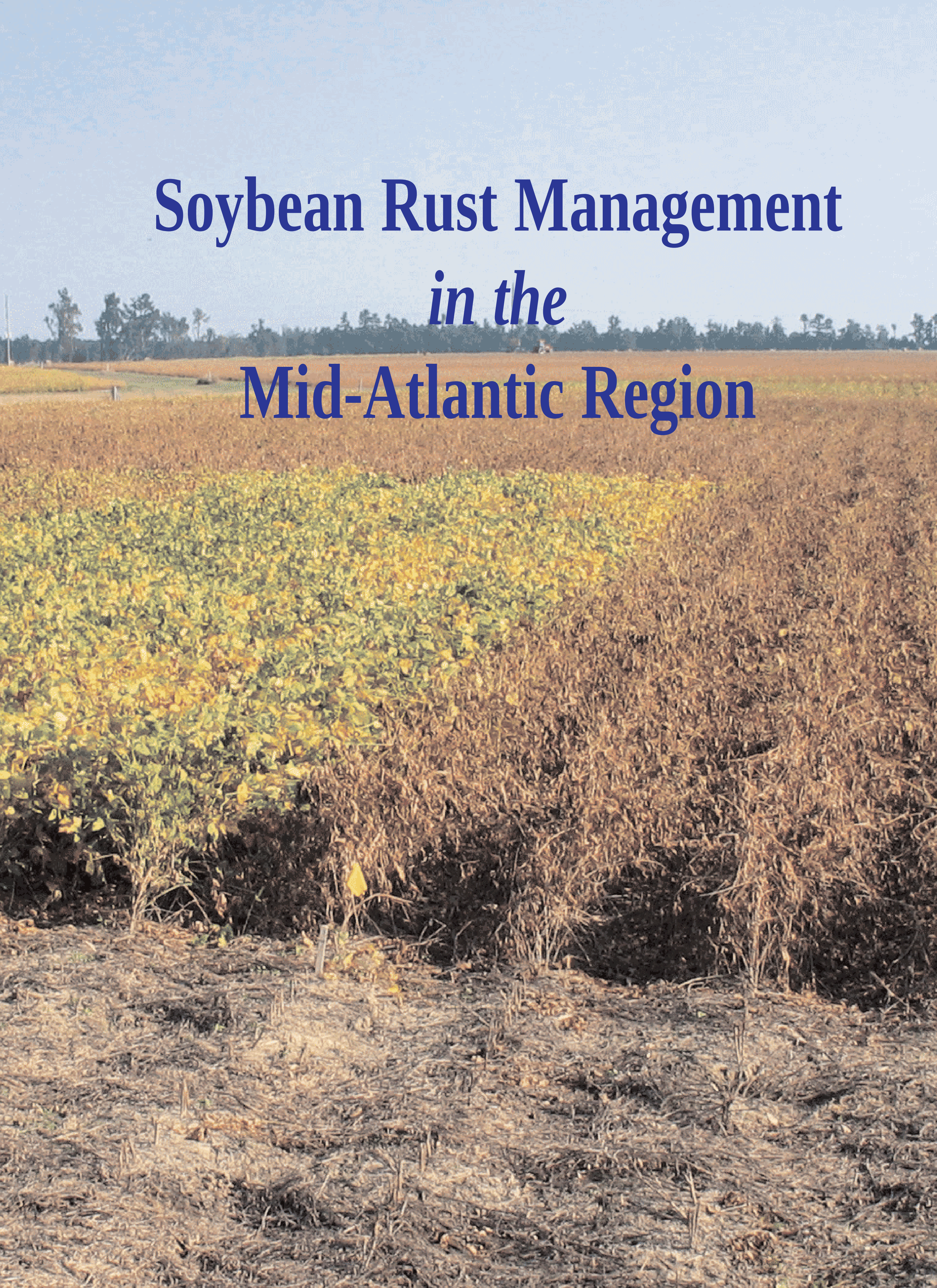
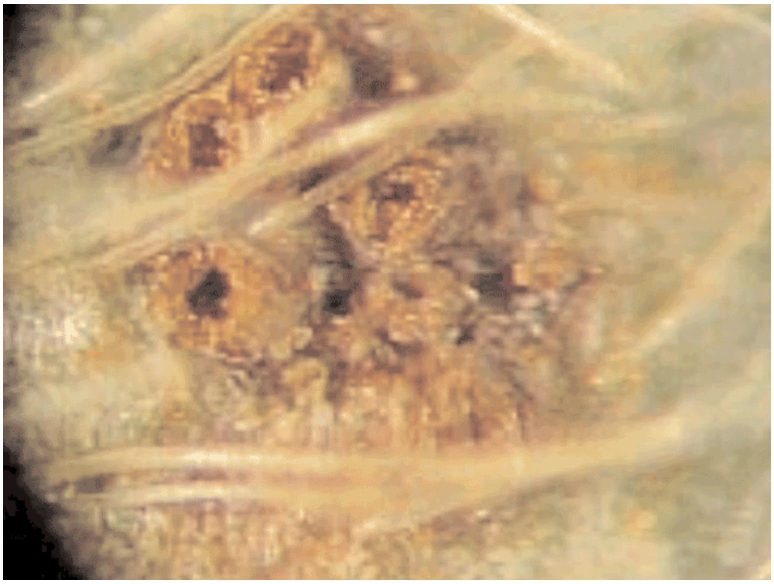
Soybean Rust Management *in the* Mid-Atlantic Region



Underside of leaf heavily infested with soybean rust. Lesions contain multiple pustules.



Enlarged view of lesion on underside of a leaf showing multiple pustules per lesion.

Photos courtesy of J. T. Yorinori, Ph.D., Embrapa Soja, Londrina, Brasil.

Soybean Rust Management *in the* Mid-Atlantic Region

Introduction

As a soybean farmer, you have many factors to consider as you make important management decisions regarding your soybean crop. Since the discovery of Asian Soybean Rust in the United States during late 2004, rust is now a perennial challenge to a profitable and productive crop. As high fuel and fertilizer prices have narrowed the margin within which you operate, an unnecessary spray can mean the difference between a profit and a loss. This hurdle is not the first that you have faced, and it will probably not be the last. Rust cannot be eradicated in the United States. However, there is good news - rust can be managed!

Since rust has been confirmed in the Southeastern United States during each of the last two growing seasons, data is being collected to help understand how rust behaves in this region. This is not a claim that any person can safely predict exactly when, and how far, rust will spread this year or the next. However, each year more is becoming known about what controls the movement of rust from one field to the next.

There is a wealth of information available regarding soybean rust, especially via the Internet. But, we must be careful in choosing what we apply to the Southeastern United States. We are not in South America: we grow different varieties and have very different weather. The goal of this collaborative effort is to provide you with the most current, accurate, and concise information based on factual observations and research conducted here in the Southeast. Research has shown that the fungicides and spray equipment currently available, when used properly, can minimize losses in your fields and your budgets. Proper timing and preparation are crucial in successfully managing rust. We hope to arm you with that knowledge and equip you with the tools to make economically feasible, educated, and calculated decisions to protect your crop.

This publication is available to you through the diligent work of your land-grant universities and by your soybean checkoff. Currently, work is underway to screen for rust-resistant cultivars, develop new fungicides, and research new management techniques. You can always count on your cooperative extension service professionals and your soybean checkoff to work together in *making your checkoff pay off*!

Aaron Wood
Executive Director
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SCSB
SOUTH CAROLINA SOYBEAN BOARD
Making Your Checkoff Pay Off.

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Soybean Rust Management Plan
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A Brief History of Rust in the Western Hemisphere

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Rust in South America: Soybean rust was first observed in South America in 2001 in Paraguay. Since 2001, it has been found in Brazil, Bolivia, Argentina, Colombia, and Uruguay. By 2004, most of the soybean acreage in Brazil received multiple applications of fungicides.

This past year the number of fungicide applications for soybeans in South America ranged from less than one in Argentina to as many as five in parts of Brazil and Bolivia. Rust was relatively light in many areas of Brazil in 2005-2006 because of drought, whereas other areas with abundant rainfall had severe pressure from rust.

In parts of Brazil and Argentina fungicide applications started two to three weeks before flowering. Rust was widespread in Argentina in 2004-2005, but yield loss from rust was considered minimal, and Argentina had record soybean yields.

Argentina was expecting severe rust in 2005-2006, because of a mild winter that resulted in large amounts of volunteer soybean that were infected with rust. Soybean rust, however, did not develop as anticipated in Argentina even in the northern states of Entre Rios and Missiones. There were periods of drought in southern Argentina that may have impeded development of rust there, but more than adequate rainfall occurred in northern areas. Some crop professionals suggest that variation in day/night temperatures south of Brazil impeded rust development. The crop consultants in Argentina take a more conservative view on management of soybean rust. In general, their recommendation is to wait until rust is found before making fungicide applications.

Detection of Rust in the United States: In November 2004, soybean rust was first detected in the continental United States in a production soybean field at the LSU AgCenter in Baton Rouge, Louisiana. In the following weeks, the disease was found in Alabama, Arkansas, Georgia, Florida, Mississippi, Missouri, South Carolina and Tennessee. At that time many researchers felt that soybean rust could become widespread in the Southeast and Midwestern states in 2005.

Rust in the United States During 2005: Potential yield losses for the United States crop in 2005 were estimated to be between 10 and 50%, but as much 80% if no action was taken for disease management. In order for disease to develop to this level, optimal environmental conditions and over-wintering on a host in a no-frost region would have to occur. It was predicted that the disease would survive on kudzu or other legumes in southern no-frost regions or be blown into the United States from the Caribbean, Central America or South America. However, by the end of 2005, soybean rust was only observed in the Southeast, and the disease did not reach levels predicted for 2005.

