Solanaceous Hosts Commodity-based Survey Reference

2014 Version

Cover Images: Skinning of red potato. Credit: Gerald Holmes, Valent USA Corporation, Bugwood.org. Eggplant fruits. Credit: Gerald Holmes, Valent USA Corporation, Bugwood.org. Ripe tomato fruits still attached to the plant in the field. Credit: Howard F. Schwartz, Colorado State University, Bugwood.org

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How to Use This Manual

I: Introduction

The first section of this manual describes the purpose of the Solanaceous Hosts Commodity-based Survey. This section provides background information about Solanaceous hosts including what a Solanaceous host is, why these hosts are important, and where they are grown in the United States.

Pest Datasheets

Pest datasheets have been developed for each target pest species. Datasheets contain specific information on the biology, ecology, hosts, distribution, survey methods, and identification resources for each target pest. Pest datasheets are located as separate links on the CAPS Resource and Collaboration site manuals page under Solanaceous (https://caps.ceris.purdue.edu/survey/solanaceous/reference/2014).

II: Planning a Survey

The next section describes how to plan a Solanaceous Hosts Commodity-based Survey and includes information on the CAPS-approved survey and identification/diagnostic methods for each of the 16 target pests. General information is provided on survey sites, survey season, and the five approved traps.

When planning a survey, states should consider a pathway approach when deciding on which pests to survey for. Information regarding the host and climate zone ranges of each pest should be considered as well.

III: Ordering Traps and Lures

This section gives specific information on how to order traps and lures for Solanaceous Hosts pest surveys.

IV: Conducting the Survey

This section gives specific information on how to conduct a survey for solanaceous pests. This section lists symptoms and signs to look for when conducting a visual survey. It also provides information on trapping, including: trap placement and trap setup; lure handling, changing, and storage; checking traps; and the length of effectiveness for approved lures.

V: Sample Processing, Sorting, and Submission

This section gives specific information on how to submit samples for identification.

I: Introduction

Purpose

The purpose of the Solanaceous Hosts Commodity-based survey (hereafter referred to as the Solanaceous Hosts Survey) is to detect new infestations of target Solanaceous pest species at low population levels. This document provides standardized guidelines for conducting a Solanaceous Hosts commodity-based detection survey in the United States and its territories.

The target species of the survey were selected by the national committee of the Cooperative Agricultural Pest Survey (CAPS) Program. Target species are either exotic pests not known to occur in the United States or pests with limited distribution. Surveys are planned and coordinated through each Plant Protection and Quarantine, State Plant Health Director's office, and state cooperators (state departments of agriculture). The goals of the Solanaceous Hosts survey are to obtain information about:

- The presence, distribution, or absence of the target species;
- Patterns of distribution throughout the United States;
- Possible pathways for introduction of target species.

The following elements are pivotal to the success of the Solanaceous Hosts survey:

- Interviews, inspection, and trapping activities in and around high-risk areas;
- Timely and accurate data reporting;
- Public outreach programs that create an awareness of Solanaceous Host pests and encourage reporting from growers and the public.

Background

Solanaceous crops generally refer to plants in the nightshade family, Solanaceae. Important genera in this group include *Capsicum* (pepper), *Nicotiana* (tobacco), and *Solanum* (eggplant, potato, and tomato).

Eggplant

Eggplant (*Solanum melongena*) was originally domesticated in India and is one of the few cultivated solanaceous species originating from the Old World. Eggplant is widely grown in temperate and tropical Asian countries and is now cultivated worldwide (Daunay, 2008). Eggplants can be produced in a variety of colors and shapes. Most commercial varieties are purplish-black in color and oval or teardrop in shape. Other, less common, varieties include Asian and miniature eggplants (Jore, 2012).

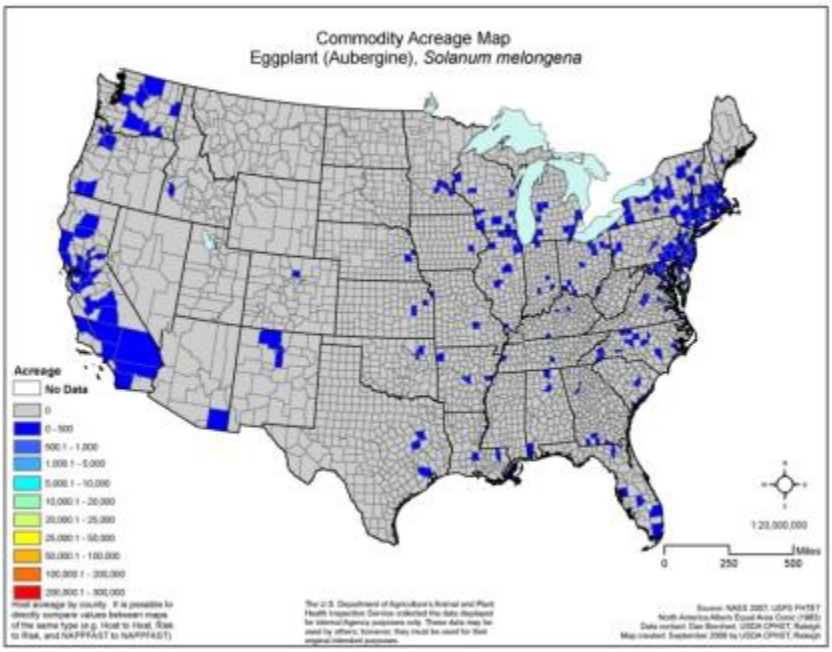

Figure 1. Eggplant commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

Eggplant is a warm season crop. In the United States, this crop is primarily grown from transplants, which reduces the growing period by half. Seeded crops can take as long as 150 days to mature. During the growing season, long periods of cool weather can cause flowers to drop which can reduce yields. Plants can yield four to six fruits during the season peak (Jore, 2012).

Eggplant can be canned, pickled, and processed in industrial operations. It can be used as a meat substitute in some dishes and is used in many traditional ethnic dishes and appetizers (Jore, 2012).

According to data from FAO (2011), world production for 2011 was estimated at 46.7 million metric tons (mmt). The top producers of eggplant include China (27.7 mmt) and India (11.9 mmt). The United States ranked 24th in world production.

In 2001, U.S. eggplant production was valued at $42.5 million; the top producing states were Georgia, Florida, California, New Jersey, and New York. Over the past five decades, United States consumption of eggplant has increased. This may be due to the introduction of new processed products and an increased interest in following a vegetarian diet (Jore, 2012).

Peppers

Cultivated peppers are members of the new world genus *Capsicum*. Production and consumption have gradually increased in the United States as well as worldwide during

the 20th century. The most important cultivated species of pepper is *Capsicum annuum* (cayenne pepper, bell pepper); Mexico is the center of diversity for this species. The centers of diversity for *C. chinense (*chili pepper) and *C. frutescens/annuum* (cayenne pepper) are the Amazonian regions of South America. Domestication possibly occurred over thousands of years by Pre-Columbian cultures of the western hemisphere. Wild species can be found from Texas to Argentina (Crosby, 2008).

Peppers can be grown on a small scale in container gardens and other nontraditional cropping arrangements, as well as on larger scales. Peppers are usually harvested weekly by hand for about one month. Most peppers are picked and sold as green peppers, but other colors are found (red, yellow, orange, purple, brown, and black). Bright colored bell peppers (usually the mature form of the pepper), take longer to ripen. Therefore, they are more costly to produce and can be sold at a premium. Bell peppers are produced and marketed in the United States year round. California's shipping season runs from April to December, while Florida's shipping season runs from October through the following July. The most popular mild peppers include bell and banana peppers, while popular hot peppers include jalapeños and habaneros (Burden, 2012).

Peppers are used as both a vegetable and a spice. Sweet and hot peppers can be processed into sauces, pickles, relishes, and canned products. Peppers have analgesic (pain reducing) properties and are used in the pharmaceutical industry. Peppers are also used to create pepper spray which is used in the law enforcement and self-defense industries. Industrial uses include pest deterrence in wood products (Crosby, 2008).

According to data from FAO (2011), world production for green chilies and peppers in 2011 was estimated at 30 million metric tons (mmt) while world production for dry chilies and peppers for 2011 was estimated at 3.4 mmt. The top producers of green chilies and peppers include: China (15.5 mmt), Mexico (2.1 mmt), and Turkey (2.0 mmt). The United States ranked 5th in world production. The top producers of dry chilies and peppers include: India (1.4 mmt), China (0.3 mmt), and Pakistan (0.2 mmt). The United States ranked 64th in world production (FAO, 2011).

United States consumption of peppers has increased from 15.3 lbs per person in 2005 to 16.4 lbs per person in 2009. In 2011, 17.6 million cwt[1] of bell peppers were grown in the United States; most production occurred in California (8.6 million cwt) and Florida (4.4 million cwt). In that same year, 4.8 million cwt of chili peppers were grown in the United States; most production occurred in California (2.5 million cwt) (reviewed in Burden, 2012).

[1]Hundredweight (cwt) is a unit of weight that is equivalent to 100 pounds that is used in trading livestock, grains, and other commodity contracts.

