MAPPING YOUR ROUTE TO THE FUTURE

Great Lakes Fruit, Vegetable & Farm Market EXPO
DeVos Place Convention Center
Grand Rapids, MI
December 7-9, 2004

Carrot

Wednesday morning 9:00 am

Where: Gallery Overlook Room F (upper level)

Recertification credits: 1 (Private, 1B)

CCA Credits: IPM(2)

Moderator: Jim Breinling, Mason Co. MSU Extension

9:00 a.m. FQPA Update

- Barbara Van Til, U.S. EPA Region V

9:30 a.m. New Products for Disease Control in Carrots

- Mary Hausbeck, Plant Pathology Dept., MSU

9:45 a.m. Why DSV Should Be a Part of a Carrot Grower's Vocabulary?

- Ryan Bounds, Plant Pathology Dept., MSU
- Mary Hausbeck, Plant Pathology Dept., MSU

10:00 a.m. 2004: Another Not So Normal Year with Carrot Insects

- Beth Bishop, Entomology Dept., MSU

10:15 a.m. A Quick Update on Carrot Weed Control

- Bernard Zandstra, Horticulture Dept., MSU

10:30 a.m. Integration of IPM Methods for Carrot Eco-Lebeling Potential

- Walter R. Stevenson, Plant Pathology Dept., Univ. of

New Products for Disease Control in Carrots

Dr. M.K. Hausbeck (517-355-4534; hausbec1@msu.edu), R.S. Bounds (Graduate Student),
and B.D. Cortright (Research Assistant)
Michigan State University, Department of Plant Pathology

Foliar Blight

Cercospora and Alternaria blights occur every year in Michigan carrot fields and require management to prevent crop loss. Cercospora blight is caused by the fungus, *Cercospora carotae*, and is the most important foliar disease of carrots in Michigan. The fungus can attack young foliage, either on the leaves or petioles, causing blight. Alternaria blight is caused by the fungus, *Alternaria dauci*, and is usually detected later in the season on older foliage. Warm temperatures and long periods of leaf wetness promote disease development. Spores of these fungi are wind-blown to nearby plants or even adjacent fields. Methods to reduce disease pressure include planting disease-free seed, following a 2-year crop rotation, minimizing overhead irrigation during warm weather, and applying fungicides. Methods to effectively schedule fungicide applications according to field scouting and the Tom-Cast disease forecasting system have been developed.

New Product Testing

Fungicides were evaluated at the MSU Muck Soils Research Farm in 2004 (Table 1). 'Fontana' carrot seeds were planted at a density of 22.8 seeds/ft of row on 21 June in three seed lines per row with rows centered 16 in. apart on three-row raised beds centered 64 in. apart. Treatment plots consisted of one row 20 ft long with 5 ft of unsprayed buffer between plots in the same row. One bed was left unsprayed between treatment plots. Twelve treatments were replicated four times in a randomized complete block design. Fungicides were applied with a CO_2 backpack sprayer equipped with three XR8003 flat fan nozzles spaced 18 in. apart and calibrated to deliver 50 gal/A at a nozzle pressure of 52 psi. Ten weekly applications were made on 6, 13, 20 and 27 August; 3, 10, 17, and 24 September; and 1 and 5 October, except for the 14-day treatment of Bravo Weather Stik 6SC which received five applications on alternate dates. The combined effect of Cercospora and Alternaria blight was assessed from plants in the center 10 ft of the middle row of each plot on 11 October. Carrots in the center 10 ft of the middle row were hand-harvested, the foliage was removed with a mechanical topper, and root yields were recorded on 11 October.

Table 1. Fungicides tested for control of Cercospora and Alternaria blights of carrot, 2004.