Soybean rust was detected first in 2005 on kudzu in Pasco County, Florida. The disease was later detected on volunteer soybeans in April in Seminole County, Georgia. Soybean rust was not detected again on soybean or kudzu for nearly two months, although weather conditions associated with multiple tropical storms seemed favorable for disease development, especially in Georgia. The disease was found on roadside kudzu in Jefferson County, Florida on 14 June 2005. Further spread of soybean rust was slow from June to July 2005, despite seemingly optimal conditions for disease. During this time, many soybean cultivars planted in the Southeast were approaching the bloom stage (R1). June was typified by cooler than average temperatures, and widespread rainfall events in the Southeast. Soybean rust detections began to increase in August when soybeans were reaching R3-R4 growth stages. Positive detections continued through November. Overall, 35, 10, 47, and 22 counties in the United States reported soybean rust in August, September, October and November, respectively. This increase in the number of detections occurred during a time in which temperatures rose by 5-10 degrees on average and rainfall decreased. With a few exceptions, soybean rust was not detected in many commercial fields until the R4 stage or later.

It was also noted in 2005 that soybean rust began in discrete focal points in the lower soybean canopy within a field, and then the disease would move upward within the canopy and to adjacent soybean plants within approximately 7-10 days, before spreading over the entire field. Large scale defoliation of fields over a brief period of time, as has been reported in South America, was not observed.

Soybean rust was widespread by the end of the 2005 growing season in the Southeast, however, northern spread in the region appeared to be slow. When most of the United States crop had been harvested in mid-November, soybean rust was found as far north as Caldwell County, Kentucky, as far east as Hyde County, North Carolina, and as far west as Liberty County, Texas.

The geographical distribution of soybean rust in 2006 extends from Texas to North Carolina.

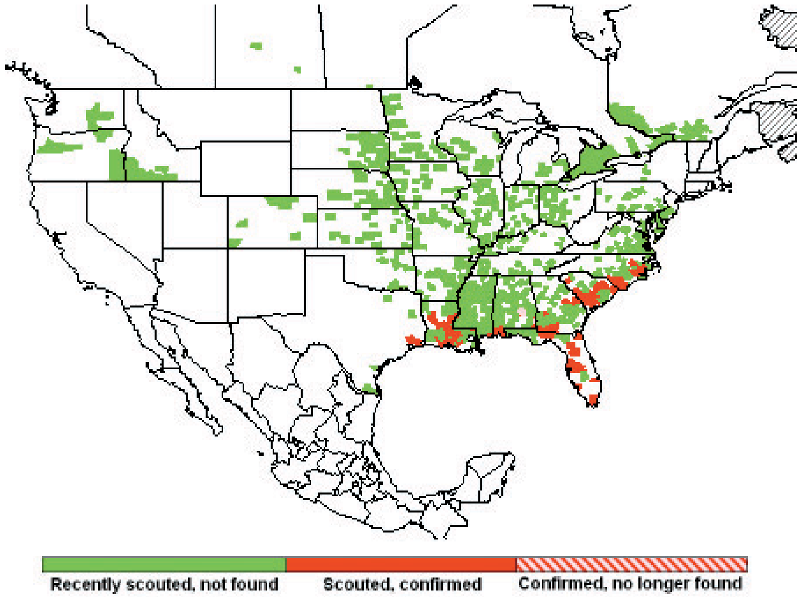

Figure 1. Counties confirmed with soybean rust as of September 28, 2006. Updated map available at http://www.sbrusa.net/

Soybean Rust Identification and Life Cycle

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Symptoms on Leaves: Soybean rust symptoms first appear as tiny brown or red spots on the upper leaf surface after fungal spores, called urediniospores, are blown into fields and land on soybean leaves. If conditions are favorable (temperatures are 59-84^{o} F with long dew periods or frequent rain events), tiny spots can appear at least 4 days after infection on the upper leaf surface and volcano-shaped pustules can be seen with a high-powered hand lens or microscope after at least 10 days on the lower leaf surface.

Unfortunately, the spots and pustules are extremely TINY initially and can EASILY go unseen or mistaken for other diseases such as brown spot, bacterial pustule and downy mildew. One rust pustule can produce spores for at least three weeks. After spore release, wind can carry these spores and spread infection to other soybean plants or weed hosts. Increases in the spread and severity of rust have been related to canopy closure, crop flowering and bean production.

Overwintering: This infection cycle continues until the plant is defoliated or weather conditions are no longer favorable. During the winter months, soybean rust can survive on kudzu in southern no-frost regions such as Florida and southern Georgia. However, if there is a lack of moisture during this time in these areas or cold temperatures kill/damage the kudzu, the fungus that causes soybean rust may not survive. There is still a great deal to learn about the over-wintering stage.

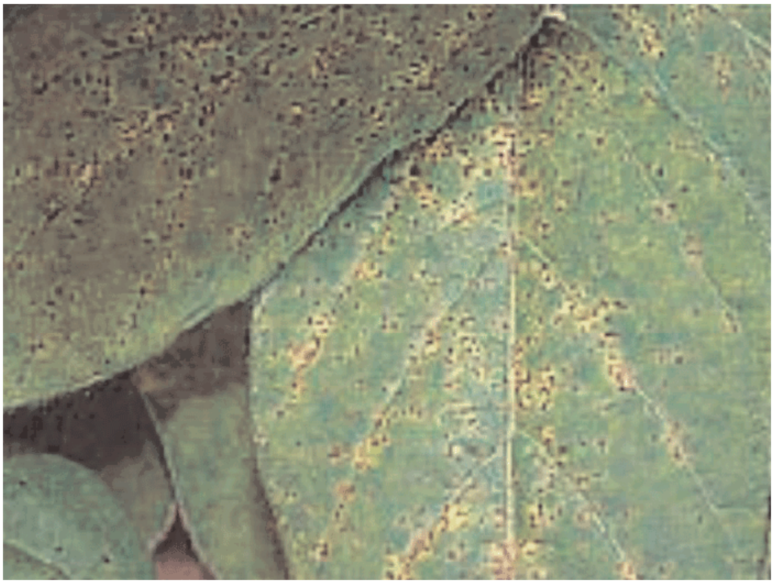

Figure 2. Typical brown-red soybean rust lesions on the upper leaf surface. Note the non-descript yellowing around some of the lesions.
Photo courtesy of USDA.

Figure 3. Close-up (60X) view of volcano-shaped pustules on kudzu. Pustules on soybeans and other hosts will look very similar. There may be a slight difference in color only.

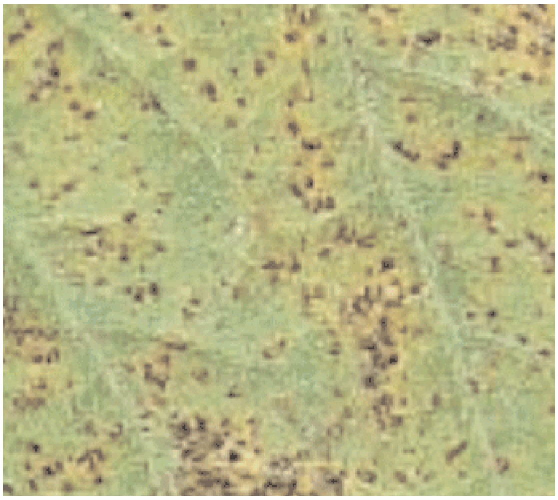

Figure 4. Raised volcano-shaped soybean rust pustules on lower soybean leaf surface.

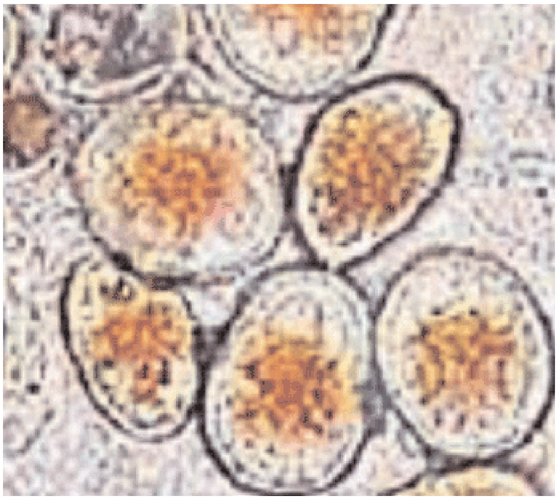

Figure 5. Soybean rust spores viewed under microscope at 400X.

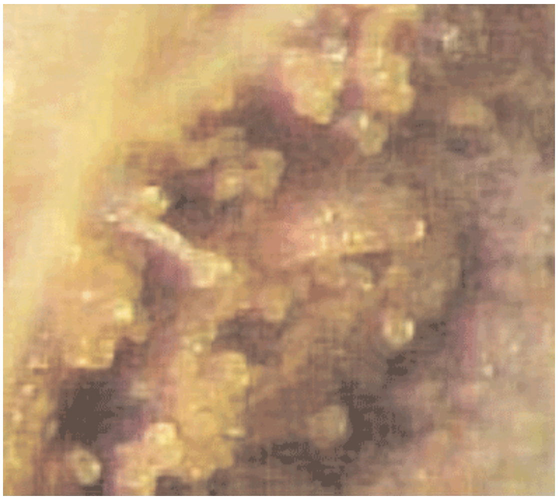

Figure 6. Close-up (60X) view of volcano-shaped pustules on Florida beggarweed. Note the light tan color compared to the darker brown of pustules on kudzu in Figure 5.

