Carrot

Wednesday afternoon 2:00 pm

Where: Grand Gallery (main level) Room C
MI Recertification credits: 2 (1B, COMM CORE, PRIV CORE)
OH Recertification credits: 2 (presentations as marked)
CCA Credits: CM(2.0)
Moderator: Corey Noyes, Horticulture Dept., MSU

2:00 pm	Non-Fumigant Nematicides and Their Efficacy in Vegetable Rotations (OH: 2B, 1 hr) • Donald Dickson, Entomology and Nematology Dept., Univ. of Florida
3:00 pm	Impact of Cash Crop and Cover Crop Rotations on Plant Parasitic Nematodes in Michigan Carrot Production (OH: 2B, 0.5 hr) • George Bird, Entomology Dept., MSU
3:30 pm	Carrot Pathology Update (OH: 2B, 0.5 hr) • Mary Hausbeck, Plant, Soil and Microbial Sciences Dept., MSU
4:00 pm	Session Ends

Carrot Pathology Update

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Michigan State University, Department of Plant, Soil & Microbial Sciences

Michigan is ranked 2nd in the US for the production of carrots, grown on 1,600 acres in 2014 with a value of $7.7 million. Michigan carrot growers rely on fungicides for disease management. High relative humidity and frequent rainfall/ irrigation common during the growing season create a favorable environment for foliar fungal pathogens. Fungal foliar blights caused by *Alternaria dauci, Cercospora carotae* threaten yields yearly by reducing photosynthetic area and weakening leaves and petioles, interfering with harvest because tops break off in lifting. These blights occur yearly and fungi overwinter readily in carrot debris in soil. Currently, the fungicides chlorothalonil (Bravo) and the strobilurins (i.e. Cabrio or Quadris) are typically used by growers for control of Alternaria and Cercospora blights other than copper-based formulations (applied for control of bacterial blight), and may be applied as frequently as every 7 to 10 days beginning in June and ending in mid-September. Minimizing overall fungicide use and diversifying the fungicide active ingredient that is applied to the carrot crop is desirable so as to minimize/eliminate detectable residues on the harvested root. Disease management programs that reduce the total number of fungicide applications also reduce grower costs, potential residues on the produce, and risk of development of fungicide resistance in the pathogens. One way to reduce the number of necessary fungicide applications without compromising disease control is through the use of disease-warning systems that predict potential outbreaks or increases in disease severity based on the weather and the use of biocontrol products.

Trials 1, 2 and 3: Carrot seeds were sown spaced 1.5 inches apart within the row in a bed of 3 rows spaced 18 inches apart (196,000 seeds/A). Four replicates were established for each treatment arranged in a randomized complete block trial. Each treatment plot consisted of a 20-foot long three-row bed with a 2-foot buffer between treatment plots within each row. Treatments were applied using a CO_2 backpack sprayer and a broadcast boom equipped with three XR8003 flat-fan nozzles calibrated at 50 psi and delivering 50 gal/A. Plants in a 10-foot section of the middle row were evaluated for disease by counting the numbers of plants with one or more petiole lesions and evaluating the petiole area for lesions using the Horsfall-Barratt scale.

Trial 1. Test alternatives for currently and newly-registered fungicides.

This trial was planted with carrot 'Cupar' seeds in a grower-cooperator's field on 30 April in Oceana County, MI in a sandy soil. Treatments were applied on 2, 9, 17, 23 and 31 July; 10, 18, and 26 August; 1, 9, 16, 23 and 30 September. Plants with one or more petiole lesions were counted and plants were evaluated for petiole disease using the Horsfall-Barratt rating scale on 13 October.

Petiole diseases caused by *Alternaria dauci* and *Cercospora carotae* developed in the field and were evaluated. Plants treated with Kocide 3000 had the lowest number of plants with infected petioles (21.5) and the lowest petiole disease severity rating of 3.0 (>3 to 6% foliar area diseased) (Table 1). The untreated controls and the biopesticides, Actinovate, Regalia, Mycostop Mix and Serenade Opti, all had considerable more disease with ≥49 plants with infected petioles and a petiole disease severity rating of 7.3 to 7.8 (>50 to 75% petiole area diseased).

Table 1. Evaluation of fungicides and biopesticides for control of petiole diseases of carrot.

