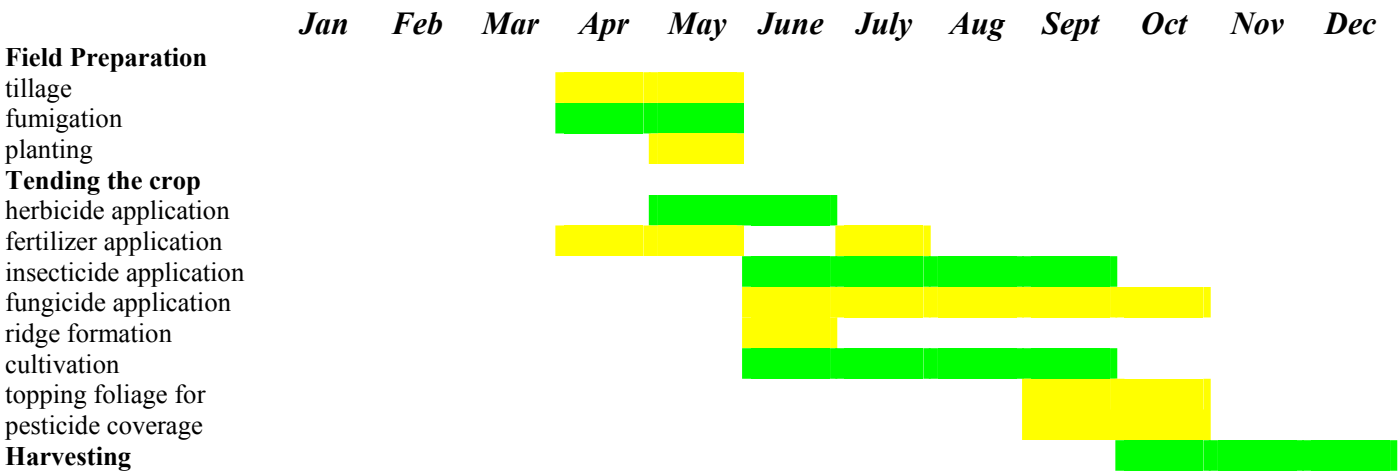

Table 2: General Timeline for Pest Management in the Field for NJ Carrot Production

