An early warning system for new and emerging plant pests

Ellie Barham, Suzanne Sharrock, Charles Lane, Richard Baker

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The Power of Plant Sentinels

Monitoring plants grown outside their native range, e.g. in botanic gardens

The main aim is to identify new pests threats

Other research opportunities to inform Plant Health include to:

- Increase understanding of known pests
- Identify new pest-host associations
- Identify potential biocontrol agents
- Support integrated management tools
The Road to the IPSN

• Work, principally in New Zealand, monitored expatriate endemic plant collections for pests: New Zealand Expatriate Plant Programme – Better Border Biosecurity (B3)

• EU 7th Framework Projects (ALIENS, PRATIQUE and ISEFOR) identified new pest threats by surveying European trees in eastern Asia growing in arboreta and specially planted in nurseries

• International workshop based at York in March 2012 led to the establishment of the IPSN in 2013 funded by EUPHRESCO
Botanic Gardens, Arboreta and BGCI

- Over 2,500 botanic gardens worldwide
- Collections include 30-40% of known plant species
- Presence of non-native species in collections
- Knowledgeable staff with a relevant experience/expertise
- Botanic Gardens Conservation International (BGCI)

Euphresco Project

Phase 1 (2013-2016): Establishing the basis for an International Plant Sentinel Network as an early-warning system for future pest threats

• Establishing international network and collaboration
• Developing and sharing best practice
Developing and Sharing Best Practice: IPSN Plant Health Checker

• Plant Health checker
• IPSN Guides
• Posters
• EPPO Conference
• Meetings
• Publications
• Workshops
**General description of environment**

Any management issues (e.g. irrigation, soil pH, sun bleaching) or any recent use of pesticides/fungicides/herbicides:

Description of environment (focusing on recent changes and individuals in close proximity):

For each section of the plant give it a rating dependent on how healthy it appears:
- **Red (R)** = In very poor health and of imminent concern due to significant damage potentially resulting in death of individual
- **Orange (O)** = Not currently a concern but could develop; should be checked frequently to monitor progress
- **Green (G)** = As would be expected on a ‘healthy plant’
- **Black (X)** = Absent/not applicable

Where an orange or red rating is given, ensure you give a description of why you’ve given it this rating in notes.

1.) Crown

- R  O  G  X

2.) Flowers / Fruits (circle)

- R  O  G  X

3.) New growth

- R  O  G  X

4.) Leaves

- R  O  G  X

5.) Trunk & branches

- R  O  G  X

6.) Base and Roots (if exposed)

- R  O  G  X

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**Notes:**

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**What do you think is wrong with this plant?**

(give an indication of how sure you are of this diagnosis)

1.) Is a re-survey required? ✓
2.) If yes, in what timeframe (include a suggested date)
3.) Should this be escalated to an appropriate staff member to carry out STEP 2?

**Reference/file name of any photographs taken:**

**4.) Name of person escalated to (if applicable):**

**5.) Date:**
Plant Health Checker – Step 2

Please read: This section should be completed if escalation is specified by STEP 1. It should be carried out by an appropriately trained staff member who has the relevant knowledge concerning the plant’s history and/or pest and pathogen identification skills.

Tick all signs/symptoms that are at abnormal levels or are unexpected for the individual, and are thus cause for concern (e.g., are out of the ordinary/new to the plant). Give a description and an indication of severity/abundance in the notes, plus note anything else of importance or interest.

1. Crown
   - Thin/sparse
   - Yellow leaves
   - Dead wood

2. Blossom/Flowers
   - Dead
   - Malformed
   - Swollen

3. New Growth (Shoots and Buds)
   - Dead
   - Dieback
   - Wilted
   - Malformed

4. Leaves
   - Dead
   - Smaller than expected (stunted)
   - Sticky
   - Rust
   - Malformed
   - Mosiacs / mottled / variation in colour
   - Galls
   - Mildew

5. Trunk & Branches
   - Canker or lesion
   - Dry
   - Approx. height of canker from ground (m)
   - Galls
   - Approx. size (m)
   - Trunk bleeding (‘weeping patches’)
   - Approx. height of bleed from ground (m)
   - Approx. number of bleeds over trunk
   - Vertical bleeds (in a line up the trunk)
   - Horizontal bleeds (around the trunk)
   - Loose Bark / bark flaking / comes off easily

