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Determining Management Strategies for Diseases and Disease-Causing Microorganisms that Impact Soybean Quality, 2019

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Abstract

To determine the impact of disease and stinkbug feeding on soybean grain quality, replicated fungicide trials were placed at the University of Arkansas System Division of Agriculture's Rohwer Research Station and the Vegetable Research Station near Rohwer and Kibler, Ark., respectively, on two varieties (CZ4105 and CZ4748) using 4 fungicide treatments at 3 timings with untreated controls included. Pods were selected prior to harvest, seed removed, and pods and seed plated in agar filled Petri dishes to determine the pathogens present. Pods were also selected from a variety trial located at Rohwer Research Station and plated in the same manner as above. All pods and seed were observed for stink bug damage, but none was found. The Kibler location had differences in foliar disease ratings, yield, and *Cercospora* colonies produced from seed. The CZ4105 variety had lower amounts of purple seed stain in all treatments where an R5 application alone was applied (except for propiconazole). The CZ4748 variety at Kibler had a high incidence of Bacillus seed decay, reported to be caused by *Bacillus subtilis* across all treatments, which was not found in other trials. Numerical averages were determined for varieties from the trial at Rohwer with higher amounts of *Phomopsis* spp. and purple seed stain in some varieties.

Introduction

Seed quality can be impacted significantly by insect damage and fungal infestations. Stink bugs are common in Arkansas soybean production, where both adults and nymphs feed on soybean pods and seed. These insects feeding on pre-mature seed can cause yield loss by initiating pod/seed abortions or seed size reduction. Quality reduction is also caused by digestive fluids entering seed during feeding, which leads to deterioration and discoloration of seed. (Lorenz et al., 2000)

Common fungal diseases that impact grain quality include purple seed stain (PSS) and Phomopsis seed decay. Purple seed stain is caused by multiple species of fungi in the genus *Cercospora* that stain the seed coat purple. This disease has not been associated with yield loss but can cause significant reduction in grain quality by causing reduced vigor and increased seed decay and discoloration (Alloatti et al., 2015). Phomopsis seed decay caused by *Phomopsis longicolla* can cause deformed, split, or moldy grain, altering seed viability and oil composition (Li et al., 2010).

Also found in this study was *Bacillus subtilis*, a bacterium that causes Bacillus seed decay and produces a slimy coat causing an often-wrinkled appearance that is most often found in seed assays but can occur in the field. *Bacillus subtilis* is ubiquitous and survives in the soil, and some strains are used as a biological seed treatment due to the antifungal secretions that they produce (Cubeta and Hartman, 1985).

These diseases are favored by the hot, humid conditions we consistently experience in Arkansas each year and survive on crop debris and in field soil. The objective of this work was to determine the impact of soybean variety and fungicide efficacy and timing on diseases that reduce seed quality. Additionally, this work seeks to determine the interactions of these diseases with stink bug feeding when opportunities to collect those data are available.

Procedures

In 2019, identical trials were established at the University of Arkansas System Division of Agriculture's Rohwer Research Station and the Vegetable Research Station near Rohwer and Kibler, Ark., respectively. Each location had two trials with one planted to CZ4105 and the other to CZ4748. Plots were 4-rows wide and 25-ft long on 38-in. row-spacings. Treatments included an untreated control and 4 fungicide treatments applied at R3, R3 + R5, and R5 for a total of 13

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treatments in 5 replications. Fungicides applied were Headline© (pyraclostrobin) 12 fl oz/ac, Priaxor© (fluxapyraoxad + pyraclostrobin) 8 fl oz/ac, Tilt© (propiconazole) 6 fl oz/ac, and Topsin-M© (thiophanate-methyl) 1lb/ac. All fungicides were applied in a total water volume of 15 gal/ac using TeeJet VS11002 spray tips. Foliar disease severity ratings were based on a 0–10 scale where disease severity 0 = no disease and 10 = dead plants. Rohwer Station trials were planted 11 June at a seeding rate of 110,000 seed/ac, fungicides were applied on 5 and 28 Aug., foliar ratings recorded on 4 Sept., and both trials were harvested 10 Oct. Trials at Kibler were planted 17 June at 116,000 seed/ac, fungicides applied 10 and 29 Aug., plots assessed for foliar diseases on 13 Sept. and 1 Oct., and plots harvested 4 Oct. (CZ4105) and 4 Nov. (CZ4748).