Other Crops and Weed Hosts Commonly Found in the Southeastern United States: Many legumes are hosts for the fungus which causes soybean rust. However, in the United States the incidence of soybean rust on vegetables in the field has been minimal. There also have been very few reports of soybean rust on weeds in the field. Many of these hosts are susceptible to infection by other species of rust which have similar symptoms. The susceptible crops and weed hosts found in the Southeastern United States are listed below:

Common vegetable and weed hosts of soybean rust:	
Beans - Green, Succulent, Garden or Snap	Kudzu*
Bean - Lima or Butter	Lupine - Blue, White, and Yellow
Florida Beggarweed	Peatree or Colorado River Hemp
Blackeyed Pea, Cowpea or Yardlong Bean	Pigeon Pea
Broadbean or Fava Bean	Urd or Black Gram
Clover - Crimson and White	Winged Bean
Coffee Senna	Woolypod Vetch
Crotolaria	

* Believed to serve as one of the the primary over-wintering sources. Over-wintering potential of the other hosts such as Beggarweed, Clover and Coffee Senna is unknown.

Monitoring Rust Movements

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Sentinel Plots in the Southeastern United States: As part of the USDA-APHIS and the United Soybean Board and North Central Soybean Research Program, the progress of soybean rust development was monitored in 2005 and in 2006 is being monitored in a total of 574 sites in 31 states. In this program there are a total of 32 sentinel plots in Georgia, 15 in North Carolina, 17 in South Carolina and 10 in Virginia. In each state the monitoring program is supervised by the state Extension Soybean Pathologist. Additionally, pathologists and regulatory scientists may conduct surveys to detect soybean rust. This information is logged into a database and counties that have been checked and found free of rust are colored green on the USDA Soybean Rust Web site. Counties where rust has been detected are colored red. Also, any detections from samples submitted to plant diagnostic clinics are also logged into this site. This program has been extremely effective in detecting soybean rust before rust has been found in commercial fields, and is the basis on which extension professionals make their recommendations to apply fungicides. All of this information can be accessed at *http://www.sbrusa.net/*. This is a near real time report of the assessments of risk by local plant pathologists. Another source of information is the North Carolina Rust forecast site *http://www.ces.ncsu.edu/depts/pp/soybeanrust/*. This site provides information on likely movement of spores from sources of rust.

Figure 7. Collecting soybean leaf samples and a Syngenta Crop Protection-provided spore trap placed in the center of a Washington County, Georgia sentinel soybean plot in 2005.

Value of Spore Traps in Predicting Spread: As part of a study conducted by Syngenta Crop Protection and the University of Arkansas, spore traps have been placed (in 2005 and 2006) in sentinel plots throughout participating soybean-producing states. The traps are used to collect rust spores onto a microscope slide coated with petroleum jelly. The slide is placed inside of a plastic tube that is used to capture wind-blown spores. The purpose of this study was to determine if these spore traps could be used to provide an additional warning tool for soybean rust by detecting the presence of rust spores that may lead to the development of the disease.

Currently, the spore traps provide an indication that soybean rust spores MAY be in the area. This does NOT necessarily mean that soybean rust will occur. In 2005, 'rust-like' spores were detected as far north as Minnesota and Canada, yet soybean rust never developed north of Kentucky. At present, researchers are trying to improve upon their ability to identify to species the spores caught in the traps. There are three reasons why these spore traps are currently poor predictors of disease spread:

1. **Without a PCR or an ELISA assay of these slides, we cannot say with 100% certainty that we have soybean rust. Without a soybean rust DNA or protein confirmation, there is a possibility that the 'rust-like' spore captured in the trap is not soybean rust.**

2. **The viability of the spores (their ability to infect soybean) can not be determined.**

3. **Even if they are soybean rust spores, a susceptible plant (a soybean or one of the weeds or vegetables listed previously) and favorable weather conditions must be present to have soybean rust. In many cases the number of spores recovered is so low that it would take one generation (seven to ten days) for the disease to develop to detectable levels.**

Since this disease has the potential to spread quickly, there is a need for a quick field diagnosis. Unfortunately, there are no accurate tests available for rapid field diagnosis of soybean rust (such as ELISA quick strips, etc.). Researchers are currently working on the development of more rapid diagnostic tests.

Common Diseases of Soybean in the Mid-Atlantic Region

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Common diseases of soybean are caused by viruses, bacteria, fungi and nematodes. Some diseases are spread by insect vectors and nematodes while others are spread by wind, splashing rain, or movement in soil. The best way to determine if disease control would be profitable is to first identify the diseases that are capable of causing economic yield losses. Symptoms of disease include the plant damage caused by a pathogen and the reaction of plants to infection. Signs are the visible evidence of the pathogen. Some diseases have characteristic symptoms and signs that are identifiable in the field. However, several soybean diseases can share common symptoms and are difficult to identify in the field even with a hand lens. Whenever in doubt, always contact your county Extension Agent for assistance in identifying the disease or collecting samples for submission to a State University diagnostic clinic.

Most of the common diseases of soybean can be managed efficiently by adopting long-term production strategies. These strategies should include maintaining a favorable soil pH and fertility level for crop growth, effective weed and insect control, and cropping systems that offer disease suppression through crop rotation and variety selection. The following photographs were selected to illustrate frequently used diagnostic symptoms and signs used for identification of specific soybean diseases. For simplicity, most of these pictures were taken where only one disease was present which may or may not be the case. When more than one disease is present, symptoms can be more complex and require microscopic examination of samples by a trained observer for disease identification.

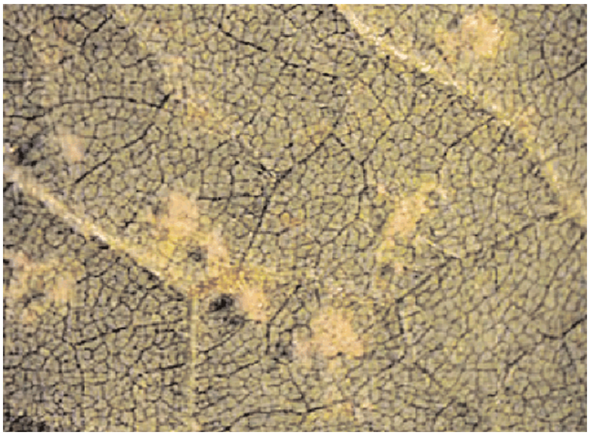

Figure 8. Yellow spots with downy mildew

Figure 9. Mildew on lower leaf surface

Downy mildew (*Peronospora manshurica*)

Symptoms: Pale green to yellow spots on upper leaf surface. Infected pods show no visible symptoms, but seed can be smaller.
Signs: Mold and spores of fungus are visible on undersurface of leaves in yellow spots (Figures 8 and 9). Seeds at harvest may be covered with crusty-appearing mold and spores.
Control: Use seed treatment, crop rotation, and less susceptible variety.

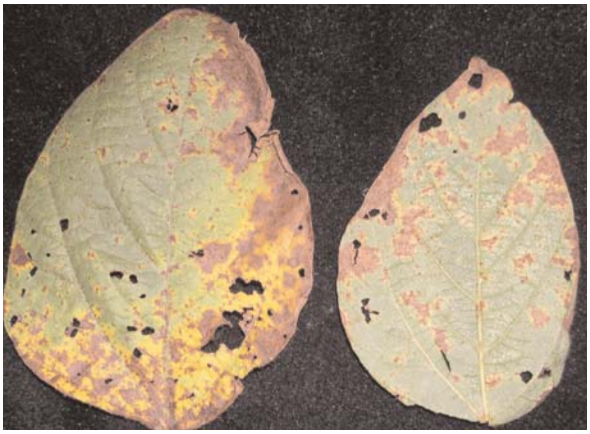

Figure 10. Disease on upper/lower leaf surface

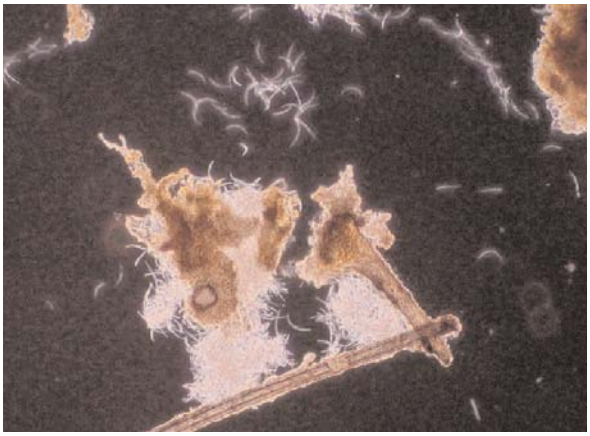

Figure 11. Pycnidia and spores of fungus

Brown spot (*Septoria glycines*)

Symptoms: Lesions are not distinctly different from similar diseases. Spots begin as irregular minute specks that expand into larger brown spots. Appears first on lower-most leaves and may spread to upper leaves (Figure 10). Disease is usually not of economic importance.
Signs: Tiny fruiting bodies of fungus (pycnidia) are immersed in necrotic tissue. Spores are curved, and exude from pycnidia in curled masses that are visible with stereomicroscope (Figure 11).
Control: Increase tillage to bury infested soybean debris, rotate crops, and plant disease-free seed. Fungicides are not recommended since disease has little or no impact on yield.

