

# PIP



## GUIDE TO GOOD CROP PROTECTION PRACTICES FOR BABY LEEK (*ALLIUM PORRUM*)

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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](http://www.coleacp.org/pip)



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FOR SUSTAINABLE DEVELOPMENT OF  
THE ACP HORTICULTURAL INDUSTRY

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**Note**

The Guide to Good Plant Protection Practices details all plant protection practices regarding the production of the fruit or vegetables in question and recommends primarily the active substances supported by pesticides manufacturers in the framework of the EU Regulation 1107/2009, which must comply with standards for pesticide residues. Some of these active substances have been tested through a field trials programme and the residue level of each active substance has been measured. The information given on the active substances suggested is however changeable and will be adapted on an ongoing basis in accordance with the new information collected by PIP.

It is, of course, understood that only those products legally registered in their country of application are authorised for use. Growers must therefore check with the local regulatory authorities to see whether the product they wish to use is included on the list of registered products.

The PIP's crop protocols and guides to good phytosanitary practices are regularly updated. For further information, see the PIP website  
[www.coleacp.org/PIP](http://www.coleacp.org/PIP)



# Table of contents

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<b>1. MAIN PESTS AND DISEASES</b> .....	<b>6</b>
1.1. Extent and impact on the quantity and quality of produce .....	6
1.2. Identification and damage .....	8
1.3. Appearance of pests and diseases in terms of the phenological stage of the plant .....	11
1.4. Extent according to country/time of year and climate conditions favourable to crop enemies .....	12
<b>2. MAIN CONTROL METHODS</b> .....	<b>15</b>
2.1. Introduction .....	15
2.2. Pest or disease cycle; positioning of control methods and factors influencing the development of the cycle .....	15
2.3. Resistant or tolerant varieties .....	26
2.4. Importance and use of natural enemies .....	26
<b>3. MONITORING THE PHYTOSANITARY STATE OF THE CROP AND INTERVENTION THRESHOLDS</b> .....	<b>27</b>
<b>4. PLANT PROTECTION PRODUCTS AND TREATMENT RECOMMENDATIONS</b> .....	<b>28</b>
<b>5. EXISTING REGISTRATIONS IN ACP COUNTRIES</b> .....	<b>39</b>
<b>6. REGULATIONS AND PESTICIDE RESIDUES</b> .....	<b>40</b>
<b>REFERENCES, WEBSITES AND USEFUL DOCUMENTS</b> .....	<b>44</b>

# 1. Main pests and diseases

## 1.1. Extent and impact on the quantity and quality of produce

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 extent 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 produce 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, lower quality product.

INSECTS				
Extent	Organs attacked		Types of loss	
	Leaves	Roots	Number of plants	Quality
<b>Thrips - <i>Thrips tabaci</i></b> Vector of Iris yellow spot virus (IYSV) and Tomato spotted wilt virus (TSWV), the latter has recently been discovered on leeks.				
+++	Eaten by nymphs and adults			Significant losses are incurred due to cosmetic damage. If infestation is severe and starts early there is significant adverse effects on growth.
<b>Leek moth - <i>Acrolepiopsis assectella</i></b>				
+	Larvae feed in leaf folds		Significant damage to plants on borders of fields, sometimes 40% loss. Plant loss also results from secondary infections cause rots.	Laceration and distortion of leaves have a significant impact on quality.
<b>Leafminer - <i>Liriomyza cepae</i>, <i>Phytomyza (Napomyza) gymnostoma</i></b>				
++	Eaten by larvae in mines		Few larvae can kill a plant, large areas of missing plants are observed when crop is young. Older plants can tolerate higher populations.	Leaves become soft and susceptible to diseases.

FUNGI				
Extent	Organs attacked		Types of loss	
	Leaves and stern	Roots	Number of plants	Quality
<b>Pink root rot - <i>Pyrenochaeta terrestris</i> (<i>Phoma terrestris</i>)</b>				
+		This soil borne fungus enters behind the root tip spreading upwards in the main body of the root.	Rotting results in total plant collapse early in the growing cycle, but most commonly occurs on roots of nearly mature plants.	
<b>Fusarium foot rot - <i>Fusarium</i> sp.</b>				
++		This soil borne fungus enters through the roots.	Can cause significant crop loss. Usually observed on scattered plants or in localised areas throughout a field.	
<b>Purple Blotch - <i>Alternaria porri</i></b>				
+++	The mycelium develop initially on old leaves.		Severe infection can lead to plant death.	Infection leads to cosmetic damage.
<b>Leaf Blight - <i>Stemphylium</i> spp.</b>				
+	The mycelium develop initially on old leaves		Rarely causes significant crop loss.	Infection leads to cosmetic damage.
<b>Rust - <i>Puccinia porri</i></b>				
+++	The mycelium develop on leaves.		Severe infection can lead to plant death.	Presence of pustules resulting in cosmetic damage.
<b>White tip disease - <i>Phytophthora porri</i></b>				
++	Mycelium extend through the leaves and stem.		Plants die if severely infected.	
<b>Downy mildew - <i>Peronospora destructor</i></b>				
+++	Mycelium develops within the leaf.			Presence on foliages leads to severe losses due to poor quality.
BACTERIA				
Extent	Organs attacked		Types of loss	
	leaves and stern	Roots	Number of plants	Quality
<b>Bacterial blight - <i>Pseudomonas syringae</i> pv. <i>porri</i></b>				
++	Bacteria enter and develop in leaves.		Disease is seedborne severely affecting leek seedlings.	

## 1.2. Identification and damage

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

### INSECTS

#### Thrips - *Thrips tabaci*

Nymphs and adults feed in colonies on the entire leaf surface. Silvery marks with black spots (frass) are observed where thrips are feeding.



Nymphs and damage

#### Leek Moth – *Acrolepiopsis assectella*

The moth eggs are laid over the surface of the leaf and are dirty white in colour.

The larvae are yellowish-green, with 8 small greyish spots on each segment, and a pale brown head capsule. The larvae feed on leaves creating transparent areas (windows). Holes form in the leaves as these areas degrade.

Reddish brown pupa encased in a loosely netted cocoon is found on the leaves and decaying plant matter.

The adult is a small (12 -15 mm wingspan) reddish-brown moth with a white triangular mark on the middle of the folded wings and with a scattered dusting of white. The hindwings are heavily fringed and pale to dark grey.



Cocoon



Larva



Adult



Damage

#### Allium leafminers – *Liriomyza cepae*, *Phytomyza (Napomyza) gymnostoma*

The insect adult lays an egg within plant tissue, usually at the base of the leaf blade. Within a few days, the insect's small dirty grey larva burrows in the leaves. The mines meander irregularly forming white tracks under the leaf surface.

The larva ultimately leaves the leaf to pupate in the soil (*L. cepae*) or pupates at the end of their galleries (*P. gymnostoma*).

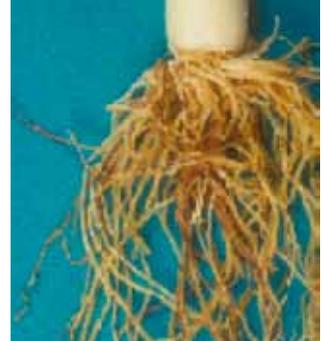


Damage

## FUNGI

### Pink root rot – *Pyrenochaeta terrestris* (*Phoma terrestris*)

Infection is initiated by roots making contact with dormant spores in the soil or on plant debris. Plants become stunted and look as if they are suffering from lack of water or nutrient deficiency. Roots of the infected plants become light pink in colour. As the disease develops the intensity of the colour increases to deep purple. Roots shrivel up and die.



Pink roots

### Fusarium foot rot – *Fusarium* sp.

The fungus commonly causes damping off symptoms of seedlings. Germinating seeds may rot and be covered with mold, or seedlings rot and die before emergence. Root are pink in colour finally turning black as they disintegrate.



