CARROT (*Daucus carota* subsp. *sativus*)
Alternaria Leaf Blight; *Alternaria dauci*
Cercospora Leaf Blight; *Cercospora carotae*

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Evaluation of the effect of fungicide treatments and application schedules on foliar blight - Hancock 2007.

A field experiment was conducted at the Hancock Agricultural Research Station in central WI, to evaluate fungicide treatments and application schedules for the control of Alternaria leaf blight (ALB) and Cercospora leaf spot (CLS) of carrot. Seeds of the cultivar Enterprise (moderately susceptible to foliar diseases) were planted 7 May at approximately 550,000 seeds/A, using a standard commercial vacuum planter. Each experimental plot consisted of a 6-ft-wide planting bed with three 22-ft-long rows spaced 24 in. apart. The experiment was designed as a randomized complete block with four replicates. The soil type was Plainfield sand with pH 6.9. Oat seed was sown on 6 Apr as a cover crop to provide early season wind protection. Fertilizer applications consisted of 0-0-60, 450 lb/A broadcast 3 Apr, pop-up fertilizer (3-18-18, 3 gal/A) during bed shaping on 3 May to aid in early seedling establishment, sidedress fertilizer consisting of NH_3SO_4, 100 lb/A, + mono-ammonium phosphate (11-52-0), 50 lb/A, + KMag, 200 lb/A, 22 Jun and foliar nitrogen applied through overhead irrigation (28% UAN, 30 lb/A 6 and 21 Aug; 40 lb/A 31 Aug). Vydate L, 0.5 gal/A was applied at planting and Asana XL (4 fl oz/A, 6 Jul) was applied for insect control. Herbicide applications included Poast (2.0 pt/A) + crop oil concentrate (10 fl oz/A) 5 Jun; Poast (1.5 pt/A) + crop oil concentrate (8 fl oz/A) 12 Jun; Lorox DF (0.75 lb/A) + Sencor DF (0.1 lb/A) + crop oil concentrate (8 fl oz/A) 14 Jun; Select (10.0 fl oz/A + crop oil concentrate (20 fl oz/A), 18 Jun and Lorox DF (0.75 lb/A) + Sencor DF (0.15 lb/A) 6 Jul. Sources of natural inoculum for both pathogens were available from nearby commercial carrot fields and no inoculation was necessary. Fungicide treatments were applied according to protocol with a tractor-mounted boom sprayer equipped with eight Tee Jet D3-23 nozzles spaced 8-in. apart and pressurized with an air compressor (40 psi). Fungicide applications were made at a rate equivalent to 35 gal water/A. Foliar disease severity was rated at four locations in the center row of each experimental plot from 3 Aug to 20 Sep using the Horsfall-Barratt 0-11 scale. No attempt was made to separate symptoms of Alternaria leaf blight and Cercospora leaf spot. On 1 Oct, two 5 ft sections from each experimental plot (10 ft total) were hand harvested and roots were graded into five size classes (based on diameter) and culls (misshapen or rotten). Roots from each size class were then grouped according to commercial processing standards for slicing carrots. The value of each treatment was calculated from total yield without culls, according to a representative commercial processing contract. Rainfall recorded during the growing season (in.) was: May (3.0); Jun (1.1); Jul (2.5); Aug (7.9); Sep (3.1). An additional 17.6 in. of water was applied as irrigation in 36 applications May-Sep.

Symptoms of foliar diseases were first observed on 3 Aug in all treatment blocks. In plots left untreated with fungicide, disease progressed slowly through mid August. In mid to late August there was excessive rainfall and conditions were ideal for disease development. By 20 Sep, 59% of the foliage in untreated plots exhibited symptoms of foliar diseases. All fungicide treatment programs provided similar and significant disease control when compared with untreated plots. Fungicide treatments (Bravo Ultrex alternated with Quadris SC) that were timed using the "hindcast data set (± correction)" and the "24 hr forecast data set (± correction)" used as little as 25% of the fungicide ai applied for the weekly Bravo Ultrex program while providing a similar level of disease control. The program using alternating treatments of Serenade MAX/Kocide/Biotune and Quadris SC provided similar control to a program consisting of weekly applications using Bravo Ultrex. Total yields were highest in plots treated with a standard program of Bravo Ultrex (weekly; 9 sprays), Bravo Ultrex/Quadris SC (72 hr forecast – 15 DSV threshold; 6 sprays), and Serenade MAX/Kocide/Biotune and Quadris SC (9 sprays). The value of graded yield and effect of treatment on crop value was highest in plots treated with Bravo Ultrex/Quadris SC (72 hr forecast – 15 DSV threshold; 6 sprays) that required 4.0 lb ai of fungicide.