Figure 12. Spots on upper/lower leaf surface

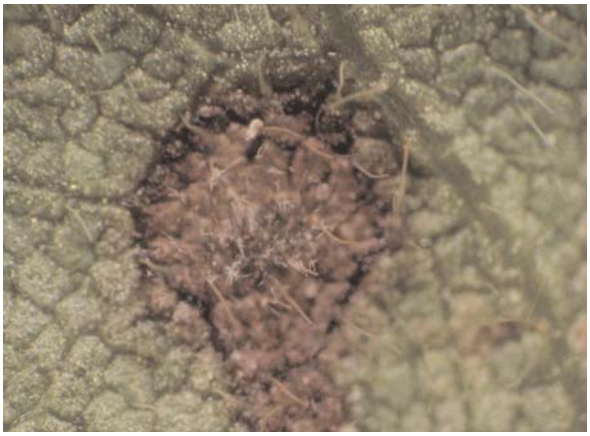

Figure 13. Sporulation of fungus in lesion

Frogeye leaf spot (*Cercospora sojina*)

Symptoms: Small spots with dark reddish-brown margin. Old lesions have papery tan to white center. Spots usually develop in mid-season in young, upper leaves of plant (Figure 12). Older, fully expanded leaves or leaves that develop in dry weather may escape disease.
Signs: Light gray to white spores of fungus are produced in moist, humid weather (Figure 13).
Control: Select less susceptible variety, increase tillage, use crop rotation, seed treatments, and apply fungicide spray at R2 or R3.

Figure 14. Cercospora blight of leaves

Figure 15. Infected pods

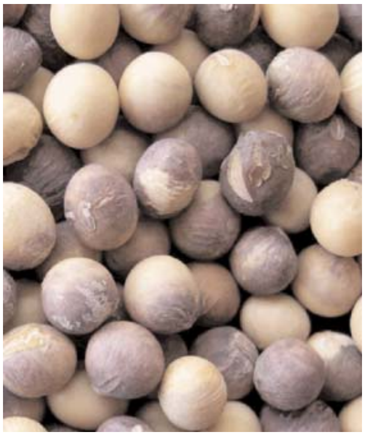

Figure 16. Purple seed stain

Cercospora blight and purple seed stain (*Cercospora kikuchii*)
Symptoms: Leaves have reddish-purple coloration and bronzing from beginning of and through seed development on upper leaves (Figure 14). Round reddish-purple lesions develop on pods which later become purplish black (Figure 15). Infected seeds have purple stain (Figure 16).
Signs: Sporulation occurs in minute lesions in humid, wet weather. Spores are long and filiform and distinguishable only under a microscope.
Control: Variety selection, seed treatment, crop rotation and fungicide application at early pod (R3).

Figure 17. Target spot lesions on lower leaves

Figure 18. Lesions on upper leaves

Target spot (*Corynespora cassiicola*)
Symptoms: Round to irregular, reddish-brown lesions surrounded by dull green or yellowish green halo. Larger spots may contain light and dark rings, hence the name, target spot (Figures 17 and 18).
Signs: Spores of the fungus are not visible without a microscope.
Control: Some varieties have resistance. The benefit of a fungicide spray for control of target spot has not been demonstrated in the Mid-Atlantic region.

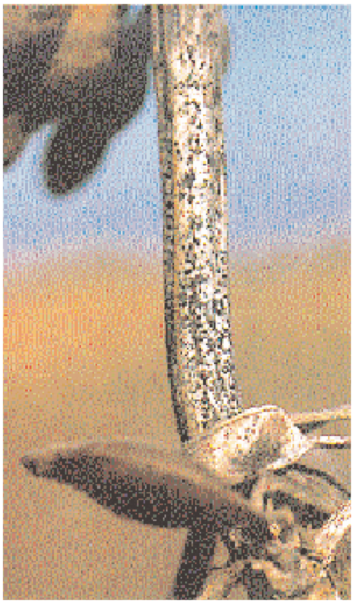

Figure 19. Black fruiting bodies at random

Figure 20. Microscopic view of fruiting body and spores

Figure 21. Seed infection

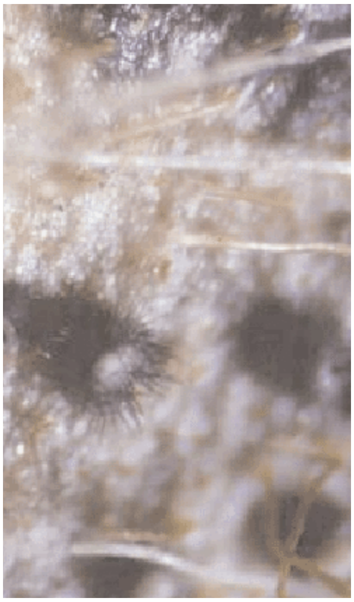

Figure 22. Fruiting bodies of fungus on infected leaf

Anthracnose (*Colletotrichum truncatum*)

Symptoms: Brown lesions develop on stems, pods and leaves (Figure 19). Infected tissues turn brown and senesce early.
Signs: The fungus produces randomly distributed, black fruiting bodies with black hairs (setae) and numerous canoe-shaped spores (Figures 20 and 22). Pods infected early fail to produce seed; late infections result in shriveled or moldy seed with dark lesions on seed coat (Figure 21).
Control: Tillage to bury infested crop residues, crop rotation, seed treatment, fungicide application at beginning pod stage (R3), and avoid delays in harvest.

Figure 23. Black fruiting bodies of fungus in rows on stems

Figure 24. Normal Seed

Figure 25. Fungus on seed is white and chalky

Pod and stem blight (*Phomopsis longicolla*)

Symptoms: Causes blight of stems, pods and leaves (Figure 23). Infected seed are shriveled, have cracks on the surface and have a chalky appearance (Figure 25).
Signs: Black fruiting bodies of fungus (pycnidia) are in rows on blighted stems and scattered on blighted pods and leaves. Mold on seed colonized by the fungus appears chalky.
Control: Tillage to bury infested residues of previous soybean crop, crop rotation, seed treatment, foliar spray of fungicide at beginning pod (R3), and avoid delays in harvest.

Figure 26. Early symptoms on young leaves

Figure 27. Lesions merge to cause blight of leaf

Figure 28. Bacterial streaming from blighted tissue

Bacterial blight (*Pseudomonas syringae pv. glycinea*)

Symptoms: Leaf spots appear water soaked at first. Yellow halos develop around lesions with brown centers (Figure 26). Over time, dead tissue falls out causing a tattered appearance (Figure 27).
Signs: Bacteria stream from infected tissue placed in water and viewed with microscope (Figure 28).
Control: Avoid highly susceptible varieties, plant pathogen-free seed, and use tillage to enhance decay of infested crop residues.

Figure 29. Lesions on upper and lower leaf surface

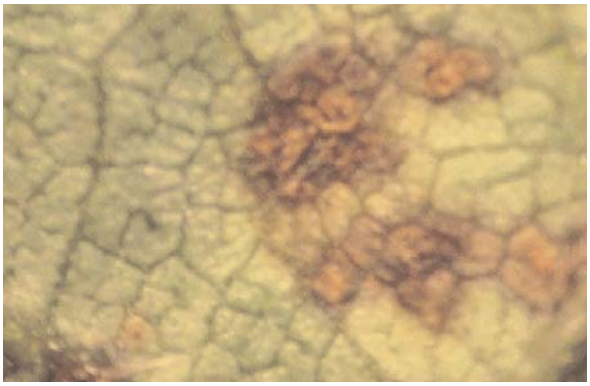

Figure 30. Pustules on lower leaf surface

Bacterial pustule (*Xanthomonas campestris pv. glycines*)

Symptoms: Begins as minute lesions with elevated centers (Figure 29). Pustules form in center of lesions mostly on lower leaf surface (Figure 30). Pustules can be confused with soybean rust.
Signs: None other than pustules formed by enlargement of host tissues on underside of leaves.
Control: Most soybean varieties have some resistance to the disease. Use same procedures as recommended for bacterial blight in problem fields.

Examples of Soilborne Diseases of Soybean:

Figure 31

Figure 32

Soilborne diseases often produce symptoms of disease in leaves that may include wilting (Charcoal rot, Sclerotinia), yellowing between veins and/or necrosis between veins (brown stem rot, sudden death syndrome, red crown rot) or mild yellowing between veins similar to manganese deficiency (soybean cyst nematode) (Figures 31 and 32).

Figure 33

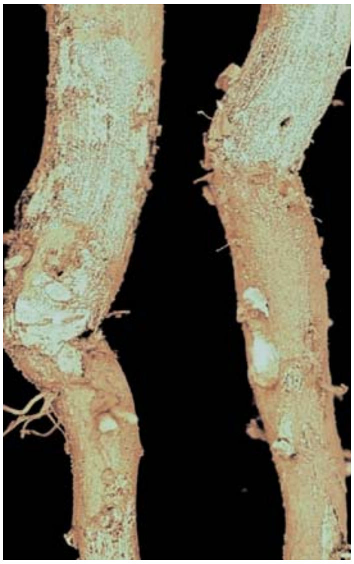

Figure 34

Charcoal rot
(*Macrophomina phaseolina*)
Symptoms: Stunting and reddish brown to black discoloration of lower stem in seedlings. Taproot and lower stem of older plants have reddish to brown stains (Figure 33). Black flecking under the bark and black streaking in wood of taproots are diagnostic symptoms.
Signs: Black sclerotia of causal fungus in taproots (Figure 34).
Control: Crop rotation, good soil fertility for maintaining crop vigor, and irrigation to minimize stress.