Product	Active ingredient(s)	Manufacturer	Registered
Amistar 80WG	azoxystrobin	Syngenta	Yes
Bravo Weather Stik 6SC	chlorothalonil	Syngenta	Yes
Cabrio 20WG	pyraclostrobin	BASF	Yes
Endorse 2.5WP	polyoxin D zinc salt	Arvesta	No
Kocide 2000 53.8DF	copper hydroxide	Griffin	Yes
Pristine 38WG	boscalid + pyraclostrobin	BASF	No
Switch 62.5WG	cyprodinil + fludioxonil	Syngenta	Yes

Cercospora blight was the primary disease in this trial and was detected during the first week of August. Few Alternaria blight symptoms developed on mature foliage in late September. Leaving plots untreated resulted in severe petiole (> 50 lesions/plant) and leaf (68%) blight (Table 2). When compared to the incidence of petiole blight of untreated plots, applications of Cabrio 20WG (8 and 12 oz/A), Amistar 80WG (3 and 5 oz/A), or Pristine 38WG reduced petiole disease when applied in alternation with Bravo Weather Stik 6SC or when Bravo Weather Stick 6SC was applied weekly (1.5 and 1 pt/A). All fungicide programs, except Switch 62.5WG, reduced the severity of petiole blight and improved petiole health compared to the untreated. No significant improvement in disease control or yield occurred when higher rates of Cabrio 20WG or Amistar 80WG were used. Applications of Switch 62.5WG did not differ from the untreated control for all parameters measured. Cabrio 20WG (8 and 12 oz) alternated with Bravo Weather Stik 6SC resulted in a significantly higher yields than the Switch 62.5WG treatment and the untreated. No phytotoxicity was observed from any treatment.

Table 2. Results of new product testing for control of Cercospora and Alternaria blights of carrot.

Treatment and rate/A (application sequence[z])	Petiole blight		Petiole health[w]	Leaf blight (%)[v]	Yield per 10-ft row (lb)
	Incidence (%)[y]	Severity[x]			
Untreated	97.9 e[u]	5.0 c	7.5 d	68.2 d	14.7 c
Bravo Weather Stik 6SC 1.5 pt (1-10)	22.0 abcd	1.5 ab	1.8 ab	5.5 abc	24.6 ab
Bravo Weather Stik 6SC 1.5 pt (1,3,5,7,9)	74.6 de	2.5 b	3.3 bc	13.8 c	25.1 ab
Bravo Weather Stik 6SC 1 pt (1-10)	18.4 abc	1.8 ab	2.0 abc	4.2 ab	25.0 ab
Cabrio 20WG 8 oz (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	5.3 ab	1.0 a	1.3 a	2.8 a	26.1 a
Cabrio 20WG 12 oz (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	2.4 a	1.5 ab	2.0 abc	6.2 abc	27.3 a
Amistar 80WG 3 oz (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	9.7 abc	1.0 a	1.8 ab	3.6 a	24.4 ab
Amistar 80WG 5 oz (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	8.0 abc	1.0 a	1.5 a	3.6 a	25.0 ab
Endorse 2.5WP 2.2 lb (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	41.5 bcde	1.8 ab	1.8 ab	4.7 abc	23.2 ab
Kocide 2000 53.8DF 1.5 lb (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	44.3 cde	2.3 ab	3.5 c	12.5 bc	25.8 ab
Pristine 38WG 10.5 oz (1,3,5,7,9) Bravo Weather Stik 6SC 1.5 pt (2,4,6,8,10)	18.0 abc	1.0 a	2.3 abc	5.1 abc	23.9 ab
Switch 62.5WG 11 oz (1-10)	97.6 e	4.5 c	6.3 d	55.6 d	18.7 bc

[z] Application sequence: 1 = 6 Aug; 2 = 13 Aug; 3 = 20 Aug; 4 = 27 Aug; 5 = 3 Sep; 6 = 10 Sep; 7 = 17 Sep; 8 = 24 Sep; 9 = 1 Oct; 10 = 5 Oct.
[y] Percentage of plants from 10 ft of the center row with at least one petiole lesion.
[x] Petiole blight severity rated on a 1 to 5 scale; where 1 = 0 petiole lesions per plant, 2 = 1-10, 3 = 11-21, 4 = 21-50, and 5 = > 50.
[w] Petiole health rated on a 1 to 10 scale; where 1 = healthy and vigorous to 10 = necrotic or dead.
[v] Evaluated using a leaf blight assessment key representing the percentage of disease foliage.
[u] Means within a column followed by the same letter are not significantly different according to Tukey's Studentized Range Test (*P*=0.05).

