

Field evaluation of fungicides for management of anthracnose on dry edible beans

New Rockford, ND (2012)

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KEY FINDINGS – see next page for additional interpretation of results

- Fungicides that include azoxystrobin or pyraclostrobin active ingredients (Headline, Quadris Opti, Quadris, and Priaxor) **performed well**.
- The fungicides Quash (metconazole), Rovral (iprodione), Vertisan (penthiopyrad), Endura (boscalid), and Folicur (tebuconazole) **provided unsatisfactory disease control**.
- Foliar fungicides did not provide satisfactory control of anthracnose related seed discoloration.

DETAILED RESULTS

Within-column means followed by different letters are significantly different

($P < 0.05$; Tukey multiple comparison procedure).

The fungicides APROACH and QUASH are currently not registered for use on dry edible beans and should not be used.

Future registration of these fungicides is anticipated, and results for these products are provided for reference only.

Treatment (application timing) ^v	Anthracnose incidence, plants ^{z†} Aug. 29-30 ^w percent	Anthracnose incidence, pods ^{y*} Aug. 29-30 ^w percent	Yield 13% moisture percent	Discolored seeds ^{x‡} percent	Seeds per pound 13% moisture seeds
1 Non-treated check (water)	65 e *	37.9 d *	864 a *	9 a *	1411 a *
2 Endura 70WG 8.0 oz/ac (A,B)	45 e	24.5 cd	839 a	11 a	1388 a
3 Switch 62.5WG 14.0 oz/ac (A,B)	15 b-e	3.9 abc	762 a	7 a	1332 a
4 Omega 500F 0.85 pt/ac (A,B)	34 de	13.5 bcd	1080 a	8 a	1314 a
5 Rovral 4F 2.0 pt/ac (A,B)	56 e	26.0 cd	987 a	10 a	1355 a
6 Proline 480SC 5.7 fl oz/ac + NIS 0.25% v/v (A,B)	15 cde	4.1 abc	860 a	9 a	1369 a
7 Folicur 3.6F 6.0 fl oz/ac (A,B)	44 e	18.4 cd	961 a	10 a	1312 a
8 Quadris 250SC 6.0 fl oz/ac (A,B)	18 b-e	7.8 a-d	1156 a	6 a	1241 a
9 Quadris 250SC 12.0 fl oz/ac (A,B)	2 abc	0.8 ab	1065 a	9 a	1293 a
10 Quadris Opti 2.4 pt/ac (A,B)	2 ab	0.4 a	940 a	9 a	1332 a
11 Headline 250SC 6.0 fl oz/ac (A,B)	5 a-d	1.0 ab	985 a	7 a	1294 a
12 Headline 250SC 9.0 fl oz/ac (A,B)	2 a	0.4 a	973 a	7 a	1294 a
13 Topsin 4.5FL 40 fl oz/ac (A,B)	25 de	7.3 a-d	1125 a	6 a	1334 a
14 Priaxor 500SC 6.0 fl oz/ac (A,B)	7 a-d	1.8 ab	914 a	10 a	1328 a
15 Approach 2.08SC 9 fl oz/ac + NIS 0.25% v/v (A,B)	20 cde	8.4 a-d	749 a	12 a	1327 a
16 Approach 2.08SC 12 fl oz/ac + NIS 0.25% v/v (A,B)	17 b-e	5.6 a-d	689 a	11 a	1281 a
17 ProPulse 400SC 10.3 fl oz/ac + NIS 0.25% v/v (A,B)	27 de	6.6 a-d	1173 a	10 a	1302 a
18 Vertisan 200EC 14 fl oz/ac + NIS 0.25% v/v (A,B)	30 de	11.1 a-d	825 a	8 a	1350 a
19 Vertisan 200EC 20 fl oz/ac + NIS 0.25% v/v (A,B)	55 e	26.8 cd	979 a	10 a	1363 a
20 Quash 50WDG 2.5 oz/ac + NIS 0.25% v/v (A,B)	58 e	25.3 cd	1067 a	8 a	1316 a
Treatment differences, F :	9.90	8.08	0.80	0.82	1.06
Treatment differences, $P > F$:	< 0.0001	< 0.0001	0.6990	0.6767	0.4245
C.V.:	26.8	39.2	32.5	20.7	5.7

^z In each plot, 50 plants were evaluated (5 consecutive plants at 5 locations located 40 inches apart in each of two rows).