Figure 35

Red crown rot
(*Cylindrocladium parasiticum*)
Symptoms: Yellowing and browning between veins of upper leaves similar to brown stem rot and sudden death syndrome.
Signs: Red fruiting bodies of fungus develop on stems at the soil line (Figure 35).
Control: Crop rotations without legume hosts (peanut, alfalfa, etc.), delayed planting until soil temperatures are warmer.

Figure 36

Figure 37a

Figure 37b

Sclerotinia stem rot (*Sclerotinia minor; S. sclerotiorum*)

Symptoms: Wilt and eventual death of portions above stem infections. Stem lesions are tan to nearly white, with reddish discoloration at margins (Figure 36).

Signs: Fungus produces black sclerotia on stems, and inside pods and in the pith of stems: (Figure 37a) small sclerotia = *S. minor*, (Figure 37b) large sclerotia = *S. sclerotiorum*.

Control: Crop rotation with non hosts (legumes, sunflower, tobacco, etc.), soil tillage to bury inoculum, and use of tolerant varieties.

Figure 38

Sclerotium blight (*Sclerotium rolfsii*)

Symptoms: Light brown lesions develop on stems near soil surface and later darken. Yellowing and wilting are usually the first symptoms.

Signs: The fungus grows from infection sites and produces a white mat of mold on infected stems (Figure 38). Numerous tan to brown resting bodies (sclerotia) about the size of mustard seed are produced by the fungus.

Control: Crop rotation with non-host crops (corn, or other grass-type crops), tillage to bury inoculum and reduce carryover and planting less susceptible varieties.

Agronomic Facts the Grower Needs to Know

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Don't Panic: While it is uncertain whether Asian Soybean Rust will be a serious economic problem in the Southeast in 2006, the potential is there. It may or may not become widespread, develop very quickly, or come early enough to be a problem. With the potential for this disease to develop, there are several agronomic facts that should be considered if producing soybeans in Georgia, the Carolinas, or Virginia.

Most growers probably do not need to be advised against panicking, but a plan of attack needs to be in place in the event that the disease does spread rapidly. There is no doubt that soybean rust can be an additional and unwanted headache in soybean production, but we do have fungicide tools at our disposal to control this disease. Soybean rust has garnered much attention by the press in the past. This year will probably be no different. Producers may also feel pressed by the agricultural chemical industry to use certain products. While there are differences in products, the key factors with controlling soybean rust are timing of application and thorough coverage.

Seriously consider crop insurance. This is the kind of situation that insurance was designed for as there is potential for serious losses, but the likelihood of that happening is low enough that insuring against that loss is not terribly expensive. Having this safety net will go a long way in helping make sound decisions about controlling this disease.

Understanding the Growth Habit of Soybeans: Due to the potentially rapid spread of soybean rust and the difficulty in identifying it, most literature focuses on spraying soybeans at specific growth stages. Most often mentioned are the reproductive stages, designated R1 through R8. R1 and R2 refer to bloom development, R3 and R4 refer to pod development, R5 and R6 refer to seed development, and R7 and R8 refer to maturity of the plant. See Table 1, pg. 18. It is believed that the reproductive stages are the critical time to spray with fungicides because rust seldom develops earlier in the season than first bloom. See Table 2, pgs. 21-22.

Table 1. Soybean Growth Stages Descriptions.

Stage	Comments
VE	Soybeans have just emerged from the ground. The only leaves present are the cotyledons.
VC	A pair of "unifoliate" leaves has developed just above the cotyledons. At this time both sets of leaves, (the cotyledons and the unifoliates), are arranged opposite each other on the stem. After this point all new foliage will consist of trifoliates (3-leaflets) arranged alternately on the stem.
V1	One trifoliate leaf on the plant in addition to the cotyledons and the unifoliate leaves.
V2-Vn	Until the plant starts to bloom the growth stages are discussed in terms of main-stem tri foliate leaves. Determinate varieties may develop as many as 16 to 20 main-stem leaves prior to flowering.
R1	One bloom present on the plant. This first flower will generally appear towards the bottom half of the plant.
R2	Full bloom. Flowers are present to the top two nodes of the plant. Typically occurs 1 day after R1 in Georgia, the Carolinas, and Virginia.
R3	Pods can be observed at any one of the uppermost four nodes on the plant. Typically occurs 10 to 12 days after R2.
R4	Full pod. Pods at any one of the top 4 nodes of the plant are ¾" long. Typically occurs 8 to 10 days after R3.
R5	Beginning seed. Seeds in the pods are 1/8" long at any one of the top 4 nodes of the plant. Typically occurs 9 to 11 days after R4.
R6	Full seed. Seeds fill the pod cavity at any one of the top 4 nodes of the plant. Typically occurs 13 to 17 days after R5. After this point beans should be safe from the effects of rust, and fungicides cannot legally be applied.
R7	Beginning maturity. At least one mature pod can be found on the plant. Typically occurs 17 to 21 days after R6. Plants are considered physiologically mature, and thus safe from frost.
R8	Full maturity. 95% of the pods are their mature color. Typically occurs 9 to 11 days after R7. Beans are close to being harvest ready.

A field has reached a growth stage when 50% of the plants meet the appropriate criteria.

Table 1 is adapted from "FEHR, W.R., C.E. CAVINESS, D.T. BUTWOOD, and J.S. PENNINGTON. 1971. Stage of development descriptions for soybeans, Glycine max (L.) Merr. Crop Science 11:929-931."

The reproductive stages are also shown schematically on the inside back cover of this publication.

Agronomic Considerations:

Fertility and pH

Correct any pH and nutrient deficiencies. A healthy plant can withstand stress better than an unhealthy plant. If pH is low, correcting that problem will pay for itself in the absence of any disease. Also correct any other known nutrient deficiencies, particularly potash. Fertilization or liming above and beyond what is needed is not expected to add any additional resistance to soybean rust.

Pest and Weed Management

Continue to manage pests. Pests that should not be ignored include stink bugs, soybean looper and velvetbean caterpillar in Georgia and perhaps South Carolina, soybean aphid in Virginia and maybe North Carolina, and corn earworm in Virginia and the Carolinas. A standard recommendation in the Coastal Plain of Georgia is to apply Boron to aid in pod set and Dimilin for the control of velvetbean caterpillar at the R3 growth stage. This practice should be continued in Georgia. (Research and farmer experience in the Carolinas and Virginia have not shown an economical response from this treatment in their states). In fact, the timing of this application corresponds with the growth stage at which soybeans are most susceptible to rust. Preliminary research indicates that fungicides may be applied with this treatment.

Weeds must also be controlled, especially early in the season. This is a given with or without the added pressure of soybean rust. Although fungicides may be compatible with glyphosate, in most years, weed control should be taken care of prior to spraying for rust.

Consider Earlier Varieties

Variety selection should primarily focus on yield potential. Once selections have been made for a particular farm, you may want to increase the acreage of your earliest variety at the expense of your latest variety. Caution is advised though, since most growers are probably already growing the earliest maturing varieties they consider economically feasible. Theoretically a shift toward earlier maturity is probably more important in Georgia (where the threat of rust is greater) than in Virginia (where the threat of rust is less). Prevailing weather patterns should be considered. Early maturing varieties require moisture during the months of July and early August, typically a drier period in south Georgia. Later maturing varieties require rainfall in late August and early September, typically a wetter period in south Georgia. The bottom line is do not sacrifice potential yield for a disease that may not be a problem.

Planting Considerations

If double-crop soybeans look no more profitable than full-season soybeans at wheat planting time, skip the wheat and grow full-season soybeans. The full-season soybeans will be safe from rust and frost sooner than double crop soybeans will. For each three weeks earlier planting, you can typically harvest about one week earlier.

Do not start planting earlier than you've been starting. In Virginia and North Carolina, this recommendation is to ensure that soil temperatures are warm enough for rapid emergence and reduced root-rot disease likelihood. In South Carolina and Georgia, this recommendation is to avoid premature flowering and subsequent yield reductions. In addition, complete your planting season as soon as practical. Delayed final planting has a lower yield expectation and a predicted greater vulnerability to rust.

Narrow rows may have a greater likelihood of rust development, but also higher yield potential than wide rows (especially in very early plantings, double-crop situations, and on the more productive soils). Don't give up yield to deal with a problem you may or may not see.

Plant populations should not be altered because of rust concerns. Lower populations have only a slightly lower theoretical vulnerability to rust. The general trend is for growers to plant more seeds than they need to plant, and these growers could probably help profits by lowering planting rates a little.

Watch the Sentinel Plots

Be sure to identify a nearby sentinel plot, preferably to the south or southwest. Soybean rust will most likely travel north or northeast. All states in the Southeast (including the state to the south of yours) plan to have sentinel plots well distributed around the state. Paying attention to the progression of the disease will buy valuable time when planning for treatment of soybean rust.

Keep track of confirmed sightings, and try to sort out rumors from facts. There will be reliable reports in all four states of where rust is and is not. Typically, our county Extension agents will know, as will our consultants, Certified Crop Advisers (CCAs), and Department of Ag personnel.

Follow Rust Forecasts

They are not perfect, and they don't all forecast the same thing, but they are useful. They do a good job of telling plant pathologists and agronomists where to focus their scouting for the disease.

Final Thoughts

Since rust will most likely come to your field on air currents from the south, there is no reason to think tillage (or absence of tillage) would influence rust likelihood or severity. As far as equipment goes, it is important to have a sprayer ready, and fitted with nozzles that give medium to fine droplets at volumes of at least 15 GPA (this is not a typical herbicide nozzle). After rust gets into the county is a poor time to be looking for a sprayer, parts for a sprayer, or a custom applicator. Know how you are going to spray before it is time for you to spray.

