

Field evaluation of fungicides for management of Sclerotinia on dry edible (pinto) beans

Carrington, ND (2013) ■ 14- and 28-inch row spacing

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SUMMARY OF RESULTS:

Combined results across both narrow (14-inch) and wide (28-inch) rows

Description (application timing) ^y	Sclerotinia incidence: ^y	Sclerotinia severity: ^x	Sclerotinia sev. index: ^w	Yield:	Test weight:	Seeds per pound
	Sept. 3-6 percent	Sept. 3-6 percent	Sept. 3-6 % of canopy	13.5% moisture lbs/ac	13.5% moisture lbs/bu	13.5% moisture seeds/lb
1 Non-treated (water; A,B)	95 de *	52 d *	50 d *	1967 g *	61.1 fg *	1346 e *
2 Topsin 4.5FL 40 fl oz/ac (A) / Topsin 4.5FL 30 fl oz/ac (B)	81 a	39 abc	32 a	2873 abc	62.4 abc	1281 abc
3 Endura 70WG 8 oz/ac (A,B)	85 abc	37 ab	33 a	2722 cd	62.4 a-d	1271 abc
4 Endura 70WG 8 oz/ac (A) / Topsin 4.5FL 40 fl oz/ac (B)	87 a-d	33 a	29 a	2944 ab	62.6 ab	1255 ab
5 Topsin 4.5FL 40 fl oz/ac (A) / Endura 70WG 8 oz/ac (B)	81 a	38 abc	31 a	3067 a	62.6 a	1241 a
6 Cannonball 50WP 7 oz/ac (A,B)	89 a-e	38 ab	34 ab	2532 def	61.9 de	1308 cde
7 Priaxor 500SC 8 fl oz/ac (A,B)	84 ab	35 a	29 a	2479 ef	61.7 ef	1313 cde
8 Omega 500F 0.85 pt/ac (A,B)	85 abc	34 a	30 a	2742 bcd	62.0 b-e	1303 b-e
9 Proline 480SC 5.7 fl oz/ac + NIS 0.125% v/v (A,B)	93 cde	48 cd	45 cd	2344 f	61.1 fg	1341 de
10 Rovral 4F 2.0 pt/ac (A,B)	89 a-e	40 abc	36 abc	2455 f	62.0 cde	1293 bcd
11 Switch 62.5WG 14.0 oz/ac (A,B)	89 a-e	37 ab	34 ab	2411 f	62.0 b-e	1319 cde
12 Approach 2.08SC 12 fl oz/ac + NIS 0.25% v/v (A,B)	91 b-e	40 abc	38 abc	2048 g	61.0 g	1340 de
13 ProPulse 400SC 10.3 fl oz/ac + NIS 0.125% v/v (A,B)	84 ab	36 ab	30 a	2676 cde	62.0 b-e	1288 abc
14 Quash 50WDG 2.5 oz/ac + NIS 0.25% v/v (A,B)	96 e	45 bcd	44 bcd	2089 g	61.5 efg	1319 cde
F:	2.37	2.30	3.20	19.99	7.07	3.05
F > P:	0.0077	0.0096	0.0004	< 0.0001	< 0.0001	0.0007
CV:	11.2	28.9	32.9	9.5	1.0	4.4

^y **Sclerotinia incidence:** The percent of plants exhibiting Sclerotinia stem rot. In each plot, 40 plants were evaluated (20 plants in each of the two center rows of each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^x **Sclerotinia severity:** Disease severity of those plants exhibiting Sclerotinia stem rot. In each plot, 40 plants were evaluated (20 plants in each of the two center rows in each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^w **Sclerotinia stem rot severity index:** Average Sclerotinia stem rot severity (including non-diseased plants). In each plot, 40 plants were evaluated (20 plants in each of the two center rows of each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^y **Fungicide application timing:**

Application A: August 5 at 7:00 to 9:30 pm; no Sclerotinia stem rot present; dry beans at late R2 to early R3 growth stage (many, but not all, plants with a full-length pod); 1 to 2 days after canopy closure in the dry beans seeded to 14-inch rows, canopy varied from completely open to partially closed in the dry beans seeded to 28-inch rows; temperature = 61.6 to 77.5°F, relative humidity = 36 to 75%, wind = 0 to 2.2 mph out of the west.

