

Introduction to Plant Health and Good Biosecurity Practice

Module 2

Harmful organisms and Pest Risk Analysis

www.planthealthy.org.uk

Charles Lane and Don Walker

Royal Society of Biology Senior Plant Health Professionals
Fera Science Ltd, York



Content

2.1 What is biosecurity and what are harmful organisms?

2.2a What is pest risk analysis (PRA) and how do we use it to determine the level of risk an organism poses?

2.2b Know what the UK plant health risk register is

2.2c Using the Plant Health Management Standard - How do we apply the principles of pest risk analysis to ensure the appropriate level of protection for a business?

2.3 Overview of the main groups of harmful organisms including an introduction to:

- e.g. *Phytophthora ramorum*, *Xylella fastidiosa*, Pepino mosaic virus, Pine wood nematode, Asian longhorn beetle, Fuchsia gall mite

2.4 What should I do if I suspect a notifiable organism?



Learning outcomes

- recognise that not all organisms are harmful, and that some organisms cause greater damage than others
- know what the UK plant health risk register is
- appreciate how pest risk analysis can also help determine the appropriate level of protection for a business
- cite some of the pests and diseases of plant health concern
- know how to report a suspect notifiable organism



2.1 Content and Learning outcomes

2.1 What is biosecurity and what are harmful organisms?

- To be able to define biosecurity
- Recognise that not all organisms are harmful, and that some organisms cause greater damage than others



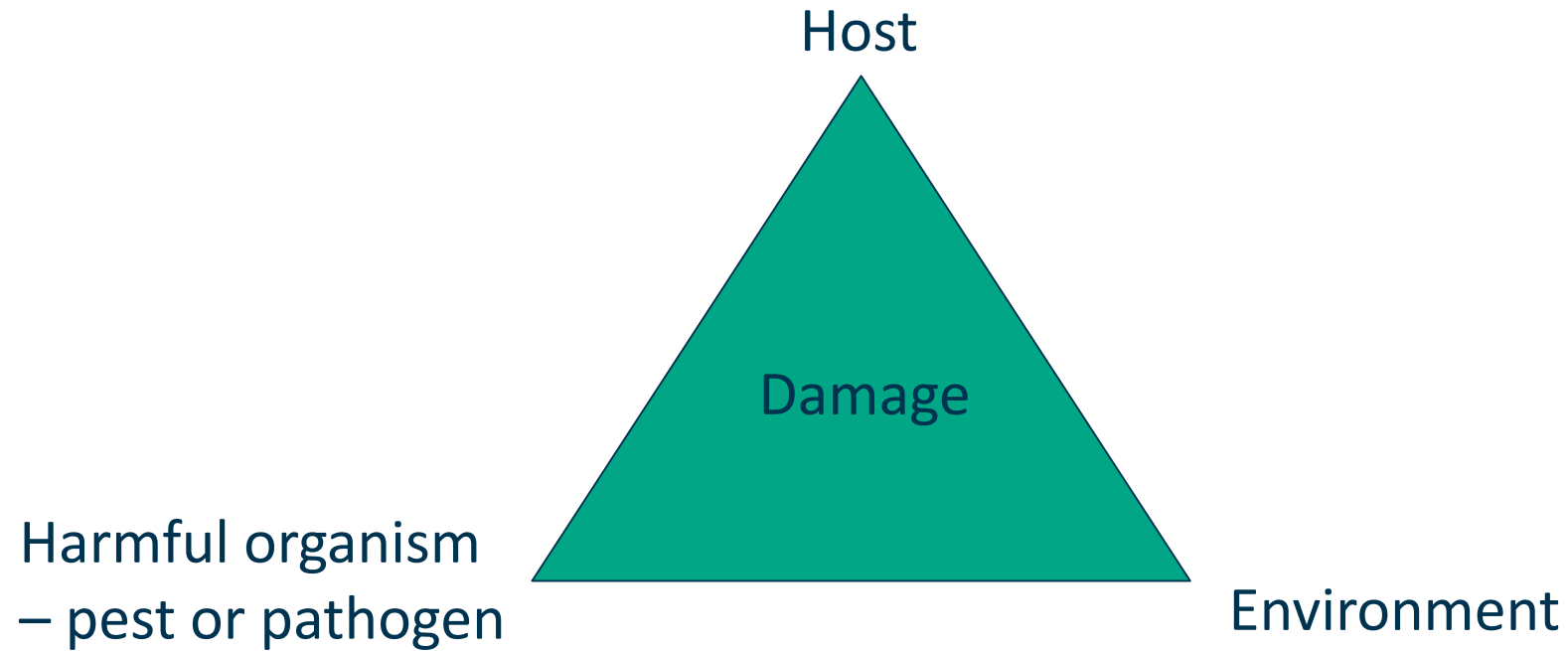
2.1 What is Biosecurity?

‘A series of precautions that aim to prevent the **introduction** and **spread** of **harmful organisms**’

Derived from: Gregory Koblentz, 2010



What are harmful organisms?



Harmful organism – any injurious agent that causes damage, commonly referred to as symptoms

Symptoms - highly variable and affected by interaction of many factors

Damage – contributing factors

- Contributing factors that influence plant husbandry and vitality
- Predisposing factors that made plants more vulnerable to attack, effect defence mechanisms and impact of any pest or pathogen

Cultural

- Soil type and compaction
- Nutritional

Environmental

- Light
- Temperature
- Water
- Aspect
- Chemicals



Urban planting scheme demonstrating a range of cultural and environmental issues





Different roles of organisms



Pathogens

e.g. Ash dieback

DISEASES



Decomposers

e.g. Leaf litter decay



Beneficials

e.g. Mycorrhizal fungi



2.1 Summary

What is plant biosecurity and what are harmful organisms?

- Biosecurity- a series of precautions that aim to prevent the introduction and spread of harmful organisms
- Harmful organism – any injurious agent that causes damage, commonly referred to as symptoms
- Cultural and environmental factors contribute to the health of plants
- Organisms play different roles in ecosystems- for fungi - pathogens that cause disease, but also decomposes and beneficials



2.2 Content and Learning outcomes

2.2a What is pest risk analysis (PRA) and how do we use it to determine the level of risk an organism poses?

