

Summaries of Discussion Sessions for 2007 Soybean Rust Symposium

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Overview of Soybean Rust in 2007

8:25AM to 10AM, Thursday, December 13th

Speakers: Bradley, Neto (substitute for Escobar), Farias

Q: Is inoculum produced during the “Host free period” in Brazil?

Neto: There are other hosts present during that period such as common bean, but these are not important hosts and do not produce much inoculums.

Q: When is Jicama bean grown in Mexico?

Farias: Jicama is planted from July through October and harvested in February and March. There are about 700 hectares. The later planted fields will probably suffer significant losses from soybean rust, maybe as high as 80-90%.

Q: Will there be a gap in the presence of jicama in the field after the March harvest and the presence of susceptible plants in the US? Will jicama provide inoculum for the US?

Farias: There is no jicama grown in Texas (Tom Isakeit) so the Mexican crop may not be that important as a source of inoculum.

Q: What happened in the southern US this year?

Bradley: Soybean rust did not look as aggressive as in previous years, probably due to the drought.

Kemerait: Most of the scouting in GA this year was in the sentinel plots.

Q: Did any growers experience diseases loss in 2007?

Kemerait: In GA, 75% of the acreage was sprayed. There were no farmer losses. There were significant losses in fungicide trials, but nearby growers sprayed and had little disease.

Hollier: There were some fields in LA that were not sprayed and may have had about 20% loss.

Calvin Viator, a consultant from south Louisiana commented that there were some significant losses this year, but most fields were sprayed twice not only for the control of soybean rust but for other diseases common to southern LA like frogeye leaf spot, Cercospora leaf blight, aerial blight, and Phomopsis. Green stem occurred some in association with fungicide use and defoliant were used to aid harvest.

Disease Control

10:20 to noon, Thursday, December 13

Speakers: Mueller, Derksen, Tedford, and Secor

Q: You suggested that sensitivity shifts for DMI's eventually stabilize. Does this mean that we can use higher rates to overcome resistance?

Tedford: Because the mechanism of resistance is polygenic and multi allelic, sensitivity shifts are small and gradual, and they tend to stabilize with increasing rates. However, this does not suggest that higher than recommended use rates can or should be used for resistance management. What this implies is that DMI fungicides experience a reduction in control rather than a loss of control like we see with fungicides that have monogenic, single allelic resistance mechanisms like the strobilurin fungicides. This is one of the reasons why the DMI fungicides are still quite effective today.

Q: Seventy percent of the crop is in indeterminate soybeans. In determinate beans, 40% of the growth occurs after R3. With 200,000 acres of wheat – followed by soybeans – where would you cut-off management of soybean rust in the soybean crop?

Mueller: Most of the trials were in indeterminate soybeans, although a few locations had determinate cultivars, and we saw no differences in effect of fungicide based on timing.

Q: Would the use of adjuvants or spreader/ sticker make a difference?

Derksen: There would be a difference in coverage but not in residue that we recovered. May have impacted stem recovery.

Q: Do you have any thoughts on the use of two triazoles in a combination?

Tedford: Based on recent research by researchers from Syngenta Crop Protection and the University of Basel Switzerland, genotypic sensitivities of various triazole fungicides vary considerably. This means that mixtures of DMI fungicides may result in better disease control depending on the genotypic distribution in the field population.

A: Secor: Never mix fungicides at reduced rates; mix at full rates in sugar beet industry

Q: You presented data for EC₅₀ values = 1ppm as a criterion for resistance. Yet, there were few isolates on the 1ppm side. Did you try to see if there is a loss of control?

Secor: We tried to answer this question in the greenhouse, but experiments have not gone well.

Q: From producer participant: I have not heard of in-furrow application. Would this put the fungicide in the lower canopy and provide more complete protection?

Mueller: There is a possibility that it may be a good approach, but it does need more work.

A: Cheminova representative: We do have additional sites with similar results, but Section 18 is only for foliar application. Nevertheless, soil application is being looked at. They are examining both liquid in-furrow and a T-band granular, but this is still only in the evaluation phase at this time.