Table 1. Severity of foliar disease symptoms.

	Treatment	Rate	Weather data [1]	Application schedule	Total lb active ingredient/ season	% Disease severity (Alternaria and Cercospora blight, combined) [2]					Relative AUDPC [3]
						3 Aug	15 Aug	28 Aug	12 Sep	20 Sep	
1	Bravo Ultrex	1.4 lb	Hindcast, 15 DSV	24 Jul, 22 Aug							
	Quadris 2.08 SC	9.2 fl oz	threshold	10 Aug, 29 Aug	2.6	2.5	5.4	17.0	24.4	28.7	0.149
2	Bravo Ultrex	1.4 lb	Hindcast – corrected, 15	24 Jul, 22 Aug							
	Quadris 2.08 SC	9.2 fl oz	DSV threshold	10 Aug, 31 Aug	2.6	1.9	5.7	12.0	14.6	15.8	0.101
3	Bravo Ultrex	1.4 lb	24 hr forecast, 15 DSV	24 Jul, 22 Aug, 11 Sep							
	Quadris 2.08 SC	9.2 fl oz	threshold	10 Aug, 29 Aug	3.8	2.2	4.1	8.5	18.2	22.9	0.101
4	Bravo Ultrex	1.4 lb	24 hr forecast – corrected,	24 Jul, 22-Aug							
	Quadris 2.08 SC	9.2 fl oz	15 DSV threshold	10 Aug, 31 Aug	2.6	3.5	6.0	9.1	17.0	21.1	0.105
5	Bravo Ultrex	1.4 lb	72 hr forecast, 15 DSV	24 Jul, 15 Aug, 29 Aug							
	Quadris 2.08 SC	9.2 fl oz	threshold	7 Aug, 22 Aug, 7 Sep	4.0	2.0	4.7	9.4	12.6	13.2	0.083
6	Bravo Ultrex	1.4 lb	72 hr forecast – corrected,	24 Jul, 22 Aug, 11 Sep							
	Quadris 2.08 SC	9.2 fl oz	15 DSV threshold	7 Aug, 29 Aug	3.8	3.2	5.1	9.4	19.0	22.9	0.109
7	Bravo Ultrex	1.4 lb	WatchDog in-field data, 15	24 Jul, 13 Aug, 29 Aug							
	Quadris 2.08 SC	9.2 fl oz	DSV threshold	3 Aug, 23 Aug, 11 Sep	4.0	1.8	4.4	8.2	9.7	12.3	0.071
8	Not treated	--		none	0	2.2	11.4	37.9	54.3	59.0	0.322
9	Bravo Ultrex	1.4 lb		Weekly (9 weeks)	10.4	2.3	4.2	7.9	12.0	18.2	0.081
10	Serenade MAX	1.0 lb		24 Jul, 7 Aug, 21 Aug, 4							
	+ Kocide 2000	1.0 lb		Sep, 18 Sep							
	+ Biotune (0.125%)										
	Quadris 2.08 SC	15.4 fl oz		31 Jul, 14 Aug, 28 Aug,							
				11 Sep	4.4	3.4	4.7	10.8	15.5	15.8	0.098
	Pr > F [4]					0.13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	LSD					NS	3.0	12.7	10.1	12.1	0.060

1. Several of the treatments were part of a multistate study to evaluate the potential to use remote-sensing estimated weather data (SkyBit E-WEATHER SERVICE) for disease prediction programs. Estimated weather data was received each day via email and used in the TomCAST disease predictor program to schedule fungicide applications. The "Hindcast" data set was an estimate for the past 24 hr. In addition, estimated forecast weather data – 24 or 72 hours ahead were provided. Treatments were scheduled using TomCAST with a 15 DSV threshold for the three original data sets (hindcast, 24 and 72 hr forecast), equivalent data sets processed to provide data sets potentially corrected for leaf wetness and in-field data from a WatchDog weather station. These were compared with a weekly spray and plots receiving no treatment.
2. Severity of leaf blight symptoms was rated on a Horsfall-Barratt scale of 0 (no infection) to 11 (all foliage dead). Symptoms of Alternaria leaf blight and Cercospora leaf spot were not separated. Ratings were converted to % foliar severity.
3. Relative area under the disease progress curve (RAUDPC). Disease severity for each date was plotted on a graph and the area under the resulting curve was calculated by for each treatment, providing a measure of the relative disease severity over the season. A severity rating of 100% for the entire season would produce a value of 1.0. All relative AUDPC values are expressed as a proportion of this value.
4. An analysis of variance was performed on the data and Fisher's protected least significant difference (LSD) was calculated (alpha=0.05). NS =not significant at $P = 0.05$.