2.2b Know what the UK plant health risk register is

2.2c Using the Plant Health Management Standard - How do we apply the principles of pest risk analysis to ensure the appropriate level of protection for a business?

2.2a Pest Risk Analysis (PRA)

Defined in Glossary of Phytosanitary Terms (ISPM 5)

- *Pest risk analysis: The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it*

[Pest – refers to pests and pathogens]

- Carried out to International standards (ISPM 2 and 11)
- PRA can be applied at different levels and boundaries:
- Regional – European – EFSA PRA
- Country – UK Risk Register
- Premise or site – Your business



Pest Risk Analysis





2.2b UK Plant Health Risk Register

13

- An integral part of UK Plant Health decision making
- It is used to rapidly screen pests for their potential risks to the UK
- New pests added every month and entries reviewed in response to new information
- Risks are assessed and shown as 'unmitigated' and 'mitigated' following actions to reduce risk
- Available online:
<https://planthealthportal.defra.gov.uk/>
- It can also be downloaded into excel to facilitate analysis of the data it contains
- New entries or changes to entries are highlighted via a news feature

UK Plant Health Risk Register

Department for Environment, Food & Rural Affairs

Search for a Pest or Organism 1,030 pests in the Risk Register

e.g. Asian longhorn beetle Search

☒ Preferred Name ☒ Synonym ☒ Common Name ☒ Host ?

Advanced Search Download Entire Risk Register

About

The UK Plant Health Risk Register is a major step in implementing the recommendations of the independent Task Force on Tree Health and Plant Biosecurity. It is a tool for government, industry and stakeholders to prioritise action against pests and diseases which threaten our crops, trees, gardens and countryside. The Register is publicly available.

Plant pests not yet on the Risk Register may still be subject to plant health controls. The Plant Health Risk Register may still be subject to plant health controls. The Plant Health Risk Register may still be subject to plant health controls.

Risk Register News

Updates and additions to the Risk Register January 2019
29/01/2019

The following pests have recently been added to the Risk Register....
[View More](#)

Updates and additions to the Risk Register December 2018
12/12/2018

The following pests have recently been added to the Risk Register....
[View More](#)

Example Searches

Show pests marked as a priority for...

Which entries are pests of *Fraxinus*?

Which entries are pests of *Solanum*?

Which pests have a PRA available?

About plant health

The UK Plant Health Information Portal provides information about plant pests and diseases, including risk assessments, links to other sites of interest and information on plant health controls and services provided by government.

[Visit the UK Plant Health Information Portal](#)

[Licensing of non-native biocontrol agents](#)

UK Plant Health Risk Register



UK Plant Health Risk Register

UK Risk Register Details for *Anoplophora glabripennis*

Common Names	show / hide
<ul style="list-style-type: none">Asian longhorn beetleStarry sky beetle	

Scenario and Pathways

Scenario for Risk Register	show / hide	Pathway Assessed for Entry to UK	show / hide	Common Pathways	show / hide
<ul style="list-style-type: none">Pest is introduced		<ul style="list-style-type: none">Wood packaging material		This section is currently being developed as part of the next phase of the Risk Register.	

Risk Ratings and Current Mitigations

Unmitigated Risks	show / hide	Current Mitigations	show / hide	Mitigated Risks	show / hide																																																																								
<table><tr><td>Likelihood [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Spread [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Impact [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Value at Risk [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Likelihood x Impact [1 - 25]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>UK Relative Risk Rating [1 - 125]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table>	Likelihood [1 - 5]	1	2	3	4	5	Spread [1 - 5]	1	2	3	4	5	Impact [1 - 5]	1	2	3	4	5	Value at Risk [1 - 5]	1	2	3	4	5	Likelihood x Impact [1 - 25]	1	2	3	4	5	UK Relative Risk Rating [1 - 125]	1	2	3	4	5		<p>Key mitigation for pest</p> <ul style="list-style-type: none">EU regulated pest,) ,UK eradication experienceRegulation ✓Surveillance ✓Industry Scheme ✓Contingency Plan ✓Awareness ✓Research ✓		<table><tr><td>Likelihood [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Spread [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Impact [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Value at Risk [1 - 5]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Likelihood x Impact [1 - 25]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>UK Relative Risk Rating [1 - 125]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table>	Likelihood [1 - 5]	1	2	3	4	5	Spread [1 - 5]	1	2	3	4	5	Impact [1 - 5]	1	2	3	4	5	Value at Risk [1 - 5]	1	2	3	4	5	Likelihood x Impact [1 - 25]	1	2	3	4	5	UK Relative Risk Rating [1 - 125]	1	2	3	4	5	
Likelihood [1 - 5]	1	2	3	4	5																																																																								
Spread [1 - 5]	1	2	3	4	5																																																																								
Impact [1 - 5]	1	2	3	4	5																																																																								
Value at Risk [1 - 5]	1	2	3	4	5																																																																								
Likelihood x Impact [1 - 25]	1	2	3	4	5																																																																								
UK Relative Risk Rating [1 - 125]	1	2	3	4	5																																																																								
Likelihood [1 - 5]	1	2	3	4	5																																																																								
Spread [1 - 5]	1	2	3	4	5																																																																								
Impact [1 - 5]	1	2	3	4	5																																																																								
Value at Risk [1 - 5]	1	2	3	4	5																																																																								
Likelihood x Impact [1 - 25]	1	2	3	4	5																																																																								
UK Relative Risk Rating [1 - 125]	1	2	3	4	5																																																																								

- Unmitigated risk rating - risk without any co-ordinated actions in place – to either pest or host. It does take into account possible industry applications of treatments for other pests which may have an effect.
- Mitigated Risk - mitigations include regulation (of pests and pathways), targeted surveys, industry management, contingency plans, publicity and research projects

An example screenshot taken from the UK risk register for the Asian longhorn beetle. It illustrates risk ratings (unmitigated, left-hand side boxes; mitigated, right-hand side boxes) in addition to current mitigations.

UK Plant Health Risk Register - Inherent pathway risk ratings

Rating	Plants for planting	Wood and wood products	Other possible pathways	Plant parts and plant products
5	Plants for planting (not seeds)	-	-	-
4	-	Non-squared wood, Bark	-	-
3	-	Solid wood packaging material (ISPM labelled)	Soil/growing medium, natural spread	-
2	Seeds (True)	Squared wood	Agric. machinery, Passengers (luggage), hitchhiking, plant waste	Cut flowers or branches
1	-	-	Manufactured plant products (e.g. wooden furniture)	Fruit or vegetables, grain, pollen, stored plant products

This table is used by the UK risk register to assign a risk rating for different types of commodities. The higher the value the greater the risk.