Scout your soybeans diligently. While no one knows exactly what "diligently" means, it makes more sense to increase scouting intensity than to decrease it. Since rust invariably starts on the bottom side of the bottom leaves, that's where successful scouting for rust is going to have to be focused, and that cannot be done from the cab of the pickup. Deciding whether to spray, with what and when, is covered in more detail in another section of this bulletin. Being informed and prepared will make this decision much easier. Therefore, decide whose advice you want to trust, a and whose you do not. To the extent that you have an opinion on your local advisors, make that decision now before rust actually gets here.

Table 2. Recommendations for Managing Soybean Rust in 2006

Stage of Development		Days to R7		Fungicide Recommendation if:		
Number	Description	Full Season	Double Crop	No Rust Confirmed within 100 miles	Rust Confirmed within 100 miles	Rust Observed in field
	Vegetative			Do Not Spray	Do Not Spray	**T** or **C** fb **T** or **C** fb **T** or **C** Also See Footnotes
R1 or R2	Early or Full Bloom	65	55	If frogeye leaf spot is identified on a susceptible variety: **S** fb **N** or **N** fb **S** or **S** fb **C**	**S**, **T**, or **C** fb **S, T** or **C**	Same as above
R3	Small Pods	53	47	Same as above	Same as above	**T** or **C** fb **T** or **C**
R4	Full Sized Pods	44	38	If frogeye leaf spot is identified on a susceptible variety: **N** fb **S** or **S** fb **C**	Same as above	Same as above
R5	Small Beans	34	30	If frogeye leaf spot is identified on a susceptible variety: **S**	**S, T,** or **C**	**T** or **C**
R6	Full-Size Beans	19	17	Do Not Spray	Do Not Spray	Do Not Spray
R7	>1 Pod/Plant Mature Color	0	0	Do Not Spray	Do Not Spray	Do Not Spray

S denotes a strobilurin fungicide, **T** denotes a triazole, **C** a combination of the two, and **N** denotes a nitrile fungicide. **fb** means followed by.

Footnotes:

Growth stage descriptions apply to the top four nodes on the main stem. This is a critical distinction for indeterminate varieties. Stage R1 is first bloom, R2 is full bloom, R3 has small pods, R4 has full sized pods, R5 has small beans in the pods, and R6 has full sized beans n the pods in at least one of the top 4 nodes.

We would increase the 100 mile threshold by up to 50 miles if rust is moving fast, conditions favor rust, and your acreage is large. We would decrease it by up to 50 miles if rust is moving slowly, weather is dry and hot, and your acreage is small.

Three weeks after the first fungicide application, assess the need for another application. Consider the development of the disease to date, the stage of growth of the soybeans, and how favorable the weather appears to be for rust development.

Check specific product labels for use guidelines and precautions, including at which growth stages the fungicide may and may not be sprayed, how many times it may be used on the same field in the same season, how close to harvest is can be sprayed, and in the case of section 18 cleared fungicides, whether it is cleared for use in your state. The label is the law.

Avoid using the same chemical alone in two consecutive applications.

No fungicide with a section 18 clearance should be used more than twice in the same year. No more than 3 applications can contain a section 18 cleared fungicide.

Higher labeled rates provide longer residual activity, and will probably delay need for subsequent applications.

If the soybean crop is insured, producers are required to follow good farming practices and to document their actions to deal with rust. Good farming practices are considered to be the recommendations of agricultural experts, including employees of Cooperative Extension System, of state and university agricultural departments, Certified Crop Advisers (CCAs), Certified Professional Agronomists (CPAs), and Certified Professional Crop Consultants (CPCCs). If a producer chooses not to spray for economic reasons, and the crop is insured, notice of damage or loss should be given to the crop insurance agent and the amount of damage associated with uninsured causes of loss assessed against the insurance guarantee. In some cases, no indemnity may be payable to the insured.

Not all producers or advisers will want to assume the same risks, treatment capabilities, and fungicide performance as these recommendations assume, and may thus want to modify these recommendations. That's OK with us. They now have the benefit of our thinking on which to base their own recommendations.

Jim Dunphy & Steve Koenning, NCSU (June, 2006)

Spray Decisions Based on Rust Movements

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Deciding when you should spray fungicides is the most critical decision you will make in controlling rust. When weather conditions are right, rust can move rapidly within and between fields. Applying a fungicide before rust becomes prevalent in a field is necessary if yield losses are to be avoided. The rule of thumb is to spray when less than 5% of the leaves have three to five pustules present. If spraying is delayed then yield losses can be substantial. Most fungicides will control rust for only two to three weeks. So, an early spray may not be the safest decision. In 2005, rust was never detected in a field prior to R1 and in many cases was not detected until R3/R4. So spraying prior to flowering is probably not cost effective and may lead to the need for a second spray.

When Should You Spray for Rust: Predicting when rust will be arriving in your field is critical to making spray decisions. Your accuracy in predicting the arrival of rust in your area can be enhanced by utilizing the following resources:

Disease Tracking Reports
As rust begins to move northward you should monitor disease progress reports on the USDA website, *http://www.usda.gov/soybeanrust/* on at least a weekly basis. This site records the incidence of rust on both kudzu and soybean. Reports for soybean include both commercial production fields and sentinel plots (see page 7). When rust reaches within 100 miles of your location you should be ready to spray. Table 2 (page 21) outlines the different scenarios that you might encounter. Growers in Georgia and Florida may want to decrease the 100-mile alert radius to 25 or 50 miles depending upon the severity of rust in their state.

Sentinel Plot Data
Multiple locations in each state are planted in one acre or smaller plots of several maturity groups (early to standard in a locality) up to three weeks prior commercial planting. This provides an extended period of favorable conditions for infection by soybean rust and early detection of the disease as it spreads northward from state to state. The greatest risk of crop infection is when plants in each maturity group begin flowering and proceed through the stages of pod and seed development. As a result, sentinel plots are expected to be the first to exhibit disease, which can provide an early warning before commercial fields show the disease. Once disease appears in sentinel plots, they should be sprayed with a triazole fungicide or a mixture of triazole/strobilurin fungicides in order to minimize opportunities for secondary spread of disease to neighboring fields. Data from the sentinel plots is reported at the USDA rust website, *http://www.usda.gov/soybeanrust/*.

Scouting Your Fields

Commercial fields need to be scouted once a week from the start of flowering (R1) up to full seed (R6). The intensity of scouting should be increased as rust moves closer and especially when windborne spores are detected in a region. Scout fields in a zigzag pattern and use different entry and exit points on each visit. Priority should be given to areas likely to have extended periods of leaf wetness due to poor air drainage as in low lying areas and locations with heavy plant growth and a dense canopy. Scouting for rust should be done by checking the leaves that are midway or lower on plants. This is where rust is most likely to develop first.

Plant Growth Stage

Until research justifies otherwise, sprays of fungicides will be recommended for control of soybean rust only during the period from flowering (R1) until the beginning of full seed (R6). Overall, it seems likely that fungicides may be the most profitable when applied in the period from flowering (R2) to beginning seed (R4). Spraying earlier or later is likely to reduce the profitability of fungicide use. No fungicide sprays are expected to be profitable if applied prior to flowering (R1) or after full seed (R6).

Stay informed on the status of soybean rust by checking the Soybean Rust Home Page in your state and/or the USDA web page *http://www.usda.gov/soybeanrust/*. Many states have electronic newsletters either posted on web sites or emailed directly to growers. Collectively, the above information should be used in the decision to apply a fungicide. Other factors may also be considered depending upon field conditions such as weather, plant growth, canopy development, yield potential, and the presence of other diseases

Newsletters by State

Clemson University has a weekly "Soybean Rust Newsletter" during the rust season. To signup for this newsletter email John Mueller at *jmllr@clemson.edu*.

North Carolina State University issues updates on an as-needed basis. To receive these updates contact your local North Carolina extension agent.

The University of Georgia has a website containing an archive of their soybean newsletters and current meeting info at *http://www.griffin.peachnet.edu/caes/soybeans/*.

Information on rust in Virginia is available in the "Virginia Soybean Update". To sign up for this monthly newsletter, email David Holshouser at *dholshou@vt.edu*.

Types of Fungicides and Rates of Application: The triazole type fungicides have curative and preventative activity, whereas strobilurin fungicides and chorothalonil are preventative only. If a soybean field has already been exposed to the rust fungus and especially if active sporulation is observed, a triazole type fungicide is preferred since it may eradicate some infections. If infection has occurred, higher rates of a triazole or a combination material may be needed. This may reduce the necessity of a second spray since higher rates in general will give longer residual activity. Some data suggest that strobilurin type fungicides may provide better protection from many of our typical late season diseases (anthracnose, cercospora blight, brown spot, frogeye leaf spot, and target spot) whereas the triazoles work best on powdery mildew and rust. This may explain the popularity of combination products in Brazil. See "Management of Soybean Rust" (pages 27 and 28) for more in-depth information on fungicides.

Method of Application: Coverage is the key! In general, higher spray pressure, higher water volume, and different nozzles will be needed to obtain small- to medium-sized droplets that will penetrate the canopy.

Yield Boost from Fungicides?: Will the strobilurin fungicides Headline or Quadris provide a yield boost in the absence of disease? We have relatively little data in the Atlantic coastal states on the effects of these materials on soybean yield. They are certainly excellent products for managing several serious foliar diseases in soybean, such as frogeye leaf spot (on susceptible varieties) and several other common diseases. Some areas where large yield increases occur also have an environment more conducive for disease, including some diseases that have not been identified or are rarely a problem in Atlantic coast states. A yield boost from a strobilurin fungicide is most common in high yield (often irrigated) environments.