^y In each plot, percent infected pods were evaluated on 50 plants (5 consecutive plants at 5 locations located 40 inches apart in each of two rows).

^x Percent of seeds exhibiting visual discoloration typical of anthracnose damage; from each plot, 250 seeds were evaluated.

^w The predominant growth stage on Aug. 29-30 was mid-seed fill (50% of pods with fully developed seeds; R6 growth stage).

^v Fungicide application timing:

Application A: July 19 at 6:45-8:30 am; R1 growth stage (one open flower per plant; 100% bloom); wind = 7.8-8.6 miles per hour, temperature = 70-75°F, relative humidity = 85-96%. No anthracnose was present.

Application B: Aug. 2 at 1:00-3:00 pm; R3 growth stage (one pod per plant at maximum pod length; early pod set); wind = 5-6 miles per hour, temperature = 79-80°F, relative humidity = 46-52%.

* Within-column means followed by different letters are significantly different ($\alpha = 0.05$; 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 incidence [$\ln(\text{inc.} + 1)$]. For ease of interpretation, treatment means are reported as the (untransformed) percent disease incidence.

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INTERPRETATION OF THE RESULTS – Anthracnose control:

This trial was valuable for identifying fungicides that appear to have little or no efficacy against anthracnose. The results from this trial suggest that Folicur (tebuconazole) applied at 6 fl oz/ac, Endura (boscalid) applied at 8 oz/ac, Vertisan (penthiopyrad) applied at 20 fl oz/ac, Rovral (iprodione) applied at 2 pt/ac, and Quash (metconazole) applied at 2.5 oz/ac likely confer little if any control of anthracnose on dry edible beans.

Due to drought stress and elevated soil salinity, the canopy never closed in this trial, and fungicide coverage was much better than would be expected under the wet conditions generally associated with anthracnose epidemics. Lower fungicide efficacy would be expected with a closed canopy. Both the efficacy and the relative performance of different products would be expected to differ under a closed canopy.

Fungicide efficacy results may be different when anthracnose develops due to seed-to-seedling transmission of disease. Due to dry weather, seed-to-seedling transmission of anthracnose did not occur in this trial; all disease development was due to foliar applications of laboratory grown spores. When disease develops due to seed-to-seedling transmission of disease, disease will be present in the canopy at the time of the first fungicide application. In this trial, no disease was present at the time of the first fungicide application in this trial, and the first fungicide application was completely preventative.

INTERPRETATION OF THE RESULTS – Yield response:

The yield response observed in this trial is likely not representative of conditions in most production fields. The lack of differences in seed yield across fungicide treatments was most likely due to the confounding influence of soil salinity. The site used for this trial had problems with elevated soil salinity, and under the drought conditions experienced in 2012, the impact of elevated soil salinity was particularly pronounced. Gradients of soil salinity were uneven across the trial, and differences in salinity across plots were the primary determinant of seed yield. In 2013, this trial will be placed at a different location without soil salinity problems.

INTERPRETATION OF THE RESULTS – Seed discoloration:

No reduction in seed discoloration was observed with the use of fungicides. Both (1) severely discolored seeds and (2) seeds exhibiting a halo of reddish discoloration around the hilum (the point at which the bean was attached to the pod) were counted as discolored. It is unclear whether the use of fungicides may reduce the incidence of severely discolored seeds to acceptable levels. In future trials, severely discolored seeds will be assessed separately from those exhibiting only modest discoloration around the hilum.