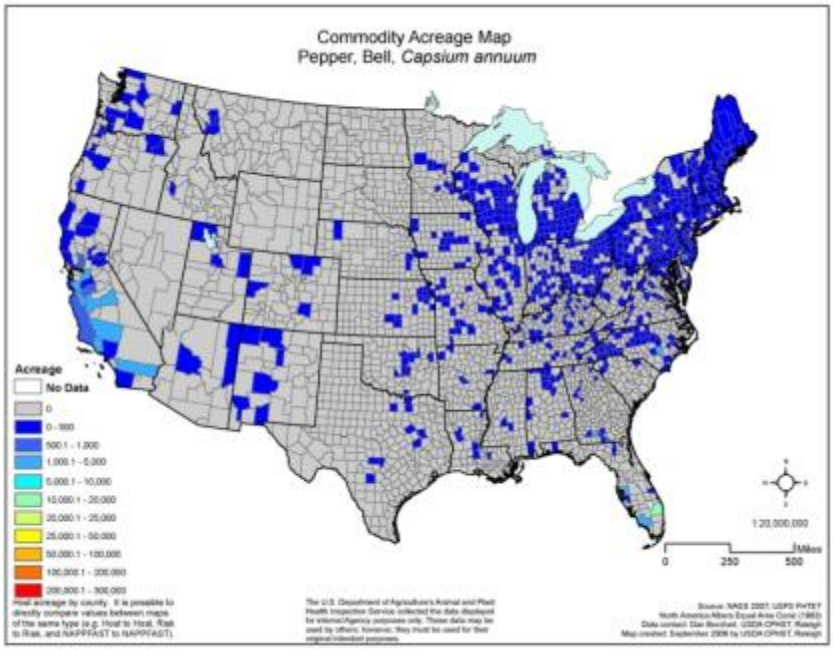

Figure 2. Bell pepper commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

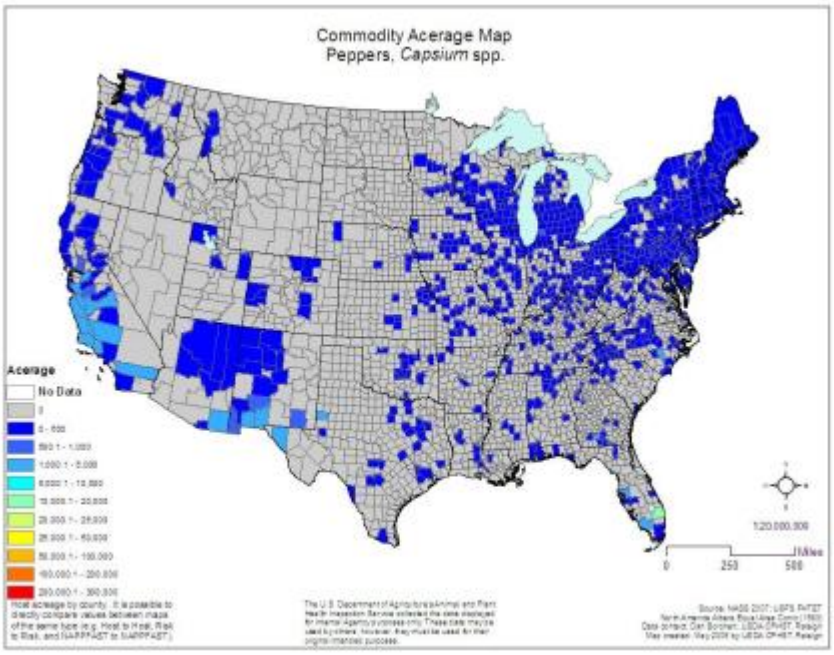

Figure 3. Pepper commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

Potato

Potatoes (*Solanum tuberosum*) are the fourth most important food crop in the world. Cultivation of potatoes first occurred around 200 B.C. by Inca Indians in Peru. The vegetable was introduced into Europe in the 16th century by the Spanish and soon became widely accepted and consumed. There are nearly 4,000 varieties found in the Andes today (Bosse and Boland, 2012).

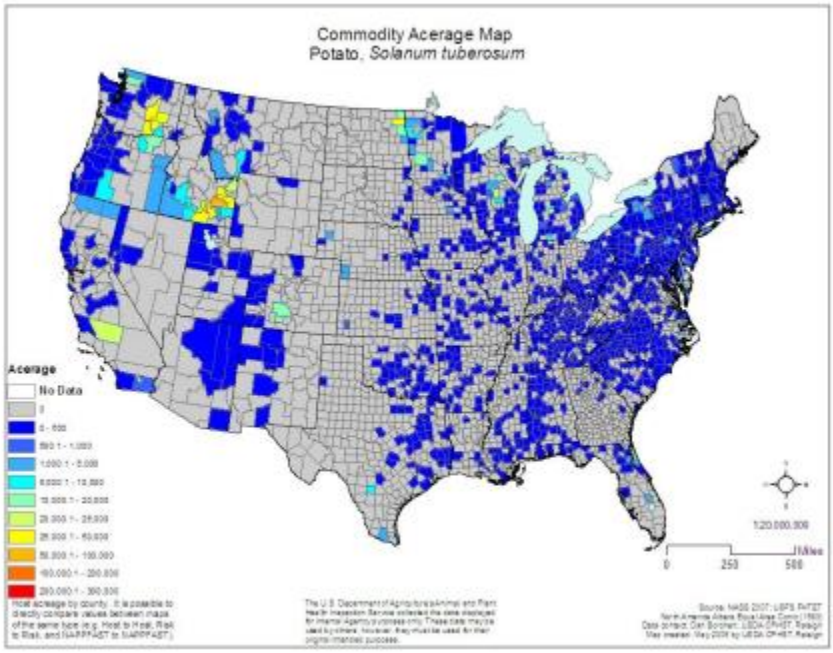

Figure 4. Potato commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

Potatoes are a tuberous crop. The tubers are specialized stems that grow right below the surface of the soil. Cut portions of whole potatoes, commonly called seed pieces or potato seed are used for the plantings. Potatoes can be grown in multiple climates and soil types. They can also be stored long term in climate controlled conditions, making them more readily available throughout the year (USDA-ERS, 2012). Almost 60% of potatoes are processed for French fries, chips, dehydrated potatoes, and other products. The rest go to the fresh market, are used for animal feed, or are re-used for seed tubers for next season's crop (Bosse and Boland, 2012).

According to data from FAO (2011), world production for potatoes in 2011 was estimated at 374 million metric tons (mmt). The top producers of potatoes include: China (88.3 mmt), India (42.3 mmt), and Russia (32.7 mmt). The United States ranked 5th in world production of potato. World production for potato seed was estimated at 31.3 mmt. The top producers of seed include: Russia (6.5 mmt), Ukraine (4.5 mmt),

and India (3.0 mmt). The United States ranked 5th in world production of seed (FAO, 2011).

Potatoes are the top vegetable crop in the United States. Idaho and Washington produce over half of the annual supply of potato. In 2010, this totaled 404.2 million cwt. Potatoes are grown commercially in 30 states. In 2010, the top five producers were Idaho (113,000 cwt), Washington (88,400 cwt), Wisconsin (24,300 cwt), Colorado (23,000 cwt), and North Dakota (22,000 cwt) (reviewed in Bosse and Boland, 2012).

Tobacco

This crop is native to the Americas and has been used for both medicinal and ceremonial purposes for thousands of years. It was first grown commercially in the United States during the 1600s. Domestic production peaked in 1954 but has been declining since, likely due to health concerns that began to rise in the 1950s. Today, tobacco (*Nicotiana tabacum* and *Nicotiana rustica*) is used by more than one billion people around the world (Huntrods, 2012).

There are six major classes of tobacco that are produced: flue-cured, air-cured, fire-cured, cigar filler, cigar binder, and cigar wrapper. The most widely grown classes in the United States are flue-cured and air-cured. In the United States, tobacco seedlings are germinated in greenhouses to control the environment and diseases. Seedlings are then transplanted to fields where they are fertilized and monitored to reduce disease and insect damage. After the tobacco is harvested, it undergoes a curing process which is necessary before use. Growing tobacco is labor intensive, and each class of tobacco has different growing and harvesting requirements (Huntrods, 2012).

Tobacco can be smoked, dipped, chewed, or sniffed. Although consumption of this commodity is decreasing in wealthy nations, its use is increasing in developing nations (Huntrods, 2012).

According to data from FAO (2011), world production for tobacco in 2011 was estimated at 31.3 million metric tons (mmt). The top producers of tobacco include: China (3.2 mmt), India (1 mmt), and Brazil (1 mmt). The United States ranked 4th in world production of tobacco (FAO, 2011).

Although tobacco acreage is smaller compared to other field crops, it has a higher market value. Based on market value, this crop is one of the top ten grown in the United States. Tobacco is commercially harvested in 10 states. In 2011, production was highest in North Carolina, followed by Kentucky, Virginia, Tennessee, and South Carolina (Huntrods, 2012).

