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## Pests on the Horizon

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## Pests on the Horizon

- Tomato leafminer - *Tuta absoluta*
- Tomato fruit borer - *Neoleucinodes elegantalis*
- Old world bollworm - *Helicoverpa armigera*
- Tomato apical stunt viroid
- Bois noir and stolbur phytoplasma – ‘*Candidatus Phytoplasma solani*’

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## Tomato leafminer - *Tuta absoluta*



Source: cs.wikipedia.org      Source: pathpiva.wileo.com      Source: agralan-growers.co.uk

Source: Deweah Muruvanda, PPD      Source: Deweah Muruvanda, PPD      Source: efa-dip.org

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## Tomato leafminer - *Tuta absoluta*

- Pest of Solanaceae family
- Native to South America; also found in Europe, northern Africa, and the Middle East
- Not known to occur in the United States
- Preferred host: tomato, can attack eggplant, potato, pepper,
- Lays eggs in all aboveground portions of the plant (leaves, shoots, flowers, fruit)
- Can be confused with the tomato pinworm (*Keiferia lycopersicella*)

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## Tomato leafminer - *Tuta absoluta*

### Prevalence and global distribution

Albania	Estonia	Lebanon	Senegal*
Algeria*	Ethiopia	Liberia*	Sierra Leone*
Argentina	Finland	Libya	Slovakia
Austria	France*	Lithuania	Slovenia
Bahrain	Gambia, The*	Luxembourg	South Sudan
Belgium*	Germany	Mali*	Spain*
Benin*	Ghana*	Malta	Sudan
Bolivia	Greece*	Morocco*	Sweden
Brazil	Guinea*	Netherlands*	Switzerland
Bulgaria	Guinea-Bissau*	Niger*	Syria
Burkina Faso*	Hungary	Nigeria*	Togo*
Cape Verde*	Iran	Oman	Tunisia
Chile*	Iraq	Panama*	Turkey
Colombia	Ireland	Paraguay	Ukraine
Costa Rica*	Israel*	Paro	United Arab Emirates
Cote D'Ivoire*	Italy*	Poland*	United Kingdom*
Cyprus*	Jordan	Portugal *	Uruguay
Czech Republic	Kenya	Qatar	Venezuela
Denmark	Kosovo	Romania	West Bank (Palestinian Authority)
Ecuador	Kuwait	Russia	Western Sahara*
Egypt	Latvia	Saudi Arabia	Yemen

\*Countries approved to export tomatoes to the United States

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## Tomato leafminer - *Tuta absoluta*


### Potential pathways:

- Movement of infested fruit and plants for planting
- All stages could be carried in fruit, leaves and stems
- Movement via the nursery trade -- since several species of Solanaceae, such as flowering tobacco, *Nicotiana glauca*, are grown as ornamentals
- If introduced into the US -- rapid dispersal could occur through movement of transplants

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### Tomato leafminer - *Tuta absoluta*

Possible establishment -- US Hardiness Zones 8-13



Source: Magarey, R. D., D. M. Borchert, and J. Schlegel. 2008. Global plant hardiness zones for phytosanitary risk analysis. *Scientia Agricola*

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### Tomato leafminer - *Tuta absoluta*

States	Year Surveeyed
Alabama	2012
Arkansas	2010
California	2012, 2013
Colorado	2013
Florida	2010, 2011, 2012, 2013, 2014
Hawaii	2012
Louisiana	2010, 2011, 2012
Maine	2012, 2013
Maryland	2013
New York	2013
North Carolina	2012, 2013
Oregon	2010, 2011
Pennsylvania	2011, 2012, 2013
Puerto Rico	2008, 2009, 2013
South Carolina	2012
Tennessee	2012, 2013
Texas	2012


16 states and Puerto Rico surveyed for *T. absoluta* in the last 4-5 years. 4547 observations – all negative.  
Source: NAPIS database

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### Tomato leafminer - *Tuta absoluta*

What PPQ has already done to be prepared:

- NPRG was completed in 2011



[http://www.aphis.usda.gov/import\\_export/plants/manuals/emergency/downloads/Tuta-absoluta.pdf](http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/Tuta-absoluta.pdf)

