VIRGINIA SOYBEAN BOARD - RESEARCH PROPOSAL

Title: **Development of grower-advisory models for improving the efficiency of foliar fungicides in soybeans**

Co-Principal Investigators: Drs. Pat Phipps, Steve Rideout, and David Holshouser

Starting Date: 1 July 2012 **Duration:** 12 months

Objectives:

1. To monitor disease-tracking reports on soybean rust (SBR) from southern states northward to Virginia and incidence of foliar diseases in sentinel plots.
2. To develop and evaluate weather-based, advisory models for fungicide application in control of common foliar diseases and SBR in Virginia.
3. To determine the profitability of fungicide sprays on soybean when applied according to weather-based advisories, scouting for early detection of disease, and growth stages when risk of disease and impact on yield are greatest (R_3 to R_6).

Justification/Practical Importance:

Soybean in 2011 was harvested on 540,000 acres in Virginia and yields are expected to average 39 bu/A. At an average value of $11/bu, cash receipts are projected to reach 231.7 million dollars. High yields were attributed to above normal rainfall and above normal temperatures in July, August and September in eastern Virginia. Rainfall totaled 7.96 in. in July, 14.21 in. in August, and 8.41 in. in September at the Tidewater AREC in Suffolk. Average minimum air temperatures were normal (±1 °F) during the growing season (May thru October), except for 3 °F above normal in September. Average maximum temperatures were near normal in October, but above normal by 5 °F in May and June, 6 °F in July, 3 °F in August, and 2 °F above normal September.

Above normal air temperatures during the season were thought to be responsible for low levels of disease and the failure of soybean rust to spread from Gulf Coast States to the Mid-Atlantic States. Overall, foliar diseases were less severe in 2011 and believed to reduce yield by only 1.5%. SBR in 2011 was found in the U.S. only in 2 counties in Georgia, 7 counties in Florida, and 1 county in Louisana. Collectively, SBR was confirmed in a total of three states and 10 counties in the U.S. in 2011. The low incidence of SBR was attributed to higher than usual temperatures in the Gulf Coast States where the rust fungus overwinters. These conditions suppressed disease development and inoculum production which are essential for epidemics of SBR.

Common leaf spot diseases and soybean rust are caused by fungi that cause infection and disease at temperatures ranging between 59 and 84° F in periods with moisture provided by rainfall, dew, or high relative humidity ≥95%. Hourly records of air temperature, relative humidity, and rainfall from 2006 through 2011 at the Tidewater AREC were used to develop disease advisory models. Determinations of when to apply fungicide were made based on weather factors (air temp, rainfall, humidity ≥95%), disease scouting and crop growth stage (R1=flowering, R3=beginning pod, R4=full pod, R5=beginning seed, R6=full seed). Critical

periods of favorable weather conditions for disease are when daily air temperatures average between 60 and 77° F, and accumulations of rainfall are ≥0.5 in. the previous 5 days or ≥1 in. the previous 10 days, or periods of relative humidity ≥95% for ≥12 hrs/day. Using these parameters, the numbers of favorable days for infection were determined from 2006 through 2011. SBR was first found in the southern U.S. in 2005 but not in Virginia until 2006. During the period from August to October, the total number of favorable days for infection was highest in 2006 and lowest in 2010 (Table 1).

Table 1. Number of days favorable for infection of leaves by common foliar diseases and soybean rust (SBR) at the Tidewater AREC (2006-2010)*

Year	Month						Total (Aug-Oct)	Counties in VA with SBR**
	Jun	Jul	Aug	Sep	Oct	R_3		
2006	21	9	11	28	17	Aug 17	56	18 (Oct 9)
2007	12	18	14	10	13	Aug 22	37	9 (Oct 19)
2008	7	14	13	12	3	Aug 12	28	10 (Oct 1)
2009	9	5	11	24	7	Aug 19	42	15 (Sep 18)
2010	0	1	4	5	10	Aug 23	19	0
2011	5	4	11	27	5	Aug 11	52	0

*Favorable days had average temperatures between 60 and 77° F, and short-term rainfall totals ≥0.5 in. in previous 5 days or ≥1 in. over previous 10 days, or periods of relative humidity ≥95% for 12 hrs or longer.
**Number of counties in Virginia with confirmed outbreaks of SBR, and the first date of initial detection.

