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VIRGINIA STATE

Soybean Rust Incidence and the Response of Soybeans to Fungicides in 2009

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2009 Growing Season

Most fields planted to soybeans in 2009 showed good emergence after planting in May and June. Rainfall in June, July, August, and October was 0.81, 0.93, 2.33 and 1.91 in. below normal, and rainfall in May and September was 0.89 and 3.2 in. above normal. Rainfall during the period totaled 25.65 in. or 1.89 in. below normal. Average minimum air temperatures were normal (±1°F) in July, 2°F above normal in June and September, 3°F above normal in August, and 4°F below normal in May and October. Maximum air temperatures were near normal in June and September, 3°F above normal in July, and 4°F above normal in May, August and October according to records at the Tidewater AREC in Suffolk. Brief periods of drought stress occurred in June and August. Harvesting began in October and was delayed by frequent rainfall in November and December. Several areas were still harvesting soybeans in January 2010. The first killing frost in the Tidewater area was on 31 October when night-time temperatures ranged in the mid 20's to 30 ºF. Soybean yields in 2009 averaged near 38 bu/A on 570,000 harvested acres according to reports by the Virginia Department of Agriculture.

Soybean Rust in 2009

The first report of soybean rust in 2009 was confirmed on kudzu in early January in Lee County, Florida (Fig. 1A). Temperatures in these areas were generally above freezing which allowed kudzu to maintain foliage on which the fungus survived throughout the winter and sporulate in the spring before soybean planting. By 15 July, reports of soybean rust in the U.S. included scattered counties along the Gulf Coast in Florida, Georgia, Louisiana, and Texas (Fig 1A). Occurrences through 15 September included several counties in Louisiana, Arkansas, Alabama and Florida (Fig. 1B). The disease was also appearing in areas as far north as Tennessee and Kentucky and as far east as a few counties in South Carolina. By 1 November, soybean rust had spread across North Carolina and Southeastern Virginia, and into counties of Texas, Oklahoma, Arkansas, Missouri, Illinois, and Indiana (Fig 1C).

The first finding of soybean rust in Virginia was on leaflets collected on 18 September from a fungicide trial at the Tidewater AREC in Suffolk. Further sampling in Virginia until the first killing frost on 30 October detected the disease in a total of fifteen counties (Brunswick, Chesapeake, Dinwiddie, Gloucester, Greensville, Isle of Wight, Matthews, Middlesex, Northumberland, Prince George, Southampton, Suffolk, Surry, Sussex, and Virginia Beach). In 2009, soybean rust was found in 16 states and 576 counties in the United States, and in three states and nine municipalities in Mexico.

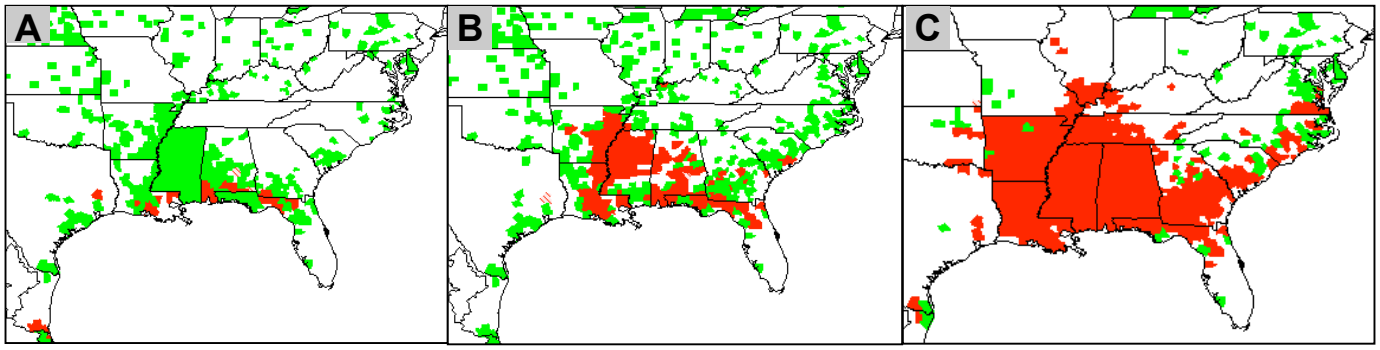

Figure 1. Counties with soybean rust on 15 July, 15 September, and 15 November 2009.

DISEASE INCIDENCE AND YIELD LOSSES IN 2009

Soybean cyst nematode was believed to cause the greatest yield losses (2.5%) because of its widespread incidence which ranges from southern-most counties of eastern Virginia to as far north as Westmoreland County in northern Virginia (Table 1). Losses of yield to southern root-knot nematode ranked second (1.5%) and showed a similar range of incidence. Other nematodes were estimated to cause minimal losses (0.5%) and included sting, common lance, lesion and stubby root nematodes. Leaf spot diseases (brown spot, frogeye leaf spot, and anthracnose) showed low to moderate incidence through September. Cercospora blight was the most prevalent and damaging to yield among foliar diseases. Overall, the reduction of yields due to soybean diseases in Virginia was estimated to be a total of 7.14% of yield potential. Based on the estimated total production of 21.66 million bushels in Virginia, the total loss of yield to diseases was 1.67 million bushels which had a value of 14.41 million dollars. This figure was based on an average value of $8.65/bu in 2009.

Table 1. Estimated loss of yield in Virginia as a result of soybean diseases in 2009.

Disease	Causal agent(s)	Percent loss
Seedling diseases	*Rhizoctonia spp., Pythium spp., etc.*	0.5
Cercospora blight	*Cercospora kikuchii*	0.6
Purple seed stain	*Cercospora kikuchii*	0.2
Downy mildew	*Peronospora manshurica*	0.0
Anthracnose	*Colletotrichum truncatum*	0.3
Brown spot	*Septoria glycines*	0.2
Pod & stem blight	*Diaporthe phaseolorum* var. *sojae*	0.3
Soybean rust	*Phakopsora pachyrhizi*	0.0
Frogeye leaf spot	*Cercospora sojina*	0.0
Southern blight	*Sclerotium rolfsii*	0.1
Brown stem rot	*Phialophora gregata*	0.2
Charcoal rot	*Macrophomina phaseolina*	0.01
Stem canker	*Diaporthe phaseolorum* var. *caulivora*	0.01
Sudden death syndrome	*Fusarium solani* f.sp. *glycines*	0.01
Root & lower stem rot	*Rhizoctonia* spp.	0.001
Red crown rot	*Cylindrocladium parasiticum*	0.1
Phytophthora root & stem rot	*Phytophthora megasperma* f.sp. *glycinea*	0.001
Sclerotinia stem rot	*Sclerotinia sclerotiorum* and *S. minor*	0.0
Viruses	SMV, PMV, BPMV, etc.	0.1
Bacterial pustule	*Xanthomonas phaseoli*	0.0
Bacterial blight	*Pseudomonas glycinea*	0.01
Soybean cyst nematode	*Heterodera glycines*	2.5
Southern root knot nematode	*Meloidogyne incognita*	1.5
Other nematodes	---various---	0.5
Total loss (%)		**7.142***

* The loss estimate equals 1.67 million bushels based on production of 21.66 million bushels in 2009. At a value of $8.65/bu, the loss would be $14.41 million in farm revenue.

