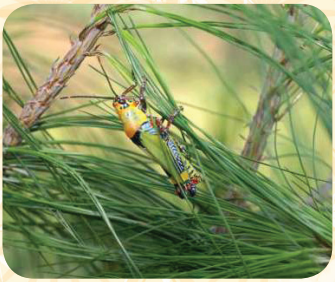
Field Guidelines for Insect Pests and Diseases of Commercial Tree Species in Uganda



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The **Sawlog Production Grant Scheme** (SPGS) supports the development of forestry industry in Uganda through providing grants and technical support as an incentive for long term investment in the forestry sector.

Preface

Plantation forestry has remarkably grown in Uganda over the last decade with the private sector taking the lead. Along with this growth are eminent risks of tree pests and diseases. While several traditional tree pests and diseases (e.g. termites) have remained crucial in the dynamics of forest plantations, new pests such as the Eucalyptus gall forming wasp *(Leptocybe invasa)* invaded the country recently and more such introductions are expected. Insect pests and diseases can cause considerable economic losses, which may compromise the development of plantation forestry enterprises.

Despite the increasing tree pest and disease risk, the vast majority of nursery operators, tree plantation owners, managers, and forestry service providers lack basic knowledge in tree pests and diseases, and there have been very limited opportunities for them to build their capacity in this critical aspect of plantation forestry. In particular, tools necessary to assist such forest practitioners in the recognition and identification of pest and disease problems associated with tree species promoted for plantation forests in the country are lacking.

Early detection and proper identification of pests and diseases are fundamental requirements for effective management. This booklet has been prepared to guide forest practitioners to make rapid preliminary diagnosis of pests and disease problems using their characteristic symptoms and signs. Although the main focus of the booklet is on existing main pests and diseases of commercial plantation trees in Uganda, some examples of external pests and diseases threatening the tree species grown in the country are also presented. Additional information is provided on collecting and sending pest and disease samples for identification.

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1.0 Insect Damage

1.1 Defoliation

Defoliators are insects that feed on leaf tissues. This feeding group also includes leaf-mining insects which feed within the leaf, leaf tiers and leaf rollers which make shelter from leaves and graze this from within, and leaf skeletonizers which eat the leaf tissue between the networks of leaf veins. Examples of common defoliators include grasshoppers, butterflies and moth larvae (caterpillars), leaf beetles, weevils. Typical symptoms of defoliation include large amount of missing foliage, normally uneaten parts of leaves e.g. petiole are common; browning of leaves; silk shelters and web enclosing foliage; insect remains including larval skin and frass, branch mortality and top kill, and whole tree mortality in very severe and persistent cases.



Photo 1: A *Phymateus sp.* (viridipes) defoliating *Pinus patula*



Photo 2: *Pinus patula* with defoliated shoot tips caused by a *Phymateus sp.* (viridipes)



Photo 3: Larvae of *Gonipterus scutellatus* skimming the epidermis of *Eucalyptus* leaf



Photo 4: Typical symptoms of defoliation caused by adult *Gonipterus scutellatus*. Note the adult G. scutellatus feeding on the leaf



Photo: 5: A caterpillar defoliating a *Pinus caribaea* seedling

1.2 Sap-Sucking

Sap-feeding insects suck liquid or semi-liquid material from succulent parts of the host plant which can be leaves, stems, roots, fruits, flowers or even seed. Sap feeders affect tree vitality by extracting sap required for normal functioning of the plant, such as shoot extension and leaf expansion. Some species, such as psyllids and mirid bugs, can inject toxic saliva into their hosts causing necrosis of plant tissue. Sap feeders can coat the surfaces of leaves and stems, and on which grows sooty mould fungi. The blackening of the surface by the mould can cause reduced photosynthetic efficiency and the loss of host vigour. Feeding by sap-sucking insects provides access for pathogenic fungi into plants, and aphids, mirids and cicadellids particularly are important in the transmission of viruses.