Prior to harvest, 10 pods per plot were collected from the tops of the canopy and placed in an envelope, sealed, and labeled according to plot number. The envelopes were then placed into a standard refrigerator and kept until processed. At the time of processing, the pods were opened, seed extracted, separated, and observed for stink bug damage. Each pod and seed were surface disinfested using a 3:1 95% ethanol to distilled water solution for 30 seconds, air-dried, and plated on sterile half-strength potato dextrose agar amended with 0.25g/L ampicillin sodium salt and 500uL/L potassium phosphite in a standard-sized Petri dish. Pods were plated 1 per Petri dish and seed five per Petri dish. Petri dishes were labeled and allowed to incubate for 10 days in ambient laboratory conditions, at which time fungal colonies were categorized and quantified. All data were subjected to analysis of variance (ANOVA), followed by means separation of fixed effects using Fisher's protected least significant difference (LSD) at $P = 0.10$. Yield data were adjusted to 13% moisture content for comparison.

Pods were also taken from a variety trial to determine if any differences existed amongst varieties. In order to determine pathogen presence, pods and seed were processed using the method described in the previous paragraph. However, this test had three replications of each variety that were combined, mixed thoroughly, and 10 pods arbitrarily selected for the assay. Replicated foliar ratings and yields have been added to the results tables for reference. Disease severity was rated as previously described, and data were subjected to ANOVA followed by means separation as determined by Tukey's honestly significant difference test at $P = 0.10$.

Results and Discussion

Fungicide trials at Rohwer had no differences in any measured variable. In the CZ4105 trial, *Phomopsis* spp. were found in pod tissue an average of 14.4% (6.8–23.6%) and in 0.7% (0–2.4%) of seed. *Cercospora* spp. were found in pod tissue an average of 0.9% (0.0–3.4%) and in 14.6% (10.6–21.8%) of seed. Foliar rating of target spot averaged 3.3 (2.4–5.0) on a scale of 0–10. Yields averaged 47.9 (46.2–48.1) bu./ac. In the CZ4748 trial, *Phomopsis* spp. were found on an average of 35.8% (24.6–56.6%) of pods and 0.5% (0.0–1.8%) of seed. *Cercospora* spp. were found on an average of 0.2% (0.0–2.0%) pods and 4.6% (0.6–9.2%) seed. Foliar rating of target spot averaged 2.4 (1.0–3.4) on a scale of 0–10. Yields averaged 50.94 (46.2–54.3) bu./ac.

The Kibler trial data for CZ4105 treatments are shown in Table 1. *Phomopsis* spp. were found on an average of 15.3% (4.0–24.2%) of pods and 5.2% (2.2–10.8%) of seed. *Cercospora* spp. were found on an average of 0.2% (0.0–2.0%) pods and 14.0% (6.2–23.6%) seed. Seed producing colonies of Cercospora spp. were fewer among those treated at R5 except for Tilt©. Foliar rating of target spot averaged 3.9 (1.3–5.8) on a scale of 0–10. Target spot was found in lesser amounts in Headline© and Priaxor© plots applied at R3 + R5. Yields averaged 48.9 (43.1–55.0) bu./ac. All treatments yielded greater than the untreated except for Tilt© and Topsin© applied at R3, and Headline© applied at R5.

The Kibler CZ4748 treatment data are shown in Table 2. *Phomopsis* spp. were found on an average of 2.9% (0.0–10.0%) of pods and 0.6% (0.0–2.4%) of seed. *Cercospora* spp. were absent on pods and averaged 0.6% (0.0–4.8%) on seed. Bacillus seed decay was found on an average of 91.7% (80.2–98.4%), which is an antagonist of other fungi observed in this study, and likely prevented colony growth. Foliar ratings of target spot averaged 3.0 (1.6–5.0) on a scale of 0–10. Target spot severity was greater in the Tilt© R3 treatment than the untreated and lesser in Headline© R3 and R3 + R5 and Priaxor© R3 + R5 and R5 treatments. Foliar ratings of Cercospora leaf blight averaged 1.8 (1.0–2.8) on a scale of 0–10. Treatments of Headline©, Priaxor©, and Tilt© applied at R3 + R5 and Headline© and Priaxor© applied at R3 performed better than the untreated. Yields averaged 55.9 (50.0–60.3) bu./ac.

The variety trial sampling was not replicated, therefore only numerical averages are available. The varieties are divided by maturity groups, and data can be observed in Tables 3–7. Stink bug activity was low in each trial, and damage to sampled seed was either minimal or not observed in trials.

Practical Applications

The data collected from these trials combined with future data will help to determine the impact variety, stink bugs, and pathogens have on grain quality individually as well as when compounded. These results will help provide best management practices to producers by providing varietal quality data, and best timings for pesticide applications, and when those applications are warranted.

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Table 1. Fungicide trial planted in CZ4105 at the Vegetable Research Station near Kibler, Arkansas Treatments, growth stage applied, and percent pods (out of 10) and seed (out of 25) that when plated produced fungal colonies, and foliar disease severity ratings based on a 0–10 scale, where 0 = no disease, and 10 = dead plants.