Symptoms

### Purple Blotch – *Alternaria porri*

Small, watery lesions with a white centre and light yellow border can be seen on the leaves. As the flecks grow larger, brownish/purple concentric rings are formed. In moist weather, the surface of the lesion may be covered with brown fruiting structures. These rings are only obvious when there is a big difference between day and night temperatures. The first symptoms appear 4 days after infection. In severe cases the tops of the leaves dieback. As the leaves mature the severity of the disease can increase.



Dieback of the top of a leaf



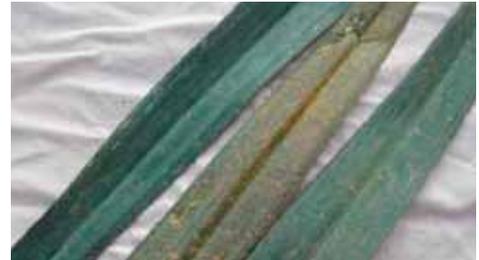
Symptoms

**Leaf blight – *Stemphylium* spp.**

The symptoms are similar to that of *Alternaria porri*. The lesions usually occur on the side of the leaf facing the prevailing wind and are small, light yellow to brown water soaked lesion and are confined to the leaves. These lesions develop into elongated spots often reach the leaf tip. Lesions usually turn light brown at the centre and later darker.

**Rust – *Puccinia porri***

The initial symptom is small, white flecks on the leaves and stems which develop into orange elongated pustules along the length of the leaf. Heavy infection results in the leaf turning yellow and dies.



Pustules on leaves

**White tip – *Phytophthora porri***

The tips of the leaves to turn yellow and dieback finally turning white. The bleached effect may extend 10cm from the tip and the discoloured part may either collapse and decay or become crisp and curled. Infected leaves may look watery, thin papery, and eventually rot away. All stages of leeks may be attacked, leaving the leek stunted in younger plants.



Symptoms



Tips dieback

**Downy Mildew - *Peronospora destructor***

Early symptoms are bleaching of leaf tips and small, irregular shaped, chlorotic lesions on leaves. As the disease develops the lesion reach up to 10 – 15cm long. Purple/grey sporulation grows on the affected lesion. Lesions may girdle the leaf causing it to collapse.



Grey/brown sporulation

**BACTERIA**

**Bacterial blight – *Pseudomonas syringae* pv. *porri***

Initial symptoms appear as water soaked lesions at the tips of leaves, which expand down the length of the leaf. These lesions develop into brown elongated stripe like lesions with yellow margins that later split and rot. The leaves become curled and twisted as growth continues.



Curled and twisted 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. The purpose is to show that the presence of a pest, disease or pathogenic agent is not always harmful to the crop. It is especially during the latter stages that they must be monitored and controlled if necessary

Stage	Length of stage	Thrips – <i>Thrips tabaci</i>	Leek moth – <i>Acrolepiopsis assectella</i>	Leafminers – <i>L. cepae</i> , <i>P. gymnostoma</i>	Pink root rot – <i>Pyrenochaeta terrestris</i> ( <i>Phoma terrestris</i> )	Fusarium foot rot – <i>Fusarium</i> sp.	Purple blotch – <i>Alternaria porri</i>	Leaf blight – <i>Stemphylium</i> spp.	Rust – <i>Puccinia porri</i>	White tip – <i>Phytophthora porri</i>	Downy mildew – <i>Peronospora destructor</i>	Bacterial blight – <i>Pseudomonas syringae</i>
Seeds						■						■
From sowing to emergence	10 days				■	■						■
From emergence to transplanting	7 – 8 weeks	■	■	■	■	■	■	■	■	■	■	■
From transplanting to first harvest	8 – 10 weeks	■	■	■	■	■	■	■	■	■	■	■
Harvesting period	5 weeks	■	■	■	■	■	■	■	■	■	■	■

- Periods during which pests and pathogenic agents are 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 :

ZAM = Zambia, TAN = Tanzania, MAD = Madagascar, KEN = Kenya

0 = no damage

+ = limited damage

++ = average damage: control necessary

+++ = heavy damage: control essential

X = generally limited damage but evolution of damage level over the year is not known

XX = damage can be average, but evolution of damage level over the year is not known

XXX = damage can be heavy, but evolution of damage level over the year is 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.

##### Thrips – *Thrips tabaci*

**Favourable conditions:** Outbreaks occur during warm dry weather. Several generation occur in a season.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	+	+	+	+	++	++	++	+++	+++	+++	++	0
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	+++	++	+	0	0	0	0	0	0	0	0	++
MAD	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

##### Leek moth – *Acrolepiopsis assectella*

**Favourable conditions:** Moths prefer warm, dry conditions, optimal development occurs at 25°C. More than three generations a year can occur.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	0	0	0	0	0	0	0	0	0	0	0	0
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	++	+++	++	+	+	+	+	+	+	+	+	++
MAD	/	/	/	/	/	/	/	/	/	/	/	/

##### Allium leafminers – *Liriomyza cepae*, *Phytomyza (Napomyza) gymnostoma*

**Favourable conditions:** Optimal egg laying and development temperature 30°C. Eggs hatch within 4 – 7 days at 24°C. Several generations a year are possible under suitable temperatures.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	0	0	0	0	+	++	++	+	+	0	0	0
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	+++	++	+	0	0	0	0	0	0	0	0	++
MAD	0	0	0	0	0	0	0	0	0	0	0	0

**Fusarium foot rot – *Fusarium* sp.**

**Favourable conditions:** Temperatures of between 18 and 23°C and relatively high air humidity are favourable to the development of symptoms of the disease.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	0	0	0	0	0	0	0	0	0	0	0	0
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	0	0	0	0	0	0	0	0	0	0	0	0
MAD	/	/	/	/	/	/	/	/	/	/	/	/

**Purple blotch – *Alternaria porri***

**Favourable conditions:** Warm and dry weather (18 – 25°C). Little growth occurs below 13°C. Heavy early morning dew favours the infection as the fungus requires 90% relative humidity for sporulation. The concentration of airborne conidia increases on windy days, after rainfall and irrigation.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	+++	+++	++	++	0	0	0	0	0	0	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	0	0	0	+	+	0	+	0	0	+	+	0
MAD	/	/	/	/	/	/	/	/	/	/	/	/

**Rust – *Puccinia porri***

**Favourable conditions:** The disease frequently occurs with high humidity (97 – 100%) for 4 hours and low rainfall. Optimal conditions for Urediniospore germination is 12 – 20°C.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	++	++	++	+	0	0	0	0	0	0	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	0	0	0	0	0	0	0	0	0	0	0	0
MAD	/	/	/	/	/	/	/	/	/	/	/	/

**White tip – *Phytophthora porri***

**Favourable conditions:** Disease frequently occurs during warm, humid conditions. Optimal temperatures 25°C. Sporangia will not develop below 10°C. Water splash from the soil, onto the foliage leads to serious infection.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	+	+	+	0	0	0	0	0	0	+	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	0	0	0	0	0	0	++	++	0	0	0	0
MAD	/	/	/	/	/	/	/	/	/	/	/	/

**Downy mildew – *Peronospora destructor***

**Favourable conditions:** Infection requires cool temperatures (less than 22°C) and the presence of free moisture on the leaf for at least 3 hours. Optimum temperatures for spore germination is 7 – 16°C.

