# Carrot Disease Forecasting and Management

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In Wisconsin, carrots for processing were raised on approximately 4000 acres at an average yield of 24.97 ton/acre and state production value of $7.13 million in 2011. While production was on comparable acreage in 2010, due to carrot losses resulting from erratic environmental conditions in 2010, overall yield was down by 3.32 tons/acre and farm gate value of nearly $2.1 million. While these agricultural statistics from just recent years demonstrate volatility in productivity, such variability has and can occur from year to year, often due to unexpected or extreme environmental conditions. Key foliar diseases of carrot, such as Alternaria and Cercospora leaf blight (inset note below), are greatly influenced by environmental conditions. Anticipation of heightened disease risk through identification and monitoring of critical environmental factors, such as precipitation and temperature, can enhance management by optimizing timing of pesticide applications and protecting yield and quality.

Our current research aims to mitigate disease through identification of most effective fungicide selections and timing of applications and development of an online and email resource for identifying key times for initiation of fungicide application based on disease forecast models. While we are in the preliminary stages of creating a state-wide, web-accessible TomCast tool for carrot disease control, we have conducted fungicide efficacy and timing studies in 2011 and 2012 (data to follow in this report)

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Alternaria leaf blight (A), caused by *Alternaria dauci*, and Cercospora leaf spot (B), caused by *Cercospora carotae*, infect leaves and petioles of carrot and are the most prevalent foliar diseases. These foliar blight fungi reduce yield by limiting the plant's photosynthetic capacity and by weakening the petioles needed for mechanical harvest.

**Evaluation of fungicide treatments and application schedule on foliar blight of carrot, 2012.**

A carrot field trial was conducted at the Hancock Research Station in central WI to evaluate fungicides and their timing for control of Alternaria leaf blight and Cercospora leaf spot, common foliar diseases of carrot in the Midwestern United States. 'Enterprise' seeds were sown at approximately 250,000 seed/A with a standard commercial planter on 11 May 2012. The experimental design consisted of 4 replicates arranged in a randomized complete block design. Each treatment plot consisted of 4.5-ft-wide beds with three 18-ft-long seeding rows, 19 in between rows on bed with 17 in from row edge to bed edge. Twelve-ft fallow breaks were

maintained between plots in the same row. Insecticide, herbicide, and fertility applications were made according to standard production practices for the region. Naturally occurring inocula of pathogens were present from nearby agricultural production fields and a neighboring carrot variety trial with no fungicides applied. Experimental plots were sprayed with fungicides using a $CO_2$ backpack sprayer equipped with four Tee Jet 8002VS nozzles spaced 19-in. apart and calibrated to deliver 35 gal/A at a boom pressure of 40 psi. All treatments were applied at a rate with a calculated equivalence to 20 gal/A. Fungicide applications were applied approximately every 2 weeks beginning 25 Jul with subsequent applications 8 Aug, 22 Aug, 5 Sept, and 19 Sept. Disease assessments took place on 25 Jul, 20 Aug, 10 Sep, and 5 Oct, and utilized the Horsfall-Barratt scale (1-11) to assess foliar symptoms in the center row of each experimental plot. Foliar disease severity was combined for all pathogens present at each rating. On 5 Oct, a center 10-ft section was hand harvested from each plot, tops were removed, and roots were weighed to determine yield. Precipitation in Hancock during the production season was 8.19 in. Weather conditions in Hancock during the production season were atypically hot and dry, requiring 51 irrigation events totaling an additional 27.65 in of water. In response to drought and heat conditions, disease pressure was low early- and mid-season.

