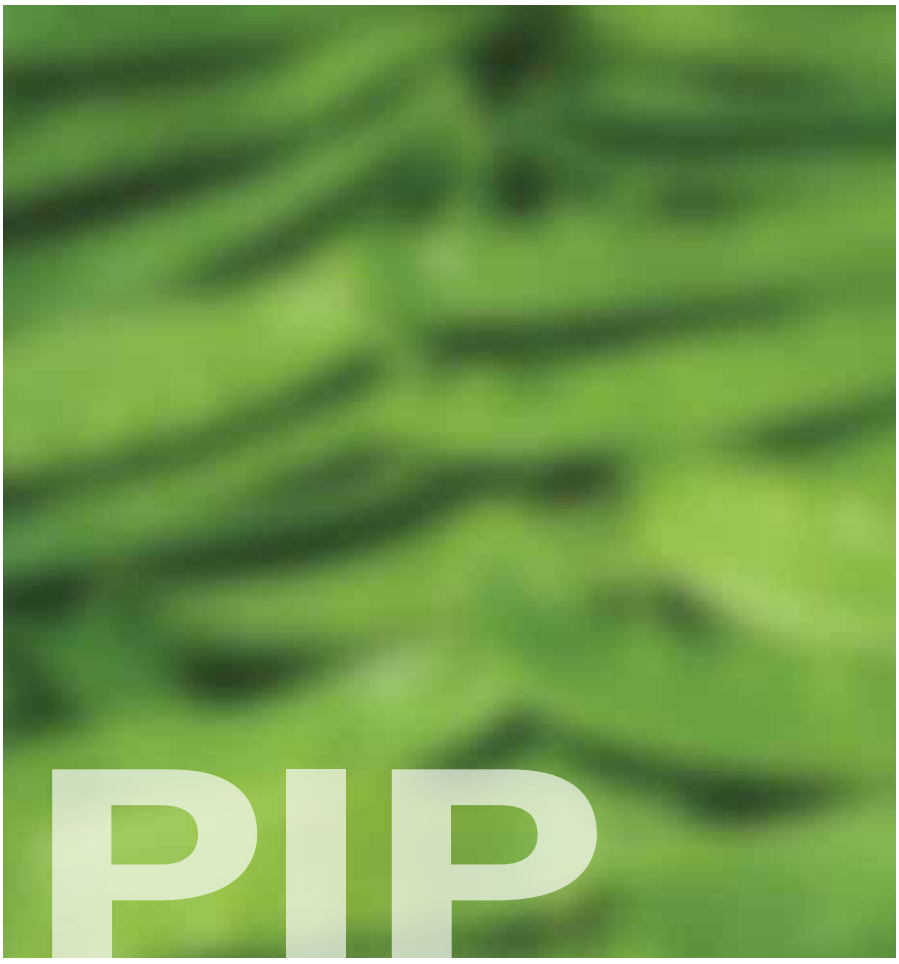


# GUIDE TO GOOD CROP PROTECTION PRACTICES

## FOR GINGER (*ZINGIBER OFFICINALE*)

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PIP is a European cooperation programme managed by COLEACP. It is financed by the European Development Fund and implemented at the request of the ACP (Africa, Caribbean and Pacific) Group of States.

In accordance with the Millennium Development Goals, the global objective is to: "Maintain and, if possible, increase the contribution made by export horticulture to the reduction of poverty in ACP countries".

**www.coleacp.org/pip**

PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

PIP is funded by the European Union.

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of PIP and COLEACP and can in no way be taken to reflect the views of the European Union.

**February 2012.**

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**Document drawn up by PIP with the technical collaboration of:**

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The Guide to Good Plant Protection Practices (fruit or vegetable) details all plant protection practices (for fruits or vegetables) and recommends primarily the active substances supported by pesticides manufacturers in the framework of the EU Regulation 1107/2009, for organic production those allowed for usage by the EU Regulation 2092/91, which must comply with standards for pesticide residues. Currently, these active substances have not been tested by PIP in ACP countries to check their conformity with MRLs.The information given on the active substances suggested is therefore changeable and will be adapted on an ongoing basis in accordance with the new information collected by PIP.

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# Introduction

Ginger: *Zingiberaceae* belongs to perennial *monocotyledoneae* plants. The edible part are the rhizome and the young shoots (pseudostems).

# 1. Main pests and diseases

## 1.1 Extent and impact on the quantity and quality of fruit produced

The main pests and diseases that will be discussed in this guide are listed below. This section presents, for each pest or disease:
the level of economic importance generally observed in ACP countries rated on the following scale: **+ = low, ++ = average, +++ = high**;
the parts of the plant affected and how they are attacked;
the resulting types of loss, all of which decrease the yield of marketable rhizomes or shoots and consequently end up causing a loss of financial income. The presence of pests and diseases can reduce yield and cause losses at different levels: fewer plants per hectare, less rhizomes or shoots per plant, smaller-sized rhizomes, lower quality of rhizomes or shoots.

There are no pest or disease of ginger that is a quarantine organisms in Europe.
One should check the status of quarantine organisms on the websites http://europa.eu/scadplus/leg/fr/lvb/f85001.htm and http://www.eppo.org/QUARANTINE/quarantine.htm since regulation can change.

| INSECTS | | | | | | |
|---|---|---|---|---|---|---|
| Extent | Organs attacked | | Types of loss | | | |
| | Rhizome | Shoots and leaves | Number of plants | Number of rhizome or shoots | Size of rhizome | Quality of shoots or rihzome |
| Shoot borer or yellow peach moth<br>*Conogethes punctiferalis*; Synonym: *Dichocrosis punctiferalis* | | | | | | |
| + | | Larvae bore into pseudostems and feed on growing shoots | | Up to 50% of pseudostems can be lost per plant | Can be reduced | |

## INSECTS

| Extent | Organs attacked | | Types of loss | | | |
|---|---|---|---|---|---|---|
| | Rhizome | Shoots and leaves | Number of plants | Number of rhizome or shoots | Size of rhizome | Quality of shoots or rihizome |
| **Rhizome scale - *Aspidiella hartii*** | | | | | | |
| + | Larvae on rhizome | | | Reduction by weakening of the plant | | In storage buds and rhizome shrivel and sprouting reduced |
| **Root Knot Nematodes - *Meloidogyne* spp.** | | | | | | |
| + | Attacks roots from rhizome | | Plant death exceptionally | Reduced if heavy infestation at early stage. Nematode infestation aggravates rhizome rot disease. | | |

## FUNGI

| Extent | Organs attacked | | Types of loss | | | |
|---|---|---|---|---|---|---|
| | Rhizome | Shoots and leaves | Number of plants | Number of rhizome or shoots | Size of rhizome | Quality of shoots or rihizome |
| ***Pythium* spp.** | | | | | | |
| ++ | Mycelium develop on rhizome, roots and collar regions of plant between stem and shoot | | Up to 90 % of plants may die | Soft rot can cause failure of rhizomes to sprout | Possible reduction because shoots and leaves turn yellow and collapse | |
| **Yellows – *Fusarium oxysporium* f.sp. *zingiberi*** | | | | | | |
| ++ | Entering throug roots or rhizome | Progress into the stems | Large areas in a crop can have 100% kill | Reduced because plant ceases to grow and become un-harvestable | | |
| **Leaf spot - *Phyllosticta zingiberi*** | | | | | | |
| ++ | | Mycelium develop on leaves | | | Reduced | Possible reduction of shoots quality due to presence of spots |
| **Anthracnose - *Colletotrichum zingiberis*** | | | | | | |
| +++ | | Mycelium develop on leaves | | | Reduced | Possible reduction of shoots quality due to presence of spots |

| BACTERIA | | | | | | |
|---|---|---|---|---|---|---|
| Extent | Organs attacked | | Types of loss | | | |
| | Rhizome | Shoots and leaves | Number of plants | Number of rhizome or shoots | Size of rhizome | Quality of shoots or rihizome |
| Bacterial wilt - *Ralstonia solanacearum* – Synonym: *Pseudomonas solanacearum* | | | | | | |
| + | Attacks through roots and rhizome | | Large areas in a crop can have 100% kill | | | |

| VIRUSES | | | | | | |
|---|---|---|---|---|---|---|
| Extent | Organs attacked | | Types of loss | | | |
| | Rhizome | Shoots and leaves | Number of plants | Number of rhizome or shoots | Size of rhizome | Quality of shoots or rihizome |
| Mosaic disease of Ginger | | | | | | |
| + | The whole plant. Mode of transmission not known | | | Reduction due to less photosynthesis and wilt | | Stunted groth of shoots |

## 1.2 Identification and damage

This section provides information and illustrations to help with the identification of the main pests and diseases.