UK Plant Health Risk Register - Social and Environmental Impact

Rating	Environmental	Social
5	Widespread, long-term population loss or extinction, affecting several species with serious ecosystem effects	Long-term social change, significant loss of employment, migration from area
4	Long-term irreversible ecosystem change, spreading beyond local area	Some permanent change of activity locally, concern over wider area
3	Measurable long-term damage to populations and ecosystem, but little spread, no extinction	Temporary changes to normal activities at local level
2	Some ecosystem impact, reversible changes, localised	Significant concern expressed at local level
1	Local, short-term population loss, no significant ecosystem effect	No social disruption

This table is used by the UK plant health risk register to assign a risk rating for both environmental and social impacts of introduced pest or pathogens. The higher the value the greater the risk.





2.2c Plant Health Management Standard – PRA and ALOP

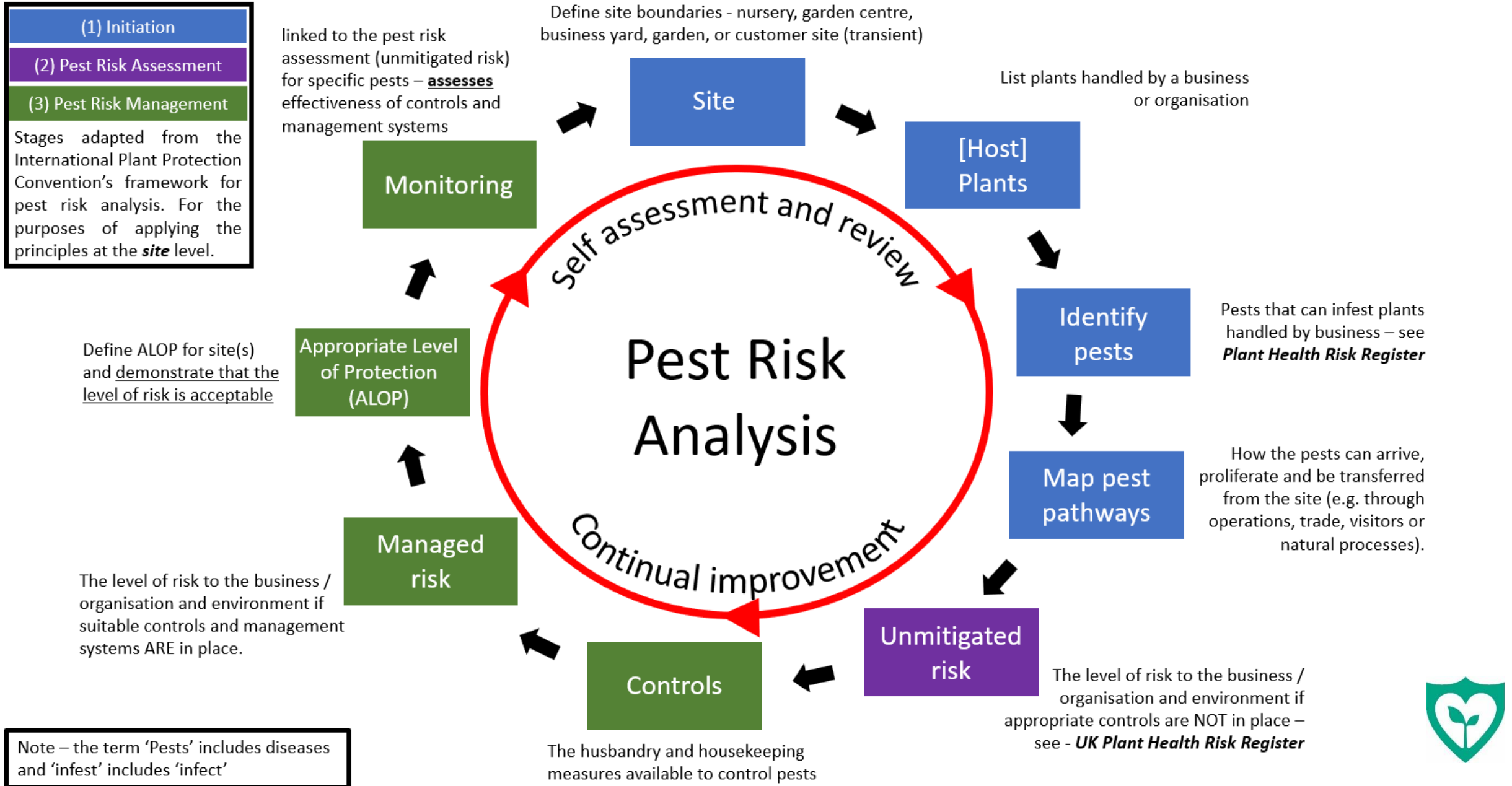
The Plant Health Management Standard (PHMS) requires each company to:

- Carry out a **Pest Risk Analysis (PRA)** in order to identify and manage risks
- This will assist the business to reach an Appropriate Level of Protection

‘the **Appropriate Level of Protection (ALOP)** deemed appropriate by the company establishing a sanitary or phytosanitary measure to protect, human, animal or plant life or health within its territory’.

Plant Health Management Standard - PRA - ALOP

18



Using PRA to demonstrate ALOP – site / business / organisation

The PHMS recommends the following steps and the considerations in the PRA process

- **Initiation**

- Site - Define site boundaries - nursery, garden centre, business yard, garden, or customer site (transient)
- Host plants - list plants handled by business
- Identify pests - use UK Plant Health Risk register for assistance, in addition to native pests and pathogens
- Map pest pathways - how the pest can arise, proliferate and be transferred (e.g. through operations, trade, visitors or natural processes)

- **Pest risk assessment**

- Unmitigated risk - the level of risk to the business and environment if appropriate controls are not in place

- **Pest risk management**

- Controls - husbandry and housekeeping measures available to control pests and pathogens
- Manage risks (mitigated risk) - the level of risk to the business and environment if suitable controls and management systems are in place
- Appropriate level of protection - define for site(s) and demonstrate the level of risk is acceptable
- Monitoring - assesses effectiveness of controls and management systems

The process should be subject to self-assessment and review to ensure continual improvement



PRA – site/premise/business

The [PHMS Guidance Documents](#) sets out five general stages in the process:

1. Defining the site
2. Recognising factors that influence plant health
3. Identify and document **critical control points*** relating to biosecurity and plant health
4. Select appropriate measures that will give confidence in the biosecurity and health of plants produced
5. Establishing document routines for separate handling of nonconforming materials

Important – the PRA is central to the Plant Health Management Standard and by going through the process the decision may be taken not to grow certain plants or source from particular regions as the risk is assessed as being too high.

