

Field evaluation of fungicides for management of *Ascochyta* blight on lentils

Carrington, ND (2012)

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KEY FINDINGS:

- Under severe *Ascochyta* blight pressure, the fungicides **Headline** (pyraclostrobin), **Priaxor** (pyraclostrobin + fluxapyroxad), and **Omega** (fluazinam) performed well.
- The efficacy of **Priaxor** appeared to be derived from the pyraclostrobin active ingredient. Priaxor is a premix of pyraclostrobin and fluxapyroxad, the active ingredients in Headline and Xemium, respectively. Headline performed well in this trial, and Xemium did not.
- The strong performance of **Inspire** (difenoconazole) + **Bravo Weather Stik** (chlorothalonil) suggests that **Bravo Top** (difenoconazole + chlorothalonil) may be a useful tool for managing *Ascochyta* blight.
- Under severe *Ascochyta* blight pressure, the fungicides **Endura** (boscalid), **Proline** (prothioconazole), **Quadris** (azoxystrobin), **Vertisan** (penthiopyrad), and **Xemium** (fluxapyroxad) provided unsatisfactory disease control.
- Use of the most effective foliar fungicides resulted in improvements in seed quality and seed grade.

RESULTS:

Disease control, yield, test weight, and kernel weight

Treatment (Fungicide application timing) ^w	Ascochyta Severity ^{z†}		Yield 13% moisture lbs/ac	Test Weight 13% moisture lbs/bu	Seeds per Pound seeds
	July 13 ^y percent	July 20 ^x percent			
1 Non-treated check (water)	83 g *	92 f *	535 c *	57.4 e *	13041 e *
2 Omega 500F 13.6 fl oz/ac (A,B)	19 def	19 e	2559 a	60.3 ab	9940 ab
3 Omega 500F 16 fl oz/ac (A,B)	16 de	15 de	2398 a	60.3 ab	9684 a
4 Omega 500F 16 fl oz/ac (A) / Headline 250SC 6 fl oz/ac (B)	8 cd	7 cde	2724 a	60.8 a	9023 a
5 Non-treated check (water) (A) / Headline 250SC 6 fl oz/ac (B)	50 efg	54 f	1517 b	60.6 a	10325 abc
6 Xemium 300SC 2.23 fl oz/ac (A,B)	74 g	93 f	626 c	58.5 cde	-- NO DATA --
7 Xemium 300SC 3.34 fl oz/ac (A,B)	71 g	93 f	492 c	58.2 de	-- NO DATA --
8 Headline 250SC 6 fl oz/ac (A,B)	4 bc	5 bcd	2782 a	60.7 a	8665 a
9 Priaxor 500SC 4 fl oz/ac (A,B)	4 bc	5 bc	2850 a	60.9 a	9510 a
10 Priaxor 500SC 6 fl oz/ac (A,B)	3 abc	2 ab	3082 a	61.1 a	9285 a
11 Priaxor 500SC 4 fl oz/ac (A) / Proline 480SC 5.7 fl oz/ac + NIS 0.125% v/v (B)	2 ab	3 ab	2998 a	60.9 a	9443 a
12 Proline 480SC 5 fl oz/ac + NIS 0.125% v/v (A,B)	56 fg	73 f	1156 bc	59.4 bc	11697 cd
13 Inspire 250EC 6.404 fl oz/ac + Bravo WS 22.294 fl oz/ac (A,B) ^v	1 a	1 a	3072 a	61.0 a	9390 a
14 Quadris 250SC 6.2 fl oz/ac (A,B)	81 g	89 f	947 bc	58.9 cd	11239 bcd
15 Vertisan 1.67EC 20 fl oz/ac + NIS 0.125% v/v (A,B)	60 g	88 f	728 c	58.3 cde	12690 de
16 Endura 70WG 6 oz/ac (A,B)	84 g	94 f	532 c	58.3 cde	-- NO DATA --
The fungicides INSPIRE / BRAVO TOP, OMEGA, and XEMIUM are currently not registered for use on lentils and should not be used. Results for these products are provided for reference only.	F: 54.36	70.76	63.12	35.76	22.23
	P > F: < 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	CV: 13.1	11.8	14.9	0.7	5.6

^z **Ascochyta severity:** Percent of the canopy exhibiting necrosis due to *Ascochyta* blight. No other foliar diseases were present above trace levels.