### INSECTS

**Shoot borer or yellow peach moth**
***Conogethes punctilferalis*; Synonym: *Dichocrosis punctiferalis***

A medium sized moth with wingspan of 18-24 mm, the wings and body are pale yellow with minute black spots. The eggs are laid in the shoot tip when very young and the larvae burrow down into the shoot tip. There are five larvae instars, the largest being light brown with few hairs and can reach up to 25 mm in length. The growing shoots turns yellow and dries. Holes can be seen in the pseudostem and frass is often also seen at the hole entrance.

Larva

Adult

**Rhizome scale - *Aspidiella hartii***

The adult female is minute, circular and light brown to grey measuring about 1.5 mm in diameter. The scale are sap suckers and feed on the surface of the rhizome in the late stage of the field crop. Sooty mould can develop particularly in storage and the rhizome shrivels and in severe infestation can inhibit bud sprouting.

### NEMATODES

**Root Knot Nematodes – *Meloidogyne* spp.**

Root knot nematodes can not be seen with the naked eye, however their damage is very obvious. The roots coming off the rhizomes will have knobbly galls, and are an integral part of the root. They are firm and can become extensive around the rhizome which is likely to be reduced in size. The nematode attack usually occurs in patches in the field and reduce grow is the visual symptom to the patch.

## FUNGI

### *Pythium* spp.

Circular and inconspicuous spots, grey in colour. Black dots (fruiting bodies (pycnidia) develop in spot centre. On the stems, light brown elongated areas with purple margins develop near the soil surface. These margins girdle the stem and turn black, hence the name black leg. Affected plants will wilt and die.

### Fusariose – *Fusarium oxysporium* f.sp. *zingiberi*

Initially yellowing of leaf margins on lower leaves, then spreading to younger leaves with leaves drying up. Other symptoms include wilting, drooping, drying, yellowing in patches or whole beds. Cream or browning of stems and rhizome.

### Leaf spot - *Phylllosticta zingiberi*

The disease starts as a water soaked spot and later turns as a white spot surrounded by dark brown margins and yellow halo. The lesions enlarge and adjacent lesions coalesce to form necrotic areas.

Spots on leaves

### Anthracnose - *Collectotrichum zingiberis*

Small round to oval light yellow spots on leaves, increase in size and often coalesce to form large discoloured areas. Holes can occur in the leaf or leaf drop.

## BACTERIA

### Bacterial wilt - *Ralstonia solanacearum*; Synonym: *Pseudomonas solanacearum*

Wilting and yellowing of lower leaves which spreads upwards until all the leaves are yellow. The pseudostem will become watery and readily breaks away from the under ground rhizome. The vascular tissue darkens to a black colour and the plant eventually collapses. Diseased rhizomes are usually darker and have water soaked areas and when cut have a milky white exudates.

Yellowing of a leaf

Water-soaked areas occur, and a milky liquid oozes out when rhizomes are cut

Rotting rhizome

Translucent rhizome

## VIRUSES

### Mosaic and Chlorotic Fleck Viruses of Ginger

Mosaic virus - Damage seen as yellow and green mosaic pattern on leaves. Plants affected show stunting.
Chlorotic Fleck – Damage seen as flecking on the leaves.

## 1.3 Appearance of pests and diseases in terms of the phenological stage of the plant

The following table shows the stages of cultivation during which crop enemies are potentially present and the stages during which their presence can do the most harm. It is especially during the latter stages that they must be monitored and controlled if necessary. The purpose is to show that the presence of a pest, disease or pathogenic agent is not always harmful to the crop.

| Stage of the crop | *Conogethes punctiferalis* | | *Aspidiella hartii* | | *Meloidogyne* spp. | | *Pythium* spp. | | *Phyllosticta zingiberi* | | *Fusarium oxysporium* f.sp. *zingiberi* | | *Collectotrichum zingiberis* | | *Ralstonia solanacearum* | | Mosaic and Chlorotic Fleck | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rhizome in storage and planting | | | | | | | | | | | | | | | | | | |
| Early rhizome and pseudostem growth | | | | | | | | | | | | | | | | | | |
| Further development of the plant | | | | | | | | | | | | | | | | | | |
| Mature crop and large canopy | | | | | | | | | | | | | | | | | | |
| At harvesting of rhizome | | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| | Periods during which pest or pathogenic agent is potentially present |
| | Periods during which the appearance of a large numbers of pest or pathogenic agent can cause the greatest loss |

## 1.4 Extent according to country/time of year and climate conditions favourable to crop enemies

**Key:**
KEN = Kenya, UGA= Uganda, and TAN = Tanzania
0 = no damage
+ = light damage
++ = medium damage: control needed
+++ = serious damage: control essential
X = light damage but importance by month not known
XX = medium damage but importance by month not known
XXX = serious damage but importance by month not known
/ = no information available
N.B. the inventory of pests and diseases has not been conducted exhaustively in all countries. The pest may be present, but has perhaps never been observed in the country on the crop, because it does not cause serious damage.

Shoot borer - *Conogethes punctilferalis*;
Synonym: Yellow peach moth - *Dichocrosis punctiferalis*

**Favourable conditions:** A moderate pest in dry months, rainfall reduces adult populations and is less of a problem in wet years and months.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | x | x | x | x | x | x | x | x | x | x | x | x |
| UGA | x | x | x | x | x | x | x | x | x | x | x | x |
| TAN | x | x | x | x | x | x | x | x | x | x | x | x |

Rhizome scale - *Aspidiella hartii*

**Favourable conditions:** A minor pest in Africa but has been reported. More prevalent in dry seasons.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | x | x | x | x | x | x | x | x | x | x | x | x |
| UGA | x | x | x | x | x | x | x | x | x | x | x | x |
| TAN | x | x | x | x | x | x | x | x | x | x | x | x |

Root Knot Nematodes - *Meloidogyne* spp.

**Favourable conditions:** All year round, as residual in the soil and can infect clean planting material.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | x | x | x | x | x | x | x | x | x | x | x | x |
| UGA | x | x | x | x | x | x | x | x | x | x | x | x |
| TAN | x | x | x | x | x | x | x | x | x | x | x | x |

**Leaf spot - *Phylllosticta zingiberi***

**Favourable conditions:** In humid and rainy weather. The problem is as important as it is rainy. The fungus spreads with splashed water during frequent heavy rain.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |
| UGA | ++ | + | ++ | +++ | + | + | + | + | + | ++ | ++ | ++ |
| TAN | ++ | ++ | ++ | + | + | + | + | + | ++ | ++ | + | + |

***Pythium* spp.**

**Favourable conditions:** In humid and rainy weather, with over wet and poorly drained soils.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |
| UGA | ++ | + | + | ++ | ++ | ++ | + | + | + | ++ | ++ | ++ |
| TAN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |

**Anthracnose - *Collectotrichum zingiberis***

**Favourable conditions:** In humid and rainy weather with leaf wetness.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |
| UGA | +++ | + | ++ | +++ | ++ | + | + | + | ++ | +++ | +++ | ++ |
| TAN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |

**Yellows – *Fusarium oxysporium* f.sp. *zingiberi***

**Favourable conditions:** In humid and rainy weather and over wet soils with poor drainage and warm temperatures.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |
| UGA | ++ | ++ | + | + | + | + | + | + | + | + | ++ | + |
| TAN | + | + | + | ++ | ++ | + | + | + | + | ++ | ++ | + |

**Bacterial wilt - *Ralstonia solanacearum*; Synonym: *Pseudomonas solanacearum***

**Favourable conditions:** In wet and poorly drained soils.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | x | x | x | x | x | x | x | x | x | x | x | x |
| UGA | x | x | x | x | x | x | x | x | x | x | x | x |
| TAN | x | x | x | x | x | x | x | x | x | x | x | x |

**Mosaic and Chlorotic Fleck Viruses of Ginger**

**Favourable conditions:** Potentially present all year round.

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEN | x | x | x | x | x | x | x | x | x | x | x | x |
| UGA | x | x | x | x | x | x | x | x | x | x | x | x |
| TAN | x | x | x | x | x | x | x | x | x | x | x | x |

# 2. Main control methods

## 2.1. Introduction

There are a limited number of pest and diseases of ginger. As a perennial crop there is a risk of transferring pathogens with the planting material, therefore extra care must be taken to avoid planting "dirty" or infected material. Also as there are some soil borne pests (nematodes) and diseases (*Fusarium* and *Pythium*), care must be taken not to plant into already contaminated soils. The relatively long crop cycle makes the control of pests and diseases difficult to rectify if they are present early in the crop cycle.