Application B: August 19 at 9:15 to 11:30 am; Sclerotinia stem rot present in buffer plots and some treatment plots; dry beans at R5; temperature = 77.3 to 86.7°F, relative humidity = 49.3 to 68.9%, wind = 3.8 to 4.5 mph out of the west.

* Within-column means followed by different letters are significantly different ($P < 0.05$; Fisher's protected least significant difference).

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Carrington, ND (2013)

14- and 28-inch row spacing

A. 14-inch row spacing

Description (application timing) ^y	Sclerotinia incidence: ^y	Sclerotinia severity: ^x	Sclerotinia sev. index: ^w	Yield:	Test weight:	Seeds per pound
	Sept. 3-6 percent	Sept. 3-6 percent	Sept. 3-6 % of canopy	13.5% moisture lbs/ac	13.5% moisture lbs/bu	13.5% moisture seeds/lb
1 Non-treated (water; A,B)	96 d *	56 a *	54 d *	1984 h *	61.2 cde *	1379 e *
2 Topsin 4.5FL 40 fl oz/ac (A) / Topsin 4.5FL 30 fl oz/ac (B)	86 a-d	41 a	36 abc	2915 abc	62.3 ab	1315 bcd
3 Endura 70WG 8 oz/ac (A,B)	83 abc	32 a	28 ab	2789 bcd	62.7 a	1281 ab
4 Endura 70WG 8 oz/ac (A) / Topsin 4.5FL 40 fl oz/ac (B)	92 b-e	32 a	30 abc	3074 ab	62.5 ab	1249 a
5 Topsin 4.5FL 40 fl oz/ac (A) / Endura 70WG 8 oz/ac (B)	83 ab	37 a	31 abc	3106 a	62.6 ab	1266 ab
6 Cannonball 50WP 7 oz/ac (A,B)	93 b-e	40 a	37 abc	2483 def	61.9 a-d	1326 b-e
7 Priaxor 500SC 8 fl oz/ac (A,B)	81 a	31 a	25 a	2668 cde	62.0 abc	1316 b-e
8 Omega 500F 0.85 pt/ac (A,B)	94 b-e	38 a	36 abc	2783 bcd	61.8 a-d	1317 b-e
9 Proline 480SC 5.7 fl oz/ac + NIS 0.125% v/v (A,B)	93 b-e	46 a	43 bcd	2379 efg	60.7 e	1346 cde
10 Rovral 4F 2.0 pt/ac (A,B)	90 a-e	40 a	36 abc	2437 efg	61.7 bcd	1321 b-e
11 Switch 62.5WG 14.0 oz/ac (A,B)	94 cde	44 a	41 bcd	2362 efg	62.1 abc	1350 cde
12 Aproach 2.08SC 12 fl oz/ac + NIS 0.25% v/v (A,B)	88 a-e	40 a	37 abc	2168 gh	61.1 de	1360 de
13 ProPulse 400SC 10.3 fl oz/ac + NIS 0.125% v/v (A,B)	86 a-d	34 a	30 abc	2802 abc	62.3 ab	1293 abc
14 Quash 50WDG 2.5 oz/ac + NIS 0.25% v/v (A,B)	98 e	45 a	45 cd	2183 fgh	61.4 cde	1364 de
	F: 2.07	1.45	2.08	10.19	3.47	3.03
	F > P: 0.0382	0.1788	0.0371	< 0.0001	0.0011	0.0032
	CV: 9.2	31.1	32.7	9.4	1.2	3.7