SENTINEL PLOTS AND COMMERCIAL FIELDS SAMPLED FOR SOYBEAN RUST IN 2009.

Five regional sentinel plots were sampled from flowering up to beginning senescence for early detection of soybean rust in 2009 (Table 2). A total of 61 samples of leaflets were processed from sentinel plots by microscopic examination; 26 at the Tidewater AREC, 19 at the Eastern Shore AREC, and 16 at the PPWS Department in Blacksburg. Sentinel plots were located at the Tidewater AREC in Suffolk, Northern Piedmont AREC at Orange, Eastern Virginia AREC at Warsaw, Eastern Shore AREC at Painter, and in Northampton County. Leaf samples were collected and either shipped overnight by site cooperators or hand carried to the Tidewater AREC, Eastern Shore AREC, or the Virginia Tech - PPWS Department for processing. Upon receipt, the samples were placed in moist chambers at room temperature (70 - 77° F), incubated for 3 to 5 days at near 100% RH, and examined under a dissecting microscope for pustules of soybean rust (Fig. 2A).

Microscopic examinations of samples from sentinel plots and commercial fields resulted in detection of soybean rust on leaflets from the sentinel plot in Suffolk on 18 September. Photographs of pustules on leaflets illustrated the small size of lesions and the need for microscopes to find and identify rust pustules (uredinia) and spores for disease detection (Fig 2B, C, D).

Nineteen samples were processed from five fungicide research trials at the Tidewater AREC. Each composite sample consisted of 100 leaflets from the five replications of plots without fungicide treatment. Five of these 19 samples collected were positive for soybean rust.

A total of 271 samples were processed from 34 counties in 2009 (Table 2). Included were 61 samples from sentinel plots, 19 from research plots, and 191 from commercial fields. The Tidewater AREC processed 209 samples, the Plant Disease Clinic (Blacksburg) processed 16 samples, and the Eastern Shore AREC processed 46 samples. Results of monitoring for soybean rust were posted on the USDA Soybean Rust Website (http://sbr.ipmpipe.org/cgi-bin/sbr/public.cgi) along with recommendations for fungicide application if needed for disease control.

Table 2. Samples processed for soybean rust in 2009.

	June		July		August		September		October		Total	Total
County	-	+	-	+	-	+	-	+	-	+	**positive**	**samples**
Sentinel plots												
Accomack	0	0	0	0	3	0	3	0	4	0	0	10
Northampton	0	0	2	0	3	0	3	0	1	0	0	9
Orange	0	0	0	0	0	0	5	0	1	0	0	6
Richmond	0	0	2	0	3	0	4	0	1	0	0	10
Suffolk	1	0	5	0	10	0	9	0	0	1	1	26
Total	1	0	9	0	19	0	24	0	7	1	**1**	**61**
Research plots												
Suffolk	0	0	0	0	10	0	4	1	0	4	**5**	**19**
Commercial Fields												
Accomack*	0	0	0	0	1	0	4	0	6	0	0	11
Brunswick*	0	0	4	0	6	0	4	0	2	1	1	17
Caroline	0	0	0	0	0	0	2	0	0	0	0	2
Charles City	0	0	0	0	1	0	1	0	3	0	0	5
Chesapeake*	0	0	2	0	10	0	8	0	3	3	3	26
Culpeper	0	0	0	0	0	0	1	0	0	0	0	1
Dinwiddie	0	0	0	0	0	0	0	0	0	1	1	1
Essex	0	0	0	0	0	0	1	0	6	0	0	7
Fauquier	0	0	0	0	1	0	1	0	0	0	0	2
Gloucester	0	0	0	0	0	0	1	0	0	1	1	2
Goochland	0	0	0	0	1	0	1	0	0	0	0	2
Greensville*	0	0	9	0	12	0	5	0	3	2	2	31
Hanover	0	0	0	0	0	0	1	0	0	0	0	1
Henrico	0	0	0	0	1	0	2	0	0	0	0	3
Isle of Wight	0	0	0	0	0	0	1	0	4	1	1	6
King George	0	0	0	0	0	0	1	0	0	0	0	1
King William	0	0	0	0	0	0	1	0	0	0	0	1
Lancaster	0	0	0	0	0	0	0	0	2	0	0	2
Matthews	0	0	0	0	0	0	0	0	0	1	1	1
Mecklenburg*	0	0	4	0	6	0	2	0	2	0	0	14
Middlesex	0	0	0	0	0	0	1	0	0	2	2	3
Northampton	0	0	0	0	2	0	5	0	9	0	0	16
New Kent	0	0	0	0	0	0	0	0	2	0	0	2
Northumberland	0	0	0	0	0	0	1	0	1	1	1	3
Prince George	0	0	1	0	0	0	1	0	2	2	2	6
Southampton	0	0	0	0	0	0	1	0	5	2	2	8
Spotsylvania	0	0	0	0	0	0	1	0	0	0	0	1
Surry	0	0	0	0	0	0	1	0	3	1	1	5
Sussex	0	0	0	0	0	0	5	0	2	1	1	8
Virginia Beach	0	0	0	0	0	0	0	0	0	2	2	2
Westmoreland	0	0	0	0	0	0	1	0	0	0	0	1
Total	0	0	20	0	41	0	54	0	55	21	**21**	**191**
Grand total	**1**	**0**	**29**	**0**	**70**	**0**	**82**	**1**	**62**	**26**	**27**	**271**

*** Counties with mobile sentinel plots having one or more fields sampled weekly after flowering until beginning maturity. Column headings: "–" rust not detected; "+" rust detected and confirmed by immune-strip test.**

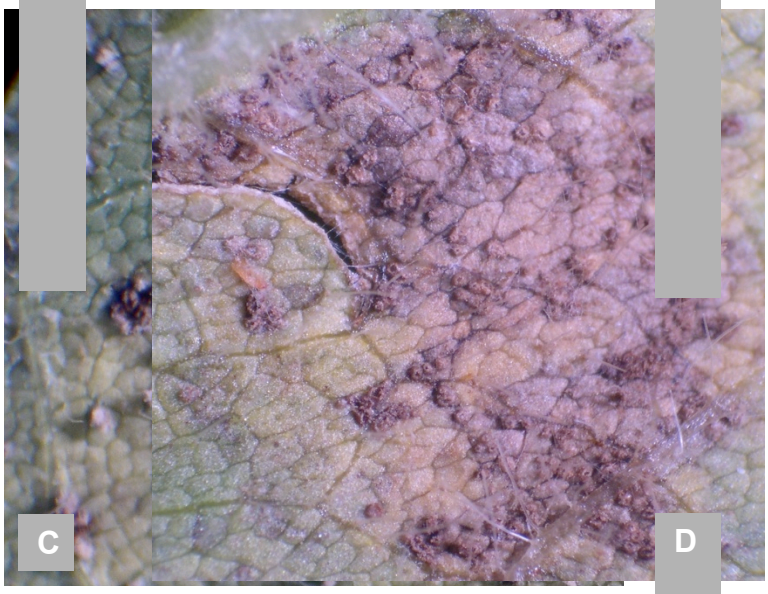

Figure 2. A) Leaflets were collected weekly and incubated for 3 to 5 days in 100% relative humidity to induce development of pustules and spore production, B) Young, white spores produced by pustules on lower surface of leaflets, C) Mixture of young and old pustules on lower surface of leaf; and D) old pustules that are no longer producing spores.