6. Base and Roots (if exposed)
   - Bootlaces/black strands (1-2mm wide)
   - Fungal mycelium/white strands
   - Mushrooms/toadstools on plant
   - Damage by mammals

7. General pest damage
   - Insect galleries under loose bark
   - Insect eggs
   - Chewing damage
   - Insect webbing
   - Insect mines
   - Frass
   - Bore holes (circle below)
   - <5mm
   - 5-10mm
   - >15mm

8. Pest sightings
   - (give an indication of how sure you are of this identification)

9. General Observations and Additional Notes

What do you think is wrong with this plant?
(give an indication of how sure you are of this diagnosis)

3.) Should this be reported to the local diagnostic laboratory - a physical sample may be required (this is only if symptoms are severe or of a pest of concern)

1.) Is a re-survey required?
2.) If yes, in what timeframe (include a suggested date)
3.) Date reported:
4.) Should this be escalated to local National Plant Protection Organisation (NPPO)? (as advised by local diagnostic laboratory)
5.) Date reported:

Broadleaf trees

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Developing and Sharing Best practice: IPSN Guides

7. General Pest Observations

Bore holes - small holes found on the trunk and branches, which are the exit holes of wood boring insects

Insect mines - tunnels inside leaves and petals by insects

Frass - fine powdery material or perforated wood found in clump, often produced by wood boring insects or the excrement of insect larvae

9. Leaf curling

Characteristic of damage
- Caused by abnormal growth of the leaf tissue
- Makes a shelter for continued eating
- Can also be caused by certain fungi and viruses

Potential cause:
- Aphidoidea
- Larvae of some Lepidoptera
- Some mites (Acari)

Mitigating Risk for Different Types of Plant Material

<table>
<thead>
<tr>
<th>Plants</th>
<th>Wood, timber, bark samples</th>
<th>Non-certified seed</th>
<th>Dried artefacts</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Can carry nematodes, insects, and pathogens</td>
<td>- Carry insects externally and pathogens internally</td>
<td>- Low risk to live plants but can cause problems for herbarium, libraries, and galleries</td>
<td>- International Seed Testing Association (ISTA) regulated</td>
</tr>
<tr>
<td></td>
<td>- Wood with bark attached is considered particularly high risk</td>
<td>- Inspect both seedlings and (later) young plants</td>
<td>- Appropriately treat e.g. fumigation, heat treatment or rapid freezing</td>
<td>- Usually considered low risk, but depends on source</td>
</tr>
<tr>
<td></td>
<td>- Check under International law (IPSN) woody packaging should be marked to show it has been treated</td>
<td>- Source carefully</td>
<td>- Source carefully</td>
<td>- Source carefully</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plants</th>
<th>Soil and growing media</th>
<th>Tissue cultures</th>
<th>Reproductive material or storage organs</th>
<th>Cut flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Carry nematodes, flies, insects, and microorganisms such as fungi and bacteria</td>
<td>- Usually considered low risk, but depends on source</td>
<td>- Can cause problems for herbarium, libraries, and galleries</td>
<td>- Dependent on type, source and cultural conditions e.g. tropical flowers such as Poinsettia that have been found to be infected with fungus polio</td>
</tr>
<tr>
<td></td>
<td>- Quarantine with any associated plant material for at least 6 weeks</td>
<td>- May carry latent infections and viruses which are very hard to detect</td>
<td>- Inspect on arrival</td>
<td>- Inspect on arrival</td>
</tr>
<tr>
<td></td>
<td>- Inspect carefully</td>
<td>- Source carefully</td>
<td>- Source carefully</td>
<td>- Source carefully</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plants</th>
<th>Wild-source seed</th>
<th>Reproductive material or storage organs</th>
<th>Cut flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- May carry insects externally and pathogens internally</td>
<td>- E.g. bulbs, fruits, etc.</td>
<td>- Dependent on type, source and cultural conditions e.g. tropical flowers such as Poinsettia that have been found to be infected with fungus polio</td>
</tr>
<tr>
<td></td>
<td>- Thoroughly inspect both seedlings and (later) young plants</td>
<td>- Common pathway for non- vector and quarantine pests and diseases</td>
<td>- Inspect on arrival</td>
</tr>
<tr>
<td></td>
<td>- Where suitable, use a surface sterilant such as dilute hydrogen peroxide</td>
<td>- Thoroughly inspect on arrival</td>
<td>- Source carefully</td>
</tr>
<tr>
<td></td>
<td>- Source carefully</td>
<td>- Source carefully</td>
<td>- Source carefully</td>
</tr>
</tbody>
</table>