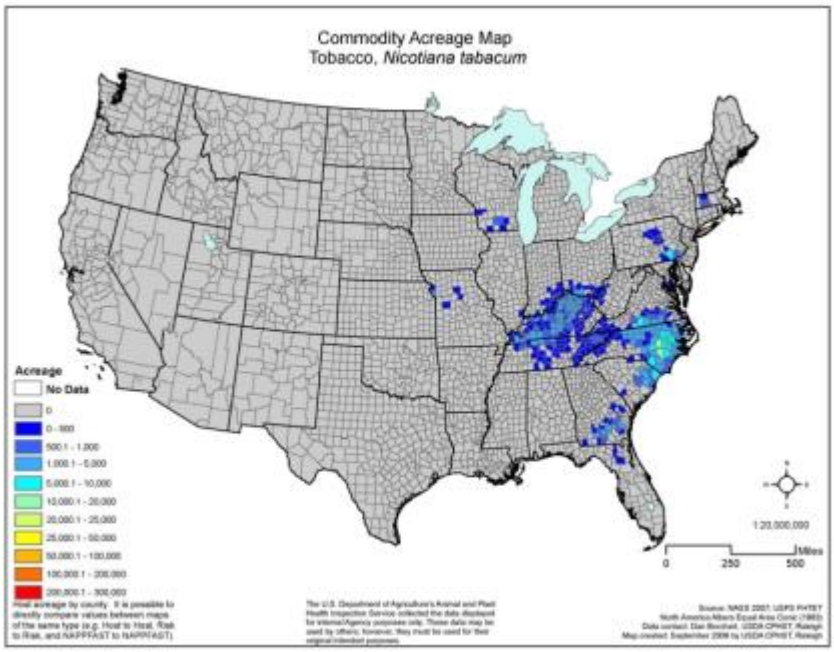

Figure 5. Tobacco commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

Tomato

The tomato (*Solanum lycopersicum*) originated in the Andean region including parts of Colombia, Ecuador, Peru, Bolivia, and Chile. Following the arrival of the Spanish, the tomato was introduced and moved throughout Europe where improvements to growing systems and development of new varieties occurred (Díez and Nuez, 2008).

There are two distinct tomato industries in the United States, fresh market tomatoes and processing tomatoes. Fresh market tomatoes make up a larger share of the United States tomato crop. These can be sold at higher prices, are juicier, and are harvested when immature. Characteristics for fresh market tomatoes include: open growth habit, high yield, earliness, and external and internal fruit quality.

Processing tomatoes do not fetch as high a price as tomatoes for fresh consumption and thus have different production and fruit requirements. The two main types of processed tomato products are tomato concentrate and whole peeled tomatoes (Díez and Nuez, 2008).

Tomatoes can be grown in the field or in greenhouses. Advantages of growing tomatoes in greenhouses include more uniform appearance and quality, production consistency, increased yields, and year round production (Boriss and Brunke, 2011).

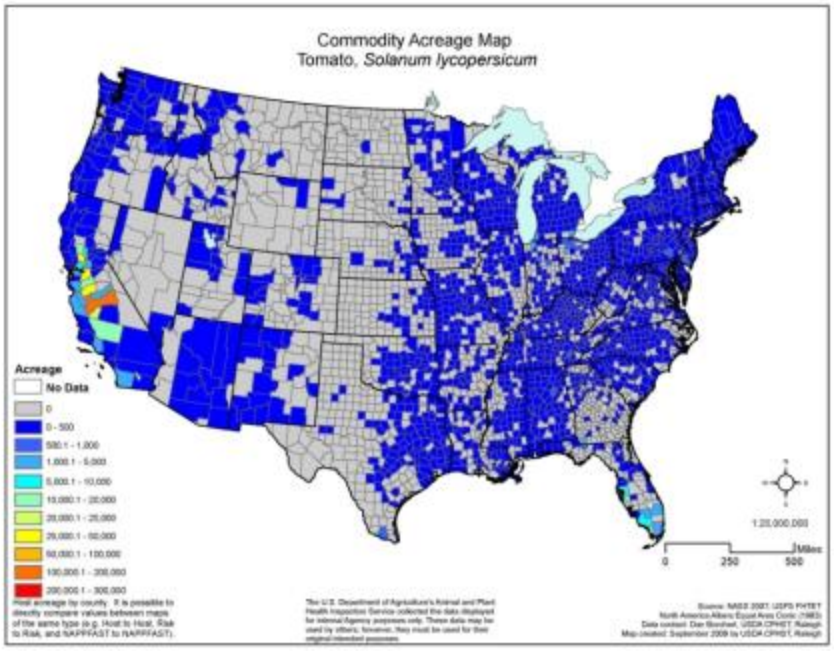

Figure 6. Tomato commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

According to data from FAO (2011), world production for tomato in 2011 was estimated at 159 million metric tons (mmt). The top producers of tomato include: China (48.6 mmt), India (16.8 mmt), and the United States (12.6 mmt) (FAO, 2011).

Average annual per capita consumption of tomatoes in the United States has increased in recent years from 12.3 lbs in 1981 to 18.5 lbs in 2008. In 2010, production was valued at $1.4 billion, making it the highest ranked fresh market vegetable. That same year, over 28 million cwt of commercial fresh market tomatoes were produced in the United States. The states with the highest production include California and Florida (producing nearly two-thirds of the acreage) as well as Tennessee and Ohio (Boriss and Brunke, 2011).

Selection of Target Species

The target pest species in this survey were selected by the National Committee of the Cooperative Agricultural Pest Survey (CAPS) Program, in cooperation with the USDA-APHIS-PPQ Center for Plant Health Science and Technology (CPHST). All target species included are exotic pests to some area(s) of the United States but not necessarily every state and territory. Tables 1 and 2 outline the targets selected for this survey, their common name, and pest type (see **Table 1. Target Insects for Survey** and **Table 2. Target Pathogens/Nematodes for Survey**).

Table 1. Target Insects for Survey

Scientific Name	Common Name	Pest Type
Autographa gamma	Silver-Y moth	Moth
Chrysodeixis chalcites	Golden twin spot moth	Moth
Helicoverpa armigera	Old world bollworm	Moth
Neoleucinodes elegantalis	Tomato fruit borer	Moth
Spodoptera littoralis	Egyptian cottonworm	Moth
Spodoptera litura	Cotton cutworm	Moth
Tecia solanivora	Guatemalan potato tuber moth	Moth
Thaumatotibia leucotreta	False codling moth	Moth
Tuta absoluta	Tomato leaf miner	Moth

Table 2. Target Pathogens/Nematodes for Survey

Scientific Name	Common Name	Pest Type
Candidatus Phytoplasma australiense	Australian grapevine yellows	Phytoplasma
Globodera pallida	Pale cyst nematode	Nematode
Globodera rostochiensis	Golden nematode	Nematode
Meloidogyne fallax	False Columbia root-knot nematode	Nematode
Meloidogyne minor	Root-knot nematode	Nematode
Ralstonia solanacearum race 3 biovar 2	Bacterial wilt; Southern bacterial wilt	Bacterium
Synchytrium endobioticum	Potato wart	Fungus

II. Planning a Survey

Choosing Target Species

Pest targets should be added to your detection survey based on their relevance to your particular state or territory. Determining which target species to survey for should be based on 1) the risk of introduction of the target and pathways of introduction; 2) presence of known or potential hosts in your state/territory; 3) the importance of Solanaceous Hosts to your state; 4) climatic suitability of your state/territory for the target; 5) resources available (financial and staff) for survey and identification of the pest (see **Table 3: Target Pests by CAPS Approved Method**); and 6) the status/importance of a particular pest to your state/territory.

Table 3. Target Pests by CAPS Approved Method

Scientific Name	Common Name	CAPS Approved Survey Method	CAPS Approved Identification/Diagnostic Method
Autographa gamma	Silver-Y moth	Trap and Lure	Morphological
Candidatus Phytoplasma australiense	Australian Grapevine yellows	Visual	Molecular
Chrysodeixis chalcites	Golden twin spot moth	Trap and Lure	Morphological
Globodera pallida	Pale cyst nematode	Soil Sample	Morphological (screening); molecular (confirmation)
Globodera rostochiensis	Golden nematode	Soil Sample	Morphological (screening); molecular (confirmation)
Helicoverpa armigera	Old world bollworm	Trap and Lure	Morphological
Meloidogyne fallax	False Columbia root-knot nematode	Soil Sample	Morphological
Meloidogyne minor	Root-knot nematode	Soil Sample	Morphological
Neoleucinodes elegantalis	Tomato fruit borer	Trap and Lure	Morphological
Ralstonia solanacearum race 3 biovar 2	Bacterial wilt; Southern bacterial wilt	Visual	Multiple: ELISA (screening), molecular & race/biovar assays (confirmation)
Spodoptera littoralis	Egyptian cottonworm	Trap and Lure	Morphological

Scientific Name	Common Name	CAPS Approved Survey Method	CAPS Approved Identification/Diagnostic Method
Spodoptera litura	Cotton cutworm	Trap and Lure	Morphological
Synchytrium endobioticum	Potato wart	Visual – at harvest	Morphological (screening); molecular (confirmation).
Tecia solanivora	Guatemalan potato tuber moth	Trap and Lure	Morphological
Thaumatotibia leucotreta	False codling moth	Trap and Lure	Morphological
Tuta absoluta	Tomato leaf miner	Trap and Lure	Morphological

CAPS Approved Methods Webpage

The CAPS Approved Methods webpage (http://caps.ceris.purdue.edu/approved_methods) lists the most up-to-date, CAPS-approved methods (CAM) for survey and identification/diagnostics of CAPS target pests. The CAM pages list approved methods for pests from the Priority Pest List, consisting of pests from 1) commodity- and taxonomic-based surveys and 2) the Pests of Economic and Environmental Importance list. The information on the CAM pages supersedes any survey and identification/ diagnostic information found in any other CAPS document. Changes are first made on the CAM pages. CAPS documents are revised to reflect these changes as soon as possible; however, the CAM page should always be the authoritative source for the most up-to-date, CAPS-approved methods. To access the CAM information, go to the CAM page and select the survey year. From there, you can select the individual CAPS pest of interest.

