United States Department of Agriculture

Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

November 2004

STRATEGIC PLAN TO MINIMIZE THE IMPACT OF THE INTRODUCTION AND ESTABLISHMENT OF SOYBEAN RUST ON SOYBEAN PRODUCTION IN THE UNITED STATES

SOYBEAN RUST
Phakopsora pachyrhizi, P. meibomiae

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GENERAL INFORMATION

Action Statement

This document is intended for use as guidance in planning for the eventual introduction and establishment of Asian Soybean Rust (ASBR), *Phakopsora pachyrhizi*, in the continental United States. This plan provides information for federal, state and private stakeholders on the protection, detection, response and recovery from the introduction and establishment of ASBR in U.S. soybean production areas.

Background Information and Introduction

Soybean rust is caused by either of two fungal species, *Phakopsora pachyrhizi* Sydow and Sydow known as the Asian species, and the New World species, *P. meibomiae* (Arthur) Arthur. *Phakopsora pachyrhizi*, the more aggressive of the two pathogens, has been reported in various countries including Argentina (not in production areas), Australia, China, Korea, Malaysia, Indonesia, Sierra Leone, Cambodia, New Guinea, Viet Nam, Ghana, India, Japan, Nepal, Taiwan, Thailand, the Philippines, Mozambique, Nigeria, Rwanda, Uganda, United States (Hawaii only), Zimbabwe, South Africa, Brazil, Paraguay and Bolivia.

Phakopsora meibomiae is less virulent on soybeans than *Phakopsora pachyrhizi*. It has been reported in Costa Rica, Cuba, Dominican Republic, Guatemala, Mexico, Venezuela, Bolivia, Barbados, Belize, Ecuador, Trinidad, Chile, St. Thomas, Brazil, and Colombia. Both occur in Brazil, Argentina, and Paraguay.

The first detection of soybean rust in the United States was *Phakopsora meibomiae* reported in Puerto Rico in 1976. *Phakopsora pachyrhizi* was reported in Hawaii in 1994 where it caused yield losses. Recent introductions of *P. pachyrhizi* in other parts of the world show a rapid spread causing severe damage in Zimbabwe (2000), South Africa (2001), Paraguay (2001), and Brazil (2002) where yield losses from this species have been reported from 10-80%. Although this document deals with the more virulent pathogen, *Phakopsora pachyrhizi*, detections of *Phakopsora meibomiae* will be assessed consistent with Plant Protection and Quarantine (PPQ) policy.

There are 30 species in 17 genera of legumes, other than soybean reported to be hosts for soybean rust in nature; 60 species in 26 genera of legumes have been successfully inoculated under greenhouse conditions. One widespread host in the United States is kudzu or *Pueraria lobata*. It is believed that kudzu could serve as an inoculum reservoir for soybean rust; thereby, maintaining an inoculum source that may play a significant role in ASBR epidemiology. Additionally, there are a variety of other important hosts that are leguminous crops or weeds that have shown varying degrees of susceptibility to both species of soybean rust.

If introduced to U.S. soybean production areas, *Phakopsora pachyrhizi* could cause large crop and economic losses to soybean growers and associated industries. Other leguminous crops may also suffer losses. ASBR spreads primarily by wind-borne spores across regions dependent upon prevailing winds and environmental conditions conducive to disease development. Recent infestations in Africa have been widespread in the same year in which they were first detected. However, in South America, two to three years were required from the time of detection for widespread occurrence. Because of the wind-born distribution of the spores and the rapid rate of disease spread, it is unlikely that an eradication program designed to eliminate the pathogen or disease upon its detection in the continental United States would be appropriate or effective. For this reason the Recovery Plan has been developed as part of this plan.

Commercial U.S. soybean cultivars are not resistant or tolerant to *Phakopsora pachyrhizi*. Fungicides have been used effectively in other countries to mitigate the impacts on soybean production. There are currently two fungicides labeled for use on soybeans in the United States. However, effective dosage rates and application methods require further development. Efforts are being made by chemical companies, researchers, and the soybean industry to identify additional efficacious chemicals, formulations, and application rates and methods. Efforts are underway by states to attain Section 18 registrations to use pesticides in the United States that are presently in use offshore.

Soybean Rust Plan

Protection
- Offshore Pest Information
- Pathway Pest Risk Assessment
- Commodity Entry Standards

Detection

Response

Recovery

APHIS-PPQ-PDMP

January 2004

PROTECTION PLAN

Stakeholders, including USDA, recognize that natural introductions of ASBR into the US and its soybean production system will very likely occur, the only question is when and where. USDA recognizes its responsibility to prevent the introduction of foreign plant pests and diseases with the potential for adversely impacting production agriculture and the environment. Therefore, USDA is working to delay the human assisted introduction of the disease through its safeguarding program. APHIS-Plant Protection and Quarantine (PPQ) will continue to support offshore information gathering, permitting and inspection activities as components of its exclusion and safeguarding activities, thereby reducing the risk of introducing ASBR through human assisted channels. An effective program to reduce the human assisted movement of the disease will help to provide additional time in preparing for the entry of the disease.

USDA-APHIS-PPQ has legislative authority under the Plant Protection Act to control the importation of commodities that may serve as pathway for the introduction of foreign plant and animal pests and diseases. The agency administers this responsibility through the Department of Homeland Security, Customs and Border Patrol agricultural quarantine inspection program at the Nation's international ports of entry and through PPQ permitting procedures.

The Protection Plan will address the following human assisted movement issues:

- Offshore Pest Information
- Pathway Pest Risk Assessment
- Commodity Entry Standards

OFFSHORE PEST INFORMATION

The collection, synthesis, and communication of information collected offshore will enhance PPQ's strategy for addressing the entry and establishment of ASBR in the continental United States. This information will be critical in tracking new infestations or outbreaks of this pathogen offshore or detecting potential bioterrorist events and then correlating this information to entry pathways. Also, offshore information will be important to enhance detection, response, and recovery activities.

