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Field evaluation of fungicides for management of Sclerotinia stem rot on soybeans

Carrington, ND (2010)

Michael Wunsch, plant pathologist
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North Dakota State University Carrington Research Extension Center

KEY FINDINGS:

Under severe Sclerotinia stem rot disease pressure,

- **Endura** (boscalid) **applied at 8 oz/ac as a single application at early bloom** (early R2 growth stage) **significantly reduced Sclerotinia stem rot and increased soybean yield.**
- **No other fungicides provided satisfactory disease control when applied as a single application at early bloom.**
- **The herbicide Cobra applied at 6 fl oz/ac at early bloom provided results very similar to Endura.** However, caution is urged regarding the use of Cobra; in the absence of significant Sclerotinia disease pressure, applications of Cobra at early bloom can reduce soybean yield.

DETAILED RESULTS:

Fungicide application timing: A: July 12 at the R1 early R2 growth stage; no Sclerotinia present **B:** July 27 at the R3 growth stage

The fungicides QUASH, and Q8Y78 are not currently registered on soybeans and should not be used.
Results are provided for reference.

Within-column means followed by different letters and non-overlapping ranges of letters are significantly different (alpha = 0.05)

PRODUCT, application rate (A, B = application timing)[1]	AUDPC[1]	YIELD	SEEDS per POUND	TEST WEIGHT	PERCENT OIL	PERCENT PROTEIN
		bu/ac	seeds	lbs/bu	percent	percent
Cobra 6 fl oz/ac + 1 pt COC **(A)**	49.5 **ab**	30.4 **ab**	3525 **a**	59.7 **abc**	19.14 **a**	32.28 **b**
Endura 70WG 8 oz/ac **(A)**	47.5 **ab**	32.7 **a**	3415 **a**	60.6 **a**	19.09 **a**	33.25 **ab**
Confidential (A)	69.3 **a-d**	21.6 **b-f**	3375 **a**	59.6 **abc**	18.94 **a**	33.20 **a**
Vertisan (LEM 17) **200EC** 24 fl oz/ac **(A)**	70.3 **a-d**	22.6 **b-f**	3463 **a**	60.1 **ab**	18.99 **a**	33.48 **a**
Topsin-M 4.5F 20 fl oz/ac **(A)**	71.5 **bcd**	22.3 **b-f**	3243 **a**	60.3 **ab**	19.13 **a**	33.55 **a**
Quash 50WDG 3.5 oz/ac **(A)**	73.4 **bcd**	20.2 **c-f**	3485 **a**	59.9 **abc**	18.99 **a**	33.70 **a**