Pathways

When planning surveys, states are encouraged to use a pathway approach when deciding on target species and locations to survey. It is understood that risk factors can be examined along a "risk continuum" beginning at offshore sites (points of origin) to points of potential establishment (commodity production areas, greenhouses), and numerous risk points in between (wholesale distribution centers, nursery sites, transportation corridors, etc.).

Hosts and Climate

The hosts of the target species as well as the climatic suitability of the targets should be considered when planning a survey.

Pest Datasheets
Each pest datasheet within the manual gives specific guidance on the hosts, biology, pathway, and climactic suitability of the target.

NAPPFAST Maps
The North Carolina State University APHIS Plant Pest Forecasting System (NAPPFAST) produces maps to support CAPS and other PPQ surveys. Depending on the level of biological data available, the pest datasheets will include host, risk, or Pareto NAPPFAST maps.

Host Map
The host risk map describes the relative density (on a scale of 1-10) of susceptible hosts. The maps are based on National Agricultural Statistics Service (NASS) and Forest Inventory and Analysis (FIA) data. The scale of one to ten describes the proportion of total host acreage per county. For example, a rank of one indicates no host acreage, while a score of ten indicates that 100% of the acres in the county contain suitable hosts for the pest.

Final Risk Map
A final risk map represents the combined host and climatic suitability on a scale of 0-10. The NAPPFAST risk map and the host risk map were multiplied to obtain a final risk map. A value of one represents low density of susceptible hosts and low likelihood of pest growth and survival. A value of 10 indicates high density of susceptible hosts and a high likelihood of pest growth and survival. A value of zero or the gray area indicates an unsuitable climate for the pest.

Pareto Map
The Pareto maps integrate maps of host abundance, climate, and pathway risks into a single risk map. Where no climate map exists, the maps were created from host and pathways only. The risk is rated on a scale of 1-10 based on a series of ordinal risk rankings. The Pareto Risk Map may more accurately reflect the risk potential of a pest than the Final Risk Map because it includes importation pathways.

NAPPFAST Zonal Statistics
States have different amounts of hosts, varying environmental conditions, and pest introduction levels represented in the risk maps at the county level. Zonal statistics can be used to identify the highest risk pests for an individual state. Files for each state may be viewed on the NAPPFAST page of the CAPS Resource and Collaboration website. If you are unfamiliar with how to analyze and use this data, please contact Dan Borchert for assistance.

For any NAPPFAST-related questions:

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Survey Sites

When choosing a survey site, select a site that contains known or potential hosts and is large enough to hold all of the traps that will be placed there. When possible, trap near the preferred hosts for the target species. Consult the individual pest datasheets for this information.

Areas of risk can include nurseries that carry Solanaceous transplants or other propagative material as well as natural and managed/cropping areas where Solanaceous plants are found. Pests may be more common on certain plant parts when compared to other plant parts. Many of the target species in this manual also have other non-solanaceous hosts that should be considered when planning surveys.

Some of the lures can inhibit attraction of other target species; therefore, when trapping for more than one target species traps with different lure types must be separated. For different moth species, separate traps by at least 20 meters (66 feet). See individual datasheets for information about lure interactions.

Survey Season

Certain pests may be more prevalent during certain seasons or at different times during the year. Please see the specific pest datasheet for each pest to help determine the time of year to survey for each pest/pest type.

Figure 7. Heliothis trap.

Trap Types

Several different traps are recommended for the Solanaceous Survey targets. Traps are recommended based on the biology of the pest. Refer to **Table 4: Solanaceous Insect Trap and Lure Combinations** for the trap and lure product names as they appear in the IPHIS Survey Supply Ordering System. The six trap types recommended for CAPS Solanaceous targets are:

- Diamond traps,
- Heliothis traps,
- Large plastic delta traps,
- Plastic bucket traps,
- Texas (Hartstack) traps, and
- Wing traps.

Diamond Traps: This trap is in the shape of a diamond when pulled apart and assembled. The trap is made of waxed cardboard with all inside surface areas covered in an adhesive. . This trap is not available through the IPHIS Survey Supply Ordering System.

Heliothis Traps: This trap (Fig. 7) is made of white plastic mesh. It comes in two parts, a bottom cone and a smaller top cone that fits over it. The cones should be secured to a pole or stake at a sufficient height. This trap can be ordered through the IPHIS Survey Supply Ordering System.

Figure 8. Large plastic delta trap (Image courtesy of John Crowe).

Large Plastic Delta Traps: Large plastic delta traps (Fig. 8) can be ordered through the IPHIS Survey Supply Ordering System. Currently, the traps are available in orange, red, or white through the ordering system. For the targets in the Solanaceous Hosts survey, the color of the trap does not affect the efficacy for trapping. States may choose any one of the three colors. Large plastic delta traps are available with an internal disposable glue liner.

Plastic Bucket Traps: This trap is also known as the unitrap can be ordered through the IPHIS Survey Supply Ordering System. The trap has a green canopy, yellow funnel, and white bucket and is used with a dry kill strip. This trap (Fig. 9) allows for the collection of large amounts of specimens without damaging some of their identifying characteristics. See **Appendix A: Plastic Bucket Trap Protocol** for more information on how to use the trap.

Figure 9. Plastic bucket trap. (Image courtesy of Julieta Brambila and Robert Meagher).

Texas (Hartstack) Trap: The Texas (Hartstack) trap is not available commercially. See Hartstack et al. (1979) or Johnson and McNeil (no date) for images and trap design.

Wing Traps: Wing traps (Fig. 10) are available in either a plastic or paper version. Plastic and paper traps are both equally effective and the State may decide which trap to use. Wing traps have a removable sticky insert. When using a wing trap, the lure (a rubber septum) should be placed inside a lure holder, which is usually included with the trap. The lure holder should be stapled to the underside of the top of the trap on a non-sticky area. This trap can be ordered through the IPHIS Survey Supply Ordering System.

Figure 10. Wing trap (Image courtesy of John Crowe).

Review each pest datasheet for additional guidance or trap modifications for the specific species.

Table 4. Solanaceous Insect Trap and Lure Combinations

Target Species	Lure Product Name	Trap Product Names
Autographa gamma	*Autographa gamma* Lure	Plastic Bucket Trap

Chrysodeixis chalcites	*Chrysodeixis chalcites* Lure	Wing Trap Kit, Paper Wing Trap Kit, Plastic
Helicoverpa armigera	*Helicoverpa armigera* Lure	Plastic Bucket Trap Heliothis Trap Texas (Hartstack) Trap
Neoleucinodes elegantalis	*Neoleucinodes elegantalis* Lure	Large Plastic Delta Trap Kits, Orange Large Plastic Delta Trap Kits, Red Large Plastic Delta Trap Kits, White
Spodoptera littoralis	*Spodoptera littoralis* Lure	Plastic Bucket Trap
Spodoptera litura	*Spodoptera litura* Lure	Plastic Bucket Trap
Tecia solanivora	*Tecia solanivora* Lure	Large Plastic Delta Trap Kits, Orange Large Plastic Delta Trap Kits, Red Large Plastic Delta Trap Kits, White
Thaumatotibia leucotreta	*Thaumatotibia leucotreta* Lure	Wing Trap Kit, Paper Wing Trap Kit, Plastic Diamond Trap Large Plastic Delta Trap Kits, Orange Large Plastic Delta Trap Kits, Red Large Plastic Delta Trap Kits, White
Tuta absoluta[1]	*Tuta absoluta* Lure	Large Plastic Delta Trap Kits, Orange Large Plastic Delta Trap Kits, Red Large Plastic Delta Trap Kits, White

IMPORTANT: Do not combine lures for more than one species in a trap.

Trap Spacing: When trapping for more than one species of moth, separate traps for different moth species by at least 20 meters (65 feet).

[1]For *Tuta absoluta*, the hard glue liners should be used in the large plastic delta traps. Traditional glue liners are still considered effective at capturing *Tuta absoluta*; however, specimens tend to be of higher quality from the hard glue liners. The product name for the hard glue liners in the IPHIS survey Supply Catalog is “Large Plastic Delta Trap - Liners - Hard Glue.”

III. Ordering Traps and Lures

All traps and lures for the Solanaceous Hosts Commodity-based Survey should be ordered through the IPHIS Survey Supply Ordering System during the open ordering season. By using the ordering system, PPQ can utilize quality assurance procedures that are not available when ordering directly from manufacturers.

