Introduction to Plant Health and Good Biosecurity Practice

Module 2

Harmful organisms and Pest Risk Analysis

www.planthealthy.org.uk

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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 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. Mycorhizzal 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

Initiation
- Identity PRA site/area
- Identify Pests and Hosts

Risk Assessment
- Geographical distribution
- Pest biology and lifecycle
- Pathways – entry, introduction and spread

Risk Management
- Management options and controls
- Monitoring
- Consultation and communication

DECISION/ACTION
2.2b UK Plant Health Risk Register

- 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

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.

- Unmitigated risk rating - risk without any coordinated 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
### UK Plant Health Risk Register - Inherent pathway risk ratings

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

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

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

Stages adapted from the International Plant Protection Convention’s framework for pest risk analysis. For the purposes of applying the principles at the site level.

1. Initiation
2. Pest Risk Assessment
3. Pest Risk Management

Define ALOP for site(s) and demonstrate that the level of risk is acceptable.

The level of risk to the business / organisation and environment if suitable controls and management systems ARE in place.

Note – the term ‘Pests’ includes diseases and ‘infest’ includes ‘infect’

Pest Risk Analysis

Self assessment and review

Continual improvement

Linked to the pest risk assessment (unmitigated risk) for specific pests – assesses effectiveness of controls and management systems.

Managed risk

The husbandry and housekeeping measures available to control pests.

Unmitigated risk

The level of risk to the business / organisation and environment if appropriate controls are NOT in place – see - UK Plant Health Risk Register

Identify pests

Map pest pathways

How the pests can arrive, proliferate and be transferred from the site (e.g. through operations, trade, visitors or natural processes).

List plants handled by a business or organisation

Define site boundaries - nursery, garden centre, business yard, garden, or customer site (transient)

[Host] Plants

Monitoring

Appropriate Level of Protection (ALOP)

Define ALOP for site(s) and demonstrate that the level of risk is acceptable.

Pests that can infest plants handled by business – see Plant Health Risk Register

Site

Plant Health Risk Register
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.
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

<table>
<thead>
<tr>
<th>Impact</th>
<th>Very likely</th>
<th>Likely</th>
<th>Unlikely</th>
<th>Highly unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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 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

**Pests**
- Nematodes
- Insects
- Mites

Legislation refers to harmful organisms as ‘pests’ – which includes pests and pathogens
2.3.1 Pathogens - microrganisms

- 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**

**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
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
Causes of Plant Disease

Nematodes

- 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

**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
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

Asian or citrus longhorn beetles (Anoplophora spp.)

- Exit hole
- Larva
- Adult
- Larval gallery
Mites

Plant Pests – Main groups of pests

- Spider mites & damage
- Fuchsia 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 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:

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:
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
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