Type of material
- General information
- Potential mitigation actions

High risk (red) to Low risk (green)
Developing and Sharing Best Practice: Posters

**Emerging Pest and Disease Threats to Trees in the UK**

**Plane Trees** *Platanus sp.*

- Highly invasive insect - 3mm length, 2mm width (picture) which is an obligate feeder on plane. Adults and nymphs feed on leaf’s underside. Heavy infestation can cause severe chlorosis, leaf fall and dieback.
- Native to North America; present in Asia, South America, Oceania and Europe.

**Plane lace bug** *Corythucha ciliata*

- Feeding females Department of Agriculture, Zimbabwe.org
- Picture bug: C. Melbourne, Per.
- Damage soft tissue of the leaf, Cheshire, Per.
- Native to New Zealand; present in Australia, New Zealand, South America and Europe.

**Polyphagous shot hole borer** *Euwallacea sp.* (and associated Fusarium euwallaceae sp. nov.)

- PSBH is a very small (2.5mm) beetle, morphologically identical to tea shot hole borer, *E. formicatus* (picture).
- Symptoms include bleeding, staining, gumming, reddish cut-out-like, numerous small severe damage holes (around 0.9mm in diameter); epicormic growth and dieback. Internally the fungus causes dark staining.
- Infested trees can be killed rapidly, and the beetle is known to have an extremely large host range.
- Present in the U.S. (California) and Israel.

**Emerging Plant Pest and Disease Threats:**

**Xylella fastidiosa**

- Main symptom is leaf scorch (images) starting from the margins of the species.
- Premature loss of older leaves.
- Overall stunting: reduction of fruit size and quantity.
- Oleander
  - Dieback of lateral shoots.
  - Premature loss of leaves.
  - Shortened internodes; on the stem between leaf bearing branches.

**Coffee** *Coffea spp.*

- Chlorotic mottling along leaf edges - turns to brown.
- General stunting of leaves and internodes.
- Discoloration after leaf scorch has killed the leaves.
- New growth will also be symptomatic (similar to scorching seen in coffee).

**Oleander** *Nerium oleander*

- Chlorotic mottling along leaf edges - turns to brown.
- General stunting of leaves and internodes.
- Discoloration after leaf scorch has killed the leaves.
- New growth will also be symptomatic (similar to scorching seen in coffee).

**Oak** *Quercus spp.*

- Chlorotic mottling along leaf edges - turns to brown.
- General stunting of leaves and internodes.
- Discoloration after leaf scorch has killed the leaves.
- New growth will also be symptomatic (similar to scorching seen in coffee).

**Grapevine** *Vitis vinifera*

- Green islands - caused by stems maturing irregularly leading to patches of brown and green tissues (images).
- Chlorotic margins of leaves eventually becoming scorching - with a yellow halo between the scorch part of the leaf and healthy green tissue - development of leaf scorch will vary with variety (middle image).
- Development of late, stunted and chlorotic shoots after a few years – mortality usually occurs after 2-5 years.

Please note: Plants must have more than one symptom before considering *X. fastidiosa* as a cause. Symptoms alone can be caused by other factors, including other pests and diseases and environmental factors (frost damage, water stressing and...)

**REPORT ANY SUSPECTED SIGHTINGS TO**

For more information about the IPSN go to: www.plantsentinel.org

**DATE:**

For more information about the IPSN go to: www.plantsentinel.org

**Date:**
Developing and Sharing Best practice: Conference & Publications

- Plant Health checker
- IPSN Guides
- Posters
- EPPO Conference
- Meetings
- Publications
- Workshops
Developing and Sharing Best practice: Workshops & training

Huntington Library, Art Collections and Botanical Gardens, U.S.