INCIDENCE OF SOYBEAN RUST IN THE U.S. IN 2009.

Soybean rust was detected in a total of 16 states in the U.S. in 2009 (Fig. 3). According to reports in previous years this number was about the same as in period from 2006 to 2008. The highest number of states reporting soybean rust was in 2007 when disease incidence spread northward into mid-western and North Central states.

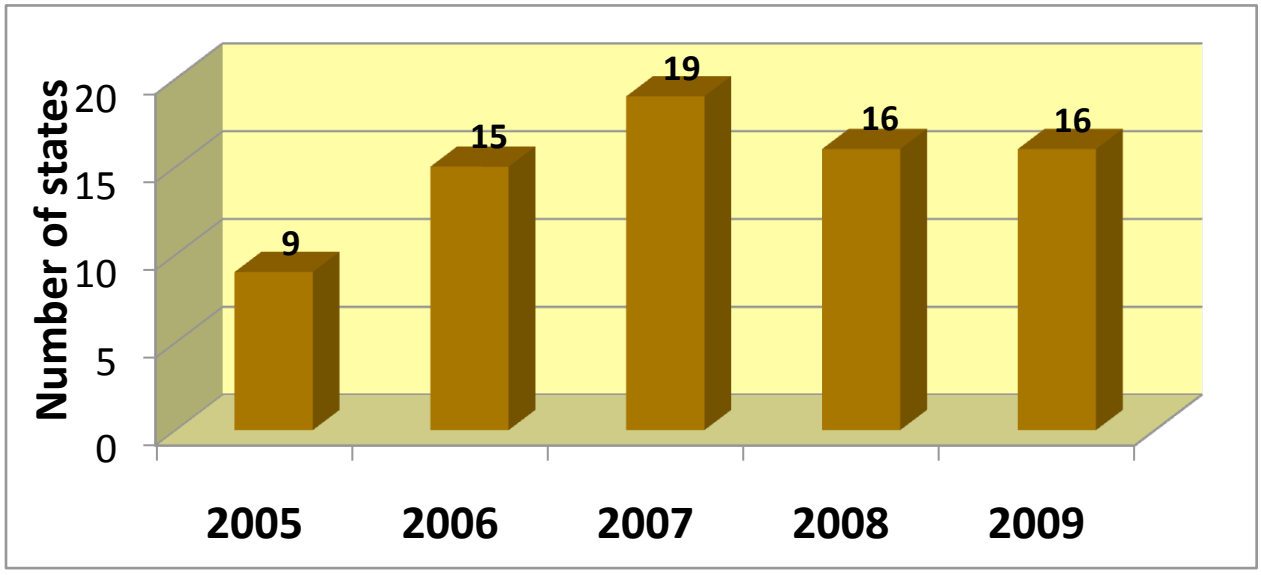

Figure 3. States Reporting Incidence of Soybean Rust in the U.S.

The number of counties reporting soybean rust in the U.S. has continued to increase each year since its first occurrence in 2005 (Fig. 4), whereas the number of states reporting the disease was highest in 2007. These trends suggest that the disease has not reached its full potential for disease spread and intensity in the U.S.

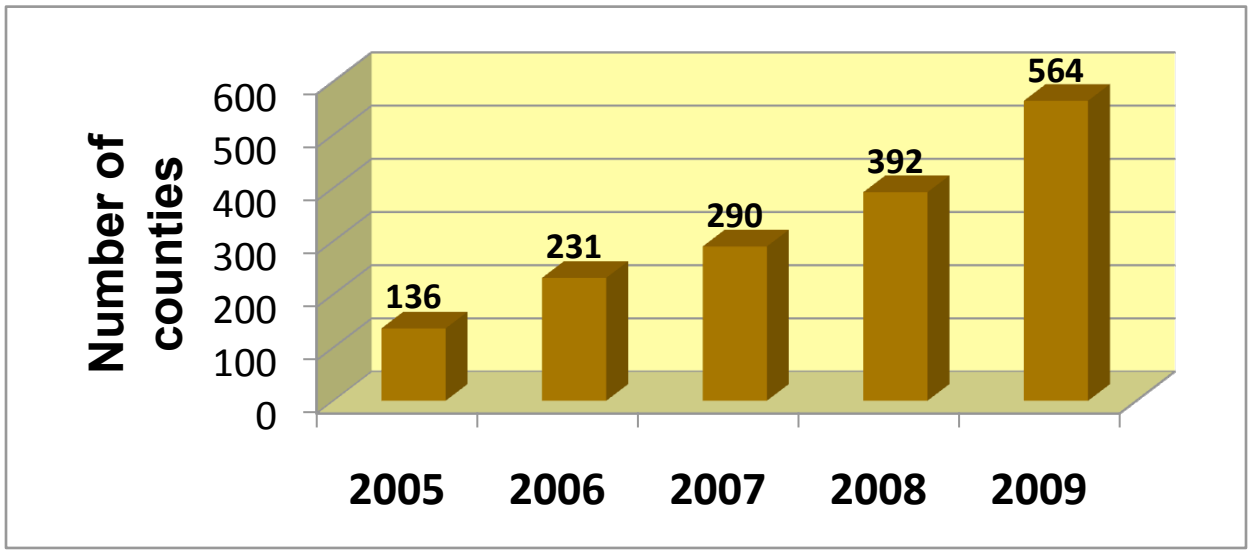

Figure 4. Number of Counties with Incidence of Soybean Rust in U.S.

INCIDENCE OF SOYBEAN RUST IN VIRGINIA IN 2009.

Soybean rust was confirmed in 15 counties in Virginia in 2009. The first occurrence was in the City of Suffolk on leaflet samples collected on 18 September. As in previous years, SBR was detected first in the Tidewater Area of Virginia and in counties on the North Carolina border. Subsequent sampling up to 1 November detected SBR throughout the Tidewater Area and north into counties bordering tributaries of the Chesapeake Bay as far north as Northumberland County (Fig 5).

Microscopic examinations of samples from sentinel plots and commercial fields resulted in detection of soybean rust on leaflets from Suffolk, Chesapeake, Virginia Beach, and the counties of Southampton, Greensville, Brunswick, Dinwiddie, Sussex, Isle of Wight, Surry, Prince George, Gloucester, Mathews, Middlesex, and Northumberland. Confirmation of soybean rust was made in all positive samples by an ELISA test.