Activities to address the collection of offshore information include:

- Communicating with foreign trading partners and regional plant protection organizations within areas known to be infested with the disease;
- Partnering with DHS, intelligence gathering agencies, Cooperative State Research, Education and Extension Service (CSREES), National Plant Diagnostic Network, and other appropriate organizations to reduce the risk of ASBR introduction through a terrorist event;
- Receiving periodic updates from APHIS-International Services about ASBR situations occurring in foreign countries;
- Participating in international forums about ASBR; and

- Collecting data on ASBR host plants in South America, Central America, Mexico and the United States to understand possible reservoirs and routes for infection.

PATHWAY PEST RISK ASSESSMENT

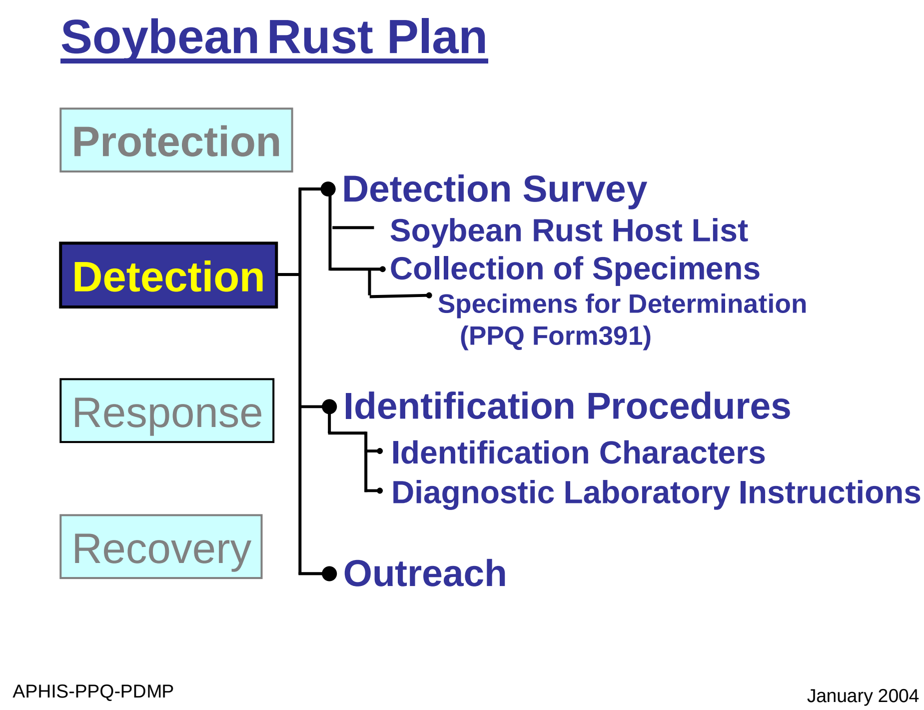
The assessment of risks associated with the introduction of ASBR on imported soybean seed, grain and meal is a critical component in identifying and recommending pathogen pathway entry standards. The assessment will consider biological, technical, and industry standards, available information to classify risk of introduction, and potential mitigative measures.

- PPQ's Center for Plant Health, Science, and Technology will prepare an assessment of risks associated with the introduction of ASBR on imported soybean seed, grain and meal from areas with the disease.

COMMODITY ENTRY STANDARDS

A technical analysis of the pathway assessment and the development of least restrictive mitigation measures will establish the framework for entry standards or requirements for soybean seed, grain and meal from areas with soybean rust. PPQ will:

- Prohibit or require appropriate treatment of host material moving into the United States that may serve as a pathway for introduction;
- Modify commodity entry standards as appropriate based on the pathway assessment and communicate standards to DHS; and
- Collaborate with foreign cooperators in the offshore mitigation of the disease to reduce the risk of entry into the continental United States.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Collection of Specimens
Specimens for Determination
(PPQ Form391)
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Identification Characters
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APHIS-PPQ-PDMP
January 2004

DETECTION PLAN

There is concern in U.S. soybean producing states about the introduction of ASBR and its potential economic impact. Based on infestation scenarios experienced in southern Africa and South America, it is more likely that soybean rust will enter the United States by wind borne spores via wind currents from West Africa or northern South America or through the Caribbean. Another likely scenario would be progressive spread on susceptible hosts through northern South America, Central America and Mexico. Scientists predict that the first infestation will likely first be found in the Gulf Coast states.

The early detection and rapid identification of ASBR is an essential component of addressing production losses associated with *Phakopsora pachyrhizi*. The Detection Plan comprises elements to provide field characteristics about the disease, details on collection and submission of specimens as well as, diagnostics, and confirmation procedures.

The Detection Plan will address the following issues:

- Detection Survey Procedures
    - Detection Survey
    - ASBR Host List
    - Collection of Specimens
        - Specimens for Determination (PPQ Form 391)
- Identification Procedures
    - Identification Characters
    - Diagnostic Laboratory Instructions
- Outreach

DETECTION SURVEY

The survey activities will be a collaborative effort by governmental agencies and other stakeholders to detect ASBR in the United States. The survey will depend on growers, handlers, field scouts, and others with soybean rust training or information. Although soybean growing areas will likely be targeted, soybean rust could be found anywhere that any of the numerous cultivated and non-cultivated legume hosts are found. Likelihood of detection will be increased by utilizing individuals with an understanding and awareness of the disease and its symptoms, knowledge of the local geography, and direct links to soybean and other bean field over a relatively large area. With such a corps of individuals more fields over a larger geographical area could be surveyed, they could be surveyed more frequently, some areas could be under continual surveillance, and surveys could be conducted throughout the entire growing period.

A national survey funded by the Cooperative Agricultural Pest Survey (CAPS) is not planned for the detection of ASBR. However, CAPS funding will be considered for proposals to establish collaborations and networks with growers, field scouts, scientists, researchers, and organizations that work in soybean fields or environs where soybean rust host material is present. This proposal could address training to recognize symptoms of the disease; training for diagnosticians to identify the pathogen; and preparation and distribution of program aides or other educational material. Detection of soybean rust will be reported in the National Agriculture Pest Information System (NAPIS) by PPQ state plant health directors or appropriate CAPS cooperators.