All necessary traps and lures needed for the Solanaceous Hosts Commodity-based Survey are specifically listed in the ordering system. See **Table 4: Solanaceous Insect Trap and Lure Combinations** or the individual pest datasheets for the trap and lure product names. Note: every effort is made not to change the CAPS-approved survey methods during a survey season. However, if changes are necessary (*i.e.,* a trap or lure is not available), a notification will be sent out through the Survey Planning forum from the CAPS Resource and Collaboration Site, and a note will be placed on that target's information page on the CAPS Approved Methods page. Please visit the CAPS Approved Methods page for the most current information.

Supplies are shipped via overnight courier, ground transportation, or palletized freight. To avoid problems when receiving supplies, surveyors should specify any particular delivery requirements in the comment box of the order form. For example enter, "Call before shipping in order to arrange for storage, personnel, or equipment to unload the shipment" or "Cannot accept pallets," etc.

Inspect lures upon receiving them from PPQ. Notify the appropriate National Operations Manager of any lures that are damaged and request replacement lures (see contact information below).

Contact information for trap and lures

For questions about the IPHIS Survey Supply Ordering System or trap and lure quality issues:

Brian Kopper
National Operations Manager, Pest Detection
USDA-APHIS-PPQ
920 Main Campus Dr.
Raleigh, NC 27606
919-855-7318
Brian.J.Kopper@aphis.usda.gov

Kristian Rondeau
National Operations Manager, Farm Bill
USDA-APHIS-PPQ
2150 Centre Ave., Building B.
Ft. Collins, CO 80526
970-490-7563
Kristian.C.Rondeau@aphis.usda.gov

For technical trap, lure, and survey methodology questions:

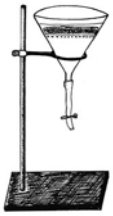
Lisa Jackson
Biological Scientist
USDA-APHIS-PPQ-CPHST
1730 Varsity Dr., Suite 400
Raleigh, NC 27606
919-855-7549
Lisa.D.Jackson@aphis.usda.gov

IV. Conducting a Survey

Soil Sampling

Soil sampling involves the collection of multiple cylindrical soil cores for the detection of nematodes. Frequently, the cores are combined and mixed thoroughly to form a composite sample. The composite sample is then processed and analyzed for the presence of target nematodes. Soil sampling for nematodes is a three step process (See Fig. 10).

1. Collection: Samples of soil or host roots are collected with the purpose of obtaining males, juveniles, female nematodes, or cysts within soil and root tissues.



2. Extraction: Samples are processed to separate nematodes from soil and debris.

3. Identification: Finally, nematodes are prepared for identification using morphological or molecular techniques. For morphological details, the morphometrics of second-stage juveniles, females, and cysts are examined. For molecular testing, a range of polymerase chain reaction (PCR) techniques are utilized.

Major characteristics used for the identification of cysts:
Cyst shape, characteristics of cyst terminal cone including nature of fenestration, cyst wall pattern, anal-vulval distance, number of cuticular ridges between anus and vulva, and Granek's ratio (for *Globodera* spp.).

Second-stage juvenile morphology used for the identification:
Body length, stylet length, shape of stylet knobs, shape and length of tail, shape and length of hyaline tail terminus, and number of refractive bodies in the hyaline part of tail (for *Globodera* spp.).

Figure 10. Sampling nematodes generally involves three steps: collection, extraction, and identification. This document focuses on collection. A processing and identification plan should be developed for each state.

Soil cores should be collected within a site using a grid-like pattern. Target some sampling around the entryways, low spots and areas where it floods, or places where soil/equipment moves into the field. These cores should be combined into a composite

sample for each survey site. Sample sites may be the same as those chosen in the visual survey. There are four pests that have soil sampling as a CAPS-Approved method: *Globodera pallida*, *Globodera rostochiensis*, *Meloidogyne fallax*, and *Meloidogyne minor*.

Sampling rates will vary based on available resources (funding level and personnel available) to conduct the survey. For program-recommended sampling rates and methodology for pale cyst nematode (*Globodera pallida*) and golden nematode (*Globodera rostochiensis*) see:
Pale Potato Cyst Nematode National Survey and Diagnostic Cyst Sample Forwarding Protocols and Golden Nematode Manual.

General guidance for cyst nematodes is also available in the Cyst Nematode Survey Reference Introduction Document linked at https://caps.ceris.purdue.edu/survey/cyst-nematodes/reference/2014.

Visual Survey

Several of the pests targeted in this survey can be detected visually by looking/scouting for characteristic symptoms/damage or signs of a pest and collecting samples of plant tissues in the field. A symptom is an indication of disease or a pest by reaction of the host (*e.g.*, canker, leaf spot, wilt, yellowing). A sign, in contrast, is an indication of a disease or pest from direct observation of a pest or its parts (physical evidence of the pest) (Fig. 11). It is important to note that none of these symptoms/signs, taken singly, are a diagnostic feature for any of the pests.

Figure 11. Top: Example of plant chlorosis (a symptom), Bottom: example of eggs and neonate larvae (a sign).

In the context of the current survey, surveyors should take note of the general condition of the plant and further examine the stems, leaves (both sides), flowers, and fruit for the pests of concern. The surveyors should pay close attention to symptomatic plants first. These would be the plants that have chlorosis (yellowing), necrosis (brown/dead tissue), feeding holes, or a generally unhealthy appearance. If no symptomatic plants are present, the surveyor should choose plants to examine based on convenience. While the surveyor should examine several plants within the site, only one data recording will be necessary for the site. It is recommended to

conduct visual surveys multiple times over the survey season. If the surveyor is trapping for insect targets, he or she will need to visit the site multiple times to service the traps and replace lures and baits. Visual surveys may be conducted during these trap-servicing visits as appropriate. There are three pests that have visual survey as a CAPS-approved method (see **Table 5. Solanaceous Hosts Commodity-based Visual Survey**).

Table 5. Solanaceous Hosts Commodity-based Visual Survey

Scientific Name	Symptoms/Damage & Signs to Look For[1]
Candidatus Phytoplasma australiense	In potato, upward rolling and purpling of the leaves is observed. The symptoms appear similar to those of 'zebra chip', a disorder of potato recently found to be associated with '*Candidatus* Liberibacter solanacearum' in New Zealand and the United States. In Jerusalem cherry (*Solanum pseudocapsicum*), symptoms include witches' brooming, foliar yellowing, and reduced leaf size. For symptoms on grape and other hosts see the CPHST Pest Datasheet for *Ca.* Phytoplasma australiense.
Ralstonia solanacearum race 3 biovar 2 (R3 Bvr2)	*R. solanacearum* R3 Bvr2 primarily causes bacterial wilt, which involves leaf chlorosis (yellowing), necrosis (browning) of vascular tissue, leaf death, stunting, vascular rings, yellowing of foliage, and rotting of tubers. Wilted leaves often start with areas of chlorosis that slowly die, leading to death of the whole plant. The stem may collapse and gray-white bacterial ooze may be present on the stem, especially when the stem is cut or broken. Stems may also blacken.
Synchytrium endobioticum	This fungus affects the stolons (underground stems) and tubers targeting the meristematic tissue by developing galls/warty growths. Young potato warts are white, soft, and pulpy in texture; the surface is rough and corrugated. Sometimes developing warts can become exposed at or above the soil line. This disease does not usually present symptoms aboveground; however stems, leaves, and flowers can sometimes develop galls. Attacked plants may show reduced vigor. Small greenish warts may form in the place of aerial buds at stem bases. For this survey, we suggest a visual survey of potato tubers at harvest for wart symptoms.

Trapping

In general, trapping is a type of survey that involves the use of a trap to catch arthropods of concern in a specific location. Often times, trap efficiency is increased through the use of some type of chemical or physical attractant. These attractants might be a light source, a food source, or a specific pheromone or chemical that is

highly attractive to the target species. In the context of the current survey, there are nine insect targets that have an approved trap and lure combination. See **Table 4: Solanaceous Insect Trap and Lure Combinations** for information on which traps to use with each target species.

Trap Sites

When choosing a survey site, select a site that is large enough to hold all the traps that will be placed there. For moths, traps with different lure combinations are normally placed 20 meters (65 feet) apart.

Trap Placement

Many of the target species listed in this manual are polyphagous and could potentially be found in multiple types of environments. For the purpose of the solanaceous manual, surveys should be targeted in areas with solanaceous hosts. Surveys could occur in commercial host crops (either in the field or in greenhouses when relevant) or in residential/urban areas where solanaceous crops are grown or sold (community gardens/garden centers).

- Survey sites should have host species of the target species.
- When possible, place traps out of direct sunlight or in partial shade.
- Make sure traps are not obscured by vegetation. Clip or remove any such vegetation.
- Separate traps with different lure types by at least 20 meters (65 feet) for moths.

For specific information on where to place traps see the specific pest datasheet as it may vary between species.

Lure Handling

Care should be taken to avoid contaminating external surfaces of traps with the attractant (lure) or cross-contaminating traps with attractants (lures) of different species (Lance, 2006). For example:

- Use latex or latex-substitute gloves when handling lures;
- Minimize direct contact with lures;
- Do not touch external portions of traps with gloves that have contacted lures; and

- At a minimum re-glove after handling lures for one species before handling traps or lures for another.