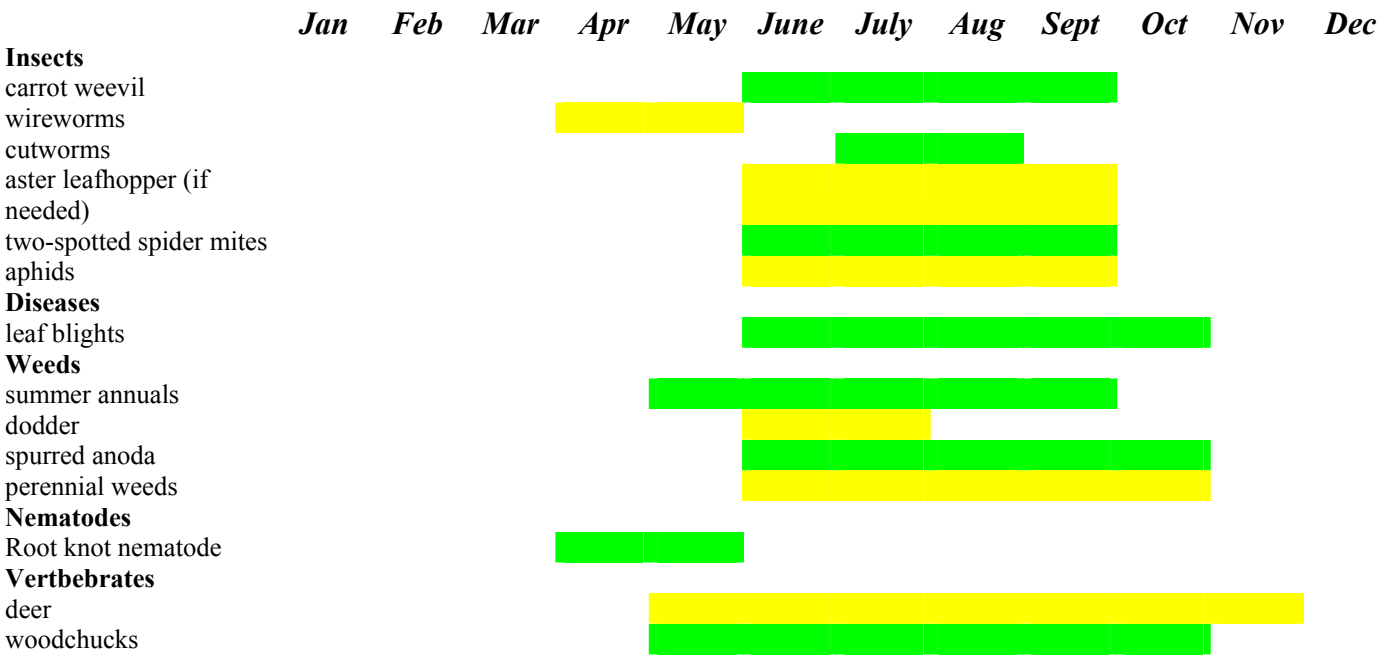

Table 3: Efficacy of Insecticides Used on Carrot Pests in New Jersey *(page 1 of 2)*

Product Name	Active Ingredient	Chemical class	Carcinogen?	Efficacy Ratings of Insecticide on Target Pests							
Registered Insecticides				**RKN**	**RLN**	**CWV**	**WG**	**CWM**	**WW**	**ALH**	**APH**
DIAZINON	Diazinon	Organophosphate		NRN	NRN	NRP	NRP	F-G	P-F	NRN	NRN
SEVIN	Carbaryl	Carbamate	C	NRN	NRN	NRP	NRN	F-G	NRN	F	NRN
BAYTHROID	Cyfluthrin	Pyrethroid	Non carcinogen	NRN	NRN	F	NRN	F-G	NRN	G	NRN
THIODAN	Endosulfan	Chlorinated Hydrocarbon	Non carcinogen	NRN	NRN	NRP	NRN	NRP	NRN	NRP	G
LANNATE	Methomyl	Carbamate	E - Not likely	NRN	NRN	NRP	NRN	G	NRN	G	G
VYDATE L	Oxamyl	Carbamate	Non carcinogen	F-P	F-P	F-P	NRP	NRN	NRP	NRN	NRN
Decis	Deltamethrin	Pyrethroid									
ASANA XL	Esfenvalerate	Pyrethroid	E - Not likely	NRN	NRN	F	NRN	G	NRN	G	NRN
Dipel	*Bacillus thuringiensis*	Biological									
PYGANIC CROP PROTECTION EC 5.0	Pyrethrins	Botanical		U	U	U	U	U	U	U	U
MALATHION	Malathion	Organophosphate	Suggestive evidence of carcinogenicity	NRN	NRN	NRN	NRN	NRN	NRN	F	F
METHOXYCHLOR	Methoxychlor	Chlorinated Hydrocarbon	D - not classifiable for human carcinogenicity	NRN	NRN	NRN	NRN	NRN	NRN	G	NRN
M-PEDE	Potassium salts of fatty acids	Insecticidal Soap		NRN	NRN	NRN	NRN	NRN	NRN	U	U
Surround	Kaolin	Clay									
SPINTOR	Spinosad	macrolytic lactone	E - Not likely	NRN	NRN	NRN	NRN	NRP	NRN	NRN	NRN
Intrepid	Methoxyfenozide	Diacylhydrazine									
NEEMIX 4	Azadirachtin	Insect Growth Regulator		NRN	NRN	U	U	U	U	U	U
Admire	imidacloprid	Neonicotinoid	E - Not likely	NRN	NRN	NRP	NRP	NRN	NRN	F	G
Provado	imidacloprid	Neonicotinoid	E - Not likely	NRN	NRN	NRP	NRN	NRN	NRN	F-G	G
VAPAM nematicide	Metam-sodium	Carbamate	B2-possible human carcinogen	F-G	F-G	NRN	NRP	NRN	NRP	NRN	NRN
TELONE II nematicide	1,3-Dichloropropene	Chlorinated Hydrocarbon	B2-possible human carcinogen	F-G	F-G	NRN	NRP	NRN	F	NRN	NRN

