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Field evaluation Contans for management of Sclerotinia stem rot on soybeans:
Evaluation of incorporation methods.

Carrington, ND (2012)

Michael Wunsch, **Michael Schaefer**, and **Billy Kraft**
North Dakota State University Carrington Research Extension Center

KEY FINDINGS:

In this trial, sclerotia of *Sclerotinia sclerotiorum* were primarily on the soil surface at the time of Contans applications. Under these conditions:

- **Contans performed similarly when it was manually incorporated** (by harrowing to 1.5 inches) **and when it was incorporated with water** (by applying 1 inch of water with overhead irrigation). Results may be different when sclerotia are not primarily on the soil surface. Future trials will test incorporation methods for Contans when sclerotia are primarily on the soil surface vs. when they are evenly distributed throughout the soil profile.
- **Incorporation of Contans by harrowing or water gave no measurable benefit when soils were moist**. Results may be different when sclerotia are not primarily on the soil surface; they are also likely to be different in dry soils. In this trial, soils were very moist in the fall and moderately moist in the spring.

The effect of Contans applications on Sclerotinia control and soybean yield could not be rigorously assessed in this trial. Plot sizes were small, and the effect of Contans applications on disease control and soybean yield were diluted by the movement of Sclerotinia spores into plots from non-treated areas adjacent to the plots.

The results suggest that when sclerotia are primarily on the soil surface and the soil surface is moist, incorporation of Contans may not always be necessary. Additional testing is needed to confirm this conclusion. Results may be different when sclerotia are evenly distributed in the soil profile or the soil is dry.

IMPORTANT BACKGROUND INFORMATION:

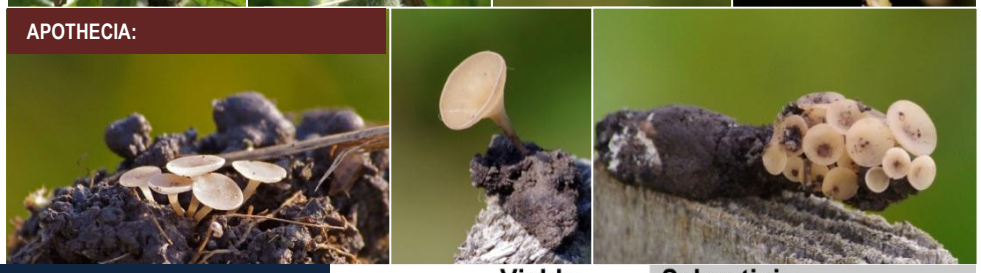
In North Dakota, Sclerotinia diseases are caused by the fungus *Sclerotinia sclerotiorum*.

- ***S. sclerotiorum* produces black fungal resting structures known as sclerotia.**
- **The sclerotia are produced in and on diseased plant tissues.**
- **Sclerotia can persist in the soil for many years.**
- **Sclerotia sometimes produce fungal growth that directly invades susceptible crops.** Direct germination generally causes basal stalk rot.
- **Sclerotia in the top 1.5 inches of the soil often germinate to produce apothecia,** tiny mushroom-like structures that are often 0.1 to 0.4 inches in diameter.
- **Apothecia release spores into the crop canopy.** When spores successfully colonize host plant tissues, disease develops.
- **Reducing the number of viable sclerotia and the number of apothecia reduces Sclerotinia disease pressure.**

Photos of diseased sunflowers courtesy of Sam Markell

SCLEROTIA PRODUCED IN/ON DISEASED CROPS:

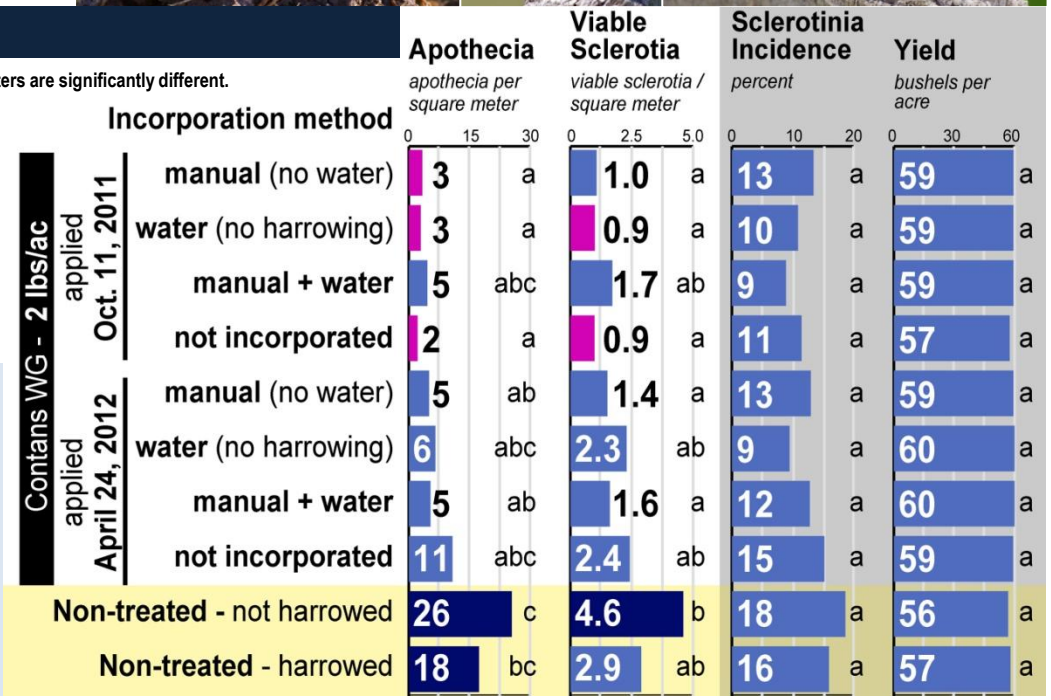
APOTHECIA:



SUMMARY OF KEY RESULTS:

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

Fall application - Soils were cool (50-59˚F on soil surface; 52-56˚F just below the soil surface) and moist (0.41 inches of rain in the previous 2 days).
Spring application - Soils were cool (52-67˚F on soil surface; 52-56˚F just below the soil surface) and moderately moist (the top inch of soil was at 25 to 40% of water-holding capacity; 0.20 inches of rain fell in previous 7 days).



Disease control and soybean yield data from this study should be treated cautiously.

The effect of Contans applications on Sclerotinia disease control and soybean yield could not be rigorously assessed in this trial. Plot sizes were small, and the effect of Contans applications on disease control and soybean yield were diluted by the movement of Sclerotinia spores into plots from non-treated areas adjacent to the plots.

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DETAILED RESULTS:

	TREATMENT & APPLICATION RATE	DATE OF TREATMENT IMPOSITION	INCORPORATION METHOD [x,y]	APOTHECIA [‡]	CARPOGENICALLY GERMINATED SCLEROTIA [z‡]	SCLEROTINIA INCIDENCE	YIELD	TEST WEIGHT	SEEDS PER POUND
				number per square meter	number per square meter	percent	bu/ac	lbs/bu	seeds
				Aug. 31 - Sept. 2 [w]	*Aug. 31 - Sept. 2 [w]*	*Aug. 31 - Sept. 2 [w]*	*13% moisture*	*13% moisture*	*13% moisture*
1	Contans 2 lb/ac	Oct. 11, 2011	manual incorporation [y] (no water)	**3** a *	**1.0** a *	**13** a *	**59** a *	**58.9** a *	**2879** a *
2	Contans 2 lb/ac	Oct. 11, 2011	water incorporation [x] (no harrowing)	**3** a	**0.9** a	**10** a	**59** a	**58.8** a	**2917** a
3	Contans 2 lb/ac	Oct. 11, 2011	manual + water incorporation	**5** abc	**1.7** ab	**9** a	**59** a	**58.9** a	**2915** a
4	Contans 2 lb/ac	Oct. 11, 2011	neither manual nor water incorporation	**2** a	**0.9** a	**11** a	**57** a	**58.5** a	**2895** a
5	Contans 2 lb/ac	April 24, 2012	manual incorporation (no water)	**5** ab	**1.4** a	**13** a	**59** a	**58.9** a	**2901** a
6	Contans 2 lb/ac	April 24, 2012	water incorporation (no harrowing)	**6** abc	**2.3** ab	**9** a	**60** a	**58.8** a	**2863** a
7	Contans 2 lb/ac	April 24, 2012	manual + water incorporation	**5** ab	**1.6** a	**12** a	**60** a	**58.4** a	**2906** a
8	Contans 2 lb/ac	April 24, 2012	neither manual nor water incorporation	**11** abc	**2.4** ab	**15** a	**59** a	**59.1** a	**2908** a
9	Control (no Contans)	Oct. 11, 2011	water incorporation (no harrowing)	**26** c	**4.6** b	**18** a	**56** a	**58.9** a	**2906** a
10	Control (no Contans)	Oct. 11, 2011	manual + water incorporation	**18** bc	**2.9** ab	**16** a	**57** a	**59.0** a	**2892** a
			F:	5.70	4.63	0.96	0.50	1.66	0.49
			P>*F*:	< 0.0001	0.0003	0.4830	0.8676	0.1324	0.8743
			CV:	43.3	42.1	60.3	8.3	0.7	2.0

[z] **Carpogenically germinated sclerotia:** Sclerotia that germinated to produce apothecia.

[y] **Manual incorporation:** Contans was incorporated within 4 hrs of application to approx. 1.5 inches deep by harrowing.

[x] **Water incorporation:** The trial was conducted under a center pivot, and 1 inch of water was applied to the plots within 24 hrs of Contans applications. Water was excluded from individual treatments with water-proof tarps.

[w] **Growth stage on Aug. 31 - Sept. 2 was R6** (full seed; at least one pod at the four uppermost nodes contain green seeds that fill the pod capacity).

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

[‡] **To meet meet model assumptions of normality and homoskedasticity, analysis of variance was conducted on the natural-log transformation of apothecia and carpogenically germinated sclerotia** [LN(x + 1)]. **For ease of interpretation, treatment means are reported as the (untransformed) apothecia and sclerotia.**

FUNDING:

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

IMPORTANT NOTICE:

- The performance of products such as Contans can differ in response to which diseases are present, levels of sclerotia in the soil, distribution of sclerotia in the soil, environmental conditions, plant architecture and the susceptibility to disease of the soybean variety planted, timing of application, and other factors.
- This report summarizes the performance of Contans as tested at the NDSU Carrington Research Extension Center in 2012 under the conditions partially summarized in the methods section (above).
- The performance of Contans may differ under other conditions; when evaluating products, 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:

- **Location of trial:** North Dakota State University Carrington Research Extension Center (47.514, -99.134). The trial was established on the irrigated footprint of a 44-acre field with center pivot irrigation; the soil type was a Heimdal-Emrick loam.
- **Tillage:** The field used for this study was under long-term conventional tillage. It was disked once and cultivated once in September 2011 prior to the first application of Contans. To ensure that the Contans-treated soil remained on the surface of the field, no further tillage operations beyond a light harrowing were conducted after applying Contans. Soybeans were direct-seeded in the spring.
- **Previous crop:** spring wheat
- **Variety:** 'Ashtabula', a conventional variety (not resistant to glyphosate)
- **Planting date:** May 11, 2012.
- **Seeding rate:** 175,000 pure live seeds per acre.
- **Row spacing:** 15 inches
- **Experimental design:** Completely randomized block design.
- **Replicates:** 6
- **Plot size and layout:** Plots were 15 ft x 15 ft and separated from each other by 60 ft. Plots were separated by 60 feet in order to minimize the effects of neighboring plots on disease levels; within a soybean canopy, spores of *S. sclerotiorum* have been documented to be distributed 60 feet from their point of origin. Because native Sclerotinia levels were assumed to be fairly low, Contans was not applied between the plots. In retrospect, Contans should have been applied between plots, as Sclerotinia pressure was very high in this field. Beginning in October 2012 and continuing in every subsequent year of the experiment, fall applications of Contans will be made between plots. Contans applications were made to a 20 ft x 20 ft block centered on the 15 ft x 15 ft treatment plot.
- **Inoculation:** 50 grams of sclerotia of *Sclerotinia sclerotiorum* were applied to the surface of each plot on October 6 to 7, 2011. All sclerotia used in this experiment were obtained from diseased sunflowers.
- **Contans application method:** Contans was applied with a 100-inch hand-held spray boom with six equally spaced Spraying Systems TeeJet twin-jet 8002 nozzles at 20 psi in 20 gallons of water per acre.
- **Specifics for each Contans application:** (1) October 11, 2011. Applications were made from 10:30 am to 12:30 pm (soil temperature: 52 to 56˚F below soil surface and 50 to 59˚F on soil surface; wind speed: 5.2 to 7.9 miles per hr, air temperature: 56 to 65˚F, relative humidity: 71-62%). Harrowing (to 1.5 inches) was conducted from 1:15 to 2:30 pm; the non-treated controls were harrowed first. An inch of water was applied to the via overhead center pivot irrigation over a 24-hour period starting at 3:00 pm on Oct. 11. Water was excluded from the non-irrigated treatments by constructing A-frame tents with 16 ft x 20 ft waterproof tarps. (2) April 24, 2012. Applications were made from 10:45 am to 1:15 pm (soil temperature: 52 to 56˚F just below the soil surface, and 56 to 67˚F on the soil surface; wind speed: 12.6 to 14.7 miles per hr, air temperature: 68 to 74˚F, relative humidity: 40-28%). Harrowing (to 1.5 inches) was conducted from 11:40 am to 1:40 pm; the non-treated controls were harrowed first. An inch of water was applied to the via overhead center pivot irrigation over a 24-hour period starting at 1:15 pm on April 24. Water was excluded from the non-irrigated treatments by constructing A-frame tents over the treatment plots with 16 ft x 20 ft waterproof tarps.
- **Irrigation:** To promote apothecial development and disease establishment, the soybeans were irrigated such that they received 1 to 1.5 inches of water per week (including rainfall events) from 10 days prior to bloom initiation until the R7 growth stage (at least one pod per plant has reached its mature color).
- **Assessments of Sclerotinia incidence, apothecia, and carpogenically germinated sclerotia:** The experiment evaluating application methods of Contans was assessed August 30 and Septemer 1 at the R6 growth stage (full seed; at least one pod at the four uppermost nodes contain green seeds that fill the pod capacity). ** In each plot, apothecia and carpogenically germinated sclerotia were assessed in five 0.76 x 1.00 meter rectangles arranged in an X-pattern (a total of 3.81 square meters per plot). Leaves and other debris were carefully removed from the soil surface to expose all apothecia. All isolated apothecia or clusters of apothecia were assumed to originate from different sclerotia, and all dense clusters of apothecia were assumed to originate from a single sclerotium. ** Sclerotinia stem rot was assessed on the 0 to 3 scale developed by Craig Grau at the University of Wisconsin: 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, 225 plants were evaluated (45 plants in each of 5 locations per plot). No differences in disease severity were observed across treatments, and only disease incidence is reported.
- **Harvest:** The trial was harvested on October 9. The remainder of the field (including the soybeans between the treatment plots) was harvested on Sept. 21 and 24.
- **Statistical analysis:** Analysis of variance was conducted PROC GLM of SAS (Version 9.2; SAS Institute, Cary, NC). 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, systematic natural-log transformations were applied to the Sclerotinia incidence and apothecia data [LN(x) for data sets with no values below 1.0; otherwise, LN(x+1)]. All other datasets met model assumptions. Analyses were conducted controlling for the effect of replicate and replicate by treatment interaction. For pairwise comparisons of treatments, the Tukey multiple comparison procedure was utilized to control the type I error rate at the level of the experiment.

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