Management of Soybean Rust

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Fungicides Available: There are no commercial soybean varieties with resistance to soybean rust at this time. Management of soybean rust will be with fungicides. Not all fungicides are effective against soybean rust. With the arrival of soybean rust in the United States, emergency registration of additional fungicides went into effect through the 2007 growing season (See Table 3, pg. 28). In general the recommendation will be to make an application if infection is likely and a second application 14 to 21 days later if conditions are favorable for disease development. Late season sprays (after stage R5, or early seed fill) have not been effective in South America unless they follow an earlier spray. The primary classes of fungicides that will be used for rust are the strobilurin and triazole fungicides. Chlorothalonil (a nitrile fungicide) is also effective in protecting against rust but has less residual activity and may require more frequent applications than strobilurin or triazole fungicides. Also, chlorothalonil cannot be applied within 42 days of soybean harvest. All triazole fungicides have some limited systemic activity (move through the plant, especially to newly developed leaves) and are thus somewhat forgiving if application is less than perfect. Strobilurin fungicides may have some local systemic activity and will move into the leaf and stem within an hour or two of application. Both strobilurin and triazole fungicides will provide protection for two to three weeks depending on the rate at which they are applied. Chlorothalonil-type products have limited persistence depending upon environmental conditions. Strobilurins and triazoles are affected much less by the environment than chlorothalonil.

Timing of Application: Overall, it seems likely that fungicides may be the most profitable when applied in the period from flowering (R2) to beginning seed (R4). Spraying earlier or later is likely to reduce the profitability of fungicide use. No fungicide sprays are expected to be profitable if applied prior to flowering (R1). Fungicide sprays after R5 are not permitted and will provide no economic benefit.

For Current Labels on Asian Soybean Rust See:
http://www.greenbook.net/FocusOn/SoybeanRust/
http://www.epa.gov/oppfead1/cb/csb_page/updates/soybean_rust.htm#section3

Table 3. Fungicides for managment of soybean rust

Brand Name	Common Name	Rate (fl oz/a)[b]	Number of Applications/year and Maximum (fl/oz/a)/year	Fungicide Class[a]	Label[c]
Bravos, Echo, Equus	Chorothalonil	24-32	3 (96)	Nitrile	Section 3
Quadris	Azoxystrobin	6.2-15.4	(92.1)	Strobilurin	Section 3
Headline	Pyraclostrobin	6.0-12.0	2 (24)	Strobilurin	Section 3
Tilt, PropiMax, Bumper	Propiconazole	4.0-8.0	2 (12)	Triazole	Section 18
Folicur, Uppercut, Orius	Tebuconazole	3.0-4.0	2 (8)	Triazole	Section 18
Laredo EC	Myclobutanil	4.0-8.0	2 (16)	Triazole	Section 18
Domark 230 ME[d]	Tetraconazole	4.0-6.0	1 (6.0)	Triazole	Section 18
Stratego	Propiconazole + Trifloxystrobin	5.5-10.0	2 (20)	Strobilurin + Triazole	Section 18
Headline SBR	Pyraclostrobin + Tebuconazole	5.9-7.8	2 (15.6)	Strobilurin + Triazole	Section 18
Quilt	Azoxystrobin + Propiconazole	14-20	2 (40.0)	Strobilurin + Triazole	Section 18
Alto[e]	Cypraconazole	2.75-4.0	2 (8.0)	Triazole	Pending
Quadris Xtra	Azoxystrobin + Cypraconazole	4.0	2 (8.0)	Strobilurin + Triazole	Pending
Caramba[f]	Metconazole	8.2-9.6	2 (19.2)	Triazole	Pending
Headline Caramba Copack	Pyraclostrobin + Metconazole	11.9	2 (23.8)	Strobilurin + Triazole	Pending
Punch	Fluzilazole	4.0	2 (8.0)	Triazole	Pending
Charisma	Fluzilazole + Famoxodone	9.0	2 (18.0)	Triazole	Pending
Topguard	Flutriafol	7.0	2 (14.0)	Triazole	Pending

[a] Combinations of a strobilurin and a triazole may provide increased control and residual activity.
[b] Higher rates provide greater residual activity and may reduce the need for later sprays.
[c] Section 3 labels are for general use and not contingent on emergency conditions. Section 18 labels are temporary and expire in November 2007 unless renewed or replaced by Section 3 labels. Pending indicates that these materials may be labeled as section 3 or section 18 materials. Fungicides labeled as Section 18 materials are restricted use pesticides when used on soybean, regardless of what the accompanying label material may say and you must have the section 18 label in your possession if using these materials. Read label for plant back restrictions on all materials used, some are very restrictive.
[d] Maximum of 1 application per year (request to amend label to allow 2 applications per season is pending).
[e] Section 18 Approved in States of MN, SD, IA, MO, MD, and IL.
[f] Section 18 Approved in States of MN, and SD.

Fungicide Spray Test Results - 2005

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During the fall of 2005 numerous fungicides tests were conducted in Georgia and South Carolina where levels of rust were severe enough to cause yield losses occurred. The results from five of these fungicide tests are reported in the tables below. In the first four tests, the fungicides were applied twice at approximately two-week intervals. In the fifth test, the fungicides were applied only once. Use of surfactants varied with the fungicide applied. In each case sprays were begun after flowering had begun.

A yield response is obviously the most important result to look for in a fungicide trial. Equally important is to see a decrease in severity of rust where the fungicide has been applied. If levels of rust are the same in the nontreated check and the fungicide treated plots then the yield response is not due rust control but the control of some other disease. In these tests the levels of rust control are very high. In all five tests more than 70% of the leaf surface area is affected by rust in the nontreated checks. Almost all of the fungicide treatments reduced the percentage of leaf area damaged below 25% and most reduced the damaged area to less than 5%.

The tests conducted in 2005, including the five reported here, were the first tests conducted in the southeastern United States to evaluate fungicides for rust control. The tests reported here clearly demonstrate the value of a fungicide applied at the proper growth stage to fields with significant levels of rust. This is evident when yields of the nontreated checks are compared to the fungicide treated plots. These tests do not clearly separate which fungicide provides greater yields or rust control. It will take at least another year of testing to begin to separate fungicides for rust control. If rust behaves differently in 2006 than in 2005 some fungicides may provide better control in one year than the next. Also we have very little understanding of which fungicides work best at each stage of plant growth and disease development.

Several fungicides with Section 3 and 18 labels as well as some with pending labels were not included in this test. All of the fungicides labeled for use on rust or with labels pending are listed in the table on the back page of this booklet. When properly applied most of these fungicides do a more than adequate job controlling rust.

Chlorothalonil was not included in the tests reported here. There is data from elsewhere that chlorothalonil is an effective component of a fungicide program to manage soybean rust. However, this product did not perform as well in our study as others did. It may be that (chlorothalonil, e.g. Echo 720, Equus, and Bravo WeatherStik) need to be applied earlier than other fungicides to insure adequate protection.

Remember, triazole fungicides will not provide adequate control of diseases other than rust on soybean. To control leaf, pod, and stem diseases other than rust a strobilurin, chlorothalonil or thiophanate methyl must be applied alone or in combination with another fungicide. Thiophanate methyl applied alone will not control rust.

Table 4. Results from Attapulgus Research and Education Center

Treatment, rate/A	Application dates z	Rust severity x 6 Oct	Yield (bu/A)
Untreated	-----	5.0 a	38.0 f
Headline, 4.71 fl oz, + Folicur, 3.16 fl oz, + Induce, 0.25%	1,2	2.0 g	55.2 ab
Headline, 3.56 fl oz, + Folicur 3.6F, 2.38 fl oz, + Induce, 0.25%	1,2	2.6 fg	52.5 abc
Folicur 3.6F, 3.56 fl oz, + Induce, 0.25%	1,2	2.3 fg	56.8 a
Headline, 6.14 fl oz, + Induce, 0.25%	1	-----	-----
Headline, 4.71 fl oz, + Folicur 3.6F, 3.16 fl oz, + Induce, 0.25%	2	2.8 e-g	54.6 ab
Headline, 6 fl oz, + Induce, 0.25%	1	5.0 a	48.7 cd

[z]The dates for the fungicide applications were 18 Jul for 1 and 9 Aug for 2.
[x]Based on a visual estimation of percentage of each leaflet infected and rated on a scale of 0 to 5, where 0=no disease, 1=trace to 5% infection, 2=5 to 15%, 3=15 to 35%, 4=35 to 67.5%, 5=67.5 to 100%.
[w]Column means with a letter in common are not significantly different (Fisher's least significant difference t-test; P=0.05).

Table 5. Results from Appling County

Treatment, rate/A	Application dates z	Rust severity x 30 Sep	Yield (bu/A)
Untreated	-----	4.6 a	59.8 c
Headline SBR, 7.8 fl oz, + Hook, 8 fl oz	1,2	0.0 d	76.7 a
Headline SBR, 7.8 fl oz, + Hook, 8 fl oz	1	0.3 cd	71.2 a
Headline SBR, 7.8 fl oz, + Hook, 8 fl oz	3	1.1 b	62.8 bc
Headline SBR, 7.8 fl oz, + Hook, 8 fl oz.	1	-----	-----
Folicur 3.6F, 4 fl oz, + Hook, 8 fl oz	2	0.0 d	69.1 ab
Quilt, 14 fl oz, + Hook, 8 fl oz	1,2	0.8 bc	70.9 a

[z]The dates for the fungicide applications were 21 Jul (R2) for 1 and 19 Aug (R4) for 2.
[y]Soybean rust infection was assessed as number of infected leaves from 20 terminal leaflets from lower canopy of each plot.
[x]Based on a visual estimation of percentage of each leaflet infected and rated on a scale of 0 to 5, where 0=no disease, 1=trace to 5% infection, 2=5 to 15%, 3=15 to 35%, 4=35 to 67.5%, 5=67.5 to 100%.
[w]Column means with a letter in common are not significantly different (Fisher's least significant difference t-test; P=0.05).