Foliar symptoms progressed slowly until the third rating date on 10 Sep. Moderate disease pressure was observed on the untreated control by the final rating date of 5 Oct, which had the highest AUDPC rating, significantly greater than all but 2 of the two-application chlorothalonil treatments, (Bravo 1,3 and Bravo 3,5). Four treatments resulted in significantly greater yields than the untreated control, and included: Bravo Weather Stik for 5 applications, Quadris for applications 1, 2, 4, 5 + Bravo Weather Stik at application 3, Quadris Top for applications 1, 2, 4, 5 + Bravo Weather Stik at application 3, and Omega for applications 1, 2, 4, 5 + Bravo Weather Stik at application 3. All of the significantly highest yielding programs included a fungicide treatment in each of the 5 bi-weekly applications. There were no phytotoxic symptoms observed with any of the fungicide programs throughout the duration of the trial.

**Table 1. Effect of foliar-applied fungicides on seasonal disease progression and yield.**

| Treatments and rate/A | Application schedule[z] | AUDPC[y] | Total Yield (ton/A)[x] |
|---|---|---|---|
| Untreated……. | | 128.1 e[w] | 38.2 ab |
| Bravo Weather Stik 6 SC 2.0 pt…….. | 1, 2, 3, 4, 5 | 103.1 abcd | 43.5 cd |
| Bravo Weather Stik 6 SC 2.0 pt…….. | 1, 3, 5 | 106.3 bcd | 38.9 ab |
| Quadris 2.08 SC 9.0 fl oz…… | 1, 2, 3, 4, 5 | 93.8 abcd | 40.8 abcd |
| Quadris 2.08 SC 9.0 fl oz…… | 1, 3, 5 | 93.8 abcd | 42.1 bcd |
| Quadris 2.08 SC 9.0 fl oz<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 90.6 abc | 43.4 cd |
| Quadris Top 2.71 SC 12.0 fl oz<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 93.8 abcd | 44.4 d |
| Inspire XT 4.17 EC 7.0 fl oz<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 87.5 ab | 40.8 abcd |
| Omega 4 SC 1.0 pt<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 100.0 abcd | 39.8 abc |
| Omega 4 SC 1.5 pt<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 90.6 abc | 44.1 d |
| A16976 550 SC 1.5 pt<br>Bravo Weather Stik 6 SC 2.0 pt…… | 1, 2, 4, 5<br>3 | 84.4 a | 42.0 abcd |
| Bravo Weather Stik 6 SC 2.0 pt<br>Quadris 2.08 SC 9.0 fl oz…….. | 1,5<br>3 | 100.0 abcd | 39.8 abc |
| Bravo Weather Stik 6 SC 2.0 pt …….. | 1,3 | 112.5 de | 38.1 a |
| Bravo Weather Stik 6 SC 2.0 pt……... | 2,4 | 103.1 abcd | 39.2 ab |
| Bravo Weather Stik 6 SC 2.0 pt……... | 3,5 | 109.4 cde | 39.9 abcd |

[z] Fungicides were applied a total of five times every 2 week: application 1: 26 Jul, 2: 8 Aug, 3:22 Aug, 4:5 Sept, 5:19 Sept.

[y] Disease intensity over time of combined leaf blight symptoms are presented as the Area Under the Disease Progress Curve (AUDPC).

[x] One 10-ft-long section of row was hand harvested from the center of each plot and yield was converted to tons/A.

[w] Column means with a letter in common or with no letter are not significantly different (Fisher's LSD, *P=0.05*).

## Evaluation of fungicide treatments and application schedule on foliar blight of carrot, 2011.

A carrot field trial was conducted on a muck soil field previously planted to onion in Endeavor, WI to evaluate control of Alternaria leaf blight, Cercospora leaf spot, and white mold. Seeds of cultivar Fontana were planted on 5 Jun 2011 (~250,000 seed/acre) using a standard commercial planter. The experimental design consisted of 4 replicates arranged in a randomized complete block design. Each treatment plot consisted of 5-ft-wide beds with four 18-ft-long rows spaced 15 in apart with 8-ft unsprayed buffer alleys between plots in the same row. Fertilizer, herbicide, and fertility applications were made according to standard production practices for the region. Naturally occurring inocula of all three pathogens were present from nearby agricultural production fields. Experimental plots were sprayed with fungicidal treatments using a $CO_2$ backpack sprayer equipped with four Tee Jet 8002VS nozzles spaced 19-in. apart and calibrated to deliver 35 gal/A at a boom pressure of 40 psi. All treatments were applied at a rate with a calculated equivalence to 20 gal/A. Disease assessments took place on 13, 28 Jul; 10, 24 Aug;