Normally, detection surveys will be carried out by “surveyors” provided with information about the disease and its symptoms at any site where available host material exists. Survey procedures will vary depending on the feasibility of surveying plants in the field, season, environmental conditions, and other factors. The actual inspection will consist of a thorough visual examination of plants in the field and of other host plants in the vicinity. Growers, scientists, researchers, and others interested in detecting soybean rust should be encouraged to plant sentinel plots with early maturing soybean cultivars, prior to the traditional planting time as areas for early detection. Soybean experimental research plots also should be included in detection surveys. Because other bean species are susceptible to ASBR, commercial plantings of those hosts should be checked in detection surveys as well.

The weed kudzu occurs in large areas throughout the southern United States, and naturally occurring stands can serve as a place for early detection surveys. We do not recommend the planting of kudzu as a sentinel crop because of its invasiveness. However, surveyors in kudzu-infested areas will be encouraged to inspect naturally growing plants for the pathogen. It is thought that in Zimbabwe and Brazil, ASBR may build up inoculum in hosts adjacent to soybean fields. These hosts may serve as reservoirs for the pathogen when soybeans are not in the susceptible stages.

Survey procedures will vary depending on the feasibility of surveying plants in the field (e.g., season, environmental conditions). The actual inspection will consist of a thorough visual examination of soybean plants in the field and of other host plants in the vicinity of the areas being surveyed. It is expected that individuals working in the field or traversing the environs would see visual signs of infection, and either collect samples or report the location of the damage to the local extension office. Information from South America indicates a distinct yellowing or browning of fields with high infection rates. This character might be useful in pin-pointing areas needing further investigation.

For early detection, check for pustules (blisters or lesions) and chlorosis (yellowing) on the underside of the lower leaves of soybean plants before flowering. *Phakopsora pachyrhizi* infects the petioles, pods, stems, and leaves, especially the undersides of leaves. The disease is caused by an obligate parasite that consists mainly of one spore type (uredinospores). Inspection can begin at anytime during growing season; however, inspection of plants with well developed leaflets is preferable. The lesions are fewer and smaller on the upper leaf surfaces. The disease is detected by inspecting the underside of the leaves for uredinial pustules that are powdery and buff or pale brown. Lesions on the upper surfaces are fewer and smaller. As the plants mature and the frequency of rainfall events increase, the severity of the disease increases as well. Lesions will be found in the middle and upper canopy in more advanced infections. Eventually, leaf drop will occur. See Identification procedures section for additional details.

Soybean Rust Host List

Because of confusion over the taxonomy of the pathogens causing soybean rust, *Phakopsora meibromiae* and *Phakopsora pachyrhizi,* the list of hosts of *Phakopsora pachyrhizi* may be incomplete. According to various recent references, a large number of legume species are host plants for *Phakopsora pachyrhizi*. *Glycine max*, *G. sojae*, *Pachyrhizus erosus*, *Pueraria lobata*, and *Vigna unguiculata* are the principle hosts (CABI, 2001). The following table lists legume species that develop rust symptoms and uredinia and urediniospores when inoculated with *Phakopsora pachyrhizi*.

Host scientific name	Host common name
Alysicarpus glumaceus	moneywort
Alysicarpus vaginalis	white moneywort
Cajanus cajan	pigeonpea
Cajanus sp.	cajanus
Calopogonium mucunoides	calopo/jicama
Canavalia gladiata	sword jackbean
Canavalia maritima	baybean
Cassia occidentalis	septicweed
Centrosema pubescens	flor de conchitas
Clitoria ternatea	Asian pigeonwings
Coronilla varia	purple crownvetch
Crotalaria anagyroides	rattlebox
Crotalariadissaromoensis	rattlebox
Crotalaria linifolia	rattlebox
Crotalaria pallida	smooth rattlebox
Crotalaria spp.	rattlebox
Crotolaria spectabilis	showy rattlebox
Delonix regia	royal poinciana
Desmodium discolor	ticktrefoil
Desmodium rhytidophyllum	ticktrefoil
Desmodium spp.	ticktrefoil
Desmodium triflorum	ticktrefoil
Desmodium varians	ticktrefoil
Dolichos axillaris	none
Glycine argyrea	glycine
Glycine canescens	glycine
Glycine clandestina	glycine
Glycine curvata	glycine
Glycine cyrtoloba	glycine
Glycine falcata	glycine
Glycine latifolia	glycine
Glycine latrobeana	glycine
Glycine max	glycine
Glycine microphylla	glycine
Glycine soja	wild soybean
Glycine spp.,	glycine

Host scientific name	Host common name
Glycine tabacina	glycine
Glycine tomentella	glycine
Hardenbergi violecea	None
Kennedia coccinea	cows clover
Kennedia prostrata	cows clover
Kennedia rubicunda,	cows clover
Kennedia spp.,	cows clover
Kummerowia stipulacea	Korean clover
Kummerowia striata	Japanese clover
Lablab purpureus	hyacinthbean
Lespedeza bicolor	shrubby lespedeza
Lespedeza juncea	Chinese lespedeza
Lotus americana	trefoil
Lotus major	trefoil
Lotus purshianus	trefoil
Lupinus albus	lupine
Lupinus angustifolius	narrowleaf lupine
Lupinus hirsutus	lupine
Lupinus luteus	European yellow lupine
Lupinus spp.	lupine
Macroptilium atropurpureum	purple bushbean
Macroptilium bracteatum	bushbean
Macroptilium lathyroides	bushbean
Macroptilium spp.	bushbean
Macrotyloma axillare	perennial horsegram
Melilotus officinalis	yellow sweetclover
Melilotus speciosus	sweetclover
Mucuna cochinchinensis	none
Neonotonia wightii	perennial soybean
Pachyrhizus erosus	yam bean
Phaseolus coccineus	scarlet runner
Phaseolus lunatus	sieva bean
Phaseolus spp.	bean
Phaseolus vulgaris	kidney bean
Pisum sativum	garden pea
Psophocarpus tetragonolobus	winged bean
Psoralea tenax	none
Pueraria lobata	kudzu
Rhynchosia minima	least snoutbean
Sesbania exaltata	bigpod sesbania
Sesbania sericea	papagayo