Mois	1	2	3	4	5	6	7	8	9	10	11	12
ZAM	+	/	/	/	/	/	/	/	/	/	/	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
KEN	/	/	/	/	/	/	+	/	/	/	/	/
MAD	XX											

Minor diseases and pests			
	Pink root rot <i>Pyrenochaeta terrestris</i> / <i>(Phoma terrestris)</i>	Leaf blight <i>Stemphylium</i> spp.	Bacterial blight <i>Pseudomonas syringae</i> pv. <i>porri</i>
<b>Favourable conditions</b>	Warm soil temperatures (24 - 28°C) promotes progress of disease.	Usually develops as a secondary infection and can occur under various circumstances but causes serious damage during warm and humid weather.	Cool temperatures and rain promote rapid progress of the disease.
ZAM	0	0	+
TAN	/	/	/
KEN	0	0	0
MAD	++	/	/

## 2. Main control methods

### 2.1. Introduction

Leeks are a relatively easy crop to grow compared to other members of the allium family. They are generally untroubled by pests and diseases and are less demanding in terms of fertility. They can be grown on a wide range of soil types and have a high requirement for water. They grow best at a pH of between 6.7 and 7.2.

There are few insects and diseases of economic importance, in the field purple blotch and white tip are major diseases affecting yield and quality of produce. The main insect pests are thrips and leafminers.

#### General points on combating plant pests and diseases:

Leeks are generally grown in seed trays under protection or in an outdoor seedbed. Seedlings are prone to soil borne diseases, therefore, clean media and strict sanitation practices are important in the nursery. Correct attention must be paid to watering and nutrition to ensure that a healthy seedling is produced.

The practice of good sanitation, correct water and nutrient application should be carried over into the fields. Generally a healthy growing crop is less prone to attack from insects and diseases. Care should be taken, for example, when applying nutrients to the crop. Over application of nitrogen will result in a very soft plant that is very prone disease, especially rust.

Crop rotations are a significant practice in relation to suppression of diseases e.g. white rot (*Sclerotium cepivorum*) and white tip (*Phytophthora porri*). Disease is frequently carried over on leek trash. There is no ideal period of rotation, but it is generally recommended that allium are not planted on the same land more than one year in three (for some diseases more than 5 years is recommended).

Application of Plant Protection Products should consider presence of natural biological controls of insect pests and should be applied after consideration of threshold levels, based on scouting, following failure of other control practices. Diseases should be managed with a preventative programme based on optimal conditions for the specific problem.

Field margins can provide a reservoir of insect predators e.g. ladybird beetles, orius bugs etc. care must be taken to avoid spray drift from the crop into these areas.

Only products registered for the crop and for a specific use should be chosen.

### 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.

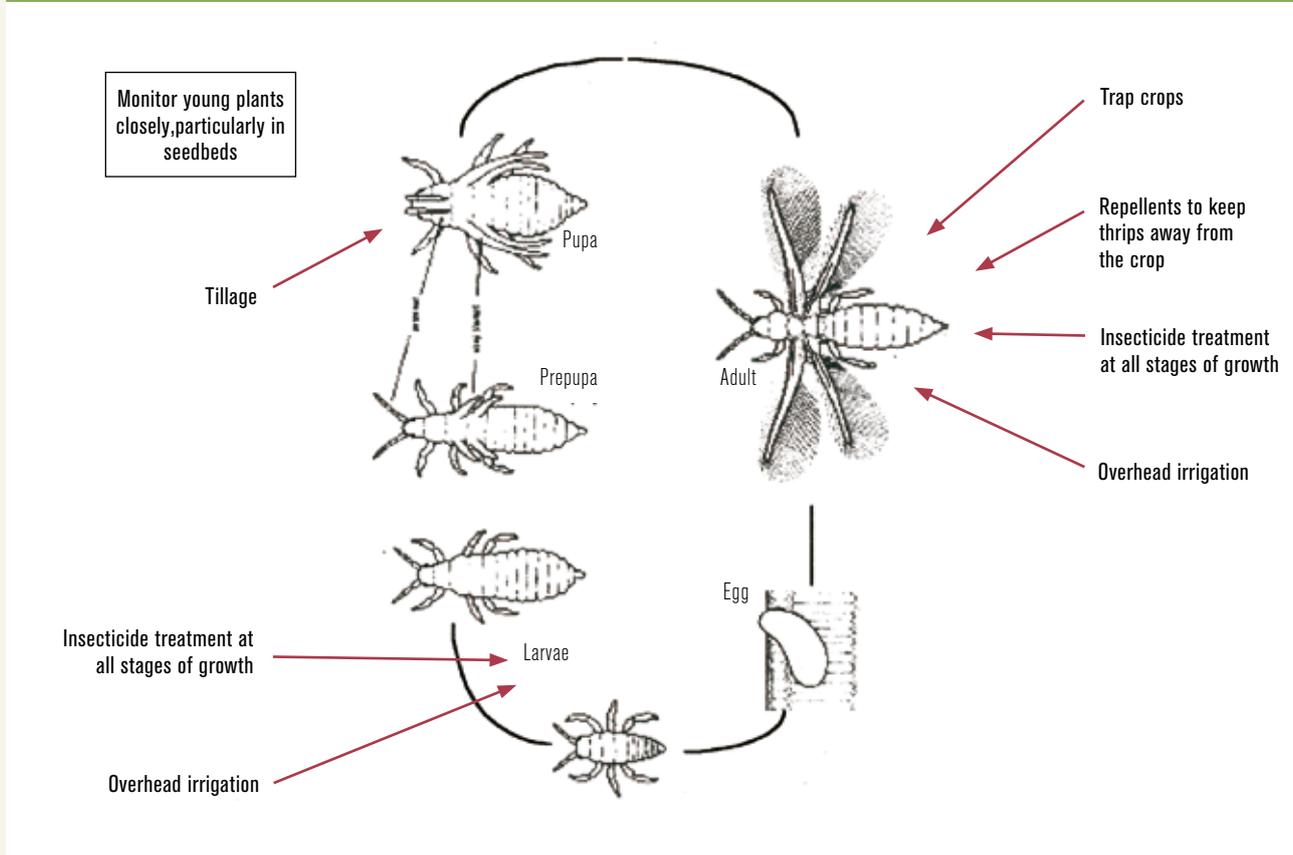
■ Cultivation practices

■ Application of plant protection product

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

### Onion Thrips - *Thrips tabaci*

#### 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

##### Nursery

- Overhead irrigation discourages the pest.
- Insecticide treatment for serious outbreaks.

##### Field

During the production cycle, and particularly in the growth stage

- Repellents such as garlic and chilli sprays help to keep thrips away from the crop.
- Traps crops e.g. marigold, cosmos and african daisy can be grown near or within the crop to encourage colonisation away from the crop.
- Early treatment of insecticides is recommended, as established colonies can be difficult to eradicate.