Nozzle and Spray Pressure Comparison

A second study was conducted at the MSU Muck Soils Research Farm to examine nozzle types, spray pressure, and reduced fungicide rates. A higher spray pressure (100 psi) was used when applying fungicides at reduced rates. Fungicides were applied with a CO_2 backpack sprayer equipped with either three XR8002 flat fan nozzles or three 8002 twin-flat fan nozzles spaced 18 in. apart and calibrated to deliver 30 gal/A at 50 or 100 psi. Nine applications were made on 6, 13, 20, and 31 August; 7, 14, 22, and 29 September; and 5 October.

Table 3. Effects of nozzle type, spray pressure, and fungicide rate on Cercospora blight of carrot.

Treatment and rate/A, applied at 7-day intervals	Nozzle type	Spray pressure (psi)	Foliar infection (%)[z]	Petiole		Plant health[x]	Yield (lb/10 ft)
				Severity[y]	Infection (%)		
Untreated	–	–	45.0 b[w]	4.5 b	98.9 d	5.3 b	17.9
Bravo Weather Stik 6SC 0.75 pt.....	flat fan	100	10.0 a	2.0 a	75.6 bcd	2.0 a	23.5
Bravo Weather Stik 6SC 1.5 pt.......	flat fan	50	7.5 a	2.0 a	49.8 ab	1.3 a	23.0
Bravo Weather Stik 6SC 0.75 pt.....	twin fan	100	7.5 a	1.9 a	80.3 cd	1.5 a	23.4
Bravo Weather Stik 6SC 1.5 pt.......	twin fan	50	7.5 a	1.9 a	60.3 abc	1.8 a	25.4
Bravo Weather Stik 6SC 0.75 pt alternate Cabrio 20WG 0.38 lb	flat fan	100	5.0 a	1.9 a	41.7 ab	1.0 a	23.0
Bravo Weather Stik 6SC 1.5 pt alternate Cabrio 20WG 0.5 lb	flat fan	50	5.0 a	1.8 a	40.8 a	1.0 a	26.5
Bravo Weather Stik 6SC 0.75 pt alternate Cabrio 20WG 0.38 lb	twin fan	100	5.0 a	2.0 a	58.7 abc	1.0 a	26.4
Bravo Weather Stik 6SC 1.5 pt alternate Cabrio 20WG 0.5 lb	twin fan	50	6.3 a	2.0 a	40.7 a	1.3 a	20.9
Cabrio 20WG 0.5 lb alternate Kocide 2000 54DF 1.5 lb .	flat fan	100	5.0 a	1.9 a	30.7 a	1.3 a	21.1
Cabrio 20WG 0.5 lb alternate Kocide 2000 54DF 1.5 lb .	twin fan	100	5.0 a	1.8 a	31.8 a	1.0 a	23.2

[z] Based on a visual estimation of the percentage of foliage infected.
[y] Severity of petiole infection based on visual estimation utilizing a 1 to 5 scale (1=no lesions, 5=>50 lesions per petiole).
[x] Overall plant health rated on a 1 to 10 scale, where 1=no sign of foliar infection, 10=complete defoliation.
[w] Column means with a common letter or with no letter are not significant different, Fisher LSD, P=0.05.