B. 28-inch row spacing

Description (application timing) ^y	Sclerotinia incidence: ^y	Sclerotinia severity: ^x	Sclerotinia sev. index: ^w	Yield:	Test weight:	Seeds per pound
	Sept. 3-6 percent	Sept. 3-6 percent	Sept. 3-6 % of canopy	13.5% moisture lbs/ac	13.5% moisture lbs/bu	13.5% moisture seeds/lb
1 Non-treated (water; A,B)	95 d *	48 a *	45 d *	1949 f *	61.1 ef *	1314 a *
2 Topsin 4.5FL 40 fl oz/ac (A) / Topsin 4.5FL 30 fl oz/ac (B)	77 a	36 a	28 ab	2832 ab	62.6 a	1248 a
3 Endura 70WG 8 oz/ac (A,B)	87 a-d	42 a	37 bcd	2656 bc	62.0 a-d	1262 a
4 Endura 70WG 8 oz/ac (A) / Topsin 4.5FL 40 fl oz/ac (B)	82 abc	33 a	27 ab	2814 ab	62.7 a	1261 a
5 Topsin 4.5FL 40 fl oz/ac (A) / Endura 70WG 8 oz/ac (B)	80 ab	39 a	31 abc	3028 a	62.7 a	1216 a
6 Cannonball 50WP 7 oz/ac (A,B)	86 a-d	36 a	31 abc	2581 bcd	61.9 bcd	1289 a
7 Priaxor 500SC 8 fl oz/ac (A,B)	87 a-d	38 a	34 a-d	2290 de	61.4 def	1310 a
8 Omega 500F 0.85 pt/ac (A,B)	77 ab	31 a	23 a	2701 bc	62.2 abc	1289 a
9 Proline 480SC 5.7 fl oz/ac + NIS 0.125% v/v (A,B)	93 cd	50 a	46 d	2309 d	61.5 c-f	1336 a
10 Rovral 4F 2.0 pt/ac (A,B)	89 bcd	40 a	37 bcd	2472 cd	62.2 ab	1266 a
11 Switch 62.5WG 14.0 oz/ac (A,B)	85 a-d	31 a	26 ab	2459 cd	62.0 a-d	1288 a
12 Aproach 2.08SC 12 fl oz/ac + NIS 0.25% v/v (A,B)	94 cd	41 a	38 bcd	1927 f	60.8 f	1319 a
13 ProPulse 400SC 10.3 fl oz/ac + NIS 0.125% v/v (A,B)	82 abc	37 a	30 abc	2549 bcd	61.8 b-e	1283 a
14 Quash 50WDG 2.5 oz/ac + NIS 0.25% v/v (A,B)	94 d	45 a	43 cd	1995 ef	61.6 b-e	1273 a
	F: 2.17	1.42	2.33	9.71	5.26	1.45
	F > P: 0.0289	0.1889	0.0196	< 0.0001	< 0.0001	0.1761
	CV: 10.9	28.1	31.1	9.9	0.9	4.6

^y **Sclerotinia incidence:** The percent of plants exhibiting Sclerotinia stem rot. In each plot, 40 plants were evaluated (20 plants in each of the two center rows of each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^x **Sclerotinia severity:** Disease severity of those plants exhibiting Sclerotinia stem rot. In each plot, 40 plants were evaluated (20 plants in each of the two center rows in each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^w **Sclerotinia stem rot severity index:** Average Sclerotinia stem rot severity (including non-diseased plants). In each plot, 40 plants were evaluated (20 plants in each of the two center rows of each plot). Disease was assessed Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity).

^y **Fungicide application timing:**

Application A: August 5 at 7:00 to 9:30 pm; no Sclerotinia stem rot present; dry beans at late R2 to early R3 growth stage (many, but not all, plants with a full-length pod); 1 to 2 days after canopy closure in the dry beans seeded to 14-inch rows, canopy varied from completely open to partially closed in the dry beans seeded to 28-inch rows; temperature = 61.6 to 77.5°F, relative humidity = 36 to 75%, wind = 0 to 2.2 mph out of the west.

Application B: August 19 at 9:15 to 11:30 am; Sclerotinia stem rot present in buffer plots and some treatment plots; dry beans at R5; temperature = 77.3 to 86.7°F, relative humidity = 49.3 to 68.9%, wind = 3.8 to 4.5 mph out of the west.