- Federal Order for U.S. Imports of Host Materials of Tomato Leaf Miner (*Tuta absoluta*) - July 23, 2014 (effective August 6, 2014)


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### Tomato leafminer - *Tuta absoluta*

If:	Then:	And:
<b>Pest-free area</b>	Tomato fruit must be imported as commercial consignments only	Each consignment of tomatoes must be accompanied by a <b>Phytosanitary Certificate + Additional Declaration:</b> "Tomato fruit in this consignment was produced in a pest-free area for <i>Tuta absoluta</i> that meets the requirements of 7 CFR 319.56-5."
<b>Systems approach: Countries with growers practicing APHIS-approved systems approach</b>	Tomato fruit must be imported as commercial consignments only; fruit must be <u>without vines, stems, or calyxes</u> unless they were produced in a pest-free area or fumigated with MeBr	Each consignment of tomatoes must be accompanied by a <b>Phytosanitary Certificate + Additional Declaration:</b> "Tomato fruit in this consignment was produced and prepared for export in accordance with an APHIS-approved systems approach and was inspected and found free of <i>Tuta absoluta</i> ." <b>OR,</b> a re-export phytosanitary certificate accompanied by a copy of the phytosanitary certificate from the country of origin that includes the additional declaration.
<b>Phytosanitary Treatment</b>	Tomato fruit must be imported as commercial consignments only	As provided in 7 CFR 305, MeBr treatment schedule T101-c-3-1, is an approved treatment for green, red, or pink tomatoes produced in areas infested with tomato leaf miner. This treatment can only be applied in a preclearance program. Only Chile has an established preclearance program.
<b>Other than above</b>		<b>Entry is prohibited.</b>

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### Tomato fruit borer - *Neoleucinodes elegantalis*



Kurt Ahlmark, FDACS Division of Plant Industry, Bugwood.org

**Host – Solanaceae:**

- Tomato,
- Pepper,
- Eggplant
- Tomato tree,
- Cocona,
- Tropical soda apple

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### Tomato fruit borer - *Neoleucinodes elegantalis*

Larvae feeding on seeds and flesh



Entrance holes

Pupation in leaf

Courtesy: Dr Ana Elizabeth Diaz Morello, Corporación La Seta (Columba); EPPD

## Tomato fruit borer - *Neoleucinodes elegantalis*

- Females lay eggs in batches of 2-3; up to 160 eggs on small fruit
- Larvae bore directly into young fruits after hatching
- Larvae feed on seeds, and then fruit
- Frequently, fruit may show no symptoms of infestation until larvae mature and exit the fruit
- Generally 1-3 larvae per fruit, though as many as 14-18 have been recorded
- Pupation occurs in the soil or in leaves.
- Adults are primarily active at night but may be found on other solanaceous weeds or crops during the day
- Fruits are destroyed, and seeds may become nonviable
- No oviposition is noted to occur below 14.7 C (58.5 F) or above 34.5 C (94 F).

## Tomato fruit borer - *Neoleucinodes elegantalis*

### Prevalence and global distribution:

- **Caribbean** – Cuba, Grenada, Jamaica, Puerto Rico, Trinidad
- **Central America** – Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama
- **North America** – Mexico
- **South America** – Argentina, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela

### If Introduced in the United States :

- *N. elegantalis* is the only species within the genus *Neoleucinodes* that is capable of survival in both warm and cold climates
- May be able to establish within Plant Hardiness Zones 7-11

## Tomato fruit borer - *Neoleucinodes elegantalis*

### Potential pathways:

- Movement of infested fruits - larvae are not readily detected in packed fruits
- Detected at U.S. ports of entry over 1,000 times since 1984; approximately 70% of the interceptions were in fruit in baggage
- Larvae have been detected in permitted cargo 26 times
- Eggplant from Honduras is the most frequently intercepted permitted cargo commodity infested with larvae of *N. elegantalis* (7 interceptions in eggplant during the last 10 years; an additional 10 interceptions were also recorded in other commodities in permitted cargo from Honduras during the last 7 years)