Typical symptoms of sap-sucking include discolouration (yellowing and browning) of leaves or needles, curled leaves (leaf distortion), honeydew and sooty mould on leaves, twigs, branches and sometimes on the ground, stunting of infested host plant, premature leaf drop, branch mortality and sometimes tree mortality



Photo 6: Aphid *(Cinara cupressivora)* colony on *Cupressus lusitanica* twig.



Photo 7: Browning of *Cupressus lusitanica* crown caused by *Cinara cupressivora*



Photo 8: A winged black pine aphid *(Cinara cronartii)* on a pine shoot. Some adults of the aphid are wingless.



Photo 9: A colony of the black pine aphids *(Cinara cronartii)* on branches of *Pinus caribaea*



Photo 10: Adults of *Thaumastocoris peregrinus* feeding on *Eucalyptus* leaf. The insect invaded Kenya recently but not in Uganda as yet



Photo 11: Discolouration of *Eucalyptus* crown caused by *Thaumastocoris peregrinus*



Photo 12: Colony of pine woolly aphids *(Pineus boerneri)* on the shoot of a *Pinus* species



Photo 13: *Prunus africana* leaves infested with *psyllids* covered by sooty mould

1.3 Gall Forming

Galls are unusual plant growths, which develop as a result of abnormal cell division and/or cell enlargements following infestation of plants by organisms such as insects, mites and fungi. They can occur on all parts of the plant but are most commonly found on leaves, stems and buds. Insect-induced galls can be caused by species in several groups, but the most important groups are wasps, bugs and flies. The shape of a gall is often characteristic of a particular insect species, but in some species the males produce galls of different shapes from those produced by the female. Galling rarely results in the death of the host tree, but severe dieback of attacked parts can occur, and branches may break under the weight of galls. Photosynthetic capacity may be reduced where leaves are heavily galled and distorted.



Photo 14: *Leptocybe invasa.* A *Eucalyptus* galling wasp of Australian origin. A nursery and field pest of *Eucalyptus*



Photo 15: *Leptocybe invasa* galls on *Eucalyptus* twig. Note the emergence holes of adults of the wasp on the galls



Photo 16: *Leptocybe invasa* galls on the midrib and petiole of a *Eucalyptus* leaf



Photo 17: *Eucalyptus* shoots severely infested by *L. invasa*. Note the distorted and abnormally small leaves



Photo 18: Lodging of *Eucalyptus* caused by severe *L. invasa* galling



Photo 19: Stunting of *Eucalyptus* saplings caused by severe *L. invasa* infestation

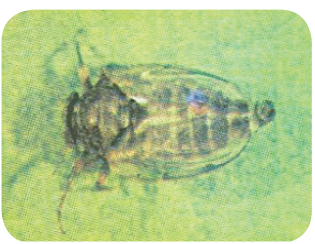

Photo 20: *Phytolama lata*. A nursery and field galler of *Milicia excelsa* (Muvule) indigenous to Africa



Photo 21: Galls on *Milicia excelsa* caused by *Phytolama lata*

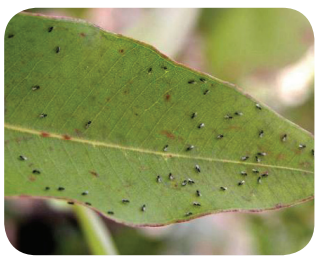

Photo 23: *Ophelimus maskelli* laying eggs on a *Eucalyptus* leaf



Photo 22: *Ophelimus maskelli.* A *Eucalyptus* galling wasp of Australian origin. Serious pest in the Middle East but not in Uganda as yet



Photo 24: Severe galling of *Eucalyptus* leaves caused by *Ophelimus maskelli*

1.4 Shoot Boring

Shoot or tip-boring insects cause the most damage when they attack the apical terminal or leader of the tree which results in irregular stem growth or multiple branching when secondary terminals take over dominance. Trees that have been subjected to repeated attack by such insects may have stunted growth, bushy appearance, or at least malformed boles, and their value for timber production can be greatly reduced or eliminated. Attacks on the buds and terminals of very young seedlings will often kill

them, or so stunt their growth that they are overtopped by weeds. Attack on saplings often results in crooked stem, but on pole-sized and mature trees the impact is usually inconsequential because height growth is well advanced and the bole form already established. Other signs and symptoms include small silky web in the axil or accumulation of frass and resin around the tip, browning of tips and shoot mortality.