After the final harvest

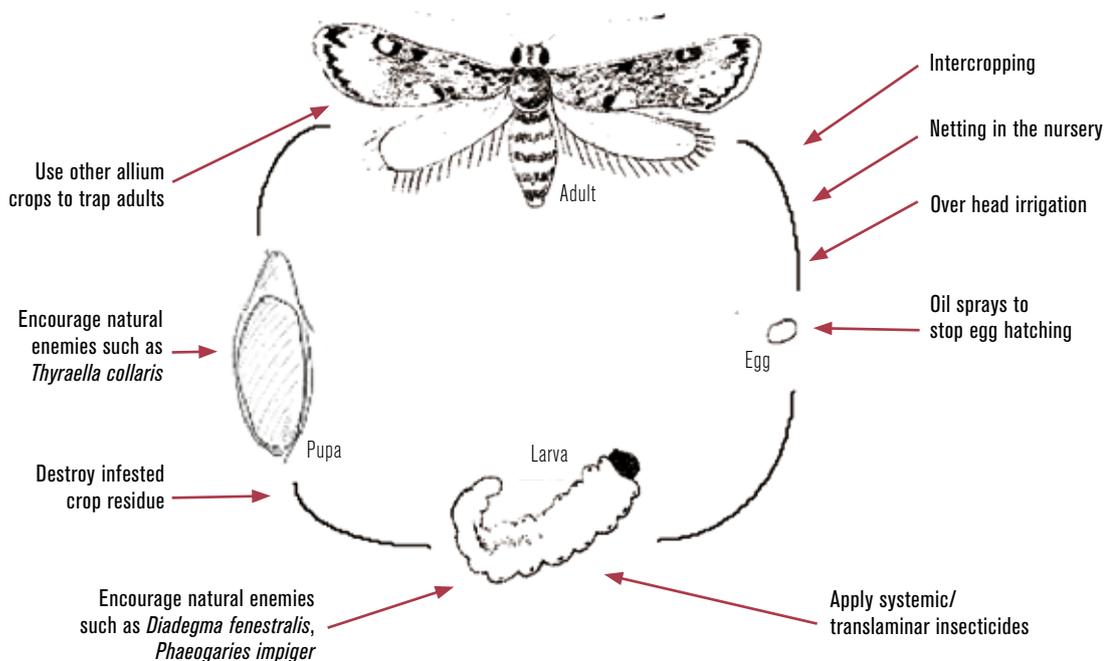
Tilling the soil after harvest can help reduce insects in the pupal stages.

##### Validity and relevance to be checked in local conditions:

- Provide good irrigation, avoid excessive fertilisation and practise good crop rotation.

### Leek moth – *Acrolepiopsis assectella*

#### 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

##### Nursery

- Use insect proof netting at nursery openings (ventilation and doors).
- Over head irrigation to disrupt egg laying.

##### Field

###### During the production cycle, and particularly in the growth stage

- Adults are attracted to sulphur volatiles released by the plant. Other allium species with stronger concentrations of volatiles, such as onions, could be used as trap crops.
- Crops can be intercropped with tall grown non host crops to disrupt volitle from leeks, thereby disrupting host finding.
- Encourage natural ennemies (e.g. with natural havens).
- Apply oil sprays or insecticides.

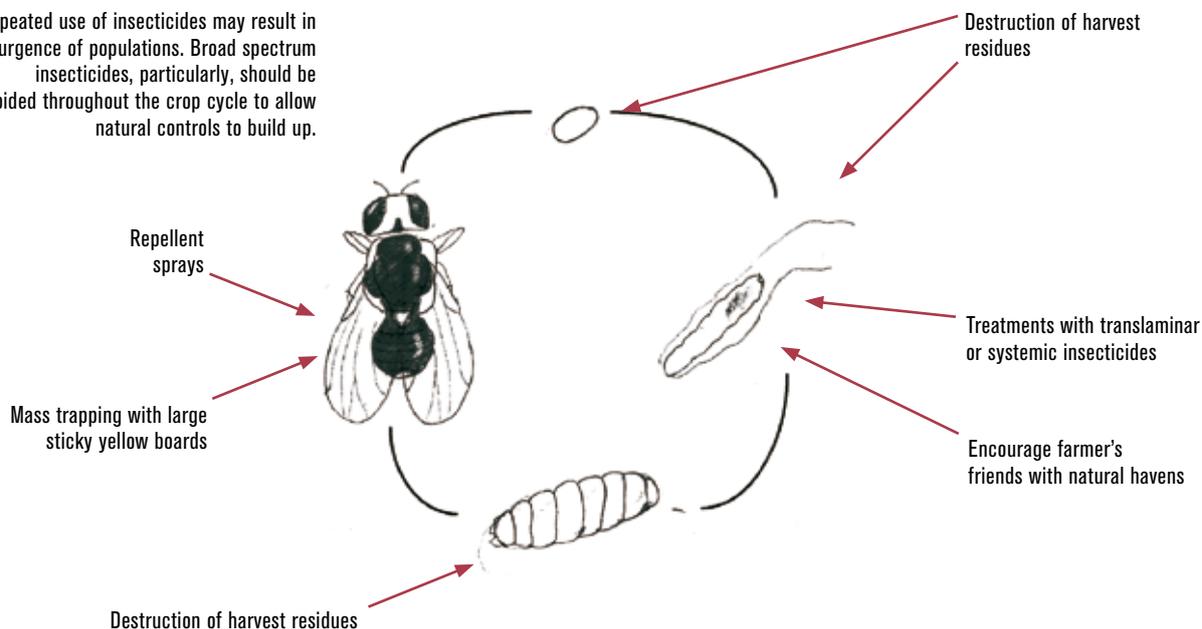
###### After the final harvest

- Destroy infested crop residue by composting.

### Allium leafminers – *Liriomyza cepae*, *Phytomyza (Napomyza) gymnostoma*

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

Repeated use of insecticides may result in resurgence of populations. Broad spectrum insecticides, particularly, should be avoided throughout the crop cycle to allow natural controls to build up.



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

##### Nursery

- Treat with selective, translaminar or systemic insecticides (to kill larvae) in case of serious outbreak.

##### Field

###### Before planting

- Plant natural havens e.g. broadbean, *Alyssum*, *Sonchus* sp. and coriander to encourage farmer's friends such as *Diglyphus* spp. and *Dacnusa* spp.

###### During the production cycle

- Mass trap adults using large yellow sticky boards, during flushes of adults.
- Repellent sprays such as garlic, chillies disrupt egg laying and feeding.
- Treat with selective, translaminar or systemic insecticides (to kill larvae) in case of serious outbreak.

###### After the final harvest

- Destruction of harvest residues.

##### Validity and relevance to be checked in local conditions:

- Coloured plastic sheeting used as mulch to limit infestation by disrupting pupation in the soil.

### Pink root rot - *Pyrenochaeta terrestris*

Natural factors favourable to the fungus:

- Compacted, poor draining soils, with low organic matter content and moderate to high soil temperatures.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	From planting to first harvest	Harvesting	After final harvest
Germination on the plant	Plant crop during cooler times of the year.		X					
	Seedlings can be dipped in 2% garlic extract as well as <i>Trichoderma</i> during transplanting.				X			
Development in the leek plant	Fungicide treatments are applied as seed dressings using alternating active substances from different families and with different types of action (to avoid the rapid appearance of resistant fungus strains) when conditions are favourable for development of the disease.		X					
	Apply fertiliser at recommended rates to promote optimal growth.			X	X	X		
Conservation in the ground	The destruction of diseased plants and the elimination of plant debris reduce the inoculum in the soil.					X	X	X
	Deep tillage of the soil is necessary to bury harvest residues so that they decompose completely.				X			
	The nursery soil can be disinfected through solarisation (laying of plastic sheeting), or the application of damp heat (60°C).	X						
Transport through soil and water	Plant seed and transplants that are free from pathogens into well-prepared, well drained and fertile soil.		X		X			
Multiplication on alternative host	Crop rotation of at least 4 years. Avoid alternate hosts such as corn as well as other alliums. However, other small grain cereal crops such as barley are recommended to reduce problems.							X

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

### Fusarium foot rot - *Fusarium* sp.

#### Natural factors favourable to the fungus

- Humid soil where high levels of nitrate fertilisers are used.