and 28 Sep and utilized the Horsfall-Barratt 1-11 scale to assess foliar symptoms on four plant canopies in the center row of each experimental plot. Foliar disease severity was combined for all diseases present at each rating. On 28 Sep, two 5-ft sections were hand harvested from each plot and weighed to determine marketable yield. Precipitation for the production season was 6.82 inches. Supplemental irrigation was not needed.

Foliar symptoms did not progress beyond trace levels until the third rating date (28 Jul). Moderate disease pressure was observed on the untreated control by the final rating date (28 Sep), which had approximately 28% foliar disease and an RAUDPC value of 0.193. All of the fungicide treatments significantly limited disease compared to the untreated control at harvest. Treatment 4 had the lowest disease rating of 6% at harvest, which was statistically better than treatments 6 and 7. Treatments 2-5 significantly suppressed disease progression (RAUDPC) compared to treatments 6, 7, and the untreated control. There were no differences observed in total yield by treatment. There were no phytotoxic symptoms observed throughout the duration of the trial.

**Table 1. Effect of foliar-applied fungicides on disease symptoms, yield, and seasonal disease progression.**

| | Treatments and rate/A | Application schedule[z] | Disease Severity (%)[y] | Total Yield (ton/A)[x] | Relative AUDPC[w] |
|---|---|---|---|---|---|
| 1 | Untreated……. | | 28.0 c[v] | 22.3 | 0.193 c |
| 2 | Bravo Weather Stik 6 SC 2.0 pt…….. | 1, 2, 3, 4, 5 | 9.0 ab | 25.3 | 0.121 a |
| 3 | Quadris Top 2.71 SC 10 fl oz<br>Bravo Weather Stik 6 SC 2.0 pt….. | 1, 2, 4, 5<br>3 | 9.0 ab | 26.9 | 0.122 a |
| 4 | Inspire XT 4.17 EC 7.0 fl oz<br>Bravo Weather Stik 6 SC 2.0 pt….. | 1, 2, 4, 5<br>3 | 6.0 a | 23.2 | 0.122 a |
| 5 | A16976 1.5 pt<br>Bravo Weather Stik 6 SC 2.0 pt….. | 1, 2, 4, 5<br>3 | 9.0 ab | 26.5 | 0.127 a |
| 6 | Omega 4 SC 1.0 pt<br>Bravo Weather Stik 6 SC 2.0 pt….. | 1, 2, 4, 5<br>3 | 13.0 b | 22.2 | 0.149 b |
| 7 | Omega 4 SC 1.5 pt<br>Bravo Weather Stik 720 SC 2.0 pt... | 1, 2, 4, 5<br>3 | 14.0 b | 22.5 | 0.151 b |

[z] Fungicides were applied on the following dates: 1=13 Jul; 2=28 Jul; 3=10 Aug; 4=24 Aug; 5=7 Sep.

[y] Disease severity of combined leaf blight symptoms from Alternaria blight, Cercospora blight, and white mold was determined by assessing overall percentage of symptomatic tissue per plant canopy.

[x] Two 5-ft-long sections of row were hand harvested in each plot and yield was converted to tons/A.

[w] Relative area under the disease progress curve (RAUDPC). Disease severity for each rating date was plotted on a graph and the area under the resulting curve was calculated in order to provide a measure of the relative disease pressure over the duration of the season. A final severity rating of 100% would produce a value of 1.0. All expressed values are a proportion to this maximum.

[v] Column means with a letter in common or with no letter are not significantly different (Fisher's LSD, *P=0.05*).