## Tomato fruit borer - *Neoleucinodes elegantalis*

### Restrictions on importation of fruit of known hosts:

Fruit	Permitted from	Requirement
<b>Tomato</b>	Grenada, Jamaica, Trinidad, and Mexico	Import permit and subject to inspection
<b>Tomato and Peppers</b>	From approved registered production sites in Central America (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama)	Pre-harvest inspection found the production site to be free of the tomato fruit borer and other pests
<b>Peppers</b>	Grenada, Jamaica	MB treatment
	Trinidad, Mexico, and Guyana	Import permit and subject to inspection
<b>Eggplant</b>	Honduras, Grenada, Jamaica, Trinidad, Costa Rica, El Salvador, Guatemala, Nicaragua, Panama, Mexico, Colombia and Guyana	Import permit and subject to inspection
<b>Naranjilla</b>	Ecuador, Guatemala, Mexico, and Nicaragua into North Atlantic ports	Import permit and subject to inspection
<b>Eggplant, peppers, and tomato</b>	Mexico	Qualified for National Agriculture Release Program (NARP)

Source: NPAG Report, Sept. 2012

## Tomato fruit borer - *Neoleucinodes elegantalis*

<u>States</u>	<u>Year Surveyed</u>
Florida	2013, 2014
Puerto Rico	2008, 2009, 2011, 2013

273 observations; all negative

Source: NAPIS database

## Old world bollworm - *Helicoverpa armigera*



W. Bilen, Pflanzenbeschaustelle, Weil am Rhein, Bugwood.org



Pablo Mazzei, Bugwood.org

### Common names:

Cotton bollworm, Old World bollworm, scarce bordered straw

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### Old world bollworm - *Helicoverpa armigera*

Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org  
 Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org  
 Helicoverpa armigera larva (photo courtesy of G. Csoka, Hungary Forest Research Institute, Bugwood.org)  
 Late-instar *Helicoverpa armigera* feeding inside a cotton boll in Brazil (photo courtesy of C. Czapak et al.)

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### Old world bollworm - *Helicoverpa armigera*

**Hosts:**  
 180 species of wild and cultivated plants in more than 45 families  
 Major host families include:

- Gramineae** (or Poaceae) -- maize, wheat and other small grains, rice, sorghum and sugarcane
- Malvaceae** -- cotton, okra and cacao
- Leguminosae** -- peas, beans and forage legumes
- Solanaceae** -- potatoes, tomatoes, bell peppers and tobacco
- Compositae** -- sunflower, artichokes and chrysanthemum

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### Old world bollworm - *Helicoverpa armigera*

**Establishment Potential**

- A 2001 USDA PERAL risk assessment concluded that based on the climate, crops and wild hosts, *H. armigera* could potentially become established in every state of the continental U.S.
- In January of 2013, *H. armigera* was first detected in Western Hemisphere (Brazil), feeding on cotton and soybeans
- In October 2012, a female *H. armigera* moth was caught in a cargo facility in Michigan

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### Old world bollworm - *Helicoverpa armigera*

States	Year Surveyed	States	Year Surveyed
Alabama	2005 - 2008, 2011 - 2012	Montana	2009, 2013
Arkansas	2007 - 2009, 2013	Nevada	2002, 2004 - 2007
California	2012 - 2013	New Hampshire	1997 - 1998
Colorado	2005 - 2013	New Jersey	2008
Connecticut	1986	New Mexico	2001, 2004
Delaware	2009 - 2010	New York	1995, 2013
Florida	2008 - 2014	North Carolina	2006 - 2008, 2011
Georgia	2001, 2003, 2005 - 2012	North Dakota	2009 - 2013
Guam	1997	Ohio	2009 - 2012
Idaho	2011	Oregon	1995-96, 2003-04, 2010, 2013
Illinois	2007 - 2009	Rhode Island	2013
Indiana	2004 - 2013	South Carolina	1996, 2003 - 2005, 2011, 2012
Iowa	2013	South Dakota	2012
Kansas	1995, 2009 - 2010	Tennessee	2009 - 2010
Kentucky	2009	Texas	2003, 2010 - 2014
Maine	2006 - 2007, 2010, 2012 - 2013	Utah	2009 - 2013
Maryland	2005 - 2007, 2013	Virginia	2009
Massachusetts	1996, 2011	West Virginia	1996, 1997, 2011 - 2013
Michigan	2012 - 2013	Wisconsin	2007 - 2010
Minnesota	2012 - 2013	Wyoming	2007, 2012 - 2013
Missouri	2006 - 2007		