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KEY FINDINGS:

- **Rotational strategies with Topsin (40 fl oz/ac) and Endura (8 oz/ac) were more effective than two sequential applications of Endura (8 oz/ac).**
- **When applied as two sequential applications 14 days apart, Omega (0.85 pt/ac), Endura (8 oz/ac), and ProPulse (10.3 fl oz/ac) performed similarly.**
- **When applied as two sequential applications 14 days apart, Rovral (2 pt/ac), Switch (14 oz/ac), Proline (5.7 fl oz/ac), Quash (2.5 oz/ac), and Aproach (12 fl oz/ac) were less effective than Omega (0.85 pt/ac), Endura (8 oz/ac), and ProPulse (10.3 fl oz/ac).** Rovral, Switch, and Proline were more effective than Quash, Aproach, and the non-treated control.
- **Under high Sclerotinia disease pressure, pinto bean yields were optimized in narrow (14-inch) row spacing relative to wide (28-inch) row spacing.** Sclerotinia severity was lower in the wide (28-inch) row spacing relative to the narrow (14-inch) row spacing, but the lower disease levels were not enough to overcome the yield penalty associated with planting pinto beans to wide rows.
- **The relative efficacy of the different fungicide treatments was similar across the narrow (14-inch) and wide (28-inch) row spacing.** Row spacing did not have an effect on fungicide efficacy in this trial.

Concentrations of active ingredients in products evaluated in this trial:

- Aproach = 250 grams picoxystrobin per liter
- Cannonball = 500 grams fludioxonil per kilogram
- Endura = 700 grams boscalid per kilogram
- Omega = 500 grams fluazinam per liter
- Topsin = 540 grams thiophanate-methyl per liter
- Priaxor = 333 grams pyraclostrobin plus 167 grams fluxapyroxad per liter.
- Proline = 480 grams prothioconazole per liter
- ProPulse = 200 grams prothioconazole + 200 grams fluopyram per liter
- Quash = 500 grams metconazole per kilogram
- Rovral = 480 grams iprodione per liter
- Switch = 250 grams fludioxonil + 375 grams cyprodinil per kilogram

FUNDING:

This project was funded by the **Northarvest Bean Growers Association.**

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 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 under the conditions partially summarized in this report.
- 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:

- **Location of trial:** NDSU Carrington Research Extension Center, Carrington, ND.
- **GPS coordinates of research trial location:** 47° 30.501', -99° 7.792'
- **Tillage:** Disked once and cultivated twice (once deep and once shallow) on May 28, 2013.
- **Fertility:** 80 lbs/ac of Nitrogen were applied as urea (46-0-0) on May 28 and incorporated to 2 inches deep.
- **Maintenance herbicide applications:** On June 26 (at 8:00 to 9:00 pm) when the dry beans had 1 to 2 trifoliate leaves, Raptor (2 fl oz/ac; 12.1% ammonium salt of imazamox, 1 lb ai/gal; BASF Corp.), Rezult B (16 fl oz/ac; sodium salt of bentazon, 53% and 5 lbs ai/gal; BASF Corp.), Assure II (10 fl oz/ac; quizalofop p-ethyl, 10.3%; 0.88 lb ai/gallon; DuPont Corp.), 1.5 gallons/100 gallons methylated seed oil (Drexel MES 100, 100% methylated seed oil; Drexel Chemical Company, Memphis, TN), and 2.5 gallons per 100 gallons liquid ammonium sulfate (28-0-0) were applied in 12.9 gallons of water/ac to control red-root pigweed, wild buckwheat, lambsquarters, foxtail barley, and other weeds. On July 5 when the beans had three trifoliate leaves, Raptor (2 fl oz/ac; ammonium salt of imazamox, 12.1%, 1 lb ai/gal; BASF Corp.), Rezult B (24 fl oz/ac; sodium salt of bentazon, 53% and 5 lbs ai/gal; BASF Corp.), 1.5% (v/v) methylated seed oil (Drexel MES 100, 100% methylated seed oil; Drexel Chemical Company, Memphis, TN), and 2% v/v ammonium sulfate (28-0-0) were applied in 20 gallons of water/ac to control red-root pigweed, mustard, and other small broadleaf weeds.
- **Variety:** 'Lariat' (pinto bean)
- **Experimental design:** randomized complete block with a split-plot arrangement **Replicates:** 6
- **Main factor:** row spacing (14 inches or 28 inches) **Sub-factor:** fungicide treatment
- **Seeded plot size:** 5 ft (center-to-center) x 25 ft long **Harvested plot size:** 5 ft (center-to-center) x approx. 21 ft long
- **Untreated buffer plots were established between treatment plots.**
- **Number of rows per plot:** Treatment plots contained 4 rows spaced 14 inches apart or 2 rows spaced 28 inches apart. Buffer and guard plots contained 4 rows spaced 14 inches apart.
- **Previous crop:** soybeans
- **Planting date:** May 28, 2013
- **Seeding rate:** 91,950 pure live seeds/ac (target plant population = 80,000 plants/ac; presumed seedling mortality = 13%)
- **Fungicide application A:** August 5 at 7:00 to 9:30 pm; no Sclerotinia stem rot present; dry beans at late R2 to early R3 growth stage (many, but not all, plants with a full-length pod); 1 to 2 days after canopy closure in the dry beans seeded to 14-inch rows, canopy varied from completely open to partially closed in the dry beans seeded to 21-inch rows; temperature = 61.6 to 77.5°F, relative humidity = 36 to 75%, wind = 0 to 2.2 mph out of the west.
- **Fungicide application B:** August 19 at 9:15 to 11:30 am; Sclerotinia stem rot present in buffer plots and some treatment plots; dry beans at R5; temperature = 77.3 to 86.7°F, relative humidity = 49.3 to 68.9%, wind = 3.8 to 4.5 mph out of the west.
- **Fungicide application details:** Fungicides were applied with a 57-inch hand boom equipped with four equally spaced Spraying Systems TeeJet XR 8001VS flat-fan nozzles at a spray volume of 15 gal water/A operated at 35 psi.
- **Disease establishment:** The trial was established on a site with a previous history of Sclerotinia epidemics. In addition, sclerotia of Sclerotinia sclerotiorum obtained from a sunflower processing plant were applied to plots on June 14 and July 15. On June 14, two to three sclerotia were placed approx. 0.5 inches deep in each of six locations per plot; on July 15, approx. 1.25 grams of sclerotia were placed approx. 0.25 inches deep in each of eight locations per plot. Prior to placement in the field, the sclerotia were artificially vernalized by alternating them between a freezer (-20°C for at least 12 hours) and room temperature (20 to 25°C for at least 8 hours) a minimum of eight times. To facilitate disease development, overhead irrigation was applied to this trial through microsprinklers established on a 20 ft x 20 ft grid.
- **Sclerotinia disease assessment:** Sclerotinia disease incidence and severity were assessed on Sept. 3-6 at the R7 growth stage (at least one pod per plant changed color / striped; physiological maturity). In each plot, 40 plants (10 plants in each of four locations per plot) were evaluated individually for the percent of the canopy exhibiting Sclerotinia stem rot disease symptoms.
- **Harvest date:** The beans were manually pulled on October 4 at maturity and harvested October 24; cool, wet weather delayed harvest.
- **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. All data met model assumptions. Customized F-tests were constructed for the main effect using replicate by treatment interaction for the error term. Analyses were conducted with replicate, main factor, main factor by replicate interaction, sub-factor, and sub-factor by main-factor interaction in the model. Single-degree-of-freedom contrasts of treatments were performed for all pairwise comparisons of treatments; to control the Type I error rate at the level of the experiment, the Fisher's protected least significant difference multiple comparison procedure was employed. Analyses were implemented in PROC GLM of SAS (version 9.2; SAS Institute, Cary, NC).