Photo 25: *Hypsipyla robusta*. An important shoot borer of mahogany species in Africa

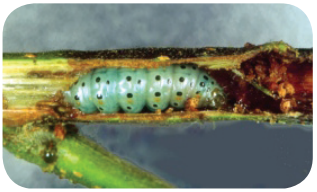

Photo 26: Larva of *Hypsipyla* robusta in the shoot of a mahogany species



Photo 27: Multiple branching of a mahogany species caused by *Hypsipyla robusta* infestation

1.5 Stem Boring and Cutting

Wood and bark boring insects that attack living trees often kill their host, but most species attack only felled, weakened or dead trees. Some feed on the outer surface of the bark, some tunnel into the inner bark while others tunnel deeply into the sapwood and heartwood. Common stem borers include termites, beetles and wood wasps. Damage is often characteristic of a particular insect group and can be recognised by the type of tunnelling, frass (insect excreta and chewed wood particles) and staining. Signs and symptoms include drying trees, swarming in the forest area, felled trees, presence of earth tubes between soil and the tree or wooden structure (for termites), piles of frass on the outside of finished wood, honeycomb wood boring damage and adult exit holes on the stem. Some insect groups damage trees by completely severing stems or branches. Such damage mostly occurs on nursery stock or newly planted trees.



Photo 28: Bark of *Grevillea robusta* girdled by *Macrotermes bellicosus*, a damaging termite species to several tree species



Photo 29: Earth tubes on the outer bark of *Eucalyptus grandis* formed by a termite species (a *Pseudacanthatermes* sp.)



Photo 30: Adult *sirex noctilio* male. *Sirex notilio* is an important borer of *Pinus* species not in Uganda as yet



Photo 31: A female *S. noctilio* laying eggs on the bark of a *Pinus* species



Photo 32: Resin exuding from the bark of a *Pinus* species attacked by *Sirex noctilio*



Photo 33: A *Pinus* species wilting following infestation by *Sirex noctilio*



Photo 34: Emergence holes of adult *Sirex noctilio* on the bark of a *Pinus* species



Photo 35: *Pinus caribaea* seedlings with severed stems thought to be caused by crickets.

1.6 Root Feeding

The insects damaging roots of trees consume the fibres and smaller roots, and others bore in the inner bark while some suck the sap. Examples of tree root feeders include white grubs (larvae of scarab beetles), termites, root weevils and cutworms (moth caterpillars). Root feeders are generally most damaging in nurseries and young plantations where the trees have small and fragile roots.



Photo 36: Typical mound of a termite species (*Odontotermes* species) damaging to seedlings of *Eucalyptus* and *Pinus* species



Photo 37: Typical mound of *Macrotermes bellicosus*- the most damaging termite species to trees in Uganda



Photo 38: Roots of a *Eucalyptus grandis* sapling severed by *Macrotermes bellicosus*



Photo 39: Extensive felling of *Eucalyptus grandis* saplings by *Macrotermes bellicosus*

2.0 Diseases

2.1 Leaf Spots

Leaf spots are patches of dead tissue (also called necrotic lesions) that are commonly caused by fungal pathogens but may be also a result of injury. Leaf spots can display a variety of textures, shapes and sizes and may be characteristic of a particular type of pathogen. In older leaf spots, fruiting bodies of the fungus may be seen as small, often dark, spots within the dead leaf tissue.