Table 6. Severity of rust and yield in bu/acre of AGS 825 soybean planted on June 23, 2005 near Blackville, SC. Plots were sprayed with fungicides on September 16 and 30 and harvested on November 11.

Fungicide Regime	Rust Severity[1]	Yield bu/A
4 oz Headline + 4 oz Folicur + N.I.S. fb 4 oz Headline + 4 oz Folicur + N.I.S.	0.28 a	51 a
6.0 oz Headline + N.I.S. fb 4 oz Headline + 4 oz Folicur + N.I.S.	0.88 b	50 a
Check	7.58 a	43 b

Means within a column with a letter in common are not significantly different (P=0.05) according to a DNMRT test.
N.I.S. = nonionic surfactant.
[1]Severity is a rating of the percentage leaf area in a plot affected by rust. 0 = no rust 8 = 100% of leaf area affected.

Table 7. Yield and rust severity of AGS 825 RR soybeans planted in an irrigated field on June 23, 2006 and treated with fungicides on September 16 and September 30. Plots were harvested on November 11.

Fungicide Regime	Rust Severity[1]	Yield bu/A
Quadris 6.2 fl oz/acre fb Quadris 6.2 fl oz/acre	0.1 c	54.2 a
Quadris Xtra 4.0 fl oz/acre fb Quadris Xtra 4.0 fl oz/acre	0.2 c	52.9 a
Quadris Xtra 4.0 fl oz/acre + COC 1% V/V fb Quadris Xtra 4.0 fl oz/acre + COC	0.1 c	52.3 a
Alto 1.03 fl oz/acre fb Alto 1.03 fl oz/acre	0.1 c	50.9 a
Quilt 14 fl oz/acre + COC 1 % V/V fb Quilt 14 fl oz/acre + COC 1 % V/V	6.0 b	50.7 a
Nontreated Check	7.4 a	44.0 b

Means within a column with a letter in common are not significantly different according to a DNMRT ($P<0.05$).
Registrations for Alto and Quadris Xtra are pending.
[1]Severity is a rating of the percentage leaf area in a plot affected by rust. 0 = no rust 8 = 100% of leaf area affected.

Table 8. Yield and severity of rust in AGS 825 soybeans planted in an irrigated field on June 23,2005 and treated with fungicides on September 20. Plots were harvested on November 11.

Fungicide	Rate oz/acre	Rust Severity[1]	Yield bu/A
Stratego	7.0	3.38 b	50.5 a
Punch	4.0	1.32 bc	48.1 a
Charisma	10.0	0.72 c	47.6 a
Punch	3.0	0.60 c	47.3 a
Nontreated	----	6.78 a	43.2 b

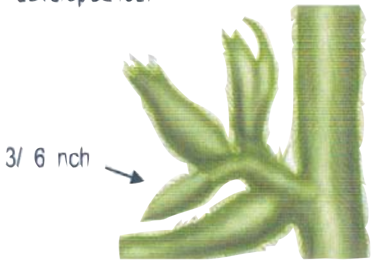
Means within a column with a letter in common are not significantly different (P=0.05) according to DNMRT.
Stratego was applied with a 0.125% v/v nonionic surfactant.
[1]Severity is a rating of the percentage leaf area in a plot affected by rust. 0 = no rust 8 = 100% of leaf area affected.

Identifying soybean growth stages

Begin scouting for soybean rust by the reproductive (R) stages. The growth stages can overlap; consider that a growth stage begins when 50% or more of the plants are in or beyond that stage. A node is a part of the stem where a leaf is attached.

Pod development- R3 and R4

R3- Beginning pod- 5-15 days) pods are 3/16 inch at one of the four uppermost nodes with a fully developed leaf

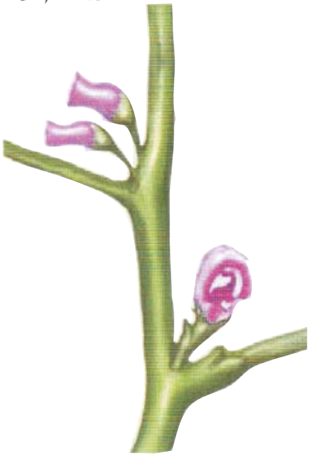


R4-Full pod -(4-26 days) pods are 3/4 inch at one of the four uppermost nodes on a main stem with a fully developed leaf. This stage is the most critical for soybean yield

Drawings adapted from photos at: Soybean Extension and Research Program Department of Agronomy, Iowa State University (www.soybeanmanagement.info). References for growth stage information: "How a Soybean Plant Develops" Special Report 53- Iowa State University and "Reproductive Soybean Development Stage and Soybean Aphid Thresholds" -University of Wisconsin Extension

Bloom stages- R1 and R2

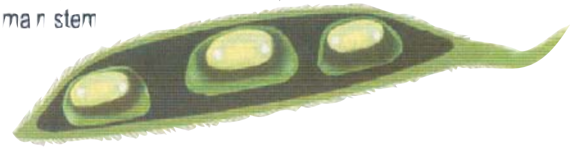
R1 Beginning bloom (1-7days) plants have at least one open flower at any node



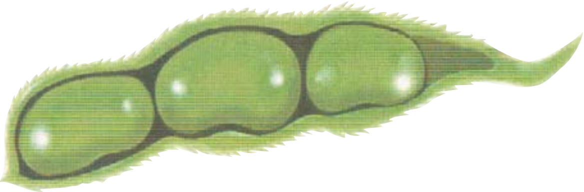
R2 Full bloom-(5-15 days) an open flower at one of the two uppermost nodes of the main stem

Seed development- R5-R6

R5-Beginning seed- (11-20 days) seed is 1/8 inch long in the pod at one of the four uppermost nodes on the main stem



R6-Full seed -(9-30 days) pod containing a green seed that fills the pod capacity at one of the four uppermost nodes on the main stem -**stop scouting when soybeans reach R6**.



Maturity R7-R8

R7 Beginning maturity (7-18 days) One normal pod on the main stem has reached its mature pod color

R-8 Full maturity 95% of pods have turned their mature color (tan or brown)

Fungicides for managment of soybean rust chart

Brand Name	Common Name	Rate (fl oz/a)[b]	Number of Applications/year and Maximum (fl/oz/a)/year	Fungicide Class[a]	Label[c]
Bravos, Echo, Equus	Chorothalonil	24-32	3 (96)	Nitrile	Section 3
Quadris	Azoxystrobin	6.2-15.4	(92.1)	Strobilurin	Section 3
Headline	Pyraclostrobin	6.0-12.0	2 (24)	Strobilurin	Section 3
Tilt, PropiMax, Bumper	Propiconazole	4.0-8.0	2 (12)	Triazole	Section 18
Folicur, Uppercut, Orius	Tebuconazole	3.0-4.0	2 (8)	Triazole	Section 18
Laredo EC	Myclobutanil	4.0-8.0	2 (16)	Triazole	Section 18
Domark 230 ME[d]	Tetraconazole	4.0-6.0	1 (6.0)	Triazole	Section 18
Stratego	Propiconazole + Trifloxystrobin	5.5-10.0	2 (20)	Strobilurin + Triazole	Section 18
Headline SBR	Pyraclostrobin + Tebuconazole	5.9-7.8	2 (15.6)	Strobilurin + Triazole	Section 18
Quilt	Azoxystrobin + Propiconazole	14-20	2 (40.0)	Strobilurin + Triazole	Section 18
Alto[e]	Cypraconazole	2.75-4.0	2 (8.0)	Triazole	Pending
Quadris Xtra	Azoxystrobin + Cypraconazole	4.0	2 (8.0)	Strobilurin + Triazole	Pending
Caramba[f]	Metconazole	8.2-9.6	2 (19.2)	Triazole	Pending
Headline Caramba Copack	Pyraclostrobin + Metconazole	11.9	2 (23.8)	Strobilurin + Triazole	Pending
Punch	Fluzilazole	4.0	2 (8.0)	Triazole	Pending
Charisma	Fluzilazole + Famoxodone	9.0	2 (18.0)	Triazole	Pending
Topguard	Flutriafol	7.0	2 (14.0)	Triazole	Pending

[a] Combinations of a strobilurin and a triazole may provide increased control and residual activity.
[b] Higher rates provide greater residual activity and may reduce the need for later sprays.
[c] Section 3 labels are for general use and not contingent on emergency conditions. Section 18 labels are temporary and expire in November 2007 unless renewed or replaced by Section 3 labels. Pending indicates that these materials may be labeled as section 3 or section 18 materials. Fungicides labeled as Section 18 materials are restricted use pesticides when used on soybean, regardless of what the accompanying label material may say and you must have the section 18 label in your possession if using these materials. Read label for plant back restrictions on all materials used, some are very restrictive.
[d] Maximum of 1 application per year (request to amend label to allow 2 applications per season is pending).
[e] Section 18 Approved in States of MN, SD, IA, MO, MD, and IL.
[f] Section 18 Approved in States of MN, and SD.