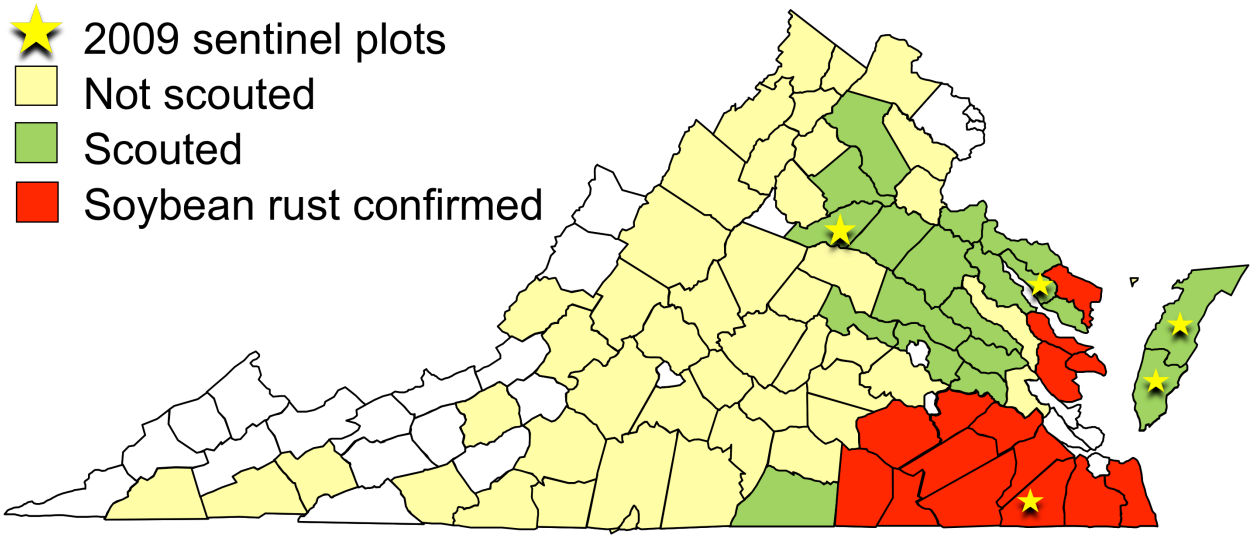

Figure 5. Incidence of Soybean Rust in Virginia in 2009.

AIR TEMPERATURES AND RAINFALL AT SENTINEL PLOTS AND FUNGICIDE TRIALS IN 2009.

Near normal rainfall occurred across much of eastern Virginia in 2009 and at locations of sentinel plots and fungicide trials, except for the Eastern Virginia AREC at Warsaw (Table 3). Periods of dry weather stress and high temperatures in August at the Tidewater AREC and Eastern Shore AREC were generally short term. More significant were the periods of dry weather stress and high temperatures during June, July and September in suppression of yield. Overall, rainfall totals (May thru October) were below normal by -1.89 in. at the Tidewater AREC, -1.48 in. at the Eastern Shore AREC, and -8.28 in. at the Eastern Virginia AREC. No tropical storms or hurricanes passed over these areas in 2009. Weather data in Suffolk was obtained from the Peanut/Cotton InfoNet (http://www.ipm.vt.edu/infonet). The Virginia Agricultural Experiment Station Mesonet (http://www.ahnrit.vt.edu/research/weather.html) collected weather data at the Eastern Virginia AREC at Warsaw, and the Eastern Shore AREC at Painter. Normal rainfall records were obtained from annual reports by the Virginia Agricultural Statistics Service.

Table 3. Weather summary for locations of fungicide trials in 2009.

Location	Month	2009 Air Temperatures (F) Avg.	Max	Min.		Rainfall (in.) 2009	Normal
Tidewater AREC, Suffolk	MAY	69.0	80.2	58.6		4.60	3.71
	JUN	75.3	87.2	65.1		3.40	4.21
	JUL	76.5	88.8	66.0		4.86	5.79
	AUG	78.1	89.3	70.1		3.38	5.71
	SEP	69.2	80.4	60.1		7.69	4.49
	OCT	60.0	71.4	49.4		1.72	3.63
	Mean	**71.4**	**82.9**	**61.5**	**Total**	**25.65**	**27.54**
Eastern Shore AREC, Painter	MAY	65.5	74.2	57.3		1.52	3.41
	JUN	72.4	80.5	64.7		4.54	3.66
	JUL	74.9	82.8	67.0		4.49	4.64
	AUG	77.3	85.3	70.0		3.60	4.23
	SEP	68.3	75.6	60.3		5.21	3.66
	OCT	60.1	67.4	50.0		3.06	3.49
	Mean	**69.8**	**77.7**	**61.6**	**Total**	**22.42**	**23.09**
Eastern Virginia AREC, Warsaw	MAY	65.4	75.0	56.2		1.43	4.51
	JUN	72.4	82.1	63.8		2.25	3.66
	JUL	74.1	84.3	64.9		3.24	4.64
	AUG	76.5	86.2	68.0		5.32	4.23
	SEP	66.9	76.5	57.9		2.28	3.66
	OCT	57.5	66.8	47.8		1.39	3.49
	Mean	**68.8**	**78.5**	**59.8**	**Total**	**15.91**	**24.19**

The optimum temperature range for leaf infection and development of soybean rust is 68 to 77º F. In addition to favorable temperature, the fungus requires moisture (leaf wetness or ≥ 95% RH) for spore germination and infection of leaflets. In an attempt to determine when conditions were favorable in 2009, the number of days was tabulated with daily average temperatures between 60 to 77º F and short-term rainfall totals ≥0.5 in. during the 5 days, ≥1 in. during 10 days, or periods of relative humidity ≥95% for ≥12 hrs/day. According to data collected at the Tidewater AREC, favorable conditions for infection were recorded for 16 days in May, 9 days in June, 5 days in July, 11 days in August, 24 days in September, and 7 days in October. The longest periods of consecutive days favorable for infection occurred for 6 days in May (May 21 to May 26), 7 days in June (Jun 4 to Jun 10), 4 days in July (Jul 18 to Jul 21), 4 days in August (Aug 13 to Aug 16), and 17 days in September (Sep 7 to Sep 23).

FUNGICIDE TRIALS:

Plots were 30-ft long and 6- to 12-ft wide. Row spacing was 18- to 30-in. depending upon location. A randomized complete block design was used with four or five replications of treatments. Fungicides were applied with either a CO_2-pressurized backpack sprayer in a 6-ft spray swath, or a Lee Spider Sprayer in a 12-ft spray swath. Both sprayers were equipped with 8002VS or Tee Jet 11015 nozzles spaced 18- in. apart and delivered a volume of 16.5 to 20 gal/A at 30 to 42 psi depending upon speed. Yield data were collected from the center, 4.75 to 6-ft-wide by 30-ft-long section in each plot with a self-propelled, small-plot combine.

RESULTS

Tidewater AREC, Suffolk, Trial 109 (Phipps). The field site was planted to Pioneer 5650RR on 28 May. The soil type was Rains fine sandy loam that was planted to cotton in 2006 and 2008 and peanut in 2007. Plots were eight, 30-ft rows spaced 18-in. apart. Roundup Ultra Max at 22 fl oz + First Rate 84WG at 0.3 oz/A were applied on 18 June for weed control, and Baythroid XL at 3 fl oz/A was applied on 18 August for insect control. All fungicide treatments were applied with a Lee Spider sprayer. Several treatments were applied only once at growth stage R_3 (Aug 20). Domark was applied at R_3 and 21 days later, and Topguard was applied either once or twice at R_3 and 21 days later. If soybean rust would have been detected within 100 mi. of the trial location prior to R_3 (20 August), the initial treatment would have been applied upon detection but not prior to R_1 (beginning flowering). Plots were harvested on 5 January 2010 following heavy rainfall in November and December.