### Planting material

The planting material is major source of inoculum, therefore every effort must be adopted to use clean planting material. Visual infection is the obvious method however this is not a guaranteed to detect problems also plant only from crops that have shown no disease symptoms.

Heat treatment of ginger rhizomes has been used for the control of bacterial wilt, nematodes and *Fusarium*. Heat can be provided by different methods (solar, hot air, hot water). However in any heat treatment there is a fine divide between enough heat to kill the pathogen but not too much so that the rhizome will not be damaged. Solarization is a low cost and environmental friendly method of pathogen elimination. Maintaining temperatures at a temperature of 40 – 50°C for 30 minutes has been shown effective at the control of bacterial wilt. However when heat treatment is undertaken care must be taken to monitor the temperature and avoid rhizome damage. Solarization under clear polythene sheets in bright sunlight is a possible practical method for heat treatment.

Ginger has been widely tissue cultured as a method rapid multiplication and elimination of pathogens. This is a possible means of producing high quality, clean planting material that can be further propagated under isolated field conditions, prior to planting in commercial production fields.

### Planting in clean soil

Soil borne pathogens pose an important threat to ginger production, particularly bacterial wilt, *Fusarium* and nematodes. It is impossible to eliminate these pathogens from the soil. However methods for their reduction can include crop rotation which include non susceptible crops, ensure the soil is not infected with irrigation water high in pathogens, cross contamination with cultivation equipment and use of soil sterilization. Chemicals for soil disinfection are an option but they are usually a temporary measure.

### Crop Monitoring

Ginger has a relatively long crop cycle therefore crop monitoring from planting to harvesting is an important crop protection strategy. A disease or pest that is not detected early can result in much more damage than if detection was early in the pest or disease attack. In addition pests and diseases can be anticipated through experience and crop history in local sites.

## 2.2. Pest or disease cycle; positioning of control methods and factors influencing the development of the cycle

Based on the stages of development of each pest or disease, the following are the applicable control methods, as well as the effects of natural factors other than those related to climate, which are described in Part 1.4. of this guide. The control methods are then positioned in terms of the plant's development cycle.

**N.B.:** the illustrations of the cycles represent the different stages of development, but in no case should these illustrations be used to identify pests or diseases. For identification, please return to part 1.2 of this guide.

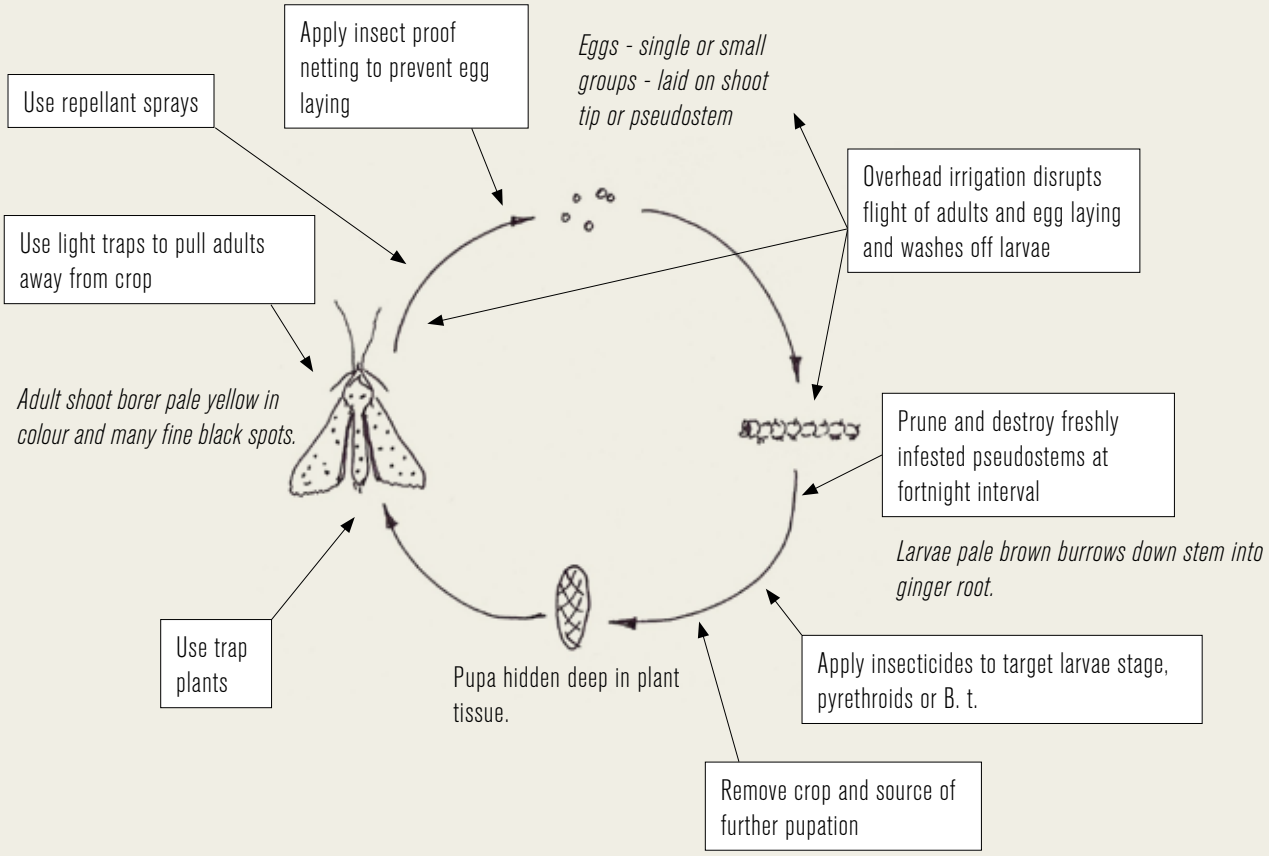
The control methods for pests or diseases whose cycle is not illustrated are presented in a table.
The second column of the table shows what actions should be taken to control the different stages of development of the pest or the disease shown in the first column.
In the second column, actions that can be referred to as "cultivation practices" are shown in green boxes, and actions that can be referred to as "application of plant protection products", in pink boxes.

| |
|---|
| *Cultivation practices* |
| *Application of plant protection product* |

The third column shows the cultivation stage during which these actions should be taken.

## SHOOT BORER OR YELLOW PEACH MOTH

### Positioning of control methods in terms of the development stage of the pest




### Positioning of control methods in terms of the development cycle of the plan

**After planting and during crop growth**

- Apply insect proof netting to prevent egg laying when plants are young.
- Plant trap plants to pull moths away from crop.
- Apply overhead irrigation, which disrupts flight of adult, and washes off larvae.
- Apply insecticides for control of larvae such as pyrethroids or B. t.
- Use repellent sprays such as neem based products.
- Prune and destroy freshly infested pseudostems at fortnight interval.
- Use light traps to pull adults away from crop.

**After last harvesting**

- Remove crop and source of further pupation.