41 States surveyed; 7876 Observations; all negative  
 Source: NAPIS database

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### Pest Interception Data

Pest	Interceptions at Ports			
	2011	2012	2013	2014
Tomato leaf miner ( <i>Tuta absoluta</i> ) <sup>1</sup>	0	0	1	0
Tomato fruit borer ( <i>Neoleucinodes elegantalis</i> ) <sup>2</sup>	55	30	16	11
Old world bollworm ( <i>Helicoverpa armigera</i> ) <sup>3</sup>	58	79	84	39
Tomato apical stunt viroid	0*	0*	0*	0*
Bois noir and stolbur phytoplasma – <i>Candidatus Phytoplasma solani</i> <sup>1</sup>	0*	0*	0*	0*

<sup>1</sup> Tomato fruit in passenger baggage from Lebanon.  
<sup>2</sup> Mostly in Tomato, pepper, eggplant, or okra fruit in passenger baggage from S. America.  
<sup>3</sup> Mostly in cut flowers and leaves, few in fruits (tomato, pepper, okra) in Cargo and passenger baggage from various countries.  
 \* not in Pest ID database.

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### Tomato apical stunt viroid

Source: Dr. Robert Gilbertson, UC Davis  
 Potato spindle tuber viroid on tomato  
 J. Th. J. Verhoeven & M. Botermans & E. T. M. Meekes & J. W. Roenthorst  
 Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

## Tomato apical stunt viroid

### Prevalence and global distribution

**Africa:** Cote d'Ivoire, Senegal, Tunisia

**Asia:** Indonesia

**Europe:** Germany, Netherlands (Found symptomless on *Solanum jasminoides* or other ornamentals in Austria, France, Italy, Finland, Poland, Slovenia).

**Middle East:** Israel

In Israel and Tunisia, TASVd occurs in greenhouse tomato production

## Tomato apical stunt viroid

### Host range:

**Solanaceae** – *Cestrum* sp. (**jessamine**), *Solanum lycopersicum* (**tomato**), *S. jasminoides* (**jasmine nightshade**), and *S. pseudocapsicum* (**Jerusalem cherry**).

In laboratory settings: TASVd is able to infect several Chenopodiaceae and Solanaceae species

Only tomato shows symptoms when infected by TASVd.

## Tomato apical stunt viroid

### Potential pathways and spread:

- Primarily transmitted by seed - infected seeds play a major role in the viroid transmission within tomato crops
- Also transmissible by mechanical means and by bumble bees
- Mechanical transmission is relatively easy through the transfer of sap, during pruning and plant manipulation
- Asymptomatic ornamentals can easily transport TASVd long distances undetected

### Control:

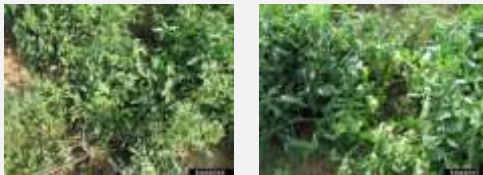
- Eradicating and excluding infected host material from production areas
- Destroy infected material and clean tools after using
- Keep other potential host plants separated from tomato production areas

## Tomato apical stunt viroid

### Current response and activities:

- Only the fruit and seed of tomato are allowed to be imported
- Other viroids prohibited for entry in to U.S. -- *Potato spindle tuber viroid* (PSTVd), *Coconut cadang-cadang viroid* (CCCVd), and *Pear blister canker viroid* (PBCVd)
- The California Department of Food and Agriculture conducts seed testing for PSTVd in tomato seed

## Bois noir and stolbur phytoplasma – '*Candidatus Phytoplasma solani*'



Nikolai Sokolov, Bugwood.org

### Common names:

Black wood of grapevine, **Bois noir**; Maize redness; Metabolbur; Parastolbur; Stolbur of potato; Stolbur of tobacco; **Stolbur of tomato**; and Tree peony yellows disease

## Bois noir and stolbur phytoplasma – '*Candidatus Phytoplasma solani*'

Vector: Planthoppers & Leafhoppers

*Hyalesthes obsoletus*



Wikipedia.org

*Macrosteles quadripunctulatus*



naturalhistory.museum.wales.ac.uk

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## Bois noir and stolbur phytoplasma – ‘*Candidatus* Phytoplasma solani’