Soybean rust was not detected in samples of leaflets from plots without fungicide treatment(s) on 3 August, 18 August, or 18 September (Table 4). None of the treatments caused symptoms of chemical injury or increased yield significantly. Brown spot and Cercospora blight were the only foliar diseases that posed a risk for yield loss (Table 5). All treatments reduced disease incidence significantly, but treatment with Stratego + Gem, USF0731, Stratego + Leverage, Headline, Headline + Domark, Headline + Topguard and Headline + Folicur were most effective against brown spot and Cercospora blight. Yields were increased significantly by two applications of Topguard at 7 fl oz/A (20 Aug, 11 Sep), one applications of Stratego 10 fl oz + Proline 1 fl oz/A (20 Aug), one application of USF0731 5.01 fl oz/A (20 Aug), and one application of Headline 6 fl oz/A (20 Aug). All treatments delayed senescence of foliage when pods were approaching maturity (12 Oct). Seed weights and numbers of seed with evidence of disease were not affected significantly by any treatment.

Table 4. Disease incidence in untreated plots, Soyrust109.*

Rating date	Downy mildew	Brown spot	Cercospora blight	Anthracnose	Target spot
No. of diseased leaflets					
3 Aug.....	89	20	0	0	12
18 Aug.....	83	0	16	21	0
Diseased leaflets-% leaf area					
18 Sep.....	85-8	0-0	65-20	0-0	0-0

* A sample of 100 leaflets was collected on the specified date, incubated in a moist chamber and diseases were identified using a dissecting microscope.

Table 5. Soybean fungicide trial 109, Suffolk.

Treatment, rate/A and application date	% leaf area with disease (12 Oct)[1]		% sense-cence[2] (12 Oct)	Yield[3] (bu/A)	Wt./100 seed (oz)	% seed disease[4]	
	Brown spot	Cercos-pora blight				anthrac-nose	*Phomop-sis* seed decay
Untreated	7.8 a	11.0 a	21.6 a	56.9 cd	.5408	3.4	2.6
Topguard 1.04SC 7 fl oz (8/20)	6.2 b	6.6 b	13.0 b	64.1 bc	.5278	3.0	1.6
Topguard 1.04SC 7 fl oz (8/20, 9/17)	4.4 de	4.2 c-e	9.6 c	67.0 ab	.5350	2.4	1.4
Topguard 1.04SC 14 fl oz (8/20)	5.0 cd	6.4 bc	12.8 bc	55.3 d	.5333	3.0	2.0
Domark 1.9ME 5 fl oz (8/20, 9/11)	5.8 bc	6.2 b-d	16.0 b	60.8 b-d	.5553	2.6	2.0
Stratego 250EC 10 fl oz + Gem 500SC 1 fl oz (8/20)	3.8 ef	4.0 d-f	5.0 d	64.1 bc	.5480	2.6	1.4
Stratego 250EC 10 fl oz + Proline 480SC 1 fl oz (8/20)	4.6 de	3.0 ef	5.8 d	75.1 a	.5274	2.2	1.2
USF0731 500SC 5.01 fl oz (8/20)	3.2 fg	2.6 ef	5.4 d	67.4 ab	.5400	2.4	0.8
Stratego 250EC 10 fl oz + Leverage 2.7SE 3.8 fl oz (8/20)	3.2 fg	3.6 ef	5.6 d	65.3 bc	.5485	2.2	1.0
Headline 2.08EC 6 fl oz (8/20)	3.0 fg	2.6 ef	3.8 d	66.9 ab	.5531	1.8	0.8
Headline 2.08EC 4.7 fl oz + Domark 1.9ME 4 fl oz/A (8/20)	3.0 fg	2.6 ef	4.8 d	60.5 b-d	.5501	2.4	1.4
Headline 2.08EC 4.7 fl oz + Topguard 1.04SC 7 fl oz/A (8/20)	3.2 fg	2.4 ef	4.4 d	63.8 b-d	.5411	2.8	1.4
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (8/20)	2.4 g	1.8 ef	3.8 d	63.8 b-d	.5567	2.6	2.0
P(F)	.0001	.0001	.0001	.0202	.2686	.8011	.3262

[1] Foliar disease rating scale: 0=none; 100=symptoms on all leaflets.
[2] % senescence is yellowing, necrosis and defoliation.
[3] Yields are weight of soybeans with 13.5% moisture. One bushel equals 60 lb. Soybeans were harvested on 5 Jan 2010.
[4] Data are percent of 100 seed with symptoms of anthracnose or *Phomopsis* on seed. A few seed also showed symptoms of purple seed stain, but percentages were <1%.
Means followed by the same letter(s) in a column are not significantly different according to Fisher's Protected LSD (*P*=0.05). Arcsine transformation of percentage data was made in statistical analysis.

Tidewater AREC, Suffolk, Trial 209 (Phipps). This trial was designed to compare disease control by the EC (emulsifiable concentrate) and SC (soluble concentrate) formulations of Headline fungicide. The variety, planting date, cultural practices, and location of this trial were the same as Trial 109. Fungicide treatments were applied with a Lee Spider Sprayer on 20 August (R_3). Plots were harvested on 5 January 2010 following heavy rainfall in November and December.

Twelve pustules of soybean rust were detected on 1 leaflet/100 collected at the test site on 18 September (Table 6). Brown spot, Cercospora blight and percent of plant senescence were reduced significantly by all treatments on 12 October (Table 7). None of the treatments caused visible evidence of chemical injury. Disease incidence and percentages of leaf senescence were reduced significantly by all treatments. Headline EC with and without surfactant increased yield significantly, whereas yields with Headline SC with and without surfactant were similar to the untreated check.

Table 6. Disease incidence in untreated plots, Soyrust209.*

Rating date	Downy mildew	Brown spot	Cercospora blight	Soybean rust
No. of diseased leaflets				
3 Aug.....	75	30	0	0
18 Aug.....	34	2	0	0
Diseased leaflets-% leaf area				
18 Sep.....	60-2	0-0	50-10	1-0

* A sample of 100 leaflets was collected on the specified date, incubated in a moist chamber and diseases were identified using a dissecting microscope.

Table 7. Soybean fungicide trial 209, Suffolk.