Table 3. Effect of foliar fungicide treatment on carrot yield and value.

Trt no.	Treatment	Total yield (t/A)[1]	Cost of chemicals ($/A)	Percentage of yield in size classes by carrot diameter (in.)					% Culls	Yield graded as slicers[2]						Effect of treatment on value ($/A)[4]
										Percentage of yield			Price/ t ($)	Value of yield ($/A)		
				< 0.75	0.75 – 1.25	1.25 – 1.63	1.63 - 2	> 2		0.75 - 1.63 in.	>1.63 in.	Discards		Gross	Net[3]	
1	Hindcast	29.7	47.0	6.6	50.1	28.4	8.3	0.0	6.5	78.6	8.3	13.1	54.3	1394.9	1347.9	318.1
2	Hindcast – corrected	27.7	47.0	7.4	48.5	34.7	3.1	0.0	6.3	83.2	3.1	13.7	54.7	1315.7	1268.7	238.9
3	24 hr forecast	29.9	55.1	6.1	47.1	32.5	9.1	2.2	3.1	79.5	11.3	9.2	54.1	1471.1	1416.0	386.2
4	24 hr forecast – corrected	31.4	47.0	5.9	44.2	37.1	9.3	0.0	3.6	81.3	9.3	9.4	54.3	1544.0	1497.0	467.2
5	72 hr forecast	37.9	70.5	5.7	51.1	31.5	5.8	1.4	4.5	82.6	7.2	10.2	54.5	1860.9	1790.4	760.6
6	72 hr forecast – corrected	31.0	55.1	5.2	47.8	31.4	9.9	0.0	5.6	79.3	9.9	10.9	54.1	1499.5	1444.4	414.6
7	WatchDog in-field data	32.6	70.5	6.9	43.7	33.0	7.7	0.0	8.7	76.7	7.7	15.6	54.3	1530.9	1460.4	430.6
8	Not treated	22.8	0.0	10.7	56.8	23.0	3.0	0.0	6.4	79.8	3.0	17.2	54.7	1029.8	1029.8	0.0
9	Standard weekly	37.1	72.5	4.3	31.3	41.5	13.5	3.2	6.3	72.8	16.7	10.6	53.5	1785.0	1712.6	682.8
10	Serenade MAX + Kocide 2000 + Biotune Quadris 2.08 F	34.7	185.1	6.1	42.4	37.9	7.7	0.0	5.8	80.3	7.7	11.9	54.5	1667.5	1482.4	452.6
Pr>F[5]		< 0.01	---	0.51	0.01	0.03	0.02	0.02	0.64	0.33	< 0.01	0.48	0.03	< 0.01	< 0.01	< 0.01
LSD[5]		6.9	---	NS	11.0	9.5	5.5	2.0	NS	NS	6.0	NS	0.6	347.9	347.9	347.9

1 Two 5-ft-long sections of row were hand dug in each plot and yield was converted to tons/A. Hand digging is likely to result in a higher apparent yield as fewer carrots are lost than when mechanically harvested. Roots were graded into five size classes and culls (misshapen or rotted). The size classes were then grouped appropriately to conform to standards for slicing carrots.

2 For comparison, values are calculated based on a typical 2004 processing contract for uncrowned carrots for slicing.

- Minimum size accepted is 0.75 inch diameter; discard class includes culls and carrots below the minimum diameter. Slicing base price per ton is: < 10% over 1.75in. diameter - $54.70; 10-19% > 1.75in. - $53.90; 20-29% > 1.75in. - $52.40; 30-39% > 1.75in. - $49.40; 40-49% > 1.75in. - $46.45; >49% > 1.75in. - $43.60.

3 Gross value minus cost of chemicals applied.

4 Net value for the treatment minus net value of the untreated control.

5 Analysis of variance was performed on data, and Fisher's protected least significant difference (LSD) was calculated (alpha=0.05). NS = not significant at $P = 0.05$.