Host scientific name	Host common name
Sesbania vesicaria	bagpod
Teramnus uncinatus	white rooster's crest
Trifolium incarnatum	crimson clover
Trifolium repens	white clover
Trigonella foenum-graecum	sicklefruit fenugreek
Vicia dasycarpa	winter vetch
Vicia faba	horsebean
Vigna luteola	hairypod cowpea
Vigna mungo	black gram
Vigna radiata	mung bean
Vigna spp.	beans
Vigna unguiculata	blackeyed pea

Collection of Specimens

The instructions for surveyors, growers, extension personnel, crop consultants, and field scouts encountering ASBR-like symptoms are detailed at the PPQ soybean rust pest alert Web site. The procedure is to place leaf, stem, or pod samples in a self locking plastic bag, and to store it in cool conditions or sealed in a paper bag if it must be kept in ambient conditions to prevent mold growth. Ensure that adequate material is collected to increase the likelihood of finding spores. Care should be taken to ensure the outside of the bags are not contaminated by the sample. Record collection information (i.e., date, location of the field, host plant and collector's name) on a form designed for that purpose or on a piece of paper included with the sample. PPQ form 391 (see next page) indicates pertinent collection information that should be included.

Submit the sample through the state departments of agriculture diagnostic service or the land grant university's diagnostic laboratory in the state in which the sample was collected. These laboratories will screen samples to assure they are not showing diseases that can be confused with ASBR.

A list of university diagnostic laboratories is available at the American Phytopathological Society's Web site at
http://www.apsnet.org/directories/univ_diagnosticians.asp.

state departments of agriculture contacts are available at the National Plant Board Web site at http://www.aphis.usda.gov/npb/npbmemb.html.

Specimen Submission Form for Diagnostic Laboratory to the PPQ National Mycologist.

This report is authorized by law (7 U.S.C. 147a). While you are not required to respond your cooperation is needed to make an accurate record of plant pest conditions. See reverse for additional OMB information.

FORM APPROVED
OMB NO. 0579-0010

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

SPECIMENS FOR DETERMINATION

Instructions: Type or print information requested. Press hard and print legibly when handwritten. Item 1 – assign number for each collection beginning with year, followed by collector's initials and collector's number. Example (collector, John J. Dingle): 83-JJD-001.
Pest Data Section – Complete Items 14, 15 and 16 or 19 or 20 and 21 as applicable. Complete Items 17 and 18 if a trap was used.

FOR IBII USE
LOT NO.
PRIORITY

1. COLLECTION NUMBER
2. DATE: MO / DA / YR
3. SUBMITTING AGENCY: ☐ State Cooperator ☐ PPQ ☐ Other ______

SENDER AND ORIGIN

4. NAME OF SENDER
5. TYPE OF PROPERTY *(Farm, Feedmill, Nursery, etc.)*
6. ADDRESS OF SENDER
ZIP
INTERCEPTION SITE
7. NAME AND ADDRESS OF PROPERTY OR OWNER
COUNTRY/ COUNTY

PURPOSE

8. REASON FOR IDENTIFICATION *("X" ALL Applicable Items)*
- A. ☐ Biological Control (Target Pest Name)
- B. ☐ Damaging Crops/Plants
- C. ☐ Suspected Pest of Regulatory Concern *(Explain in REMARKS)*
- D. ☐ Stored Product Pest
- E. ☐ Livestock, Domestic Animal Pest
- F. ☐ Possible Immigrant *(Explain in REMARKS)*
- G. ☐ Survey *(Explain in REMARKS)*
- H. ☐ Other *(Explain in REMARKS)*

9. IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE PROVIDE A BRIEF EXPLANATION UNDER "REMARKS".

HOST DATA

10. HOST INFORMATION
NAME OF HOST *(Scientific name when possible)*
NUMBER OF ACRES/PLANTS
11. QUANTITY OF HOST
PLANTS AFFECTED *(Insert figure and indicate ☐ Number ☐ Percent)*:

12. PLANT DISTRIBUTION
- ☐ LIMITED
- ☐ SCATTERED
- ☐ WIDESPREAD

13. PLANT PARTS AFFECTED
- ☐ Leaves, Upper Surface
- ☐ Leaves, Lower Surface
- ☐ Petiole
- ☐ Stem
- ☐ Trunk/Bark
- ☐ Branches
- ☐ Growing Tips
- ☐ Roots
- ☐ Bulbs, Tubers, Corms
- ☐ Buds
- ☐ Flowers
- ☐ Fruits or Nuts
- ☐ Seeds

PEST DATA

14. PEST DISTRIBUTION
- ☐ FEW
- ☐ COMMON
- ☐ ABUNDANT
- ☐ EXTREME

15. ☐ INSECTS ☐ NEMATODES ☐ MOLLUSKS

NUMBER SUBMITTED	LARVAE	PUPAE	ADULTS	CAST SKINS	EGGS	NYMPHS	JUVS.	CYSTS
ALIVE								
DEAD								

16. SAMPLING METHOD
17. TYPE OF TRAP AND LURE
18. TRAP NUMBER

19. PLANT PATHOLOGY – PLANT SYMPTOMS *("X" one and describe symptoms)*
☐ ISOLATED ☐ GENERAL

20. WEED DENSITY
☐ FEW ☐ SPOTTY ☐ GENERAL

21. WEED GROWTH STAGE
☐ SEEDLING ☐ VEGETATIVE ☐ FLOWERING/FRUITING ☐ MATURE

22. REMARKS

23. TENTATIVE DETERMINATION

24. DETERMINATION AND NOTES *(Not for Field Use)*

SIGNATURE
DATE

FOR IBII USE
DATE RECEIVED
NO.
LABEL
SORTED
PREPARED
DATE ACCEPTED
RR

PPQ FORM 391
(AUG 02)
Previous editions are obsolete.