Lure Storage

Inspect lures upon receiving them from the manufacturer. Notify the appropriate National Operations Manager of any lures that are damaged and request replacement lures. Store lures as directed by the manufacturer until used. It is generally acceptable to store lures for different species in the same freezer if they are doubly contained in factory-sealed packages that are, in turn, held separately by species in a secondary closed container such as a glass jar or zip-lock bag (Lance, 2006).

Lure Changing

The length of effectiveness of lures is usually reported by lure manufacturers assuming temperatures of 30°C (86°F) during the day and 20°C (68°F) at night for a daily average of 25°C (77°F) under laboratory conditions. However, release rates of many lures are dependent on several factors including temperature, humidity, and other environmental conditions. Therefore, the length of effectiveness of lures may be reduced in hot and dry climates. In this manual, CAPS has listed a conservative length of effectiveness that should be effective for even the warmest climates in the United States (see **Table 6. Length of Effectiveness for Solanaceous Commodity-based Survey Lures)**. However, if you notice reduced non-target captures in your traps while the lure should still be effective, go ahead and change the lure and decrease the number of weeks between lure changes.

Table 6. Length of Effectiveness for Solanaceous Commodity-based Survey Lures

Target Species	Lure Product Name	Length of Effectiveness
Autographa gamma	*Autographa gamma* Lure	28 days
Chrysodeixis chalcites	*Chrysodeixis chalcites* Lure	28 days
Helicoverpa armigera	*Helicoverpa armigera* Lure	28 days
Neoleucinodes elegantalis	*Neoleucinodes elegantalis* Lure	30 days
Spodoptera littoralis	*Spodoptera littoralis* Lure	84 days
Spodoptera litura	*Spodoptera litura* Lure	84 days
Tecia solanivora	*Tecia solanivora* Lure	30 days
Thaumatotibia leucotreta	*Thaumatotibia leucotreta* Lure	56 days
Tuta absoluta	*Tuta absoluta* Lure	28 days

Checking Traps

- Check traps every two weeks or after bad weather events (rain, strong winds, or snow) which can disturb the sample.
- Examine trap for damage.
- Remove any debris blocking entrances, including leaves, twigs, spider webs, etc.
- Ensure that all lures are still in place.
- Remove any suspect specimens from the trap and submit the samples per the sample submission instructions.
- Change lures per the length of effectiveness for each species (see **Table 6. Length of Effectiveness for Solanaceous Commodity-based Survey Lures**).

Trapping Season

The trapping period will be the period of expected flight activity of adult moths. Traps should be placed in the field as soon as adult flight activity is expected to begin and remain throughout the active period. Actual trapping seasons may vary by location and target species. Refer to individual pest datasheets in this document to determine the trapping season for each target. Flight period descriptions in the datasheets are usually based on the flight season in the pest's native range. The country/ region is listed in the datasheet. States should compare the hardiness zones of these regions to the hardiness zones of their state to determine the predicted flight period in their state. Degree Days may also be used, where listed.

V. Sample Processing, Sorting, and Submission

Consult the most recent version of Procedures for Submitting Survey Samples to Domestic and Other Identifiers for information on how to process and submit survey samples.

When submitting specimens from sticky traps, please follow the instructions in Appendix E-2 of the CAPS Guidelines found here: http://caps.ceris.purdue.edu/webfm_send/2053.

For Australian grapevine yellows, follow the instructions in Phytoplasma sample submission for Cooperative Agricultural Pest Survey (CAPS) Program and Farm Bill Goal 1 Surveys FY 2014.

Screening Specimens

Screeners should have had some training in recognition of common native solanaceous pests. Familiarity with the CAPS target species is also helpful. Work with your state or university taxonomists for individual training and consult the screening aids that are available for some groups at: http://caps.ceris.purdue.edu/screening_aids

For states without screening ability, there are PPQ domestic identifiers and several other options. For nematodes, there are PPQ domestic identifiers and several other options including nematology programs at some land grant universities who take samples from other states for a fee. If your state would like to take advantage of the arrangements listed below to receive unscreened samples, please contact your PPQ Program Manager for more information prior to the trapping/ survey season.

Arthropods:

For the Western United States
Kira Metz
412 Minnie Belle Heep
2475 TAMU
College Station, TX 77843
979-450-5492
Kira.Metz@aphis.usda.gov

For the Eastern United States
Julieta Brambila
CAPS Office
USDA, APHIS, PPQ
1911 SW 34th Street
Gainesville, FL 32608
352-372-3505 ext. 438
Julieta.Brambila@aphis.usda.gov

The identifiers for *Candidatus* Phytoplasma australiense are:

Screening:
Curt Colburn
Clemson University
Molecular Plant Pathogen Detection (MPPD) laboratory
511 Westinghouse Rd.
Pendleton, SC 29670
864-646-2133
gcolbur@clemson.edu

Kevin Ong
Texas Plant Disease Diagnostic Lab
1500 Research Parkway, Suite A130
College Station, TX 77845
979-845-8032
kevo@tamu.edu

Craig Webb
Plant Pathologist - Domestic Identifier
USDA, APHIS, PPQ
Department of Plant Pathology
Kansas State University
4024 Throckmorton Plant Sciences
Manhattan, Kansas 66506-5502
785-532-134
Craig.A.Webb@aphis.usda.gov

Arthropods:
Prescreened suspect samples of CAPS arthropod target species must be sent to the state or university insect taxonomist in your state for identification. If there is no such position, and/or if arrangements are not made with the entities listed in the previous section, as a fall-back procedure, the specimens can be sent to the PPQ Area Identifier that covers the geographic area. Consult The Lists of PPQ Identifiers and PPQ National Specialists for contact information. Check their areas of coverage and notify the identifier prior to sending any specimens.

If a state or university taxonomist or PPQ area identifier believes the submitted specimen is a species new to the United States or state and/or a CAPS target species, it is necessary to send the preserved specimens to the USDA-ARS Systematic Entomology Laboratory (SEL) for final confirmation. If an Area Identifier or other taxonomist is uncertain as to the possibility that the specimen is a new or target species, consider sending the specimens first to one of the contacts listed above, as an intermediate step before forwarding to SEL.

When sending to SEL, be sure to include the PPQ form 391 (see Appendix B or use the fillable form available at http://www.aphis.usda.gov/library/forms/pdf/PPQ_Form_391.pdf) marked "Prompt" with the sample going forward. Notify and send an electronic copy of the 391 to the PPQ National Identification Services (NIS) Urgent Team at ppq.nis.urgents@aphis.usda.gov, an e-mail group, with the sample number and date forwarded.

If you have any questions, contact your regional survey coordinator or the Domestic Diagnostic Coordinator, Joel Floyd in Riverdale, Maryland.

Joel Floyd
Domestic Diagnostics Coordinator
USDA, APHIS, PPQ National Identification Services
4700 River Rd., Unit 52, Rm. 4D-04B
Riverdale, MD 20737
301-851-2115
Joel.P.Floyd@aphis.usda.gov

PPQ identifiers processing domestic samples can notify submitters of non-target and native species identifications without entering the samples in the AQAS database; however, any suspects that are forwarded to SEL for final identification must be entered into AQAS prior to sending.

Send the specimen(s) to the following address:

Location Leader
Systematic Entomology Laboratory
Attn: Communication and Taxonomic
Services Unit
Building 005, Room 137, BARC-West
10300 Baltimore Avenue
Beltsville, MD 20705
Phone number for overnight carrier airway bill 301-504-7041

The specimens will be routed by the SEL location leader to the appropriate specialist for final confirmation. Communications of identification results will be through the PPQ NIS domestic diagnostics coordinator in Riverdale, Maryland.

Pathogens/Nematodes:
Prescreened suspect samples of CAPS pathogen target species must be sent to the state or university taxonomist in your state for identification. If there is no such position, and/or if arrangements are not made with the entities listed in the previous section, as a fall-back procedure, the specimens can be sent to the PPQ Area Identifier that covers the geographic area. Consult The Lists of PPQ Identifiers and PPQ National Specialists for contact information. Check their areas of coverage and notify the identifier prior to sending any specimens. Potato tubers that have characteristic potato wart symptoms,

however, can be sent directly to the CPHST Beltsville laboratory and do not need to be prescreened at the state level.

If a state or university taxonomist or PPQ area identifier believes the submitted specimen is a species new to the United States or state and/or a CAPS target species, it is necessary to send the samples to the CPHST Beltsville Laboratory (*Ralstonia*, potato wart) or the USDA–ARS Nematology Laboratory (*Globodera* and *Meloidogyne* spp.) for final confirmation.

For Australian grapevine yellows:
For FY 2014 and 2015 surveys: Follow instructions in Phytoplasma sample submission for Cooperative Agricultural Pest Survey (CAPS) Program and Farm Bill Goal 1 surveys FY 2014 and 2015

For FY2016 surveys: Follow instructions in Phytoplasma sample submission for Cooperative Agricultural Pest Survey (CAPS) Program and Farm Bill Goal 1 surveys FY 2016

There are screening and confirmation procedures in place for these samples.