Treatment	Active Ingredient	Plants with ≥1 infected petiole (no.)	Petiole disease severity*
Untreated control.......	--	51.0	7.3
Kocide 3000 1.75 lb ..	copper hydroxide	21.5	3.0
Actinovate 12 oz........	*Streptomyces lydicus* WYEC 108	50.0	7.8
Regalia 4 qt................	*Reynoutria sachalinensis* extract	49.0	7.3
Mycostop Mix 16 oz .	*Streptomyces griseoviridis* Strain K61	52.0	7.5
Serenade Opti 20 oz ..	QST 713 strain *Bacillus subtilis*	49.0	7.3
Untreated control.......	--	49.3	7.8

*Rated on the Horsfall-Barratt scale of 1 to 12, where 1=0% petiole area diseased, 2=>0 to 3%, 3=>3 to 6%, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100% petiole area diseased.

Trial 2. Test the Tom-Cast forecasting system to time fungicide sprays.

This trial was planted with carrot 'Cupar' seeds in a grower-cooperator's field on 30 April in Oceana County, MI in a sandy soil. Three fungicide programs were applied to the Tom-Cast trial in accordance to three different spray schedules: (1) a 7-to-10-day spray schedule, (2) a Tom-Cast schedule based on the threshold disease severity values (DSVs) of 15, and (3) a Tom-Cast schedule based on a threshold DSV of 25. Fourteen sprays of the 7-to-10-day treatments were applied on 2, 9, 17, 23 and 31 July; 10, 18, and 26 August; 1, 9, 16, 23 and 30 September; 7 October. Eight 15 DSV treatments were applied on 2 and 20 July; 4, 14, and 20 August; 1, 9, and 30 September. Four 25 DSV treatments were applied on 2 and 28 July; 18 August; and 9 September. Plants with one or more petiole lesions were counted and plants were evaluated for petiole disease using the Horsfall-Barratt rating scale on 20 October.

Table 2. Evaluation of fungicides applied according to the Tom-Cast disease forecaster.

Application schedule	Applications (no.)	Plants with ≥1 infected petiole (no.)	Petiole disease severity*
Untreated control	--	42.5	7.0
Bravo WeatherStik SC 2 pt alternated with Quadris SC 15.5 fl oz			
7- to 10-day intervals	14	4.0	2.0
Tom-Cast 15 DSV.................	8	6.8	2.0
Tom-Cast 25 DSV.................	4	9.0	2.3
Quadris SC 15.5 fl oz alternated with Fontelis SC 24 fl oz			
7- to 10-day intervals	14	2.8	2.0
Tom-Cast 15 DSV.................	8	3.0	2.0
Tom-Cast 25 DSV.................	4	6.5	2.0
Fontelis SC 24 fl oz alternated with Switch WDG 14 oz alternated with Merivon SC 5 fl oz			
7- to 10-day intervals	14	2.8	2.0
Tom-Cast 15 DSV.................	8	3.8	2.0
Tom-Cast 25 DSV.................	4	3.5	2.0

*Rated on the Horsfall-Barratt scale of 1 to 12, where 1=0% petiole area diseased, 2=>0 to 3%, 3=>3 to 6%, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100% petiole area diseased.

The untreated control plants had the most disease (42.5 plants with infected petioles) and a petiole disease severity rating of 7.0 (>50 to 75% petiole area diseased) (Table 2). All other treatments limited plants with infected petioles to ≤9 and petiole disease severity to 2.0 to 2.3 (>0 to 3% petiole area diseased). Applying the treatments according to the Tom-Cast disease forecaster saved 6 sprays when scheduled at 15 DSVs and 10 sprays when scheduled at 25 DSVs.

Trial 3. Evaluation of registered fungicides for control of foliar and petiole diseases.

This trial was planted with carrot 'Cupar' seeds in a grower-cooperator's field on 30 April in Oceana County, MI in a sandy soil. Treatments were applied on 2, 17, 31 July; 10, 24 August; 14, 23 September; and 7 October. Plants with one or more petiole lesions were counted and plants were evaluated for petiole and foliar disease using the Horsfall-Barratt rating scale on 13 October.

Petiole and foliar diseases caused by *A. dauci* and *C. carotae* developed in the field and were evaluated. All treatments were significantly better than the untreated control for all parameters measured (Table 3).