^y Lentils were at mid-pod fill on July 13 (bloom complete). ^x Lentils were nearing maturity on July 20.

^w **Fungicide application timings A and B:**

Application A: June 22, 2012 at 6:30-8:00 am; 90% of plants with an open blossom; no foliar disease; wind = 4 mph out of the west, temperature = 55-64°F, relative humidity = 72-90%.

Application B: July 5, 2012 at 6:30-10:00 am; lentils at the end of bloom; *Ascochyta* blight at moderate levels (approx. 10-15% of canopy diseased) in non-treated checks; wind = 3-6 mph out of the north to northwest, temperature = 55-62°F, rel. humidity = 76-87%.

^v **Applied to approximate the performance of Bravo Top 4.59SC.** Syngenta had insufficient supplies of Bravo Top available for testing. To obtain preliminary information on the potential performance of Bravo Top, the component ingredients of Bravo Top (difenoconazole and chlorothalonil) were evaluated by tank-mixing Inspire and Bravo WeatherStik.

* Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

† In order to meet model assumptions of normality and homoskedasticity, analysis of variance was conducted on the natural-log transformation of disease severity [$\text{LN}(\text{sev.} + 1)$]. For ease of interpretation, treatment means are reported as disease severity.

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SEED QUALITY:

Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

Treatment (Fungicide application timing) ^w	SEED QUALITY							
	Viable seeds ^v percent	Split & broken ^u percent	Diseased ^t percent	Stained ^s percent	Discolored (Total) ^r percent	Wrinkled ^q percent	Grade - US ^p 1 to 4	Grade - Canada ⁿ 1 to 5
1 Non-treated check (water)	74 ab*	2.5 a*	6.5 e*	7.3 cd*	13.8 fg*	11.1 cd*	4	4
2 Omega 500F 13.6 fl oz/ac (A,B)	92 a	2.9 a	3.7 bc	6.5 bcd	10.3 de	7.3 abc	4	4
3 Omega 500F 16 fl oz/ac (A,B)	88 a	2.2 a	4.1 bcd	4.8 abc	8.9 b-e	3.8 ab	4	4
4 Omega 500F 16 fl oz/ac (A) / Headline 250SC 6 fl oz/ac (B)	94 a	2.4 a	2.0 ab	3.2 ab	5.2 a-d	4.9 ab	3	3
5 Non-treated check (water) (A) / Headline 250SC 6 fl oz/ac (B)	82 ab	1.7 a	2.7 ab	4.1 abc	6.9 a-e	4.1 ab	3	3
6 Xemium 300SC 2.23 fl oz/ac (A,B)	----- NO DATA -----							
7 Xemium 300SC 3.34 fl oz/ac (A,B)	----- NO DATA -----							
8 Headline 250SC 6 fl oz/ac (A,B)	95 a	2.9 a	1.9 ab	3.5 ab	5.5 a-d	6.1 ab	3	3
9 Priaxor 500SC 4 fl oz/ac (A,B)	91 a	2.4 a	1.7 ab	2.4 a	4.1 ab	1.9 a	3	3
10 Priaxor 500SC 6 fl oz/ac (A,B)	88 a	1.4 a	1.1 a	2.1 a	3.2 a	2.6 a	2	2
11 Priaxor 500SC 4 fl oz/ac (A) / Proline 480SC 5.7 fl oz/ac + NIS 0.125% v/v (B)	94 a	1.7 a	2.4 ab	3.6 ab	6.0 a-d	3.7 ab	3	3
12 Proline 480SC 5 fl oz/ac + NIS 0.125% v/v (A,B)	85 ab	1.8 a	5.6 cde	5.6 abc	11.1 ef	6.0 ab	4	4
13 Inspire 250EC 6.404 fl oz/ac + Bravo WS 22.294 fl oz/ac (A,B) ^m	91 a	3.4 a	1.7 ab	3.2 ab	4.9 abc	4.5 ab	4	4
14 Quadris 250SC 6.2 fl oz/ac (A,B)	78 ab	3.4 a	3.7 bc	5.8 abc	9.5 cde	9.4 bcd	4	4
15 Vertisan 1.67EC 20 fl oz/ac + NIS 0.125% v/v (A,B)	57 b	2.7 a	6.6 de	9.9 d	16.5 g	13.5 d	4	4
16 Endura 70WG 6 oz/ac (A,B)	----- NO DATA -----							
	F:	1.44	1.44	14.12	8.62	15.60	7.81	
	P > F:	0.2112	0.2112	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	CV:	44.8	44.8	29.1	31.2	24.5	39.9	

^w Fungicide application timings A and B:

Application A: June 22, 2012 at 6:30-8:00 am; 90% of plants with an open blossom; no foliar disease; wind = 4 mph out of the west, temperature = 55-64°F, relative humidity = 72-90%.