Nematodes:
Final confirmations of suspect quarantine nematode species can potentially occur at the USDA-ARS Nematology Laboratory for morphological and some molecular identifications or the CPHST Beltsville Laboratory for molecular confirmation of *Globodera* species. Submitters considering the forwarding of any samples to these labs must first have sample screened to highly suspect for quarantine species by a taxonomist, and must contact the National Field Operations Manager for Pest Detection or the Domestic Diagnostics Coordinator prior to forwarding to ascertain the appropriateness of using the national laboratories for confirmation.

When sending to PPQ domestic identifier, the CPHST Beltsville Laboratory or the USDA–ARS Nematology Laboratory, be sure to include the PPQ form 391 (see Appendix A or use the fillable form available at http://www.aphis.usda.gov/library/forms/pdf/PPQ_Form_391.pdf) marked “Prompt” with the sample going forward. Notify and send an electronic copy of the 391 to the PPQ National Identification Services (NIS) Urgent Team at ppq.nis.urgents@aphis.usda.gov, an e-mail group, with the sample number and date forwarded for national confirmation.

If you have any questions, contact the National Field Operations Manager for Pest Detection or the Domestic Diagnostic Coordinator (addresses below);

Brian Kopper.
National Field Operations Manager for Pest Detection
USDA-APHIS-PPQ
920 Main Campus Dr.
Raleigh, NC 27606

Ph. 919-855-7318
Brian.J.Kopper@aphis.usda.gov

Joel Floyd
Domestic Diagnostics Coordinator
USDA, APHIS, PPQ National Identification Services
4700 River Rd., Unit 52, Rm. 4D-04B
Riverdale, MD 20737
301-851-2115
Joel.P.Floyd@aphis.usda.gov

PPQ identifiers processing domestic samples can notify submitters of non-target and native species identifications without entering the samples in the AQAS database; however, any suspects that are forwarded to the USDA–ARS Nematology Laboratory or the CPHST Beltsville Laboratory for final ID must be entered in AQAS prior to sending. States forwarding samples can use the PPQ form 391 as above.

After prior approval from the Domestic Diagnostics Coordinator, the following are the addresses for sending the specimen(s):

CPHST Beltsville Laboratory
Sample Diagnostics
USDA-APHIS-PPQ-CPHST
BARC-East, Bldg. 580
Powder Mill Road
Beltsville, MD 20705-2350
Phone: (301) 504-7100, VOIP: (301) 313-9200
Group e-mail: APHIS-PPQCPHSTBeltsvilleSampleDiagnostics@aphis.usda.gov

USDA-ARS Nematology Laboratory

Dr. David J. Chitwood or Dr. Zafar Handoo
USDA–ARS Nematology Laboratory
Bldg. 010A, Room 111, BARC–West
10300 Baltimore Ave.
Beltsville, MD 20705–2350
Dr. Handoo: 301-504-6666
Dr. Chitwood: 301-504-8634
Zafar.Handoo@ars.usda.gov
David.Chitwood@ars.usda.gov

Communications of identification results will be through the PPQ NIS domestic diagnostics coordinator in Riverdale, Maryland.

Communication of Results

Native or non-target species identifications will be communicated directly back to the state taxonomist, identifier, or originator of the sample. If the insect/pathogen/nematode is confirmed as a CAPS target species or new pest to the United States, the Domestic Diagnostics Coordinator will alert the National Survey Coordinator of the identification. The notification will then go to PPQ Policy Management and Field Operations program managers, and the SPHD and SPRO of the state of origin. One of these individuals will then forward the confirmation to the originator of the sample and other state CAPS personnel. Confirmations of CAPS targets or new species to the United States can then be entered in the NAPIS system.

Pest Profiles of Emerging Threats

CAPS and APHIS Legislative and Public Affairs (LPA) are collaborating to produce outreach-focused “Pest Profiles” targeted toward growers and the public at large. The Pest Profiles use common language and are meant for public education about a pest as opposed to most of our other pest datasheets which are written for the survey specialist and/or the crop industry.

- *Tuta absoluta* - Tomato leaf miner
- *Neoleucinodes elegantalis* - Tomato fruit borer

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Appendix A: Plastic Bucket Trap Protocol

Plastic Bucket Trap Protocol

The plastic bucket trap is a long-lasting insect trap used in conjunction with a lure to monitor or detect various species of moths. The plastic bucket trap is the preferred trap for some moth species as it is able to catch large numbers of moths without damaging some of their identifying characters. The trap has four parts: 1) lid, 2) lure basket with cap, 3) funnel, and 4) bucket. The trap is available in various color combinations. For PPQ programs, the trap consists of a green lid, yellow funnel, and white bucket. Fig. 1 is a photograph of a trap cut in half.

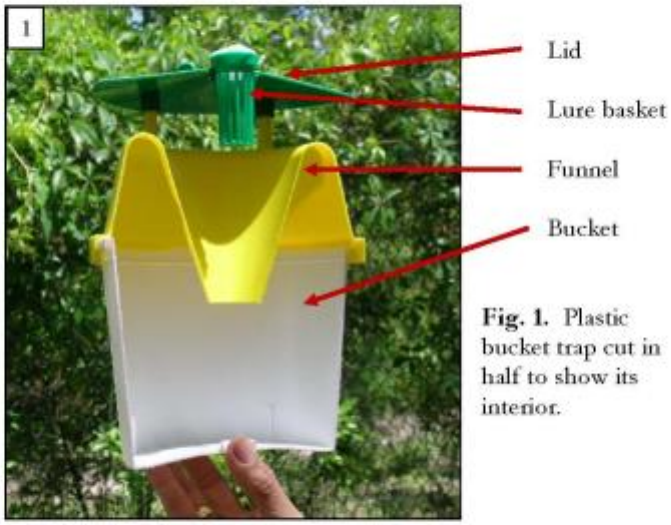


Fig. 1. Plastic bucket trap cut in half to show its interior.

1

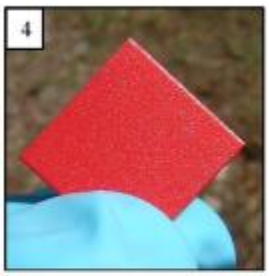
Follow the steps below to prepare the bucket traps for use in the field.

1. Pheromone

Unwrap a pheromone lure and place it inside the lure basket. Handle lures with gloves (see Fig. 4). Close the basket with a cap and insert the basket through the circular opening on the center of the lid (Fig. 2). If the cap no longer snaps snuggly into the trap lid opening, secure it with a piece of tape.

Fig. 2. Lure basket with cap inserted through center of lid.

The synthetic pheromone is embedded in a small rubberized square (as seen in the photos below) or septum (similar to a pencil eraser). If the lure is flat and small (Figs. 3 and 4) you may attach the lure to a small paper clip and fold the clip so that the lure does not fall out of the basket. If a lure basket is not available, attach the lure to a cork with a pin and place the cork in the lid's opening. Always carry extra corks.



Figs. 3 and 4. Lure made of a small rubberized square with embedded synthetic pheromone chemicals.

When not in use, the lures should be stored, unwrapped, in a freezer not used for food or drinks. MSDS documents for the pheromones to be used should be available and should be read.

2. Handle

Attach a wire handle to the lid through its two loops, as shown in the photos below (Figs. 5 and 6). A wire handle is usually included with each purchased trap. If a handle is not included, is lost, or is damaged and needs to be replaced, make one with a 12-inch long wire or with string, but the latter does not last as long as the wire.

Figs. 5 and 6. Wire handle attached to trap's lid.

3a. Sponge

Place a dry cellulose sponge in the bottom of the trap, as shown in Fig. 7. The sponge will absorb rainwater (except for extremely heavy amounts) that may enter the trap, keeping the moths somewhat dry.

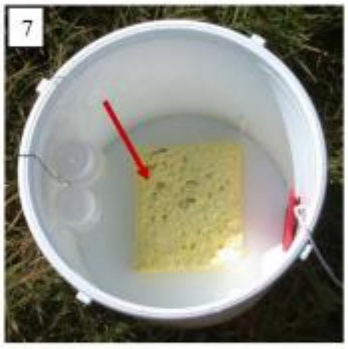


Fig. 7. Cellulose sponge inside the trap.

3

3b. Wire screen

Alternatively, the bottom part of the trap, the bucket, requires two modifications. Drill two to four drain holes in the bottom (see Fig. 8). If water remains in the trap, the killing agent (the pesticide) can spoil; in addition, the trapped insects may decay, making identification impossible.

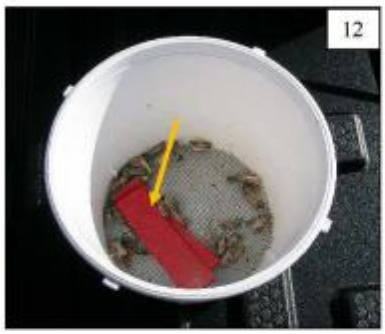
Fig. 8. Bucket with four drilled holes.

Then, add a wire screen slightly larger than the bucket bottom's inside diameter (Figs. 9 and 10). The screen keeps the pesticide strip(s) and the moths from getting too wet from rainwater accumulated in the trap. Prepare a cardboard template for long term use. Cut the wire mesh with metal-cutting scissors.

Figs. 9 and 10. Metal wire screen inside the bucket.