Product Name	Active Ingredient	Chemical class	Carcinogen?	Efficacy Ratings of Insecticide on Target Pests							
Insecticides with Registrations Pending				**RKN**	**RLN**	**CWV**	**WG**	**CWM**	**WW**	**ALH**	**APH**
Agenda, Icon, Regent	Fipronil	Phenylpyrazole	C	NRN	NRN	NRP	NRP	NRP	NRP	NRP	NRP
Turbine	Flonicamid	Cyanomethanytrifluoromethyl nicotinamide		NRN	NRN	NRN	NRN	NRN	NRN	NRP	NRP
Fury, Mustang	Zeta-cypermethrin	pyrethroid	C	NRN	NRN	NRN	NRN	NRP	NRN	NRP	NRP
Taerain	*Metarhizium anisopliae*	Biological		NRN	NRN	NRN	NRN	NRN	NRN	NRP	NRP
Brigade, Capture	Bifenthrin	pyrethroid	C	NRN	NRN	NRP	NRN	NRP	NRN	NRP	NRP
Actara, Adage, Centric, Platinum	Thiamethoxam	neonicotinoid		NRN	NRN	NRP	NRP	NRN	NRP	NRP	NRP
Potential New Insecticides – Currently Not Registered				**RKN**	**RLN**	**CWV**	**WG**	**CWM**	**WW**	**ALH**	**APH**
Methyl iodide nematicide	Iodomethane	Methyl iodide		NRP	NRP	NRN	NRP	NRN	NRP	NRN	NRN
Terrapy nematicide	fatty acid in alkyl glycoside	biopesticide		NRP	NRP	NRN	NRN	NRN	NRN	NRN	NRN
AKD-3088 nematicide	AKD-3088			NRP	NRP	NRN	NRN	NRN	NRN	NRN	NRN
DBI-3204	Bistrifluron	Benzoylphenyl urea		NRN	NRN	NRN	NRN	NRP	NRN	NRN	NRN
Matric	Chromafenozide	Insect Growth Regulator		NRN	NRN	NRN	NRN	NRP	NRN	NRN	NRN
Cultural Controls				**RKN**	**RLN**	**CWV**	**WG**	**CWM**	**WW**	**ALH**	**APH**
Crop Rotation				F	F	F	U	U	P	NA	NA
Trap Cropping				NA	NA	U	NA	NA	NA	NA	NA
Sanitation				NA	NA	F-G	NA	NA	U	NA	NA

****KEY to Codes Used to Name Insect Pests Above:***	*****KEY to Codes Used for Efficacy Ratings of Insecticides Above:***
RKN = Northern Root Knot Nematode	*NE = No effect*
RLN = Root Lesion Nematode	*L = Limited effect*
CWV = Carrot Weevil	*NG = Negative effect*
WG = White Grubs	*NU = Negative effect depending on method of application*
CWM = Cutworms	*U = Unknown*
WW = Wireworms	
ALH = Aster Leafhopper	
APH = Aphids	

Table 4: Efficacy of Fungicides Used on Carrot Diseases in New Jersey *(page 1 of 2)*