Photo 1: Leaf spots on *Eucalyptus* leaf caused by a *Mycosphaerella* species (fungus)



Photo 2: Leaf blotching and defoliation resulting from *Mycosphaerella* leaf spots



Photo 3: Corky leaf spot on *Eucalyptus grandis* leaves thought to be caused by bacterial infection

2.2 Shoot blight

Shoot blight is the rapid wilting and death of soft leaves, stems and buds at the end of the shoots caused by pathogens that can infect and kill soft shoot tissue during humid weather. These symptoms can also be caused by insect and vertebrate pests but in these cases there will be visible evidence at the site of attack (for example puncture wounds, frass, bark stripping). To diagnose blight caused by pathogens, the shoots must be examined to find the region where the tissue has been killed, causing it to darken. Fruiting bodies of the pathogen can sometimes be seen within the killed tissue either as pimples (often darkly coloured) or wefts of fungal threads producing clusters of spores.

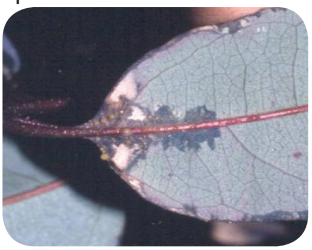

Photo 4: Water-soaked leaf lesions on *Eucalyptus* leaf caused by a bacterium *(Pantoea ananatis)*. The lesions develop into blights.

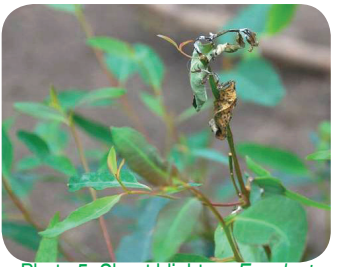

Photo 5: Shoot blight on *Eucalyptus* thought to be caused by a fungal species. Note the white *mycelial* growth on infected tissues



Photo 6: Severe bacterial blight on a sprouting ramet of a clonal *Eucalyptus* hybrid.



Photo 7: shoot blight on *Pinus caribaea*. Cause unknown.

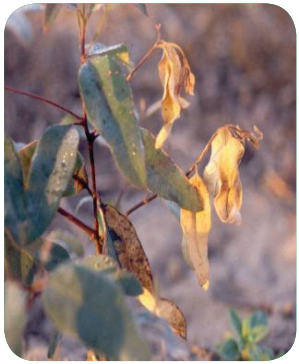

Photo 8: Blight on *Eucalyptus* seedling caused by *Pantoea ananatis*

2.3 Wilt

Wilt refers to loss of rigidity and drooping of plant parts generally caused by insufficient water in the plant. The leaves of infected plants or parts of infected plants lose turgidity, become flaccid and lighter green to greenish yellow, droop, and finally wilt, turn yellow, then brown. Wilted leaves may be flat or curled. Young tender shoots also wilt and die. In cross sections of infected stems and twigs, discoloured brown areas appear as a complete or interrupted ring consisting of discoloured vascular tissues.



Photo 9: Wilting of *Eucalyptus* sapling caused by a bacterium species *(Ralstonia solanacearum)*



Photo 10: Characteristic streaks in the stem of *Eucalyptus* infected by *R. solanacearum*



Photo 11: Wilting of Pinus seedlings caused by a fungus (*Fusarium* species)



Photo 12: Poorly developed roots of pine seedlings infected by a *Fusarium* species.



Photo 13: Discoloration of stem vascular tissues of a pine seedlings infected by a *Fusarium* species



Photo 14: Wilt on field planted *Pinus caribaea*. Cause not yet identified



Photo 15: Stem of a wilting *Pinus caribaea* with white resin deposits. Cause of wilting unknown



Photo 16: Decomposing roots of a *Pinus caribaea* wilting due unknown cause

2.4 Mildews and Moulds

Mildew refers to a fungal disease of plants in which the mycelium and spores of the fungus are seen as a whitish growth on the host surface. Moulds are profuse or woolly fungus growth on surfaces of plant tissue. A number of mildew and mould fungi grow on or in leaf tissue without causing the death of the infected tissue. These are true parasites that infect leaf cells to obtain their nutrition. Others do not infect the leaf cells but live superficially on the leaf surface and obtain their nutrition from other sources. Common moulds and mildews are sooty mould, which grows on sugary excretion (honeydew) of sap sucking insects, botrytis mould and powdery mildew which parasitizes the leaves on which it grows.