		Pods		Seed		Foliar	
Treatment and rate/ac	Growth Stage	Phomopsis	PSS†	Phomopsis	PSS†	TS†	Yield§
Headline 2.08 SC 12 fl oz	R3	15.0	0.0	7.2	15.0 abc‡	2.3 cde	55.0 a
Headline 2.08 SC 12 fl oz	R3+R5	20.0	0.0	2.4	10.0 c	1.3 e	53.2 ab
Headline 2.08 SC 12 fl oz	R5	8.0	0.0	10.2	6.2 c	3.8 a-d	47.2 cde
Priaxor 4.17 SC 8 fl oz	R3	14.0	0.0	6.4	15.6 abc	2.7 b-e	48.5 bcd
Priaxor 4.17 SC 8 fl oz	R3+R5	24.2	2.0	4.8	14.4 abc	1.5 de	54.7 a
Priaxor 4.17 SC 8 fl oz	R5	24.0	0.0	2.2	9.2 c	4.5 abc	50.3 abc
Tilt 3.6 EC 6 fl oz	R3	22.0	0.0	2.2	20.8 ab	5.5 a	47.5 cde
Tilt 3.6 EC 6 fl oz	R3+R5	12.2	0.0	10.8	14.4 abc	4.5 abc	45.0 de
Tilt 3.6 EC 6 fl oz	R5	21.2	0.0	7.2	13.2 bc	5.0 ab	47.2 cde
Topsin-M 70 WP 1 lb	R3	10.0	0.0	3.0	23.6 a	5.8 a	46.7 cde
Topsin-M 70 WP 1 lb	R3+R5	16.0	0.0	3.2	12.0 bc	4.8 ab	48.0 cd
Topsin-M 70 WP 1 lb	R5	8.2	0.0	4.2	6.6 c	4.8 ab	49.3 bcd
Untreated	N/A	4.0	0.0	3.6	21.2 ab	4.5 abc	43.1 e

† PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Columns followed by the same letter are not statistically significant at $P = 0.10$ as determined by Fisher's protected least significant difference (LSD) test.

§ Yield (bu./ac) adjusted to 13%.

Table 2. Fungicide trial planted in CZ4748 at the Vegetable Research Station near Kibler, Ark. Treatments, growth stage applied, and percent pods (out of 10) and seed (out of 25) that when plated produced fungal colonies of known pathogens, and foliar disease severity ratings based on a 0–10 scale, where 0 = no disease, and 10 = dead plants.

		Pods		Seed		Foliar		
Treatment and rate/ac	Growth Stage	Phomopsis	PSS†	Phomopsis	PSS	TS†	CLB†	Yield§
Headline 2.08 SC 12 fl oz	R3	0.0	0.0	0.0	0.0	2.0 de‡	2.0 bc	59.5
Headline 2.08 SC 12 fl oz	R3+R5	2.0	0.0	0.0	4.8	1.6 e	1.4 cd	60.3
Headline 2.08 SC 12 fl oz	R5	10.0	0.0	0.0	1.6	1.8 e	1.0 d	60.3
Priaxor 4.17 SC 8 fl oz	R3	0.0	0.0	0.8	3.0	1.8 e	2.2 ab	55.3
Priaxor 4.17 SC 8 fl oz	R3+R5	2.0	0.0	1.4	0.0	1.8 e	1.0 d	53.1
Priaxor 4.17 SC 8 fl oz	R5	0.0	0.0	0.8	1.6	3.0 cde	1.0 d	55.8
Tilt 3.6 EC 6 fl oz	R3	6.0	0.0	0.0	0.6	5.0 a	2.2 ab	50.0
Tilt 3.6 EC 6 fl oz	R3+R5	0.0	0.0	0.8	3.2	3.8 abc	1.4 cd	58.4
Tilt 3.6 EC 6 fl oz	R5	6.0	0.0	0.0	0.0	3.0 cde	1.8 bc	51.4
Topsin-M 70 WP 1 lb	R3	4.0	0.0	0.8	3.4	4.8 ab	2.8 a	55.6
Topsin-M 70 WP 1 lb	R3+R5	6.0	0.0	2.4	0.0	2.8 cde	2.0 bc	54.6
Topsin-M 70 WP 1 lb	R5	0.0	0.0	0.8	0.0	4.6 ab	2.2 ab	53.8
Untreated	N/A	2.0	0.0	0.0	0.0	3.4 bcd	2.2 ab	59.0

† PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Columns followed by the same letter are not statistically significant at $P = 0.10$ as determined by Fisher's protected least significant difference (LSD) test.

§ Yield (bu./ac) adjusted to 13%.

Table 3. Soybean maturity groups (MG) 3.8–4.5 percent pods (out of 10) and seed (out of 25) that when plated produced colonies of known pathogens, and foliar disease severity ratings based on a scale, where 0 = no disease, and 100 = dead plants.