Table 3. Control of foliar and petiole diseases of carrot with registered fungicides.

Treatment and rate/A	Active ingredient	Plants with ≥1 infected petiole (no.)	HB diseased petiole area*	HB diseased foliar area*
Untreated control..........	--	43.0 a**	5.8 a	5.8 a
Bravo WeatherStik 2 pt.	chlorothalonil	4.8 c	1.8 c	3.8 bc
Quadris 15.5 fl oz..........	azoxystrobin	3.5 c	1.8 c	3.0 cd
Pristine 12 oz................	pyraclostrobin/boscalid	0.5 c	1.5 c	2.8 de
Switch 12.5 oz..............	cyprodinil/fludioxonil	19.3 b	2.5 bc	3.3 cd
Rovral 42 pt..................	iprodione	9.5 bc	2.3 bc	2.8 de
Fontelis 1.5 pt...............	penthiopyrad	1.5 c	1.5 c	3.0 cd
Tilt 4 fl oz.....................	propiconazole	19.0 b	3.3 b	4.3 b
Quadris Opti 1.6 pt........	azoxystrobin/chlorothalonil	2.0 c	1.8 c	3.0 cd
Quilt Xcel 8 fl oz..........	azoxystrobin/propiconazole	2.3 c	2.0 c	3.3 cd
Cabrio 12 oz.................	pyraclostrobin	4.3 c	2.0 c	3.3 cd
Merivon 5 fl oz.............	fluxapyroxad/pyraclostrobin	1.0 c	1.8 c	2.0 e
Endura 4.5 oz................	boscalid	3.0 c	2.0 c	2.8 de

*Rated on the Horsfall-Barratt scale, where 1=0% tissue area diseased, 2=>0 to 3%, 3=>3 to 6%, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100% tissue area diseased.

**Column means with a letter in common are not significantly different (LSD t test; *P*=0.05).

Trial 4. Identify processing carrot cultivars for Michigan that are resistant to plant diseases.

The trial was established in a Houghton muck soil at the Plant Pathology Farm in Lansing, MI. Seeds of 15 carrot cultivars were sown with 2.3 inch seed spacing with a Mater Mattic vacuum seeder on 22 May. Treatments were arranged in a completely randomized block design with four replicates established for each treatment. Each treatment replicate consisted of a 15-foot long three-row bed with a 5-foot buffer between replicates within a row. Ridomil Gold SL was applied in a banded treatment at 0.6 pt/A with a back pack sprayer on 25 May to control root rots. Plants in a 3-foot section of each treatment were evaluated for disease by rating the petiole area for lesions using the Horsfall-Barratt scale.

Petiole diseases caused by *A. dauci* and *C. carotae* developed in the field and were evaluated. Uneven germination due to excessive rainy weather resulted in uneven plant stands, but trends can be noted (Table 4). Petiole disease severity ranged from a low of 5.7 (>12 to 25% petiole area diseased) for 'Carson' to a high of 8.0 (>75 to 87% petiole area diseased) for 'Cupar.'

Table 4. Evaluation of resistance of processing carrot cultivars to petiole diseases.

Cultivar	Seed company	Petiole disease severity[1]	Cultivar	Seed company	Petiole disease severity[1]
Apache	Siegers Seed Co.	7.5	CR2289	Siegers Seed Co.	ned[3]
Bermuda[2]	Bejo Seeds Inc.	7.0	Cupar	SeedWay, Bejo Seeds Inc.	8.0
Bergen	SeedWay	ned[3]	Danvers 126	SeedWay	ned[3]
Berlin	Bejo Seeds Inc.	7.0	Finley	SeedWay	ned[3]
Bermuda	Bejo Seeds Inc.	7.0	Florida	SeedWay	7.5
Canada	SeedWay, Bejo Seeds Inc.	7.3	Fontana	SeedWay	ned[3]
Canberra	Bejo Seeds Inc.	7.3	Presto	Siegers Seed Co.	6.3
Carson	SeedWay	5.7	Texto	Siegers Seed Co.	7.0

[1]Rated on the Horsfall-Barratt scale of 1 to 12, where 1=0% foliar area diseased, 2=>0 to 3%, 3=>3 to 6%, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100% foliar area diseased.
[2]'Bermuda' replaced 'Beijing.'
[3]Not enough data to calculate average due to poor plant stand.

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