Tebuzol 3.6F 4 fl oz/ac **(A)**	74.9 **bcd**	20.0 **c-f**	3476 **a**	60.0 **abc**	18.80 **a**	33.63 **a**
Omega 500F 12 fl oz/ac **(A)**	80.2 **cd**	18.9 **c-f**	3454 **a**	59.5 **abc**	18.76 **a**	33.23 **ab**
Proline 480SC 3 fl oz/ac **(A)**	79.5 **cd**	17.2 **def**	3240 **a**	60.0 **abc**	18.98 **a**	33.63 **a**
Q8Y78 240SC 24 fl oz/ac **(A)**	76.7 **bcd**	22.5 **b-f**	3541 **a**	59.6 **abc**	19.04 **a**	32.95 **ab**
Priaxor 4.5 fl oz/ac **(A)**	79.4 **cd**	14.2 **f**	3230 **a**	59.2 **abc**	18.48 **a**	33.00 **ab**
Headline 250EC 6 fl oz/A + **Topsin-M 4.5F** 20 fl oz/A **(A)**	79.6 **cd**	17.2 **def**	3337 **a**	59.8 **abc**	19.00 **a**	33.48 **a**
Aproach (YT669) **250SC** 12 fl oz/ac **(A)**	86.1 **d**	15.6 **ef**	3310 **a**	58.5 **c**	19.05 **a**	32.90 **ab**
Domark 230ME 5 fl oz/ac **(A)**	88.6 **d**	15.7 **ef**	3201 **a**	59.3 **abc**	19.03 **a**	32.88 **ab**
Headline 250EC 8 fl oz/ac **(A)**	87.4 **d**	13.4 **f**	3354 **a**	58.8 **bc**	19.18 **a**	33.25 **ab**
Confidential (A) / Omega 500F 12 fl oz/ac **(B)**	40.8 **a**	32.5 **a**	3306 **a**	60.4 **ab**	18.74 **a**	33.63 **a**
Confidential (A) / Topsin-M 4.5 FL 20 fl oz/ac **(B)**	63.5 **a-d**	25.3 **a-e**	3504 **a**	59.9 **abc**	18.62 **a**	33.93 **a**
Endura 70WG 8 oz/ac **(A)** / **Topsin-M 4.5FL** 20 fl oz/ac **(B)**	53.7 **abc**	26.4 **a-d**	3528 **a**	60.4 **ab**	18.72 **a**	33.50 **a**
Proline 480SC 3 fl oz/ac / **Topsin-M 4.5FL** 20 fl oz/ac **(B)**	69.7 **a-d**	25.2 **a-e**	3386 **a**	60.2 **ab**	19.03 **a**	33.60 **a**
Proline 480SC 3 fl oz/ac **(A)** / **Omega 500F** 12 fl oz/ac **(B)**	62.6 **a-d**	27.7 **abc**	3444 **a**	59.9 **abc**	18.75 **a**	33.35 **a**
Proline 480SC 3 fl oz/ac / **Endura 70WG** 8 oz/ac **(B)**	69.5 **a-d**	25.0 **a-e**	3304 **a**	60.1 **abc**	18.87 **a**	33.65 **a**
Non-treated control 2	84.1 **d**	19.2 **c-f**	3245 **a**	59.9 **abc**	19.34 **a**	32.93 **ab**
Non-treated control 1	82.3 **cd**	18.1 **c-f**	3212 **a**	59.8 **abc**	19.01 **a**	33.05 **ab**
Treatment differences, *F*:	5.76	9.29	0.74	2.91	0.96	3.15
Treatment differences, *P* > *F*:	< 0.0001	< 0.0001	0.7744	0.0011	0.5255	0.0005
C.V.:	15.41	16.67	7.75	0.96	2.13	1.26