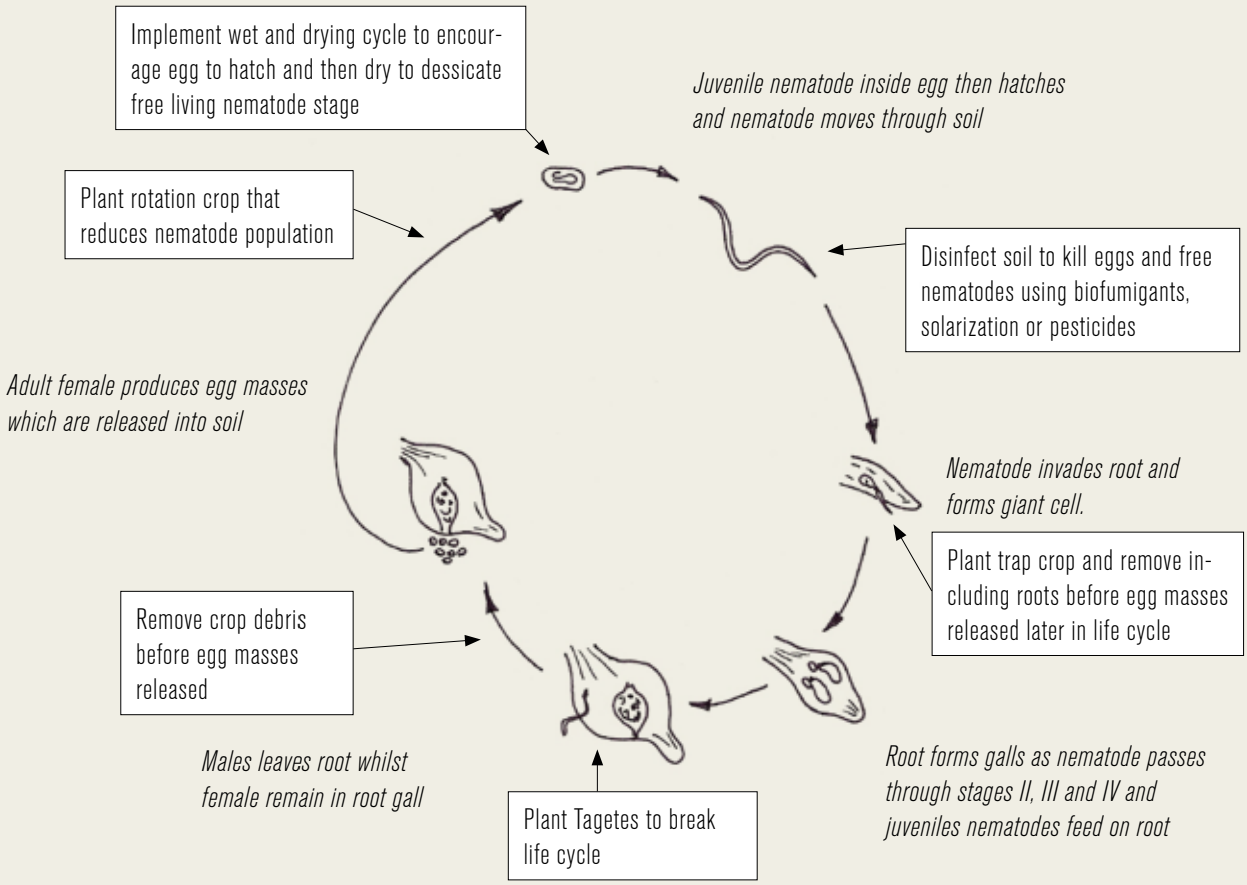
| Rhizome scale – *Aspidiella hartii* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Development stage of the pest | Action | Stades de la culture | | | | | | |
| | | Storage of rhizome | Choice of piece of land | Field preparation | Planting | From transplanting to harvest of rhizome | Postharvest | In the field after last harvesting |
| Eggs laid on rhizome | Avoid vicinity of host plants* | X | X | X | | X | | |
| Crawlers | Avoid crawlers moving to clean material | X | | | | | X | |
| | Dip rhizomes in contact insecticide spray to kill crawlers as only stage without waxy layer for protection | X | | | X | | X | |
| Scale larvae and adult female | Apply systemic insecticide to growing plant | | | | | X | | |
| Adults | Destroy badly infected rhizomes, avoid replanting in land affected by scale infected rhizomes | X | X | | X | | X | X |

X = action to be taken at the cultivation stage shown in the corresponding column

* Hosts include species of: Colocasia, Curcuma longa, Dioscorea, Ipomoea batatas and Zingiber

## ROOT KNOT NEMATODE

### Positioning of control methods in terms of the development stage of the pest




### Positioning of control methods in terms of the development cycle of the plant

**At field preparation**

- Select production site that has low population of nematodes.
- Plant rotation crop that will reduce nematode population.
- Undertake soil sterilization which includes biofumigation (using brassicas family plants that release isothiocyanates on breakdown of tissue), solarization or chemical pesticdes.
- Put soil through wetting (irrigation) and drying cycle (cultivation) that in turn promotes egg masses to germinate and then desiccates free living nematodes to reduce nematode pressure.
- Plant Tagetes to break life cycle.
- Plant trap crop and remove including roots before egg masses released later in life cycle.

**During sensible stage of the plant (see 1.3)**

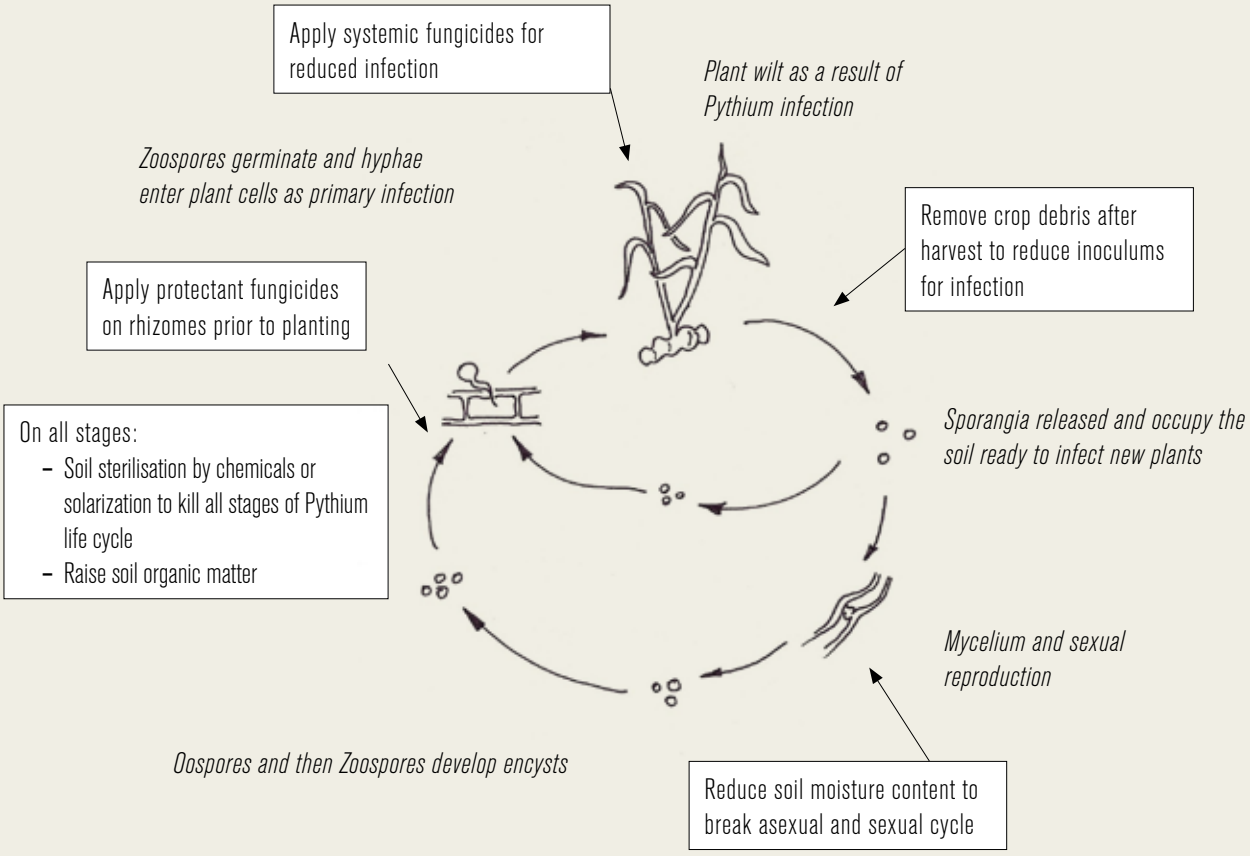
- Boost growth with added fertiliser (e.g. urea) to over come nematode effect on growth (this does not control nematodes but reduces impact on crop performance).