Photo 17: A leaf of *Eucalyptus grandis* covered by powdery mildew



Photo 18: *Botrytis* grey mould on *Eucalyptus* seedlings

2.5 Cankers

Cankers are necrotic lesions on a stem, branch or twig of a plant. Canker pathogens infect and colonise the bark and may spread inwards to kill the cambium tissues, resulting in localised wounds or more extensive damage that can effectively girdle the tree. Signs include sunken areas that may contain pimple-like fruiting bodies of the canker fungus erupting through the bark, stem lesions indicated by the discolouration (darkening) of the inner bark/ cambium, particularly at the boundary with healthy tissue; and separation of the bark from the cambium. Cankers are often associated with wounds or borer damage, or with branch stubs.



Photo 19: Stem canker on *Eucalyptus* caused by *Botryosphaeria* species. Note the dark brown exudates from the inner bark

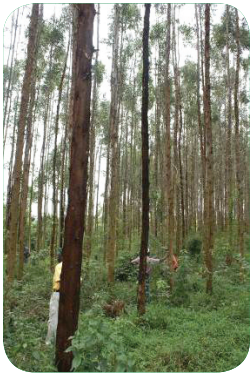

Photo 20: *Eucalyptus* stand infected by *Botryosphaeria* canker



Photo 21: canker on *Eucalyptus* twigs caused by a *Coniothyrium* species



Photo 22: *Eucalyptus* stem distorted by *Coniothyrium* canker

2.6 Root, Collar and Stem Rot

Root and collar rot pathogens infect and kill the phloem, cambium and sapwood in the roots and/or at the root collar (ground level) and the stem. Infected wood is usually darkly discoloured. Trees with root or collar rot often die quickly with the foliage of the entire crown rapidly wilting and drying. Some root and collar rot pathogens provide characteristic signs, which can be helpful in diagnosis. For example, *Armillaria* species colonises the surface of the root bark by a growth of dark-brown or black, bootlace (shoestring) like structures called rhizomorphs, which appear superficially attached to the host. Trees killed by species of *Armillaria* will usually have a leathery sheet of white mycelium (fungal filaments) growing underneath the bark. The fungus produces a pulpy rot with black zone lines in the wood. Decay of above-ground and below-ground woody tissues may reduce the tree's growth rate, diminish the amount and quality of products that can be

obtained from discoloured or decayed wood, and shorten the life span of the tree.



Phot 23: *Armillaria* fruiting structures (mushroom) at the base of an infected tree



Photo 24: White leathery mycelial sheet of *Armillaria* underneath the bark of an infected tree



Photo 25: *Eucalyptus* seedling with sunken lesion near the root collar caused by damping off pathogen

3.0 Catalogue of Signs, Symptoms, and Possible Causes

Symptoms	Fungus	Bacteria	Virus	phyto-plasma	Nematode	Insect	Abiotic
Abnormal growth							
Abnormal colour	X	X	X	X	X	X	X
Abnormal form/ shape	X	X	X	X	X	X	X
Malformed bark	X	X	X	X	X	X	X
Dwarfing			X	X		X	
Mosaic			X				
Witches broom			X	X			
General death							
Blight	X	X	X	X		X	X
Collapsed (toppled)	X	X			X	X	X
Damping-off	X						
Dieback	X	X	X	X	X	X	X
Seedling blight	X	X	X		X	X	X
Wilt	X	X	X	X		X	X
Necrosis							
General necrosis	X	X	X	X	X	X	X

Symptoms	Fungus	Bacteria	Virus	phyto-plasma	Nematode	Insect	Abiotic
Rot (internal, dry, soft)	X	X			X		
Lesion (pot, scab, fleck, streak)	X	X	X	X	X	X	X
Necrotic (area, canker, streak)	X	X				X	
Physical evidence of pest activity							
Cyst on root surface					X		
Exit hole						X	
External feeding						X	
Frass						X	
Fungal growth	X						
Honey dew, sooty mould	X						
Internal feeding						X	
Ooze, bacterial		X					
Shredding					X		
Webbing					X		
Altered plant growth							
Early senescence			X	X		X	X
Empty grains	X		X	X		X	X
Flower drop, shedding	X	X	X	X	X		X
Galls	X	X			X	X	X
Mummification, shrivelled	X		X	?			X