* **‘Critical control points** - points within or between production or movement processes where plant health can be readily assessed (visual inspection or sampling and testing)’



UK Plant Health Risk Register - Inherent pathway risk ratings

		Likelihood					
		Very likely	Likely	Unlikely	Highly unlikely		
Impact	High					High	
	Medium					Medium	
	Low					Low	

Risk = Impact x Likelihood

This table demonstrates how risk is calculated and values determined

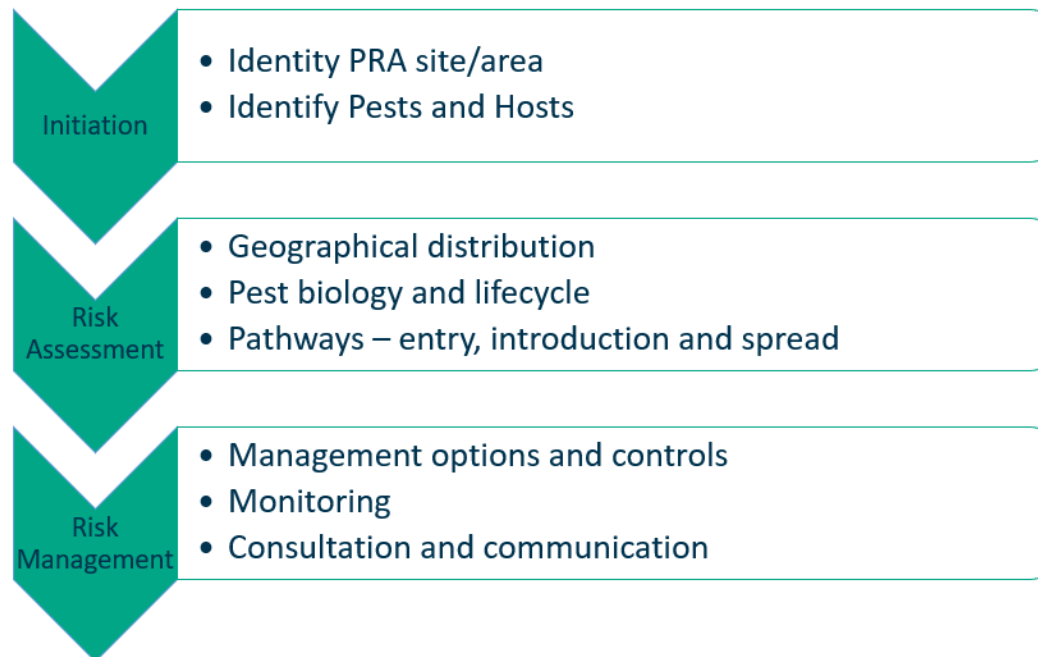


2.2 Pest risk analysis - summary

Pest Risk Analysis is a 3 part process carried out to International Standards

Helps identify and manage risks

Assist in achieving the Appropriate Level of Protection (ALOP)



Any PRA should be reviewed regularly and as knowledge changes

E.g. host being traded, geographical distribution of pests etc





2.3 Content and Learning outcomes

2.3 Overview of the main groups of harmful organisms including an introduction to:

2.3.1 Pathogens

e.g. *Phytophthora ramorum*, *Xylella fastidiosa*, Pepino mosaic virus,

2.3.2 Pests

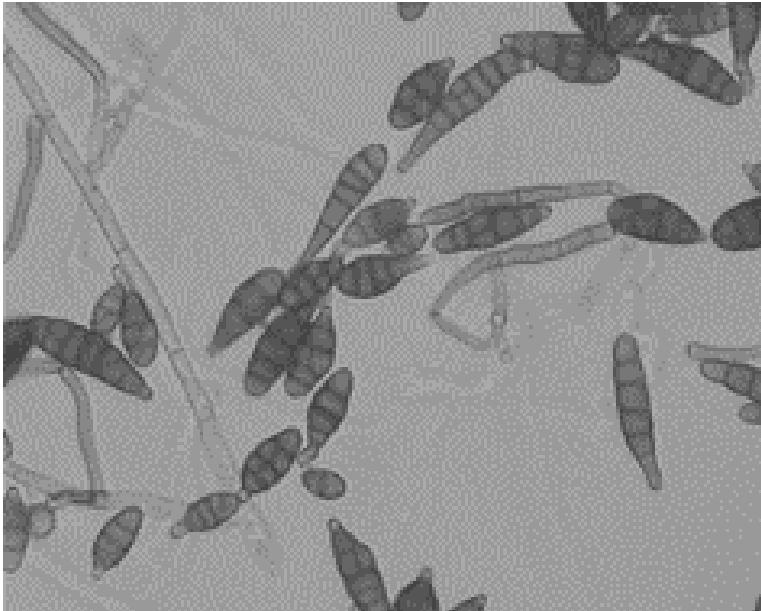
e.g. Pine wood nematode, Asian longhorn beetle, Fuchsia gall mite

- give some examples of the pests and diseases of plant health concern

2.3 Harmful organisms

Pathogens

- Fungi and Fungal like organisms
- Bacteria
- Viruses, viroids and phytoplasmas



Fungal spores

Pests

- Nematodes
- Insects
- Mites



Insect pest

Legislation refers to harmful organisms as 'pests' – which includes pests and pathogens