			Pod	Seed		Foliar		
Variety	MG	Tech	Phom.†	Phom.†	PSS†	TS†	CLB†	Yield§
Credenz CZ3841LL	3.8	LL	70	0	7	0.0 e‡	0.0 c	35.0 hi
Credenz CZ3929GTLL	3.9	GT/LL	0	0	5	1.0 de	7.3 bc	84.5 a-h
Local LS3976X	3.9	Xtend	67	0	0	0.0 e	n/a	73.5 a-i
NK S39-G2X	3.9	Xtend	30	0	0	0.0 e	n/a	62.2 b-i
Dyna-Gro S41XS98	4.1	Xtend/STS	50	0	9	0.0 e	0.0 c	60.8 b-i
S13-2743C	4.1	Conv.	20	0	7	0.0 e	5.0 bc	n/a
Armor 42-D27	4.2	Xtend	40	4	8	0.0 e	0.3 c	80.7 a-h
Asgrow AG42X9	4.2	Xtend	67	20	12	0.0 e	3.7 bc	67.6 a-i
Credenz CZ4222LL	4.2	LL	90	0	10	0.0 e	0.0 c	68.9 a-i
Credenz CZ4280X	4.2	Xtend	30	0	12	0.0 e	3.7 bc	88.8 a-h
Dyna-Gro S42EN89	4.2	Enlist	20	4	4	2.3 cde	8.3 bc	81.4 a-h
Local LSX4301XS	4.2	Xtend	70	4	0	0.0 e	6.7 bc	80.0 a-i
Pioneer P42A96X	4.2	Xtend	60	0	24	0.0 e	10.3 bc	84.4 a-h
Progeny P4241 E3	4.2	E3	20	0	12	0.0 e	0.0 c	56.4 b-i
Progeny P4255RX	4.2	Xtend	80	0	7	0.0 e	3.3 bc	91.0 a-g
Progeny P4265RXS	4.2	Xtend/STS	60	0	4	0.0 e	10.0 bc	76.7 a-i
Progeny P4291LR	4.2	LL/GT27	20	0	0	2.0 cde	1.3 bc	86.3 a-h
Asgrow AG43X0	4.3	Xtend	50	0	4	0.3 de	0.3 c	74.9 a-i
REV4310X	4.3	Xtend	40	0	0	0.0 e	1.0 bc	85.5 a-h
AgriGold G4440RX	4.4	Xtend	60	0	4	0.0 e	3.7 bc	91.9 a-g
Armor 44-D92	4.4	Xtend	30	0	4	0.3 de	1.3 bc	79.0 a-i
Delta Grow 45E23	4.4	E3	30	0	0	0.0 e	0.0 c	57.9 b-i
Eagle Seed ES4460RYX	4.4	Xtend	30	0	0	0.0 e	14.0 bc	80.4 a-i
Local LS4487XS	4.4	Xtend	30	0	4	0.7 de	7.0 bc	79.2 a-i
Mission A4448X	4.4	Xtend	30	0	0	0.3 de	1.0 bc	91.8 a-g
MorSoy 4447 RXT	4.4	Xtend	10	4	8	0.7 de	5.7 bc	96.1 a-g
NK S44-C7X	4.4	Xtend	20	0	0	0.3 de	10.3 bc	90.5 a-h
Progeny P4444RXS	4.4	Xtend/STS	13	0	0	0.0 e	0.7 bc	85.9 a-h
S13-3851C	4.4	Conv.	20	0	10	0.0 e	1.0 bc	49.9 c-i
AgriGold G4579RX	4.5	Xtend	60	8	4	0.3 de	7.3 bc	97.4 a-g
Armor X45D51	4.5	Xtend	80	13	7	0.0 e	1.3 bcd	96.5 a-f
Credenz CZ4539GTLL	4.5	GT/LL	30	0	0	2.3 cde	0.7 cd	97.4 a-g
Credenz CZ4540LL	4.5	LL	50	3	0	0.0 e	1.0 bc	82.8 a-h
Credenz CZ4570X	4.5	Xtend	60	0	4	0.0 e	2.7 bc	88.4 a-h
Dyna-Gro S45XS37	4.5	Xtend/STS	80	4	0	0.0 e	6.7 bc	91.4 a-g
Dyna-Gro S45XS66	4.5	Xtend/STS	40	8	0	0.3 de	10.0 bc	97.1 a-f
Local LS4565XS	4.5	Xtend	70	7	4	0.0 e	1.3 bc	83.8 a-h
Local LS4583X	4.5	Xtend	30	0	7	0.0 e	0.3 c	74.6 a-i
Local LSX4501X	4.5	Xtend	50	0	4	0.0 e	0.3 c	85.0 a-h
Local LSX4503GTLL	4.5	GT/LL	30	0	0	1.0 de	3.7 bc	85.0 a-h
Progeny P4525 E3	4.5	E3	44	4	12	2.0 cde	1.5 bc	41.6 f-i
Progeny P4565LR	4.5	LL/GT27	11	0	4	1.0 de	2.3 bc	100.1 a-e

† Phom. = *Phomopsis* spp.; PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Foliar disease severity ratings and yield columns followed by the same letter are not statistically significant at *P* = 0.10 as determined by Tukey's honestly significant difference test.