This is a 6-Part form. Copies must be disseminated as follows:
- ☐ PART 1 – PPQ
- ☐ PART 2 – RETURN TO SUBMITTER AFTER IDENTIFICATION
- ☐ PART 3 – IBII OR FINAL IDENTIFIER
- ☐ PART 4 – INTERMEDIATE IDENTIFIER
- ☐ PART 5 – INTERMEDIATE IDENTIFIER
- ☐ PART 6 – RETAINED BY SUBMITTER

IDENTIFICATION PROCEDURES

Accurate and timely identification is the key to determining whether a response will be attempted and, if so, the extent, direction, and magnitude of that response. It will also help determine program changes and failures.

Identification Characters

Symptoms of soybean rust appear identically regardless if they are caused by *Phakopsora pachyrhizi* or *Phakopsora meibomiae*. Host plants infected with soybean rust first exhibit small lesions that gradually increase in size and turn from gray to tan or brown. They become polygonally shaped restricted by leaf veins, and may eventually reach 2 to 3 square millimeters.

Infection begins on the lower first leaves of plants and appears as chlorotic or mosaic-like areas with uredinia observed usually at or after the plant flowering stage. Lesions may appear on most above-ground plant parts, but are most common on the underside of the leaves. As the plant matures and sets pods, infection progresses rapidly under the right environmental conditions (i.e., moisture, high humidity and heat) to cause high rates of infection in the middle and upper leaves of the plant. Clouds of spores have been observed within and above canopies of highly infected plant stands.

Plants show two different lesion reactions to infection by soybean rust. Tan lesions consist of small uredinia surrounded by slightly discolored necrotic areas on leaf surfaces. Early stages show an ostiole, or small hole, where urediniospores emerge. As uredinia become larger, they release masses of tan colored urediniospores that appear as light brown or white raised areas. Uredinial pustules become more numerous with advancing infection and often will coalesce forming larger pustules that break open releasing masses of urediniospores.

The other type of lesion that occurs with soybean rust infection is the reddish-brown lesion. These lesions have larger areas of necrosis that are reddish brown surrounding a limited number of uredinia. A few urediniospores are usually visible on the surface.

Early symptoms of soybean rust are easily confused with bacterial pustule (caused by *Xanthomonas campestris pv. phaseoli* (Smith) Dye), or bacterial blight (caused by *Psuedomonas glycinea* Coerper), and brown spot (caused by the fungus S*eptoria glycines)*. The diseases also occur often on the underside of soybean leaves causing a raised light brown blister within a lesion. These leaf lesions vary from small specks to large irregular brown areas that form when small lesions coalesce. A hand lens or dissecting microscope are usually used to distinguish these disease symptoms from ASBR, but early the stages of disease are difficult to distinguish if no spores, conidia, or bacteria are evident.

The more advanced raised blister-like pustules of the other disease resemble the uredial cones or pustules of the rust. The symptoms can be distinguished by two microscopic characteristics. Uredial pustules open through a round ostiole while bacterial pustules are torn across by a fissure. Also, white clumps of urediniospores can generally be observed lodged on top of the uredial cone sometimes emerging in columns. Breaking open the pustule will reveal large numbers of urediniospores. Urediniospores can be identified by mounting them on a microscopic slide and examining them under a compound microscope. Conidia of *Septoria glycines* are microscopic, producing multi-celled elongate conidia through dark ostiolate pycnidia. Bacterial pustule produces bacterial streaming when observed under a compound microscope with no spores being observed.

Photographs of soybean rust symptoms and uredinospore morphology are available on PPQ's pest detection Web site at http://www.aphis.usda.gov/ppq/ep/pestdetection/soybean_rust/soybeanrust.html.

Examination of the morphology of soybean uredinia and urediniospores found in soybean rust cone pustules cannot be used to confidently to distinguish *Phakospora pachyrhizi* from *Phakopsora meibomiae*. They can be distinguished based on differences in the telia and teliospores. However, these are seldom seen in nature. Therefore, the only definitive methods for correct identification of ASBR are molecular techniques polymerase chain reaction (PCR).

The United States Department of Agriculture's Agriculture Research Service (ARS) laboratories in Ft. Detrick, Maryland have developed primers for a PCR identification of *Phakopsora pachyrhizi* and *Phakopsora meibomiae* and made them available to APHIS, PPQ, Center for Plant Health, Science, and Technology (CPHST) in Beltsville, MD. ASBR diagnostic protocols have been validated by CPHST. In using PCR techniques, DNA is extracted from spore or infected leaf samples, subjected to PCR, and then ground up and purified before being analyzed for the presence of key diagnostic sequences of DNA that distinguish it from related species.

Diagnostic Laboratory Instructions

If university or state departments of agriculture laboratories determine that a sample is *Phakopsora* spp. on soybean or another leguminous hosts, further identification to the species level will be necessary. There are no *Phakopsora* species on legume hosts recorded in the continental United States. A new *Phakopsora* record, because of its potential economic importance, will require verification by the PPQ national mycologist in Beltsville, Maryland. Verification will utilize the validated PCR-based molecular test.

