Comparative efficacy of fungicides for managing Ascochyta blight in chickpeas: 
FUNGICIDE TANK-MIXES WITH CHLOROTHALONIL

A comprehensive review of 45 chickpea Ascochyta fungicide efficacy studies conducted across North Dakota from 2007 to 2019.

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Compiled by: Michael Wunsch, plant pathologist NDSU Carrington Research Extension Center

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North Dakota Crop Protection Product Harmonization Board & Registration Board
BASF and Syngenta
Across five studies conducted in Carrington and Hofflund (30 miles east of Williston), Bravo WeatherStik or Echo 720 (1.38 pt/ac) was less effective than Proline (5.7 fl oz/ac) except under low disease pressure.

BRAVO WEATHER STIK at 1.38 pints contains 469.5 grams chlorothalonil (FRAC M5). Many brands of chlorothalonil are available, and testing was also conducted with Echo 720.
Across all studies in which Bravo Weather Stik or Echo 720 (1.38 pt) and Proline (5.7 fl oz) were evaluated:

- Bravo Weather Stik / Echo 720 was overwhelmed by Ascochyta at lower levels of disease pressure than Proline (5.7 fl oz/ac)

Blue dots: Each dot corresponds to the performance of the fungicide in one field trial.

**IMPACT OF FUNGICIDE ON YIELD:**

**Bravo WS / Echo 720** 1.38 pt/ac  
active ingredient = chlorothalonil (719 g a.i./liter)

- Maximum = 38.1

**IMPACT OF FUNGICIDE ON CHICKPEA YIELD:**

**Proline** 5.7 fl oz/ac  
active ingredient = prothioconazole (480 g a.i./liter)

- Maximum = 50.1
Bravo WeatherStik is most effective as a tank-mix partner with other fungicides.

Across 11 studies conducted over 4 years, Tank-mixing Bravo WeatherStik (1.38 pt/ac) and Proline (5.0 or 5.7 fl oz/ac) consistently improved Ascochyta management relative to Proline applied alone.

Gains in disease control and yield were observed at low, moderate and high Ascochyta disease pressure.
Bravo Weather Stik is most effective as a tank-mix partner with other fungicides.

Across 11 studies conducted over 4 years, tank-mixing Bravo WeatherStik (1.38 pt/ac) and Proline (5.0 or 5.7 fl oz/ac) consistently improved Ascochyta management relative to Proline applied alone. Gains in disease control and yield were observed at low, moderate and high Ascochyta disease pressure.

### Fungicide efficacy, chickpea Ascochyta FRAC M5 fungicide:

**Bravo WeatherStik (1.38 pt/ac)** tank-mixed with **Proline (5.0 or 5.7 fl oz/ac)**

#### LOW DISEASE PRESSURE:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ascochyta 0-100 (rAUDPC)</th>
<th>Yield pounds/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>15 b</td>
<td>833 b</td>
</tr>
<tr>
<td>Proline 5.7 fl oz/ac</td>
<td>6 a</td>
<td>1592 ab</td>
</tr>
<tr>
<td>Proline 5.7 fl oz/ac + Bravo WS 1.38 pt/ac</td>
<td>4 a</td>
<td>2386 a</td>
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#### MODERATE to HIGH DISEASE PRESSURE:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ascochyta 0-100 (rAUDPC)</th>
<th>Yield pounds/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>56 b</td>
<td>1130 c</td>
</tr>
<tr>
<td>Proline 5.7 fl oz/ac</td>
<td>19 a</td>
<td>2362 b</td>
</tr>
<tr>
<td>Proline 5.7 fl oz/ac + Bravo WeatherStik 1.38 pt/ac</td>
<td>11 a</td>
<td>2745 a</td>
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</table>

#### HIGH to VERY HIGH DISEASE PRESSURE:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ascochyta 0-100 (rAUDPC)</th>
<th>Yield pounds/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>67 c</td>
<td>200 b</td>
</tr>
<tr>
<td>Proline 5.7 fl oz/ac</td>
<td>19 b</td>
<td>1629 a</td>
</tr>
<tr>
<td>Proline 5.0-5.7 fl oz/ac + Bravo WeatherStik 1.38 pt/ac</td>
<td>8 a</td>
<td>2088 a</td>
</tr>
</tbody>
</table>
Bravo Weather Stik is most effective as a tank-mix partner with other fungicides. Preliminary data from a study conducted in Carrington in 2019:

Increasing the application rate of Bravo Weather Stik from 1.38 pt/ac to 2.0 pt/ac may increase the efficacy of tank-mixes with Proline.