Symptoms	Fungus	Bacteria	Virus	phyto-plasma	Nematode	Insect	Abiotic
Premature fall	X	X	X	X	X	X	X
Premature ripening							X
Reduced root system			?	?	X		X
Others							
Gummosis, resinosis	X	X				X	X
Odour	X	X					
Ooze, non bacterial							X
discoloration	X	X				X	X

4.0 Collecting and Sending Samples for Identification

Samples for laboratory analysis can include those from diseased roots, stems or foliage. In addition, samples of soil or growth media can be analyzed for the presence of pathogens and these are particularly important when roots disease is suspected. Water samples can also be analyzed for the presence of disease agents but, given the more specialized nature of such analyses, special arrangements must be made before these can be undertaken. Insect specimens (larvae, pupae and adults) and damaged roots, stem or foliage material can also be submitted for diagnosis.

4.1 Plant Materials

- Collect fresh material that shows the early stages of symptom development or has evidence of pest infestation (e.g. fungus fruiting bodies)
- Get it to the investigating laboratory as quickly as possible
- Pack it loosely yet securely to keep humidity low and reduce the chance of mould fungi developing on the way. Do not pack in plastic bags.
- Provide information on symptoms and other details of the problem (date of collection, name of collector, location, tree species, tree age, infestation history, weather conditions, recent management practices that may influence pest/disease situation, etc.)
- Give each sample a unique code that will allow the receiving laboratory to keep track of your query. It is vital that all material be carefully and permanently labelled.

4.2 Insect Specimens

- Larvae are difficult to identify, therefore try to collect adult stage.
- Larvae should be air dried or frozen prior to dispatch and carefully packed in a small tube (vial) with tissue paper or cotton to avoid damage.
- Small insects can be preserved in 70% alcohol. Place identifying labels (written in pencil or indelible black ink on paper) inside the containers.
- Some insect (e.g. butterflies) may lose their colour patterns when stored under alcohol. For such insect, dry specimens are preferred. Butterflies and moths can be sun dried by placing them (with wing spread) in newspapers and sent in small envelopes.
- All specimens should be carefully labelled with collector's name, date of collection, site and any host information (species, size, age).
- Keep a carefully labelled reference collection of all insects sent for identification for future cross-referencing.

4.3 Information Checklist

(a) Details of collector

Name of collector:_____

Company:_____

Address:_____

_____

Telephone no: _____Fax no._____

Email:_____

(b) Location where disease/pest is occurring and dates

GPS location:_____
Village:_____ Parish_____
Sub-county_____ County _____
District _____
Estate:_____
Compartment no: _____
Soil type:_____
Date sample collected:_____
Date sample dispatched:_____

(c) Type of sample:

☐ Soil
☐ Stems
☐ Roots
☐ Leaves/needles
☐ Seedlings/cuttings
☐ Twigs
☐ Water
☐ Insects
☐ Other

(d) Pest/disease description and history

(i)Tree species affected _____

Symptoms:

☐ Wilt
☐ Stunting
☐ Leaf spot
☐ Root rot
☐ Die-back
☐ Cankers
☐ Tree death
☐ Other

Distribution

☐ Single plant
☐ Scattered plants
☐ Widespread
☐ Patchy

(ii) Can you associate the pattern with:

☐ Low wet area
☐ Elevated dry area
☐ Neither

(iii) Estimate percent of trees affected_____

(iv) Date problem first noticed_____

(v) Age of tree affected _____

(vi) Unusual disturbances:

☐ Hail
☐ Lightening
☐ Pruning
☐ Injury
☐ Other

(vii) Weather conditions prior to symptom development

Temperature range _____
Rainfall (wet or dry)_____
Hot/Cold winds_____

(viii) Additional information (e.g. on control actions taken, etc.), if any:

_____
_____








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