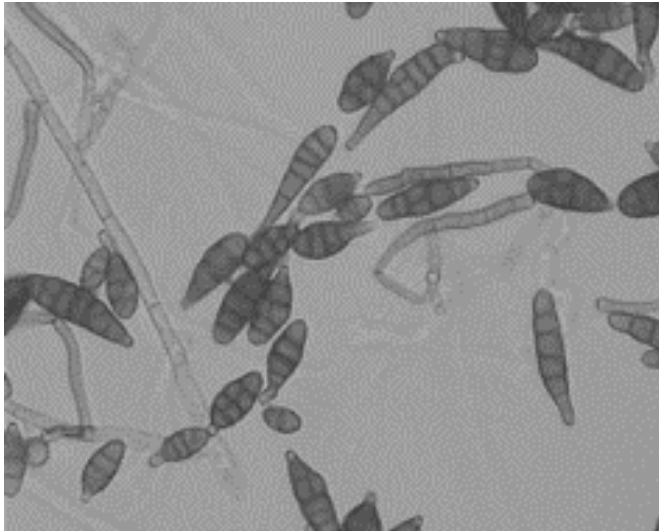




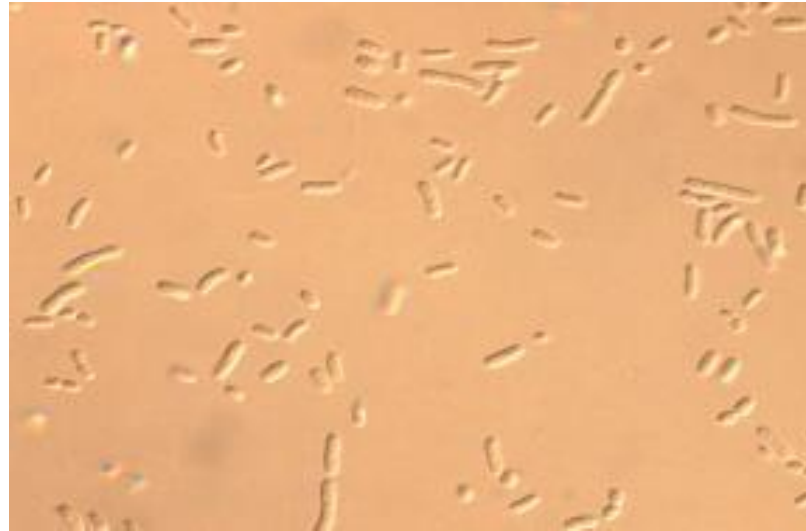
2.3.1 Pathogens - microorganisms

25

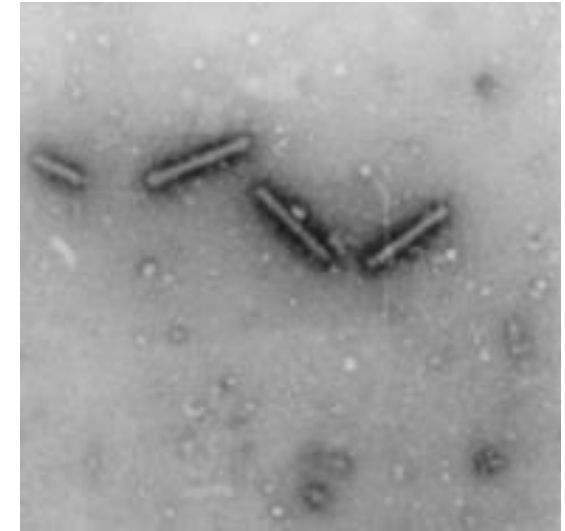
- Fungi
- Bacteria
- Viruses, viroids and phytoplasmas



Fungal spores (small)
ca. 1/10th of a mm



Bacterial cells (very small)
ca. 1/100th of a mm

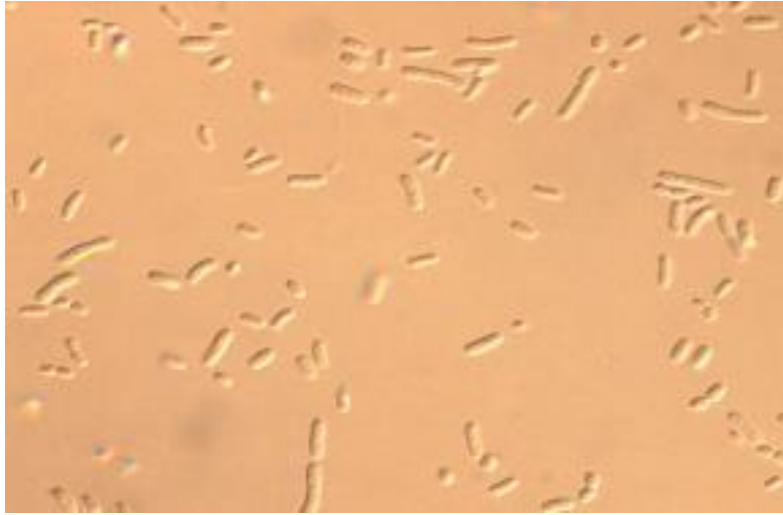


Virus particles (very very small)
1/1000th of a mm



Bacteria

Causes of Plant Disease



Bacterial cells



Fire blight



Pseudomonas syringae on Magnolia



Horse chestnut bleeding canker



Pseudomonas syringae on hibiscus



Bacterial colony



Potato soft rot

Bacteria

Background information

- Colonise natural openings, wounds and insect feeding damage
- Cannot be seen with the naked eye – unless aggregated together – slime and sticky gum

Symptoms

- Leaf spots, mosaics, pustules
- Cankers and lesions
- Wilts and dieback
- Soft rots

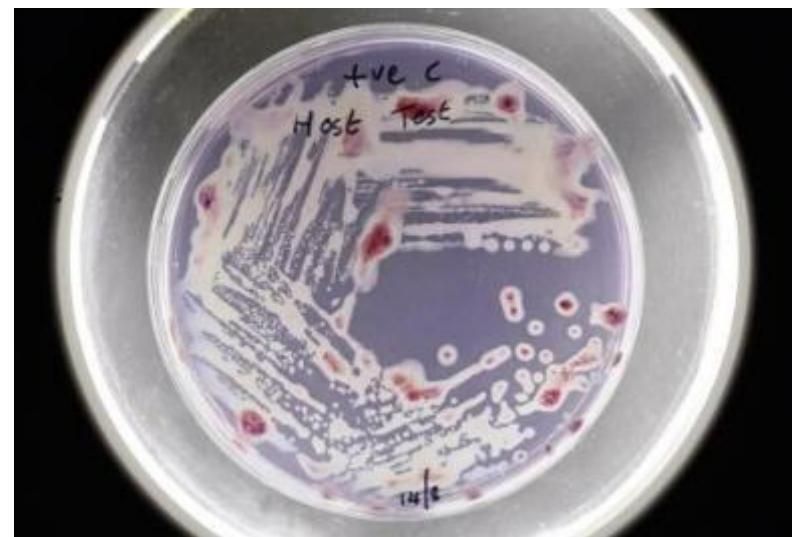
Spread

- Infected propagating material, seed
- Splash dispersal and contaminated surfaces
- Wind blown soil and debris
- Water – rain, irrigation, rivers