Treatment and rate/A[z]	% leaf area with disease (12 Oct)[1] Brown spot	Cercospora blight	% senescence[2] (12 Oct)	Yield[3] (bu/A)	100 seed wt. (oz)	% seed disease anthrac-nose	*Phomopsis* seed decay
Untreated	6.4 a	14.0 a	21.6 a	60.0 c	.5582	3.0	3.0 a
Headline 2.08EC 6 fl oz (8/20).	2.2 b	1.4 b	3.4 b	68.7 a	.5486	4.4	1.6 b
Headline 2.08EC 6 fl oz + Coverall 3.2 fl oz/A (8/20).....	2.8 b	2.4 b	4.0 b	66.2 ab	.5435	2.8	1.2 b
Headline 2.08SC 6 fl oz (8/20)	2.2 b	2.8 b	3.4 b	60. 5 c	.5550	1.4	1.0 b
Headline 2.08SC 6 fl oz + Coverall 3.2 fl oz/A (8/20).....	2.4 b	2.2 b	4.0 b	61.9 bc	.5448	3.4	1.8 ab
P-value	.0001	.0001	.0001	.0523	.5815	.2240	.0293

[1] Foliar disease rating scale: 0=none; 100=symptoms on all leaflets.
[2] % senescence is yellowing, necrosis and defoliation.
[3] Yields are weight of soybeans with 13.5% moisture. One bushel equals 60 lb. Soybeans were harvested on 4 Jan 2010.
[4] Data are percent of 100 seed with symptoms of anthracnose or *Phomopsis* on seed. A few seed also showed symptoms of purple seed stain, but percentages were <1%.
Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (*P*=0.05). Arcsine transformation of percentage data was made in statistical analysis.

Duke farm, Trial 309, Suffolk (Phipps). The field site was planted to Pioneer 5560RR on 1 June. The soil type was Eunola loamy fine sand that was planted to corn in 2008, soybean in 2007 and peanut in 2006. Herbicide treatments were the same as in Trial 109. All treatments were applied once using a Lee Spider Sprayer at R_3 on 18 August. Plots were harvested on 9 November with a small-plot combine.

None of the treatments caused symptoms of chemical injury. Soybean rust was not detected in the trial, but incidence of downy mildew, brown spot, Cercospora blight, and anthracnose may have caused some loss of yield based on observations of disease on 3 August, 18 August, and 18 September (Table 8). All of the treatments delayed plant senescence significantly on 21 October except for Topguard 1.04SC at 7 fl oz/A (Table 9). Stratego + Proline, Quilt Xcel, Headline + Domark, or Headline + Folicur resulted in the greatest suppression of senescence. Yield was increased significantly only by Headline + Topguard. Seed weights were increased significantly only by Headline + Topguard or Headline + Folicur. Several treatments were effective in elimination of purple seed stain, but only Headline + Domark eliminated *Phomopsis* seed decay.

Table 8. Disease incidence in untreated plots, Soyrust309.*

Rating date	Downy mildew	Brown spot	Cercospora blight	Anthracnose
No. of diseased leaflets				
3 Aug.....	75	25	0	0
18 Aug.....	65	0	32	0
Diseased leaflets-% leaf area				
18 Sep.....	95-8	0-0	72-5	15-1

* A sample of 100 leaflets was collected on the specified date, incubated in a moist chamber and diseases were identified using a dissecting microscope.

Table 9. Soybean fungicide trial 309, Suffolk.

Treatment, rate/A and application date	% senses-cence[1] (21 Oct)	Yield[2] (bu/A)	Wt./100 seed[v] (oz)	% seed disease[3] purple seed stain	% seed disease[3] *Phomopsis* seed decay
Untreated.....	97.6 a	51.0 b-d	.4795 b-d	0.4 a	0.8
Topguard 1.04SC 7 fl oz (8/18)	94.6 a	46.2 d	.4665 d	0.4 a	0.2
Topsin XTR 20 fl oz (8/18)	81.0 b	56.0 a-c	.4933 a-c	0.0 b	0.4
Stratego 250EC 10 fl oz + Gem 500SC 1 fl oz (8/18).....	75.0 b-e	52.9 a-c	.4963 a-c	0.0 b	0.4
Stratego 250EC 10 fl oz + Proline 480SC 1 fl oz (8/18).....	76.0 b-d	50.4 cd	.4742 cd	0.2 ab	0.6
Quilt 14 fl oz + Crop Oil 25.4 fl oz (8/18).....	82.0 b	53.8 a-c	.4996 ab	0.0 b	0.4
Quilt Xcel 14 fl oz + Crop Oil 25.4 fl oz (8/18)	68.0 de	55.6 a-c	.4898 a-d	0.0 b	0.4
Headline 2.08EC 4.7 fl oz + Domark 1.9ME 4 fl oz/A (8/18)	78.0 bc	55.0 a-c	.4905 a-d	0.0 b	0.0
Headline 2.08EC 4.7 fl oz + Topguard 1.04SC 7 fl oz/A (8/18).....	70.0 c-e	58.9 a	.5060 a	0.0 b	0.2
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (8/18)	67.0 e	57.3 ab	.5092 a	0.0 b	0.2
P-value	.0001	.0111	.0274	.0912	.7394

[1] % senescence is yellowing, necrosis and defoliation.
[2] Yields are weight of soybeans with 13.5% moisture. One bushel equals 60 lb. Soybeans were harvested on 9 Nov.
[3] Data are percent of 100 seed with symptoms of disease.
Means followed by the same letter(s) are not significantly different at $P=0.05$, except if $P>0.05$ and ≤ 0.10, analysis was at $P=0.10$.

Duke farm, Trial 409, Suffolk (Phipps). Soil at the field site was Nansemond fine sandy loam, and planted to corn in 2008, peanut in 2007 and cotton in 2006. The field site was planted to AG5905 on 29 May. Cultural practices were the same as Trial 309. Fungicide treatments were applied with a Lee Spider Spray on 19 August (R_3). Plots were harvested on 9 October with a small-plot combine.

Soybean rust was not detected in the trial (Table 10). Observations of disease in plots without fungicide treatment on 3 August, 18 August, and 21 September indicated that downy mildew, brown spot, Cercospora blight, and anthracnose posed a risk of reducing yield. None of the treatments caused chemical injury. Brown spot, Cercospora leaf spot and pod and stem blight were reduced significantly by all treatments on 6 October. All fungicide treatments resulted in significant suppression of foliar disease, plant senescence and incidence of purple seed stain (Table 11). Yields were not increased significantly by any treatment. None of the treatments were significantly different from the untreated check on the basis of seed weight.

Table 10. Disease incidence in untreated plots (Soyrust409).*

Rating date	Downy mildew	Brown spot	Cercospora blight	Anthracnose	Bacterial blight
No. of diseased leaflets					
3 Aug.....	90	50	0	0	4
18 Aug.....	88	14	21	0	0
Diseased leaflets-% leaf area					
21 Sep.....	100-15	15-2	68-40	45-5	0-0

* A sample of 100 leaflets was collected on the specified date, incubated in a moist chamber and diseases were identified using a dissecting microscope.

Table 11. Soybean fungicide trial 409, Suffolk.