Diagnostic laboratories should contact Dr. Mary Palm at (301) 504-5327 or Dr. John McKemy at (301) 504-5280 if *Phakopsora* spp. on a legume host is found. At the same time, the state department of agriculture in the host state should be contacted before samples are forwarded for testing. After consultation with Drs. Palm or McKemy, samples should be properly secured and sent by overnight freight to:

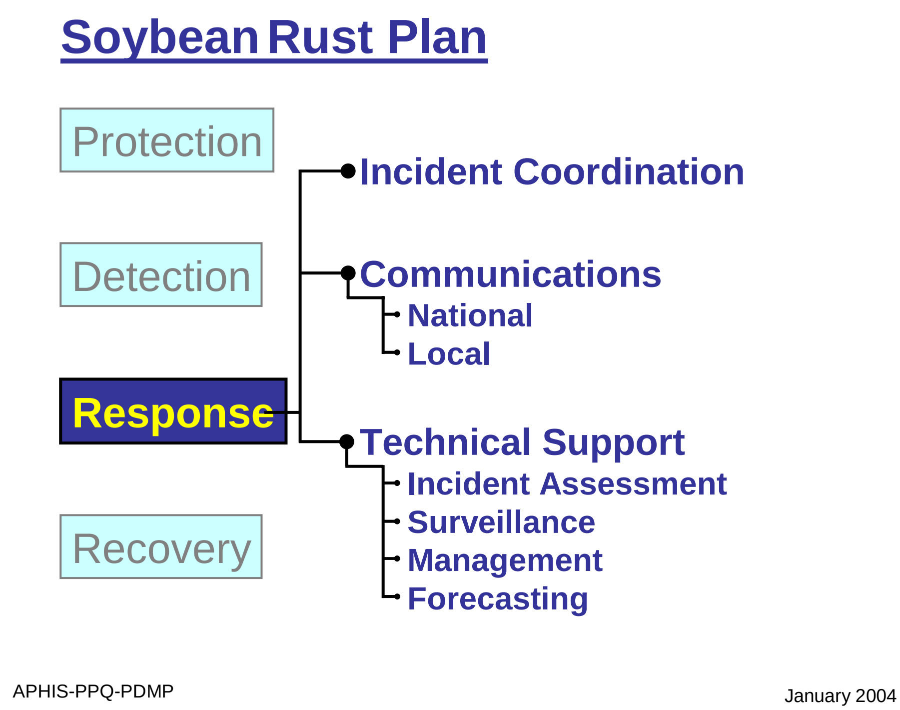
Dr. Mary Palm
USDA, APHIS, PPQ
Bldg. 011A, Room 329, BARC-West
10300 Baltimore Blvd.
Beltsville, MD 20705-2350

OUTREACH

The preparation and distribution of information regarding survey and identification procedures is the foundation for the early detection of ASBR. The early detection and diagnosis of the pathogen relies on producer, crop consultant, or handler referral of symptomatic material. It is absolutely essential that appropriate program training and detection aides showing symptoms and instructions for referring specimens be provided to the public frequenting soybean production and other host areas.

To meet this need:

- CSREES in cooperation with ARS and PPQ will develop technical information for survey training programs and program aides for distribution to stakeholders and interested parties;
- CSREES will identify and activate distribution systems to communicate technical information;
- PPQ in cooperation with ARS and CSREES will review existing air current data and human assisted pathways in an effort to correlate potential dispersal of the disease from known infected areas to potential survey locations in the United States.


Soybean Rust Plan
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Management
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APHIS-PPQ-PDMP
January 2004

RESPONSE PLAN

The objective of the response plan is to provide technical and educational support for local decisions. Thereby, minimizing the impacts and facilitating the dissemination of information on the first confirmed detection of ASBR in the continental United States.

The Response Plan will address the following issues:

- Incident Coordination
- Communication
    - National
    - Local
- Technical Support
    - Incident Assessment
    - Surveillance
    - Management
    - Forecasting

INCIDENT COORDINATION

PPQ will take a leadership role in coordinating a response to the introduction of ASBR. It is understood that there are national and regional industry, as well as producer concerns regarding the scope of a PPQ or non-infested state response and resulting actions. The national response will be coordinated through the PPQ regional offices with responsibility for the affected area.

PPQ has proposed five scenarios for the detection of ASBR. They are:

- **Port of Entry Environs –** During routine survey of port environs ASBR is confirmed on kudzu (or other wild host).
- **Soybean Production Area –** ASBR is confirmed from samples taken from soybeans.
- **Other Crop Production Area** - ASBR is confirmed from samples from crops other than soybeans.
- **Wild Host Area –** ASBR is confirmed from samples of wild host.
- **Host Seed Production Area**-ASBR is confirmed from samples forwarded from seed industry.

The level of response will be contingent on the specific circumstances of the detection.

COMMUNICATION

National

Once soybean rust is confirmed in the United States, prompt communication with all affected and interested parties is essential. After PPQ's national mycologist confirms the presumptive disease identification, PPQ and APHIS's Legislative and Public Affairs (LPA) staff will communicate the detection in the following manner:

- Secretary will notify DHS;
- Under Secretary for Marketing and Regulatory Programs will notify the Secretary and USDA mission area Under Secretaries;
- APHIS Administrator will notify the under secretary and leadership of the National Association of State Departments of Agriculture (NASDA) through a conference call, and if appropriate schedule a national NASDA call to discuss the issue;
- PPQ will notify Administrator and APHIS mission areas;
- LPA's legislative personnel, in coordination with USDA's Office of Congressional Relations, will contact representatives in the affected state(s), along with other interested stakeholders;
- PPQ will notify the President of the National Plant Board through a telephone call, and if appropriate schedule national NPB call to discuss the issue;
- PPQ will notify the American Soybean Association and the United Soybean Board through a telephone call;
- PPQ will notify ARS and CSREES through a telephone call. CSREES will communicate with the National Pest Diagnostic Network;
- PPQ will notify the American Phytopathological Society of the ASBR detection through email;
- LPA and CSREES will coordinate with the affected state and the American Soybean Association to prepare a press release or stakeholder announcement announcing the detection of ASBR;
- LPA and CSREES will coordinate distribution of press release or stakeholder announcement to all interested industry media. LPA will coordinate answers to media inquiries;
- PPQ will post notification on its ASBR Web site and maintain a toll free "hot line"; and
- PPQ, state plant health directors will have the responsibility to ensure initial detections of ASBR are reported in NAPIS.