Survival

- Plant debris, soil, surfaces, seeds, insects, water

Bacterial colony growing on an agar plate



Symptoms of bacterial fireblight



Bacterial diseases

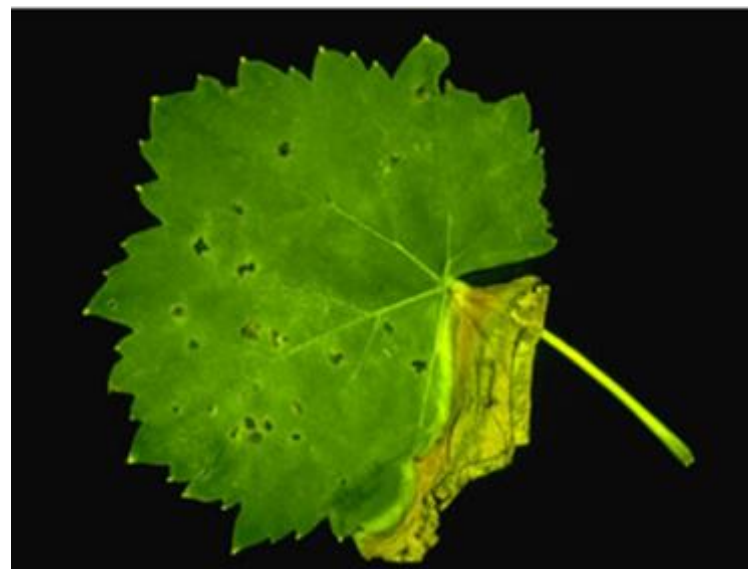
Xylella dieback of olive



Bacterial ooze on stem



Bacterial ooze on leaf surface



Bacterial leaf spots





Fungi

Causes of Plant Disease



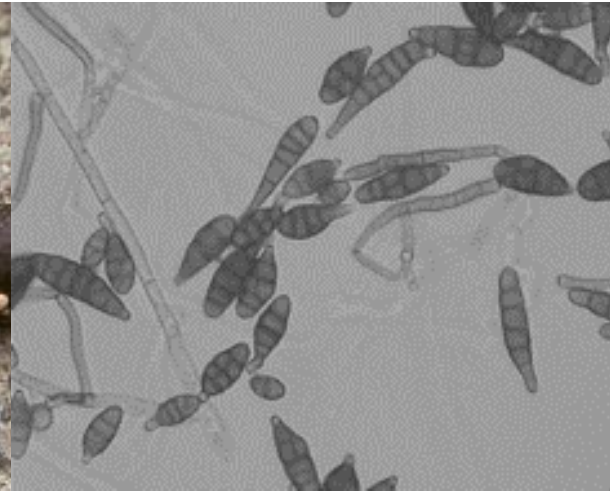
Trametes versicolor



Rhizopus/Mucor



coral spot



Alternaria spores



rhododendron bud blast



Ganoderma on hornbeam



peach leaf curl



acer tar spot



Fungi

30

Background information

- Direct infection of healthy tissues
- Entry via wounds and natural openings

Symptoms

- Leaf, fruit and flower spots
- Cankers and lesions
- Wilts, dieback
- Soft rots, decay

Spread

- Produce spores - air or water borne
- Contaminated soil, plants, footwear

Survival

- Specialist survival spores
- Upto 25+ years in plant debris and soil

Ash dieback



Strawberry red core



Poinsettia powdery mildew



Strawberry blackspot

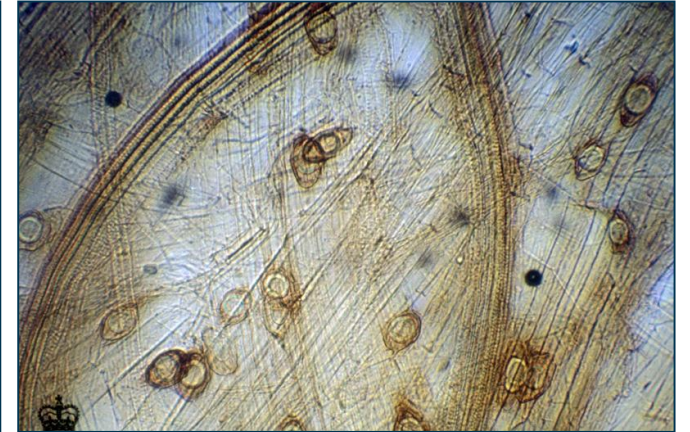
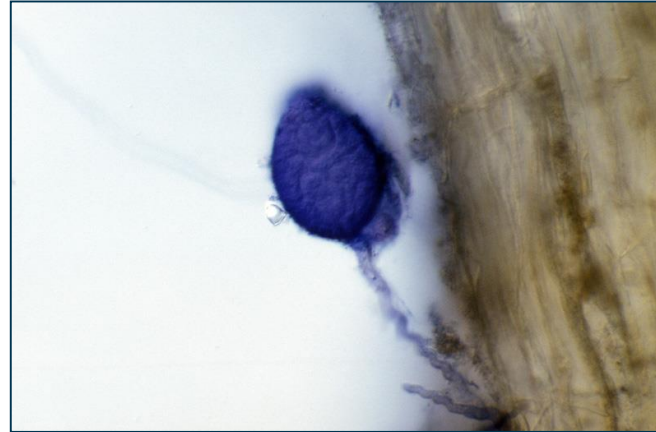




Fungi

A survey of 732 nurseries across 18 countries revealed that 91.5% had at least one species of Phytophthora