<table>
<thead>
<tr>
<th>2019</th>
<th>Carrington</th>
<th>‘CDC Frontier’</th>
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<tbody>
<tr>
<td>60</td>
<td>d</td>
<td>a</td>
</tr>
<tr>
<td>21</td>
<td>c</td>
<td>a</td>
</tr>
<tr>
<td>6</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>9</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>8</td>
<td>b</td>
<td>a</td>
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<tr>
<td>3</td>
<td>a</td>
<td>a</td>
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<td>3</td>
<td>a</td>
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<table>
<thead>
<tr>
<th>Yield 13.5% moisture pounds/acre</th>
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</thead>
<tbody>
<tr>
<td>Non-treated control</td>
</tr>
<tr>
<td>Bravo WS 22 fl oz/ac</td>
</tr>
<tr>
<td>Bravo WS 32 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 22 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.0 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.7 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.0, 22 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.7, 22 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.0, 32 fl oz/ac</td>
</tr>
<tr>
<td>Proline + Bravo WS 5.7, 32 fl oz/ac</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>ASCOCHYTA AUDPC 0-100</th>
</tr>
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<tbody>
<tr>
<td>2019</td>
</tr>
<tr>
<td>d</td>
</tr>
<tr>
<td>c</td>
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<tr>
<td>b</td>
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<td>a</td>
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</table>

Fungicide efficacy, chickpea Ascochyta - FRAC M5 fungicide:
**Bravo Weather Stik** (1.38 or 2.0 pt/ac) tank-mixed with **Proline** (5.0 or 5.7 fl oz/ac)
Across all studies in which Proline (5.0-5.7 fl oz) + Bravo WS (1.38 pt) and Proline (5.7 fl oz) were evaluated:

- At very high Ascochyta pressure, the yield gains from the tank-mix also declined just as with Proline applied alone, but average yield gains at any given level of disease pressure were higher with the tank-mix.

Blue dots: Each dot corresponds to the performance of the fungicide in one field trial.

Fungicide efficacy, chickpea Ascochyta - FRAC M5 fungicide:
**Bravo WeatherStik** (1.38 or 2.0 pt/ac) tank-mixed with **Proline** (5.0 or 5.7 fl oz/ac)

Bravo Weather Stik is most effective as a tank-mix partner with other fungicides
Fungicide efficacy, chickpea Ascochyta - FRAC M5 fungicide: Bravo WeatherStik tank-mixed with Provysol, Veltyma or Revytek, new fungicides containing the triazole mefentrifluconazole (FRAC 3)

Mefentrifluconazole might also respond strongly to tank-mixing with Bravo WS

<table>
<thead>
<tr>
<th>ACTIVE INGREDIENTS:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>PROVYSOL</strong> (FRAC 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provysol, 3.0 fl oz</td>
<td>mefentrifluconazole, 35.5 grams</td>
<td></td>
</tr>
<tr>
<td>Provysol, 5.0 fl oz</td>
<td>mefentrifluconazole, 59.2 grams</td>
<td></td>
</tr>
<tr>
<td><strong>VELTYMA</strong> (FRAC 3, 11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veltyma, 7.0 fl oz</td>
<td>mefentrifluconazole, 41.4 g pyraclostrobin, 41.4 grams</td>
<td></td>
</tr>
<tr>
<td>Veltyma, 9.0 fl oz</td>
<td>mefentrifluconazole, 53.3 grams pyraclostrobin, 53.3 grams</td>
<td></td>
</tr>
<tr>
<td><strong>REVTYKE</strong> (FRAC 3, 7, 11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revytek, 8.0 fl oz</td>
<td>mefentrifluconazole, 31.5 grams fluxapyroxad, 21.0 grams pyraclostrobin, 42.0 grams</td>
<td></td>
</tr>
<tr>
<td>Revytek, 10.0 fl oz</td>
<td>mefentrifluconazole, 39.3 grams fluxapyroxad, 26.2 grams pyraclostrobin, 52.4 grams</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ascochyta severity</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>**August 22-24</td>
<td>early senescence percent of canopy**</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-treated control</td>
<td>94</td>
</tr>
<tr>
<td>Bravo WeatherStik, 1.38 pt/ac</td>
<td>50</td>
</tr>
<tr>
<td>Bravo WeatherStik, 2.0 pt/ac</td>
<td>12</td>
</tr>
<tr>
<td>Proline, 5.0 fl oz/ac</td>
<td>26</td>
</tr>
<tr>
<td>Proline, 5.7 fl oz/ac</td>
<td>20</td>
</tr>
<tr>
<td>Proline, 5.0 fl oz/ac + Bravo WeatherStik, 1.38 pt/ac</td>
<td>3</td>
</tr>
<tr>
<td>Proline, 5.7 fl oz/ac + Bravo WeatherStik, 1.38 pt/ac</td>
<td>2</td>
</tr>
<tr>
<td>Proline, 5.0 fl oz/ac + Bravo WeatherStik, 2.0 pt/ac</td>
<td>2</td>
</tr>
<tr>
<td>Proline, 5.7 fl oz/ac + Bravo WeatherStik, 2.0 pt/ac</td>
<td>1</td>
</tr>
<tr>
<td>Provysol 3 fl oz</td>
<td>23</td>
</tr>
<tr>
<td>Provysol 5 fl oz</td>
<td>11</td>
</tr>
<tr>
<td>Provysol 3 fl oz + Bravo WeatherStik 1.38 pt</td>
<td>4</td>
</tr>
<tr>
<td>Provysol 3 fl oz + Bravo WeatherStik 2.0 pt</td>
<td>3</td>
</tr>
<tr>
<td>Provysol 5 fl oz + Bravo WeatherStik 1.38 pt</td>
<td>5</td>
</tr>
<tr>
<td>Veltyma 7 fl oz</td>
<td>19</td>
</tr>
<tr>
<td>Veltyma 9 fl oz</td>
<td>13</td>
</tr>
<tr>
<td>Veltyma 7 fl oz + Bravo WS 1.38 pt</td>
<td>7</td>
</tr>
<tr>
<td>Veltyma 9 fl oz + Bravo WS 1.38 pt</td>
<td>2</td>
</tr>
<tr>
<td>Revytek 8 fl oz</td>
<td>32</td>
</tr>
<tr>
<td>Revytek 10 fl oz</td>
<td>15</td>
</tr>
<tr>
<td>Revytek 8 fl oz + Bravo WS 1.38 pt</td>
<td>5</td>
</tr>
<tr>
<td>Revytek 10 fl oz + Bravo WS 1.38 pt</td>
<td>2</td>
</tr>
</tbody>
</table>