Treatment and rate/A	% leaf area with disease (6 Oct)[1] Brown spot	Cercos-pora blight	Pod and stem blight	% senescence[2] (6 Oct)	Yield[3] (bu/A)	Wt./100 seed (oz)	% purple seed stain[4]
Untreated	10.0 a	14.6 a	3.2 a	17.0 a	57.9	.5396	1.0 a
Topsin XTR 20 fl oz (8/19).....	6.2 b	9.2 b	1.4 b	10.4 b	58.8	.5346	0.2 b
Stratego 250EC 10 fl oz + Coverall 3.2 fl oz (8/19).....	4.8 bc	2.8 d	0.2 c	8.0 bc	65.1	.5334	0.0 b
Stratego 250EC 10 fl oz + Gem 500SC 1 fl oz (8/19).....	3.6 c	3.6 d	0.2 c	8.0 bc	64.8	.5331	0.0 b
Stratego 250EC 10 fl oz + Proline 480SC 1 fl oz (8/19)	4.6 bc	4.4 cd	0.2 c	9.2 bc	64.1	.5348	0.2 b
Quilt 14 fl oz + Crop Oil 25.4 fl oz (8/19).....	5.0 bc	5.8 c	0.8 bc	10.0 b	60.6	.5557	0.2 b
Quilt Xcel 14 fl oz + Crop Oil 25.4 fl oz (8/19).....	3.8 c	3.8 d	0.0 c	7.0 c	57.0	.5279	0.0 b
Headline 2.08EC 6 fl oz + Coverall 3.2 fl oz (8/19).....	3.0 c	2.8 d	0.6 bc	7.2 c	60.8	.5381	0.2 b
Headline 2.08EC 4.7 fl oz + Domark 1.9ME 4 fl oz/A (8/19)	3.6 c	2.6 d	0.2 c	7.0 c	64.2	.5417	0.0 b
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (8/19).....	5.0 bc	2.8 d	0.0 c	6.6 c	60.3	.5340	0.2 b
P(F).....	.0001	.0001	.0001	.0001	.1093	.4142	.0246

[1] Foliar disease rating scale: 0=none; 100=symptoms on all leaflets.
[2] % senescence is yellowing, necrosis and defoliation.
[3] Yields are weight of soybeans with 13.5% moisture. One bushel equals 60 lb. Soybeans were harvested on 9 Oct.
[4] Data are percent of 100 seed with symptoms of disease.
Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (*P*=0.05). Arcsine transformation of percentage data was made in statistical analysis.

Duke farm, Trial 509, Suffolk (Phipps). Soil at the field site was Nansemond fine sandy loam, and planted to corn in 2008, peanut in 2007 and cotton in 2006. Seed of AG 5905 were planted in rows spaced 18-in. apart on 29 May. Roundup Ultra Max at 22 fl oz plus First Rate 84WG at 0.3 oz were applied on 18 June for weed control. All treatments were applied once using a Lee Spider Sprayer at R_1 (27 Jul),

R_3 (18 Aug) or R_5 (26 Aug). Plots were harvested on 9 October with a small-plot combine.

Soybean rust was not detected in the trial (Table 12). Downy mildew, brown spot and Cercospora blight to pose a risk for yield loss based on observations of leaflets from plots without fungicide treatment on 3 August, 18 August, and 21 September. All treatments reduced incidence of brown spot, Cercospora blight, pod and stem blight, and leaf senescence significantly according to plot ratings on 6 October (Table 13). Treatments did not cause any plant injury. Neither yield nor seed weight was increased significantly by treatments.

Table 12. Disease incidence in untreated plots.*

Rating date*	Downy mildew	Brown spot	Cercospora blight
No. of diseased leaflets			
3 Aug.....	60	20	0
18 Aug.....	61	0	24
Diseased leaflets-% leaf area			
21 Sep.....	31-5	0-0	52-10

* A sample of 100 leaflets was collected on the specified date, incubated in a moist chamber and diseases were identified using a dissecting microscope.

Table 13. Soybean fungicide trial 509, Suffolk.

Treatment, rate/A and application date[1]	% leaf area with disease (6 Oct)[2] Brown spot	Cercospora blight	Pod and stem blight	% senescence[x] (6 Oct)	Yield[w] (bu/A)	Wt./100 seed (oz)
Untreated	9.6 a	17.6 a	3.6 a	25.0 a	57.9	.4945
Headline 2.08EC 4.7 fl oz + Proline 480SC 2.5 fl oz/A (7/27)	2.6 d	10.0 b	0.2 c	9.4 b	66.6	.5212
Headline 2.08EC 4.7 fl oz + Proline 480SC 2.5 fl oz/A (8/18)	4.6 b	3.4 c	0.2 c	5.0 c	66.9	.5288
Headline 2.08EC 4.7 fl oz + Proline 480SC 2.5 fl oz/A (8/26)	4.6 b	4.2 c	0.6 ab	6.0 bc	66.9	.5328
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (7/27)	1.8 d	10.4 b	0.2 c	8.2 bc	61.1	.5356
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (8/18)	2.8 cd	3.2 c	0.4 ab	7.0 bc	61.3	.5146
Headline 2.08EC 4.7 fl oz + Folicur 3.6F 4 fl oz/A (8/26)	4.4 bc	2.6 c	0.2 b	7.0 bc	62.8	.5259
Quilt Xcel 14 fl oz + Crop Oil 25.4 fl oz (7/27).....	2.8 cd	11.8 b	0.2 b	7.0 bc	63.5	.5488
Quilt Xcel 14 fl oz + Crop Oil 25.4 fl oz (8/18).....	5.0 b	4.4 c	0.0 b	8.6 bc	63.8	.5345
Quilt Xcel 14 fl oz + Crop Oil 25.4 fl oz (8/26).....	5.2 b	5.2 c	1.0 b	8.0 bc	61.7	.5251
P(F).....	.0001	.0001	.0001	.0001	.1112	.0054

[1] Treatments were applied at R_1 (beginning flowering-7/27), R_3 (beginning pod-8/18), or R_5 (beginning seed-8/26).
[2] Foliar disease rating scale: 0=none; 100=symptoms on all leaflets.
[3] % senescence is yellowing, necrosis and defoliation.
[4] Yields are weight of soybeans with 13.5% moisture. One bushel equals 60 lb. Soybeans were harvested on 9 Oct.
Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (*P*=0.05).
Arcsine transformation of percentage data was made in statistical analysis.

Eastern Shore AREC, Painter (Rideout and Waldenmaier). Trials were conducted to compare foliar disease management by fungicide treatments on full-season conventionally-tilled soybeans with one trial receiving primarily one treatment application (Table 14) and the other trial receiving primarily two treatment applications (Table 15). The trials were conducted on a Bojac fine sandy loam soil (organic matter <1%) at the Eastern Shore AREC, Painter, VA. Standard practices for weed and insect control were followed in both trials. Soybeans (cultivar S48C9RR) were planted on 1 July. Plots consisted of two, 30-ft rows spaced 2.5-ft apart and were bordered by two non-treated rows. Treatments were arranged in a randomized complete block design with five replications. Treatments were applied with a Spider SprayTrac Sprayer which delivered 20 gal/A at 40 psi. The spray boom had four Tee Jet 11015 nozzles spaced 18-in. apart. Treatments were applied on 19 September when 75% of the soybeans were at reproductive stage R_3 and again on 5 October. Soybeans were harvested and weighed on 7 December for the single application trial and 8 December in the double application trial. A 100-seed sample was collected from each plot during harvest to assess seed weight and percent discolored seeds.

Wet weather prevailed throughout most of the season with precipitation amounting to 4.9, 4.1, 5.6, 3.2, and 8.4 in. for Jul, Aug, Sep, Oct, and Nov, respectively. Wet weather at the end of the season delayed harvest. There were no significant differences in yield, 100 seed weight, weight or percent discolored seed or Purple Seed Stain (PSS). Percentages of total discolored seed were high in both trials as a result of *Phomopsis* seed decay, anthracnose, and occasional bean pod mottle virus. Two fungicide applications did not improve yield or seed quality significantly when compared with a single fungicide application.