4. Insecticidal strips

Place two insecticidal strips (Figs. 11 and 12), which kill the moths that enter the bucket. The active ingredient in the strips is Dichlorvos, also known as DDVP and Vapona. The strips should be handled with gloves. Read and have available the MSDS documents for this product. Store unopened strips in a freezer not used for food or drink. Rain, wind, high heat or an abundance of captured moths may reduce its potency from 3 to 4 weeks to a week or less. If using only one kill strip, change it every 2 weeks.



Figs. 11 and 12. Pesticide strips.

5. Label the trap

Attach a rain-proof printed label (see Fig. 13) or handwrite a note with a water-proof black marker on the bucket trap. It should indicate that the trap belongs to a state or a PPQ program. Include a phone number in case someone has concerns or questions about the trap.

Fig. 13. Label on the trap's lid.

6. Placement of traps

The traps function best when placed in the open, away from foliage, as illustrated on Fig. 14. When hung under foliage, the 3-dimensional shape of the pheromone plume (chemical in the air) is disrupted and the effectiveness of the trap is much reduced. Hang the traps from such places as greenhouse roofs or in the open using metal rods (see Fig. 14) or other materials.

Figs. 14. Trap set away from foliage, in open field.

In the field, transfer the caught moths to labeled zip-loc bags and store them in a cooler (Figs. 15 and 16). Place them overnight in a freezer to kill any surviving specimens.

Figs. 15 and 16. Moths placed in a ziploc bag and stored in a cooler.

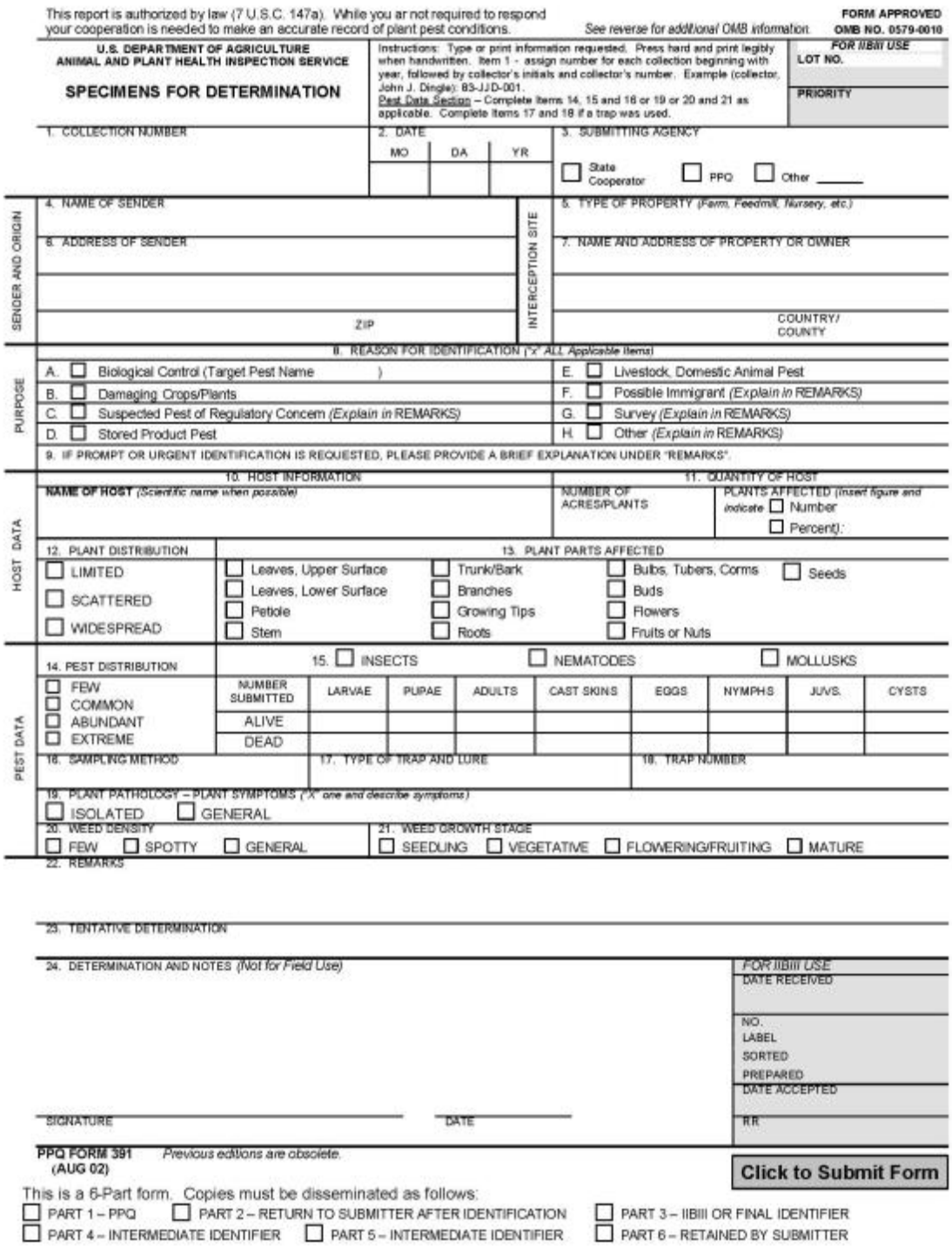
Prior to shipping, screen the samples. Remove any moth vastly different from the target and all other arthropods (beetles, flies, spiders). Write on PPQ Form 391 the approximate number of moths being submitted. Place an absorbent paper, such as a piece of a paper towel, inside each plastic bag to reduce moisture and to pad the specimens for their protection. The specimens should be well padded inside a box to prevent the specimens from being crushed or otherwise damaged. If longer-term storing is necessary, freezing works best, but refrigeration is acceptable as well.

The general recommendation for maintenance of the plastic bucket traps is to wash them occasionally with soap and water to keep them clean, and to store them indoors, or at least protected from sun, rain and dust. Keep the wire handle and the wire screen in good repair. The traps can be used multiple times and for multiple species since the chemicals degrade quickly in outdoor conditions. These traps usually last more than 5 years.

This protocol is designed to aid in the detection of exotic moths of concern by giving instructions on how to use generic plastic bucket traps. All photos were taken by J. Brambila and R. Meagher. These instructions are primarily based on work by R. Meagher.

This aid was prepared by Julieta Brambila (USDA/APHIS/PPQ Eastern Region), Lisa Jackson (USDA/APHIS/PPQ/CPHST), and Dr. Robert L. Meagher (USDA/ARS/CMAVE), on April 2010.

Appendix B: PPQ Form 391



This report is authorized by law (7 U.S.C. 147a). While you ar 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 IIBIII 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. ADDRESS OF SENDER
ZIP

INTERCEPTION SITE
6. TYPE OF PROPERTY (Farm, Feedmill, Nursery, etc.)
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)	E. ☐ Livestock, Domestic Animal Pest
B. ☐ Damaging Crops/Plants	F. ☐ Possible Immigrant (Explain in REMARKS)
C. ☐ Suspected Pest of Regulatory Concern (Explain in REMARKS)	G. ☐ Survey (Explain in REMARKS)
D. ☐ Stored Product Pest	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)
11. QUANTITY OF HOST
NUMBER OF ACRES/PLANTS
PLANTS AFFECTED (Insert figure and indicate ☐ Number ☐ Percent):

12. PLANT DISTRIBUTION
☐ LIMITED ☐ SCATTERED ☐ WIDESPREAD

13. PLANT PARTS AFFECTED

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

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)

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

SIGNATURE DATE

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

Click to Submit Form

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

OMB Information

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0010. The time required to complete this information collection is estimated to average .25 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Instructions

Use PPQ Form 391, Specimens for Determination, for domestic collections (warehouse inspections, local and individual collecting, special survey programs, export certification).

BLOCK	INSTRUCTIONS
1	1. Assign a number for each collection beginning the year, followed by the collector's initials and collector's number **EXAMPLE** In 2001, Brian K. Long collected his first specimen for determination of the year. His first collection number is 01-BLK-001 2. Enter the collection number
2	Enter date
3	Check block to indicate Agency submitting specimens for identification
4	Enter name of sender
5	Enter type of property specimen obtained from (farm, nursery, feedmill, etc.)
6	Enter address
7	Enter name and address of property owner
8A-8L	Check all appropriate blocks
9	Leave Blank
10	Enter scientific name of host, if possible
11	Enter quantity of host and plants affected
12	Check block to indicate distribution of plant
13	Check appropriate blocks to indicate plant parts affected
14	Check block to indicate pest distribution
15	• Check appropriate block to indicate type of specimen • Enter number specimens submitted under appropriate column
16	Enter sampling method
17	Enter type of trap and lure
18	Enter trap number
19	Enter X in block to indicate isolated or general plant symptoms
20	Enter X in appropriate block for weed density
21	Enter X in appropriate block for weed growth stage
22	Provide a brief explanation if Prompt or URGENT identification is requested
23	Enter a tentative determination if you made one
24	Leave blank

Distribution of PPQ Form 391

Distribute PPQ Form 391 as follows:

1. Send Original along with the sample to your Area Identifier.
2. Retain and file a copy for your records.