Cercospora incidence was first noted at the beginning of August and progressed to moderate levels by the end of September. At the time of harvest, all treatments (regardless of rate, nozzle type, and spray pressure) had significantly better ratings of foliar infection, petiole severity, and plant health than the untreated (Table 3). There was no significant difference among the treatments for these same ratings and values were similar. Significant differences among the treatments were noted for petiole infection. All treatments, except the reduced rates of Bravo Weather Stik 6SC (0.75 pt) applied every seven days at 100 psi, had significantly fewer infected petioles than the untreated. Spraying Cabrio 20WG (0.5 lb) in alternation with Kocide 2000 54DF (1.5 lb) at 100 psi, either with flat or twin-flat fan nozzles, resulted in the fewest infected petioles. There was no significant difference in control when using a reduced rate of Bravo Weather Stik 6SC (0.75 pt) alternated with Cabrio 20WG (0.38 lb) and increasing the pressure with both nozzle types. Though not significant, there was an increase of infected petioles (20 to 25.8%) when reducing the rate of Bravo Weather Stik and increasing pressure for either nozzle type. Plots were hand harvested, keeping carrot loss to a minimum, and no significant differences in yield were noted for among the treatments.

Why DSV Should be a Part of a Carrot Grower's Vocabulary

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Introduction. Disease forecasters can play an important role in Integrated Pest Management (IPM) systems for vegetable crops by alerting growers when weather conditions are favorable for disease development. The Tom-Cast disease forecasting system was originally designed to manage diseases of tomato and has since been adopted by the Michigan asparagus and carrot industries for disease management. Since 1997, researchers at MSU have tested the Tom-Cast system for controlling Alternaria and Cercospora blights of carrots, both in commercial production fields and at the Muck Soils Research Farm. The purpose of this presentation is to provide a brief summary of recent Tom-Cast research and to re-emphasize the benefits of using Tom-Cast to prompt sprays for managing carrot foliar blights.

Tom-Cast. Tom-Cast uses the hours of leaf wetness for each 24-hour period (11:00 AM to 11:00 AM) and the average temperature during the wetness periods to calculate a disease severity value (DSV) (Table 1). DSVs range from 0 to 4, corresponding to environmental conditions unfavorable to highly favorable for disease development. Daily DSVs are summed and accumulate, and when a threshold value of 15 DSVs is reached, a fungicide spray is applied and the DSV total is reset to zero.

Table 1. Leaf wetness duration and temperatures used to calculate DSVs for Tom-Cast.

Mean temperature		Leaf wetness periods (hours) required to produce daily Disease Severity Values (DSVs) of:				
°C	°F	**0**	**1**	**2**	**3**	**4**
13-17	55.0-63.5	0-6	7-15	16-20	21+	
18-20	63.6-69.0	0-3	4-8	9-15	16-22	23+
21-25	69.1-78.0	0-2	3-5	6-12	13-20	21+
26-29	78.1-85.1	0-3	4-8	9-15	16-22	23+

(source: Madden et al. 1978. Phytopathology 68:1354-1358)

Weather Monitoring Equipment. Leaf wetness and temperature were monitored with sensors manufactured by Spectrum Technologies, Inc. The sensors (Figure 1) are relatively inexpensive yet reliable for obtaining the weather information used by Tom-Cast. A computer equipped with the Specware software program must be used to launch (activate) the sensor. Under the "options" tab of the Specware program, set the "wetness threshold" to 0 and select "save parameters". This ensures the sensor will detect leaf wetness whenever moisture is present on the leaf wetness grid. Further details on use of the Specware program can be obtained from "Forecasting with Tom-Cast and Spectrum Weather Equipment"

Figure 1. A leaf wetness and temperature sensor is oriented at a 45° angle facing north and located in the upper 75% of the carrot canopy.

(http://plantpathology.msu.edu/labs/hausbeck/hausbeck Publications.htm) or by contacting your local extension agent.

Does the system work? Yes, applying fungicides when prompted by Tom-Cast results in similar disease control and often requires fewer applications when compared with calendar-based (7- or 10-day) spray schedules. In 2001 and 2002, Bravo Ultrex (1.4 lb/A) was applied every 7 days or according to three disease forecasting systems. Five to seven fewer sprays were prompted by Tom-Cast 15 DSV when compared to the weekly schedule (Figure 2). Tom-Cast 15 DSV was the only disease forecaster to limit foliar blights to low levels comparable to the weekly fungicide program.