**Hosts:**

<i>Calendula officinalis</i> (Marigold.)	<i>Prunus ameniaca</i> (Apricot)
<i>Capsicum annuum</i> (Pepper)	<i>Prunus mume</i> (Japanese Flowering Plum)
<i>Cichorium intybus</i> (Chicory)	<i>Prunus persica</i> (Peach)
<i>Convolvulus</i> spp. (Bindweed)	<i>Rhododendron</i> spp. (Rhododendron)
<i>Macroptilium lathyroides</i> (Bushbean)	<i>Rubus fruticosus</i> (Blackberry)
<i>Malus domestica</i> (Apple)	<i>Solanum lycopersicum</i> (Tomato)
<i>Oenothera biennis</i> (Evening-primrose)	<i>Solanum tuberosum</i> (Potato)
<i>Datura stramonium</i> (Jimsonweed)	<i>Trifolium pratense</i> (Red Clover)
<i>Paeonia suffruticosa</i> (Peony)	<i>Valeriana</i> spp. (Valerian)
<i>Paeonia tenuifolia</i> (Paeonia)	<i>Vitis vinifera</i> (Grape)
<i>Pisum sativum</i> (Pea)	<i>Zea mays</i> (Corn)

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## Bois noir and stolbur phytoplasma – ‘*Candidatus* Phytoplasma solani’

**Prevalence and global distribution**

Bosnia and Herzegovina	Iran
Bulgaria	Italy
China	Jordan
Cuba	Poland
Czech Republic	Romania
France	Russia
Georgia	Serbia
Germany	Spain
Greece	Turkey

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## Pests on the Horizon

**Regulatory actions if detection is confirmed:**

- Issuance of an Emergency Action Notification to place property on hold
- Trace-back and trace-forward investigations
- Delimiting surveys and testing
- Establish quarantine areas
- Short-term -- destruction or disinfestation orders
- Longer term -- prohibiting the planting of host crops for a period of time
- Long term -- compliance agreements and permits to move regulated articles out of a quarantine area

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## Pests on the Horizon

**What states can do to prepare:**

- Primary, alternate host and visual surveys (i.e. CAPS)
- Outreach and work with industry, scientists and public on potential impacts and proposed mitigations
- Develop field identification tools
- Staff training on potential response and treatments

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## Resources

**New Pest Response Guidelines**  
[http://www.aphis.usda.gov/wps/portal/aphis/ourfocus/importexport?fdmy&urlile-wcm%3apath%3a%2Faphis\\_content\\_library%2Fsa\\_our\\_focus%2Fsa\\_plant\\_health%2Fsa\\_manuals%2Fct\\_online\\_manuals](http://www.aphis.usda.gov/wps/portal/aphis/ourfocus/importexport?fdmy&urlile-wcm%3apath%3a%2Faphis_content_library%2Fsa_our_focus%2Fsa_plant_health%2Fsa_manuals%2Fct_online_manuals)

**National Plant Health Emergency Management Framework**  
[http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/biosecurity/download/PHE-framework\\_2012.pdf](http://www.aphis.usda.gov/plant_health/plant_pest_info/biosecurity/download/PHE-framework_2012.pdf)

**Cooperative Agriculture Pest Survey (CAPS): Resource and Collaboration Site**  
<https://caps.ceris.purdue.edu/>

**Cooperative Agriculture Pest Survey (CAPS): Pest Tracker**  
<http://pest.ceris.purdue.edu/>

**New Pest Advisory Group (NPAG)**  
[http://www.aphis.usda.gov/wps/portal/aphis/ourfocus/planthealth?urlile-wcm%3apath%3a%2Faphis\\_content\\_library%2Fsa\\_our\\_focus%2Fsa\\_plant\\_health%2Fsa\\_program\\_overview%2Fsa\\_cpst%2Fct\\_new\\_pest\\_advisory\\_group](http://www.aphis.usda.gov/wps/portal/aphis/ourfocus/planthealth?urlile-wcm%3apath%3a%2Faphis_content_library%2Fsa_our_focus%2Fsa_plant_health%2Fsa_program_overview%2Fsa_cpst%2Fct_new_pest_advisory_group)