During the 5-yr period, the highest numbers of favorable days for infection was from August through October when soybeans were in beginning pod (R_3) to full seed (R_6) stages. Moderate to high numbers of favorable days totaled 56 days in 2006, 52 days in 2010, 42 days in 2009, and 37 days in 2007. Numbers of favorable days were lowest in 2010 when maximum temperatures averaged 4 to 6° F above normal, and total rainfall was about 50% of normal until heavy rainfall occurred between Sep 27 and October 1. Soybean rust was not detected in Virginia in 2010, but was found in 7 states and only 11 counties. In 2009, SBR was found in 16 states and a total of 564 counties. Common foliar diseases of soybean also showed low incidence in 2010 and 2011, whereas 2009 and 2006 were years with high disease incidence.

In 2010 and 2011, the most logical explanation for why SBR was not detected in Virginia was the general lack of inoculum and disease incidence in states south of Virginia. In 2010, SBR was not detected in South Carolina and only on one leaflet in a field in North Carolina. SBR was not detected in any of these states in 2011, and was only found in a total of X states by the end of September.

In Virginia trials from 2006 to 2011, fungicide sprays were evaluated for control of common diseases and soybean rust. The yield response to fungicide treatment in 2006, 2007, 2008, 2009, 2010 and 2011 averaged 0.3, 2.2, 0.9, -2.4, 5.4, 1.8 and 3.0 bu/A, respectively. Yields were increased significantly by an average of 7.4 bu/A by two treatments in 2006, 4.6 bu/A by two treatments in 2007, 5.5 bu/A by 1 treatment in 2008, 7.6 bu/A by 20 treatments in 2009, 6.5 bu/A by 1 treatment in 2010, and 8.9 bu/A by 2 treatments in 2011.. Results showed that tank mixtures of a strobilurin and a triazole reduced disease incidence and increased yield by as much as 18.2 bu/A in 2009.

To effectively manage SBR and common foliar diseases of soybean in Virginia, it is important that we understand the importance of scouting, early disease detection, application timing(s), and weather conditions that trigger infection and disease development. This information is necessary for development and recommendation of effective use patterns for fungicides. Because foliar diseases are highly dependent upon favorable weather conditions for infection, the timing of fungicide sprays needs to coincide with conditions that favor infection, disease development, and spread. In the case of Virginia, a priority of our research is to make the most efficient use of fungicides for improving disease control and increasing profit.

Although this project is a major undertaking that requires multiple years of research, we believe that it encompasses the critical steps needed to maximize the profitability of fungicides in managing the foliar diseases of soybean. One of our goals continues to be the development of effective use patterns for fungicides that generally requires only an average of one application of a fungicide spray per season.

Procedures:

Tracking SBR, sentinel plots for detection of SBR and common diseases: Tracking SBR from Gulf Coast States northwards to Virginia will be monitored weekly using the national SBR site http://www.sbrusa.net/ during the growing season in 2011. State commentaries on our results of monitoring sentinel plots and commercial fields for SBR and other diseases in Virginia will be posted the site as well. Sentinel plots will be located in Suffolk (Tidewater AREC), Painter (Eastern Shore AREC), and Warsaw (Eastern Virginia AREC).

Diagnostic tests will be conducted on leaf samples from sentinel plots and commercial fields during the growing season for early detection of SBR and common diseases. Leaflets (100) will be collected from flowering (R_1) to maturity (R_8) and processed weekly for early detection of common diseases and SBR. Observations and tests of leaflets will be performed in diagnostic laboratories at the Tidewater AREC in Suffolk and the Eastern Shore AREC. A goal of this effort is to provide growers with early warnings of SBR and common diseases, and recommendations on the need for a fungicide spray.

Soybean fungicide advisories: Weather-based advisory models will be run daily for detection of periods when air temperatures, rainfall, and relative humidity are favorable for infection, disease development and spread. Should conditions be favorable for infection for 5 consecutive days, a favorable disease advisory will be issued if plants are beyond the beginning pod stage (R_3). A protection period of 21 days after a fungicide application will be observed before considering the need to make a second application. A second application will be considered should another favorable or highly favorable period be detected and soybeans have not reached the full seed stage (R_6).