Q: Triazoles have been used in Brazil for several years now, soybeans are only sprayed in the US once or twice a year, and the pathogen does not overwinter across the US. With that in mind, what are the resistance risks for triazole fungicides in the US?

A: Tedford: Clearly, fungicides are the selection pressure that drives resistance development. Therefore, the more often fungicides with the same mode of action are applied within a growing season, the greater the likelihood of selecting for resistant fungal isolates. With that said, soybeans only receive one or possibly two applications of fungicides a year in the US. This is a far lower risk than for crops like potatoes or any other crop that receive six to eight fungicide applications per season. So the resistance risk is fairly low. In addition, soybean growers have several fungicides available with different modes of action as compared to triazoles. So they can further reduce the

resistance risk by either alternating between triazole and strobilurin products or applying mixtures of the two.

Advances in Biology of the Pathogen

1:15PM to 2:55PM, Thursday, December 13th

Speakers: Dufault, Velez-Climent, Narvaez, Jurick, Bonde, Hartman, and Luster

Q: A general question from Doug Luster: What kudzu studies are going on?

Schneider: LSU – Nicole Ward, a graduate student, is working on a kudzu project in which she is freezing potted, infected plants and then will determine if rust survives. Rust appeared early in the 2007 season on the same patches of kudzu that were infected in 2006, while many patches remained disease-free for the entire season or multiple years. This suggests that the pathogen overwintered in those patches even though plants were defoliated by frosts.

Marois and O'Brien: We are investigating relative susceptibility of kudzu from various sites. See poster #5. Inoculum for these studies is greenhouse grown on soybeans.

General question series:

Q: We need to hear more about the life cycle of the fungus; what can you tell us?

Hartman: We just see the uredinial stage repeating over and over again; it's basically a dead end. Telia can develop at the end of the season, but doesn't go from there. We haven't found the alternate host yet.

Q: Alternative hosts – as you look at the lesion types, are you finding a generally-seen type or are they difficult to define?

Hartman: Sporulation is considered part of a positive. About 10% have tan lesions, but there are a lot of differential reactions; might be tough to find in the field.

Q: How about *Vigna* spp as alternative hosts?

Hartman: There are definitely hosts in this genus, and Mo Bonde has done quite a bit of this research. Schneider: There is a freshwater marsh *Vigna* species, *V. luteola*, or deer pea, in Louisiana. This plant forms a dense vine canopy similar to kudzu, and it may survive in coastal Louisiana because the marshes are much warmer than nearby terrestrial sites. Hartman: We should collect some of this and test for susceptibility.

Q: Once an appressorium forms, is surface moisture still required?

Bonde: In 1976, they observed penetration following 6-7 hours but moisture for 8-12 hours increased the amount of disease observed. Additional time of leaf wetness appears to extend the infection.

Q: What is the difference between the lesion types?

Bonde: The original description was on soybeans. Bromfield used these lesion types (tan, red-brown), etc, usually related to the color of the spores for tan lesions. Red-brown was attributed to rapid death of the host cells and very little sporulation. Kudzu has both types of lesions. There are often gradations between types, but kudzu appears to be one or the other.

Q: In the study of the collected leaves in bags for the overwintering study, did the salts and humidity induce different flora on the leaves (besides rust)?

Jurick: The highly moist leaves (with paper towels) degraded very quickly, but the other flora appeared to be fungal. The salts (lower RH) bags tended to survive better.

Q: Are the temps that are sufficient to freeze back kudzu low enough to kill the spores?

Jurick: We need a study to better observe this in the field.

Q: Frosts and freezes in SC usually decimate the kudzu, but some are wondering if maybe the fungus is actually overwintering even if the leaves fall off. How about on the other leguminous weeds (clovers, etc)?

Jurick: We did observe stems and found low incidence of pustules on the stems, usually in the depression that runs along the stem, perhaps they are in a microclimate. We did not test the viability of the spores recovered from the stems, but that should be part of a future study.

Q: What about the foliage produced way above the ground, is the fungus surviving there?