§ Yield (bu./ac) adjusted to 13%.

Table 4. Soybean maturity groups (MG) 4.6–4.7 percent pods (out of 10) and seed (out of 25) that when plated produced colonies of known pathogens, and foliar disease severity ratings based on a scale, where 0 = no disease, and 100 = dead plants.

			Pod	Seed		Foliar		
Variety	MG	Tech	Phom.†	Phom.†	PSS†	TS†	CLB†	Yield§
AgriGold G4605RX	4.6	Xtend	70	0	0	0.0 e‡	6.7 bc	74.6 a-i
Armor X46D09	4.6	Xtend	50	0	14	0.0 e	7.3 bc	98.2 a-e
Armor X46D30	4.6	Xtend	40	0	3	0.3 de	21.7 ab	98.2 a-e
Asgrow AG46X0	4.6	Xtend	67	0	8	0.0 e	7.0 bc	69.1 a-i
Asgrow AG46X6	4.6	Xtend	60	0	4	0.0 e	3.3 bc	90.0 a-h
Credenz CZ4600X	4.6	Xtend	40	3	0	0.7 de	1.0 bc	63.0 b-i
Credenz CZ4649LL	4.6	LL	0	0	4	0.0 e	5.0 bc	88.0 a-h
Delta Grow 46E29	4.6	E3/STS	33	0	4	0.7 de	0.3 c	50.5 c-i
Delta Grow 46X25	4.6	Xtend	50	0	0	0.0 e	1.0 bc	99.3 a-e
Delta Grow 46X65	4.6	Xtend/STS	30	0	0	0.0 e	1.0 bc	74.1 a-i
Dyna-Gro S46EN29	4.6	Enlist	10	0	4	2.3 cde	1.0 bc	87.3 a-h
Dyna-Gro S46XS60	4.6	Xtend/STS	0	0	0	0.3 de	2.3 bc	69.0 a-i
Eagle Seed ES4680RYX	4.6	Xtend	30	0	0	0.0 e	0.0 c	77.4 a-i
Go Soy 46GL18	4.6	LL/GT27	10	0	4	1.0 de	1.0 bc	63.9 a-i
Hefty H46X0S	4.6	Xtend	50	0	0	0.3 de	1.0 bc	90.2 a-h
LGS4420RX	4.6	Xtend	0	0	0	0.7 de	0.3 c	73.0 a-i
Local LS4677X	4.6	Xtend	40	3	7	0.0 e	17.0 abc	71.0 a-i
Local LSX4601XS	4.6	Xtend	20	0	8	0.3 de	0.3 c	88.8 a-h
Local LSX4602ES	4.6	Xtend	30	0	13	1.0 de	2.3 bc	104.5 a-c
Mission A4618X	4.6	Xtend	50	4	9	0.7 de	2.0 bc	60.7 b-i
Pioneer P46A57BX	4.6	Xtend	40	4	12	1.7 de	10.3 bc	83.9 a-h
Progeny P4620RXS	4.6	Xtend/STS	40	13	10	1.0 de	36.7 a	62.0 b-i
Progeny P4670RX	4.6	Xtend	30	4	8	0.0 e	1.0 bc	89.2 a-h
Progeny P4682 E3	4.6	E3	30	5	15	1.7 de	0.3 c	44.9 e-i
R16-253	4.6	Conv.	40	0	8	0.0 e	2.7 bc	118.8 a
R16-259	4.6	Conv.	30	0	0	0.0 e	4.0 bc	59.4 b-i
REV 4679X	4.6	Xtend	50	0	0	0.0 e	20.3 abc	103.3 a-d
USG 7460ET	4.6	Enlist	30	0	32	2.3 cde	1.0 bc	82.0 a-h
Armor X47D18	4.7	Xtend	40	0	4	0.0 e	1.3 bc	93.7 a-g
Armor X47D85	4.7	Xtend	60	3	7	0.3 de	2.3 bc	74.8 a-i
Armor X47D86	4.7	Xtend	30	0	3	0.3 de	1.7 bc	92.0 a-g
Asgrow AG47X0	4.7	Xtend	40	0	28	0.0 e	1.0 bc	84.6 a-h
Asgrow AG47X9	4.7	Xtend	20	0	36	0.7 de	2.3 bc	72.5 a-i
Credenz CZ4770X	4.7	Xtend	30	0	0	2.0 cde	4.0 bc	99.6 a-e
Delta Grow 47E19	4.7	E3	0	0	4	0.0 e	1.5 bc	79.5 a-i
Delta Grow 47E25	4.7	E3	10	0	16	0.0 e	1.0 bc	74.3 a-i
DM 47X01	4.7	Xtend	20	0	4	1.0 de	4.3 bc	84.9 a-h
Dyna-Gro S47XT20	4.7	Xtend	50	0	17	0.3 de	2.3 bc	92.9 a-g
Local LS4798X	4.7	Xtend	20	0	28	1.7 de	14.0 bc	86.1 a-h
Local LSX4701E	4.7	Enlist	40	4	0	5.0 bcd	7.0 bc	90.7 a-h
MorSoy 4706 RXT	4.7	Xtend	40	0	0	0.7 de	1.3 bc	95.5 a-g
Progeny P4710 E3	4.7	E3	0	0	4	0.3 de	1.0 bc	68.1 a-i
Progeny P4775 E3S	4.7	E3/STS	18	5	0	3.7 b-e	1.3 bc	55.1 b-i
Progeny P4799RXS	4.7	Xtend/STS	40	0	4	0.3 de	0.7 bc	73.3 a-i
R15-2422	4.7	Conv.	20	0	0	0.0 e	1.7 bc	62.5 b-i
USG 7470XT	4.7	Xtend	20	0	27	0.3 de	1.0 bc	88.3 a-h
USG 7478XTS	4.7	Xtend/STS	30	0	7	0.0 e	4.0 bc	76.6 a-i