Fungicide trials: Evaluations of fungicides on full-season (early planted) and double-cropped (late planted) soybeans will be in field trials at the Tidewater AREC in Suffolk and farms in southeastern Virginia and the Eastern Shore AREC at Painter. Trials will include recommended pre-mixes of strobilurin and triazole fungicides. The application timing standard will be treatment at growth stage R_3 and growth stage R_3 and R_5. Timings in additional plots may be earlier or later depending upon disease tracking, weather-based advisories, growth stage of

soybeans, and incidence of common diseases (i.e. Cercospora blight, anthracnose, frogeye leaf spot, Phomopsis blight) and SBR. Treatments will be replicated four or five times in a randomized block design. Plots will be 6- to 12-ft wide by 30-ft long and replications will be separated by 8-ft alleyways. Row spacing will be according to standard planting practices at each location. Fungicide sprays will be applied by a Spider Sprayer with a 12-ft spray boom or a CO_2-backpack sprayer with a 6-ft spray boom. Applications will be made using nozzles spaced 18 in. apart and calibrated to deliver a volume of 16 to 20 gal/A.

Fungicide treatments: The following treatments (active ingredients) will be evaluated.

1. Non-treated check
2. Headline 250EC (pyraclostrobin) 6 fl oz/A
3. Quilt Excel 2.2SC (azoxystrobin+propiconazole) 10.5 fl oz/A + Induce 0.125% v/v
4. Stratego YLD 500SC (trifloxystrobin+prothioconazole) 4 fl oz/A + Induce 0.125% v/v
5. Prosaro 4.21SC (prothioconazole+tebuconazole) 6.8 fl oz/A + Induce 0.125% v/v
6. Headline 250EC (pyraclostrobin) 4.7 fl oz + Domark 230ME (tetraconazole) 5 fl oz/A
7. Priaxor 4.17SC (pyraclostrobin) 4 fl oz/A + Experimental Xemium

Data collection: Records of air temperature, relative humidity ($\geq$95% = leaf wetness), rainfall, disease-tracking, and spore movement will be monitored during the growing season. Hourly records of weather data at Suffolk, Skippers, Capron, and Waverly will be collected by Spectrum Technologies, WatchDog Weather Stations. Campbell Instruments weather monitors will collect data at the Eastern Virginia AREC and Eastern Shore AREC.

Disease will be monitored on foliage in the lower and upper canopy of plants in each plot and recorded at 2- to 4-week intervals. Additional sampling of commercial fields may be needed as dictated by SBR tracking and spore movement for early detection of the disease. Every effort will be made to detect disease problems in early stages of development and maximize the opportunity for fungicides to be profitable in control of SBR and other diseases.

Plots will be harvested with a plot combine and yields recorded in bu/A at 13.5 % moisture. Treatment comparisons and the determination of significant differences in treatments will be made by analysis of variance and Fisher's least significant difference test at 95% confidence level. Disease progress will be plotted for assessing the rate of disease spread and compared across treatments using area under the disease progress curve as appropriate. Additional data will include defoliation, the weight of 100 seed and incidence of Phomopsis, purple seed stain, and anthracnose on seed. The profitability of fungicide treatments will be based on the market value of soybeans, yield, and costs of fungicide application. Additional factors for grower consideration will include estimates of added expenses for contract scouting of fields and custom application of fungicides.

Personnel and Finances:

The work outlined in this project will be performed in Virginia, and results will be shared with colleagues in the mid-Atlantic Region and reported at local, state and national meetings. Results of the trials will be reported on Virginia Tech Extension Resources web page for access by extension agents, growers and other interested parties. Personnel assigned to this project will use equipment at the Eastern Virginia AREC at Warsaw, the Eastern Shore AREC at Painter, and Tidewater AREC in Suffolk.

Budget (1 Jul 2012 to 30 Jun 2013):

Tidewater AREC (Pat Phipps; David Holshouser)

Barron Keeling (CY) – Research Specialist	$5,802
Fringe Benefits (Classified)	2,234
Materials and Supplies	464
Total	$8,500

Eastern Shore AREC (Steven Rideout)

Hourly Wage Part-Time Employee	$5,479
Fringe benefits	521
Materials and Supplies	900
Total Direct Costs	$6,900

Grand Total $15,400