Product Name	Active Ingredient	Chemical Class	Carcinogen?	Efficacy Ratings of Fungicides on Target Diseases									
Currently Registered Fungicides				**PythD**	**PhytD**	**Rhiz**	**ALB**	**CLB**	**XB**	**AY**	**SsF**	**SsS**	**BotS**
QUADRIS	Azoxystrobin	Methoxyacrylate		U	U	U	G	G	NRN	NRN	NRN	NRN	NRN
CABRIO	Pyraclostrobin	Methoxyacrylate		NRN	NRN	NRN	G	G	NRN	NRN	NRN	NRN	NRN
RIDOMIL GOLD	Mefanoxam	Phenylamide		G	F	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN
Ridomil	Metalaxyl	Phenylamide	E-No evidence of carcinogenicity	G	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN
ROVRAL	Iprodione	Dicarboxamide	Likely Human Carcinogen	NRN	NRN	NRN	G	NRP	NRN	NRN	NRN	NRN	NRN
Copper(Basicop, Kocide, Tenn-cop)	Copper formulations	Elemental copper		NRN	NRN	NRN	F-P	F-P	F	NRN	NRN	NRN	NRN
Bravo, Echo, Equus	Chlorothalonil	Chlorinated benzonitrile	Likely Human Carcinogen	NRN	NRN	NRP	G	G	NRN	NRN	NRN	NRN	NRN
ENDURA	boscalid	Carboxamide	Insufficient to assess	NRN	NRN	N	G	NRP	NRN	NRN	NRN	NRN	NRN
Pristine	Pyraclostrobin + boscalid	Methoxyacrylate + Carboxamide	Insufficient to assess										
MYCOSTOP	*Streptomyces griseoviridis* strain K61	Biological		U	U	U	NA	NA	NA	NA	NA	NA	NA
Sonata	*Bacillus pumilus*	Biological											
SERENADE	QST 713 strain of *Bacillus subtilis*	Biological		NRN	NRN	NRN	U	NRN	U	NRN	NRN	NRN	NRN
Prestop	*Gliocladium catenulatum*	Biological											
MESSENGER	Harpin protein	Immune response illicitor		U	U	U	U	U	U	U	U	U	U
CONTANS	*Coniothyrium minitans*	Biological		NRN	NRN	NRN	NRN	NRN	NRN	NRN	F	NRN	NRN
MERTECT	Thiabendazole	Benzamidazole		NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	G	G
VAPAM	Metam-sodium	Carbamate	B2-possible human carcinogen	F	F	U	NRN	NRN	NRN	NRN	NRN	NRN	NRN
TELONE II	1,3-Dichloropropene	Chlorinated Hydrocarbon	B2-possible human carcinogen	U	U	U	NRN	NRN	NRN	NRN	NRN	NRN	NRN

Product Name	Active Ingredient	Chemical Class	Carcinogen?	Efficacy Ratings of Fungicides on Target Diseases									
Fungicides with Registrations Pending				**PythD**	**PhytD**	**Rhiz**	**ALB**	**CLB**	**XB**	**AY**	**SsF**	**SsS**	**BotS**
Reason	Fenamidone	imidazolinone		NRN	NRN	NRN	NRP	NRP	NRN	NRN	NRP	NRN	NRN
Honor	Nocobifen	nicotinamide		NRN	NRN	NRN	NRP	NRP	NRN	NRN	NRP	NRU	NRU
Vortex	Ipconazole	triazole		NRP	NRP	NRP	NRN	NRN	NRN	NRN	NRN	NRN	NRN
Actino-iron, Actinovate	*Streptomyces lydicus*	biological		NRP	NRP	NRP	NRN	NRN	NRN	NRN	NRN	NRN	NRN
AuxiGro	Glutamic Acid	Glutamic Acid		NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRU
AQ-10	*Ampelomyces quisqualis*	biological		NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN
Orbit, Tilt	propiconazole	triazole	C	NRN	NRN	NRP	NRP	NRP	NRN	NRN	NRP	NRU	NRU
Flint, Twist	trifloxystrobin	Methoxyacrylate		NRN	NRN	NRN	NRP	NRP	NRN	NRN	NRP	NRN	NRN
Stratego	trifloxystrobin + propiconazole	triazole + methoxyacrylate	C	NRN	NRN	NRP	NRP	NRP	NRN	NRN	NRP	NRU	NRU
Potential New Fungicides– Currently Unregistered													
Methyl iodide nematicide	Iodomethane	Methyl iodide		NRP	NRP	NRP	NRN	NRN	NRN	NRN	NRP	NRN	NRN
Terrapy nematicide	fatty acid in alkyl glycoside	biopesticide		NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN	NRN
Omega	Fluazinam	pyradinimane		NRN	NRN	NRP	NRP	NRP	NRN	NRN	NRP	NRU	NRU
Muscador albus	*Muscador albus*	biological		NRU	NRU	NRU	NRU	NRU	NRU	NRN	NRU	NRU	NRU
AKD-3088 nematicide	AKD-3088			NRU	NRU	NRU	NRN	NRN	NRN	NRN	NRN	NRN	NRN
Previcur	propamocarb hydrochloride	carbamate		NRP	NRP	NRP	NRP	NRP	NRN	NRN	NRP	NRU	NRU
Cultural Controls													
Rotation				F	F	F-P	P	P	F	U	F	F	U
Disease Forecasting				NA	NA	NA	G	G	NA	NA	NA	NA	NA
Key to Disease Pest Codes Used Above:	*PythD = Pythium damping-off;* *PhytD = Phytophthora damping-off;* *Rhiz = Rhizoctonia;* *ALB = Alternaria leaf blight;* *CLB = Cercospora leaf blight;* *XB = Xanthomonas leaf blight;* *AY = Aster yellows;* *SsF = Sclerotinia in Field;* *SsS = Sclerotinia in Storage;* *BotS = Botrytis in Storage*			***Key to Efficacy Ratings Used Above:***	*E = Excellent;* *G = Good;* *F = Fair;* *P = Poor;* *U = Unknown;* *NRP = not registered for use, possible efficacy;* *NRN = Not registered, not likely to be efficacious;* *NA = not applicable, not used, or not suspected of being efficacious*								