**After last harvesting**

- Remove crop debris (especially infected roots) and source of further source of egg mass release.

## *PYTHIUM* SPP.

### Positioning of control methods in terms of the development stage of the fungus




### Positioning of control methods in terms of the development cycle of the plant

**At field preparation**

- Avoid choosing a field with a history of *Pythium* infection.
- Consider sterilization by solarization or chemical application.
- Raise soil organic matter to increase microflora activity and natural competition for harmful soil pathogens

**At planting**

- If a wet site then plant on ridges to increase drainage.
- Dip rhizomes prior to planting in fungicide that will reduce *Pythium* development.

**During sensible stage of the plant (see 1.3.)**

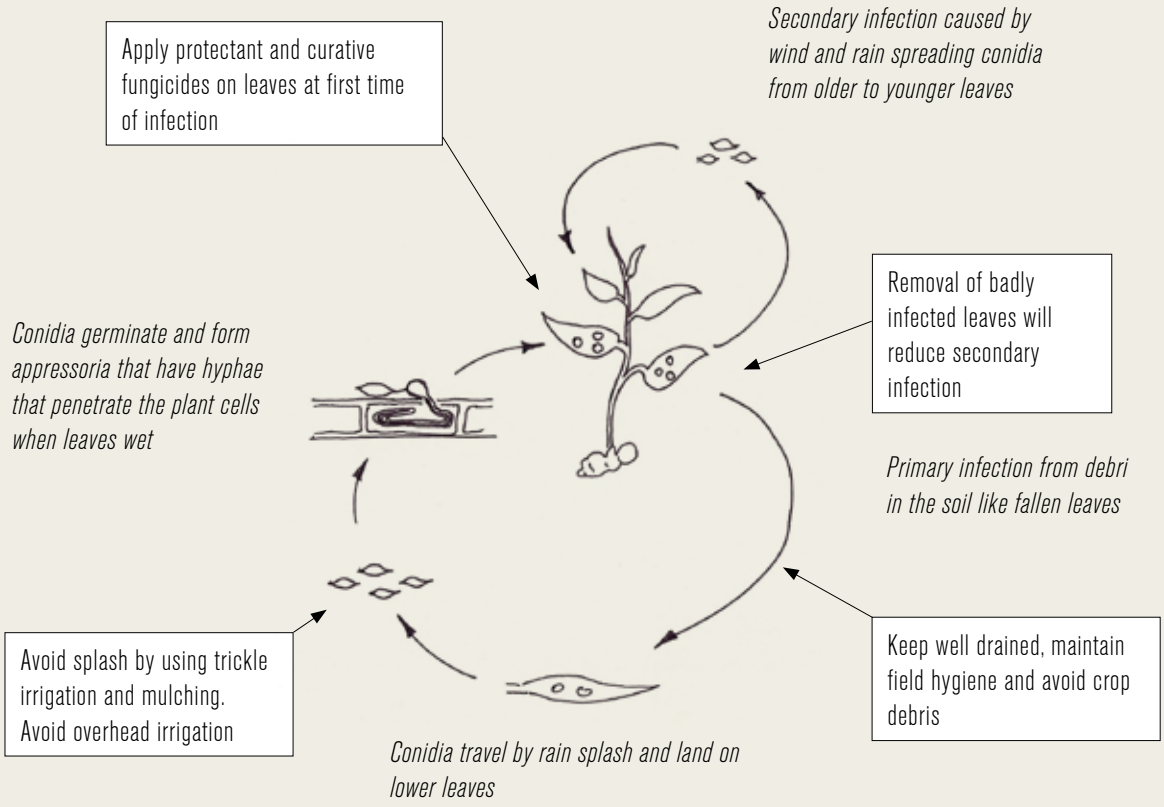
- Apply fungicides that work systemically where conditions are expected to encourage *Pythium*.
- Do not apply excessive irrigation.

**After last harvesting**

- Remove old crop as source of additional inoculum.

## ANTHRACNOSE - *Colletotrichum zingiberis*

### Positioning of control methods in term of the development stage of the fungus




### Positioning of control methods in terms of the development cycle of the plant

**Soil choice and preparation**

- Avoid splash by using trickle irrigation and mulching. Avoid overhead irrigation.
- Avoid crop debris.

**During sensible stage of the plant (see 1.3.)**

- Apply protectant and curative fungicides on leaves at first time of infection.
- Removal of badly infected leaves will reduce secondary infection.
- Keep well drained, maintain field hygiene and avoid crop debris.

**After last harvesting**

- Avoid crop debris.

| Leaf spot - *Phylllosticta zingiberi* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Development stage of the fungus | Action | Cultivation stages | | | | | | |
| | | Storage of rhizome | Choice of piece of land | Field preparation | Planting | From transplanting to harvest of rhizome | Postharvest | In the field after last harvesting |
| Germination<br>Development in the plant | Apply fungicide protectant or eradicant at first sign of infection | | | | | X | | |
| Spreading | Avoid vicinity of host plants | | X | X | | X | | |
| | Avoid secondary infection by hand removal and rouging badly infected plants | | | | | X | | |

X = action to be taken at the cultivation stage shown in the corresponding column

| Fusariosis – *Fusarium oxysporium* f.sp. *zingiberi* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Development stage of the pest | Action | Cultivation stages | | | | | | |
| | | Storage of rhizome | Choice of piece of land | Field preparation | Planting | From transplanting to harvest of rhizome | Postharvest | In the field after last harvesting |
| Germination | Dip rhizomes in contact fungicide spray to reduce infection, however will not totally eliminate problem as systemic disease | | | | X | | | |
| | Avoid areas with heavy nematode infestations | | X | | | | | |
| Development in the plant | Apply systemic fungicide to growing plant | | | | | X | X | |
| Conservation in the soil | Soil sterilization by solar, biofumigation | | | X | | | | |
| | Soil sterilization by fungicides | | | X | | | | |
| | Avoid replanting in land affected by Fusarium | | X | | | | | |
| | Crop rotation of at least 2-5 years between ginger | | X | | | | | X |
| Spreading | Avoid vicinity of host plants | | X | X | X | X | | |
| | Avoid planting infected material to reinfect clean rhizomes. Only take planting material from areas known to be free from disease | | | | X | | | |
| | When cutting up seed, discard any pieces showing shrivelling or brown discolouration and regularly dip the cutting knife in methylated sprits or a commercial disinfectant solution | | | | X | | | |

X = action to be taken at the cultivation stage shown in the corresponding column

| Bacterial wilt - *Ralstonia solanacearum*; Synonym: *Pseudomonas solanacearum* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Development stage of the pest | Action | Cultivation stages | | | | | | |
| | | Storage of rhizome | Choice of piece of land | Field preparation | Planting | From transplanting to harvest of rhizome | Postharvest | In the field after last harvesting |
| Entry into the plant | Dip rhizomes in bactericide to reduce infection levels, however systemic disease so only likely to be partially effective | | | | X | | | |
| Development in the plant | No effective control measure once infected crop in field | | | | | | | |
| Conservation in the soil | Only take planting material from areas known to be free of this disease | | | | X | | | |
| | All crop residues where the disease is known to occur should be destroyed, by burning if possible | | | X | | | | X |
| | Soil sterilization by solar, biofumigation | | | X | | | | |
| | Soil sterilization by bactericides | | | X | | | | |
| Spreading | Infested areas should not be replanted with ginger, but planted with a perennial grass and fenced off to stop animals and people walking through and spreading the disease | | X | | | | | X |
| | Avoid vicinity of host plants | | X | X | X | X | | |
| | Implements and boots should be washed down with a commercial agricultural disinfectant | | | X | X | X | | |
| | Avoid using infected material to plant next to clean material or in clean land | | | | X | | | |

X = action to be taken at the cultivation stage shown in the corresponding column

## Viral diseases of ginger

### Main control methods

- Avoid vicinity of host plants.
- Avoid using infected material to plant next to clean material or in clean land.
- Identify clean rhizome material that might require certified or material from tissue culture origin.