Jurick: We have observed foci when new green leaves appear in an old focus, but sometime new foci develop nearby.

Q: Have you looked at kudzu in protected areas such as under bridges and culverts – could this be a source?

Jurick: There is a site in Marion County where the kudzu is below large trees. These areas still had some green leaves after a frost – possibly “escapes”.

Q: If the kudzu lives through a frost, can we assume the fungus survives as well?

Jurick: Even after 5 hours below zero at the Hickory Hill (Hernando) site, there was active sporulation observed the following day.

Q: What are the overwintering buds like – is this a place for spore survival?

Jurick: The buds expand after about 1-2 weeks following a frost.

Narvaez: We haven't found spores in the buds we have checked, but it would make sense that the newly pushed leaves would be quickly infected.

Q: Have you seen any immune responses from kudzu?

Bonde: We have one accession that we are rechecking that has had an immune response from all SBR accessions. The frequency of RB and tan is normally about 50-50 in kudzu. The RB reaction is less common on soybean.

Epidemiology, Physiology and Yield Loss Assessment

3:15PM to 5:45PM, Thursday, December 13th

Speakers: Pedersen, Kumudini, Shaner, Nutter, and Scherm

Q: Did your model take into account the freeze we had in 2007?

Scherm: No environmental conditions were considered, only the drought was taken into account.

Q: Eighty five percent of the acreage was sprayed in 2005 and less in 2006 – was this taken into account in the model?

Scherm: No. The assumption was that the sentinel plots were not sprayed. The data set is not a perfect one, but it is probably one of the best on an invasive species with lots of data collected over a large scale.

Q: Can you explain the “green wave” concept?

Scherm: Example: The Puccinia pathway for wheat stem rust; it moves in a leapfrog fashion. The pathogen has the ability to build up in the waves of plantings and leapfrogs into the later plantings further north. With soybean rust, the planting dates differ quite a bit, but the crop planted in the north catches up, so there is less succession south to north. And when you take into account flowering, you are talking about a shorter season.

Q: Would the observations hold true across different maturity groups (determinate vs indeterminates)?

Kumudini: In terms of leaf loss, you still have leaf loss in the branches, regardless of MG. Impact of photosynthesis was the same regardless of growth stage. The data show that there is not much in terms of differences over maturity groups

Q: Defoliated plants didn't show much difference in yield vs. the control – could this be explained in oil loss or protein content of the seed?

Kumudini: Seed quality was not analyzed, but colleagues have mentioned that stress doesn't affect seed quality much.

Q: Do you use nearest-neighbor analysis – clustered, dispersed, or random?

Scherm: We were looking at distances but not degree of aggregation. We would need spatial distribution of all the plots since they are not random.

Q: The extent of the latent infection period – it may extend 4-6 weeks – is there a precedent for that? If that is the case, do you think the presence of hyphae in leaves as opposed to pustules explains the yield loss even when we have disease starting after R6?

Shaner: For yellow stripe rust of wheat the latent period is 35 days. This would set a precedent. The infection site has to reach a certain size before it produces a pustule on a slow rusting variety. Maybe it can get too hot for soybean rust (or too cool), and the hyphae are growing slowly.

Nutter: Alfalfa rust is affected by cool temperatures (cooler = longer latent period).

Q: Temperature and moisture availability can be rate-limiting. Do your models capture these parameters for photosynthesis or the other models?

Kumudini: We conducted the study under optimal conditions, so we did not observe whether drought stress affected leaf loss, but we observed 2005-06 data in Londrina (when it was very dry and had very low yields). Artificially inoculated beans were observed pre- and post-infection – there was a reduction in photosynthesis.

Q: Could you visually detect SBR vs. the spectrophotometry?

Nutter: We did not.. This could be interesting for future studies.

Policies and Potpourri

Evening Session A, 7:30PM, Thursday, Dec. 13th

Speakers: Draper, Hershman, Bloomberg, and Golod

Q. Are there additional fungicides for 2008?

A. Draper: Most are now section 3's with some new section 18's.

Q. Are there concerns for the development of resistance if fungicides are applied for plant health and non-disease uses?

Bloomberg: We are looking for new markets. Yield responses can happen in some cases, but the IPM approach is still important.