† Phom. = *Phomopsis* spp.; PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Foliar disease severity ratings and yield columns followed by the same letter are not statistically significant at $P = 0.10$ as determined by Tukey's honestly significant difference test.

§ Yield (bu./ac) adjusted to 13%.

Table 5. Soybean maturity group (MG) 4.8 percent pods (out of 10) and seed (out of 25) that when plated produced colonies of known pathogens, and foliar disease severity ratings based on a scale, where 0 = no disease, and 100 = dead plants.

			Pod	Seed		Foliar		
Variety	MG	Tech	Phom.†	Phom.†	PSS†	TS†	CLB†	Yield§
AgriGold G4815RX	4.8	Xtend	30	0	0	2.0 cde‡	1.0 bc	47.7 d-i
AGS GS48X19	4.8	Xtend	10	0	20	0.7 de	0.7 bc	81.9 a-h
Armor X48D25	4.8	Xtend	30	7	17	1.3 de	0.7 bc	69.2 a-i
Armor X48D88	4.8	Xtend	50	0	5	2.7 cde	7.0 bc	69.6 a-1
Asgrow AG48X9	4.8	Xtend	20	0	10	1.3 de	1.0 bc	61.1 b-i
Credenz CZ4820LL	4.8	LL	56	20	0	8.3 ab	7.3 bc	75.2 a-i
Credenz CZ4869X	4.8	Xtend	80	0	12	1.0 de	1.3 bc	48.2 d-i
Delta Grow 48E10	4.8	E3	33	0	0	2.0 cde	3.7 bc	46.4 e-i
Delta Grow 48E39	4.8	E3	20	0	0	2.3 cde	2.3 bc	56.5 b-i
Delta Grow 48E49	4.8	E3/STS	33	0	0	5.0 bcd	1.3 bc	94.0 a-g
Delta Grow 48X45	4.8	Xtend	40	0	0	1.0 de	1.0 bc	40.5 ghi
DM 48E01	4.8	Enlist	50	0	0	1.0 de	11.7 bc	59.8 b-i
Dyna-Gro S48XT56	4.8	Xtend	20	0	7	1.3 de	1.0 bc	67.7 a-i
Eagle Seed ES4840RYX	4.8	Xtend	50	0	0	2.3 cde	4.0 bc	63.1 a-i
Go Soy 481E19	4.8	E3	20	0	4	0.3 de	1.7 bc	54.2 b-i
Go Soy 482E18	4.8	E3	50	0	0	4.0 b-e	15.0 abc	75.4 a-i
Go Soy 48C17S	4.8	Conv.	60	0	5	0.0 e	1.7 bc	24.8 i
Hefty H48E0	4.8	E3	30	0	4	2.3 cde	2.3 bc	107.4 ab
Hefty H48E9	4.8	E3	50	16	4	2.3 cde	15.0 bc	86.4 a-h
LGC4845RX	4.8	Xtend	11	0	4	1.0 de	2.3 bc	90.2 a-h
LGS4899RX	4.8	Xtend	30	0	4	3.3 cde	1.0 bc	58.3 b-i
Local LS4889XS	4.8	Xtend	30	0	4	1.0 de	0.3 c	79.2 a-i
Local LSX4801X	4.8	Xtend	0	0	0	0.7 de	1.3 bc	63.0 b-i
MorSoy 4846 RXT	4.8	Xtend	20	0	12	2.3 cde	2.3 bc	62.7 b-i
Pioneer P48A60X	4.8	Xtend	55	0	4	2.3 cde	0.3 c	67.5 a-i
Pioneer P48A99L	4.8	LL	60	0	8	10.0 a	8.7 bc	71.6 a-i
Progeny P4816RX	4.8	Xtend	10	0	8	1.0 de	1.0 bc	66.8 a-i
Progeny P4821RX	4.8	Xtend	20	0	0	2.0 cde	1.0 bc	61.7 b-i
Progeny P4833 E3	4.8	E3	0	0	0	3.7 b-e	4.0 bc	86.3 a-h
Progeny P4851RX	4.8	Xtend	30	0	16	1.0 de	0.7 bc	79.6 a-i
Progeny P4891 E3	4.8	E3	20	12	16	0.7 de	4.0 bc	94.0 a-g
S14-15138R	4.8	RR1/STS	20	0	10	0.7 de	1.0 bc	82.0 a-h
USG 7480ET	4.8	Enlist	30	0	0	3.7 b-e	10.3 bc	70.1 a-i
USG 7480XT	4.8	Xtend	30	0	0	1.0 de	1.0 bc	61.8 b-i
USG 7489XT	4.8	Xtend	0	0	12	1.0 de	0.7 bc	71.2 a-i