## 2.3. Resistant or tolerant varieties

There are no resistant reports of ginger varieties currently commercially available.

## 2.4. Importance and use of auxiliaries

There are no auxiliaries currently reported to be commercially available the pests of ginger, however this does not exclude naturally occurring predators and parasites of the various pests as these are widely report for caterpillar pests, and scale insects.

There are numerous registered products that contain Trichoderma spp that are used against root based diseases including *Pythium* and *Fusarium*. These should be used by dipping the rhizomes prior to planting and drenching young plants in the early stages of growth to build up the levels of Trichoderma in the rhizosphere.

*Pochonia chlamydosporia*, a nematode biocontrol agent can be incorporated in ginger beds at the time of sowing.

# 3. Monitoring the phytosanitary state of the crop and intervention thresholds

## Guidelines on completion of the weekly summary sheets

On a weekly basis, transfer the average figures per STATION from the scouting forms to this weekly summary. Check that the TIME OF DAY the scouting took place each week was the SAME (within half an hour) for all previous scout reports. Indicate time of day scouted in the column provided (a block should always be scouted at the same time of day). It is important to remember that these are figures per station i.e. from two whole plants (one on either side of the path) . A build up of pest levels is expected and is only a risk if the ratio of beneficial to pest is not increasing, or the % parasitism is not increasing. Graphs of weekly changes in ratios and average number of pest per station can be made manually to plot progress. Enter all sprays and beneficials applied to the crop on a weekly basis (so that up to date information is available on the weekly crop walk).

The weekly summary sheet should be used DURING THE WEEKLY CROP WALK to make decisions about risk and progress of IPM. The effect of sprays on beneficials as well as pest will be clear from changes in ratios or average per leaf. Keep records of observations of pesticide sensitivities observed and share this information with other managers.

The block should be scouted once per week, at the same time of day throughout its life - for accurate comparison of pest levels. If more than one spray is considered necessary per week – a second scout record should be produced to justify the second spray.

Stop at ten stations and examine a plant on either side of the bed (pests numbers can be higher on sunny side of rows) = 2 plants per station. Always scout in the stations in the same order so that comparisons can be made each week if hot spots are identified (eg the number recorded at station 1 each week can be compared to the number recorded at station 1 the next week.

*Indicative thresholds proposed :*

| | |
|---|---|
| **Shoot borer** | Calculate percentage plants present and treat when above 1 % |
| **Rhizome scale in field,** | Calculate percentage plants present and treat when above 1 % |
| **Rhizome scale in storage** | Remove any seen. |
| **Root Knot nematode** | Lift plants when suspected and record for action after harvest |
| ***Pythium* spp.** | Lift plants, inspect for infection, remove infected plants and drench area when two or more plants infected. |
| **Yellows** | Lift plants, inspect for stem discolouration, remove infected plants and drench area when two or more plants infected. |
| **Leaf spot (*Phyllosticta* spp.)** | Protectant/Erradicant spray when first seen |
| **Leaf Spot (*Colletotrichum* spp.)** | Protectant/Erradicant spray when first seen |
| **Bacterial wilt** | Remove infected plants when first seen. |
| **Mosaic virus** | Remove infected plants when first seen |

Any hotspots of pests or disease should be identified.
THEN, bring this to the attention of the Farm Manager for possible spot treatment.
Always scout the numbered stations in the same order – so they can be compared each week.

Farm :

Block :

Crop age (wks) :

Date scouted :

Scout name (PRINT) :

TIME of DAY Scouted :

| | Pests | | | | | | | | | | Diseases | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Shoot borer | Rhizome scale | RKN | | | | | | | | Station | *Pythium* | Yellows | Leaf spot (*Phyllosticla* spp) | Leaf spot (*Colletotrichum* spp) | Bacterial wilt | Mosaic virus | | | | | | |
| 1 | | | | | | | | | | | 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | 10 | | | | | | | | | | | | |
| total | | | | | | | | | | | total | | | | | | | | | | | | |
| av.per station | | | | | | | | | | | av.no. diseased leaves / plant | | | | | | | | | | | | |
| Percent | | | | | | | | | | | | | | | | | | | | | | | |

**Other observations:** (distribution of problem, other symptoms or problems, waterlogging, drip lines blocked, etc)

# 4. Active substances and treatment recommendations

## Introduction

For each pest or disease, proposals of the strategy for the use of Plant Protection Products (PPP) are indicated below.
A list of active substances is suggested for each pest or disease. When available, the critical GAP which allows compliance with European MRLs currently in force on rhizome of ginger, or others stem vegetables for shoots of ginger, is also shown. Any change in one or more elements of these GAPs (increase in the doses, frequency of application and number of applications, last application before harvest not respecting the recommended pre-harvest interval) can result in residues in excess of the MRL in force. At this stage, however, it is worth noting that no tests have been carried out in ACP production environments to check compliance of MRLs with the GAPs indicated. These GAPs does not represent a treatment calendar to be applied as such. In practice, the frequency of treatments must take account locally of the severity of attacks and the real risks of damage
The list of active substances proposed has been drawn up taking into account the products used worldwide. The active substances are classified by resistance risk group (classification and codes of FRAC - Fungicide Resistance Action Committee - http://www.frac.info/frac/index.htm and IRAC - Insecticide Resistance Action Committee - http://www.irac-online.org/). In practice, it is important to alternate active substances belonging to different groups.
The most appropriate development stages of the crop (green boxes) for the application of each active substance are also suggested, taking into account the pre-harvest interval to be respected so as to comply with MRLs, the modes of action of the active substances and the effects on natural enemies.

Regarding plant protection products allowed for usage by the EU regulation 2092/91 on organic agriculture, prior to any usage the producer should check with his/her certification body that such usage is allowed.

*There are no fixed MRL for ginger so we cannot give information on GAPs and we have no data on residues decline in order to define PHI for residues below the LOQ.*

| Shoot borer (all caterpillar species) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Strategy:** Apply insecticides at the first sign of damage or entry hole from larvae. Control is entirely concentrated on controlling the larvae stage of the life cycle. Ensure good leaf cover for contact insecticides. | | | | | | | | | | |
| Active substance | Recommended GAP* | | | | | Proposed application period | | | | |
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to 6 weeks after emergence | From 6 weeks after emergence to harvest of shoots | From emergence to harvest of rhizome |
| **Group 18 – Ecdysone aganists/moulting disruptors** | | | | | | | | | | |
| azadirachtin | 15 – 60** | Repeat as required | Repeat as required | 2 | 2 | | | | | |
| indoxacarbe | 250 | 3 | 10 | / | 3 | | | | | |
| **Group 3 – Pyrethroids (sodium channel modulators)** | | | | | | | | | | |
| beta-cyfluthrin | 25 | / | / | / | 7 | | | | | |
| cypermethrin | 50 | / | / | / | 7 | | | | | |
| deltamethrin | 12,5 | 3 | 7 | / | 2 | | | | | |
| lambda-cyhalothrin | 25 | 2 | 7 | / | 7 | | | | | |
| **Group 5 – Spynosines** | | | | | | | | | | |
| spinosad | 96 | 4 | 10 | / | 3 | | | | | |
| **Group 11 – Microbial disruptors of insect midgut membranes** | | | | | | | | | | |
| *Bacillus thuringiensis var kurstaki* | / | Repeat as required | 7 | 2 | 2 | | | | | |
| **Group 1 – Organohosphates and carbamates** | | | | | | | | | | |
| malathion | / | / | 14 | / | / | | | | | |
| mehomyl | 450 | / | 7 | / | / | | | | | |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

/ elements of the recommended GAP not available

** or neem oil at 0.5%

**Rhizome scale – *Aspidiella hartii***

**Strategy:** Scale concentrated on rhizome and lower stems. Drench rhizomes where scale seen prior to planting and in store. Do not drench rhizomes that will be sold as fresh ginger. Apply to stems as foliar application as either contact for control of crawlers or as systemic control of scales feeding on the sap of the plant.