Report from the Front Line: Experiences from Veterans

Evening Session B, 7:30PM, December 13, 2007

Speakers: Isakeit, Damicone, Dalenberg, Sellers, Black, and Viator

Following are brief synopses of the presentations and discussion:

Mark Halsey: "The job of the evening is to get down to business. We're not talking about small plots or Petri dishes. We are talking about business."

Paper 1: Tom Isakeit, Extension Specialist from Texas

Points: What drove the epidemic in Texas in 2007? RAIN and more Rain! Detection of rust was an issue. My mantra to my clientele (to find soybean rust), "Look for yellowish areas on the upper leaf surface and then turn the leaf over."

The first incidence of Asian soybean rust for Texas in 2007 was on volunteer soybeans growing in the lower Rio Grande Valley in February. However, those soybeans were gone by the time soybeans from the spring planting had emerged. In early June, I found infected kudzu in east Texas. This kudzu was under a bridge and the rust may have overwintered there. Also in June, soybean rust occurred at low levels in commercial soybean fields in southern Texas.

After the finding of rust in southern Texas in June, the pathogen had moved north within a few weeks. In fact, in travelling north, I could find the disease in every soybean field I stopped in. In one trip to Northern Texas, the Red counties (as marked on map) were a message to soybean growers in the country that there was something heading your way. The "red" counties overstate the actual amount of rust: soybean acreages were small in Texas and the severity of disease in the northern part of the state was low, too. One of the most severe cases of rust occurred in Victoria County, south of Houston. However, the impact of rust on yield in this area is not known, partly because insects and flooding also affected yield. There were about 87,000 acres of soybeans in Texas in 2007, a drop

from the usual 200,000 to 250,000 acres. The sentinel plots in the lower Rio Grande Valley (Weslaco) did not work because the disease showed up in commercial fields first. The difference is likely because the drip irrigation and wide row spacing used in Weslaco created a less-favorable microclimate for rust than the narrower row spacing and furrow irrigation in the commercial fields.

The ease of diagnosis of rust depended upon which part of the state you were in. In southern Texas, it was easy to diagnose rust because leaves are mostly free of other diseases. In northern Texas, there is more “clutter” because of other diseases on the leaves.

Paper 2: John Damicone, Extension Specialist from Oklahoma

Didn't find rust in 2005. Five plots were scouted with hand lens. In 2006, 15 plots were monitored. In 2007, UPS (United Parcel Service) shipped leaves, which were assessed with a dissecting scope.

Rust progress was slower than Damicone though it would be considering that 2007 was a very wet year. Was it worth spraying? Rust was tough to identify and was often confused with Septoria brown spot.

Large on-farm demonstrations were run in which significant increase in yield were documented, 11 bu/A in one and 9 bu/A increase in another.

Conclusions: Asian soybean rust is a hard disease to find and evaluate; sentinel plots worked, and 40% of acreage was treated. Rust was not aggressive in 2007. The current monitoring program is not sustainable because of high demands related to travel and time commitment. Rust incidence and golf handicap positively correlated.

Paper 3. Ken Dalenberg, Soybean Producer from Illinois

Overview of Illinois Situation

Sentinel plots: 40 sentinel plots supported by various organizations

Field sampling: Plant clinic did a good job of sampling and diagnosis

Rust identified in southern part of state in late September and late October in northern Illinois.

Quick and comprehensive action after first find, when mobile surveys were activated, was critical. There would be value for sentinel plots for diseases other than soybean rust. As disease incidence begins to build, it gives the farmers the opportunity to implement management practices. We need to have more soybean plots in the area south of the soybean belt and fewer numbers in the soybean belt.

Getting the word out: The multi-state publication, *Soybean Rust: What is Your Risk?* was given to attendees at field days and meetings. Weekly commentaries on the soybean

IPM-PIPE were valuable. Research being conducted at the IFAS research station in Quincy, FL is extremely valuable. Benefits of fungicide applications are inconsistent.