#### Major elements of the control strategy:

- The pathogen is conserved in the soil and on plant debris, in a saprophyte state.
- A crop rotation cycle of at least 4 years can reduce the impact of the disease.
- Avoid crowding of seedlings in the seedbed.
- The use of resistant varieties and healthy certified seed.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	From planting to first harvest	Harvesting	After final harvest
Germination on the plant	Liming helps to limit the disease.				X			
	Transplant into raised beds to avoid areas becoming overly damp.				X			
	Seedlings can be dipped in 2% garlic extract as well as <i>Trichoderma</i> during transplanting.				X			
	Fungicide treatments are applied as seed dressings using alternating active substances from different families and with different types of action (to avoid the rapid appearance of resistant fungus strains) when conditions are favourable for development of the disease.		X					
Development in the leek plant	Avoid excessive nitrate fertilisers.			X	X	X		
	The destruction of diseased plants and the elimination of plant debris reduce the inoculum in the soil.					X	X	X
Conservation in the ground	Deep tillage of the soil is necessary to bury harvest residues so that they decompose completely.				X			X
	The nursery soil can be disinfected through solarisation (laying of plastic sheeting), or the application of damp heat (60°C).	X						
	Treat planting media using sporekill.	X						
	Crop rotation cycle of at least four years.				X			X

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

### Purple blotch (*Alternaria porri*) et Leaf blight (*Stemphylium* spp.)

#### Natural factors favourable to the fungus

- Sensitivity of plant increases as it reaches maturity.

#### Major elements of the control strategy:

- The use of long rotation periods (3 to 4 years) with crops other than allium, can reduce the impact of the disease.
- The use of resistant varieties and of healthy seeds is strongly recommended.
- Fungicide treatments are largely ineffective, but seed treatments protect crop at early stages of development.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	De la plantation à la première Harvesting	Harvesting	After final harvest
Germination on the plant	Reduce hours of leaf wetness i.e. good field drainage and reduced plant density.				X	X	X	
	Fungicide treatments are applied as seed dressings.		X					
Development in the leek plant	Fungicide treatments applied as spraying using alternating active substances from different families and with different types of action (to avoid the rapid appearance of resistant fungus strains) when conditions are favourable for development of the disease.					X		
Production of spores	Harvest residues must be removed and destroyed.						X	X
Spores carried by the wind	Avoid planting young plants downwind from older allium crops.				X			
	Intercrop leeks with taller growing non host plants such as tomatoes and babycorn.				X	X		
Multiplication on alternative host	Avoid growing allium crops in close proximity to each other and to the nursery, particularly longer-term crops such as onions.			X	X	X		
	Fungicide treatment of older allium crops in the area will help suppress available inoculum for infecting younger crops			X	X	X		

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

## Rust - *Puccinia porri*

### Natural factors favourable to the fungus

- Disease is enhanced on stressed plants (those exposed to conditions that are too dry or wet or excessive nitrogen and low potash).

### Major elements of the control strategy:

- The use of resistant/ tolerant varieties and healthy seed should be planted in well-drained soils.
- Crop rotation, separating allium crops.
- Good hygiene in the field is the best preventive measure i.e. control of allium weeds and remove and destroy crop residue. This will reduce the available inoculum in the field.
- Careful inspection of leaves allows detection of an infestation from the start and intervention as soon as symptoms appear.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	De la plantation à la première Harvesting	Harvesting	After final harvest
Germination on the plant	Reduce hours of leaf wetness i.e. good field drainage and reduced plant density.			X	X	X	X	
Development in the leek plant	During period of favourable climate conditions, protectant fungicide treatments should be used. Be sure to cover the leaves completely; treatments should be applied within a few hours following sprinkler irrigation, to improve penetration of treatment into the crop canopy.			X	X	X	X	
Production of spores	Remove and destroy foliage and debris from affected plots after harvest.						X	X
Spores carried by the wind	Avoid planting young plants downwind from older allium crops.				X			
	Intercrop leeks with taller growing non host plants such as tomatoes and babycorn.				X			
Multiplication on alternative host	Remove allium weeds and volunteer plants from fields and surrounding areas.			X	X	X	X	X

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

### White tip - *Phytophthora porri*

#### Major elements of the control strategy:

- The use of resistant/ tolerant varieties and healthy seed should be planted in well-drained soils.
- Crop rotation, separating allium crops.
- Careful inspection of leaves allows detection of an infestation from the start and intervention as soon as symptoms appear.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	From planting to first harvest	Harvesting	After final harvest
Germination on the plant	Solar or steam treat substrate.	X						
	Reduce hours of leaf wettnes i.e. good field drainage and reduced plant density.			X	X	X	X	
	Fungicide treatments are applied using alternating active substances from different families and with different types of action (to avoid the rapid appearance of resistant fungus strains) when conditions are favourable for development of the disease.		X					
Development in the leek plant			X					
Production of spores	Infected crop residue should be removed from the field at the end of harvest and not incorporated into the soil.						X	X
Spores carried by the wind	Avoid planting young plants downwind from older allium crops.				X			
Multiplication on alternative host	Avoid growing allium crops in close proximity to each other and to the nursery, particularly longer-term crops such as onions.		X	X	X	X		

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

#### Validity and relevance to be checked in local conditions:

- In the rainy season, the nursery should be sheltered.
- Apply organic manure (plant compost) to strengthen the resistance of seedlings to disease (foliar or ground application).

### Downy mildew - *Peronospora destructor*

Major elements of the control strategy:

- The use of resistant/ tolerant varieties and healthy disease free seedling should be selected for transplanting.
- Crop rotation, separating allium crops.
- Careful inspection of leaves allows detection of an infestation from the start and intervention as soon as symptoms appear.

Development stage of the fungus	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	From planting to first harvest	Harvesting	After final harvest
Germination on the plant	Select fields that receive good air movement, sheltered locations should be avoided.				X			
	Crop rows should be orientated parallel with prevailing winds.				X			
Development in the leek plant	Apply fungicides as protectants during early stage of crop development.					X		
Production of spores	Use prediction models to determine effective time to start systemic and protectant fungicide treatments.					X	X	
	Incorporate crop residue soon after harvest.							X
Spores carried by the wind	Avoid planting young plants downwind from older allium crops.				X			
Multiplication on alternative host	Crop rotation cycle of 3 to 4 years will help reduce inoculum in the soil.				X			
	Control volunteer hosts.			X	X	X	X	

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

Validity and relevance to be checked in local conditions:

- Select fields that receive good air movement.

### Bacterial blight - *Pseudomonas syringae* pv. *porri*

Major elements of the control strategy:

- Use clean, disease free seed.
- Rotate crops separating alliums.
- Irrigate using drip or furrow systems.

Development stage of the bacteria	Action	Cultivation stages						
		Preparation of substrate and nursery environment	Sowing	Nursery	Transplanting	From planting to first harvest	Harvesting	After final harvest
Development on the plant	Avoid excessively damp ground and excessive watering. Irrigate using drip or furrow systems.			X	X	X	X	
	Plant crop in well prepared soil which has good drainage capacity.				X			
	Avoid case fertilising with high nitrogen.			X	X	X	X	
Dissemination	Apply bactericides to reduce spread within the field.					X	X	
Conservation in the ground	Incorporate crop residue soon after harvest. Disease only persists in the soil until plant material has completely decomposed.							X
Transported through water	If overhead irrigation used, avoid irrigation when conditions are conducive to disease development.			X	X	X	X	
	Where possible use mulching to reduce water splashing on plants.				X	X	X	
Multiplication on alternative host	Remove volunteer plants from in and around fields to reduce inoculum.			X	X	X	X	

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

Validity and relevance to be checked in local conditions:

- In the rainy season, the nursery should be sheltered.
- Apply organic manure (plant compost) to strengthen the resistance of seedlings to disease (foliar or ground application).

### 2.3. Resistant or tolerant varieties

Suppliers	Varieties	Resistance or tolerance				
		White tip	Purple blotch	Rust	Virus	General
Alan Romans (UK)	Leek zermatt			x		
Gourmet seed International (USA)	Tornado, Malabar			x		
Johnsons (UK)	Bluegreen winter - Tadorna Sultan F1	x		x		x
Ruk Zwaan (Neth)	Alcazar RZ, Alora			x		
Thompson & Morgan (UK)	Oarsman F1 hybrid King Richard Pandora, fatima			x x	x	
Unwins (UK)	Edison Autumn poristo				x	x

### 2.4. Importance and use of natural enemies

Natural enemies such as certain beetles, green lacewing and syrphus fly larvae can play the role of auxiliaries, preventing and limiting population explosions of certain pests. Broad-spectrum insecticides should therefore be avoided as much as possible. The use of selective active substances, when available, is preferred as a means of protecting natural enemies.