[1] **Area Under the Disease Progress Curve (AUDPC):**

$$\mathrm{AUDPC} = \sum_{i=1}^{n}\left((x_i + x_{i+1})/2\right) * (t_{i+1} - t_i)$$

where x_i = disease severity index at the ith observation, t_i = time in days at the i^{th} observation, and n = number of observations

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DETAILED RESULTS (continued):

Fungicide application timing: A: July 12 at the R1 early R2 growth stage; no Sclerotinia present **B:** July 27 at the R3 growth stage

The fungicides QUASH, and Q8Y78 are not currently registered on soybeans and should not be used. Results are provided for reference.

Within-column means followed by different letters and non-overlapping ranges of letters are significantly different (alpha = 0.05)

PRODUCT, application rate (A, B = application timing) [1]	WHITE MOLD SEVERITY INDEX [2]			WHITE MOLD INCIDENCE [3]			WHITE MOLD SEVERITY [4]			AUDPC [5]
	Aug. 9	Aug. 19-20	Aug. 31	Aug. 9	Aug. 19-20	Aug. 31	Aug. 9	Aug. 19-20	Aug. 31	
	0 to 3 scale			percent			1 to 3 scale			
Cobra 6 fl oz/ac + 1 pt COC **(A)**	1.48 **bc**	1.48 **a**	1.54 **a**	64 **abc**	65 **a**	65 **a**	2.26 **a-d**	2.27 **a**	2.39 **a**	49.5 **ab**
Endura 70WG 8 oz/ac **(A)**	1.29 **ab**	1.50 **a**	1.72 **ab**	61 **ab**	63 **a**	67 **ab**	2.12 **ab**	2.41 **a-e**	2.57 **a-e**	47.5 **ab**
Confidential (A)	2.00 **efg**	2.14 **c-f**	2.22 **c-e**	80 **de**	83 **bcd**	85 **c-f**	2.42 **b-g**	2.56 **a-g**	2.60 **a-e**	69.3 **a-d**
Vertisan 200EC 24 fl oz/ac **(A)**	2.08 **e-j**	2.08 **cde**	2.28 **d-f**	85 **def**	84 **cd**	86 **d-g**	2.44 **c-g**	2.49 **a-f**	2.64 **a-f**	70.3 **a-d**
Topsin-M 4.5F 20 fl oz/ac **(A)**	2.01 **efg**	2.25 **c-g**	2.34 **d-f**	88 **def**	92 **d-g**	92 **e-h**	2.29 **a-e**	2.45 **a-e**	2.56 **abc**	71.5 **bcd**
Quash 50WDG 3.5 oz/ac **(A)**	2.19 **g-k**	2.21 **c-h**	2.28 **d-f**	86 **def**	84 **cd**	83 **cde**	2.53 **d-h**	2.61 **d-h**	2.73 **b-f**	73.4 **bcd**
Tebuzol 3.6F 4 fl oz/ac **(A)**	2.20 **g-k**	2.27 **d-i**	2.37 **d-g**	84 **def**	86 **cde**	89 **d-h**	2.57 **e-h**	2.63 **d-h**	2.67 **a-e**	74.9 **bcd**
Omega 500F 12 fl oz/ac **(A)**	2.37 **i-m**	2.43 **f-j**	2.51 **e-h**	91 **fgh**	90 **d-g**	92 **e-h**	2.58 **fgh**	2.70 **fgh**	2.72 **b-f**	80.2 **cd**
Proline 480SC 3 fl oz/ac **(A)**	2.35 **i-m**	2.38 **e-i**	2.54 **e-h**	91 **fgh**	89 **c-g**	92 **e-h**	2.55 **e-h**	2.67 **d-h**	2.75 **b-f**	79.5 **cd**
Q8Y78 240SC 24 fl oz/ac **(A)**	2.14 **f-j**	2.42 **e-i**	2.56 **e-h**	87 **def**	92 **d-g**	94 **fgh**	2.47 **c-g**	2.63 **c-h**	2.71 **b-f**	76.7 **bcd**