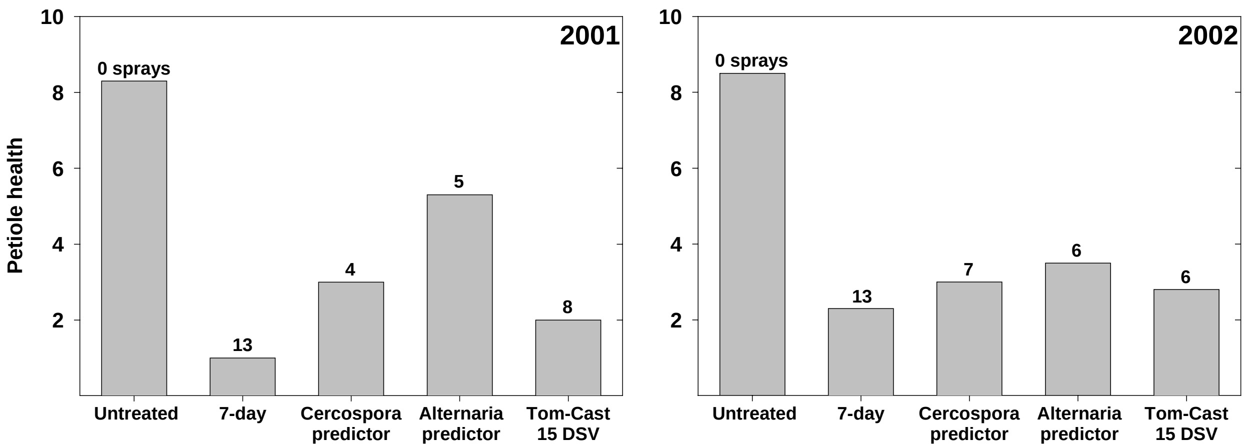

Figure 2. Petiole health (1 = healthy, vigorous; 10 = weak, dead) of 'Cellobunch' carrots treated with Bravo Ultrex 82.5WDG (1.4 lb/A) in 2001 and 2002.

In a separate 2-year study (2001 and 2002), fungicide sprays were initiated either prior to disease or when disease symptoms developed at a trace, 5%, or 10% level and reapplied every 10 days or according to Tom-Cast using a 15, 20, or 25 DSV threshold. Tom-Cast 15 DSV prompted 1 to 3 fewer sprays than the 10-day schedule and limited blights to low levels. A total of 4 sprays were saved by initiating fungicide spray when a trace amount of disease developed on the foliage and reapplied according to Tom-Cast 15 DSV when compared to the 10-day schedule initially applied prior to disease development (Table 2).

Table 2. Cost of fungicide programs when Bravo Ultrex 82.5WDG (1.4 lb/A) alternated with Quadris 2.08F (6.2 fl oz/A) was applied in 2001 and 2002.

Application interval	Disease present when sprays begun	2001		2002	
		# Sprays	Cost/A	# Sprays	Cost/A
10-day	none	9	$102	9	$92
Tom-Cast 15 DSV	none	8	$92	6	$63
Tom-Cast 15 DSV	trace (scouting)	5	$56	5	$50
Tom-Cast and scouting savings:		$46/A		$42/A	

A 2003 study identified that the use of strobilurin fungicides (Amistar/Quadris, Cabrio, or Pristine) should be included in the fungicide program when Tom-Cast 15 DSV was used to prompt sprays to protect a blight-susceptible variety. These fungicides must be used in alternation with protectant fungicides (Bravo or Kocide) to prevent fungicide resistance from developing. On blight susceptible 'Fontana' carrots, a strobilurin fungicide was necessary when using Tom-Cast 15 DSV to reduce disease to levels comparable to the weekly treatment. Tom-Cast prompted 50% fewer sprays than the 7-day treatment in this study.