Explanations of the importance of natural enemies and ways of encouraging their presence can be found in documents especially dedicated to this matter.

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

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Growers should identify insect pests and diseases and inspect their crops regularly for all the species mentioned in this guide. It is easier to control infestations if they are detected at an early stage. It is recommended that growers visit their fields and monitor pest levels at least twice a week. Certain information is given below on the thresholds whose validity and relevance are to be checked in local conditions.

### **Thrips (*Thrips* sp.)**

Presence of thrips should be regularly checked using a beating tray. Both nymphs and adults cause superficial damage which leads to a reduction in quality therefore a threshold level of 20%.

### **Leafminer fly (*Liriomyza* spp.)**

Both adults and larvae cause damage that reduces the quality of the crop. The crop is most vulnerable during peak adult flight activity. Some insecticides can increase the leafminer problems due to the side effects on natural enemies. When monitoring leafminers, their natural enemies (such as *Diglyphus* spp. and *Dacnusa* spp.) should also be monitored. Threshold levels should take these natural enemies into account and should be increased if present.

A threshold of 10% leaves with feeding holes is recommended in the EPPO standards.

### **Leek moth**

Typically, adults are monitored using pheromone traps. In some countries pest prediction models using Day Degrees are used. In the US a base temperature of 6°C is used when applying day degrees to determine the duration of pre-oviposition.

### **Leaf blight (*Alternaria porii* et *Stemphylium* spp.)**

Early symptoms of both *Alternaria* and *Stemphylium* leaf blights are similar in appearance (oval-shaped tan and deep purple lesions on leaf blades). However, generally the control strategy is the same.

### **Downy mildew (*Peronospora destructor*)**

Prediction models have been developed to determine the most likely time for downy mildew occurrence. The DOWNCAST prediction model is based on the following conditions: For sporulation to occur there needs to be 6 hours between midnight and dawn when RH% is 95% at a temperature of 4 – 24°C with no leaf wetness. In addition for infection in the next 24 – 48 hours, there needs to be 6 hours of leaf wetness at temperature of 6 – 25°C.

## 4. Plant Protection Products and treatment recommendations

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### Introduction

For each pest or disease, proposals for the strategy on the use of Plant Protection Products (PPP) are indicated below.

A list of active substances and biocontrol agents is suggested for each pest or disease. When available, the critical Good Agricultural Practice (GAP) is also shown.

PHIs (Pre-harvest interval) are indicated for:

- Compliance with the European Maximum Residue Limits (MRLs) currently in force on spinach including amaranthus spinach (on products exported into the EU).
- Compliance with the CODEX MRL (for products sold in the countries where the CODEX MRLs are relevant).
- Special private standards, who allow harvested products without any quantifiable residues i.e. with "0" residues taking into account European LOQ.

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. These GAPs does not represent a treatment calendar to be applied as such. In practice, the frequency of treatments must take into account the severity of attacks and the real risks of local damage.

The GAPs highlighted in yellow was tested in Kenya in 2009 by PIP on baby-leek.

When there is intrinsically no residues issue for an active substance or a biological agent (highlighted in blue in the tables) the PHI is fixed by default to 2 days.

The list of active substances proposed has been drawn up taking into account the products used by ACP producers and the products registered in ACP countries. It is nevertheless worth noting that not all the ACP producers contacted provided information on the PPP used.

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 if high risk for resistance is possible.

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 impact on natural enemies.

Others substances act as a physical trap on some small insects, nematodes and fungus and are not considered like conventional Plant Protection Products. For instance propylene glycol alginate can trap small insects like thrips when applied correctly. This substance as no pesticide resistance and no residues of concern but one should check locally authorization for use on crops.

Other PPPs not shown in the following tables can be effective, for example, neem extract (to control thrips, leafminers etc.), soap solutions (to control thrips, etc.), vinegar, soap, and salt (to control *Alternaria* sp.). The effectiveness of this type of PPP depends in large measure on the origin of the raw materials used, so efficacy needs to be checked locally.

Commercial soap-based PPPs (to control thrips etc.) and garlic based products (to repel thrips, leafminers etc.) also exist and are not listed in the following tables because they pose no problems in terms of residues.

PIP updates quarterly on its website the compilation of GAPs (Good Agricultural Practice) taking into account changes in EU or Codex MRLs.

## Thrips

**Strategy:** Interventions must begin in the nursery and be continued on young plants. Avoid wherever possible the repeated use of broad-spectrum insecticides (pyrethroids), as this will kill natural enemies resulting in a resurgence in populations under optimal conditions.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 6 - Avermectins</b>											
Abamectin	9	3	7	7	/	/					
<b>Group 3 - Pyrethroids (sodium channel modulators)</b>											
Alpha-cypermethrin	50	/	/	/	/	/					
Cypermethrin	25	2	10	7	/	/					
Deltamethrin	12,5	3	7	3	3	3					
Lambda-cyhalothrin	20	2	/	3	/	/					
Pyrethrin	100	/	/	2	2	2					
<b>Not classified</b>											
Azadirachtin	75 to 150	/	/	2	2	2					
Petroleum oil	5.000	/	/	2	/	/					
<b>Group 4 - Nicotinic (Acetylcholine receptor agonists/antagonists)</b>											
Thiamethoxam	150	3	10	3	3	3					
Thiocyclam hydrogen oxalate	600	3	/	7	/	/					
<b>Group 21 - Mitochondrial complex I electron transport inhibitors</b>											
Rotenone	200	/	/	2	2	2					
<b>Group 5 - Spinosines</b>											
Spinosad	96	4	7	7	/	/					
<b>Group 1 - Organophosphates and carbamates</b>											
Dimethoate	240	2	10	14	/	/					
Methiocarb	750	3	7	21	/	/					
<b>Group 27 - Synergists</b>											
Piperonyl butoxyde	1.275	/	/	2	2	2					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

/ elements of the recommended GAP not available

n.a. : not applicable

### Leafminer – *Liriomyza cepae*, *Napomyza* sp.

**Strategy :** Use contact pesticides to target feeding adults. Apply systemic or translaminar insecticides to target larvae in the leaf. 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) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 6 - Avermectins</b>											
Abamectin	9	3	7	7	/	/					
<b>Groupe 17</b>											
Cyromazine	/	/	/	/	/	/					
<b>Group 5 - Spynosines</b>											
Spinosad	96	4	7	7	/	/					
<b>Not classified</b>											
Petroleum oil	5.000	/	/	2	/	/					
<b>Group 4 – Nicotinic (Acetylcholine receptor agonists/antagonists)</b>											
Thiocyclam hydrogen oxalate	600	3	/	7	/	/					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

/ elements of the recommended GAP not available

n.a. : not applicable

## Leek moth

**Strategy :** Larvae enter plant very soon after hatching. Insecticides with some translaminar/ systemic activity will be necessary to target the hidden larvae. Pesticides such as Bt's should be carefully coordinated with moth activity and subsequent egg laying, in order to target emerging larvae. Timing and choice of treatment should consider natural enemy activity.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 1 - Organophosphates and carbamates</b>											
Dimethoate	240	2	10	14	/	/					
<b>Group 3 - Pyrethroids (sodium channel modulators)</b>											
Bifenthrin	20	2	/	7	/	/					
Cyfluthrin	15	/	/	3	/	/					
Cypermethrin	25	2	10	7	/	/					
Deltamethrin	6,25	3	7	3	3	3					
Lambda-cyhalothrin	5	2	/	3	/	/					
Pyrethrin	96	/	/	2	/	/					
Tau-fluvalinate	72	/	/	/	/	/					
<b>Group 11 - Microbial (disruptors of insect midgut membranes)</b>											
Bacillus thuringiensis	/	Not restricted	7	2	2	2					
<b>Group 21 - Mitochondrial complex I electron transport inhibitors</b>											
Rotenone	200	/	/	2	2	2					
<b>Group 27 - Synergists</b>											
Piperonyl butoxyde	960	/	/	2	2	2					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

/ elements of the recommended GAP not available

n.a. : not applicable

Pink root rot – *Pyrenochaeta terrestris*Fusarium root rot – *Fusarium* sp.