Local

The detection of ASBR will require addressing a number of issues and concerns in the state and area where the pathogen is found. In order to assist those with questions in the affected community specific communication efforts need to be undertaken:

- CSREES in cooperation with local, state, LPA and PPQ (e.g., state plant health directors) will schedule and conduct evening public meetings in affected areas; and
- LPA, CSREES extension, and state public affairs officials will be available to media.

TECHNICAL SUPPORT

Producers and handlers within the affected area will initially require on the ground support to make and facilitate decisions to minimize the impacts after the detection of ASBR.

Incident Assessment

PPQ has formed a Soybean Rust Detection Assessment Team to be dispatched to the first detection site of ASBR in the continental United States. The team is composed of recognized scientists and regulatory officials with practical experience with plant diseases and working knowledge or understanding of ASBR. The team will include several federal or state scientists, a Center for Plant Health Science and Technology scientist, and PPQ staff with experience with the pathogen. The team will also include the respective PPQ, State Plant Health Director and State official. The team is to be led by a Regional office designee to serve as the Incident Manager.

The intent is to dispatch the team to the detection site within 24 hours to gather pertinent situation information, review technical aspects at the site, evaluate available information and data, and prepare a report for the PPQ deputy administrator of the team's findings.

Surveillance

The initial confirmation of ASBR will generate the collection and submission of additional host material from areas within the affected region. A programmed delimiting survey in crop land or rural areas is not anticipated as such a survey could serve as a pathway for spreading the pathogen. Through public information, education, and the distribution of program training and detection aides producers and handlers would be encouraged to scout their production areas for signs of the disease and to make appropriate collections for identification. Information from the detection plan would serve as the basis for collection and submission.

Once collected, samples will need to be analyzed by qualified specialists to identify the pathogen. Field samples will be screened and suspected positives forwarded to the closest state diagnostic laboratory or National Plant Diagnostic Network (NPDN) for confirmation.

To meet surveillance objectives it will be necessary for:

- CSREES to prepare and distribute appropriate public information program aides describing the symptoms of ASBR, location information that accompany samples, and where samples should be submitted;
- PPQ, CSREES, and ARS to dispatch trained plant pathologists to the detection site capable of screening submitted material;
- NPDC to be able to perform presumptive identifications;
- CPHST to dispatch a scientist to NPDN to confirm diagnosis;
- PPQ be prepared to receive samples and confirm diagnoses and to determine when NPDC should be authorized to make the final identification in an infested area; and
- NAPIS must be prepared to accept and process data.

Management

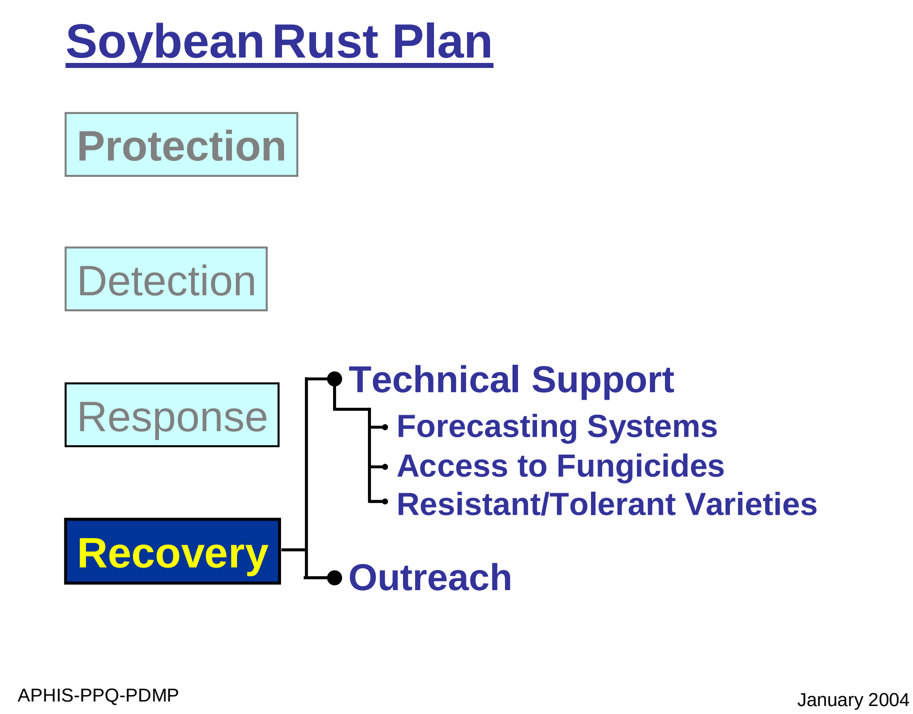
Producers and handlers will request advice and assistance to minimize production losses resulting from the detection of ASBR. In order to meet this need it will be necessary for:

- State officials to request the Environmental Protection Agency for appropriate exemption for specific fungicides;
- Researchers to determine critical crop development stage for fungicide applications which allow for economic control of the rust;
- State officials to communicate information regarding fungicide use, dosage, timing, etc. to producers;
- State officials, industry, or producer to communicate with fungicide suppliers about needs and shipping schedules;
- PPQ in cooperation with CSREES and state to have identified and listed licensed aerial and ground applicators;
- PPQ, Aircraft and Equipment Operations to be prepared to provide treatment equipment calibration and other appropriate technical assistance; and
- PPQ will provide temporary mapping capability.

Forecasting

A critical component in managing ASBR after its establishment will be the implementation of a forecasting system comparable to that used for tobacco blue mold. PPQ, in collaboration with academic institutions, is developing a forecasting model. The system will provide information to producers and other stakeholders about the probability of the rust occurring within a specific area or region.

PPQ will provide forecasting support for the initial detection event if the capability has been developed.