† Phom. = *Phomopsis* spp.; PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Foliar disease severity ratings and yield columns followed by the same letter are not statistically significant at *P* = 0.10 as determined by Tukey's honestly significant difference test.

§ Yield (bu./ac) adjusted to 13%.

Table 6. Soybean maturity groups (MG) 4.9–5.1 percent pods (out of 10) and seed (out of 25) that when plated produced colonies of known pathogens, and foliar disease severity ratings based on a scale, where 0 = no disease, and 100 = dead plants.

			Pod	Seed		Foliar		
Variety	MG	Tech	Phom.†	Phom. †	PSS†	TS†	CLB†	Yield§
AGS GS49X19	4.9	Xtend	10	4	8	1.0 de‡	7.0 bc	74.6 a-i
Armor X49D67	4.9	Xtend	30	0	4	1.3 de	1.3 bc	62.3 b-i
Asgrow AG49X9	4.9	Xtend	20	0	8	2.3 cde	4.0 bc	83.6 a-h
Credenz CZ4918LL	4.9	LL	70	7	4	4.0 b-d	3.7 bc	66.8 a-i
Credenz CZ4938LL	4.9	LL	10	5	0	0.3 de	3.7 bc	60.3 b-i
Credenz CZ4979X	4.9	Xtend	40	0	16	1.3 de	2.3 bc	63.6 a-i
Delta Grow 4977LL/STS	4.9	LL/STS	30	0	4	6.7 abc	8.3 bc	73.2 a-i
Delta Grow 49E29	4.9	E3	20	0	4	0.0 e	6.7 bc	75.9 a-i
Delta Grow 49X15	4.9	Xtend	20	0	4	1.0 de	1.0 bc	76.8 a-i
Dyna-Gro S49EN79	4.9	Enlist	30	0	8	3.7 b-e	4.3 bc	61.2 b-i
Dyna-Gro S49XT39	4.9	Enlist	40	0	12	1.3 de	4.3 bc	82.9 a-h
Dyna-Gro S49XT70	4.9	Xtend	10	0	5	1.0 de	1.0 bc	93.2 a-g
Go Soy 49G16	4.9	RR1	50	0	8	0.7 de	1.7 bc	91.7 a-g
LGS4931RX	4.9	Xtend	10	0	13	2.7 cde	4.7 bc	84.2 a-h
Local LSX4901X	4.9	Xtend	0	0	0	1.0 de	1.0 bc	90.3 a-h
Mission A4950X	4.9	Xtend	40	0	4	0.7 de	2.7 bc	87.5 a-h
NK S49-F5X	4.9	Xtend	20	0	0	1.0 de	0.7 bc	80.2 a-i
Petrus Seed 4916GT	4.9	RR1	56	0	12	0.3 de	1.0 bc	72.6 a-i
Progeny P4999RX	4.9	Xtend	20	0	0	0.7 de	1.3 bc	81.7 a-h
REV 4927X	4.9	Xtend	30	3	7	0.7 de	0.7 bc	85.5 a-h
REV 4940X	4.9	Xtend	30	0	7	4.7 b-e	1.3 bc	89.5 a-h
USG 7496XTS	4.9	Xtend/STS	10	0	20	1.3 de	1.7 bc	88.9 a-h
AgriGold G5000RX	5.0	Xtend	0	0	17	0.7 de	1.3 bc	62.3 b-i
Go Soy 50G17	5.0	RR1	50	0	5	0.3 de	1.0 bc	69.3 a-i
Local LS5087X	5.0	Xtend	10	0	4	0.7 de	1.0 bc	69.5 a-i
Progeny P5016RXS	5.0	Xtend/STS	10	0	8	0.7 de	3.7 bc	53.4 b-i
Armor 51-D77	5.1	Xtend	30	0	4	1.0 de	1.7 bc	66.1 a-i
Credenz CZ5150LL	5.1	LL	0	0	8	1.0 de	4.0 bc	81.2 a-h
Eagle Seed ES5155RYX	5.1	Xtend	20	9	22	4.0 b-e	1.3 bc	73.3 a-i
Go Soy 512E18	5.1	E3	20	0	4	0.0 e	2.3 bc	87.1 a-h
Hefty H51E9	5.1	E3	30	0	18	0.0 e	2.3 bc	71.1 a-i
Progeny P5170RX	5.1	Xtend	30	0	4	1.3 de	1.3 bc	73.3 a-i
R15-1587	5.1	Conv.	50	0	0	0.0 e	1.3 bc	56.4 b-i
R16-2546C	5.1	Conv.	60	0	8	0.0 e	0.7 bc	59.1 b-i
R16-39	5.1	Conv.	10	0	0	0.0 e	1.0 bc	55.4 b-i