**Strategy :** Control of insects and diseases that provide the entry point for infection. Seed treatment to protect crop at early stages of development.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 2 - Dicarboximides</b>											
Iprodione	/	/	/	Seed							
<b>Group 4 - Acylalanines</b>											
Metalaxyl – M	2,5 g/kg	/	/	Seed							
<b>Group M - Multisite activity</b>											
Thiram	4 g/kg	/	/	Seed							
<b>Not classified</b>											
Trichoderma	1.000	-	-	2							
<b>Group 1 - MBC fungicides</b>											
Thiophanate-methyl	Dipping 5 to 10 minutes the plants - 10 ml of a commercial product at 500 g/l / in 1 litre of water										

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

/ elements of the recommended GAP not available

n.a. : not applicable

Purple blotch – *Alternaria porri*Leaf blight – *Stremphylium* spp.

**Strategy:** Apply preventative treatments, especially as crop canopy ages and becomes more dense and if leaf-wetness periods favour infection.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 2 - Dicarboximides</b>											
Propiconazole	750	3	7	>21***	>21***	>21***					
<b>Group 3 - DMI-fungicides</b>											
Difenoconazole	125	3	21	21	/	/					
Tebuconazole	80	/	7	/	/	/					
<b>Group 11 - Qol fungicides</b>											
Azoxystrobin	250	3	21	3	3	3					
Trifloxystrobin	100	2	21	21	/	/					
<b>Group M - Multisite contact activity</b>											
Chlorothalonil	1.500	3	7	3	3	3					
Copper	1.400 to 2.400	/	/	20	/	/					
Mancozeb	2.000	3	7	3	3	>21***					
Propineb	2.500	/	10	14	/	/					
<b>Group 7 - Carboximides</b>											
Boscalid	400	2	7	14							
<b>Group 9 - AP fungicides (Anilino-Pyrimidines)</b>											
Pyrimethanil	740	/	/	/	/	/					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

\*\*\* preferably to use only in the nursery

/ elements of the recommended GAP not available

n.a. : not applicable

**Rust - *Puccinia porri***

**Strategy:** When climatic conditions are favourable, treat every 7 to 10 days, paying particular attention to older leaves.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 11 - Qol fungicides</b>											
Azoxystrobin	250	3	21	3	3	3					
Pyraclostrobin	100	2	7	14	/	/					
Trifloxystrobin	100	2	21	21	/	/					
<b>Group M - Multisite activity</b>											
Chlorothalonil	1.500	3	7	3	3	3					
Copper	1.400 to 2.400	/	/	20	/	/					
<b>Group 3 - DMI fungicides</b>											
Cyproconazole	60	2	21	14	/	/					
Difenoconazole	125	3	21	21	/	/					
Tebuconazole	250	3	14	14	/	/					
Triadimenol	250	3	14	21	/	/					
<b>Group 5 - Amines fungicides</b>											
Fenpropimorphe	750	/	14	21	/	/					
<b>Group 7 - Carboximides</b>											
Boscalid	400	2	7	14	/	/					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

/ elements of the recommended GAP not available

n.a. : not applicable

White tip – *Phytophthora porri*

**Strategy:** When climatic conditions are favourable for disease development, fungicide treatments will be applied starting in the nursery, wetting the leaves thoroughly and applying the treatment within a few hours of a sprinkler irrigation. During times when optimal conditions occur weekly preventative sprays should be applied. At first signs of infection curative treatments can be applied every 10 to 14 days.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 4 - PA-fungicides</b>											
Metalaxyl-M + mancozeb	100 + 1.600	3	7	7	>21***	>21***					
<b>Group 11 - Qol fungicides</b>											
Azoxystrobin	250	3	21	3	3	3					
Famoxadone	150	3	10	28	/	/					
Pyraclostrobin	100	2	7	14	/	/					
Trifloxystrobin	100	1	n.a.	21	/	/					
<b>Group M - Multisite activity</b>											
Chlorothalonil	1.500	3	7	3	3	3					
Copper	5.000		7	20	/	/					
Mancozeb	2.000	3	7	3	3	>21***					
Propineb	2.500	/	10	14	/	/					
<b>Group 3 - DMI-fungicides</b>											
Difenoconazole	125	3	21	21	/	/					
<b>Group 7 - Carboximides</b>											
Boscalid	400	2	7	14	/	/					
<b>Group 27 - Cyanoacetamide-oximes</b>											
Cymoxanil	150	3	14	28	/	/					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

\*\*\* preferably to use only in the nursery

/ elements of the recommended GAP not available

n.a. : not applicable

Downy mildew – *Peronospora destructor*

**Strategy:** When climatic conditions are favourable for disease development, fungicide treatments will be applied starting in the nursery. During times when optimal conditions occur weekly preventative sprays should be applied.

Active substance	Recommended GAP*						Proposed application period				
	Dose g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) **			Preparation of soil	Sowing	Nursery	Transplant to harvest	First to final harvest
				EU MRL	Codex MRL	LOQ					
<b>Group 4 - PA-fungicides</b>											
Metalaxyl-M + mancozeb	100 + 1.600	3	7	7	>21***	>21***					
<b>Group 11 - Qol fungicides</b>											
Azoxystrobin	250	3	21	3	3	3					
<b>Group M - Multi site activity</b>											
Chlorothalonil	1.500	3	7	3	3	3					
Copper	1.400 to 2.400	/	/	20	/	/					
Mancozeb	2.000	3	7	3	3	>21***					
Potassium phosphite	2.000	/	14	2	/	/					
<b>Group 27 - Cyanoacetamide-oximes</b>											
Cymoxanil	150	3	14	28	/	/					

\* the elements of the recommended GAP shown here allow to comply with the harmonised European MRL the Codex MRL or the LOQ ("0" residues) - see part 6 of this guide)

\*\* see introduction in part 4 of the Guide

\*\*\* preferably to use only in the nursery

/ elements of the recommended GAP not available

n.a. : not applicable

## Sources of GAP validated by PIP trials (boxes highlighted in orange in previous pages)

Active substance	Commercial product tested	Manufacturer	Trials	
			Year	Country
Azoxystrobin	Ortiva 250 SC	Syngenta	2009	Kenya
Chlorotalonil	Bravo 500 SC	Syngenta	2009	Kenya
Deltaméthrine	Decis 2.5 EC	Bayer CropScience	2009	Kenya
Iprodione	Rovral 250 Flo	Bayer CropScience	2009	Kenya
Mancozèbe	Dithane M45	Dow AgroSciences	2009	Kenya
Metalaxyl + mancozèbe	Ridomil Gold MZ 68 WG	Syngenta	2009	Kenya
Thiamethoxam	Actara 25 WG	Syngenta	2009	Kenya

Note : GAPs indicated in previous pages are those corresponding to the PPPs listed above. User of this information should check if the product used is equivalent (same concentration and same type of formulation) to the reference product. If it is not the case, the indicated GAP could not be adequate.