Royal Botanic Gardens Kew, UK

Shenzhen Fairy Lake Botanical Garden (CAS), China
Data Collection - Targeted Surveys

IPSN Fact Sheet for Agapanthus gall midge

Purpose of study
1. To determine the worldwide distribution of the Agapanthus gall midge, deducing both its natural and introduced range.
2. To collect information on the biology and lifecycle of the midge.

Research question:
1. Are Agapanthus plants in your collection affected by the agapanthus gall midge? If yes, which species and in what measure?
2. How severe are the symptoms?
3. During which months of the year are active larvae present?

Brief description:
The agapanthus gall midge is an undescribed pest affecting Agapanthus. The tiny gall midge lays eggs which develop into maggots on flower head sheaths. The midge can cause the bud to be deformed and discoloured and often fail to open. For help completing this form please refer to the corresponding IPSN Fact Sheet for Agapanthus gall midge.

Survey Details
| Name of Botanic Garden / Arboretum: |
| Country: |
| Address: |
| Survey carried out by: |
| Date of survey: |
| Best description of survey: |

The agapanthus gall midge is an undescribed pest affecting Agapanthus that belongs to the Cecidomyiidae family of flies. The midge can cause the bud to be deformed and discoloured and often fail to open. For help completing this form please refer to the corresponding IPSN Fact Sheet for Agapanthus gall midge.

Survey questions:
1. Are Agapanthus plants in your collection affected by the agapanthus gall midge? Survey known hosts.
2. How severe are the symptoms? Include images.
3. During which months of the year are active larvae present? Complete survey details as above.
4. Which species of Agapanthus are affected? Include with survey of known hosts and move to other Agapanthus spp.

*Please make a note if agapanthus gall midge is not found, including which species surveyed.*

Plant Details - SURVEY 1
| Species (cultivar): |
| Accession number: |
| GPS (degrees): |
| Country/region species is native to: |
| Age/amount of time plant has been present in garden (years): |
| General Description of Health: |
| General Description of Health: |
| General Description of Health: |
| General Description of Health: |
| General Description of Health: |

Symptoms Check (flowers):
| Deformed buds |
| Bulbs with brown discoloration |
| Bulbs fail to open, dry up or rot |
| Flower head collapsed or falls to develop |
| Maggots present |

*If you think this plant is infected by the gall midge?

Figure 2: Symptoms of agapanthus gall midge infestation. Severity from low to high (left to right): severity in the corresponding Plant Health Checkers is rated; 1 (no visible symptoms), 2a, 2b, 2c, 2d, 3, 4 to 6 (all buds affected/flower head completely aborted).

Infestation has been observed at very early stages of flowering, when the flower head sheath had not yet opened. When infected at this stage the larvae develop between the stems of the developing buds inside the sheath, rather than inside buds (Figure 1a). Heavy infestation at this stage can cause the flower head to abort completely.

Lifecycle
There is limited knowledge of the lifecycle of the agapanthus gall midge, but it is understood that it is quite similar to other Cecidomyiidae flies. The eggs are laid on or in the buds of Agapanthus and the larvae develop inside the sheath, rather than inside buds (Figure 1). Infestation has been observed at very early stages of flowering, when the flower head sheath had not yet opened. When infected at this stage the larvae develop between the stems of the developing buds inside the sheath, rather than inside buds. Heavy infestation at this stage can cause the flower head to abort completely.

Observations in the UK indicate that the midge can have multiple generations during the Agapanthus season; active larvae were found from early July to early October 2015.

Figure 3. Agapanthus gall midge adult (dead) and larvae with scale bar
Data Collection – Online Reporting

• Working with CABI-UK
• Electronic version of the IPSN Plant Health Checker
• Pilot project completed April 2016
• Trialled by 2 UK gardens

Image credit: Abigail Rumsey © CABI
Phase 2 (2017-2020): An International Plant Sentinel Network (IPSN) as an early-warning system; research on future pest threats

- Targeted surveys / first detection / research
- Capacity building
- 14 European organisations
The Future

A self-sustaining network that is championed by NPPOs, scientists working within plant health, botanic gardens and arboreta and supported by BGCI
Thank you for listening

ellie.barham@bgci.org

www.plantsentinel.org

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