Priaxor 4.5 fl oz/ac **(A)**	2.29 **g-l**	2.48 **g-j**	2.52 **f-h**	87 **def**	92 **d-g**	92 **e-h**	2.60 **fgh**	2.69 **e-h**	2.70 **b-f**	79.4 **cd**
Headline 250EC 6 fl oz/A + **Topsin-M 4.5F** 20 fl oz/A **(A)**	2.29 **h-l**	2.48 **g-j**	2.53 **f-h**	90 **ef**	91 **d-g**	93 **e-h**	2.53 **e-h**	2.72 **fgh**	2.72 **b-f**	79.6 **cd**
Aproach 250SC 12 fl oz/ac **(A)**	2.58 **lm**	2.60 **ij**	2.61 **f-h**	97 **gh**	96 **g**	96 **h**	2.65 **gh**	2.70 **fgh**	2.73 **b-f**	86.1 **d**
Domark 230ME 5 fl oz/ac **(A)**	2.69 **m**	2.62 **hij**	2.69 **gh**	98 **h**	95 **fg**	95 **gh**	2.75 **h**	2.75 **fgh**	2.82 **ef**	88.6 **d**
Headline 250EC 8 fl oz/ac **(A)**	2.55 **lm**	2.69 **j**	2.75 **h**	96 **gh**	97 **g**	97 **h**	2.63 **gh**	2.78 **h**	2.85 **f**	87.4 **d**
Confidential (A) / Omega 500F 12 fl oz/ac **(B)**	0.96 **a**	1.42 **a**	1.63 **a**	48 **a**	61 **a**	65 **a**	1.97 **a**	2.30 **ab**	2.50 **abc**	40.8 **a**
Confidential (A) / Topsin-M 4.5 FL 20 fl oz/ac **(B)**	1.79 **c-f**	1.94 **bc**	2.17 **cd**	82 **def**	83 **bcd**	85 **cde**	2.20 **abc**	2.35 **abc**	2.57 **a-d**	63.5 **a-d**
Endura 70WG 8 oz/ac **(A)** / **Topsin-M 4.5FL** 20 fl oz/ac **(B)**	1.50 **bcd**	1.66 **ab**	1.88 **abc**	66 **abc**	71 **ab**	74 **abc**	2.24 **a-d**	2.31 **ab**	2.53 **abc**	53.7 **abc**
Proline 480SC 3 fl oz/ac / **Topsin-M 4.5FL** 20 fl oz/ac **(B)**	2.03 **e-h**	2.17 **c-g**	2.13 **cd**	87 **def**	86 **cde**	84 **cde**	2.35 **b-f**	2.52 **a-g**	2.53 **ab**	69.7 **a-d**
Proline 480SC 3 fl oz/ac **(A)** / **Omega 500F** 12 fl oz/ac **(B)**	1.77 **de**	1.97 **bcd**	2.03 **bcd**	77 **cd**	79 **bc**	79 **a-d**	2.27 **a-f**	2.47 **a-f**	2.56 **a-e**	62.6 **a-d**
Proline 480SC 3 fl oz/ac / **Endura 70WG** 8 oz/ac **(B)**	2.04 **e-i**	2.09 **cde**	2.23 **c-e**	87 **def**	87 **c-f**	89 **d-h**	2.36 **b-f**	2.40 **a-d**	2.51 **abc**	69.5 **a-d**
Non-treated control 2	2.52 **klm**	2.51 **g-j**	2.60 **e-h**	97 **gh**	97 **g**	97 **h**	2.59 **fgh**	2.594 **b-h**	2.69 **b-e**	84.1 **d**
Non-treated control 1	2.36 **j-m**	2.57 **ij**	2.64 **h**	87 **def**	94 **efg**	94 **fgh**	2.68 **gh**	2.74 **gh**	2.79 **def**	82.3 **cd**
Treatment differences, χ^2, df:	616.2, 22	512.1, 22	479.6, 22	866.3, 22	677.66, 22	553.2, 22	276.8, 22	223.2, 22	148.5, 22	***F*:** 5.76
Treatment differences, *P* > χ^2:	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	***P*:** < 0.0001
										C.V.: 15.41