## 5. Existing registrations in ACP countries

The registration status, known by the COLEACP/PIP, in some ACP countries is given below for active substances listed in this Guide

**Remarks :** This information should be tallied with the legislation in force locally in each area of production

**For Zambia and Madagascar,** we currently have no information on existing registrations.

### Kenya

#### Registered fungicides in Kenya

Substance active	Type d'homologation
Copper	Vegetables
Iprodione	Vegetables
Mancozeb	Vegetables
Metalaxyl-M	Various crops
Propineb	Vegetables
Tebuconazole	Vegetables
Thiram	Seeds

#### Registered insecticides in Kenya

Substance active	Type d'homologation
Abamectin	Vegetables
Alpha-cypermethrin	Various crops
Azadirachtin	Horticultural crops
<i>Bacillus thuringiensis</i>	Vegetables
Bifenthrin	Vegetables
Cypermethrin	Vegetables
Deltamethrin	Vegetables
Dimethoate	Vegetables
Lambda-cyhalothrin	Vegetables
Pyrethrin	Vegetables
Spinosad	Vegetables
Thiamethoxam	Vegetables
Thiocyclam hydrogen	Horticultural crops

### Tanzania

Product registered in Kenya are usually also registered in Tanzania.

## 6. Regulations and pesticide residues

### Status of the active substances in Regulation 1107/2009; European MRL and Codex MRL in November 2011

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

Active substance	European regulation		Codex MRL
	Status Reg 1107/2009	MRL	
Abamectin	Approved	0,01*	0,01*
Alpha-cypermethrin	Approved	0,5	0,5
Azadirachtin	Approved	1	/
Azoxystrobin	Approved	10	/
<i>Bacillus thuringiensis</i>	Approved	n.a.	n.a.
Boscalid	Approved	5	0,05*
Bifenthrin	Not approved	0,05*	0,05*
Chlorothalonil	Approved	10	0,01*
Copper	Approved	20	/
Cyfluthrin	Approved	0,02*	0,01*
Cymoxanil	Approved	0,05*	/
Cypermethrin	Approved	0,5	0,5
Cyproconazole	Approved	0,05*	/
Cyromazine	Approved	0,05*	/
Deltamethrin	Approved	0,2	0,2
Difenoconazole	Approved	0,5	0,3
Dimethoate	Approved	0,02*	0,05*
Famoxadone	Approved	2	0,02*
Fenpropimorph	Approved	1	/
Iprodione	**	n.a.	n.a.
Lambda-cyhalothrin	Approved	0,02*	/
Mancozeb	Approved	0,3	/
Metalaxyl-M	Approved	3	0,5
Methiocarb	Approved	0,2	0,05*
Petroleum oil	Approved	0,2	0,05
Propineb	Approved	3	0,5
Potassium phosphite	Pending	0,01*	/
Pyperonyl butoxyde	***	n.a.	n.a.
Pyraclostrobin	Approved	0,5	0,7
Pyrethrin	Approved	1	0,05*

Active substance	European regulation		Codex MRL
	Status Reg 1107/2009	MRL	
Pyrimethanil	Approved	1	/
Rotenone	Not approved	0,01*	/
Spinosad	Approved	0,5	0,01*
Tau-fluvalinate	Approved	0,1	/
Tebuconazole	Approved	1	/
Thiamethoxam	Approved	0,05*	/
Thiocyclam hydrogen	Not approved	0,01*	/
Thiophanate-methyl	Approved	0,1*	/
Thiram	Approved	0,1*	/
Triadimenol	Approved	0,1*	/
<i>Trichoderma</i>	**	n.a.	n.a.
Trifloxystrobin	Approved	0,2	0,7

Approved active ingredient approved for use in EU countries.

Not approved active ingredient not authorized in EU countries but usable in countries out of EU if the EU MRL are respected for the imported products in EU.

\* LOQ value

\*\* status depends on the type. See

[http://ec.europa.eu/sanco\\_pesticides/public/index.cfm?event=activesubstance.selection](http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection) to know which one are approved

\*\*\* Not a PPP. It is a synergist n.a. = not applicable

/ doesn't exist or not available

### 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](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](http://ec.europa.eu/sanco_pesticides/public/index.cfm)

See also the leaflet "New pesticide residues in food" [http://ec.europa.eu/food/plant/protection/pesticides/explanation\\_pesticide\\_residues.pdf](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](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](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 – Codex

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>.

# References, Websites and useful documents

## 1. References and useful documents

### General

- BEJO ZADEN *Major Onion Pests and Diseases*. Pub. Bejo zaden.
- BULTER, E.J & JONES, S.G (1949) *Plant Pathology*. Pub. Macmillan
- CABI (2006) *The UK Pesticide Guide 2006*. Pub. CABI publishing.
- CHAPUT, J (1995) *Identification of diseases and disorders of onions*. Min. pf Agr. Food & Rural Affairs Factsheet.
- EPP0 Standards. Guidelines on Good Plant Protection practices *Allium* Crops.
- KOIKE, S et al. (2007) *Vegetable Diseases. A Colour Handbook*. Pub. Academic Press.
- NAQVI, S et al. Ed. (2004) *Diseases of Fruits and Vegetables. Diagnosis and Management*. PubKluwer Academic Publishers.
- SCHWARTZ, H, F & MOHAN, S.K (1999) *Compendium of Onion and Garlic Diseases*. Pub. APS Press.

### Thrips

- Kucharczyk, H & Legutowska, H (2000) *Thrips tabaci as a pest of leek cultivated in different countries*. Thrips & Tospoviruses proceedings of the 7th International symposium on Thysanoptera. 211-213.

### Leek moth

- Borchert, D et al. (2003) *Pest Assessment : Leek moth, Acrolepiopsis assectella (Zeller) (Lepidoptera : Yponomeutidae) – Draft*. Pub. USDA-APHIS ODA Leek Moth (Acrolepiopsis assectella) survey. Oregon Dept. Of Agr.
- INRA (Institut National de la Recherche Agronomique) (2000) *Acrolepiopsis assectella – Leek Moth, Onion Moth*. <http://www.inra.fr/Internet/Produits/HYPPZ/RAVAGEUR/6across.htm>
- NPAG Data. Leek Moth: *Potential Threat to American Onion and Allium Growers*. Draft – August 1, 2000.

### Fungal diseases

- Gilles, T & Kennedy, R (2003) *Effects of an interaction between inoculum density and temperature on germination of Puccinia allii Uredinispores on leek rust progress*. Phytopathology. 93 : 413 – 420.
- OXSPRING, L (2003) *Diseases and disorders of leeks (Allium porrum L.) in Southern Australia*. Issue 2. Pub. SARDI R&D Institute.
- SCHWARTZ, H (2007) *Soil-borne diseases of onion*. No 2.940 Pub. Colorado State Uni.

### Bacterial diseases

- Samson, R et al. (1998) *Description of the bacterium causing blight of leek as Pseudomonas syringae pv. parri*. Phytopathology 88: 844 – 850.
- Koike, S.T et al (1999) *Bacterial blight of leek. A new disease in California caused by Pseudomonas syringae*. Plant. Dis. 83: 165 – 170.

## 2. Useful Webpages

- <http://ip30.eti.uva.nl/bis/> - World Biodiversity Database. Arthropods of economic Extent. Agromyzidae. *Phytomyza gymnostoma*. Description.
- <http://www.ipo.dlo.nl/lpowww/dps/phero/sexphero.html>
- <http://www.trece.com/phercat.html>
- Scentry biologicals inc. – <http://www.scentry.com>
- Arbico organisa – <http://www.arbico-organics.com>
- Oecos – <http://www.oecos.co.uk>



## 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 mays*)  
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 annum*, *Capsicum chinense*) and sweet peppers (*Capsicum annum*)  
Citrus (*Citrus* sp.)  
Coconut (*Cocos 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.)