Application B: July 5, 2012 at 6:30-10:00 am; lentils at the end of bloom; *Ascochyta* blight at moderate levels (approx. 10 to 15% of canopy diseased) in the non-treated checks; wind = 3-6 mph out of the north to northwest, temperature = 55-62°F, relative humidity = 76-87%.

^v **Viable seeds:** Germination rate of harvested seeds; assessed as the percent of 246 to 250 lentils that germinated in 10 to 12 days in a standard germination assay.

^u **Split & broken:** The percent (by weight) of lentils in which cotyledons are separated or held together loosely (split lentils) or one-quarter or more of the complete lentil is broken (broken lentils).

^t **Diseased:** Lentils with large dark colored lesions or obvious fungal growth on seed coat.

^s **Stained:** Lentils with mottling, small dark-colored spots, or water spots (distinct light brown discoloration) on seed coat.

^r **Discolored (total):** The combined total of diseased and stained seeds.

^q **Wrinkled:** The percent (by weight) of lentils exhibiting sharp ridges and depressions in the seed coat. Lentils with a dimpled seed coat or folds restricted to the outside ring of the seed were excluded.

^p **Grade - US:** A 1 to 4 scale in which 1 = U.S. Grade No. 1 lentils, 2 = U.S. Grade No. 2 lentils, 3 = U.S. Grade No. 3 lentils, and 4 = U.S. Sample Grade lentils.

ⁿ **Grade - Canada:** A 1 to 5 scale in which 1 = No. 1 Canada lentils, 2 = No. 2 Canada lentils, 3 = Extra No. 3 Canada lentils, 4 = No. 3 Canada lentils, and 5 = Sample Canada lentils (due to damage).

^m **Applied to approximate the performance of Bravo Top 4.59SC.** Syngenta had insufficient supplies of Bravo Top available for testing. To obtain preliminary information on the potential performance of Bravo Top, the component ingredients of Bravo Top (difenoconazole and chlorothalonil) were evaluated by tank-mixing Inspire and Bravo WeatherStik.

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‡ In order to meet model assumptions of normality and homoskedasticity, analysis of variance was conducted on the natural-log transformation of disease severity [$\text{LN}(\text{sev.} + 1)$]. For ease of interpretation, treatment means are reported as disease severity.

The fungicides INSPIRE / BRAVO TOP, OMEGA, and XEMIUM are currently not registered for use on lentils and should not be used. Future registration of some of these fungicides is anticipated, and results for these products are provided for reference only.

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METHODS – AGRONOMICS AND STATISTICS:

- **Location of trial:** 3 miles south of the NDSU Carrington Research Extension Center, Carrington, ND.
- **GPS coordinates of research trial location:** 47.4714,-99.1374
- **Variety:** CDC 'Richlea' (a medium-green lentil)
- **Experimental design:** randomized complete block **Replicates:** 4
- **Seeded plot size:** 5 feet wide (center-to-center) x 25 feet long **Harvested plot size:** 5 feet wide (center-to-center) x approx. 19 feet long
- **Row spacing:** 7 inches **Rows per plot:** 7
- **Non-treated buffer plots were established between treatment plots.**
- **Previous crop:** spring wheat
- **Planting date:** April 23, 2013 **Seeding rate:** 18 pure live seeds per square foot
- **Seed treatment:** Cruiser 5FS 1.28 fl oz/cwt + ApronMaxxRTA 5.0 fl oz/cwt + Mertect 340F 1.05 fl oz/cwt
- **Rhizobium inoculant:** "Nodulator" peat-based granular inoculant for peas and lentils (*Rhizobium leguminosarum*; Becker Underwood, St Joseph, MO); applied at the commercially recommended rate of 6 oz/1000 feet of row.
- **Fungicide application A:** June 22, 2012 at 6:30-8:00 am; 90% of plants with an open blossom; no foliar disease. Wind = 4 mph out of the west, temperature = 55-64°F, relative humidity = 72-90%.
- **Fungicide application B:** July 5, 2012 at 6:30-8:00 am; lentils at the end of bloom; *Ascochyta* blight at moderate levels (approx. 10 to 15% of canopy diseased) in the non-treated checks. Wind = 3-6 mph out of the north to northwest, temperature = 55-62°F, relative humidity = 76-87%.
- **Fungicide application details:** Fungicides were applied with a 60-inch hand boom equipped with four equally spaced Spraying Systems TeeJet XR 8001VS flat-fan nozzles at a spray volume of 17.5 gal water/acre operated at 35 psi.
- ***Ascochyta* inoculation details:** To promote disease, the trial was inoculated with laboratory-grown pycnidiospores of *Ascochyta lentis*. Spore applications were made at 20 psi with a 60-inch hand boom equipped with four equally spaced Spraying Systems TeeJet TJ60-8003 twin jet nozzles. **Inoculation 1:** June 26 at 9:30 pm; the spores were applied concurrently with the application of overhead irrigation; a solution of 3.6 x 105 spores/ml was applied to the treatment plots at an application rate of 19.66 gal/ac (5.5 x 105 spores/sq ft). **Inoculation 2:** June 27 at 9:30 pm; the spores were applied concurrently with the application of overhead irrigation; a solution of 2.5 x 105 spores/ml was applied to the treatment plots at an application rate of 16.95 gal/ac (3.3 x 105 spores/sq ft). **Inoculation 3:** June 28 at 5:30 am; the spores were applied concurrently with the application of overhead irrigation; a solution of 2.5 x 105 spores/ml was applied to the treatment plots at an application rate of 27.1 gal/ac (5.0 x 105 spores/sq ft). **Inoculation 4:** June 28 at 10:00 pm; the spores were applied concurrently with the application of overhead irrigation; a solution of 5.0 x 105 spores/ml was applied to the treatment plots at an application rate of 16.95 gal/ac (6.0 x 105 spores/sq ft). **Inoculation 5:** June 29 at 10:00 pm; the spores were applied concurrently with the application of overhead irrigation; a solution of 5.0 x 105 spores/ml was applied to the treatment plots at an application rate of 27.1 gal/ac (1.0 x 106 spores/sq ft).
- **Disease assessments:** *Ascochyta* severity was evaluated on July 13 during the pod-fill period (bloom completed) and on July 20 shortly before maturity. No other foliar diseases were present above trace levels.
- **Harvest date:** August 6, 2012. The trial was swathed July 31, 2012.
- **Statistical analysis:** Data were evaluated with analysis of variance. The assumption of constant variance was assessed by plotting residuals against predicted values, and the assumption of normality was assessed with a normal probability plot. To meet model assumptions, a systematic natural-log transformation [LN(x+1)] was applied to the *Ascochyta* severity data. All other data met model assumptions. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, Tukey's multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC GLM of SAS (version 9.2; SAS Institute, Cary, NC).

WE GRATEFULLY ACKNOWLEDGE:

This project was made possible with grants from the **Northern Pulse Growers Association** and the **North Dakota Department of Agriculture Crop Protection Product Harmonization Board and Registration Board**. Supplementary financial support was provided by the **BASF Corporation** and **ISK BioSciences**.

We gratefully acknowledge **Becker Underwood** for donating the *Rhizobium* inoculant used in this trial, **Syngenta Crop Protection** for donating the seed treatment products Cruiser and Mertect, and **JM Grain** for helping us obtain seed of CDC Richlea lentils for use in this trial.

IMPORTANT NOTICE:

- Fungicide performance can differ in response to which diseases are present, levels of disease when products are applied, environmental conditions, plant architecture and the susceptibility to disease of the chickpea variety planted, crop growth stage at the time of fungicide application, and other factors.
- This report summarizes fungicide performance as tested at the NDSU Carrington Research Extension Center in 2012 under the conditions partially summarized in the methods section (above).
- Fungicide efficacy may differ under other conditions; when choosing fungicides, always evaluate results from multiple trials.
- This report is shared for educational purposes and is not an endorsement of any specific products.