[1] **Application timing: A --** July 12, plants at R1 to R2, with R2 predominant; **B --** July 27, plants at R3

[2] **White mold severity index:** A combination of white mold incidence and severity. Rated on a 0 to 3 scale, with 0 = no symptoms, 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. For each treatment, 300 plants were evaluated (75 plants per treatment per replicate across four replicates).

[3] **White mold incidence:** Percent of plants exhibiting white mold (SSR) symptoms. For each treatment, 300 plants were evaluated (75 plants/trt/rep).

[4] **White mold severity:** White mold severity on plants showing disease. Rated on a 1 to 3 scale, with 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. For each treatment, 300 plants were evaluated (75 plants per treatment per replicate across four replicates).

[5] **Area Under the Disease Progress Curve (AUDPC):** $$\mathrm{AUDPC} = \sum_{i=1}^{n}\left((x_i + x_{i+1})/2\right) * (t_{i+1} - t_i)$$

where x_i = disease severity index at the ith observation, t_i = time in days at the i^{th} observation, and n = number of observations

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METHODS:

- **Location of trial:** North Dakota State University Carrington Research Extension Center; Carrington, ND
- **GPS coordinates of research trial location:** 47.5077,-99.1310
- **Variety:** Dairyland Seeds 'DSR 0401'
- **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.**
- **Planting date:** May 19, 2010.
- **Seeding rate:** 220,000 pure live seeds/ac
- **Fungicide application A:** July 12, 2012 at R1 to early R2 growth stage (early bloom). No Sclerotinia stem rot was present.
- **Fungicide application B:** July 27, 2012 at the R3 growth stage (pods 5 mm at one of the four uppermost nodes).
- **Fungicide application details:** Fungicides were applied in 17.5 gallons of water/ac using a 60" hand boom equipped with four equally spaced Spraying Systems TeeJet flat-fan 8001VS nozzles and operated at 35 psi.
- **Disease establishment:** This trial was established on a site with a history of Sclerotinia epidemics. Laboratory-produced ascospores of Sclerotinia sclerotiorum were applied to the trial on July 17-18. Replicates 1 to 2 were inoculated with $1.3x10^7$ ascospores/square meter in 40 gal. water/ac. on July 17 at 9:30-10:30 pm. Replicates 3 and 4 were inoculated with $2.7x10^7$ ascospores/square meter in 53 gal. water/ac. on July 18 at 9:30-10:30 pm. Applications were made at 35 PSI with a 60-in. hand boom with four equally spaced TeeJet 8002. To facilitate disease development, overhead microsprinkler irrigation was utilized during the bloom and pod-fill growth stages.
- **Disease assessments:** Sclerotinia stem rot incidence and severity were evaluated Aug. 9, Aug. 19-20, and Aug. 31. The 0 to 3 scale developed by Craig Grau at the University of Wisconsin was used: 0 = no symptoms, 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. In each plot, 75 plants were evaluated (25 plants in each of three locations per plot).
- **Area under the disease progress curve (AUDPC) calculations:** The relative area under the disease progress curve was calculated with the formula

$$\mathrm{AUDPC} = \sum_{i=1}^{n}\left((x_i + x_{i+1})/2\right) * (t_{i+1} - t_i)$$

where x_i = disease severity index at the i^{th} observation, t_i = time in days at the i^{th} observation, and n = number of observations
- **Harvest date:** Sept. 28-29, 2010
- **Statistical analysis – disease data:** Disease severity index, disease severity, and disease incidence were evaluated with cumulative, cumulative, and binary logistic regression, respectively, (Hosmer and Lemeshow, 2000), and single-degree-of-freedom contrasts of all pairwise comparisons of treatments were implemented with Wald chi-square tests. Analyses were conducted controlling for the effect of experimental replicate and, where possible, replicate-by-treatment interaction. Analyses were implemented in PROC GENMOD of SAS (version 9.2; SAS Institute, Cary, NC), and the Bonferroni multiple comparison procedure (Neter et al. 1996) was utilized to control the Type I error rate at the level of the experiment across the 253 pairwise treatment comparisons.
- **Statistical analysis – AUDPC, seed yield, and seed quality data**: Analysis of variance was conducted on the plot-level yield and test weight data. Seed moisture levels were evaluated for each sample, and yields and test weights were adjusted to 13% moisture. The assumptions of constant variance and normality were assessed by plotting residuals against predicted values and evaluating their variance and by plotting residuals against their ranks and examining their linearity. The assumptions were met, and no transfomations were applied to the data. Single-degree-of-freedom contrasts were performed for all pairwise combinations of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure (Neter et al. 1996) was employed. Analyses were conducted with replicate and treatment as main effects and with replicate by treatment interaction included and were implemented in PROC GLM of SAS (version 9.2; SAS Institute, Cary, NC).

FUNDING:

This project was funded by the **North Dakota Soybean Council.**

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.