For the future:

Continue to monitor for Asian soybean rust.

What are benefits of plant health issues?

Watch sentinel plots to the south of us.

Encourage funding of sentinel plots.

Determine economics of spraying in the absence of rust.

Paper 4. Billy Wayne Sellers, Soybean Producer from Georgia

Management of Asian soybean rust is fact of life for growers in Georgia now. Even if rust does not occur in a specific field, growers need to recognize that it could occur and cause significant damage. Mr. Sellers has experienced yield losses in the past and estimates that in 2005 use of the fungicide Headline SBR increased his yield by nearly 25 bu/A.

Mr. Sellers reported that growers in Georgia get their recommendations to spray primarily from the Cooperative Extension and also from consultants. The decision to spray (or not to spray) is based upon the reports from the USDA-sponsored sentinel plots, the growth stage of the crop, weather conditions favorable for the spread of disease, and the desire of the grower to protect his crop. Mr. Sellers reported that the most popular fungicides for control of Asian soybean rust in Georgia in 2007 included Folicur (and other tebuconazole products), Headline, Stratego, and Quadris. The popularity of these fungicides is tied both to efficacy and the familiarity of these products to peanut farmers.

Mr. Sellers feels that the most important efforts in the management of Asian soybean rust have been 1) the development and implementation of the sentinel plot monitoring system, 2) the willingness of the EPA to grant Section 18 labels, and 3) cooperation among different universities, government agencies, and chemical companies.

Last word: “Soybean growers can effectively manage Asian soybean rust, but they must watch the progress of the disease through sentinel plots and make timely fungicide applications.”

Paper 5. Crop Consultants: Kevin Black, Illinois

Ultimate role: Support those who work with growers.

The sequence of events was reviewed from the first discovery of soybean rust, to the present. This included the Brazil trip in 2005.

Further discussion included a description of the “RustCon” alert system (modeled after the Defcon system) that is used as part of the SBR information updates provided to GROWMARK FS member cooperative employees. Training efforts, aimed at company

crop specialists, also were summarized. The formal SBR sentinel plot system was augmented by private sentinel plots placed by member companies.

Additional self-training included a whirlwind trip to Louisiana during Fall, 2006, and graciously hosted by Drs. Ray Schneider and Blaine Viator. The return of SBR to Illinois late in 2007 provided an additional opportunity to observe, photograph, and sample the disease. The SBR infection location in Massac County, Illinois also was used as a training location for GROWMARK FS Crop Specialists.

Finally, the importance of the “Network” was stressed. The network is made up of plant pathologists and other professionals, nationwide, who give of their time to help inform and support individuals in the private sector. These individuals have greatly enhanced the knowledge level of crop consultants and others who will be called upon to manage SBR in soybeans. For the Midwestern states, economic SBR infections are expected to be somewhat rare. Thanks to the network, when SBR does aggressively invade the Midwest, adequate preparation will have taken place.

Paper 6. Crop Consultants: Blaine Viator, Louisiana.

Cercospora leaf blight, Rhizoctonia, frogeye leaf spot, pod and stem diseases have been the diseases of primary concern in soybeans in south Louisiana. Sentinel plots work for the grower in the management of Asian soybean rust! Consultants and growers should consider buying a small portable microscope.

Questions and Comments:

Q: The work that John Damicone did in Oklahoma was of great importance to Kansas. Disease developed so slowly in Oklahoma that we did not call for any sprays to occur in Kansas. This saved Kansas growers a bunch of money!

A: Damicone: Sentinel plots work very well, but they require a whole lot of work. Planting is not the biggest deal, but travel, time, and reading the leaves is a big deal.

Jardine: Kansas wanted the scouts to look at the leaves initially in field before sending to lab.

Comment from Dr. Calvin Viator, consultant from Louisiana: “I really like the coordinated effort between extension, research, and industry and I think it is really working. There may have been a little bit of initial panic, but we have a lot of pressure and we believe that we can handle this rust disease. We have always called for one fungicide application and now we have added another; I think it helps not only with rust, but with other diseases as well. I want to congratulate everyone who is involved.”