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METHODS – SEED QUALITY ASSESSMENTS

Seed quality assessments:

- **Viable seeds:** The viability of the harvested seeds was assessed as the percent of 246 to 250 seeds that germinated in 10 to 12 days in a standard germination assay.
- **Split and broken seeds:** The percent (by weight) of lentils exhibiting cotyledons that were separated or held together loosely (split lentils) or having one-quarter or more of the seed broken (broken lentils). In each plot, all split and broken lentils encountered while counting 250 whole lentils were weighed.
- **Diseased lentils:** The percent (by weight) of lentils exhibiting dark colored lesions or obvious fungal growth on the seed coat. From each plot, 250 whole lentils were assessed.
- **Stained lentils:** The percent (by weight) of lentils exhibiting mottling, small dark-colored spots, or water spots (distinct light brown discoloration) on the seed coat. From each plot, 250 lentils were assessed.
- **Discolored lentils:** The combined total of diseased and stained seeds.
- **Wrinkled seeds:** The percent (by weight) of lentils exhibiting sharp ridges and depressions in the seed coat. Lentils with a dimpled seed coat or with folds restricted to the outside ring of the seed were excluded. From each plot, 250 lentils were assessed.
- **U.S. Grade:** The U.S. grade of the lentils was determined on dockage-free lentils using the guidelines established by the USDA Grain Inspection, Packers, and Stockyards Administration. U.S. Grade No. 1 lentils exhibited less than 2% defective lentils (by weight; includes split and broken lentils and diseased lentils), less than 0.2% foreign material, less than 4% skinned lentils, and good color. U.S. Grade No. 2 lentils exhibited between 2 and 3.5% defective lentils, between 0.2 and 0.5% foreign material, between 4 and 7% skinned lentils, or fair color. U.S. Grade No. 3 lentils exhibited between 3.5 and 5.0% defective lentils, less than 0.5% foreign material, between 7 and 10% skinned lentils, or poor color. U.S. sample grade lentils exhibited more than 5% defective lentils, more than 0.5% foreign material, or more than 10% skinned lentils. The USDA does not provide strict guidelines on lentil color; for the purposes of this study, lentils exhibiting less than 1% (by weight) diseased seeds and less than 2.5% (by weight) stained seeds were considered to have "good" color, lentils exhibiting between 1 and 3.5% (by weight) diseased seeds or between 2.5 and 7% (by weight) stained seeds were considered to have "fair" color, lentils exhibiting more than 3.5% (by weight) diseased seeds or more than 7% (by weight) stained seeds were considered to have "poor" color. Grade assessments were made separately for each plot, and the grades assigned to each treatment represent the average grade observed across replicates of the experiment.
- **Canadian grade:** The Canadian grade of lentils was determined on dockage-free lentils using the guidelines established by the Canadian Grain Commission. No. 1 Canada lentils exhibited less than 1% stained lentils (by weight, includes lentils exhibiting water spots and mottling); less than 2% peeled, split and broken lentils; less than 1% lentils damaged by disease or other causes; less than 2% total damaged lentils (peeled, split, broken, insect damaged, diseased, etc.); and having good natural color. No. 2 Canada lentils exhibited between 1 and 4% stained lentils; between 2 and 3.5% peeled, split and broken lentils; between 1 and 2% lentils damaged by disease or other causes; between 2 and 3.5% total damaged lentils (stained + disease or other causes); or having reasonably good natural color. Extra No. 3 Canada lentils exhibited between 4 and 7% stained lentils; between 3.5 and 5% peeled, split and broken lentils; between 2 and 5% lentils damaged by disease or other causes; between 3.5 and 5% total damaged lentils (stained + disease or other causes); or having fair color. No. 3 Canada lentils exhibited more than 7% stained lentils; between 5 and 10% peeled, split and broken lentils; between 5 and 10% lentils damaged by disease or other causes; between 5 and 10% total damaged lentils (stained + disease or other causes); or having poor color. Sample grade Canada lentils exhibited more than 10% peeled, split and broken lentils; more than 10% lentils damaged by disease or other causes; or more than 10% total damaged lentils (stained + disease or other causes). Grade assessments were made separately for each plot, and the grades assigned to each treatment represent the average grade observed across replicates of the experiment.

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