Table 5: Efficacy of Herbicides Used on Carrot Weeds in New Jersey *(page 1 of 2)*

Product Name	Active Ingredient	Chemical Class	Carcinogen?	Efficacy Ratings of Herbicides on Target Weeds						
Registered Herbicides				*broadleaf annual*	*broadleaf perrenial*	*grass annual*	*grass perennial*	*yellow nutsedge*	*spurred anoda*	*dodder*
FUSILADE	Fluazifop-P-butyl			N	N	E	E	N	N	
GRAMOXONE	Paraquat dichloride		E - no evidence of carcinogenicity	F/G	F/G	F/G	F/G	F		F/G
SENCOR	Metribuzin	triazinone	Non carcinogen	F/G	N	F	F	NRP	N	
ROUNDUP	Glyphosate		E - no evidence of carcinogenicity	G	G	G	G	F	N	G
LOROX	Linuron		C	P/F/G	N	P/F	P/F	N	N	
POAST	Sethoxydim	cyclohexanone		N	N	E	E	N	N	
PREFAR	Bensulide	Organophosphate		N/P/F	N	G	G	N	N	
TRIFLURALIN	Trifluralin	trifluorodinitrotoluidine	C	P/F	N	G	G	N	N	
SELECT	Clethodim		E - no evidence of carcinogenicity	N	N	G	G	N	N	
Dual Magnum (24C - 2004)	S-metolachlor	Choroacetanilide	C	P/F/G	N	G	G	F/G	N	
Scythe	Pelargonic acid	Fatty acid		F/G	F/G	F/G	F/G	F/G	U	F/G
Afinity, Aim	Carfentrazone-ethyl	Aryl triazolinne		N/P/F/G	N	N	N	N	U	
Potential New Herbicides – Currently Unregistered										
Everest	Flucarbazone-sodium	Sulfonylaminocarbonyl-triazolinone		NRP	N	NRP	NA	NRP	NRP	U
Valor	Flumioxazin	N-phenylphthalimide derivative		NRP	NRP	NRP	NRP	NRP	NRP	U
Cultural Controls										
Crop Rotation				G	P	G	P	P	F	F
Cultivation				G	P	G	P	P	G	U
		Key to Codes Used for Efficacy Ratings Above:	*E = Excellent; G = Good; F = Fair; P = Poor; U = Unknown; NRP = not registered for use, possible efficacy; NRN = Not registered, not likely to be efficacious; NA = not applicable, not used, or not suspected of being efficacious.*							

Table 6: Toxicity of Insecticides and Nematicides Used on Carrot to Beneficials *(page 1 of 2)*