**We have no data available on the GAP for active substances that could be used to control this pest**

It is reported that storage in saw dust + dried leaves of Strychnos nux-vomica (Poison Nut) prevents infestation of rhizome scale. This plant is highly toxic for human and should be used only on rhizome for seeds.

| Active substance | Recommended GAP* | | | | | Proposed application period | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to harvest of rhizome | Post harvest for seeds |
| **Group 1 – Organohosphates and carbamates** | | | | | | | | | |
| dimethoate | / | / | / | / | / | | | | |
| **Group 4 – Nicotinic Acethylcholine receptor agonists/antagonists** | | | | | | | | | |
| acetamiprid | / | / | / | / | / | | | | |
| imidacloprid | / | / | / | / | / | | | | |
| thiametoxam | / | / | / | / | / | | | | |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

/ elements of the recommended GAP not available

| Root Knot Nematode – *Meloidogyne* spp. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Strategy:** Treat with nematicides where permitted by local regulations. Application is done at planting. | | | | | | | | |
| Active substance | Recommended GAP* | | | | | Proposed application period | | |
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to harvest of rhizome |
| Group 18 – Ecdysone aganists / moulting disruptors | | | | | | | | |
| azadirachtin | 150 | / | / | / | / | | | |
| Group 1 – Organophosphates and carbamates | | | | | | | | |
| fenamiphos | 720 | 1 | / | / | / | | | |
| oxamyl | 500 | 1 | / | / | / | | | |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

/ elements of the recommended GAP not available

| Damping off – *Pythium* spp. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Strategy:** Rhizome treatment may help combat these diseases. Once the disease is located in the field, removal of affected clumps and drenching the affected and surrounding beds. Application of Trichoderma harzianum along with neem cake helps in preventing the disease. | | | | | | | | | |
| Active substance | Recommended GAP* | | | | | Proposed application period | | | |
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to harvest of rhizome | Post harvest for seeds |
| **Group M - Multisite activity** | | | | | | | | | |
| mancozeb | mixture at 0.3 % | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 30 minutes | | | Dip rhizome for 30 minutes |
| | mixture at 0.3 % | 1 | n.a. | n.a. | n.a. | | | Drenching of beds | |
| | 1.36 g/ litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Dip rhizome for 15 to 20 minutes |
| **Group 1 - MBC fungicides** | | | | | | | | | |
| thiophanate-methyl | 0.5 g/litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Dip rhizome for 15 to 20 minutes |
| **Group 4 - PhenylAmide fungicides** | | | | | | | | | |
| metalaxyl-M | 0.08 g/ litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Immersion des rhizomes pendant 15 à 20 minutes |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

** as a mixture of 3 different active substances

/ : elements of the recommended GAP not available

n.a. : not applicable

| Anthracnose and leaf spot - *Collectotrichum zingiberis* and *Phylllosticta zingiberi* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Strategy:** In the field apply fungicides at the first sign of infection. Repeat as necessary by rotating fungicide groups. | | | | | | | | | | |
| Active substance | BPA conseillée* | | | | | Proposed application period | | | | |
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to 6 weeks after emergence | From 6 weeks after emergence to harvest of shoots | From emergence to harvest of rhizome |
| **Group 11 - QoI fungicides** | | | | | | | | | | |
| azoxystrobin | 250 | / | / | / | / | | | | | |
| **Group M – Multisite activity** | | | | | | | | | | |
| mancozeb | 1600 | / | 7 | / | 30 | | | | | |
| copper | 2000 | / | 7 | / | / | | | | | |
| **Group 2 - Dicarboximides** | | | | | | | | | | |
| iprodione | 1000 | / | 7 | / | 21 | | | | | |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

/ elements of the recommended GAP not available

| Fusariosis – *Fusarium oxysporium* f.sp. *zingiberi* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Strategy:** Rhizome treatment may help combat this disease. | | | | | | | | | |
| Active substance | Recommended GAP* | | | | | Proposed application period | | | |
| | Dose g/ha | Maximum number applications | Minimum interval between applications (days) | Pre-harvest interval (days) for shoots production | Pre-harvest interval (days) for rhizome production | Before planting | At planting | From emergence to harvest of rhizome | Post harvest for seeds |
| **Group M - Multisite activity** | | | | | | | | | |
| mancozeb | mixture at 0.3 % | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 30 minutes | | | Group M: Multisite activity |
| | 1.36 g/ litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Dip rhizome for 30 minutes |
| **Group 1 - MBC fungicides** | | | | | | | | | |
| thiophanate-methyl | 0.5 g/litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Dip rhizome for 15 to 20 minutes |
| **Group 4 - PhenylAmide fungicides** | | | | | | | | | |
| metalaxyl-M | 0.08 g/ litre of water** | n.a. | n.a. | n.a. | n.a. | Dip rhizome for 15 to 20 minutes | | | Dip rhizome for 15 to 20 minutes |

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL (see part 6 of this guide).

/ : elements of the recommended GAP not available

n.a. : not applicable

| Bacterial wilt - *Ralstonia solanacearum*; synonym: *Pseudomonas solanacearum* |
|---|
| **Strategy:** The seed rhizomes may be treated with Streptocycline 200 ppm for 30 minutes and shade dried before planting. Once the disease is noticed in the field all beds should be drenched with Bordeaux mixture 1% or copper oxychloride 0.2%. |

# 5. Existing registrations

There are no registration on ginger in ACP countries.

# 6. European regulations and pesticide residues

**Status of the active substances in Regulation 1107/2009 and European MRLs in February 2012.**

**Caution:** The information contained in this table is subject to change by future directives of the Commission of the European Communities.

| MRLs for ginger rhizome and shoots of ginger | | | |
|---|---|---|---|
| Active substance | Status in Reg. 1107/2009 | European MRL | |
| | | Ginger rhizome | Others stem vegetables (for shoots of ginger) |
| Acetamiprid | Approved * | 0,1 | 0,01 |
| Azadiractin | Approved | 0,01 | 1 |
| Azoxystrobine | Approved | 0,1 | 0,05 |
| Bacillus thuringiensis | Approved | n.a. | n.a. |
| Beta-cyfluthrin | Approved | 0,1 | 0,02 |
| Copper | Approved | 40 | 20 |
| Cypermethrin | Approved | 0,2 | 0,05 |
| Deltamethrin | Approved | 0,05 | 0,05 |
| Dimethoate | Approved | 0,1 | 0,02 |
| Fenamiphos | Approved | 0,05 | 0,02 |
| Imidacloprid | Approved | 0,05 | 0,05 |
| Indoxacarbe | Approved | 0,05 | 0,02 |
| Iprodione | Approved | 0,1 | 0,02 |
| Lambda - cyhalothrin | Approved | 0,05 | 0,02 |
| Malathion | Approved | 0,02 | 0,02 |
| Mancozeb | Approved | 0,1 | 0,05 |
| Metalaxyl - M | Approved | 0,1 | 0,05 |
| Methomyl | Approved | 0,1 | 0.02 |
| Oxamyl | Approved | 0,02 | 0,01 |
| Spinosad | Approved | 0.02 | 0,2 |

| MRLs for ginger rhizome and shoots of ginger | | | |
|---|---|---|---|
| Active substance | Status in Reg. 1107/2009 | European MRL | |
| | | Ginger rhizome | Others stem vegetables (for shoots of ginger) |
| Thiametoxam | Approved | 0.05 | 0.05 |
| Thiophanate-methyl | Approved | 0.1 | 0.1 |

* Approved means that the active substance is listed in the positive list of the Regulation for inclusion.
** Withdrawn means not listed in the positive list of active substances in the Regulation.
n.a. non applicable

## Note on the status of active substances in EU

Before a Plant Protection Product can be marketed in EU, its active substance must be approved by the European Commission. Regulation (EC) 1107/2009 (replacing former "Directive 91/414/EEC") came into force on 14th June 2011. By 25th May 2011 the Commission adopted the Implementing Regulation (EU) N° 540/2011 as regards the list of approved active substances. These Regulations and all other related Regulations can be accessed using the search facility on the following: http://ec.europa.eu/food/plant/protection/evaluation/index_en.htm

It should be noted that if an active substance is not registered in the EU it can still be used in the ACP countries in food items exported to Europe, provided the residue complies with the EU MRL.