† Phom. = *Phomopsis* spp.; PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Foliar disease severity ratings and yield columns followed by the same letter are not statistically significant at $P = 0.10$ as determined by Tukey's honestly significant difference test.

§ Yield (bu./ac) adjusted to 13%.

Table 7. Soybean maturity groups (MG) 5.2–5.6 percent pods (out of 10) and seed (out of 25) that when plated produced colonies of known pathogens, and foliar disease severity ratings based on a scale, where 0 = no disease, and 100 = dead plants.

			Pod	Seed		Foliar		
Variety	MG	Tech	Phom.†	Phom.†	PSS†	TS†	CLB†	Yield§
Armor 52-D71	5.2	Xtend	20	0	24	1.0 de‡	1.0 bc	75.1 a-i
Asgrow AG52X9	5.2	Xtend	10	0	0	1.3 de	1.0 bc	72.1 a-i
Credenz CZ5299X	5.2	Xtend	20	0	0	1.3 de	1.3 bc	78.0 a-i
Delta Grow 52E22	5.2	E3	0	0	24	0.0 e	1.0 bc	64.5 a-i
Delta Grow 52X05	5.2	Xtend/STS	10	0	3	1.0 de	2.3 bc	77.5 a-i
Dyna-Gro S52XS39	5.2	Xtend/STS	20	0	0	1.3 de	2.3 bc	83.9 a-h
Progeny P5211 E3	5.2	E3	20	0	7	0.0 e	2.3 bc	64.4 a-i
Progeny P5252RX	5.2	Xtend	0	3	3	4.3 b-e	1.3 bc	85.2 a-h
R16-2547	5.2	Conv.	0	0	0	0.0 e	2.0 bc	53.9 b-i
Asgrow AG53X0	5.3	Xtend	10	0	8	2.7 cde	1.3 bc	62.0 b-i
Local LS5386X	5.3	Xtend	10	0	11	1.3 de	5.7 bc	83.2 a-h
Progeny P5335RX	5.3	Xtend	30	0	0	1.0 de	1.0 bc	70.2 a-i
R13-818	5.3	Conv.	44	0	0	0.0 e	2.0 bc	56.7 b-i
Delta Grow 54X25	5.4	Xtend	30	0	4	2.7 cde	4.0 bc	80.4 a-i
R13-13997	5.4	Conv.	20	0	10	0.0 e	1.3 bc	79.0 a-i
R13-14635RR	5.4	RR1	10	0	8	0.7 de	2.7 bc	82.8 a-h
R14-1422	5.4	Conv.	20	5	0	0.0 e	1.7 bc	74.5 a-i
R16-1445	5.4	Conv	40	0	0	0.0 e	1.3 bc	85.2 a-h
R16-378	5.4	Conv.	30	0	4	0.0 e	2.0 bc	80.5 a-i
Armor 55-D57	5.5	Xtend	30	0	0	1.0 de	1.3 bc	54.1 b-i
Delta Grow 5585RR2	5.5	RR2	20	0	10	0.3 de	1.3 bc	75.7 a-i
Local LS5588X	5.5	Xtend	20	0	7	1.0 de	1.3 bc	56.3 b-i
Progeny P5554RX	5.5	Xtend	89	5	0	1.3 de	2.3 bc	73.8 a-i
Dyna-Gro S56XT99	5.6	Xtend	10	0	0	1.0 de	12.0 bc	61.6 b-i
Progeny P5688RX	5.6	Xtend	40	0	10	1.0 de	2.3 bc	84.4 a-h

† Phom. = *Phomopsis* spp.; PSS = Purple seed stain (*Cercospora* spp.); TS = Target Spot (*Corynespora cassiicola*); CLB = Cercospora leaf blight (*Cercospora* spp.).

‡ Foliar disease severity ratings and yield columns followed by the same letter are not statistically significant at *P* = 0.10 as determined by Tukey's honestly significant difference test.

§ Yield (bu./ac) adjusted to 13%.