CV: 18.9

CV: 35.8
Across four studies conducted in Carrington from 2017-2019, tank-mixing Priaxor (4.0 fl oz) with Bravo WS (1.38 pt) sometimes, but not always, improved Ascochyta management.

This tank-mix performed strongest under very high disease pressure and otherwise performed less consistently than Proline + Bravo WS.
Fungicide efficacy, chickpea Ascochyta - FRAC M5 fungicide:

**Bravo WeatherStik** (1.38 pt/ac) 
tank-mixed with **Miravis Top** (13.7 fl oz/ac)

Miravis Top is a premix of pydiflumetofen (FRAC 7) and difenoconazole (FRAC 3)

Across two studies conducted in Carrington and Hofflund, ND in 2019,
Tank-mixing Miravis Top (13.7 fl oz) with Bravo WS (1.38 pt) sometimes, but not always, improved Ascochyta management.

This tank-mix performed less consistently than Proline + Bravo WS.

<table>
<thead>
<tr>
<th></th>
<th>2019 Hofflund CDC Frontier</th>
<th>2019 Carrington CDC Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCOCHYTA 0-100 (RAUDP)</td>
<td>d</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>c</td>
</tr>
<tr>
<td>YIELD pounds/acre</td>
<td>391</td>
<td>1668</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>bc</td>
</tr>
<tr>
<td>YIELD pounds/acre</td>
<td>336</td>
<td>1185</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Preliminary conclusions from ongoing research

• **Tank-mixing Bravo WeatherStik (1.38 pt/ac) and Proline (5.0 or 5.7 fl oz/ac) consistently improved Ascochyta management** relative to Proline applied alone. Gains in disease control and yield were observed at low, moderate and high Ascochyta disease pressure.

• **Increasing the application rate of Bravo WeatherStik** from 1.38 pt to 2.0 pt/ac may increase the efficacy of tank-mixes with Proline (5.0 or 5.7 fl oz/ac).

• **Provysol**, the new triazole fungicide from BASF, and associated premix fungicides may also show strong increases in efficacy when tank-mixed with Bravo WeatherStik.

• **Tank-mixing Bravo WS with the SDHI fungicide Priaxor and the SDHI + triazole premix fungicide Miravis Top** improved Ascochyta management under high disease pressure but did not provide consistent improvements in Ascochyta management.
Fungicide application timing:

- The first application was made at the first appearance of Ascochyta symptoms (one or two small lesions on a low percentage of plants).
  - In dry years, this typically has corresponded to early bloom.
  - In wet years, this typically has corresponded to late vegetative growth.

- Subsequent applications were made 10-14 days apart until chickpeas began to senesce except when there is an extended stretch of dry weather, in which case an application is delayed until shortly before forecasted rain.
  - In most years, this corresponds to 3 to 5 applications.
Fungicide application methods:

- Spray volume: 15 or 17.5 gal/ac.
- Droplet size: fine or medium
- Nozzles, pressure: TeeJet extended-range flat-fan nozzles, 30 to 40 psi

Fungicide rotation:

- Rotating fungicide modes of action is critical for maintaining the effectiveness of fungicides. It also improves disease control.
- When conducting fungicide efficacy testing in chickpeas, the same fungicide is applied sequentially in order to ensure that every fungicide is exposed to the same conditions all season.
- The fungicide efficacy results are meant to be used as tools for choosing appropriate fungicides when developing fungicide rotation strategies.
The comparative performance of fungicides sometimes differs across studies.

Fungicides differ in **residual activity** – how long a fungicide confers satisfactory disease control after being applied.

- When disease pressure occurs primarily shortly after fungicides are applied, both long and short-residual fungicides perform well.
- When disease onset is late, only long-residual fungicides perform well.

Fungicides differ in the **level of disease pressure that can be successfully controlled by the fungicide**.

- Under low to moderate disease pressure, many fungicides may perform well.
- Under high disease pressure, only the most effective fungicides perform well.
Thank you!

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North Dakota Crop Protection Product Harmonization Board & Registration Board
BASF, DuPont, Arysta LifeScience, and Syngenta