Q: When are your fungicide applications going out in Louisiana?

Viator: Late R2-early R3 followed by 2-3 weeks follow-up. In 2006 a single shot wore off, we had rust everywhere, while in 2007 rust never did explode after application.

Q: What about the green stem effect?

A: Viator: We may simply be looking at healthier beans. Comment added that gramoxone could be used to defoliate.

Consultants are important for soybean producers. I don't see how they are going to survive and spray.

Damicone: If rust is in an adjacent county, be ready to spray.

Sentinel plots are very valuable, but take a lot of money and resources. How are we going to keep doing them even when we run out of resources? There is a lot of thought being put towards this.

Sentinel Plots, Spore Trapping, and Disease Forecasting

7:45AM to 9:30AM, Friday, December 14th

Speakers: Giesler, Szabo, Isard, Pan, and Russo

Q: Concerning spores in raindrops, how long were the rain events for your wet trap collections? If the rain is longer than 30 minutes, won't spore washout occur? What about germination of spores in a rain droplet?

Szabo: When the spores come down in a rain event is not known because collections are made for a week. When spores are in a rain droplet they will not germinate. When they are on a surface, the spores will germinate in the presence of water.

Q: Why synthesize data?

Isard: For sentinel plot data this is the best way of dealing with it.

Q: When do you know if cyclonic orientation occurs?

Pan: That could be predicted by ocean-atmosphere coupled models on a global scale several months in advance. This very long-term prediction is beyond our model's temporal scale now, but it can be explored in the future.

Q: Do we need sentinel plots in the northern states of the US?

Hershman: It is too early in the process to say that we don't need sentinel plots in the north. We have yet to have a big SBR year and the system has not been fully tested. Spores are being trapped in the northern states beginning as early as May and June. Long

distance transport raises the specter that rust could show up in the North about the same time it does in the upper Midsouth. In the long term, the plots in the North could turn out to be as important as those in the South, albeit not as regularly. Time will tell. The plots in the North are also needed for data collection for SBR model refinement.

Disease Resistance and the Infection Process

9:45AM to 12:30PM, Friday, December 14th

Speakers: Walker, Neto, Pastor-Corrales, Hyten, Schneider, van de Mortel, Chen, and Luster

Q: Where, how, and what improvements will be taken to improve the field screening for soybean rust resistance in the future.

Walker: The rust nurseries will be in the same locations as 2007 (Alabama, Florida, Louisiana, and South Carolina). Fields will be selected to enhance good agronomic growth of introductions. I will be looking closer at the data from 2007 to short list some of the entries. I may look more into the other accessions that were seedling screened by Miles et al. at Fort Dietrick to see if there are additional sources of resistance. I hope to improve the assay evaluations for assessing rust.

Q: When will a resistant cultivar be released in Brazil?

Neto: A variety for the central region of Brazil will be the first release – this will be in 2008-2009. The year after that, two varieties with rust resistance will be released for the southern region.

Q: Can deployment of resistance genes be effective in Brazil?

Neto: Maybe not. *Rpp1* and *Rpp3* have already been “broken” in the south; *Rpp4* was effective but appears to be broken at some locations. It doesn’t appear that “stacking” these genes may be effective, although more research needs to be done to determine this for sure.

Q: What is the status of using antibodies for detection of the soybean rust pathogen?

Luster: Antibodies are working well for germinating spores and in-plant detection is improved after the plant has been infected for 3 days.

Q: Are upregulated genes different in the susceptible and resistant reaction?

van de Mortel: Most genes expressed in the resistant and susceptible types have the same profiles – but the time of expression differed.

Q: Has anyone investigated the genetic structure of the soybean rust fungus?

Luster: We at Fort Dietrick have been using 32 SSR markers to evaluate the molecular genetics of different isolates. The genetic diversity seems to be incredibly broad.

Q: Do you know of other rust systems which have this diversity?

Luster: Yes, a good example is wheat leaf rust that appears complex and diverse with 70-100 races occurring across the country.