UNDAMAGED SEEDS

When evaluating seed discoloration, seeds that exhibited no obvious yellow to red discoloration of the seed coat (left) or no pronounced reddish halo around the hilum (right) were not considered discolored.

DISCOLORED SEEDS

When evaluating seed discoloration, seeds with severe staining and lesioning (left) and seeds exhibiting a halo of reddish discoloration around the hilum (right) were considered discolored.

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METHODS:

- **Location of trial:** Adjacent to the Gavilon LLC elevator, 1 mile east of New Rockford, ND
- **GPS coordinates of research trial location:** 47.6718, -99.0965
- **Variety:** 'Pintoba' (pinto bean)
- **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 16.5 feet long
- **Row spacing:** 30 inches **Rows per plot:** 2
- **Non-treated buffer plots were established between treatment plots.**
- **Previous crop:** fallow
- **Planting date:** May 31, 2012 **Soil temperature at planting:** 52°F
- **Seeding rate:** 91,950 pure live seeds/ac (target plant population = 80,000 plants/ac; presumed seedling mortality = 13%)
- **Fungicide application A:** July 19 at 6:45-8:30 am; R1 growth stage (one open flower per plant; 100% bloom); wind = 7.8-8.6 miles per hour, temperature = 70-75°F, relative humidity = 85-96%. No anthracnose was present.
- **Fungicide application B:** Aug. 2 at 1:00-3:00 pm; R3 growth stage (one pod per plant at maximum pod length; early pod set); wind = 5-6 miles per hour, temperature = 79-80°F, relative humidity = 46-52%.
- **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/A operated at 35 psi.
- **Disease establishment:** To promote anthracnose disease pressure, seed with a 1% incidence of anthracnose infection was planted. Due to dry weather, seed-to-seedling transmission of anthracnose did not occur from the anthracnose-infected seeds used in this experiment. Sixteen isolates of *Colletotrichum lindemuthianum*, causal agent of anthracnose on dry beans, were grown on Mathur's media and on green bean media for 2 to 4 weeks, spores were harvested, and spore suspensions were applied with a 60-inch hand boom equipped with four equally spaced 8003 twin-jet nozzles at 20 psi in 17.5 gallons of water per acre. Spore applications were made at approximately 9:00 to 9:30 pm on July 23 (218,000 spores/ml), July 24 (85,000 spores/ml), July 25 (32,800 spores/ml), Aug. 6 (20,000 spores/ml), Aug. 7 (21,000 spores/ml), and Aug. 8 (20,000 spores/ml). To facilitate disease establishment, 0.11 inches of water was applied with microsprinklers from approx. 8:45 to 10:00 pm on July 23, July 24, July 25, July 26, July 27, Aug. 6, Aug. 7, Aug. 8, Aug. 9, and Aug. 10.
- **Disease assessments:** Anthracnose disease ratings were conducted August 29-30 at the R6 growth stage (50% of pods with fully developed seeds). In each plot, 50 plants were evaluated (five consecutive plants at five locations located 50 inches apart in each of two rows). Each plant was scored for the presence/absence of anthracnose symptoms and for the approximate percentage of pods exhibiting anthracnose lesions.
- **Seed discoloration assessments:** The incidence of seeds exhibiting yellow staining, red to black lesions, and reddish halos around the hilum was assessed by evaluating 250 seeds per plot.
- **Seed weight assessments:** In each plot, 250 seeds were weighed. Split and broken seeds were excluded from the analysis.
- **Harvest date:** Sept. 25, 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 was applied to the anthracnose incidence data (both incidence of plants and incidence of pods; LN(x) for data sets in which all values ≥ 1.0 , LN(x+1) for data sets with values < 1.0). 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, the Tukey 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).

FUNDING:

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

We gratefully acknowledge the Gavilon LLC elevator in New Rockford, ND for hosting this trial on land owned by the elevator.

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 outside of New Rockford, ND by 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.