## Note on MRLs:

The quantities of pesticide residues found in food must be safe for consumers and remain as low as possible.
The maximum residue limit (MRL) is the maximum concentration of pesticide residue legally permitted in or on food or feed.

### MRLs in the EU

Pursuant to Regulation (EC) No 396/2005 harmonized Community MRLs have been established.

The European Commission (EC) sets MRLs applying to foodstuffs marketed in the territories of the EU countries, either produced in the EU or in third countries.

Annex I to the Regulation contains the list of crops (Regulation (EC) 178/2006) on which MRLs are assigned, Annexes II and III contain the MRLs: temporary MRLs can be found in Annex III, final MRLs in Annex II. Substances for which an MRL is not required are listed in Annex IV (Regulation (EC) 149/2008). When there is no specific MRL for a substance / crop a default MRL, usually set at 0.01 mg/kg, is applied.

When establishing an MRL, the EU takes into account the Codex MRL if it is set for the same agricultural practices and it passes the dietary risk assessment. Where appropriate Codex MRLs exist, the import tolerance will be set at this level.

EU harmonized MRLs came into force on 1 September 2008 and are published in the MRL database on the website of the Commission
http://ec.europa.eu/sanco_pesticides/public/index.cfm

See also the leaflet "New rules on pesticide residues in food"
http://ec.europa.eu/food/plant/protection/pesticides/explanation_pesticide_residues.pdf

## How are MRLs applied and monitored in EU?

– Operators, traders and importers are responsible for food safety, and therefore for compliance with MRLs.
– The Member State authorities are responsible for monitoring and enforcement of MRLs.
– To ensure the effective and uniform application of these limits, the Commission has established a multiannual Community monitoring program, defining for each Member State the main combinations of crops and pesticides to be monitored and the minimum number of samples to be taken. Member States must report results to the Commission, which published an annual report. At present the reports are published by the European Food Safety Authority (EFSA) http://www.efsa.europa.eu/en/scdocs.htm
– In case of detection of pesticide residue levels posing a risk to consumers, information is transmitted through the Rapid Alert System for Food and Feed (RASFF) and appropriate measures are taken to protect the consumer. The database is accessible on http://ec.europa.eu/food/food/rapidalert/rasff_portal_database_en.htm and RASFF publishes an annual report http://ec.europa.eu/food/food/rapidalert/index_en.htm.
– PIP monthly updates on its website a summary of RASFF notification for fruit and vegetable imports from ACP countries.

## MRLs in ACP countries

ACP countries don't have set their own MRLs therefore they usually admit Codex LMRs for foodstuffs marketed in their country.
The Codex Alimentarius Commission was established in 1961 by the Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) with the objective to develop an international food code and food standards. Membership of the Codex Alimentarius Commission is open to all Member Nations and Associate Members of FAO and WHO. More than 180 countries and the European Community are members of the Codex Alimentarius Commission.

The Joint FAO/WHO Meetings on Pesticide Residues (JMPR) is not officially part of the Codex Alimentarius Commission structure, but provide independent scientific expert advice to the Commission and its specialist Committee on Pesticide Residues for the establishment of Codex Maximum Residue Limits, Codex MRLs for pesticides which are recognized by most of the member countries and widely used, especially by countries that have no own system for evaluating and setting MRLs.

The Codex MRL database can be found on the web site: http://www.codexalimentarius.net/pestres/data/index.html?lang=en.

# Annexes

## References and useful documents

Ravindran, P. N.; K. Nirmal Babu, K. (2004). Ginger: The genus Zingiber. Published by CRC Press, ISBN 0415324688, 9780415324687, 552 pages
Anon. (2001). Crop Protection Compendium. CAB international, Wallingford, UK
Malais, M.H. and Ravensberg, W. J. (2003). Knowing and Recognising. Koppert biological control systems. Reed Business information, The Netherlands.
Ginger: Product Profile No. 11 – Uganda Export Promotion Board

## Useful websites

Shoot borer
http://thailand.ipm-info.org/pests/Durian_fruit_borer.htm

Soil borne pathogens
http://www.cals.ncsu.edu/course/pp728/Pythium/Pythium_aphanidermatum.html
http://www.rbgsyd.nsw.gov.au/science/hot_science_topics/Soilborne_plant_diseases/Vietnam_template3/Pythium

Pest and diseases of ginger
http://www.extento.hawaii.edu/Kbase/Crop/crops/gin_root.htm
http://www.intercooperation.org.in/images/icindia/Ginger%20pests%20&%20diseases%20(ISPS).pdf
http://www.uom.ac.mu/Faculties/foa/AIS/SIROI/SIROIWEBUK/Maurice/Areu/vegguide/ginge.htm
http://portal.areu.mu/modules.php?name=News&file=article&sid=191

Bacterial wilt
http://www.cipotato.org/potato/pests_diseases/bacterial_wilt/bw_research.asp

## CROP PRODUCTION PROTOCOLS

Avocado (*Persea americana*)
French bean (*Phaseolus vulgaris*)
Okra (*Abelmoschus esculentus*)
Passion fruit (*Passiflora edulis*)
Pineapple Cayenne (*Ananas comosus*)
Pineapple MD2 (*Ananas comosus*)
Mango (*Mangifera indica*)
Papaya (*Carica papaya*)
Pea (*Pisum sativum*)
Cherry tomato (*Lycopersicon esculentum*)

## GUIDES TO GOOD PLANT PROTECTION PRACTICES

Amaranth (*Amaranthus* spp.)
Baby carrot (*Daucus carota*)
Baby and sweet corn (*Zea mayis*)
Baby Leek (*Allium porrum*)
Baby pak choy (*Brassica campestris* var. *chinensis*), baby cauliflower (*Brassica oleracea* var. *botrytis*), baby broccoli and sprouting broccoli (*Brassica oleracea* var. *italica*) *and head cabbages* (*Brassica oleracea var. capitata* and *var. sabauda*)
Banana (*Musa* spp. – plantain (*matoke*), apple banana, red banana, baby banana and other ethnics bananas)
Cassava (*Manihot esculenta*)
Chillies (*Capsicum frutescens, Capsicum annuum, Capsicum chinense*) and sweet peppers (*Capsicum annuum*)
Citrus (*Citrus* sp.)
Coconut (*Cocus nucifera*)
Cucumber (*Cucumis sativus*), zucchini and pattypan (*Cucurbita pepo*) and other cucurbitaceae with edible peel of the genus *Momordica, Benincasa, Luffa, Lagenaria, Trichosanthes, Sechium* and *Coccinia*
Dasheen (*Colocasia esculenta*) and macabo (*Xanthosoma sagittifolium*)
Eggplants (*Solanum melongena*, *Solanum aethiopicum*, *Solanum macrocarpon)*
Garlic, onions, shallots (*Allium sativum, Allium cepa, Allium ascalonicum*)
Ginger (*Zingiber officinale*)
Guava (*Psidium catteyanum*)
Lettuce *(Lactuca sativa*), spinach (*Spinacia oleracea* and *Basella alba*), leafy brassica (*Brassica* spp.)
Lychee (*Litchi chinensis*)
Melon (*Cucumis melo*)
Organic Avocado (*Persea americana*)
Organic Mango (*Mangifera indica*)
Organic Papaya (*Carica papaya*)
Organic Pineapple (*Ananas comosus*)
Potato (*Solanum tuberosum*)
Sweet potato (*Ipomea batatas*)
Tamarillo (*Solanum betaceum*)
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)

PIP
FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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