Phytophthora – sporangia and oospores



Downy mildew – sporangia





Viruses

Causes of Plant Disease



Cucumber mosaic virus



spraing (tobacco rattle virus)



elm yellows phytoplasma



bean common
mosaic virus



virus particles seen under
electron microscope



TSWV on dahlia



potato tuber spindle viroid



columnnea latent viroid

Viruses

Background information

- Nucleic acid with protein coat
- Invade and take over genetic machinery of plant cells
- Multiply very rapidly
- Some highly host specific
- Some have very wide (1000+) host range

Symptoms

- Mosaics, ringspots, vein clearing
- Leaf rolling and curling
- Galls and tumours

Spread

- Mainly vector transmitted - specific insect-virus relationships
- Mechanical transmission
- Infected seeds, pollen, vegetative propagation

Survival

- In hosts – plants and vectors



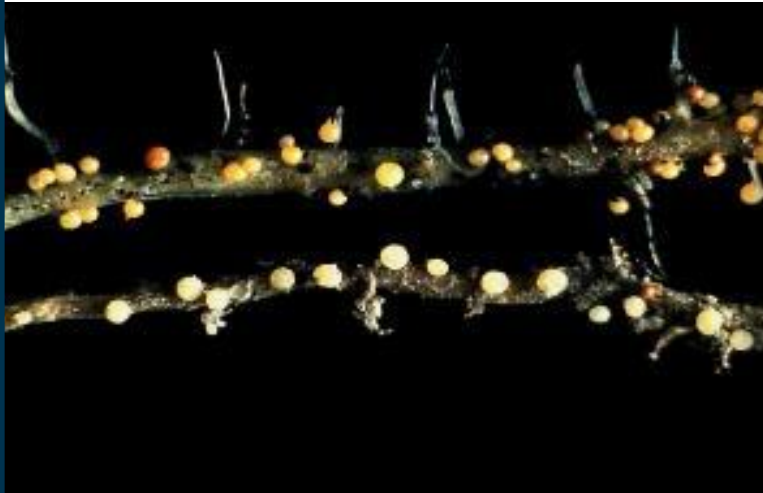
Pepino mosaic virus





Nematodes

Causes of Plant Disease



potato cyst nematode



pinewood
nematode damage



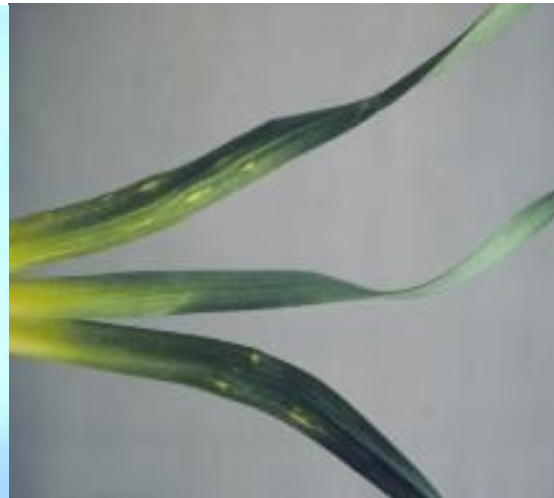
free living nematode
root damage



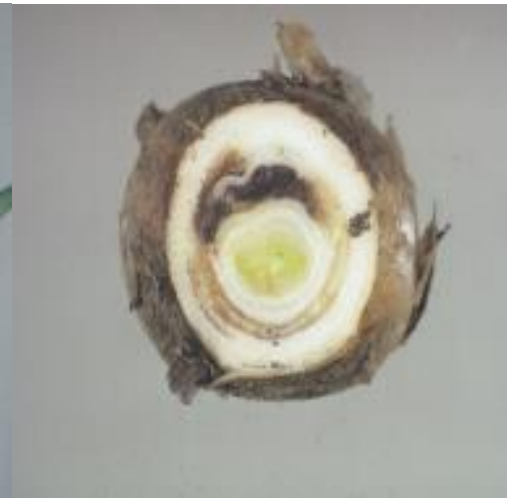
nematodes
attracted to roots



Ditylenchus damage on
daffodil (1)



Ditylenchus damage on
daffodil (2)



Ditylenchus damage
on daffodil (3)



leaf and bud nematode
on buddleia



Nematodes

35

Background information

- Threadlike -commonly called roundworms or eelworms
- Soil inhabiting and root feeding
 - Free-living nematodes (FLN) – live in soil
 - Cyst nematodes
- Aerial plant parts feeding
 - Buds, stems, leaves
- Vector viruses

Symptoms

- Root and stem rots
- Stem, bud and leaf distortion
- Stem and bulb decay
- Dieback e.g. Wood inhabiting nematodes