Soybean Rust Plan
Protection
Detection
Response
Recovery
Technical Support
Forecasting Systems
Access to Fungicides
Resistant/Tolerant Varieties
Outreach
APHIS-PPQ-PDMP
January 2004

RECOVERY PLAN

The occurrence of ASBR will have an impact on the production of soybeans in the United States. Because of the severity of the disease and costs to prevent or control field infections it is likely the production of soybeans in southern-most states could become unprofitable. Growers can expect an increase in production costs related to fungicides and their application to protect the crop.

It is suggested that growers consider removing non-cultivated soybean rust host material from field borders. The removal of this material will reduce the amount of hosts available, thereby reducing the amount of available host material to initiate an infection while decreasing the availability of sites for inoculum buildup.

The best long term strategy for minimizing the effects of soybean rust in the United States is in the development of resistant/tolerant varieties. There are thousands of plant lines of soybean in germplasm repositories and screening for soybean resistance has been on-going for several years in other countries and the United States in the containment facilities at the ARS Foreign Disease-Weed Science Research Unit in Ft. Detrick, Maryland. However, the availability of cultivars with good resistance and other characters desired in soybean for commercial production is still five to seven years away .

Fungicides have been shown to be effective in controlling soybean rust in Zimbabwe, South Africa and Brazil. An effort is underway to obtain a State Quarantine Exemption for seven fungicides by South Dakota and Minnesota with USDA assistance. Several chemical companies that already have fungicides registered for soybeans have relabeled their products to include control for *Phakopsora sp.* on soybeans and other leguminous crops.

Once an effective fungicide or fungicides, are available for use by growers, a recommendation will be made to extension scientists, crop consultants and growers to have sentinel plantings placed strategically in soybean growing areas that would allow for early detection of the disease, which would facilitate producer decisions about protectant applications of fungicides. Since ASBR manifests primarily on maturing plants, the sentinel plantings should be made about 3 weeks before the commercial crop is planted. This provides an opportunity to observe the first signs of the disease on the sentinels thereby allowing time to effect control of the pathogen in commercial plantings before the disease becomes epidemic. An early protectant application of fungicide will be needed around flowering time when sentinel plants are infected. Subsequent applications may be necessary as the crop matures and the disease begins to intensify.

Dr. Clive Levy, with the Commercial Farmer's Union of Zimbabwe reported that once an infestation of soybean rust is detected, if early enough, effective control was obtained with carefully timed fungicide applications. Detection early in the season with properly timed application of fungicides appears to present the best alternative for controlling soybean rust in the United States. In areas of high rust severity, the first application is at first flowering and then two more applications in 21 day intervals thereafter. In areas with lower severity, the last application is not necessary. In Zimbabwe some farmers found a schedule of first applications 50 days after planting, then at 70 and 90 days after planting. In all cases, but especially in the first applications, it is most effective to apply the fungicides in such a manner that the lower canopy is receives treatment.

Once the disease becomes established in the United States, a valuable tool to assist in the management of ASBR would be predictive models that forecast the probability of occurrence and movement of the disease throughout the nation's soybean production area. This information would be extremely useful to producers and others for surveillance and monitoring activities and timely applications of fungicides.

Through cooperation, education, and training growers will be provided with the tools to make informed decisions about managing ASBR and soybean production.

Components of Recovery include:

- Technical Support
    - Forecasting System
    - Access to fungicides
    - Resistant/Tolerant Varieties
- Outreach

TECHNICAL SUPPORT

Producers will require short term assistance in minimizing the impact of ASBR in commercial production areas. PPQ, affected states and the chemical companies can play a role for developing forecasting systems and obtaining exemptions or registrations for fungicides. Likewise, PPQ and the soybean industry will collaborate in the development of resistant or tolerant varieties to minimize production losses and reduce fungicide use.

Forecasting

The establishment of ASBR will have an effect on production of soybeans throughout the continental United States. The disease will become endemic in many parts of our country while other areas of the United States will experience seasonal occurrences of the disease. An early warning or forecasting system would provide producers with a decision-making tool for field control to better manage their crop production and enhance changes for reducing yield losses.

- CPHST in cooperation with ARS and CSREES will review existing air current data in an effort to correlate potential dispersal of the disease from known infected areas to other areas in the United States.
- CPHST in cooperation with ARS and CSREES will support development of an early warning system to assist producers in management of the disease.

Access to Fungicides

Currently there are only two fungicides (Quadris=azoxystrobin and Bravo=chlorothalonil) registered for ASBR control in the United States. It is important that several fungicides be available in the event they are needed for soybean rust control so that resistance development is minimized.

We have addressed this issue by:

- PPQ and the USDA Office of Pest Management Policy, in collaboration with the Environmental Protection Agency and industry, have pursued obtaining label revisions and/or approvals for U.S. registered fungicides for use against ASBR; and
- APHIS, the USDA Office of Pest Management Policy, the South Dakota University, and the Minnesota Department of Agriculture in collaboration with the Environmental Protection Agency, scientists, and industry will develop technical application information (dosage, rate, method, etc.).

Resistant/Tolerant Varieties

The scientific community and industry agree that the development and use of resistant/tolerant varieties is the long range goal to overcome production losses associated with ASBR. To this end:

- ARS and CSREES with cooperation of seed companies will develop commercially acceptable rust resistant or tolerant soybean varieties to minimize the economic impact of the establishment of ASBR on the industry.
  - Identify resistant germplasm from international sources and evaluate resistance susceptibility at other international locations;
  - Isolate and clone genes expressed from resistant soybean varieties;
  - Expand studies on genetic diversity of the pathogen in order to assess variability within pathogen populations and evolution of new races of the pathogen; and
  - Determine the potential pathway within the U.S. soybean production region for development of resistant varieties.

OUTREACH

The successful recovery from the introduction of soybean rust will be a scientific and communication challenge. Producers and the industry as a whole will have many questions and concerns especially regarding management of the disease. In order to be as responsive as possible:

- CSREES, with cooperation from APHIS and ARS, will develop information for use in preparing technical training programs and program aides describing actions to reduce crop damage;
- CSREES will identify and activate distribution systems to communicate technical information;

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