Product Name	Active Ingredient	Chemical Class	Carcinogen?	Rating of Impact of Pesticide on Beneficial Organisms				
Registered Insecticides				*Diptera*	*Hymenoptera*	*Coleoptera*	*Neuroptera*	*Fungi*
DIAZINON	Diazinon	Organophosphate		NU	NU	NU	NU	NE
SEVIN	Carbaryl	Carbamate	C	NG	NG	NG	NG	NE
BAYTHROID	Cyfluthrin	Pyrethroid	Non carcinogen	NG	NG	NG	NG	NE
THIODAN	Endosulfan	Chlorinated Hydrocarbon	Non carcinogen	NG	NG	NG	NG	NE
LANNATE	Methomyl	Carbamate	E - Not likely	NG	NG	NG	NG	NE
VYDATE L	Oxamyl	Carbamate	Non carcinogen	NU	NU	NU	NU	NE
Decis	Deltamethrin	Pyrethroid		NG	NG	NG	NG	NE
ASANA XL	Esfenvalerate	Pyrethroid	E - Not likely	NG	NG	NG	NG	NE
Dipel	*Bacillus thuringiensis*	Biological		NE	NE	NE	NE	NE
PYGANIC Crop Protection EC 5.0	Pyrethrins	Botanical		L	L	L	L	NE
MALATHION	Malathion	Organophosphate	Suggestive evidence of carcinogenicity	NG	NG	L	NG	NE
METHOXYCHLOR	Methoxychlor	Chlorinated Hydrocarbon	D - not classifiable for human carcinogenicity	L	L	L	L	NE
M-PEDE	Potassium salts of fatty acids	Insecticidal Soap		L	L	L	L	U
Surround	Kaolin	Clay		U	U	U	U	U
SPINTOR	Spinosad	macrolytic lactone	E - Not likely	L	L	L	L	NE
Intrepid	Methoxyfenozide	Diacylhydrazine		U	U	U	U	U
NEEMIX 4	Azadirachtin	Insect Growth Regulator		U	U	U	U	U
Admire	imidacloprid	Neonicotinoid	E - Not likely	L	U	L	L	NE
Provado	imidacloprid	Neonicotinoid	E - Not likely	L	U	L	L	NE
VAPAM nematicide	Metam-sodium	Carbamate	B2-possible human carcinogen	NE	NE	NE	NE	U
TELONE II nematicide	1,3-Dichloropropene	Chlorinated Hydrocarbon	B2-possible human carcinogen	NE	NE	NE	NE	U

Product Name	Active Ingredient	Chemical Class	Carcinogen?	Rating of Impact of Pesticide on Beneficial Organisms				
Insecticides with Registrations Pending				*Diptera*	*Hymenoptera*	*Coleoptera*	*Neuroptera*	*Fungi*
Agenda, Icon, Regent	Fipronil	Phenylpyrazole	C	U	U	U	U	U
Turbine	Flonicamid	Cyanomethanytrifluoromethyl nicotinamide		U	U	U	U	U
Fury, Mustang	Zeta-cypermethrin	pyrethroid	C	NG	NG	NG	NG	NE
Taerain	*Metarhizium anisopliae*	Biological		U	U	U	U	U
Brigade, Capture	Bifenthrin	pyrethroid	C	NG	NG	NG	NG	NE
Actara, Adage, Centric, Platinum	Thiamethoxam	neonicotinoid		L	U	L	L	NE
Potential New Insecticides and Nematicides – Currently Unregistered								
Methyl iodide nematicide	Iodomethane	Methyl iodide		NE	NE	NE	NE	U
Terrapy nematicide	fatty acid in alkyl glycoside	biopesticide		NE	NE	NE	NE	U
AKD-3088 nematicide	AKD-3088			NE	NE	NE	NE	U
DBI-3204	Bistrifluron	Benzoylphenyl urea		U	U	U	U	U
Matric	Chromafenozide	Insect Growth Regulator		U	U	U	U	U
Cultural Controls								
Crop Rotation				NE	NE	NE	NE	NE
Trap Cropping				NE	NE	NE	NE	NE
Sanitation				NE	NE	NE	NE	NE
			*****KEY to Codes Used Above for Ratings of Pesticide Harmfulness to Beneficials:***	*NE = No effect;* *L = Limited effect;* *NG = Negative effect;* *NU = Negative effect depending on method of application;* *U = Unknown*				

Acknowledgements

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