Spread

- Motile – up to 1 m in soil
- Contaminated soil and plants

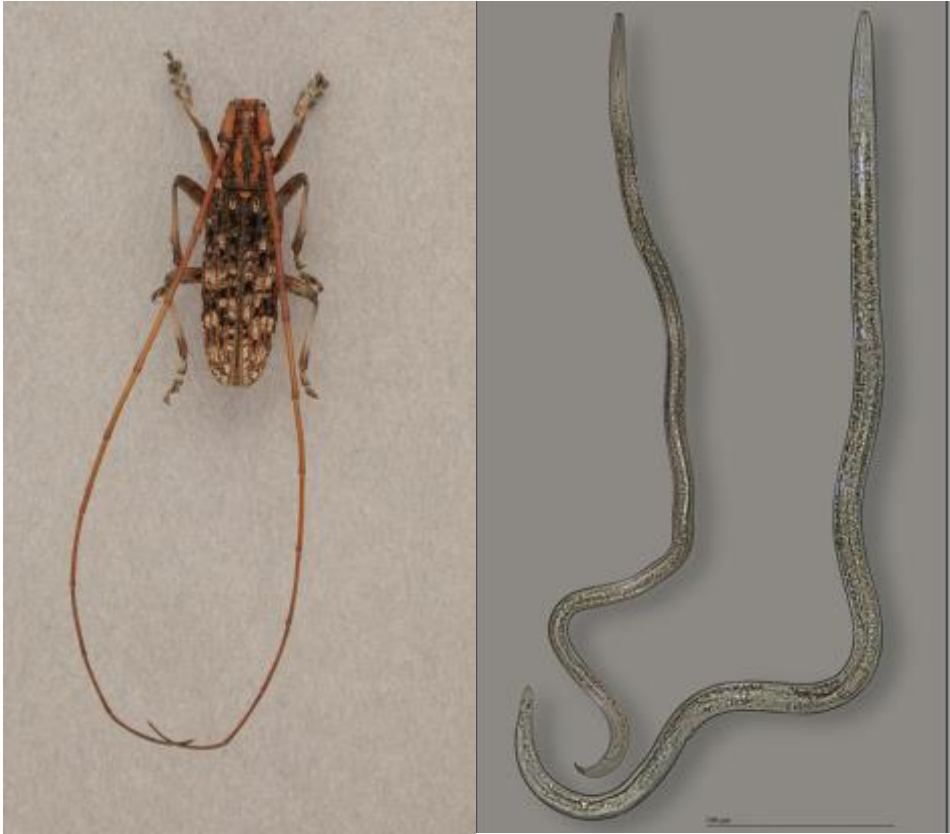
Survival

- Thick cuticle and Cysts





Pine wood nematode



Pine wood nematode and its longhorn beetle vector



Infested wood (staining) within dining chair



Tree dieback due to PWN

This finding has opened discussions at a pan-European level with regard to the potential risks associated with the international trade in manufactured wooden products.



Insects

Plant Pests – Main groups of pests



Fascinating fact: approximately 80% of all the known species in the world are insects.





Insect pests – sap-suckers



Aphids



Whiteflies



Scale insects



Thrips



Mealy bugs



Psyllids



Insect pests – sap sucker damage

- Unsightly
- Reduce vigour
- Cause discolouration
- Cause distorted growth
- Produce honeydew
- Sooty mould growth
- Transmit viruses

woolly aphid

thrips damage to flower

sooty mould on hebe

tomato spotted wilt virus
(thrips-transmitted)

bay sucker damage

cherry blackfly damage



Insect pests – chewers & tunnellers- Quarantine example

40

Asian or citrus longhorn beetles (*Anoplophora* spp.)



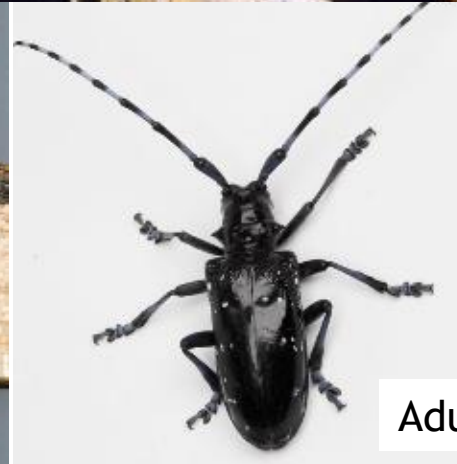
Exit hole



Exit hole



Larva



Adult



Larval gallery



Mites

Plant Pests – Main groups of pests



spider mites & damage



Fuschia gall mite & damage

lime erineum mite

acer gall mite



Insect pests – mites

Fuchsia gall mite (*Aculops fuchsiae*) – leaf and bud damage



Not notifiable if found in private gardens, but still notifiable in nursery & garden centre trade.

First described in Brazil. Now present in southern England, strongly suspected to have arrived in UK on infested cuttings illegally imported by a fuchsia enthusiast in Jersey.



2.3 Summary

Pathogens cause diseases

- Fungi
- Bacteria
- Viruses, viroids and phytoplasmas

Pests

- Nematodes
- Insects
- Mites

Legislation refers to harmful organisms as 'pests' – which includes pests and pathogens



2.4 Content and Learning outcomes

2.4 What should I do if I suspect a notifiable organism?

know how to report a suspect notifiable organism



2.4 What should I do if I suspect a notifiable organism?

A procedure must be in place to identify and deal with issues assessed as notifiable pest and pathogen interceptions or outbreaks

The procedure should include:

- Inform the local plant health inspector immediately if a notifiable pest or pathogen is suspected
- Isolate and contain the affected plants
- Clearly mark the affected products to ensure that they are not inadvertently moved or sold
- Act on the plant health inspector's instructions
- No treatment or disposal action shall take place without the authorisation of the plant health inspectors
- Review good biosecurity practices around the area to prevent further spread of the suspect notifiable organism



Who do I report a suspect notifiable organism to?

In England and Wales:

Report suspicious findings to Forestry Commission (<https://www.gov.uk/guidance/report-a-tree-pest-or-disease-overview>)

or the Animal and Plant Health Agency (APHA)

(<https://www.gov.uk/government/organisations/animal-and-plant-health-agency/about/access-and-opening#plant-and-bee-health-services>).

In Scotland:

<https://www2.gov.scot/Topics/farmingrural/Agriculture/plant/PlantHealth>

Contact the Scottish Government's Horticulture and Marketing Unit: Email: hort.marketing@gov.scot

In Northern Ireland:

General guidance: <https://www.daera-ni.gov.uk/topics/plant-and-tree-health>

Reporting: <https://www.daera-ni.gov.uk/articles/get-involvedreport-suspected-cases>



2.4 Summary

A procedure must be in place to identify and deal with issues assessed as notifiable pest and pathogen interceptions or outbreaks

Consider:

- Reporting immediately
- Containing plants and prevent further movement
- Follow guidance from plant health inspectors
- Review biosecurity practices

Different reporting mechanisms for:

- England and Wales
- Scotland
- Northern Ireland



Acknowledgements

The authors wish to thank the many plant health professionals within Fera Science Ltd, Defra and APHA's Plant Health and Seeds Inspectorate (PHSI) for content and assistance in producing the slides.

We would also like to thank the Royal Society of Biology Plant health professionals register advisory group for reviewing the content of these modules and providing advice and guidance.

Nicola Spence (Defra Chief Plant Health Officer), Ged Hayward (APHA - England), Susan Ross (SASA - Scotland), Nicola Cummings (DAERA – Northern Ireland), Nia Meddins (Welsh Government), Alan MacLeod (Defra), Denise A'Hara (SASA), Nick Mainprize (Forestry Commission), Tim Edwards (Boningale Nurseries Ltd.), Maureen Wakefield (Fera Science Ltd.), Gerry Saddler (SASA), Joanne Needham (Royal Society of Biology).