Table 14. Soybean yields and percent discolored seed from a full-season soybean fungicide trial conducted at the ESAREC in Painter, VA in 2009 (single application trial).

Treatment (Rate/A)*	Yield bu/A	Seed wt. g/100 seed	Purple Seed Stain (%)	Total Discolored Seed (%)
Nontreated Control	30.7 **	16.8	0.6	23.0
Stratego 2EC 10 fl oz + Gem 500SC 1fl oz	33.4	17.1	0.2	28.6
Stratego 2EC 10 fl oz + Proline 480SC 1 fl oz	32.2	17.2	0.2	23.2
USF 0731 500SC 3.5 fl oz	34.3	17.2	0.2	27.4
Gem 500SC 3.5 fl oz	31.7	17.2	0.0	27.8
Topsin XTR 20 fl oz	32.5	16.9	0.6	24.8
Quilt 1.66SC 14 fl oz +COC 1% v/v	31.8	17.5	0.0	23.0
Quadris 2.08SC 6 fl oz + Tilt 3.6EC 3 fl oz	33.2	17.3	0.2	24.4
Quadris 2.08SC 6 fl oz + COC 1% v/v	35.3	17.4	0.0	21.6
Headline 2EC 6 fl oz + Induce 4 pt/100 gal	35.7	17.7	0.2	27.0
Headline 2EC 4.7 fl oz + Folicur 3.6F 4 fl oz	31.4	17.4	0.0	28.2
Prophyt 4.2SC 4 pt + Tebuzol 3.6F 4 fl oz	33.8	17.3	0.0	25.6
Quilt 1.66SC 14 fl oz + COC 1% v/v	36.2	17.5	0.4	25.6
Headline 2EC 6 fl oz + Induce 4 pt/100 gal	33.2	17.6	0.0	31.4
LSD (*P*=.05)	*n.s.*	*n.s.*	*n.s.*	*n.s.*

* All treatments were applied one time on 19 September, except the last two treatments in list were applied on 19 September and 5 October.

** Means within each column were not significantly different (*P*= 0.05, Fisher's LSD).

Table 15. Soybean yields and percent discolored seed from a full-season soybean fungicide trial conducted at the ESAREC in Painter, VA in 2009 (two application trial).

Treatment (Rate/A)*	Yield bu/A	Seed wt. g/100 seed	Purple Seed Stain (%)	Total Discolored Seed (%)
Nontreated Control	31.1 **	17.9	0.4	30.2
Stratego 2EC 10 fl oz + Gem 500SC 1fl oz	32.7	18.1	0.4	30.8
Stratego 2EC 10 fl oz + Proline 480SC 1 fl oz	33.6	17.9	0.0	28.8
USF 0731 500SC 3.5 fl oz	35.1	18.1	0.0	26.6
Gem 500SC 3.5 fl oz	34.2	18.0	0.0	34.6
Topsin XTR 20 fl oz	34.7	18.1	0.6	32.2
Quilt 1.66SC 14 fl oz + COC 1% v/v	31.0	17.9	0.0	28.2
Quadris 2.08SC 6 fl oz + Tilt 3.6EC 3 fl oz	33.9	17.8	0.6	27.6
Quadris 2.08SC 6 fl oz + COC 1% v/v	33.9	18.2	0.2	27.8
Headline 2EC 6 fl oz + Induce 4 pt/100 gal	35.0	18.2	0.2	30.4
Headline 2EC 4.7 fl oz + Folicur 3.6F 4 fl oz	31.1	18.2	0.2	35.4
Prophyt 4.2SC 4 pt + Tebuzol 3.6F 4 fl oz	33.2	18.0	0.2	27.4
Quilt 1.66SC 14 fl oz + COC 1% v/v	30.1	17.2	0.2	31.0
Headline 2EC 6 fl oz + Induce 4 pt/100 gal	30.6	18.2	0.0	35.0
LSD (*P*=.05)	*n.s.*	*n.s.*	*n.s.*	*n.s.*

* All treatments were applied two times on 19 September and 5 October, except the last two treatments in list were applied only on 19 September.

** Means within each column were not significantly different (*P*= 0.05, Fisher's LSD).

Summary

Soybean Rust Incidence and the Response of Soybeans to Fungicides in 2009

1. Soybean leaflets were examined in 271 samples of soybean leaflets from five regional sentinel plots, 19 samples from research plots at the Tidewater AREC and 164 samples from commercial fields in 34 counties for detection of soybean rust in 2009.

2. Sentinel plots were located at the Tidewater AREC (Suffolk), Northern Piedmont AREC (Orange), Eastern Virginia AREC (Warsaw), Eastern Shore AREC (Painter), and in Northampton County. Samples of 100 leaflets were collected and processed at 2-week intervals until flowering and thereafter weekly until crop maturity for early detection of soybean rust.

3. Soybean rust was detected in a total of 16 states in the U.S. in 2009. Except for 2007 having soybean rust in 19 states, numbers of states reporting rust have been similar (15 to 16 states) since 2006. However, since its first occurrence in the U.S. in 2005, the number of counties with soybean rust has increased each year (136 in 2005, 231 in 2006, 290 in 2007, 392 in 2008, and 564 in 2009). These trends suggest that the disease has yet to reach its full potential for disease spread in the U.S.

4. The first outbreak of soybean rust in 2009 was found in leaf samples from Suffolk on September 18; thereafter, the disease was confirmed in 15 counties and cities (Brunswick, Chesapeake, Dinwiddie, Gloucester, Greensville, Isle of Wight, Matthews, Middlesex, Northumberland, Prince George, Southampton, Suffolk, Surry, Sussex, and Virginia Beach).

5. No loss of yield to soybean rust in Virginia was expected since the disease appeared after soybeans were beyond growth stage R6 (full seed); the time after which the disease is not likely to reduce yield.

6. The slow build up of soybean rust along the Gulf Coast states and only low levels of the disease in that region by July 15 coupled with the absence of tropical storms or hurricanes for long distance transport of inoculum were generally thought to minimize the risk for soybean rust outbreaks before the R6 stage or before the end of September in 2009.

7. Near normal rainfall across much of Virginia during the growing created favorable conditions for common diseases in soybeans including soybean rust throughout most of 2009 (i.e. Cercospora blight, purple seed stain, brown spot, anthracnose, pod and stem blight, etc.).

8. Field evaluations of fungicides in 2009 demonstrated that several products were effective in control of common diseases of soybean in Virginia. Furthermore, the yield response ranged from a few bushels in low disease pressure to as high as 18.2 bu/A in moderate to high disease pressure. Yield responses under disease pressure were greatest with products such as Stratego 20 fl oz + Surfactant, Stratego 10 fl oz + Proline 1 fl oz/A, Headline 6 fl oz/A, Headline 4.7 fl oz + TopGuard 7 fl oz/A, and Headline 4.7 fl oz + Proline 2.5 fl oz.